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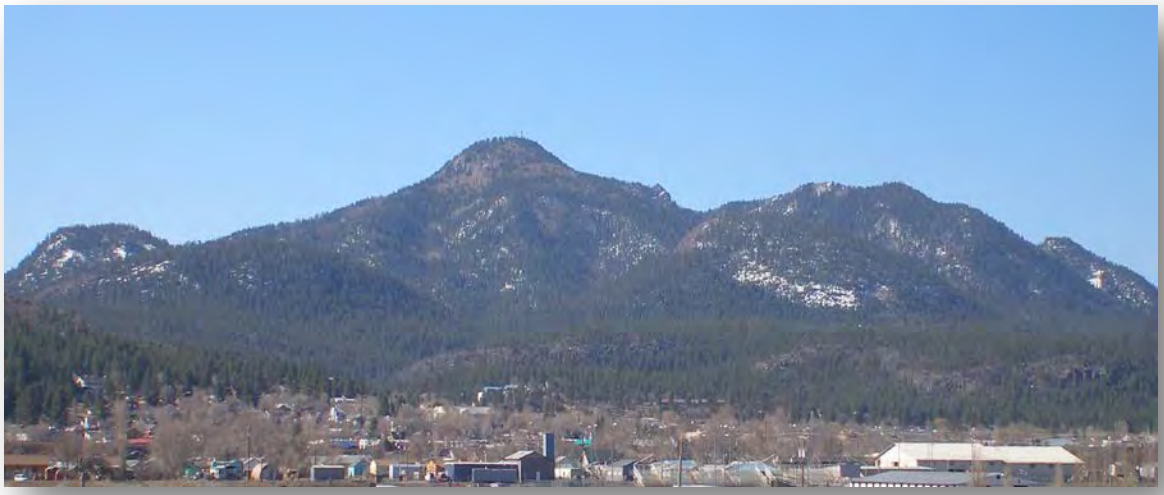
July 2012

Bill Williams Mountain Restoration Project

Draft Environmental Impact Statement

Kaibab National Forest
Coconino County, Arizona

All or portions of Sections 1-3, 10-15, 22-27, & 34-36 T21N R1E; Sections 4-10, 15-22, & 27-31 T21N R2E; and Sections 31-33 T22N R2E Gila &Salt River Meridian.



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Draft Environmental Impact Statement (DEIS) for the Bill Williams Mountain Restoration Project

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Abstract: The Kaibab National Forest proposes mechanical treatments and prescribed burning on approximately 15,200 acres on and surrounding Bill Williams Mountain to reduce the risk of catastrophic wildfire and improve forest health and the watershed for the City of Williams. There are four alternatives, Alternative 1 is no action, Alternative 2 is the preferred alternative, and Alternatives 3 and 4 are modifications of the preferred alternative. There are four one-time site-specific Forest Plan amendments needed to implement the preferred alternative: 1) Re-designating approximately 8900 acres of land suitability, 2) Allowing a deviation from Forest Plan guidelines regarding Mexican Spotted Owl habitat, 3) Allowing a deviation from Forest Plan standards and guidelines in ponderosa pine stands outside of goshawk Post-Fledgling Family Area's (PFA's) and nest areas, and 4) Allowing Forest managers to exceed fire planning objectives for the Arizona Bugbane Botanic Area.

It is important that reviewers provide their comments at such times and in such a way that they are useful to the Agency's preparation of the Environmental Impact Statement. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns and contentions. The submission of timely and specific comments can affect a reviewer's ability to participate in subsequent administrative review or judicial review.

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Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the respondent with standing to participate in subsequent administrative review or judicial review.

Comments may be sent via email to: *comments-southwestern-comments-kaibab@fs.fed.us*

or via facsimile to (928) 635-5680 with "Bill Williams Mountain Restoration Project" on the subject line.

Written comments may be sent to: Kaibab National Forest, Attention: Bill Williams Mountain Restoration Project, 742 South Clover Road, Williams, AZ 86046.

Comments must be received during the 45-day comment period which follows publication of the Notice of Availability of the draft environmental impact statement in the Federal Register. Publication is estimated for July 2012.

Summary

The Kaibab National Forest proposes to treat approximately 15,200 acres with mechanized equipment and prescribed fire. The area affected by the proposal is located adjacent and up to approximately 4 miles south-southwest of the city of Williams, Arizona and includes Bill Williams Mountain, which is the primary watershed and municipal water supply for Williams, has historic and cultural value and is an important communication site for Northern Arizona. This action is needed to improve the health and sustainability of forested conditions on and surrounding Bill Williams Mountain by reducing hazardous fuels and moving vegetative conditions in the project area toward the desired conditions. This work would be done to directly and indirectly improve the watershed conditions contributing to the City of Williams water supply.

Bill Williams Mountain is the primary watershed for the City of Williams. A major wildfire and subsequent flooding would be devastating to the City and the surrounding communities, as well as downstream to the Havasupai Tribe from Cataract Canyon. There is a multi-million dollar communication site at the top of the Mountain that is extremely important to Northern Arizona and the loss of all or part of this site would disrupt emergency communications that are so vital to this area.

Two large wildfires in Northern Arizona in 2010 and the ensuing monsoon rains highlighted the values-at-risk in the project area and the need for treatment on Bill Williams Mountain. A high-intensity wildfire on Bill Williams Mountain could result in the loss of critical emergency communications systems; the silting in of reservoirs that act as municipal water sources as well as reductions in water quality; the loss of irreplaceable cultural and tribal resources; the loss of recreational areas and opportunities; the loss of important wildlife and plant habitat; and the potential loss of lives and homes.

In the early part of 2011, the Forest invited the public and various interested parties to participate in numerous informal “brainstorming” sessions where participants were solicited for ideas, questions, and concerns about treating hazardous fuels on Bill Williams Mountain. All of the ideas and comments we received were helpful in refining a proposal for the project area.

A Notice of Intent (NOI) was published in the Federal Register on Thursday, April 21, 2011 formally initiating scoping of the proposed action and seeking public comment on the proposal. The proposed action includes 4 one-time site-specific amendments to the Forest Plan. Using the comments we received from the public, other agencies, and interested and affected Tribal governments and communities during scoping of the proposed action, we identified a list of significant and non-significant issues (see *Section 1.6 Issues*).

These issues led us to develop and consider alternatives to the proposed action. We analyzed four alternatives in detail and considered but eliminated from detailed study several alternatives. The four alternatives analyzed in detail include the no action alternative – Alternative 1 and the proposed action – Alternative 2, which includes 4 proposed amendments to the Forest Plan, as well as Alternatives 3 and 4 which were developed to address one or more significant issues to the proposed action. There are no proposed amendments to the Forest Plan in Alternatives 3 and 4.

Major Conclusions: The analysis by resource specialists indicates all of the action alternatives would reduce hazardous fuels and the risk for high intensity stand-replacing wildfires and allow for the reintroduction of fire as a natural part of the ecosystem. The action alternatives would reduce fuel buildup and help prevent the spread of wildfire onto private property and into drainages leading to the City of Williams' reservoirs. Currently and under the no action alternative, approximately 61% of the project area has the potential for active crown fire. Under the action alternatives, this is reduced to approximately 18% for Alternative 2 (the preferred alternative), 27% for Alternative 3 and 35% under Alternative 4. Under Alternative 2 only, approximately 8,900 acres of ponderosa pine forest surrounding the base of Bill Williams Mountain would have reduced stand densities similar to pre-settlement reference conditions and would be removed from the KNF Forest Plan's designated suitable timber base by amending the Forest Plan. Timber stands would be thinned and grouped which would break up the continuity of the forest and increase forest diversity, tree vigor and stand resiliency. The reduction of tree densities on steep slopes would improve forest health by reducing competition for nutrients, and would protect the loss of specialized wildlife habitat from fire and forest disease and pests. Treating fuel accumulations would abate fire risks to Mexican Spotted Owl habitat, while conserving existing nesting and roosting habitat. Reducing mistletoe infection levels would be more manageable as the area would be managed in an uneven-aged condition over time. Alternatives 2-4 would remove poorly located roads out of drainage bottoms. Alternatives 2 and 3 would allow the construction of a new and more sustainable road system that would also provide access for the fuel treatments. The total net number of miles of open roads would remain essentially the same under all of the alternatives. The purpose and need for action would be best achieved with implementation of Alternative 2 – the Proposed Action.

Based upon the effects of the alternatives, the responsible official would decide whether to select the proposed action or one of the alternatives, what mitigation and/or monitoring measures would be required during implementation of the proposed action or any alternative selected, and what language and content changes are needed to the Kaibab National Forest Land Management Plan.

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Chapter 1 – Purpose of and Need for Action

Document Structure

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

- *Chapter 1. Purpose and Need for Action:* The chapter includes information on the history of the project proposal, the purpose of and need for the project, and the agency's proposal for achieving that purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.
- *Chapter 2. Alternatives, including the Proposed Action:* This chapter provides a more detailed description of the agency's proposed action as well as alternative methods for achieving the stated purpose. These alternatives were developed based on significant issues raised by the public and other agencies. This discussion also includes mitigation measures. Finally, this section provides a summary table of the environmental consequences associated with each alternative.
- *Chapter 3. Affected Environment and Environmental Consequences*: This chapter describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by resource area.
- *Chapter 4. Consultation and Coordination:* This chapter provides a list of preparers and agencies consulted during the development of the environmental impact statement.
- *Appendices:* The appendices provide more detailed information to support the analyses presented in the environmental impact statement such as the existing and desired conditions report, public comments and responses, etc.
- *Index:* The index provides page numbers by document topic.

Additional documentation, including more detailed analyses of project-area resources, may be found in the project planning record located at Williams Ranger District office in Williams, Arizona.

1.1 Background

Bill Williams Mountain lies just southwest of Williams, Arizona and has an elevation of 9,256 feet. It was identified by both the City of Williams and the USDA Forest Service as a critical resource deserving special protection from catastrophic wildfire in the Greater Williams Area Community Wildfire Protection Plan (2005).

There is a multi-million dollar communications site on the top of the mountain providing communications towers for the Arizona Department of Public Safety, USDA Forest Service, Arizona State Land Department, Burlington Northern Santa Fe railroad and several other governmental and private enterprises. The north side of the mountain is home to a small ski resort, and private property, homes and other infrastructure surround the base of the mountain. It

is an important sacred site and traditional use area for several Native American tribes, and has been determined eligible as a traditional cultural property.

Bill Williams Mountain is also the apex of six watersheds, including the Sycamore and Hell Canyon watersheds to the south and east, the Cataract Creek and Spring Valley Wash watersheds to the north, and the Ash Fork Draw and Upper Partridge Creek watersheds to the west. The City of Williams relies heavily on three of these watersheds to provide clean and abundant water to the local reservoirs as their municipal water source.

Two large wildfires in Northern Arizona in 2010 and the ensuing monsoon rains highlighted the values-at-risk in the project area and the need for treatment on Bill Williams Mountain. The Eagle Rock Fire on Sitgreaves Mountain burned approximately 3,500 acres on the Kaibab National Forest and on the neighboring Coconino National Forest the Schultz Fire burned approximately 15,200 acres on the San Francisco Peaks. Both fires involved area closures, and evacuations. These high-intensity wildfires led to flooding, erosion and sedimentation problems as well as landscapes and habitats that will take decades to recover. A high-intensity wildfire on Bill Williams Mountain could result in the loss of critical emergency communications systems; the silting in of reservoirs that act as municipal water sources as well as reductions in water quality; the loss of irreplaceable cultural and tribal resources; the loss of recreational areas and opportunities; the loss of important wildlife habitat; and the potential loss of lives and homes.

Vegetation treatments and prescribed burning have been planned and implemented in many areas surrounding the mountain, such as within the City and Twin Project area boundaries. However, our experiences from 2010 and lessons learned from previous years have led us to re-evaluate the treatments within these areas and we now recognize the urgency and need to treat the steep slopes of Bill Williams Mountain.

It is not a question of “if” but “when” a large fire will occur on the mountain. It is time to take significant steps to reduce hazardous fuels and reduce the risk of a high intensity stand-replacing fire near the City of Williams and within its municipal watershed.

Figure 1. Photo comparison of reference and current conditions in the Bill Williams Restoration Project Area. The photo on the left was taken southwest of Williams, AZ in the 1890’s and overlooks town. The photo on the right was taken from approximately the same location in 2011. Since the forested condition in the foreground of the picture on the left does not appear to have been logged (i.e. there are no visible stumps in the openings), it provides a good

example of the reference conditions for portions of the project area. Comparison of the two pictures demonstrates how open forested conditions were and how dense they have become.

1.2 Purpose and Need for Action[1]

The purpose of the Bill Williams Mountain Restoration Project is to improve the health and sustainability of forested conditions on and surrounding Bill Williams Mountain by reducing hazardous fuels and moving vegetative conditions in the project area toward the desired conditions. This work would be done to directly and indirectly improve the watershed conditions contributing to the City of Williams water supply.

There is a need for:

- Reintroducing fire as a natural part of the ecosystem;
- Reducing the risk for high intensity stand-replacing wildfires;
- Reducing fuel buildup to help prevent the spread of wildfire onto private property and into drainages leading to the City of Williams reservoirs;
- Reducing overall stand densities and moving stand conditions toward forest structures considered to be more typical of forest structure under pre-settlement fire regimes;
- Treating fuel accumulations to abate fire risks to Mexican spotted owl habitat, while conserving existing nesting and roosting habitat;
- Improving tree vigor and stand resiliency;
- Improving the diversity of age classes and structure of woody vegetation;
- Improving ground cover, including down woody debris, fine litter and herbaceous understory composition and productivity;
- Reducing mistletoe infection levels to more manageable levels where the area can be managed in an uneven-aged condition over time;
- To provide forest products, such as firewood, for people living in Williams, AZ and the surrounding area, in order to meet their needs for forest and wood products, while protecting these resources for future generations;
- And by improving the motorized transportation system to provide for a more sustainable road system where poorly located roads are relocated or obliterated.

Site-Specific Forest Plan amendments for the proposed action are listed below:

There is a need to amend the Kaibab National Forest (KNF) Land Management Plan (Forest Plan, as amended, 1988) to re-designate the land suitability classification within the project area to allow restoration treatments to move vegetative conditions toward the reference conditions for the area. This amendment is needed because the long-term desired conditions for the area (achieved through strict-sense restoration and maintenance burning) would preclude timber production over the landscape and not meet the intent of the Forest Plan.

There is a need to amend the Forest Plan (1988, as amended) to allow the Forest to deviate from Forest Plan Guidelines for Mexican Spotted Owls (MSO) by thinning trees over 9” diameter

[1] The purpose and need for action is derived from the differences between existing conditions and desired conditions in the project area. DEIS Appendix E documents the existing resource conditions and desired conditions in the Bill Williams Mountain project area. Desired conditions are based on management direction in the 1988 Kaibab Forest Plan, as amended, and also on reference conditions for vegetation.

breast height (dbh) in order to achieve fuels-reduction objectives in MSO Protected Habitat (mixed-conifer and pine-oak forest on slopes ≥40% and all areas within the Bill Williams Protected Activity Center).

There is a need to amend the Forest Plan (1988, as amended) to allow the Forest to deviate from Forest Plan Standards and Guidelines in ponderosa pine stands outside of goshawk post-fledgling family areas (PFAs) and goshawk nest areas by reducing canopy cover below 40% in certain areas in order to achieve restoration objectives.

There is a need to amend the Forest Plan (1988, as amended) to allow the Forest to exceed the maximum fire size and average annual burned area objectives of $1/10^{th}$ acre per year within Land Use Zone – Special Area 6, the Arizona Bugbane Botanic Area.

1.3 Proposed Action

To meet the purpose and need for action, the Kaibab National Forest proposes to treat stands on and surrounding Bill Williams Mountain with mechanized equipment and prescribed fire.

A combination of commercial timber harvest treatments and non-commercial mechanical treatments is proposed on approximately 15,200 acres. Mechanized treatments include hand felling, ground-based logging systems, cable-logging systems and helicopter logging. Treatments would thin stands to meet or move toward the desired conditions and in some stands, non-commercial treatments may be the only treatments feasible/necessary to achieve resource objectives.

Prescribed fire is also proposed on approximately 15,200 acres of the project area. In some areas, prescribed fire would be used in conjunction with mechanical treatments to achieve restoration and fuel treatment objectives. In other areas where operability is limited and more costly, only prescribed burning may be used to meet resource objectives.

The Proposed Action includes four one-time site-specific Forest Plan amendments to meet the purpose and need for action and move vegetative conditions in the project area toward the desired conditions. They are as follows:

This proposed action would amend the Kaibab National Forest (KNF) Land Management Plan (Forest Plan, as amended, 1988) to re-designate the land suitability classification within portions of the project area to allow restoration treatments to move vegetative conditions toward the reference conditions for the area. This amendment is needed because the long-term desired conditions for the area (achieved through strict-sense restoration and maintenance burning) would preclude timber production over the landscape and not meet the intent of the Forest Plan.

This proposed action would amend the Forest Plan to allow the Forest to deviate from Forest Plan Guidelines for Mexican Spotted Owls in order to achieve fuels-reduction objectives in MSO Protected Habitat (mixed-conifer and pine-oak forest on slopes ≥40% and all areas within the Bill Williams Protected Activity Center).

This proposed action would amend the Forest Plan to allow the Forest to deviate from Forest Plan Standards and Guidelines in ponderosa pine stands outside of goshawk post-fledgling family areas (PFAs) and goshawk nest areas in order to achieve restoration objectives.

This proposed action would amend the Forest Plan to allow the Forest to exceed the maximum fire size and average annual burned area objectives within Land Use Zone – Special Area 6, the Arizona Bugbane Botanic Area.

A detailed description of Alternative 2, the proposed action, is provided in Chapter 2 (Section 2.2).

1.4 Decision Framework

Based on the purpose and need for action, the findings in the Final Environmental Impact Statement (FEIS) and supporting project record, and consideration of the best available science, the Forest Supervisor will decide:

1. Whether to select the proposed action or one of the alternatives;
2. What mitigation and/or monitoring measures will be required during implementation of the proposed action or any alternative selected; and
3. What language and content changes are needed to the Kaibab National Forest Land Management Plan.

1.5 Public Involvement

Public involvement for this project began prior to the publication of the Notice of Intent (NOI) to prepare an Environmental Impact Statement. The Forest invited the public and various interested parties to participate in numerous informal "brainstorming" sessions during January, February and March of 2011. Participants were solicited for ideas, questions, and concerns about treating hazardous fuels on Bill Williams Mountain, and thereby improving forest health near the community.

Where possible, we incorporated the input we received into the purpose and need for action and the desired conditions for the project area. Many overarching themes were repeated during these discussions. For example, many statements were made about the need to avoid incidents like the Schultz Fire as well as the events that followed. Others stated we should consider the cost-benefits of treating the fuels now versus trying to suppress a high-intensity wildfire. All of the ideas and comments we received are appreciated and were helpful in refining a proposal for this project area.

The NOI was published in the Federal Register on Thursday, April 21, 2011. The NOI asked for public comment on the proposal by May 23, 2011. In addition, as part of the public involvement process, the Forest invited public comment and participation through listing the project in the Schedule of Proposed Actions (SOPA); posting the scoping packet online (http://fs.usda.gov/goto/kaibab/projects); and mailing letters to potentially interested persons, tribal governments, and State and other Federal agencies. Three letters and six emails were recorded from this effort. A scoping meeting was also hosted at the Williams Ranger District on Wednesday May 11, 2011 to discuss the proposed action and accept comments. The Forest received nine written comments as well as several oral questions and comments that were recorded at the public scoping meeting.

Using the comments we received from the public, other agencies, and interested and affected Tribal governments and communities during scoping of the proposed action, we identified a list of significant and non-significant issues (see *Section 1.6 Issues*).

1.6 Issues

The Forest Service separated the issues into two groups: significant and non-significant issues. Significant issues were identified 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 on Environmental Quality (CEQ) NEPA regulations explain 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 explanations regarding their categorization as non-significant may be found in the Issue Processing Report (Appendix C).

The Forest Service has identified the following significant issues from our scoping efforts. They are grouped as to whether the issue can be remedied by implementing a mitigation measure or an alternative to the proposed action and they have been reworded to reflect cause-and-effect statements.

<u>Significant Issues Remedied by Implementing Mitigation Measures</u>

Issue 1 – *The Proposed Action may cause the loss of pre-settlement trees which will have potentially significant impacts on old growth recruitment and critical wildlife habitat.*

A mitigation measure has been developed to generally retain pre-settlement trees (DEIS, Section 2.3). Some pre-settlement trees may be incidentally taken due to harvesting operability and unforeseen circumstances related to health and safety. A pre-settlement tree is generally a tree that was living prior to 1870.

Issue 2 – *The proposed prescribed burning may increase debris flow and increase surface erosion which will result in ash filling a stock tank located on Benham private property and negatively affect the water treatment plant for the city of Williams.*

Implementation of Soil and Watershed Best Management Practices (BMPs) would reduce the potential for debris flows and surface erosion to impact a stock tank on Benham private property and the Water Treatment Plant for the City of Williams (DEIS, Appendix B).

Issue 3 *– The vertical arrangement of strategic fire lines around the proposed burn blocks may result in erosion problems.*

Implementation of Soil and Watershed Best Management Practices (BMPs) would reduce the likelihood of erosion problems such as soil loss and downcutting from construction of strategic fuels treatment lines (DEIS, Appendix B).

Issue 4 *– The project may negatively impact the growth and productivity of Native American medicinal and ceremonial plants.*

A mitigation measure has been developed to minimize impacts to Native American medicinal and ceremonial plants in consultation with the Tribes (DEIS, Section 2.3).

Issue 5 - *The proposed project has not been designed to retain a sufficient amount of large logs and other dead and down material compatible with MSO needs and primary constituent elements of MSO critical habitat.*

A mitigation measure has been developed to retain large down logs and woody debris where possible and when needed to meet desired conditions (DEIS, Section 2.3). Where possible we will avoid direct ignition of large down logs and woody debris in the project area to meet desired conditions.

Issue 6 – *The proposed action may degrade wildlife habitat because of the proposed treatments in dwarf mistletoe stands.*

A mitigation measure has been developed to retain some dwarf mistletoe as a natural component in stands (DEIS, Section 2.3).

Issue 7 – *The proposed action includes new road construction and temporary road construction which may negatively affect the watershed.*

Implementation of Soil and Watershed Best Management Practices (BMPs) would reduce the potential for impacts from road construction to the watershed (DEIS, Appendix B).

An alternative was considered but eliminated from detailed study that would include no new road construction or temporary road construction (DEIS, Section 2.4).

Issue 8 *– The Proposed Action would not follow all recommendations for management of MSO habitat per the Final Rule for designation of Critical Habitat (FWS 2004) because it would reduce shade below 40% across a large portion of MSO Critical Habitat.*

A mitigation measure has been developed to retain more trees per pre-settlement evidence on highly productive sites (DEIS, Section 2.3) in order to retain 40% shade in MSO Critical Habitat.

<u>Significant Issues Remedied by Implementing Different Alternatives</u>

Issue 9 *– The Proposed Action would not follow all recommendations for management of Mexican Spotted Owl (MSO) habitat per the MSO Recovery Plan because it would cut trees greater than 9" diameter breast height (dbh) in a MSO Protected Activity Center (PAC) and other Protected Habitat.*

Alternatives 3 and 4 were developed in response to this issue. They do not include a site-specific Forest Plan amendment that would allow for thinning trees above 9" dbh, and would follow the Guidelines in the Forest Plan and MSO Recovery Plan for MSO protected habitat (DEIS, Section 2.2).

Indicator: Acres of PAC and Protected Habitat thinned above nine inches dbh

Issue 10 *– The Proposed Action would implement three site specific Forest Plan amendments that are not needed to meet restoration objectives.*

Alternatives 3 and 4 respond to this issue. They do not include any site specific Forest Plan amendments (DEIS, section 2.2).

> Indicator: a) Acres of land where land suitability was re-designated, b) Percent canopy cover in vegetative structural stage (VSS) 4, 5, & 6

Issue 11 *– The Proposed Action would negatively affect wildlife and cultural resources due to road construction and its associated impacts (e.g. habitat loss, fragmentation, compaction, etc.).*

Mitigation measures have been developed to protect cultural resources (DEIS, Section 2.3).

Alternative 4 was partially developed to respond to this issue. It does not include any new road construction (DEIS, Section 2.2).

> Indicator: a) Miles of new road construction, b) Acres of edge habitat created due to new road construction

Issue 12 *– The Proposed Action would allow cable logging which is not ecologically sound because it would harvest old growth trees.*

Alternatives 3 and 4 respond to this issue. They do not include the use of cable logging systems to treat vegetative conditions on steep slopes within the project area (DEIS, Section 2.2).

> Indicators: a) Acres treated with cable logging, b) Average number of large diameter trees per acre over time

Issue 13 *– The Proposed Action would allow mechanical treatment in the Arizona (AZ) bugbane botanical area which would invite non-native invasive species and damage the populations.*

Mitigation measures have been developed to prevent and control the spread of non-native invasive species within the project area (DEIS, Section 2.3).

Alternative 4 responds to this issue because it does not include mechanical treatments (except for hand-felling techniques) in the AZ bugbane botanical area (DEIS, Section 2.2).

> Indicator: a) Acres of AZ bugbane botanical area potentially impacted by mechanized equipment

Issue 14 *– The Proposed Action would mechanically treat approximately 15,200 acres, which would impact wildlife viability, soil conditions and water resources, when the objectives could be achieved primarily through prescribed burning.*

An alternative was considered but eliminated from detailed study that would only utilize prescribed burning techniques (DEIS, Section 2.4).

Additionally, the No Action alternative responds to this issue in several ways because it does not include any mechanical treatments or prescribed burning on steep slopes within the project area, except in those areas already covered under the City and Twin Projects (Decision Notice/Finding of No Significant Impact (DN/FONSI) 2005; DN/FONSI 2005 respectively). The No Action alternative will serve as the baseline for comparing the effects and anticipated effectiveness of each alternative in meeting the purpose and need.

> Indicators: a) Wildlife viability, b) Soil erosion hazard, c) Short-term effect on water quality and yield, d) Long-term effect on water quality and yield

Issue 15 *– The Proposed Action includes mechanical treatments and prescribed burning on steep slopes which could cause erosion and sedimentation and subsequently affect water sources and properties downstream.*

The No Action alternative responds to this issue in several ways because it does not include any mechanical treatments or prescribed burning on steep slopes within the project area, except in those areas already covered under the City and Twin Projects (DN/FONSI 2005; DN/FONSI 2005 respectively). The No Action alternative will serve as the baseline for comparing the effects and anticipated effectiveness of each alternative in meeting the purpose and need.

> Indicator: a) short-term effect on water quality and yield, b) long-term effect on water quality and yield

Issue 16 *– The Proposed Action includes the use of a helicopter logging system which is expensive and a significant disturbance to wildlife and nearby residents.*

Alternative 4 was partially developed to respond to this issue. It does not include the use of helicopter logging systems to treat vegetative conditions on steep slopes within the project area (DEIS, Section 2.2).

> Indicators: a) Acres treated with helicopter logging, b) Estimated cost, c) Wildlife viability

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Chapter 2 – Alternatives, Including the Proposed Action

2.1 Introduction

This chapter describes and compares the alternatives considered for the Bill Williams Mountain Restoration Project. It includes a description of each alternative considered. Maps for the alternatives can be found in Appendix A. This section also presents the alternatives in comparative form, sharply defining the differences between each alternative and providing a clear basis for choice among options by the decision maker and the public. Some of the information used to compare the alternatives is based upon the design of the alternative and some of the information is based upon the environmental, social and economic effects of implementing each alternative.

2.2 Alternatives Considered in Detail

The Forest Service developed four alternatives, including the No Action and Proposed Action alternatives, in response to issues raised by the public.

Alternative 1 – No Action

Under the No Action alternative, current management would continue in the project area. This alternative would not implement any new treatments or actions described in the proposed action (or other action alternatives described below). The no action alternative would not fulfill the purpose and need for action and represents a continuation of the existing conditions and management.

Alternative 2 – The Proposed Action

To meet the purpose and need for action, the Kaibab National Forest proposes the following actions under Alternative 2 - The Proposed Action:

Mechanical Treatments

Alternative 2 - The Proposed Action includes a combination of commercial timber harvest treatments and non-commercial mechanical treatments on approximately 15,200 acres. Treatments would thin stands with mechanized equipment to meet or move toward the desired conditions; in some stands, non-commercial treatments may be the only treatments feasible/necessary to achieve resource objectives.

The operability zones portrayed in Map 1 (DEIS, Appendix A) are used to define the proposed action and illustrate the operational feasibility of mechanically treating the project area. These zones share common operational attributes such as topography, terrain and potential logging system.

Operability Zones 1, 2 & 6: Ground-based logging systems would be used to treat up to 11,150[2] acres within these zones and are limited in use to slopes less than 40%.

[2] Please note this number was updated from 11,100 acres in the scoping packet to 11,150 acres because of a

Operability Zones 3 & 4[3]: Ground-based logging systems would be used to treat up to 70 acres within zone 3 and a cable logging system would be used to treat up to 130 acres within zone 4. Because of the location of these zones near the top of the mountain and the only roaded access along Forest Service Road (FSR) 111 (Bill Williams Mtn. Rd), these zones would require specialized equipment (e.g. forwarder and excaliner). Additionally, these zones would require an adverse skid to reach FSR 111 and then, due to the switchbacks along FSR 111 near the summit, skidding would also be required down FSR 111 to reach a suitable landing. Initial reviews of these zones indicate that the proposed ground-based logging system within these zones would be the most economically feasible treatment option; however, helicopter logging systems may also be utilized.

Operability Zone 5: A cable logging system would be used to treat up to 350 acres within this zone. Slopes within this zone are steep ranging from 40-60%, and approximately 1 mile of new road (to be closed following harvest) would be needed to facilitate removal of the fuels. Initial review of this zone indicates that the proposed cable logging system would be the most economically feasible treatment option; however, helicopter logging systems may also be utilized.

Operability Zone 7: Helicopter logging would be used within this zone to treat up to 3,500 acres due to steep slopes and limited access. Flights would average about 4,000 feet long one-way.

Post-Mechanical Treatments

Activity slash treatments would be accomplished using whole-tree skidding, machine piling, hand piling, mulching, crushing, commercial/personal use fuelwood sales, lop and scatter, and/or prescribed burning.

Rehabilitation and reclamation of areas impacted from treatments would occur to ensure the health and productivity of the forested ecosystem is sustained.

Strategic Fuels Treatments

Strategic fuel treatments designed specifically to enhance control lines would be implemented to enable land managers to achieve resource objectives with prescribed fire while serving to protect important resources. Treatments would reduce surface, ladder, and canopy fuels (i.e. fuel loading) up to 300 feet along both sides of control lines. The potential location of these lines are illustrated in Map 2 (DEIS, Appendix A) and mitigation measures (DEIS, Chapter 2 Section 2.3.1) have been developed should additional control lines be necessary. Approximately 2,500 acres[4] would receive non-commercial treatments and fuels would most likely be thinned by hand-felling techniques or, where practical, machinery equipped with cutting or grinding heads. These

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rounding error.

[3] Please note the proposed action in the scoping packet indicated that ground-based logging systems would be used within zones 3 & 4. Operability zone 3 would treat approx. 70 acres using a ground-based system (e.g. a forwarder). However, in order to move material out of operability zone 4 we would use a cable logging system in combination with the ground-based system used in zone 3. This information has been clarified in Alternative 2 – the proposed action since scoping.

[4] Please note the proposed action in the scoping packet indicated that 1,500 to 2,500 acres would be treated as part of the strategic fuels treatment. In order to simplify the analysis, this has been clarified to indicate that approximately 2,500 acres would be treated; the maximum acreage that would be impacted.

treatments represent the minimum acreage needed to prepare stands on steeper slopes for prescribed burning and would be combined with mechanical treatments where possible.

Prescribed Fire

Prescribed fire would be used on approximately 15,200 acres of the project area within Operability Zones 1 through 7. In some areas, prescribed fire would be used in conjunction with mechanical treatments to achieve restoration and fuel treatment objectives, such as in Operability Zones 1, 2 & 6. In other areas where operability is limited and more costly (Zones 3, 4, 5 & 7), only prescribed burning may be used to meet resource objectives; this would be dependent on implementation of the strategic fuel treatments designed to enhance control lines (described above).

- Prescribed burning may be implemented across the project area either prior to or following the mechanical treatments, with the exception of areas on steep slopes requiring the strategic fuels treatments described above. In most areas of the project, prescribed fire will follow mechanical treatments. Areas to be burned will be grouped into several burn units using natural and man-made features, such as roads, trails, and natural rock stringers, for control lines. The size, location, timing, and sequence of burning will consider impacts, such as smoke and risk of fire escape, to downwind communities and users of the National Forest.
- A combination of firing techniques, including ground and aerial ignitions, would be used to accomplish objectives and minimize the risk to human resources.
- Because the intent of prescribed burning is to reduce fuel loading, raise crown base heights and reduce live tree density, maintenance burning would be required every few years.

Transportation

Alternative 2 includes:

- Constructing approximately 23 miles of new roads to provide sustainable access for ground-based logging treatments (Map 3, DEIS, Appendix A). Sustainable access is a road system that will require less long-term maintenance and is located to allow logging access.
- Constructing approximately 16 miles of temporary roads that would be obliterated after use (Map 3, DEIS, Appendix A).
- Obliterating approximately 28 miles of poorly located roads (Map 4, DEIS, Appendix A).

Map 5 (DEIS, Appendix A) illustrates the transportation system after implementation of the project. Most of the newly constructed roads would be closed following implementation and allowed to re-vegetate naturally; additionally, drainage features such as culverts will be removed to minimize the long-term maintenance investment of retaining these roads. The resulting open road system after implementation would reflect the June 2011 travel management decision (Map 6, DEIS, Appendix A).

Trails

Because of the proposed changes to the transportation system, Alternative 2 would extend the Bixler Trail by converting a portion of Forest Service Road (FSR) 45 (from Bixler saddle south) to a non-motorized trail, constructing approximately 1 mile of new trail, and constructing a new trailhead and parking area along FSR 122 (shown on Map 5, DEIS, Appendix A).

Forest Plan Amendments

Alternative 2 - The Proposed Action includes four Forest Plan amendments:

1. Amend the Forest Plan to re-designate the land suitability classification on 8,954 acres of ponderosa pine cover type within the project area to allow restoration treatments to move vegetative conditions toward the reference conditions for the area. This amendment will reduce the acres of land suitable for timber production by 8,954 acres because replanting will not occur (see p. 9 of the Forest Plan).
2. Allow a one-time project specific amendment to the Forest Plan to allow the Forest to deviate from Forest Plan Guidelines for Mexican Spotted Owls on steep slopes (slopes ≥40%) and within the Bill Williams Protected Activity Center by harvesting and thinning trees greater than nine inches (see Chapter 4, Regionally Consistent Standards and Guidelines for the Mexican Spotted Owl, Section B – Protected Areas, page 24).
3. Allow a one-time project specific amendment to the Forest Plan to allow the Forest to deviate from Forest Plan Guidelines in ponderosa pine cover type outside of goshawk post-fledgling family areas (PFAs) and goshawk nest areas by not meeting the canopy cover Guidelines for vegetation structural stages (VSS) 4, 5, and 6 (see Chapter 4, Regionally Consistent Standards and Guidelines for the Ecosystem Management in Northern Goshawk Habitats, Vegetation Management section, p. 29-30).
4. [5]Allow a project specific amendment to the Forest Plan to allow the Forest to exceed the maximum fire size (one acre) and average annual burned area objectives (1/10th acre) within Land Use Zone – Special Area 6, the Arizona Bugbane Botanic Area (p. 93).

Implementation

Implementation of the proposed action would begin in 2012 and would occur as funding and/or favorable conditions allow.

Alternative 3

The main differences from the Proposed Action and Alternative 3 are: no cable logging, (the cable logging acres would be added to helicopter logging acres), and no Forest Plan amendments.

To meet the purpose and need for action, the Kaibab National Forest proposes the following actions under Alternative 3:

Mechanical Treatments

Alternative 3 includes a combination of commercial timber harvest treatments and non-commercial mechanical treatments on approximately 15,200 acres. Treatments would thin stands with mechanized equipment to meet or move toward the desired conditions; in some stands, non-commercial treatments may be the only treatments feasible/necessary to achieve resource objectives.

The operability zones portrayed in Map 7 (DEIS, Appendix A) are used to define Alternative 3 and illustrate the location of mechanical treatments within the project area. These zones share common operational attributes such as topography, terrain and potential logging system.

<u>Operability Zones 1, 2 & 6:</u> Ground-based logging systems would be used to treat up to 11,150 acres within these zones and are limited in use to slopes less than 40%.

[5] This Forest Plan amendment was added to the proposed action in light of comments raised during the scoping process regarding the ability of the proposed action to meet the desired conditions within the constraints of the Standards and Guidelines for the Arizona Bugbane Botanic Area.

Operability Zones 3: Ground-based logging systems would be used to treat up to 70 acres within zone 3. Because of the location of this zone near the top of the mountain and the only roaded access along Forest Service Road (FSR) 111 (Bill Williams Mtn. Rd), this zone would require specialized equipment (e.g. forwarder). Additionally, this zone would require an adverse skid to reach FSR 111 and then, due to the switchbacks along FSR 111 near the summit, skidding would also be required down FSR 111 to reach a suitable landing. Initial reviews of this zone indicate that the proposed ground-based logging system within this zone would be the most economically feasible treatment option; however, helicopter logging systems may also be utilized.

Operability Zone 7: Helicopter logging would be used within this zone to treat up to 3,980 acres due to steep slopes and limited access. Flights would average about 4,000 feet long one way.

Post-Mechanical Treatments

Activity slash treatments would be accomplished using whole-tree skidding, machine piling, hand piling, mulching, crushing, commercial/personal use fuelwood sales, lop and scatter, and/or prescribed burning.

Rehabilitation and reclamation of areas impacted from treatments would occur to ensure the health and productivity of the forested ecosystem is sustained.

Strategic Fuels Treatments

Strategic fuel treatments designed specifically to enhance control lines would be implemented to enable land managers to achieve resource objectives with prescribed fire while serving to protect important resources. Treatments would reduce surface, ladder, and canopy fuels (i.e. fuel loading) up to 300 feet along both sides of control lines. The potential location of these lines are illustrated in Map 2 (DEIS, Appendix A) and mitigation measures (DEIS, Chapter 2 Section 2.3.1) have been developed should additional control lines be necessary. Approximately 2,500 acres would receive non-commercial treatments and fuels would most likely be thinned by hand-felling techniques or, where practical, machinery equipped with cutting or grinding heads. These treatments represent the minimum acreage needed to prepare stands on steeper slopes for prescribed burning and would be combined with mechanical treatments where possible.

Prescribed Fire

Prescribed fire would be used on approximately 14,710 acres of the project area within Operability Zones 1 through 7, except within Land Use Zone – Special Area 6, the Arizona Bugbane Botanic Area. In some areas, prescribed fire would be used in conjunction with mechanical treatments to achieve restoration and fuel treatment objectives, such as in Operability Zones 1, 2 & 6. In other areas where operability is limited and more costly (Zones 3 & 7), only prescribed burning may be used to meet resource objectives; this would be dependent on implementation of the strategic fuel treatments designed to enhance control lines (described above).

- Prescribed burning may be implemented across the project area either prior to or following the mechanical treatments, with the exception of areas on steep slopes requiring the strategic fuels treatments described above. In most areas of the project, prescribed fire will follow mechanical treatments. Areas to be burned will be grouped into several burn units using natural and man-made features, such as roads, trails, and natural rock stringers, for control lines. The size, location, timing, and sequence of

burning will consider impacts, such as smoke and risk of fire escape, to downwind communities and users of the National Forest.
- A combination of firing techniques, including ground and aerial ignitions, would be used to accomplish objectives and minimize the risk to human resources.
- Because the intent of prescribed burning is to reduce fuel loading, raise crown base heights and reduce live tree density, maintenance burning would be required every few years.

Transportation

Alternative 3 includes:
- Constructing approximately 22 miles of new roads to provide sustainable access for ground-based logging treatments (Map 8, DEIS, Appendix A).
- Constructing approximately 16 miles of temporary roads that would be obliterated after use (Map 8, DEIS, Appendix A).
- Obliterating approximately 28 miles of poorly located roads (Map 4, DEIS, Appendix A).

Map 9 (DEIS, Appendix A) illustrates the transportation system after implementation of the project. Most of the newly constructed roads would be closed following implementation and allowed to re-vegetate naturally; additionally, drainage features such as culverts will be removed to minimize the long-term maintenance investment of retaining these roads. The resulting open road system after implementation would reflect the June 2011 travel management decision (Map 6, DEIS, Appendix A).

Trails

Because of the proposed changes to the transportation system, Alternative 3 would extend the Bixler Trail by converting a portion of Forest Service Road (FSR) 45 (from Bixler saddle south) to a non-motorized trail, constructing approximately 1 mile of new trail, and constructing a new trailhead and parking area along FSR 122 (shown on Map 9, DEIS, Appendix A).

Implementation

Implementation of Alternative 3 would begin in 2012 and would occur as funding and/or favorable conditions allow.

Alternative 4

The main differences between Alternative 3 and Alternative 4 are: no helicopter logging, no new road construction, and no Forest Plan amendments.

To meet the purpose and need for action, the Kaibab National Forest proposes the following actions under Alternative 4:

Mechanical Treatments

Alternative 4 includes a combination of commercial timber harvest treatments and non-commercial mechanical treatments on approximately 11,150 acres. Treatments would thin stands with mechanized equipment to meet or move toward the desired conditions; in some stands, non-commercial treatments would be the only treatments implemented to achieve resource objectives.

The operability zones portrayed in Map 10 (DEIS, Appendix A) are used to define Alternative 4 and illustrate the location of treatments within the project area. These zones share common operational attributes such as topography, terrain and potential logging system.

Operability Zones 1, 2 & 6: Ground-based logging systems would be used to treat up to 11,150 acres within these zones and are limited in use to slopes less than 40%.

Post-Mechanical Treatments

Activity slash treatments would be accomplished using whole-tree skidding, machine piling, hand piling, mulching, crushing, commercial/personal use fuelwood sales, lop and scatter, and/or prescribed burning.

Rehabilitation and reclamation of areas impacted from treatments would occur to ensure the health and productivity of the forested ecosystem is sustained.

Strategic Fuels Treatments

Strategic fuel treatments designed specifically to enhance control lines would be implemented to enable land managers to achieve resource objectives with prescribed fire while serving to protect important resources. Treatments would reduce surface, ladder, and canopy fuels (i.e. fuel loading) up to 300 feet along both sides of control lines. The potential location of these lines are illustrated in Map 2 (DEIS, Appendix A) and mitigation measures (DEIS, Chapter 2 Section 2.3.1) have been developed should additional control lines be necessary. Approximately 2,500 acres would receive non-commercial treatments and fuels would be thinned by hand-felling techniques. These treatments represent the minimum acreage needed to prepare stands on steep slopes for prescribed burning.

Prescribed Fire

Prescribed fire would be used on approximately 14,710 acres of the project area, except within Land Use Zone – Special Area 6, the Arizona Bugbane Botanic Area. In some areas, prescribed fire would be used in conjunction with mechanical treatments to achieve restoration and fuel treatment objectives, such as in Operability Zones 1, 2 & 6. On steep slopes only prescribed burning would be used to meet resource objectives; this would be dependent on implementation of the strategic fuel treatments designed to enhance control lines (described above).

- Prescribed burning may be implemented across the project area either prior to or following the mechanical treatments, with the exception of areas on steep slopes requiring the strategic fuels treatments described above. In most areas of the project, prescribed fire will follow mechanical treatments. Areas to be burned will be grouped into several burn units using natural and man-made features, such as roads, trails, and natural rock stringers, for control lines. The size, location, timing, and sequence of burning will consider impacts, such as smoke and risk of fire escape, to downwind communities and users of the National Forest.
- A combination of firing techniques, including ground and aerial ignitions, would be used to accomplish objectives and minimize the risk to human resources.
- Because the intent of prescribed burning is to reduce fuel loading, raise crown base heights and reduce live tree density, maintenance burning would be required every few years.

Transportation

Alternative 4 includes:

- Constructing approximately 38 miles of temporary roads that would be obliterated after use (Map 11, DEIS, Appendix A).
- Obliterating approximately 28 miles of poorly located roads (Map 4, DEIS, Appendix A).

Map 12 (DEIS, Appendix A) illustrates the transportation system after implementation of the project. The resulting open road system after implementation would reflect the June 2011 travel management decision (Map 6, DEIS, Appendix A).

Implementation

Implementation of Alternative 4 would begin in 2012 and would occur as funding and/or favorable conditions allow.

2.3 Mitigation and Monitoring

The mitigation and monitoring measures designed specifically for the Bill Williams Mountain Restoration Project are described below in Sections 2.3.1 and 2.3.2. The effectiveness of the mitigations measures is disclosed in Chapter 3 of the Environmental Impact Statement as the analyses for each alternative assumes the appropriate mitigations have been implemented. Monitoring measures are included in the project to ensure best management practices and mitigation measures are being implemented and that the objectives of the project are being met.

2.3.1 Mitigation

The Forest Service employs several measures to reduce or prevent negative impacts to the environment in the planning and implementation of management activities. The application of these measures begins at the planning and design phase of a project. The Forest Plan Standards and Guidelines and the direction contained in the Watershed Conservation Practices Handbook (FSH 2509.25) are the first protection measures to be applied to a project. Both of these sources are incorporated by reference and are not reiterated here. Additional site-specific mitigation measures have been developed for this project, and are presented below. Unless specified otherwise, each mitigation measure applies to all action alternatives.

Wildlife[6]

Mexican Spotted Owls

1. Minimize the loss of oak and other hardwoods >10” diameter at root collar [drc], down logs >12” midpoint diameter, trees >18” diameter at breast height [dbh], and snags >18” dbh outside of areas where needed to move toward desired conditions.
2. Do not disturb the Bill Williams Protected Activity Center (PAC) and minimize smoke impacts to nesting Mexican spotted owls during the breeding season (March 1st-August 31st) if it is active. Activity will be determined by conducting surveys in and within a

[6] These derive from direction of the 1988 Kaibab National Forest Land Management Plan (as amended), from internal project development, from recommendations of the US Fish and Wildlife Service and Arizona Game and Fish Department, and from public scoping. For the purposes of this section, “disturbance” includes mechanical treatment of hazardous fuels, temporary road construction, road decommissions, road closures, and trail construction; it does not include the use of prescribed fire.

half-mile of the PAC one year prior to implementation or during the year of implementation. If surveys are not conducted during the year of implementation or the year prior to implementation, assume breeding activity.

3. Work with the U.S. Fish and Wildlife Service (FWS) when developing silvicultural prescriptions for the 100-acre Core of the Bill Williams PAC. Any prescriptions that may occur within the PAC Core would be restricted to thinning the understory and mid-story while still retaining substantial vertical diversity within the Core.
4. In areas outside of MSO Protected Habitat, MSO Target/Threshold Habitat, goshawk nest areas and goshawk PFAs, retain 1-2 trees per pre-settlement evidence in order to restore forests to pre-settlement conditions. In highly productive sites within MSO Restricted Habitat but outside Target/Threshold Habitat, leave more trees per pre-settlement evidence. In areas where pre-settlement evidence is limited or absent scientific literature will inform prescriptions. On highly productive sites, the high end of the historic range of variability of trees/acre will be used to inform prescriptions. These measures will allow the project to retain at least 40% shade cover in MSO Habitat.

Northern Goshawks

5. Limit human disturbance associated with the project implementation of Post-fledlging Family Areas (PFAs) during the breeding season (March 1st-September 30th).

Habitat Attributes

6. Minimize the loss of pre-settlement trees, regardless of mistletoe infection. Where pre-settlement trees infected with mistletoe exist and where necessary, leave additional post-settlement trees in groups to promote the abundance of VSS 5 (18”+ dbh) and 6 (24”+ dbh) groups across the landscape. Note that pre-settlement trees will be visually identified.

Vegetation

7. Due to potential bark beetle infestation problems, avoid non-commercial thinning that will create excessive amounts of activity slash between the dates of January 1 and July 1, especially near private property.

Range

8. When necessary, pastures scheduled for burning will be rested for at least one growing season prior to and following burning. Soil stability and plant health will be assessed prior to the authorization of grazing in burned areas.

Rare Plants

9. Known locations of rare plant species will be protected to limit negative impacts (e.g. where possible road construction will avoid known plant populations).
10. Rare plant surveys and surveys for Native American medicinal and ceremonial plants, such as Porter's licorice-root (syn. osha root, *Ligusticum porteri*), within the project area will occur where suitable habitat exists. The extent and scale of these surveys will be dependent upon funding.

Noxious Weeds

11. Implement “Appendix B: Design Features, Best Management Practices, and Mitigation Measures” identified in the “Final Environmental Impact Statement for Integrated

Treatment of Noxious or Invasive Weeds on the Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona" (2005).

Mitigations specific to the Bill Williams Botanical Area (Land Use Zone – Special Area 6)

12. There will be an "inner buffer zone" where no timber management activities or manual/mechanical removal of fuels will occur. This includes areas where the plant currently exists and its adjacent habitat (e.g., root zone). The inner buffer zone, as well as the distribution of the existing population, will be determined and mapped by rare plant specialists.

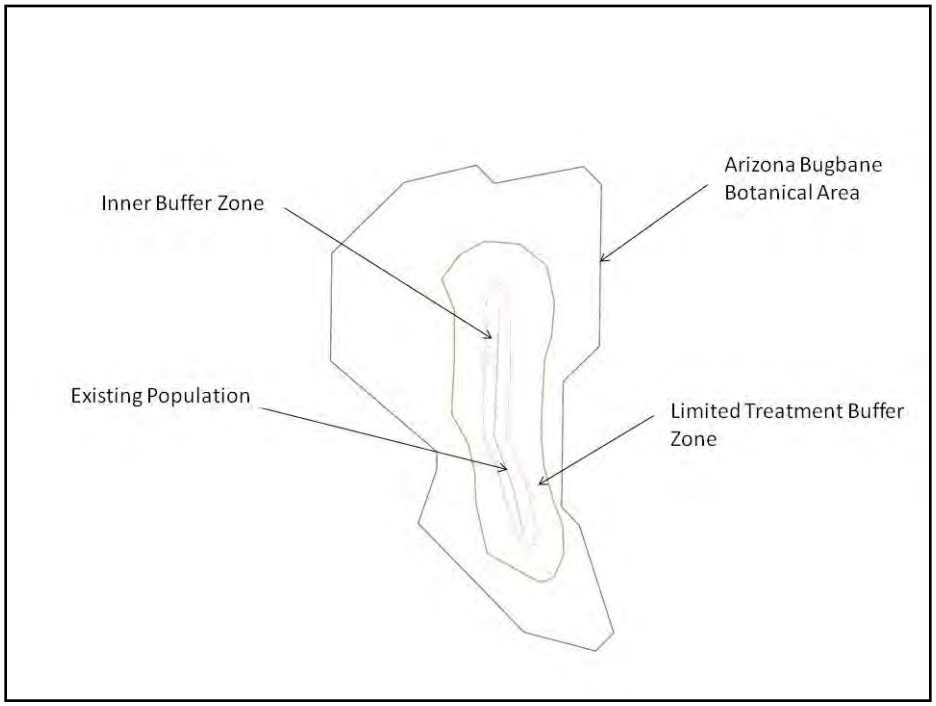


Figure 2. Schematic showing the buffer zones for the Arizona Bugbane Botanical Area mitigation measures.

13. There will be a "limited treatment buffer zone" surrounding the existing Arizona bugbane population (i.e., surrounding the "inner buffer zone") that is delineated by topography, slope, aspect, and potential habitat where the only treatment will be ladder fuel reductions to protect the overstory canopy. The only fuels that may be removed in the limited treatment buffer zone are those posing an immediate threat from fire to the overstory canopy. The buffer will be clearly flagged prior to any project-related activities. The exact location of the limited treatment buffer zone boundary will be determined and mapped collaboratively on the ground by fuels, silviculture, soils, and rare plant specialists.
14. Existing Arizona bugbane populations would not be directly ignited during prescribed burning.
15. Deciduous trees ≥ 5" DBH or shrubs ≥ 5" DRC within the Botanical Area will not be removed during thinning operations. Where safe and practical minimize the loss of deciduous trees and shrubs >12" DRC.

16. Trees within the Botanical Area that are part of the upper canopy and contribute to suitable habitat will not be removed during thinning. Areas within the Botanical Area not contributing to suitable habitat where portions of the upper canopy may be removed will be identified by silviculture and rare plant specialists.
17. Fell trees near existing Arizona bugbane populations away from the populations.
18. Treated slash in areas of the Botanical Area with soils at high risk of unacceptable erosion will be hand-piled. Grapple piling may be used on stable soils if monitoring demonstrates acceptably low impacts to soils.
19. Dozers may be used for fireline construction only on former roads or in consultation with the soils and rare plant specialists.
20. The Botanical Area will not be seeded following thinning or burning treatments in order to prevent the introduction of invasive species and to prevent attracting wild ungulates to the area.

Cultural Resources

The following mitigation measures are in accordance with Appendix J of the First Amended Programmatic Agreement (PMOA 2009) between the Arizona National Forests, Arizona State Historic Preservation Officer, and the Advisory Council on Historic Preservation. *Prior to the various project implementation phases, project managers must consult with archaeologists who will then flag or paint site boundaries for avoidance.* If any unrecorded heritage resources are discovered during project implementation, all project related activities will cease immediately and the consultation process as outlined in Section 800.13 of the Advisory Council on Historic Preservation's regulations 36 CFR Part 800 will be initiated.

21. *Pre-Commercial Thinning, Roundwood and Sawtimber Thinning*: These activities "have predictable effects and a very low likelihood of affecting historic properties." (PMOA 2009). If known historic properties are within these types of project areas, the sites will be flagged, then the fuels will be hand carried and piled outside of site boundaries.
22. *Mechanical Timber Harvesting*: Prior to any proposed commercial or non-commercial harvesting project managers must consult with heritage specialists to ensure that sites will not be adversely affected. These sites must either be marked for avoidance or monitored in the case of treatment. An archaeologist will meet with the project managers and equipment operators prior to project implementation to insure that the project managers and operators know how to distinguish the areas to be avoided, and who to contact in the event of a last minute project design change or if a previously unrecorded site is uncovered due to the project activities.
23. *Prescribed Fire*: All fire sensitive sites will be flagged for avoidance. *Project and fire managers must consult with archaeologists, prior to implementing burn activities, to ensure that on-site fuels are such that they will not burn with prolonged or extreme heat.* If necessary, excess fuels will be removed by hand from sites.
24. *Mechanical and Hand Piling*: All known eligible or unevaluated heritage resource site will be flagged for avoidance, thus all wood piling and heavy machinery activities will be conducted outside of site boundaries, except for sites that are bisected by Forest Service Roads. In those cases, all activities will be confined to the road prisms.
25. *Fire-line Construction*: All planned fire-lines must avoid known heritage resource sites. Planned fire lines constructed with bulldozers can occur within previously surveyed areas where known sites have been flagged for avoidance by archaeologist. If lines are proposed to be constructed in areas that have not been evaluated by archaeologists, these area will require additional survey prior to fire-line construction. In the event that

emergency dozer fire-lines are warranted, fire managers must contact the Forest Archaeologist immediately so that site avoidance and mitigation measures can be devised and employed as needed.

26. *Road Maintenance / Construction*: Engineers use road graders to conduct routine road maintenance activities within existing road prisms and features. No protective or mitigation measures are required in areas that have undergone previous surveys and *where no heritage resource sites are known to exist.* New road construction may occur only in previously surveyed areas that contain no eligible or unevaluated sites. If new roads are proposed in unsurveyed areas, the project area must first be surveyed for heritage resources and an amendment to the project clearance drafted.

Scenic Resources

The Recreation Opportunity Spectrum/Scenery Management System (ROS/SMS) Guidebook states recovery timelines for Scenic Integrity Objectives (SIO) 2 and SIO 3 of one year and two years respectively, after implementation. The Forest Plan, as amended, allows for the SIO to drop one level during critical project and management activities, such as the restoration of Bill Williams Mountain. It is highly unlikely that the SIO recovery to satisfactory levels will meet the expected timelines; therefore, SMS direction for the SIO levels 2 and 3 would be met within 5-10 years after project completion.

27. When thinning forest vegetation geometric shapes will not be introduced and high contrast will be avoided between treatment locations. Feather edges of treatment areas to reduce the contrasting scenery of these edges.
28. Prescribed burn blocks will not have geometrical shapes and fire lines will be constructed, where ever possible, to reduce the contrast so that they are not noticeable in the middle and background views.
29. Control lines will be rehabilitated by re-contouring berms, pulling logs and rocks across the lines and disguising entry and exit points.
30. In grassland restoration treatments, slash needs to be hand piled and burned within the first 300 feet of the foreground. Beyond 300 feet in middle-ground and background areas, slash must be treated.
31. Hand pile in the first 300 feet and burn activity generated slash in the foreground areas of sensitive travel corridors (County Road ((CR)) 73, Forest Road ((FR)) 173B, FR 106, FR 111, FR 108, FR 122) and surrounding the new and existing trailheads, Forest Trails (FT 38, FT 21, FT 72, FT 124, FT 46, FT 130). Beyond 300 feet, slash must be treated.
32. New and temporary road construction inside of sensitive travel corridors will use native materials for riprap. Develop and review slope stabilization materials with the Landscape Architect prior to construction. Try to balance cut and fill. If constructed slopes are necessary, stabilize slopes using best management practices or rehabilitate slopes by roughening surface, seeding with weed-free native species and mulching. Do not leave “eye brows” at the tops of cut slopes.
33. Roads that are considered unnecessary for further management of the mountain will be decommissioned once work is completed. Roads must be effectively closed at entry/exit points preferably with large boulders and/or logs and allowed to re-vegetate naturally, or will be scarified, seeded (with native species) and mulched to promote vegetation. Road bed will be stabilized per best management practices. Berms will only be used if there is no other effective means of closing off these roads.
34. Tree marking within 150 feet from Forest Roads and Forest Trails (includes roads number CR 73, FR 106, FR 111, FR 108, FR 122 and trail numbers FT 38, FT 21, FT 72,

FT 124, FT 46, FT 130) shall be done in a manner to minimize visibility. Butt marks may face roads and trails.

35. Utilize existing skid roads and landings to the extent possible.

Recreation Resource

36. In Semi-primitive Non-motorized (SPNM) areas (Approx. 2,698 acres):
    - Approximately 2/3 of a mile of re-opened Maintenance Level (ML) -1 roads will be required for the project. The roads will be closed to continued use and restored to original conditions when the projects are completed. The same measures will be in place for all landings and skid trails.
    - Activity generated slash must be treated. Slash treatment should generally occur within one year after treatment. [For much of the SPNM area it is expected that little slash will be generated, as the whole tree will be removed via the helicopter logging operations.]
    - Flush cut or low cut stumps to 6" in the foreground of travel corridors that will remain open. Flush cut or low cut to 8" in middle-ground or background areas.
37. In Semi-Primitive Motorized (SPM) areas (Approx. 4,910 acres):
    - Activity slash in foreground areas of SPM will be piled and burned, which will include along all new and existing roadways located in this ROS class. Slash will be treated throughout the ROS, mostly through burning within 2 years, where possible.
    - Flush cut or low cut stumps to 6" in the foreground of travel corridors. This will include all the new roads added within this ROS. Flush cut or low cut to 8" in middleground or background areas.
    - Do not establish personal use or commercial use fuelwood cutting areas in this class. Prohibit motorized cross country travel for fuelwood cutting.
38. In Roaded Natural (RN) areas (Approx. 8,776 acres):
    - Temporary roads will be obliterated when projects are completed. Roads that are considered unnecessary for further management of the mountain will be decommissioned once work is completed. Roads must be effectively closed at entry/exit points preferably with large boulders and/or logs and allowed to re-vegetate naturally, or will be scarified, seeded (with native species) and mulched to promote vegetation. Road bed will be stabilized per best management practices. Berms will only be used if there is no other effective means of closing off these roads.
    - In foreground areas of travel corridors stumps should be cut as low as possible or flush cut.
    - Hand pile slash within the first 300 feet of developed recreation sites, private homes, Forest Trails, trailheads and Forest Roads (CR 73, FR 106, FR 111, FR 108, FR 122 and surrounding the new and existing trailheads and Forest Trails (FT 38, FT 21, FT 72, FT 124, FT 46, FT 130). Beyond 300 feet in middle-ground and background areas, slash must be treated. When possible activity created slash in foreground areas must be treated within one year in areas adjacent to and visible from developed recreation sites, private homes, Forest Trails and Forest Roads, and within two years in the rest of this ROS class.
39. In Rural (R) areas (Approx. 1,282 acres):
    - Temporary roads will be obliterated when projects are completed. ML-1 roads must be effectively closed at entry and exit points with large boulders and/or logs and pulling debris and rocks across roads.

- Stump heights shall be flush cut, generally less than 6", or as low as possible on larger diameter trees.
- Fire control lines will be disguised in foregrounds of sensitive travel corridors, and areas next to communities/private lands, and developed recreation sites by pulling debris and rocks across the lines, and disguising entrance/exits.
- Hand pile visible slash within the first 300 feet of developed recreation sites, private homes, Forest Trails, trailheads and surrounding the existing trailheads and Forest Trails (FT 124, FT 46, and FT 130). Beyond 300 feet in middle-ground and background areas, slash must be treated. Where possible activity created slash must be treated within one year in areas adjacent to and visible from developed recreation sites, private homes, Forest Trails and Forest Roads, and within two years in the rest of this ROS class.

40. During project implementation, especially during mechanical treatments, temporary road and trail closures will be implemented at the authorized officer's discretion for health and safety.

Mitigation Measures to Address Tribal Concerns

41. The Kaibab National Forest will consider all requests to issue temporary closures within the project area to accommodate ceremonial use as authorized in the Food, Conservation, and Energy Act of 2008, SEC. 8104
42. The Kaibab National Forest will ensure that free-use permits for the collection of tree boughs, thinning slash, branches and other non-merchantable timber are readily available to tribal members for fuelwood or personal ceremonial use.
43. The Kaibab National Forest will coordinate with the Hopi Tribe to provide timbers for the purpose of rebuilding kivas and clan houses, and for other traditional and cultural purposes. The Hopi Tribe will provide for the transport of all such materials. The Forest will work with additional tribes to provide forest products for similar requests.
44. The Kaibab National Forest will maintain the confidentiality of specific ceremonial sites and traditional collecting areas. Specific ceremonial sites will be avoided by project activities, or the Forest will work with the affiliated Tribe to develop site-specific mitigation measures.
45. The Havasupai Tribe will be invited to monitor the project during the first phase of implementation. The Forest will work all tribes to coordinate project monitoring by tribal representatives upon request.
46. The Kaibab will work with the Hualapai Tribe to conduct plant surveys within the project area.
47. The Forest will continue to work with tribes to identify traditionally important plant species and populations that occur within the project area, and facilitate the sustainable collection of these resources for traditional and cultural purposes. Monitoring of known collection sites will occur within the project area during implementation. Newly documented populations will be recorded and mapped for consideration as collection sites.

2.3.2 Monitoring

Monitoring is gathering information, observing processes, and examining the results of management activities to provide a basis for evaluation. Monitoring is done at both the project and Forest Plan level. The Bill Williams Mountain Restoration Project contains project specific monitoring. It also includes Forest Plan monitoring and evaluation items where appropriate.

Monitoring in the Bill Williams Mountain Restoration Project includes implementation monitoring and evaluation to guarantee that Best Management Practices and Forest Plan Standards and Guidelines are being incorporated during the project activities, as well as effectiveness monitoring and evaluation to determine whether objectives of the project are being met. Below are monitoring measures that will be incorporated into this project.

Wildlife

Mexican Spotted Owls

1. Survey suitable MSO nesting/roosting habitat in the project area prior to implementation, either during the year of implementation or one year prior to implementation.
2. Conduct pre- and post-treatment microhabitat monitoring in MSO Protected and Restricted Habitat. Dependent on available resources, post-treatment monitoring will occur 1-2 years after the first thinning or burning treatments within Protected Habitat; post-treatment monitoring should not be withheld until the entire project area has been treated. Attributes to monitor include units/acre and/or basal area of oaks and other hardwoods greater than or equal to 10 inches drc, trees 12-18 inches dbh), trees greater than or equal to 18 inches dbh, down logs greater than or equal to12 inches midpoint diameter, and snags greater than or equal to 18 inches dbh.

Fuels Management

3. Pre- and post-burn monitoring will be accomplished using various fuels surveys to determine the success in reducing fuel loads and fire risk (canopy closure, fuel ladders, duff and litter layer depths, etc.) of first-entry treatments. Successive maintenance burning will be monitored post-treatment to determine success in further reducing fuel loads and fire risk.

Rare Plants

4. Known locations of rare plant populations within the project area will be monitored throughout project implementation and thereafter to ensure their protection and viability.

Noxious Weeds

5. Monitor the project area for noxious weeds for at least three years following both mechanical and burning treatments. Control weeds as necessary.

Monitoring specific to the Bill Williams Botanical Area (EMA 6)

6. The Botanical Area will be monitored throughout project implementation and thereafter for invasive plant species until the area has adequate native plant establishment to limit future invasions. Invasive plant species will be treated as necessary.
7. Effectiveness monitoring within the Botanical Area and existing Arizona bugbane populations will occur throughout project implementation to ensure adequate protection.

Scenic Resources

8. Closures of temporary or ML-1 roads will be monitored following closure to ensure effectiveness. Additional enforcement and physical measures will be taken to restrict unauthorized road use.
9. Treatment of activity created slash will be monitored to assure timeliness and compliance with ROS classes and SIO categories.

2.4 Alternatives Considered but Eliminated from Detailed Study

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). Public comments received in response to the Proposed Action provided suggestions for alternative methods for achieving the purpose and need. Some of these alternatives may have been outside the scope of the project, duplicative of the alternatives considered in detail, or determined to have components that would cause unnecessary environmental harm or unnecessary safety concerns. Therefore, a number of alternatives were considered, but dismissed from detailed consideration for reasons summarized below.

- An alternative was considered but eliminated from detailed study that would only utilize prescribed burning techniques to meet the desired conditions. While this alternative would partially meet the purpose and need for action, it was determined by the Interdisciplinary Team (IDT) that we could not conduct a prescribed burn on the steep slopes within the project area safely and without causing an undue risk to life and property due to a lack of control features that would help contain the fire to a specific area. Even in consideration of the City Project which surrounds the base of Bill Williams mountain south and southwest of town, the treatments associated with that project do not create a sufficient enough fuel break near Clover Hill (which is just above City and Santa Fe reservoirs) and the ski area to safely contain a prescribed burn onto federal lands. Additionally, this alternative would not meet the purpose and need for action because it would not provide for forest products, and would not effectively meet the need to reduce stand densities. As Kaufmann et al. (2005) demonstrates, the best way to restore forested stands that are denser than historical times is through mechanical thinning.

- An alternative was considered but eliminated from detailed study that would implement a permanent campfire ban within the project area. This alternative was eliminated from detailed study because it would not meet the purpose and need for action (Section 1.2) and was outside the scope of the project. It would not reduce hazardous fuels and would not move vegetative conditions in the project area towards the desired conditions. While escaped campfires pose a hazard to the watershed, forest managers already possess the ability and discretion to implement campfire bans and restrict campfire use within the project area when conditions warrant.

- An alternative was considered but eliminated from detailed study that would not construct any temporary roads or new system roads. This alternative was eliminated from detailed study because it would not meet the purpose and need for action (Section 1.2). While hand crews can be used in areas that have no roads to treat areas to move toward the desired conditions, there is a need to improve the motorized transportation system in the project area to provide for a more sustainable road system where poorly located roads are relocated. This alternative would not allow the relocation of poorly located roads because construction of new roads would be necessary to replace the access to the area. Additionally, this alternative was eliminated because Alternative 1, the No Action Alternative, does not include any temporary roads or new system road construction and addresses this issue.

- An alternative was considered but eliminated from detailed study that would conserve trees larger than 16 inches diameter at breast height (dbh) outside of a well-defined wildland-urban interface (WUI) zone comprising a one-quarter (1/4) mile distance from established residential and other community infrastructure. This alternative would implement a 16 inch diameter cap on treatments outside of the WUI. This alternative was suggested to the Forest Service by the Center for Biological Diversity (CBD) and their reasons for suggesting the alternative (as written in their 2011 scoping comments) have been considered in whole and in part. This alternative was eliminated from detailed study for the following four reasons:

    1. CBD states "A size threshold of 16-inches dbh consistently defines "large" trees in the literature on southwestern ponderosa pine forests (Abella et al. 2006, Friederici 2003)." The definition of a large tree is somewhat subjective and neither the Forest Service nor the literature CBD cites defines "large" trees as those being greater than or equal to 16 inches dbh. Friederici (2003) discusses the debate about diameter caps within the context of the experimental plots of the Greater Flagstaff Forest Partnership and does not define large trees as those greater than or equal to 16 inches dbh, rather discusses how a 16 inch diameter cap was implemented to address political concerns at the expense of restoration objectives. Abella et al. (2006) focuses its research on 16 inch trees because that "size has been widely proposed in the Southwest" and states "Consensus disintegrates…when attention turns to thinning young, postsettlement trees of relatively large diameter (*often* defined as > 16 in.) *emphasis added*." Additionally, Abella et al. (2006) states that "[diameter] caps are a one-size-fits-all policy" and recognizes how management decisions regarding diameter caps should consider management objectives and desired future stand conditions. The Forest Service does not define large trees as those above a certain diameter because it recognizes that different sizes of trees provide different functions within the ecosystem, which is why the effects to several different diameter classes of trees are analyzed in Chapter 3. Chapter 3 discloses the environmental effects of thinning trees across varying diameter classes to meet ecological objectives.

    2. While CBD suggests a wildland-urban interface (WUI) zone comprising a one-quarter (1/4) mile distance from established residential and other community infrastructure, the Region 3 supplement to Forest Service Manual 5140 (effective 09/07/2010) states that

        > WUI includes those areas of resident populations at imminent risk from wildfire, and human developments having special significance. These areas may include critical communications sites, municipal watersheds, high voltage transmission lines, observatories, church camps, scout camps, research facilities, and other structures that if destroyed by fire, would result in hardship to communities. These areas encompass not only the sites themselves, but also the continuous slopes and fuels that lead directly to the sites, regardless of the distance involved.

Following the regions definition of WUI and the recommendations in the Greater Williams Area Community Wildfire Protection Plan (2005), the entire project area (≈18,000 acres) is considered within the WUI.

3. A significant issue was identified from the scoping comments that reflected the importance of retaining pre-settlement trees (see Issue 1). In order to address the issue, the Forest Service developed a mitigation measure designed to retain where possible all pre-settlement trees. Pre-settlement trees are generally defined as those trees greater than 140 years old and are more indicative of the vegetative reference conditions than an arbitrary diameter cap. The effects analysis in Chapter 3 discloses the effectiveness of the mitigation measure for each alternative analyzed in detail.

4. A 16 inch diameter cap would not meet the Purpose and Need for Action (Section 1.2) and not meet or move vegetative conditions toward the goals and objectives of the Forest Plan. The Forest Service has a vast amount of experience analyzing and implementing restoration projects (with and without diameter caps) in the Southwest. For example, on the Williams Ranger District we have recently worked on the Spring Valley Urban/Wildland Interface Fuels Reduction Project (decision signed in 1999), the Frenchy Vegetation/Fuels Management Project (decision signed in 2003), the Dogtown Fuels Reduction Project (decision signed in 2004), the City Project (decision signed in 2005), and the McCracken Project (decision signed in 2012). Our experience has shown that projects with diameter caps do not adequately reduce the risk for a stand-replacement fire because stand density and canopy closure can remain high. Additionally, projects with diameter caps are likely to create more of an even-aged forest structure (because more trees are retained in the older age classes) and are not likely to create or maintain vegetation structural stage (VSS) classes 1 & 2 where openings and young trees dominate the landscape. Also, it is difficult to manage for uneven aged management when there are too many mistletoe infection centers in the overstory; our Forest Plan directs us to manage for uneven-aged forest structure and an even distribution of VSS classes (10/10/20/20/20).

- An alternative was considered but eliminated from detailed study that would represent the "Citizen's Alternative" as suggested by WildEarth Guardians (see their 2011 scoping comments for details). It was considered in whole and in part. This alternative would implement a 12 inch diameter cap and was eliminated for the same reasons as the alternative described above that was suggested by the Center for Biological Diversity; A 12 inch diameter cap would not meet the Purpose and Need for Action (Section 1.2) and not meet or move vegetative conditions toward the goals and objectives of the Forest Plan. Other portions of the alternative such as treatments in the Wildland-Urban Interface (see discussion point #2 above); fuel breaks (Strategic Fuel Treatments); restoring natural fire regimes (see Section 1.2 Purpose and Need for Action) and prescribed fire (Section 2.2); protection of soils (Appendix B Soil and Watershed Best Management Practices); mitigation and monitoring measures (Section 2.3) are already incorporated and considered in the proposed action.

2.5 Comparison of Alternatives

This section provides a comparison of the key features of the alternatives analyzed in detail (Table 1) and a summary of the effects of implementing each alternative (Table 2). Information in the tables is focused on activities and effects where different levels of effects or outputs can be distinguished quantitatively or qualitatively among alternatives.

Table 1. Comparison of Alternatives – Key Features**

Key Feature	Unit of Measure	ALTERNATIVES			
		Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3	Alternative 4
Mechanical Treatments	Acres using ground-based logging equipment	0 acres	11,220 acres	11,220 acres	11,150 acres
	Acres using a cable logging system	0 acres	480 acres	0 acres	0 acres
	Acres using a helicopter logging system	0 acres	3,500 - 4,050 acres[7]	3,980 – 4,050 acres[8]	0 acres
Strategic Fuels Treatments	Acres of non-commercial fuels treatments to enhance control lines	0 acres	2,500 acres*	2,500 acres*	2,500 acres
Prescribed Fire	Acres of prescribed burning	0 acres	15,200 acres	14,710 acres	14,710 acres
Transportation	Miles of new road construction	0 miles	23 miles	22 miles	0 miles
	Miles of temporary road construction	0 miles	16 miles	16 miles	38 miles
	Miles of road obliterated	0 miles	28 miles	28 miles	28 miles
Trails	Conversion of FSR 45 to non-motorized trail	No	Yes	Yes	No
	Construction of new miles of trail	0 miles	1 mile	1 mile	0 miles
	Construction of a new Bixler trailhead	No	Yes	Yes	No
Forest Plan Amendments	Acres of land suitability re-designated	0 acres	8,954 acres	0 acres	0 acres
	Allow deviation from Forest Plan Guidelines	No	Yes	No	No

[7] Within operability zone 7 helicopter logging would be used to treat up to 3,500 acres due to steep slopes and limited access. Helicopter logging systems may also be utilized in operability zones 3, 4, and 5.

[8] Within operability zone 7 helicopter logging would be used to treat up to 3,500 acres due to steep slopes and limited access. Helicopter logging systems may also be utilized in operability zone 3.

	regarding MSO Protected Habitat				
	Allow deviation from Forest Plan Standards and Guidelines in ponderosa pine stands outside of goshawk PFAs and nest areas	No	Yes	No	No
	Allow the exceedance of fire planning objectives for the Arizona Bugbane Botanic Area	No	Yes	No	No

Please note that the Strategic Fuels Treatment acres and acres of prescribed burning overlap with the mechanical treatments.
** Acreages and mileages are approximate.
* This acreage of treatment over laps with other areas because there is the potential the area may be treated with either mechanized equipment or with hand-felling techniques.

Table 2. Comparison of Alternatives – Summary of Effects on Resources.

Resource and Unit of Measure	ALTERNATIVES			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
--- SILVICULTURE ---				
Tree Density	Maintains highest tree density of alternatives	Lowest tree density of alternatives	Reduces tree density	Reduces tree density except on in inoperable areas for ground based equipment.
Vegetative Structural diversity	Lowest diversity; little new development of new tree age classes, grasses/forbs/shrubs	Highest diversity; highest development of new tree age classes, grasses/forbs /shrubs; most uneven-aged structure over time of all alternatives	Increased diversity; develops new age classes of trees, grasses/forbs/shrubs; will lose uneven-aged structure over time	Increased diversity; develops new age classes of trees, grasses/forbs/shrubs; will lose uneven-aged structure over time. Inoperable areas will be similar to Alt 1.
Large Trees	Retains all large trees initially; large oak, aspen, and juniper would be lost over time; large trees will remain at high risk due	Largest intial reduction of large trees of alternatives; growth increases allows higher number of large trees than no-	Retains most existing large trees initially; retains and develops most large trees of alternatives in 40 years;	Retains most existing large trees initially; retains and develops most large trees of alternatives in 40 years;

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
	to wildfire, bark beetle attacks, and heavy competition	action in 20 and 40 years; highest increase in longevity of large trees of alternatives	increased longevity of large trees	increased longevity of large trees. Inoperable areas will be similar to Alt 1.
Forest Health	Poorest forest health; mistletoe continues to increase and intensify over time; stand and individual tree vigor and growth decrease over time; highest susceptibility to epidemic bark beetle attack and catastrophic stand replacing fires	Best forest health of alternatives; lowest mistletoe levels; highest stand and individual tree growth and vigor; lowest susceptibility to epidemic beetle attack and catastrophic stand replacing fires	Improved forest health; reduced mistletoe levels; increased tree growth and vigor; reduced susceptibility to epidemic bark beetle attack and catastrophic stand replacement fire	Improved forest health; reduced mistletoe levels; increased tree growth and vigor; reduced susceptibility to epidemic bark beetle attack and catastrophic stand replacement fire. Inoperable areas will be similar to Alt 1.
Old Growth	Meets forest plan minimum allocation; retains most area of alternatives closest to plan specified old growth characteristics	Meets forest plan minimum allocation; retains least area of alternatives closest to plan specified old growth characteristics	Meets forest plan minimum allocation	Meets forest plan minimum allocation
Snags and Downed Logs	Retains all snags and downed logs initially; develops most snags and downed logs of all alternatives over time	Retains most snags and downed logs initially (some may be lost to prescribed burning but this is mitigated); develops fewest snags and downed logs over time of alternatives	Retains most snags and downed logs initially (some may be lost to prescribed burning but this is mitigated); develops more snags and downed logs over time than alternative 2	Retains most snags and downed logs initially (some may be lost to prescribed burning but this is mitigated); develops more snags and downed logs over time than alternative 2. Inoperable areas will be similar to Alt 1.

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
--- FIRE AND FUELS MANAGEMENT ---				
Active Crown Fire Potential	61% of area demonstrates potential for active crown fire.	Reduces area for potential active crown fire to 18%.	Reduces area for potential active crown fire to 27%.	Reduces area for potential active crown fire to 35%.
Historic Fire Regimes and Condition Class	Fire regime is significantly altered from historic range. High risk of losing key ecosystem components.	Moves most of the area to a fire regime within historical range. Risk is low of losing key ecosystem components.	Moves less than half of the area to historic fire regime range. Some of the area likely to regress more rapidly in future.	Moves less than half of the area to historic fire regime range. Ecosystem components likely lost in future. Some of the area likely to regress more rapidly in future.
Firefighter ability to direct attack	Provides little opportunity for firefighters to safely attack an emerging fire directly. This affects potential costs and containment size.	Makes over half of the project area available for direct attack. Fires likely to be contained quickly in these areas.	Under half of the area available for direct attack tactics.	A third of the area available for direct attack tactics. This affects potential costs and containment size.
Effects to the steep slopes of Bill Williams Mountain	Heavy fuel loadings, low canopy base heights and dense canopy bulk densities exists. Area has high potential for catastrophic fire which directly affects wildlife habitat, watershed and plant communities.	Fuel loadings are reduced, canopy base heights increased and canopy bulk densities are lowered leaving less potential for large areas of crown fire. Habitat, watershed and plants more defendable from catastrophic fire.	Fuel loadings are reduced, canopy base heights increased and canopy bulk densities are lowered leaving less potential for large areas of crown fire. Habitat and watershed are more defendable than Alt. 1 or 4, but not as much as 2. Rare plant species will continue to	Fuel loadings are potentially increased, canopy base heights increased and canopy bulk densities are lowered. Habitat and watershed have high potential of catastrophic fire and potential increase in mortality during prescribed fire due to

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
			have a high risk of catastrophic fire as well as a large area of risk on the north face of the mountain.	densities. Rare plant species at high risk of high fire severity.
--- AIR RESOURCES ---				
Particular Matter 2.5 emissions	Does not produce emissions during prescribed fire activities of mechanical treatments.	Produces emissions from prescribed fire and mechanical treatments during implementation.	Produces emissions from prescribed fire and mechanical treatments during implementation.	Produces emissions from prescribed fire and mechanical treatments during implementation , but less than alternatives 2 and 3.
--- SOIL AND WATER QUALITY ---				
Soil disturbance / displacement	No new soil disturbance or displacement would occur	1,600 to 2,300 acres are expected to exhibit some level of soil disturbance in the form of topsoil displacement and minor profile redistributions from mechanical equipment used to fell, bunch, skid, yard, and land logs and fireline installation. These disturbances will be of short duration as sites will stabilize and revegetate within 1 to 5 years. Adverse disturbance will be minimized by implementation of Best Management Practices (BMPs)	While the types of disturbances would be similar to Alternative 2, fewer acres (approx. 50-100 ac.) are expected to exhibit soil disturbance since areas proposed for cable logging would be excluded under this Alternative, reducing the amount of felling, yarding, landing, and hauling. However, this alternative would not fully achieve the desired	Soil disturbance types would be similar to Alternatives 2 and 3 with fewer acres (approx. 400-625 ac.) expected to exhibit soil disturbance since areas proposed for cable and helicopter logging would be excluded under this Alternative reducing the amount of felling, yarding, landing, and hauling. However, this alternative would

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
		and Soil and Water Conservation Practices (SWCPs) as outlined in Table 3.4.4-1. This Alternative would achieve desired condition for soils and watershed by removing sufficient canopy cover to allow sunlight to penetrate to the forest floor, increasing the growth response of grasses, forbs and shrubs. Fine roots and vegetative ground cover provided by grasses and forbs can more effectively protect soils from erosion by wind and water than forest litter alone.	condition for soils in the project area since higher residual tree canopy cover would intercept more sunlight than Alternative 2 in untreated areas and areas where diameter limits would restrict tree canopy and basal area reductions, decreasing light penetration to the forest floor, thus decreasing the response of grasses and forbs which provide maximum protection of soil surfaces from wind and water erosion.	substantially reduce the acreage that progresses toward desired condition for soils in the project area since approximately 4,000 acres would exhibit higher residual tree canopy cover that would intercept more sunlight than Alternatives 2 or 3. The reduced light penetration to the forest floor would result in a corresponding decrease in the response of grasses and forbs necessary to protect soil surfaces from wind and water erosion.
Soil erosion	No soil erosion above current levels would occur. The 28 miles of poorly located roads that would be obliterated under the Action Alternatives would continue to erode, further decreasing soil productivity in these areas and contributing to	Erosion potential is expected to increase on 10 to 15 percent of areas treated mechanically due to removal or displacement of ground cover. This erosion would be short term (1 to 5 years), localized, and mitigated with implementation of	Erosion potential is expected to increase approximately the same amount as Alternative 2 on areas treated mechanically since the same number and lengths of skid trails and roads and number of landings are	Erosion potential is expected to increase approximately the same amount as Alternatives 2 and 3 on areas treated mechanically since the same number and lengths of skid trails and roads and number of

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
	downstream surface water quality degradation.	BMPs and SWCPs. Erosion potential on Terrestrial Ecosystem Survey (TES) map units currently in unsatisfactory condition would be reduced due to introduction of additional Coarse Woody Debris (CWD) on soil surfaces in these map units.	expected to occur. Since fewer trees would be removed, traffic on these areas would be reduced slightly. Erosion would be short term (1 to 5 years), localized, and mitigated with implementation of appropriate BMPs and SWCPs. Erosion potential on TES map units in unsatisfactory condition would be reduced due to introduction of additional CWD on soil surfaces in these map units.	landings are expected to occur. Soil erosion potential would not increase in areas not treated. Since fewer trees would be removed and fewer acres treated, traffic on these areas would be reduced slightly. Erosion on treated areas would be short term (1 to 5 years), localized, and mitigated with implementation of appropriate BMPs and SWCPs. Erosion potential on TES map units in unsatisfactory condition in operability zones 3, 4, 5, and 7 (106 ac.) would remain in unsatisfactory condition and would not be improved through introduction of additional CWD on soil surfaces in

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
				these map units.
Soil compaction	No additional areas of soil compaction would occur	Approximately 1,600 – 2,300 acres are estimated to exhibit varying degrees of soil compaction, depending on the number and locations of skid trails, landings, and roads, timing of activities, and types of machinery and manual treatments employed. Some dispersed soil compaction would likely occur in areas where trees are mechanically felled and bunched prior to skidding, yarding, and landing.	Slightly fewer acres are expected to exhibit soil compaction since cable logging would be excluded under this Alternative. Fewer acres would be treated and fewer large trees would be felled, bunched, skidded to landings, and hauled. However, the number of skid trails and landings would be approximately the same as Alternative 2.	Soil compaction would be similar to Alternative 3 since cable logging and helicopter yarding would be excluded under this Alternative. However, in remaining area to be treated using ground-based machinery the number of skid trails and landings would be approximately the same as Alternative 2.
Soil Nutrient Cycling	No changes to nutrient cycling would occur.	Soil nutrient cycling would progress toward desired conditions as litter layers are replaced, CWD is increased, and the understory of grasses, forbs, and shrubs improves. Fine roots of grasses and forbs would improve soil aggregate stability, water infiltration, and decrease soil bulk densities.	Soil nutrient cycling would progress toward the desired condition in treatment areas, but not to the extent provided by Alternative 2. Less light would penetrate the forest canopy and reach the forest floor, resulting in a sparser understory vegetative community. Duff would continue to	Soil nutrient cycling would progress toward the desired condition, but not to the extent provided by Alternative 2. Substantial acreage would remain untreated under this Alternative, limiting the acreage of soils that would progress toward desired condition. Duff would continue to provide soil

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
			provide soil nutrients and contribute to soil profile development, but not to the extent that grasses, forbs, and associated litter would.	nutrients and contribute to soil profile development, but not to the extent that grasses, forbs, and associated litter would.
Herbaceous ground cover	Herbaceous ground cover would continue to decline as forest canopies continue to close, soil duff layers increase, and fuel loads continue to increase	Herbaceous ground cover would be greater than the No Action Alternative within one to five years following thinning treatments since more open stand structures would occur following thinning.	Fewer trees would be removed during thinning, resulting in less open stand structure and less light penetration to the forest floor. Herbaceous ground cover would therefore be less than Alternative 2, but greater than Alternative 1.	Less than Alternative 2, but potentially more than Alternative 3.
Soil CWD component	TES map units that do not currently have adequate CWD would exhibit a gradual increase in CWD over a long period of time through tree mortality and decadence. However, these TES units would not benefit from the introduction of CWD that would occur rapidly through vegetation treatments proposed under Alternatives 2	Vegetation treatments will increase CWD in unsatisfactory TES units, improving nutrient stores and protecting soil surfaces under this Alternative. On TES map units that currently have excess CWD, prescribed burning or piling followed by use of prescribed fire would bring CWD levels to desired conditions of 5 to 7 tons per acre.	Vegetation treatments will increase CWD in unsatisfactory TES units, improving nutrient stores and protecting soil surfaces under this Alternative. On TES map units that have excess CWD, treatments would achieve the same desired conditions with regard to CWD	Vegetation treatments will increase CWD in unsatisfactory TES units, improving nutrient stores and protecting soil surfaces under this Alternative. On TES map units that have excess CWD, treatments would achieve the same desired conditions with regard to CWD

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
	through 4.		as Alternative 2.	as Alternative 2. With exclusion of cable logging and helicopter use, substantially fewer acres would be treated, limiting the acreage of soils that would progress toward desired condition with regard to the CWD component.
Soil heating and water repellency (hydrophobicity)	There would be no soil heating or additional soil water repellency (hydrophobicity) under the No Action Alternative. However, conditions would be conducive to increased hazard of high severity wildfire that would result in large areas of hydrophobic soils that would be prone to erosion and sediment delivery to ephemeral and intermittent drainages.	Areas where pile burning is conducted, and some areas where prescribed burning is conducted would exhibit hydrophobic soil conditions and soil sterilization caused by rapid oxidation of soil minerals and organic matter. The occurrence of these conditions would depend primarily on the timing, duration, type, and intensity of fire use. Vegetation treatments would produce more open stand conditions, including canopy gaps that would	The effects of this Alternative are similar to those of Alternative 2. However, there would be fewer piles to burn or less scattered activity-related woody debris under this Alternative since fewer trees would be removed in Mexican spotted owl (MSO) protected activity centers (PACs), pine/oak habitat, and the ponderosa pine type where slopes exceed 40 percent.	The effects of this Alternative are similar to those of Alternatives 2 and 3. However, there are substantially fewer acres treated and therefore fewer piles to burn or less scattered activity-related woody debris under this Alternative since cable logging and helicopter yarding are excluded. While this alternative would reduce the risk of high severity wildfire in areas

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
		reduce fire burn severity and minimize areas of hydrophobic soils. The greatest risk of increased areas of hydrophobic soils would be where prescribed burning is conducted prior to forest thinning. These treatments would reduce the risk of high severity wildfire and associated adverse impacts to soils and watersheds.	While this alternative would reduce the risk of high severity wildfire and associated adverse impacts to soils and watersheds, it would not be to the extent provided by Alternative 2.	where ground-based logging occurs, other areas would remain at risk of high severity wildfire and associated soil heating and hydrophobicity since they would not be treated.
Soil Organisms	No changes to soil organism populations would be introduced as a result of this project under the No Action Alternative.	Soil organism populations are expected to decline for short periods (1 to 3 years) in areas of soil disturbance, compaction and where fire is introduced. Soil organism populations are expected to recover rapidly under this alternative as greater sunlight would reach the forest floor, increasing soil biological activity.	Soil organism populations are expected to decline for short periods (1 to 3 years) in areas of soil disturbance, compaction and where fire is introduced. Soil organism populations are expected to recover more slowly under this Alternative in MSO PACs and pine/oak habitat where slopes exceed 40 percent since less light would penetrate to the forest floor to warm soils and increase soil biological	Soil organism populations are expected to decline for short periods (1 to 3 years) in areas of soil disturbance, compaction and where fire is introduced. Soil organism populations would be unaffected in areas excluded from cable logging and helicopter yarding.

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
			activity.	
Water quality	There would be no changes to surface water quality as a result of this project under the No Action Alternative.	No detectable change in downstream water quality is anticipated.	No detectable change in downstream water is anticipated.	No detectable change in downstream water is anticipated.
Water yield	There would be no changes to water yield as a result of this project under the No Action Alternative	Since only a small percentage of each 6th-level watershed is being treated, only minor increases in water yield are expected. Within the project area, increased soil moisture and groundwater recharge can be expected as tree basal area is reduced.	Since only a small percentage of each 6th-level watershed is being treated, no detectable change in water yield is expected. Within the project area, increased soil moisture and groundwater recharge can be expected as tree canopy and numbers are reduced. This effect will be slightly less than alternative 2 as fewer trees are removed.	No detectable change in water yield is expected under this Alternative. While increased soil moisture and groundwater recharge can be expected in treatment area, there would be substantially fewer acres treated under this Alternative.
---WILDLIFE---				
Mexican Spotted Owl (MSO)	Perpetuates high probability of active crown fire that would degrade most or all MSO habitat. Will likely lead to a scenario similar to Pumpkin Fire of 2000 (where an entire Protected Activity Center	Most reduces probability of active crown fire in MSO habitat. Outside cable-logging areas, uneven-aged management most sustainably conserves MSO habitat at or toward desired conditions.	Moderately reduces probability of active crown fire in MSO habitat. Even-aged management (9" diameter cap on tree-cutting) moderately conserves MSO	Least reduces probability of active crown fire in MSO habitat, but is still preferable over Alternative 1. Prescribed fire alone does little to conserve MSO habitat at or toward

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
	was consumed by stand-replacing wildfire).		habitat at or toward desired conditions, although in an unsustainable manner.	desired conditions.
Northern Goshawk	Perpetuates high probability of active crown fire that would degrade most or all goshawk habitat.	Most protects nest areas and Post-Fledging Family Areas (PFAs) from active crown fire. Most restores foraging areas toward conditions to which the species adapted and evolved. *Alternatives 2-4 have identical effects on goshawk nest areas and PFAs, in terms of vegetative treatments.*	Moderately protects nest areas and PFAs from active crown fire. Moderately restores foraging areas (i.e., landscapes outside PFAs) toward conditions to which the species adapted and evolved.	Least protects nest areas and PFAs from active crown fire. Least restores foraging areas toward conditions to which the species adapted and evolved. *Alternatives 2-4 have identical effects on goshawk nest areas and PFAs, in terms of vegetative treatments*
Golden Eagle and Sensitive Species, Management Indicator Species, and Migratory Birds that primarily use grasslands, meadows, and forest/woodland savannas with low tree densities and more open canopies.	Perpetuates encroachment of habitat by invading conifers.	Most restores habitat.	Somewhat restores habitat. Effects of Alternatives 3-4 are identical.	Somewhat restores habitat. Effects of Alternatives 3-4 are identical.
Sensitive Species, Management Indicator Species, and Migratory Birds that primarily use forests and woodlands that are denser or with more closed canopies.	Perpetuates high probability of active crown fire that would degrade most or all densely forested habitat.	Most restores habitat toward pre-settlement conditions. Most protects historically dense areas from active crown fire. Most reduces tree density in currently dense areas that were historically open.	Moderately restores habitat toward pre-settlement conditions. Moderately protects historically dense areas from active crown fire. Moderately reduces tree density in currently dense	Least restores habitat toward pre-settlement conditions. Least protects historically dense areas from active crown fire. Least reduces tree density in currently dense areas that were historically open.

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
			areas that were historically open.	
Road-related concerns for general wildlife conservation	Road-related habitat degradation does not occur.	Road-related habitat degradation occurs under this Alternative. Alternatives 2 and 3 are identical in terms of road-related effects on wildlife.	Road-related habitat degradation occurs under this Alternative. Alternatives 2 and 3 are identical in terms of road-related effects on wildlife.	Road-related habitat degradation is least under this Alternative.
--- RECREATION RESOURCES ---				
Recreation Resources 1. % of area of each Recreation Opportunity Spectrum (ROS) class in treatment (for project area). 2. Ability to maintain recreation settings over time. 3. Displacement of Recreationists.	1. 0% for all ROS Classes, inside of the project area. 2. Decreased 3. Little to no displacement of recreationists, except due to fire activity	1. 30% of Roaded (R), 82 % of Roaded Natural (RN), 95% of Semi Primitive Motorized (SPM), 100% of Semi Primitive Non Motorized (SPNM) 2. Increased 3. Short-term Increase in the displacement of recreationists during implementation	1. 30% of R, 82 % of RN, 95% of SPM, 100% of SPNM 2. Increased 3. Short-term Increase in the displacement of recreationists during implementation	1. 30% of R, 70% of RN, 83% of SPM, 18% of SPNM 2. Slightly Increased 3. Slightly less Short-term Increase in the displacement of recreationists during implementation
--- SCENIC RESOURCES ---				
Scenic Resources	No short-term impacts. There is the potential for unnaturally large, stand replacing wildfires to dramatically change the scenic attractiveness of the area, and to the chance of achieving the	Short-term effects while management activities are taking place and about 5 years following completion. Most improved ability to protect and maintain scenic resources in the project area. Meet forest plan scenic integrity	Short-term effects while management activities are taking place. Improved ability to protect and maintain scenic resources. Meet forest plan scenic integrity objectives in project area.	Somewhat improved ability to protect and maintain scenic resources in the project area. Makes least progress toward meeting forest plan scenic integrity objectives in the project area.

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
	desired landscape character for many decades.	objectives in project area.		
--- RANGE ---				
Potential change in forage production	None initially; Abundance and productivity will decrease in the long-term; Species richness may decline in the long-term.	Greatest increase in understory abundance and productivity of all alternatives; Species richness may increase.	Increase in understory abundance and productivity; Species richness may increase.	Increase in abundance and productivity; Species richness may increase. Least change of action alternatives.
--- HERITAGE ---				
Cultural Resource Concerns	The continued deposition of fuels increases the likelihood of a high intensity catastrophic wild fire on Bill Williams Mountain. It is likely that many of the prehistoric and especially the few sites with combustible features would suffer adverse effects from intense fire effects and post-fire erosion.	Reducing the amount of dead and down woody debris, ladder fuels, and unnaturally high tree density would greatly reduce the risk of effects to heritage resource sites from catastrophic wildfire.	Same as Alternative 2.	Similar to effects in Alternative 2 and 3; however, because the steep slopes of Bill Williams Mountain would not be treated, most of the heritage resources which are located downslope would be vulnerable to the effects of post fire flooding and erosion following a high intensity catastrophic fire.
--- WEEDS AND RARE PLANT SPECIES ---				
Rate of introduction and spread of invasive weeds (short-term)	No effect	Greatest potential increase of all alternatives.	Potential increase	Potential increase
Rate of introduction and spread of invasive weeds (long-term)	Greatest increase of all alternatives following intense wildfire.	Potential increase or decrease; Increase less than that of alternative 1 following an	Potential increase or decrease; Increase less than that of	Potential increase or decrease; Increase less than that of

Table 2. Comparison of Alternatives – Summary of Effects on Resources.				
Resource and Unit of Measure	**ALTERNATIVES**			
	Alternative 1 No Action	**Alternative 2 Proposed Action**	**Alternative 3**	**Alternative 4**
		intense wildfire.	alternative 1 following an intense wildfire.	alternative 1 following an intense wildfire.
Rare Plant Species (short-term)	No Effect	Improvement in habitat quality for Forest Service Sensitive species; Greatest potential reduction in habitat quality for Arizona bugbane of all alternatives.	Improvement in habitat quality for Forest Service Sensitive species; Potential reduction in habitat quality for Arizona bugbane.	Improvement in habitat quality for Forest Service Sensitive species; Potential reduction in habitat quality for Arizona bugbane.
Rare Plant Species (long-term)	Greatest potential reduction in habitat quality for all species and of all alternatives.	Improvement in habitat quality for Forest Service Sensitive species; Potential reduction in habitat quality for Arizona bugbane.	Improvement in habitat quality for Forest Service Sensitive species; Potential reduction in habitat quality for Arizona bugbane.	Improvement in habitat quality for Forest Service Sensitive species; Potential reduction in habitat quality for Arizona bugbane.
--- LANDS AND MINERALS ---				
Threat to communication site	Highest risk of loss due to catastrophic fire	Least amount of risk of all alternatives	Less risk than alternative #1and #4, but more risk than alternative #2	Less risk than alternative #1, but more risk than alternatives #2 and #3
--- SOCIAL AND ECONOMIC ---				
Social Impacts	High-risk of undesirable consequences	Moderate short-term impacts	Moderate short-term impacts	Moderate short-term impacts
Economic Impacts	No cost to implement, however, the risk of high costs to mitigate high intensity fire and flooding would be similar to costs in Alternative 3.	The cost to implement is approximately $17.1 million.	The cost to implement is approximately $56.2 million.	The cost to implement is approximately $7.1 million.

Chapter 3 – Affected Environment and Environmental Consequences

3.1 Introduction

This Chapter summarizes the physical, biological, social, and economic environments of the project area and the effects of implementing each alternative on that environment. It also presents the scientific and analytical basis for the comparison of alternatives analyzed in detail (Chapter 2 Section 2.2). The best information available was used to discuss the affected environment and environmental consequences of the action alternatives and the "best available science" was considered throughout the discussions presented within this chapter. The specialist reports in the project record for the Bill Williams Mountain Restoration Project are hereby incorporated by reference to supplement the sections in this chapter.

3.2 Silviculture

3.2.1 Affected Environment

The vegetative cover types for the Bill Williams Mountain Restoration Project (project area) are displayed in Table 3.2-1. Cover types are identified by areas with the highest representation of a vegetative species (stands). Depending on the complexity of cover types, stand sizes within the project area range from 1/10 of an acre to a couple hundred, averaging 45 acres. Smaller stands typically exist on Bill Williams Mountain slopes due to the high diversity of abiotic factors such as drainages, soils, slope and aspect.

Table 3.2-1 Bill Williams Vegetation Cover Types(FS Lands)

Vegetation Cover Type	Acres	% of Project
Ponderosa Pine	10,554	69%
Oak Woodland	717	5%
Douglas Fir	299	2%
White Fir	1,619	11%
Pinyon-Juniper Woodlands	654	4%
Juniper Woodland	947	6%
Mixed-Hardwoods	146	< 1%
Aspen	140	< 1%
Grasslands	64	< 1%
Mountain-mahogany	40	< 1%
Rocklands	22	< 1%
TOTAL Treatment ACRES	**15,202**	

The base of Bill Williams Mountain is primarily surrounded by ponderosa pine cover type. The southwestern slope of the mountain consists of dry ponderosa pine and gradually transitions to Douglas-fir and white fir at higher elevations. The northeastern slope of the mountain consists of Douglas-fir and white fir cover types with scattered aspen and ponderosa pine. Stands that average above 40% slope represent 17% of the project area.

Ponderosa Pine and Pine-Oak

The ponderosa pine cover type is approximately 69% of the project area. Some ponderosa pine stands are on the steep slopes of Bill Williams Mountain but mainly are on and surrounding the lower slopes. The presence of white fir, Douglas fir, woodlands, shrublands and grasslands occasionally occurs as small inclusions to the ponderosa pine cover type. Based on the quality and density of gambel oak within ponderosa pine cover type defined in the MSO recovery plan and forest plan, stands were classified as pine-oak. Within the project area, there are 88 stands of pine-oak, approximately 4,440 acres. Much of the ponderosa pine within the project area is dominated by the same age class, approximately 60 to 100 years old. A high density of even-aged ponderosa pine forest limits forest diversity, sustainability, health, and protection in and surrounding the project area (Allen et al 2002, Binkley et al 2007, Cooper et al. 1960, Fettig et al 2007 Stoddard et al 2011, Triepke et al 2011 Savage and Mast 2005, Strom and Fulé 2007).

Figure 3.2-1 displays the current distribution of vegetative structural stages (VSS) for the project area's ponderosa pine cover type in Northern Goshawk (goshawk) post –family fledgling area's (PFAs) and landscapes outside goshawk PFAs (LOGPFA) habitats. VSS in the Kaibab Forest Plan (forest plan) describes forested areas in the following classification: 1 (Grass/Forb/Shrubs), 2 (Seedling/Sapling), 3 (Young Forest.), 4 (Mid-age Forest), 5 (Mature Forest), 6 (Old Forest).

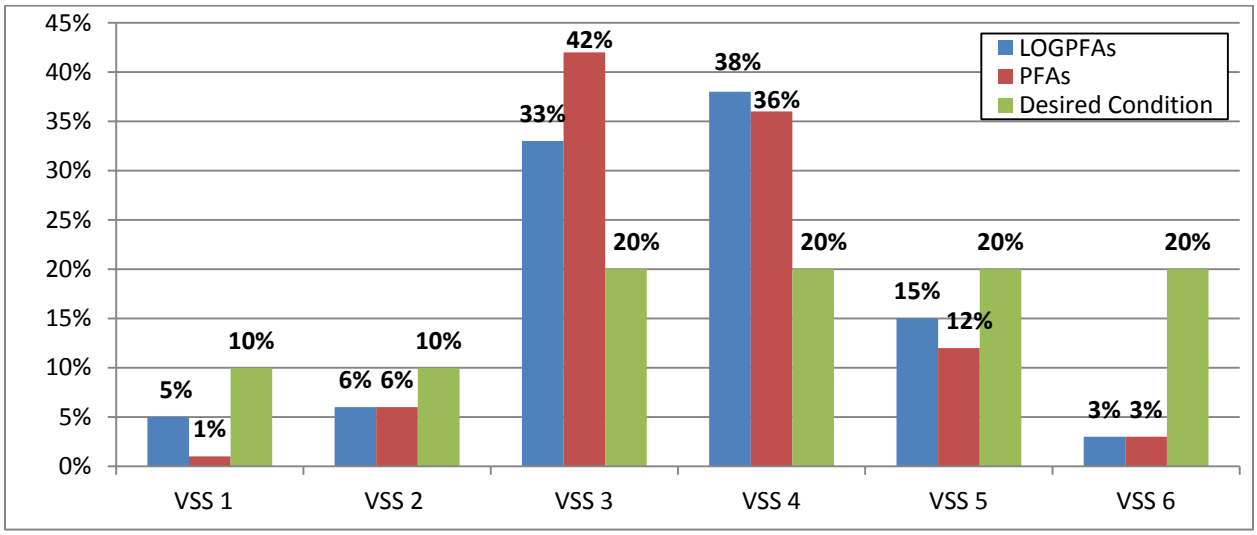


Figure 3.2-1 Ponderosa Pine Cover Type by Vegetative Structural Stages (VSS) under Current Condition

Figure 3.2-1 shows the current limited forest structural and age diversity in the ponderosa pine cover type. There is currently a deficit of VSS 1, 2, 5 and 6 from the desired condition. VSS 3 and 4 are approximately twice the desired percentage. Limited forest structure diversity leads to uncertain forest

sustainability (Binkley et al. 2007). Figure 3.2-2 shows the project area's ponderosa pine cover type VSS projected for 40 years in the future.

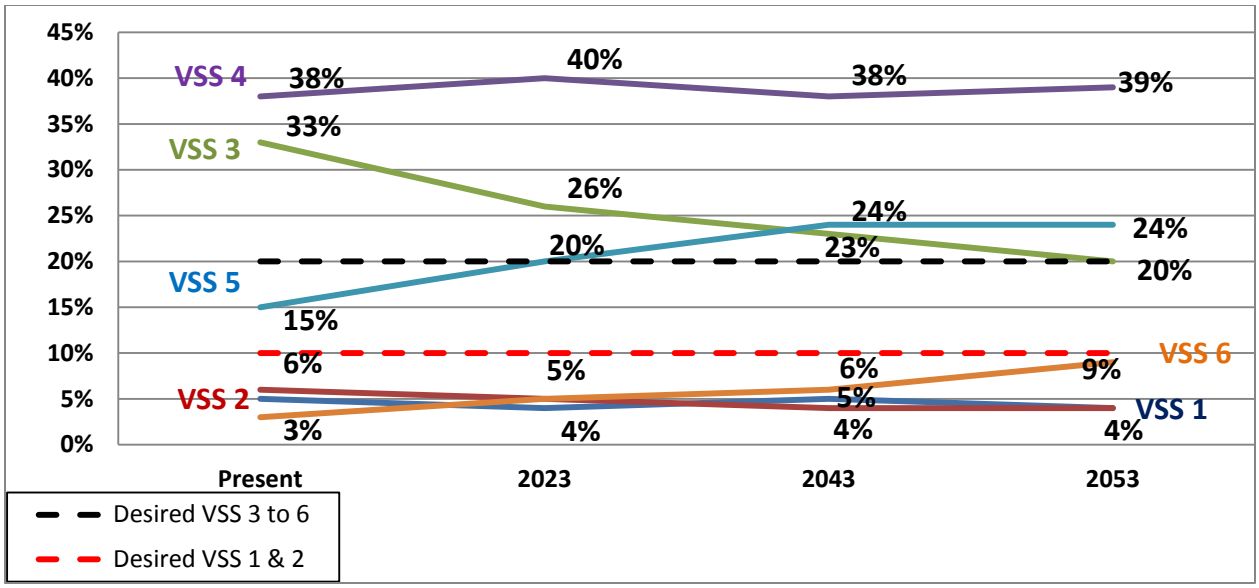


Figure 3.2-2 40 year Projection of Ponderosa Pine Cover type (LOGPFA) Sustainability in the Project Area

Figure 3.2-2 shows the majority of the ponderosa pine cover type in the project area will remain dominated by a mid-aged forest (VSS4) for 40 year analysis period, limiting the sustainability of desired VSS 1, 2 and 6 conditions. Figure 3.2-2 assumes disturbances such as fire, insect and diseases are static. Depending on the intensity and severity of fire, insect or diseases; the associated mortality would contribute to changes in structural diversity and sustainability (Binkley et al. 2007, Fettig et al. 2007, Strom and Fulé 2007). The current condition of crown fire risk is discussed in the fuels report. Figure 3.2-1 and -2 shows the deviation from the desired VSS conditions currently and through time.

Research on bark beetles shows when trees are stressed from over stocking they are more susceptible to attack by *Dendroctonus* bark beetles (Negrón et al. 2000, Fettig et al. 2007). Ponderosa pine stands with a basal area (BA) greater than 120 $ft.^2$/ac are considered to be high hazard for bark beetle attack, while stands with basal areas between 80-120 $ft.^2$/ac are categorized as moderate risk. Figure 3.2-3 compares stand density by basal area (BA) to the risk of a bark beetle attack. Currently the majority of the ponderosa pine cover type in the project area is at high risk to bark beetle attacks. For the 40 year analysis period, the same areas maintain and increase a high risk of bark beetles attacks.

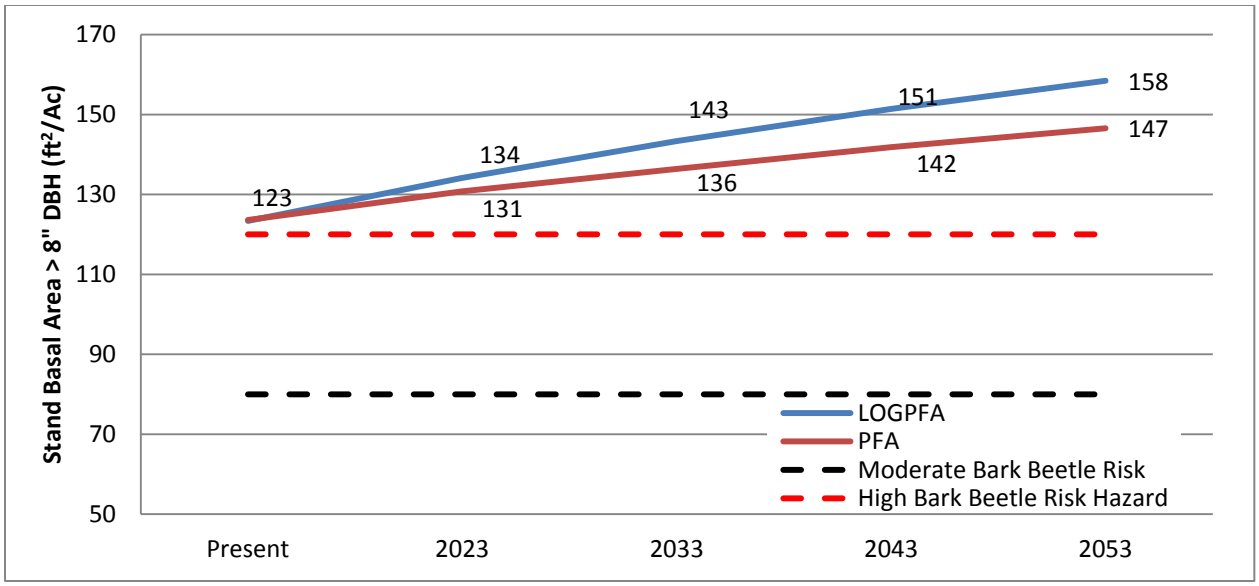


Figure 3.2-3 40 year Measure of Bark Beetle Risk and Sustainability for the Ponderosa Pine Cover Type

The high risk of bark beetle attack in the majority of the ponderosa pine cover type displays concerns of a potential bark beetle build up and outbreak. Fettig et al. (2007) summarized research on how *Dendroctonus*, specifically, prefer larger diameter trees when bark beetle risk is high. *Dendroctonus* target larger trees in an outbreak due to the increased tree stress brought on from lack of nutrients, water, competition and high tree density (Klenner and Arsenault 2009). Depending on the intensity and severity of a potential bark beetle outbreak, mortality would contribute the change in structural diversity and sustainability (Negron et al. 2009). A bark beetle outbreak would move forest structure away from desired conditions by increased fuel loadings and mortality of the oldest tree cohort. During the recent severe drought in northern Arizona, a majority of ponderosa pine mortality attributed to bark beetles were caused by *Ips* species (Negrón et al. 2009). Significant correlations were found between increasing tree density and the probability and amount of tree mortality caused by *Ips* attacks.

The project area is a chronic home for dwarf mistletoe (DM). Conklin and Fairweather 2010 recognize through various researches that DM affects a variety of insects, birds and mammals. It is also explained that DM changes forest structure. Hawksworth and Wiens 1996 explain how infection centers generally become more open over time, lowering canopy cover and basal area. The project area consists of approximately 5,178 acres of the ponderosa pine cover type exhibiting high infection levels; these are areas where greater than 20% of the trees per acre (TPA) in a stand are infected. 20% is a manageable level for sustainable uneven aged management over time. 51% of the ponderosa pine cover type consist of moderate to low infection levels (lower than 20% of TPA infected). Figure 3.2-4 illustrates the intensity of DM within the ponderosa pine stands of high infection levels. 40 years into the future show TPA infected increases to 68%. High infection levels would move stands toward decreased canopy covers and basal areas, increased fire severities and move forest structure away from desired conditions (Hawksworth and Wiens 1996).

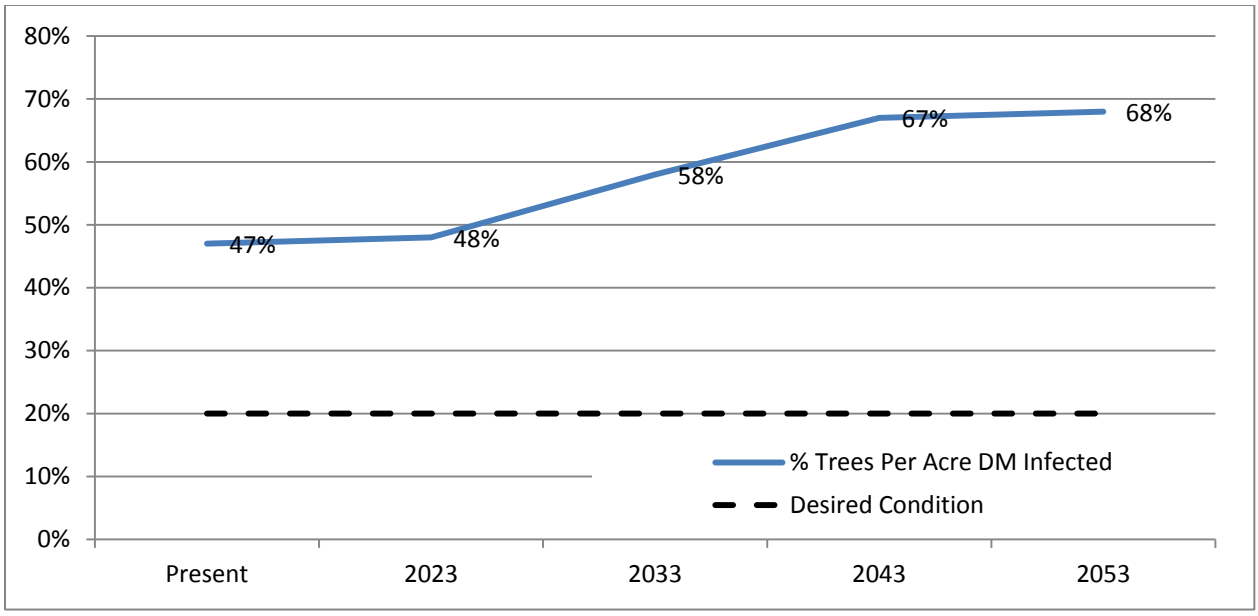


Figure 3.2-4 % of TPA infected of extremely infected DM Stands (Ponderosa Pine Cover Type)

Figure 3.2-5 shows the severity of the high DM infected areas. Dwarf mistletoe rating (DMR) is used to quantify infection severity (Hawksworth 1977). The severity of DM in areas with high infection levels rise above extreme within a 40 year period. DMR is associated with growth and mortality impacts. In areas of high DM infection, mortality can be expected due to the added stress leading to tree attacks by bark beetles (Kenaley et al. 2008, Conklin and Fairweather 2010).

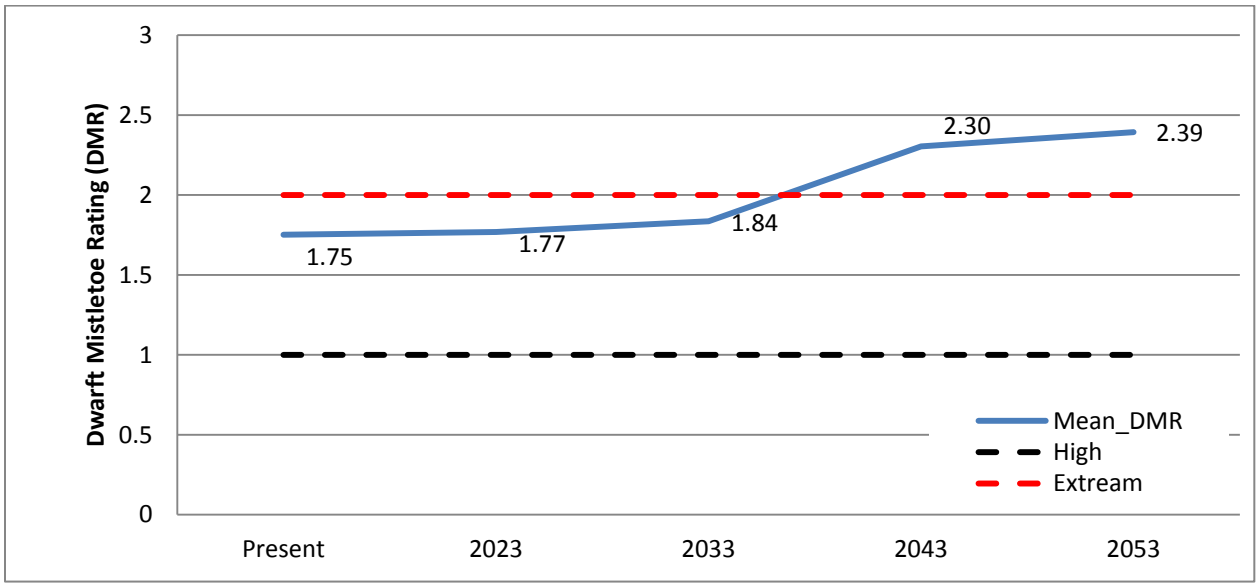


Figure 3.2-5 Dwarf Mistletoe Rating of Extremely Infected DM Stands (Ponderosa Pine Cover Type)

Conklin and Fairweather 2010 explains how DM rarely kills all the trees in a stand or results in sizable deforestation but tree growth will decline as trees become dominated by stunted and deformed

characteristics. Sacrificing productivity and habitat, DM infections beyond the foreseeable future can lead to an open, uneven aged forest, changing the structural diversity and sustainability. Due to low forest productivity from high and extreme levels of stand DMR, uneven aged silviculture management would be difficult and forest structures would not meet desired conditions.

Mixed Conifer

Mixed conifer is approximately 12% of the of the project area which consist of Douglas-fir and white fir stands. The majority of the mixed conifer stands are on the steep slopes of Bill Williams Mountain. Mixed conifer consists of white fir, Douglas fir, woodland species, ponderosa pine and small patches of aspen. Age classes within the mixed conifer are highly variable due to historic land management practices.

The majority of the mixed conifer in the project area was historically dominated by ponderosa pine and Douglas fir, and is considered to be a dry (historic frequent-fire) mixed conifer forest type (Cocke et al. 2005). Fire exclusion has altered the project area's mixed conifer by allowing grassy openings between forested areas to fill in with younger trees. Historically, fire reduced the density of younger trees competing against older trees. Portions of the mixed conifer type are in mid-succession or climax condition with an understory of white fir. Over time, species composition within the entire mixed conifer type will shift from fire-resistant shade-intolerant species to non-fire-resistant shade-tolerant species dominance (e.g., white fir) (Fulé et al 2009). Most of the stands within the mixed conifer have currently transitioned to the dominance of shade tolerant species. Some wet mixed conifer (historic infrequent fire) forest type can be found in isolated area on the north facing slope and major drainages on Bill Williams Mountain. Cocke et al. (2005) show in studies on the San Francisco Peaks, approximately 30 miles west of the project area, how mesic species have encroached to lower altitudes and how mixed conifer cover types densities have increased since 1876. They explain how these changes have created conditions opposite to those suitable for warmer, drier future climates that will display increased fire risk, setting the stage for sudden severe change.

Within the mixed conifer cover type, an increased amount of competition to the older age classes decreased their resistance and resilience to insect, diseases and fire under current conditions. Departure from forest conditions conducive to low intensity-frequent fire limits forest diversity, sustainability, health, and protection in and surrounding the project area (Cocke et al. 2005, Fulé et al 2009). Figure 3.2-1 displays the current distribution of VSS for the project area's mixed conifer cover type in goshawk LOGPFA habitat.

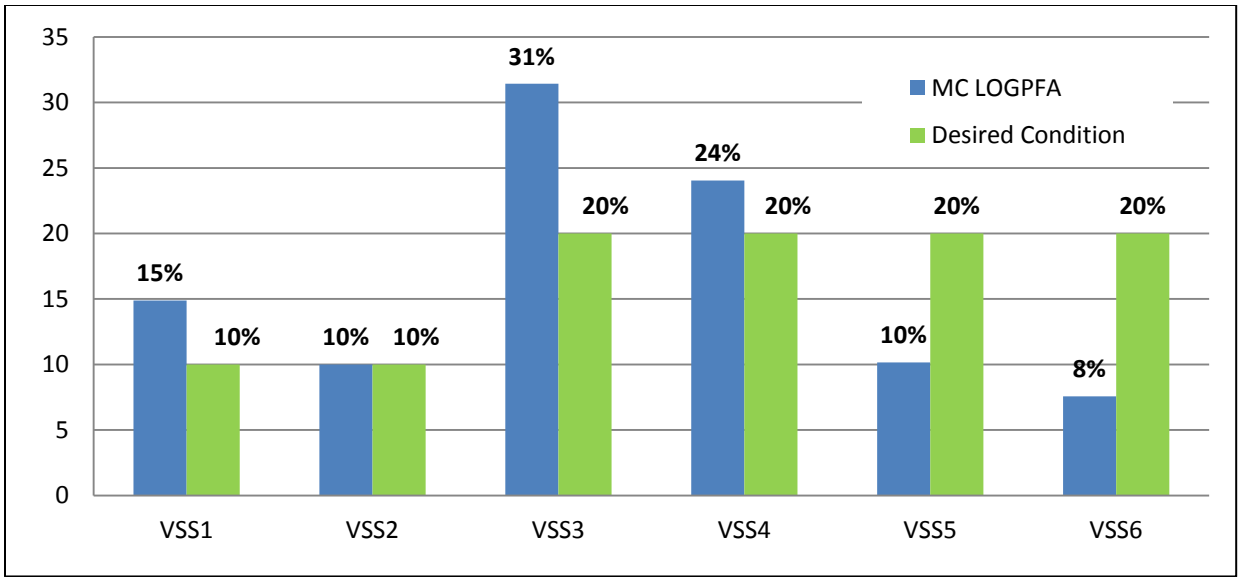


Figure 3.2-6 Mixed Conifer Cover Type VSS Current Condition

Figure 3.2-6 shows the current departure of forest structural and age diversity to the desired condition in the mixed conifer cover type. There is currently a deficit of VSS 5 and 6 from the desired condition. Mid-aged VSS 3 and 4 are in excess. There is active regeneration demonstrated in VSS 1 and 2. Departure from the desired condition limits diversity in forest structure leading to uncertain forest sustainability. Figure 3.2-7 shows the project area's mixed conifer cover type VSS for the next 40 years.

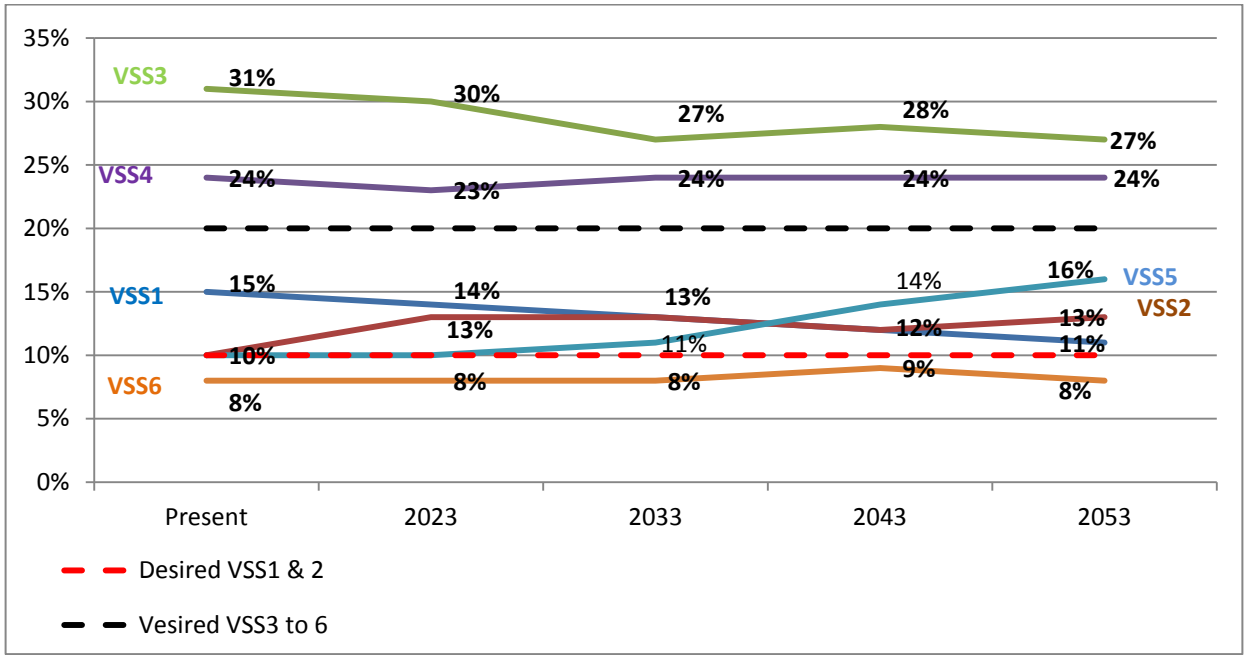


Figure 3.2-7 40 year Measure of Mixed Conifer Cover type (LOGPFA) Sustainability

Figure 3.2-7 shows the majority of the mixed conifer cover type in the project area will remain dominated by a mid-aged forest (VSS4) and young forest (VSS3) for 40 years, limiting the sustainability of desired VSS 5 and 6 conditions. Figure 3.2-7 assumes disturbances such as fire, insect and diseases are static. Depending on the intensity and severity of fire, insect or diseases; the associated mortality would contribute to changes in structural diversity and sustainability. The current condition of crown fire risk in mixed conifer is discussed in the fuels report.

Mixed conifer species such as Douglas-fir and white fir are capable of living in conditions with higher tree densities (Higher Stand Density Index (SDI) maximums). With the ability of some mixed conifer species sustaining higher densities, species such as ponderosa pine and gambel oak become the first to be stressed and perish from competition. Species lost from mixed conifer stands reduced species diversity and risk losing of old trees. This is with the assumption of no interactions of other disturbance agents such as bark beetles and DM. Currently the majority of the mixed conifer cover type in the project area is at high risk to bark beetle attacks, Figure 3.2-8. Over the 40 years of the projected stand growth, the same areas maintain and have increasing high risk of bark beetles attacks. Through time the high risk of bark beetle attacks will result in the loss of old trees and increased fuel loadings ultimately reducing forest diversity and increasing the risk of stand replacing wildfires.

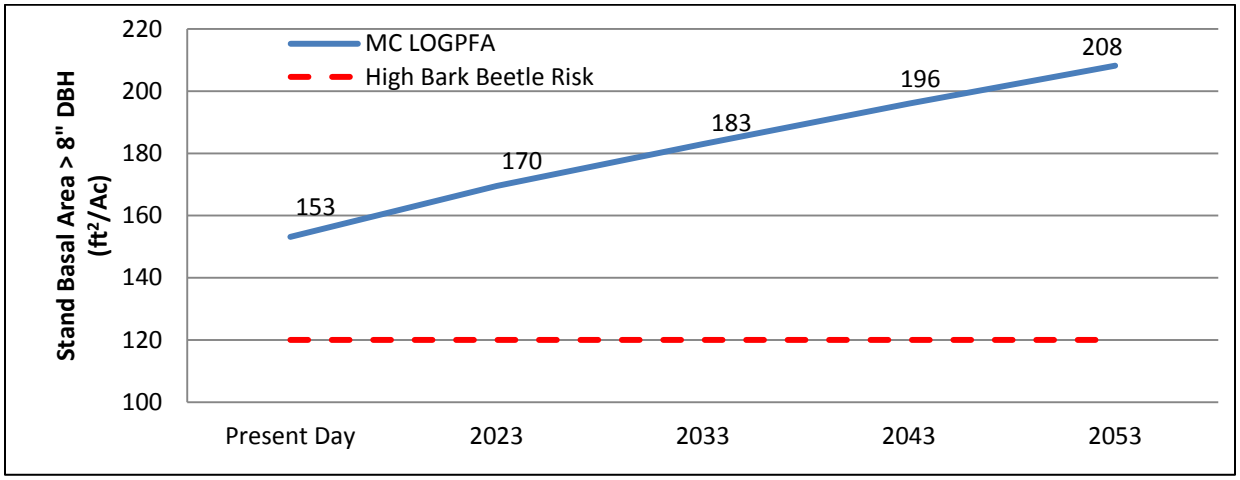


Figure 3.2-8 40 year Measure of Bark Beetle Risk and Sustainability for Mixed Conifer Cover Type

DM also exists in the mixed conifer cover type. The project area consists of approximately 720 acres of the mixed conifer cover type exhibiting high DM infection levels (> 20% Infected TPA). 20% is a manageable level for sustainable uneven aged management over time. 64% of the mixed conifer cover type consists of moderate to low infection levels (< 20% Infected TPA). Figure 3.2-9 illustrates the intensity of DM within mixed conifer stands of high infection levels for Douglas-fir and ponderosa pine. 40 years into the future show TPA infected increases to 75% for ponderosa pine and 42% of Douglas-fir. The reduction of DMR in Figure 3.2-9 is due to the added regeneration of non infected trees combined with overstory mortality. Through time the regeneration becomes more infected and trends for Douglas-fir increases.

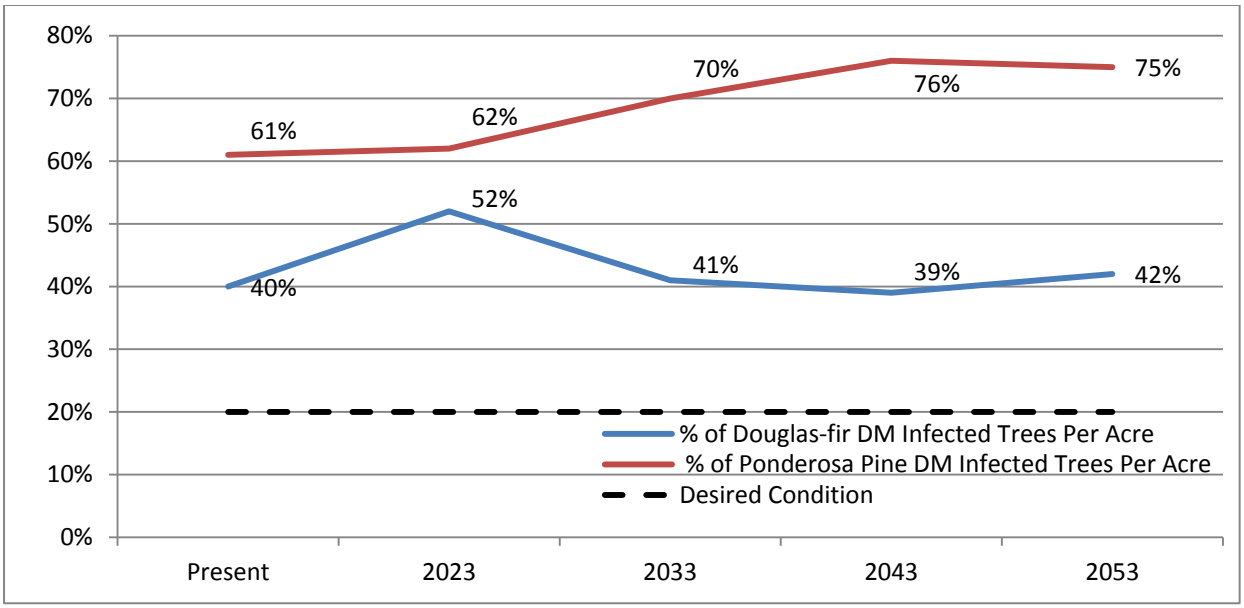


Figure 3.2-9 Percent of TPA infected of extremely infected DM Stands (Mixed Conifer Cover Type)

Figure 3.2-10 shows the severity of the high DM infected areas. The severity of DM in mixed conifer areas of high infection levels rise above extreme after present day. Analysis shows that ponderosa pine DMR keeps raising for the 40 year period while Douglas-fir DMR declines below extreme to high DMR. This decline is due to the added regeneration of non infected trees combined with overstory mortality. Through time the regeneration becomes more infected and trends for Douglas-fir increases.

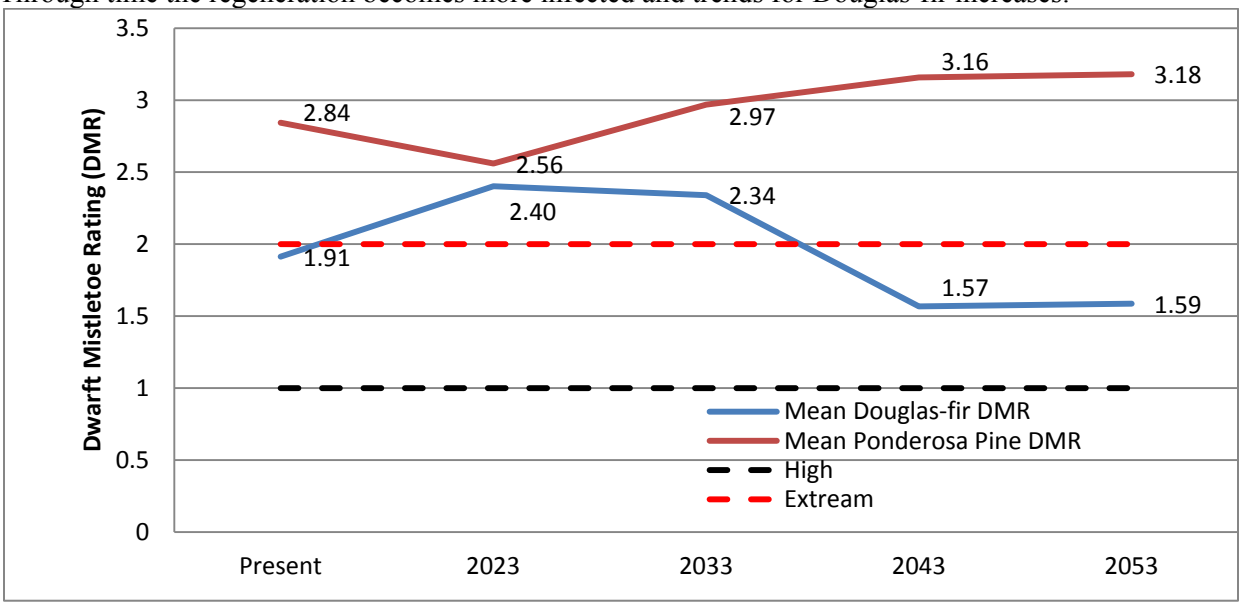


Figure 3.2-10 DM Rating of Extremely Infected DM Stands (Mixed Conifer Cover Type)

Aspen

There are 140 acres of aspen stands within the project area. These are stands that consist of aspen. Aspen also exist in isolated patches within the mixed conifer cover type and are typically on steep slopes. The

aspen cover type within the project area have been encroached and suppressed by conifer species resulting in a decline to the population (Fairweather et al 2008).

Woodlands and Shrublands

Oak, juniper and pinyon woodlands consist of approximately 15% of the project area. Stands typed mixed hard woods typically consist of gambel oak, choke cherry, mountain-mahogany and cliff-rose. Shrublands are primarily mountain-mahogany and cliff-rose. Conifer species are found establishing in these stands and are evenly aged.

Grasslands and Rocklands

Grasslands have been encroached for the past 140 years by ponderosa pine and juniper. In many areas, tree encroachment has reduced the grass and forage production below the stands' potential(USDA 2005, Stoddard et al 2011). Rocklands are a minor component of the project area but contain minor inclusions of aspen and conifer species.

3.2.2 Direct and Indirect Effects

Vegetation Structure

The primary forest management direction in the forest plan is to manage for: uneven-age stand conditions, old age trees so old forest structure will be sustained over time and a mosaic of vegetation densities, age classes and species composition across the landscape. The vegetation structure analysis assumes a projected treatment date of 2013. To accurately depict the 3 scales of analysis for vegetation structure, all three scales are displayed side by side. Alternatives differ based on biasing toward a certain type of forest structure or when creating early seral stage conditions (forest canopy openings of grassy areas and seedlings/saplings). Table 3.2-6 shows how the alternatives could differ based on assumptions of how much of the area will be moved into an early seral stage. For example, in the ponderosa pine cover type alternative 3 and 4 will maintain the 20% of a stands area in an early seral stage. 20% of early seral stages in alternatives 3 and 4 are created and maintained for regeneration openings. Alternative 1 will generally maintain a low percentage of early seral stage conditions from no treatments. Additional seral stages created in alternative 2 are by increasing openings or interspaces between groups which emphasizes an open forest strategy (Cooper 1960, Covington and Moore 1994,White 1985, Allen et al 2002). Assumptions for alternative 2 are based on evidence of historic tree distribution in the project area and past projects on the Williams Ranger District that restored forest structure to historic tree distributions (Covington, W.W. and M.M. Moore. 1994). The purpose of Table 3.2-6 is to show, with generalized assumptions, on how alternative 2 will represent a pine savanna condition with grassy openings surrounding tree groups compared to all the alternatives. Assumptions are bases on aerial imagery of the project area and previous treatments.

Table 3.2-6 Estimated Stand Percentages of Seral Stages Between Alternatives after Treatment Year*

		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Ponderosa Pine*	Early	5%	50%	20%	20%
	Mid to Late	95%	50%	80%	80%
d Co nif	Early	5%	40%	20%	20%

	Mid to Late	95%	60%	80%	80%
Pinyon Juniper	**Early**	20%	75%	75%	75%
	Mid to Late	80%	25%	25%	25%
Aspen	**Early**	5%	50%	50%	50%
	Mid to Late	95%	50%	50%	50%

* Percentages do not include, Arizona Bugbane Botanical Area, PAC Core, and Goshawk Nest. These areas will maintain a higher percentage of mid to late seral stages.

Ponderosa Pine and Pine-Oak

Vegetation structures for approximately 91% of the ponderosa pine cover type (LOGPFA) are demonstrated in VSS through time in Figures 3.2-11 to 3.2-15. Reference the wildlife section for MSO Pine oak analysis on evaluation criteria. For the following vegetation structure analysis, pine oak habitat is averaged within its overlapping goshawk habitat. The alternative's effects are being based on direct actions/no actions represented in 2014 and how well it meets the desired condition 40 years into time. Indirect effects are described as changes due to an increase or decrease of density from another VSS.

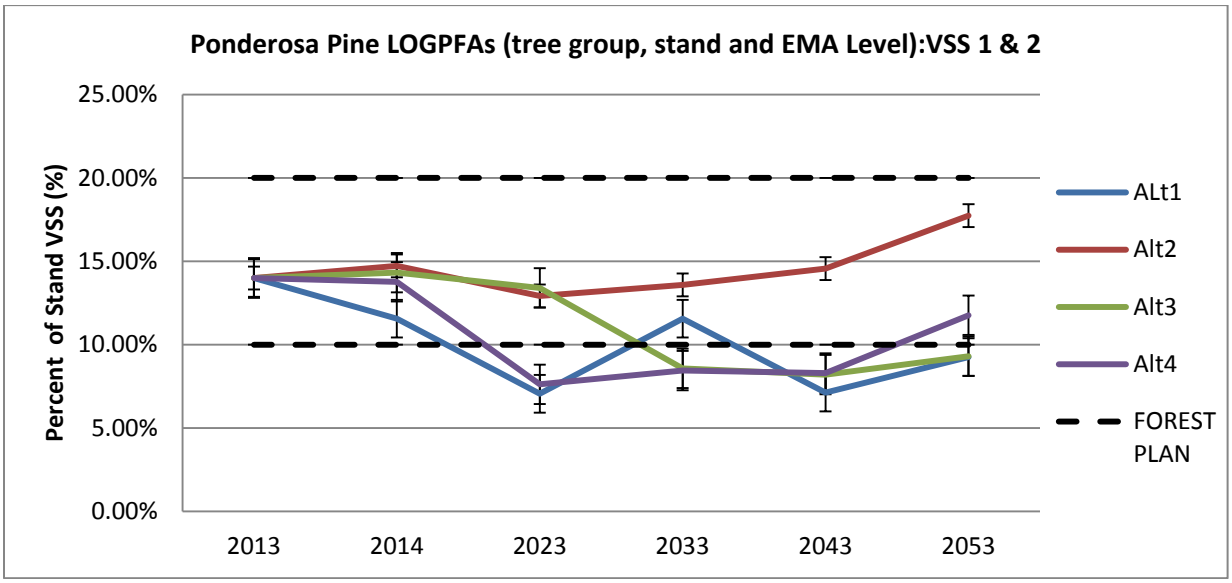


Figure 3.2-11 Ponderosa Pine LOGPFAs (tree group, stand and EMA Level): VSS 1 and 2

Ponderosa pine forested areas of grass/forb/shrub to seedling/sapling stages (VSS1 and 2) would be regulated and implemented based on area percentages which would guarantee the amount desired for each alternative. Figure 3.2-11 demonstrates the current amount of VSS 1 and 2s with estimated regeneration rates, indirect effects from other VSS classes' excelling in VSS indirectly changes VSS 1 and 2 percentages. The VSS 1 and 2 analysis biases toward areas dominated with grasses, forbs, seedlings and

saplings. The main reason the analysis shows low percentages is due to larger yellow pines, larger trees and reserve trees among areas designated for regeneration. With larger trees and uneven aged management areas designated as VSS 1 and 2, bring VSS classifications higher. Because VSS is area based, the creation of areas for VSS 1 and 2 will be established upon implementation. VSS 1 and 2 are combined to show the trends through time. The modeled groupie clumpy nature of all the action alternatives also shows a lower than desired conditions. Modeling shows direct effects between the alternatives on VSS 1 and 2 but future non-modeled events can increase grass/forb/shrub to seedling/sapling stages from burning and future tending events (White 1985). It is likely grass/forb/shrub and seedling/sapling stages would increase within the project area under action alternatives (White 1985, Rleveld 1978). VSS 1 and 2 are underrepresented due to the averaging of multiple sizes with grass/forb/shrub to seedling/sapling stages with larger trees, based on basal area of tree sizes, in a group. An example is if there is a group dominated by seedling/saplings with one larger tree, the VSS can increase. Natural regeneration was modeled every decade in each simulation (Rleveld 1978). Even though alternative 2 would exceed the grass/forb/shrub percentage across the ponderosa pine type, it is deemed acceptable because the entire grass/forb/shrub stage isn't intended for regeneration areas. The regeneration within alternative 2 will be managed to the overstory ponderosa pine groups, sustaining the uneven aged groups. Alternative 1 would maintain even aged conditions across the ponderosa pine cover type, limiting the amount of grass/forb/shrub and seedling/sapling stages needed to meet the desired conditions. Under alternative 1, grass/forb/shrub and seedling/sapling stages would only increase from overstory mortality events triggered from insects and diseases. Alternative 2, 3 and 4 best meet the desired conditions for VSS 1 and 2 on the LOGPFA.

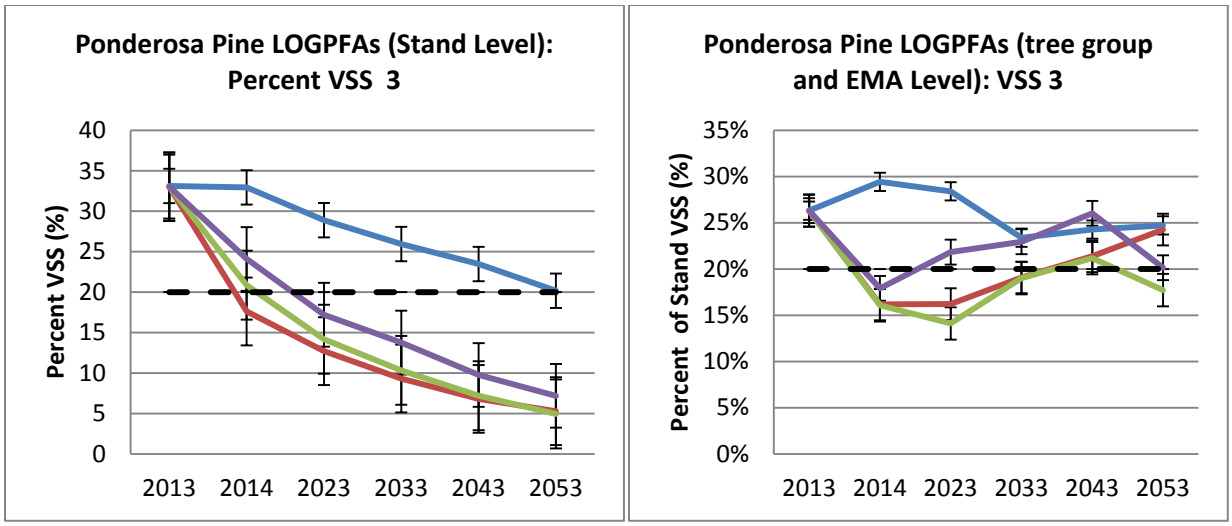


Figure 3.2-12 Ponderosa Pine LOGPFAs (tree group, stand and EMA Level): VSS 3 (Use legend in 3.2-11)

The action alternatives for VSS 3(young forest), in all three scales, trend to forest plan guidelines directly after treatment where no action directly after treatment remains above 10 percent of the desired condition. Through time at the tree group and EMA level, all alternatives returned to desired condition, with alternative 2 being closest to 20%. Through time at the stand level, all alternatives show decline with alternative 1 becoming the best represented. This can be explained with the nature of the initial cutting of the action alternatives. Modeling was based on irregular tree spacing and irregular tree group spacing. Alternative 1 is left with uniform, even-aged growing condition taking up more growing space than if trees were grouped. Through time, the reduction of young forest at the stand level for the action alternatives alleviates growing space for VSS 4, 5 and 6. Future vegetative cutting treatments of larger VSS classes will bring stand level averages toward desired conditions.

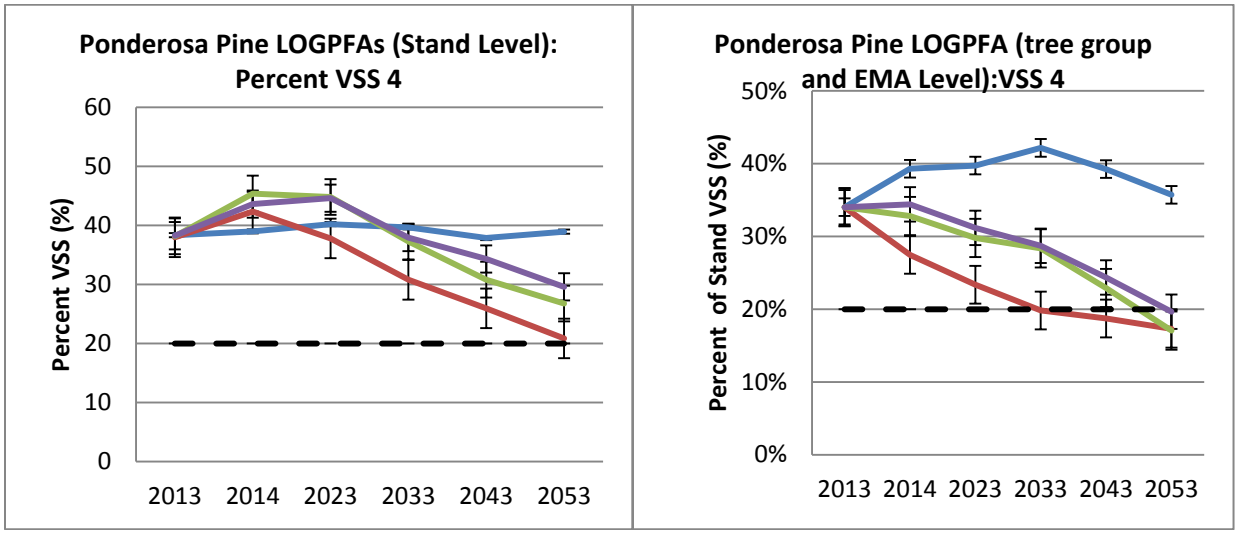


Figure 3.2-13 Ponderosa Pine LOGPFAs (tree group, stand and EMA Level): VSS 4 (Use legend in 3.2-11)

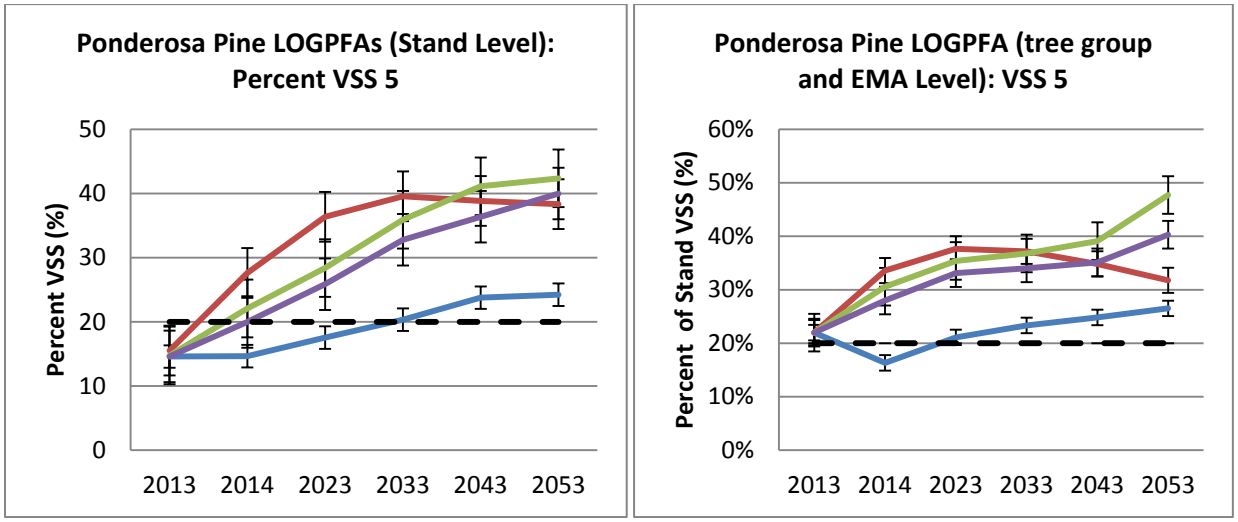


Figure 3.2-14 Ponderosa Pine LOGPFAs (tree group, stand and EMA Level): VSS 5(Use legend in 3.2-11)

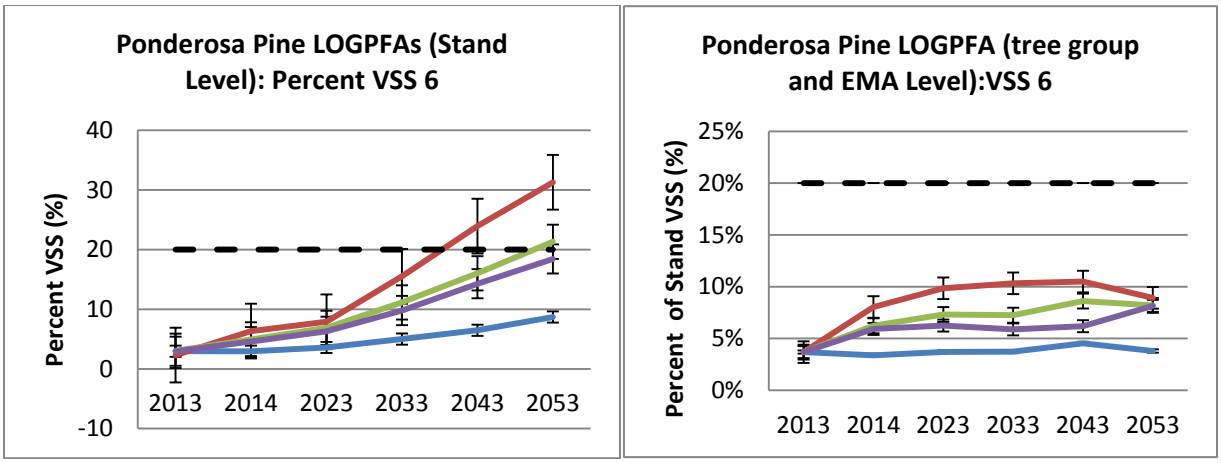


Figure 3.2-15 Ponderosa Pine LOGPFAs (tree group, stand and EMA Level): VSS 6 (Use legend in 3.2-11)

Figures 3.2-13 through 3.2-15 show the effects to VSS 4, 5 and 6 by alternative. For all alternatives, stand level VSS 4 shows that direct effects are minor. Even though each alternative provides a unique direct effect, the following provides a general summery of all the VSS classes in LOGPFA. Alternative 1 moves directly away from the desired condition while alternative 2 moves toward it. Alternative 3 and 4 for each scale eventually meet the desired condition through time.

Indirectly from the majority of VSS 3 and 4 being treated, alternative 2 builds an access of VSS 5. Alternative 1 remains moving away from desired condition through time. The excess of VSS 5 in alternative 2 indirectly relates to the future increases in VSS 6. Alternative 3 and 4 directly meet the VSS 5 desired condition the best. Through time alternative 3 and 4 VSS 5 class will become older and larger, moving into VSS 6. Among the alternatives for VSS 6, alternative 2 moves the best toward the desired condition directly and through time.

Goshawk nest and PFA are the remaining ponderosa pine in the project area excluding LOGPFA. Due to forest plan direction regarding goshawk nest areas, the analysis for goshawk nest areas will focus on mature and old forest VSS classes. Analysis will show primarily forest structure for PFAs, which include nest stands. Figures 3.2-16 to 3.2-20 demonstrate the vegetation structures for Goshawk PFAs.

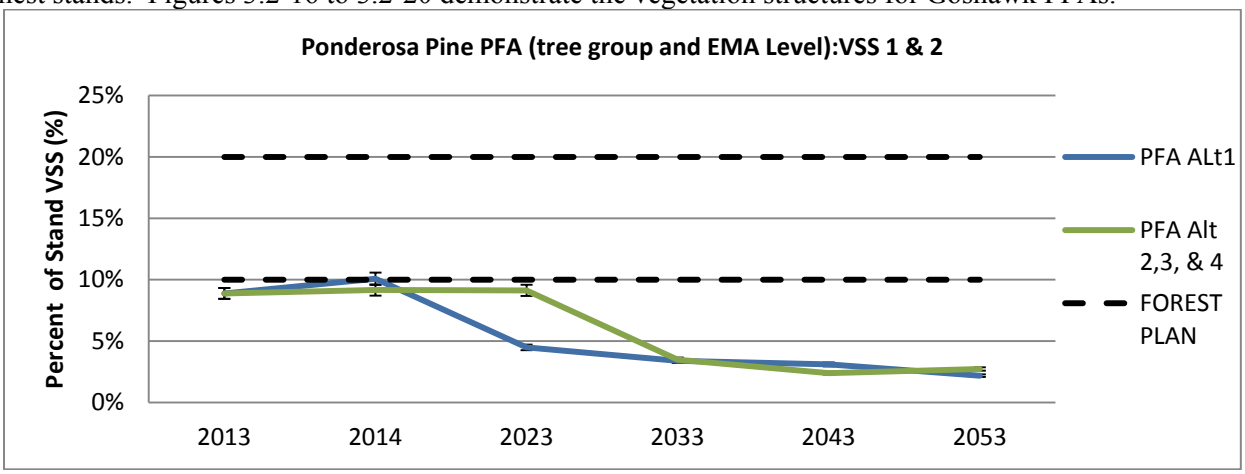


Figure 3.2-16 Ponderosa Pine PFA (tree group, stand and EMA Level): VSS 1 and 2

PFA forested areas of grass/forb/shrub to seedling/sapling stages (VSS1 and 2) would be regulated and implemented in action alternatives based on area percentages which would guarantee the amount desired for each alternative. Figure 3.2-16 demonstrates the current amount of VSS 1 and 2s with estimated regeneration rates, indirect effects from other VSS classes' excelling in VSS indirectly changes VSS 1 and 2 percent VSS. The VSS 1 and 2 analysis biases toward areas dominated with grasses, forbs, seedlings and saplings. The main reason the analysis shows low percentages is due to larger yellow pines, larger trees and reserve trees among areas designated for regeneration. With larger trees and uneven aged management areas designated as VSS 1 and 2, bring VSS classifications higher. Because VSS is area based, the creation of areas for VSS 1 and 2 will be established upon implementation. VSS 1 and 2 are combined to show the trends through time. The modeled groupie clumpy nature of all the action alternatives also shows a lower than desired conditions. The modeled groupie clumpy nature of all the action alternatives shows a lower than desired conditions. Modeling shows direct effects between the alternatives on VSS 1 and 2 but future non-modeled events can increase grass/forb/shrub to seedling/sapling stages from burning and future tending events(White 1985). It is likely grass/forb/shrub and seedling/sapling stages would increase within the project area under action alternatives (White 1985, Rleveld 1978). Similar trends are shown in LOGPFA VSS 1 and 2.

Natural regeneration was modeled every decade in each simulation (Rleveld 1978). Alternative 1 would maintain even aged conditions across the PFA limiting the amount of grass/forb/shrub and seedling/sapling stages needed to meet the desired conditions. Under alternative 1, grass/forb/shrub and seedling/sapling stages would only increase from overstory mortality events triggered from insects and diseases or stand replacing fires. Alternative 2, 3 and 4 best meet the desired conditions for grass/forb/shrub and seedling/sapling stages in PFAs.

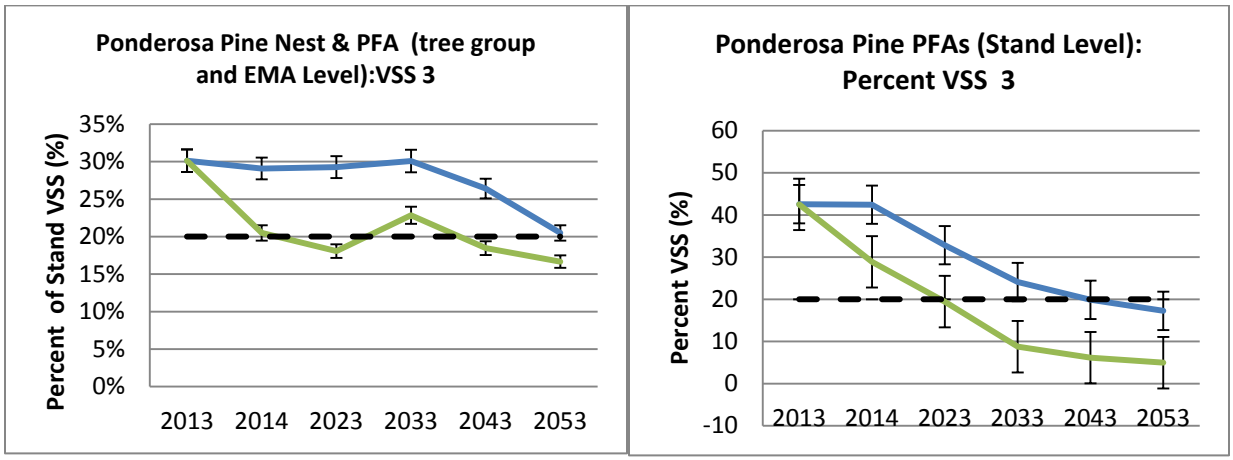


Figure 3.2-17 Ponderosa Pine PFA and Nest (tree group, stand and EMA Level): VSS 3 (Use legend in 3.2-16)

Figure 3.2-17 demonstrates VSS 3 class in ponderosa pine PFA. At all scales, alternative 1 VSS 3 eventually moves toward the desired condition through time. The stand scale, the action alternatives directly move the best toward VSS 3 after treatment. The tree group and EMA level, VSS 3 stabilizes within acceptable conditions. The stand level, VSS 3 falls below the desired condition over time. This is due to other class becoming more represented. Future thinning treatments can move the stand level VSS toward the desired condition.

Figure 3.2-18 show PFA VSS 4 at all scales trend above the desired condition for all alternatives. The action alternatives move the closest to the desired condition through time. The increased amount of VSS 4 is indirectly from VSS 3 groups moving up in classification through time.

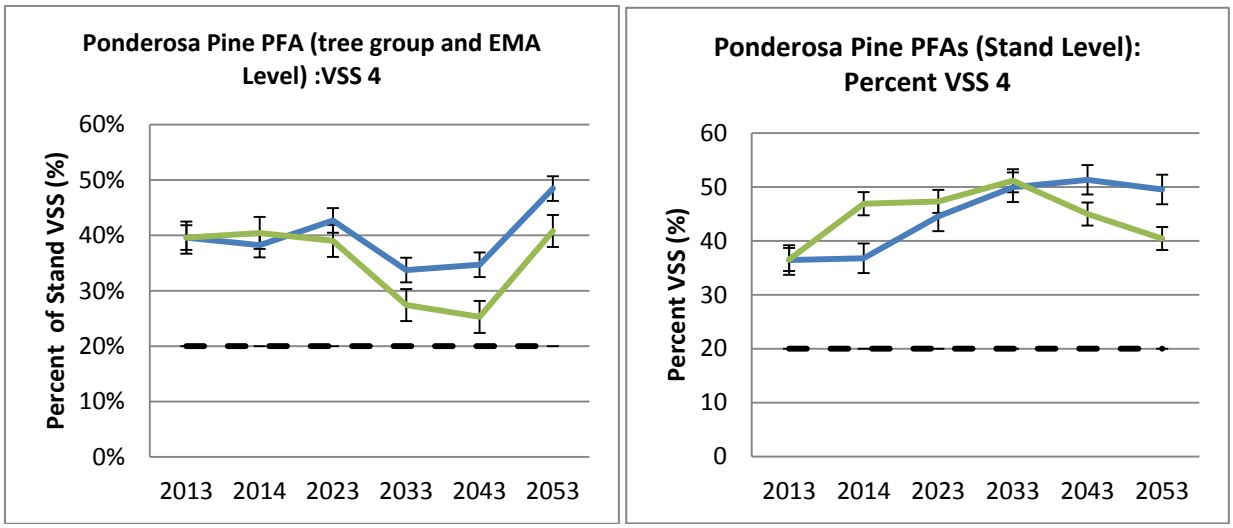


Figure 3.2-18 Ponderosa Pine PFA and Nest (tree group, stand and EMA Level): VSS 4 (Use legend in 3.2-16)

Figure 3.2-19 displays the nest and PFA side by side. Treatments in VSS 5 for PFA and nest directly move VSS within desired condition. The trends for action alternatives in nest and PFA move above 20% of VSS 5 through time. Trending toward older and mature forest structures is desirable in goshawk nest and PFA based on the forest plan. At all scales for alternative 1 in PFA and nest, directly decrease below 20% VSS5. At the stand level, alternative 1 trends to 20% through time with nest rising at year 2043. This is due to VSS 3 moving into VSS 4, indirectly VSS 6 in alternative 1 remains low.

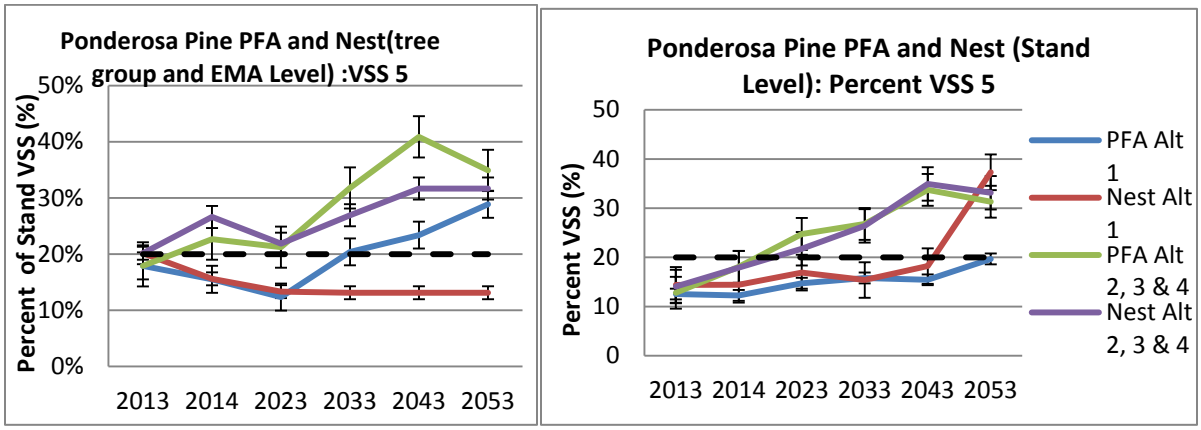


Figure 3.2-19 Ponderosa Pine PFA and Nest (tree group, stand and EMA Level): VSS 5

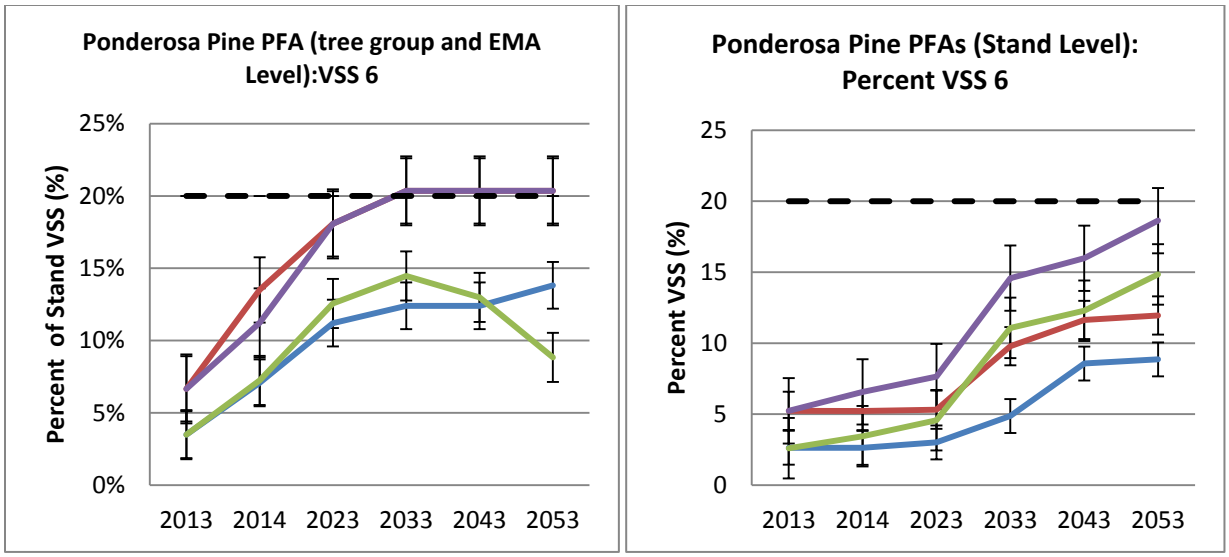


Figure 3.2-20 Ponderosa Pine PFA and Nest (tree group, stand and EMA Level): VSS 6 (Use legend in 3.2-19)

Figure 3.2-20 displays VSS 6 for PFA and nest. VSS 6 for all action alternatives, at all three scales, move toward the desired condition. The action alternatives in the tree group and EMA level, start trending downward after 2033. This is due to an excess of VSS 4 rising. Future thinning of VSS 4 would bring VSS 6 up to desired conditions in time.

The following is the analysis for canopy cover in VSS 4, 5 and 6. Canopy cover guidelines according to the forest plan apply to mid-aged to old forest (VSS 4, 5 and 6) and not to grass/forb/shrubs to young forest (VSS 1, 2, and 3). For this analysis, canopy cover is represented at the three scales required for goshawk habitat using point data representing tree groups, stand and EMA levels. Point data was used because stand data will average in VSS 1 to 3 groups. Point data provides higher accuracy and higher landscape coverage than stand data. Canopy cover is based on FVS modeling which is measured vertically, consistent with the forest plan. Canopy cover calculated in FVS for this analysis is measured with overlapping canopies as described in Crookston and Stage 1999. The FVS canopy cover provides for a canopy cover measure in groupie clumpy structures, which is the nature of ponderosa pine forest and desired conditions rather than an evenly spaced forest.

Within ponderosa pine LOGPFA canopy cover is close to the desired condition at 2013, represented in Figure 3.2-21. Alternative 1 for VSS 4 and 5 directly increases above the desired condition after 2013. Alternative 1 continues to maintain the highest canopy cover between all of the action alternatives and continues through time. This is possible because canopy cover began increasing immediately after 2013, with no thinning of trees. The trend of the action alternatives directly reduced canopy cover below desired conditions after treatment. However, the action alternatives recovered in VSS 4 and 5 within 20 to 30 years after treatment. The reduction of canopy cover is due to the reduction of smaller diameter trees within VSS 4 and 5 groups, reducing vertical canopy diversity ultimately reducing canopy cover density. Not only do the action alternatives recover but they trend within 10% of alternative 1 after 40 years. The recovery of canopy cover is due to crowns filling in after being released and understory recruitment.

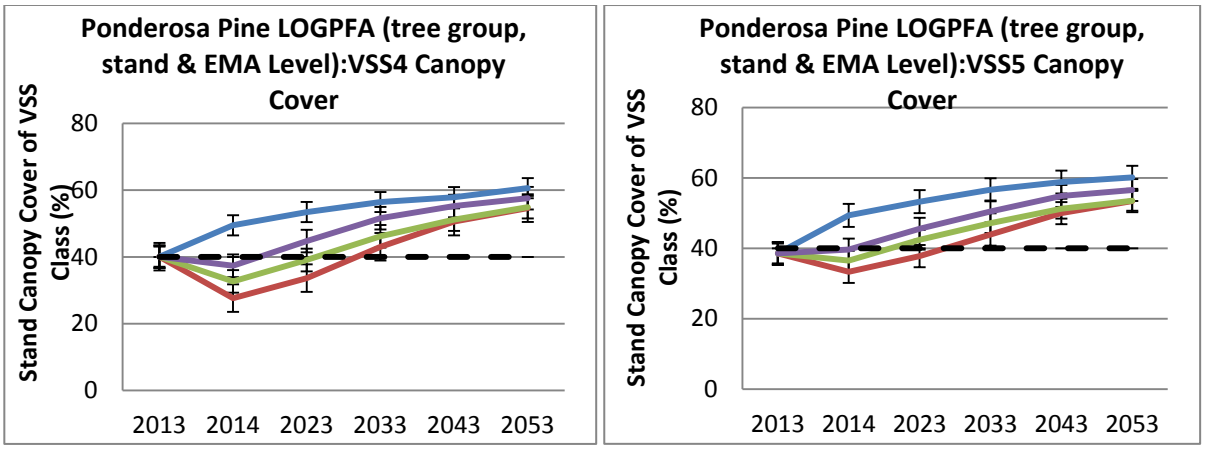


Figure 3.2-21 Ponderosa Pine Canopy Cover for LOGPFAs (tree group, stand and EMA Level): VSS 4 and 5 (Use legend in 3.2-22)

Figure 3.2-22 shows VSS 6 canopy cover for LOGPFA with similar trends as VSS 4 and 5. Alternative 1 best meets the desired condition directly. The existing condition starts at 30% and after the action alternatives trends slowly move toward desired conditions. Alternative 4 did not show a reduction but did not increase at the rate alternative 1. By 30 years into the future, all action alternatives are above the desired condition and 40 years results in 12 percent of each alternative. In 40 years alternative 1 and 2 canopy covers remained the furthest apart but were over the desired condition of 40%.

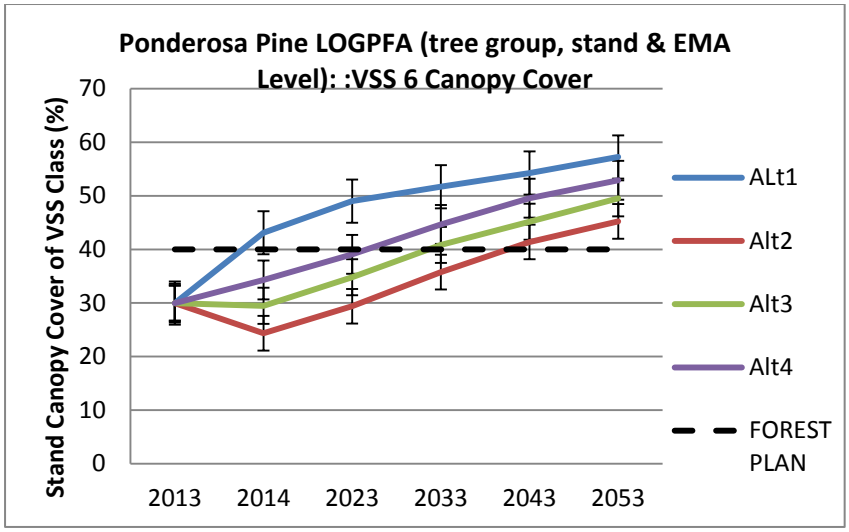


Figure 3.2-22 Ponderosa Pine Canopy Cover for LOGPFAs (tree group, stand and EMA Level): VSS 6

According to the forest plan, canopy cover desired conditions for PFA and goshawk nests are desired to be higher than LOGPFA. The forest plan expresses that one of the unique nesting habitat conditions for goshawk is high canopy covers. For PFAs, canopy cover for VSS 4 is split into one third and two thirds, as specified in the forest plan. VSS 4 canopy cover was measured through time against all alternatives. Figure 3.2-23 illustrates the effects of canopy cover for all four alternatives 40 years into the future. One third of VSS 4 for alternative 1 directly meets the desired condition of 60% and starts to plateaus through time. The action alternatives drop above 55% and recover to the desired condition within 20 years after

the treatment. The rest of VSS4, two thirds, in alternative 1 directly increases and comes close to the desired condition after 2013 and exceed it 10 years into the future. The action alternatives, starting at 42%, reduced down to 40% canopy cover. The recovery rate is slower for the action alternatives and recovers 20 years into the future. At the end of the 40 year period canopy covers are within 6% of each other. The slow recovery time is due to the thinning of younger smaller trees that are growing underneath tree canopies in alternative 1. Crowns filling out and light regeneration helped the recovery.

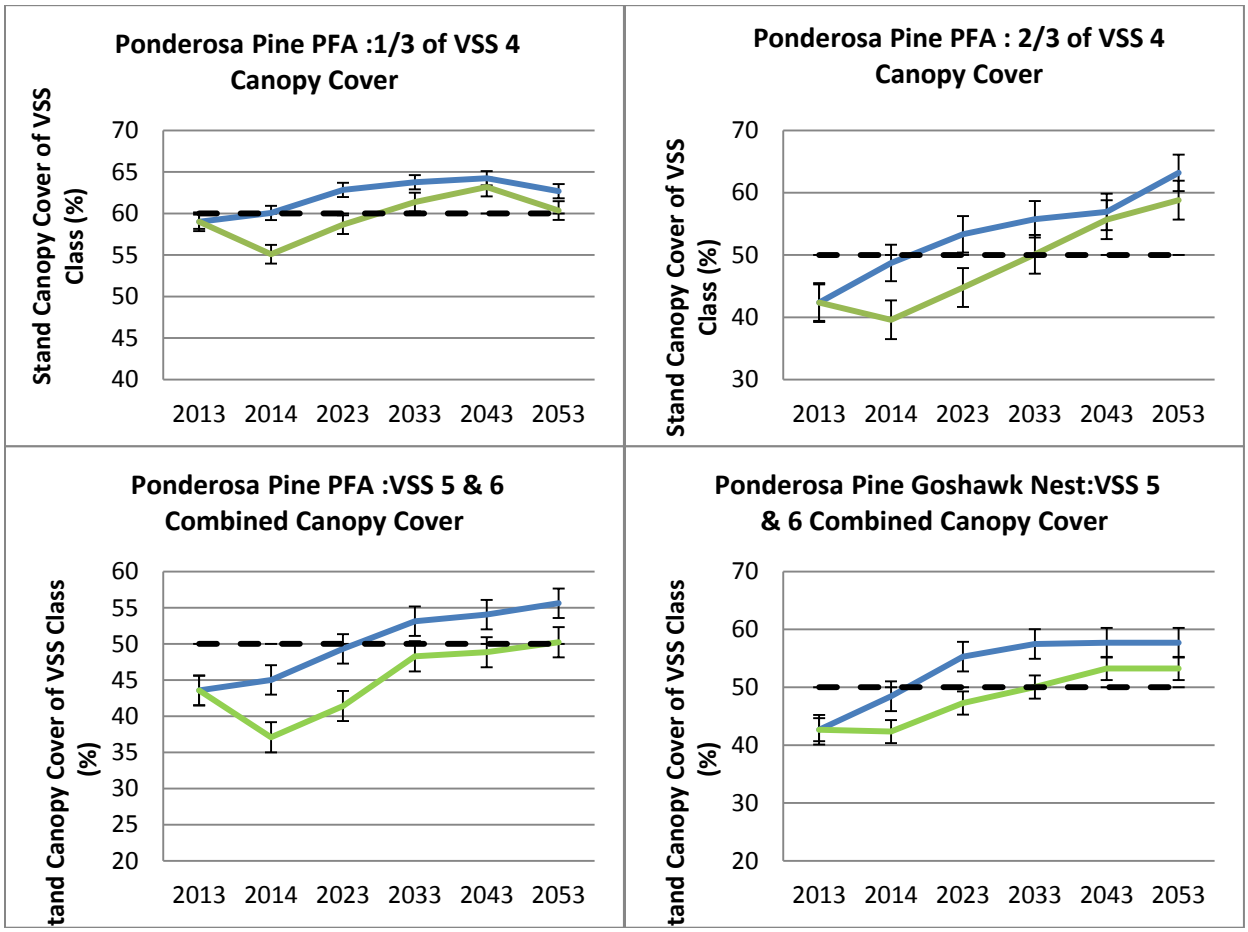


Figure 3.2-23 Ponderosa Pine Canopy Cover for PFA and goshawk nests (tree group, stand and EMA Level): VSS 4, 5 and 6 (Use legend in 3.2-16)

Canopy cover for VSS 5 and 6 in PFA and nests are also demonstrated in Figure 3.2-23. The trends are similar to the previous goshawk habitats. In PFAs VSS 5 and 6 canopy covers of alternative 1 show upward trends meeting canopy cover desired conditions within 20 years. The action alternatives in 20 years come within 5% of the desired condition and slowly recover at the end of the 40 years period. The slow recovery of VSS 5 and 6 groups is primarily due to tree crowns filling in slowly and less of establishment of regeneration within the group. Specific to the nest stands, alternative 1 meets the desired condition within 10 years and plateaus. The action alternatives meet the desired condition in 20 years thus resulting within 5% of each other after 40 years. The action alternatives in all goshawk habitats are deemed to meet the canopy cover objectives due to showing trends toward desired conditions through time.

Mixed Conifer

Vegetation structures for 100% of the Mixed Conifer cover type (LOGPFA) are demonstrated in VSS through time in Figures 3.2-24 to 3.2-28. Reference the wildlife section for MSO mixed conifer analysis on evaluation criteria. For the following vegetation structure analysis, mixed conifer habitat is averaged in with its overlapping goshawk habitat. The figures demonstrate the variations of alternatives from the projected treatment date of 2013. The alternative's effects are being based on direct actions/no actions which are represented in 2014 and how well it meets the desired condition 40 years into time. Indirect effects are measured based on reductions or non-reductions of an individual VSS that changes the percentage of others in the population making them more or less represented.

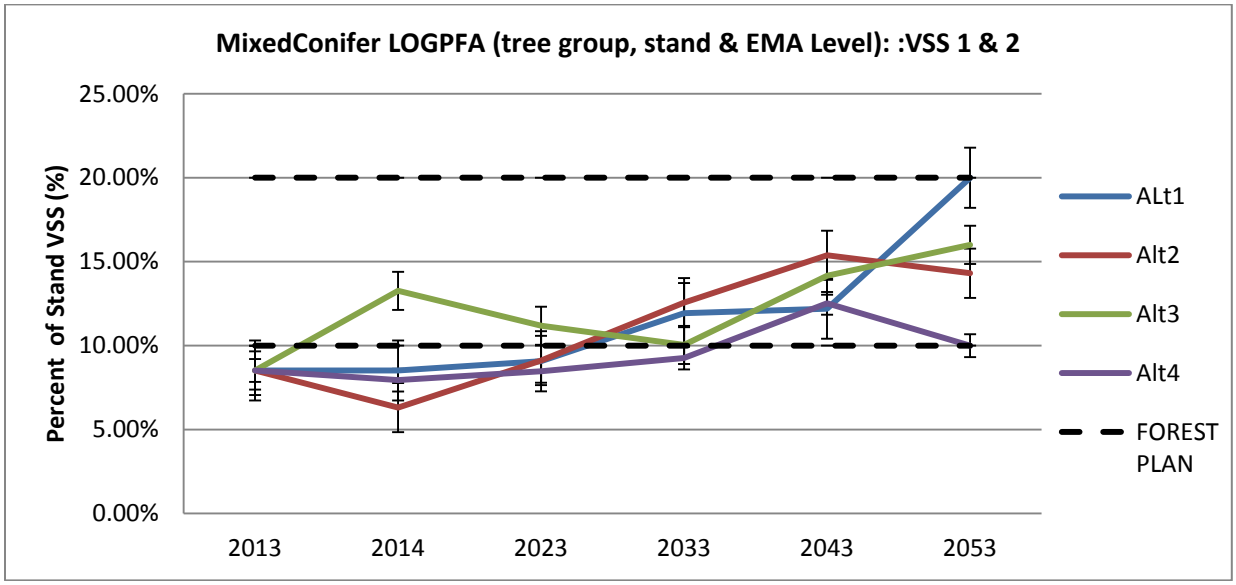


Figure 3.2-24 Mixed Conifer LOGPFAs (tree group, stand and EMA Level): VSS 1 and 2

Mixed conifer forested areas of grass/forb/shrub to seedling/sapling stages (VSS1 and 2) would be regulated and implemented in action alternatives based on area percentages which would guarantee the amount desired for each alternative. Figure 3.2-24 demonstrates the current amount of VSS 1 and 2s with estimated regeneration rates, indirect effects from other VSS classes' excelling in VSS indirectly changes VSS 1 and 2 percent. The VSS 1 and 2 analysis biases toward areas dominated with grasses, forbs, seedlings and saplings. The main reason the analysis shows low percentages is due to larger yellow pines, larger trees and reserve trees among areas designated for regeneration. With larger trees and uneven aged management areas designated as VSS 1 and 2, bring VSS classifications higher. Because VSS is area based, the creation of areas for VSS 1 and 2 will be established upon implementation. VSS 1 and 2 are combined to show the trends through time. The modeled groupie clumpy nature of all the action alternatives also shows a lower than desired conditions. The modeled groupie clumpy nature of all the action alternatives shows a lower than desired conditions. Modeling shows direct effects between the alternatives on VSS 1 and 2 but future non-modeled events can increase grass/forb/shrub to seedling/sapling stages from burning and future forest thinning events.). It is likely grass/forb/shrub and seedling/sapling stages would increase within the project area under action alternatives (White 1985, Rleveld 1978). VSS 1 and 2 are also under represented due to the averaging of multiple sizes with grass/forb/shrub to seedling/sapling stages with larger trees, based on basal area of tree sizes, in a group.

An example is if there is a group dominated by seedling/saplings with one larger tree, the VSS can increase.

Mixed conifer VSS3 is illustrated through time in Figure 3.2-24 for all three scales. The action alternatives for VSS 3, in all three scales, trend to acceptable levels directly after treatment where no action remained above the desired condition. At the tree group and EMA level, all alternatives show a reduction in VSS 3 and quickly spike back up in the future. This is indirectly due to the increases and decreased of VSS 4, 5 and 6. The increase of VSS 3 indirectly tied to the decrease of VSS 4. The benefit of these fluctuations through time can be observed in the stabilization of VSS 5 and 6 groups. The majority of the LOGPFA being designated as MSO protected habitat, Arizona Bugbane botanical area or in a non-operability zone affected VSS 3 outcomes due to the limitations of the prescriptions. The prescriptions for alternatives 3 and 4 focused on thinning conifers from below to the most conservative depending on the habitat overlap, 9 inches in MSO protected or 12 inches in Arizona bugbane. In alternative 4 areas differed from treatment, excluding strategic fuels locations, based on non-operability. Fire was simulated under the various treatments. The high reduction of VSS 3 for alternative 3 is due to thinning from below treatments. Conversely, this increased the percent VSS 4, 5 and 6 for alternative 3. A similar reduction is shown in alternative 4 due to the increased mortality from prescribed fire, with no vegetative treatment. The fire effect of increased fuel created by VSS 3 groups is discussed in the fuels section.

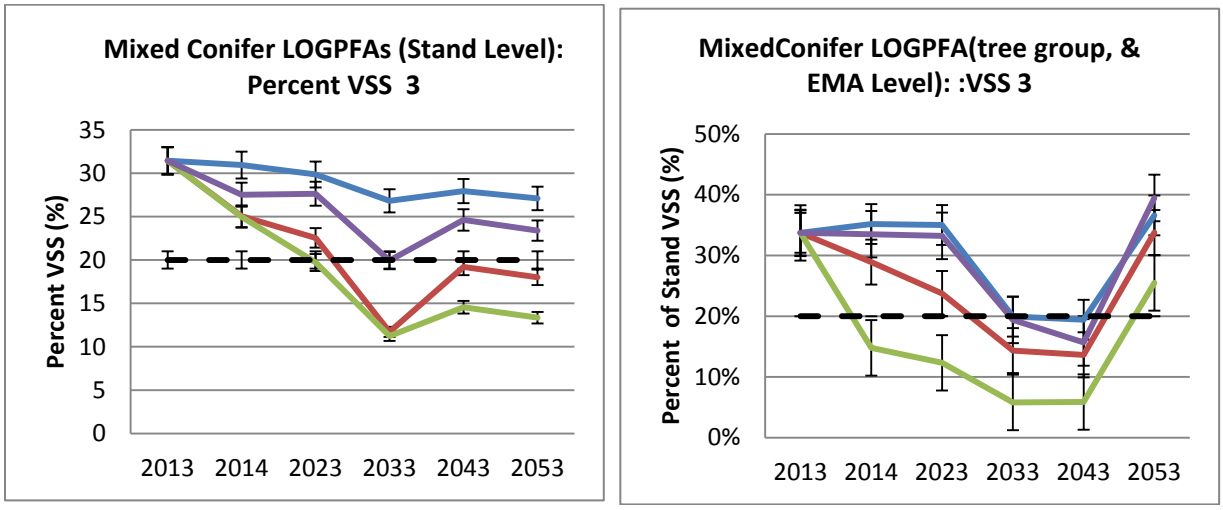


Figure 3.2-25 Mixed Conifer LOGPFAs (tree group, stand and EMA Level): VSS 3 (Use legend in 3.2-24)

Figure 3.2-26 shows at all three levels of analysis how percentages stay above the desired condition, with alternative 2 returning the closest to the desired condition at the stand level.

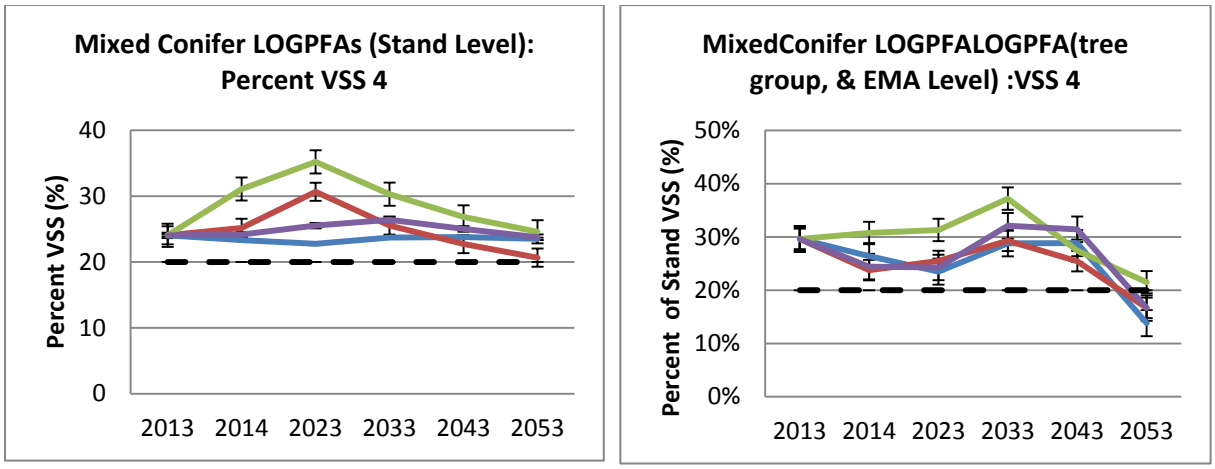


Figure 3.2-26 Mixed Conifer LOGPFAs (tree group, stand and EMA Level): VSS 4 (Use legend in 3.2-24)

Figure 3.2-27 shows the three levels of analysis for mixed conifer VSS 5. All alternatives trend above the desired condition with alternative 4 and 2 directly trending closer. At the stand level, alternative 4 and 1 maintain below the desired condition.

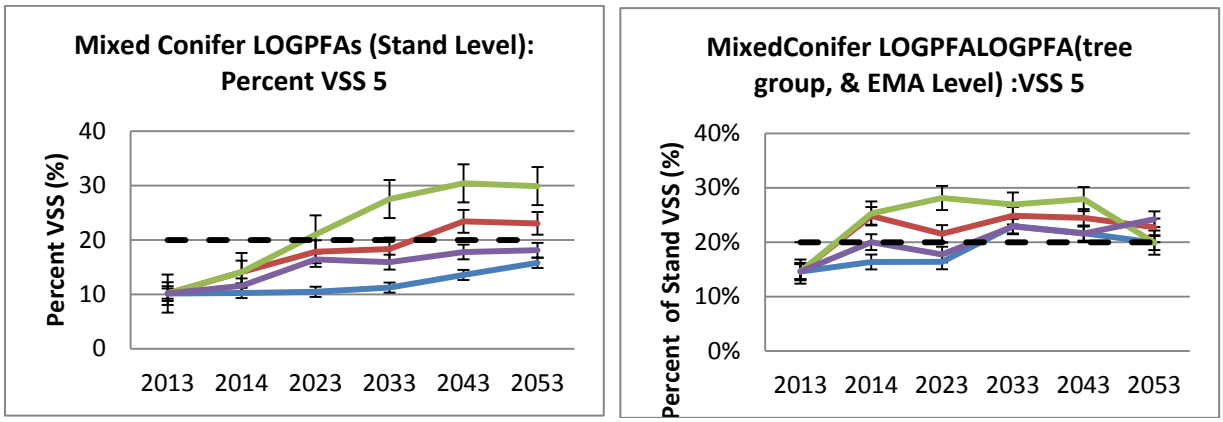


Figure 3.2-27 Mixed Conifer LOGPFAs (tree group, stand and EMA Level): VSS 5 (use legend in 3.2-24)

Figure 3.2-28 shows the three levels of analysis for mixed conifer VSS 6. All alternatives trend toward the desired condition with alternative 3 and 2 directly trending faster. At the stand level, alternative 3 meets the desired condition at the end of the 40 year period. At the tree group and EMA level, alternative 2 rises to the desired condition and maintains itself around the threshold, while alternative 3 fully exceeds the desired condition from the reductions of fire mortality VSS 3. Similar trends of alternative 3 could be seen in alternative 4 depending on mortality from burning.

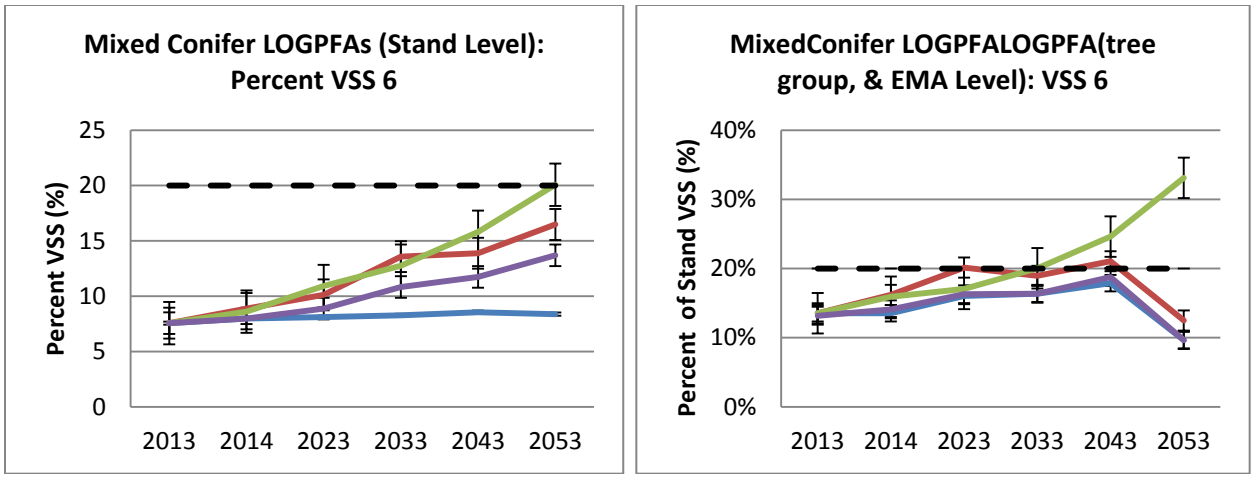


Figure 3.2-28 Mixed Conifer LOGPFAs (tree group, stand and EMA Level): VSS 6(Use legend in 3.2-24)

Canopy cover guidelines according to the forest plan apply to mid-aged to old forest (VSS 4, 5 and 6) and not to grass/forb/shrubs to young forest (VSS 1, 2, and 3). Mixed conifer LOGPFA, canopy cover is displayed in Figure 3.2-29 and Figure 3.2-30. Alternative 1 for VSS 4 and 5 directly increases above the desired condition after 2013. Alternative 1 continues to maintain its canopy cover and continues through time. Alternative 2 and 4 through time, above the desired condition, come close to exceeding alternative 1. Alternative 2 developed higher canopy cover, 40 years after treatment. Alternative 3 reduced canopy cover is due to the thinning of conifers below a specific diameter limit, smaller trees within groups of VSS 4, 5 and 6 contributed to the majority of the canopy cover. Similar trends of alternative 3 could be seen in alternative 4 depending on mortality from burning.

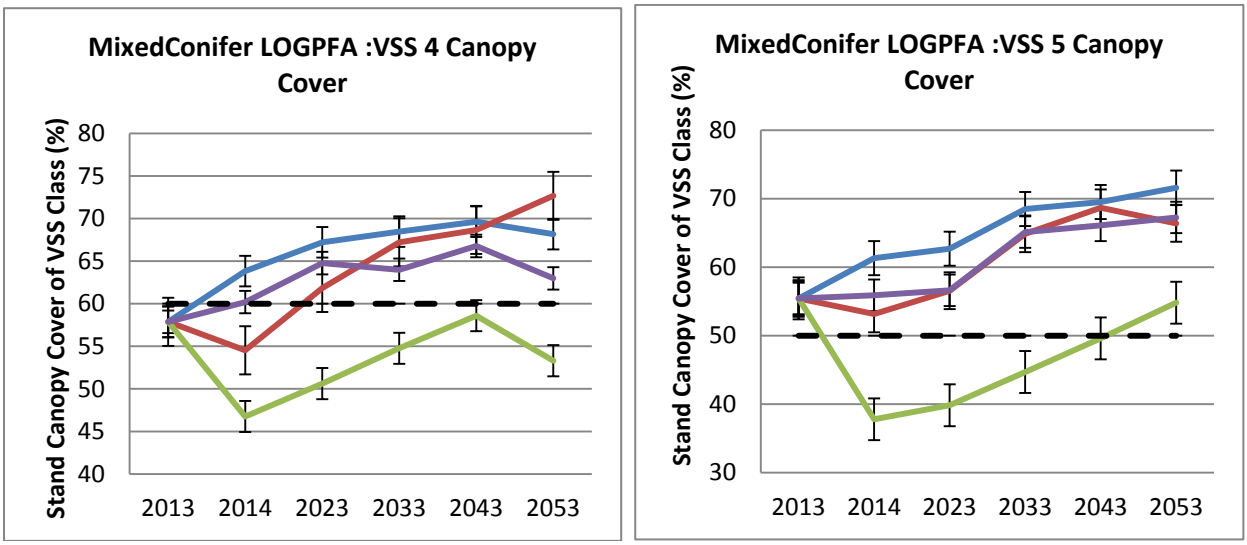


Figure 3.2-29 Mixed Conifer Canopy Cover for LOGPFAs (tree group, stand and EMA Level): VSS 4 and 5 (Use legend in 3.2-24)

VSS 6 canopy cover displayed in Figure 3.2-30 show similar trends to VSS 4 and 5. Main differences are that the no action, alternative 2 and 4 meet the desired condition 20 years into the future. Alternative 3 shows the same decreased trends from the reduction of small diameter trees.

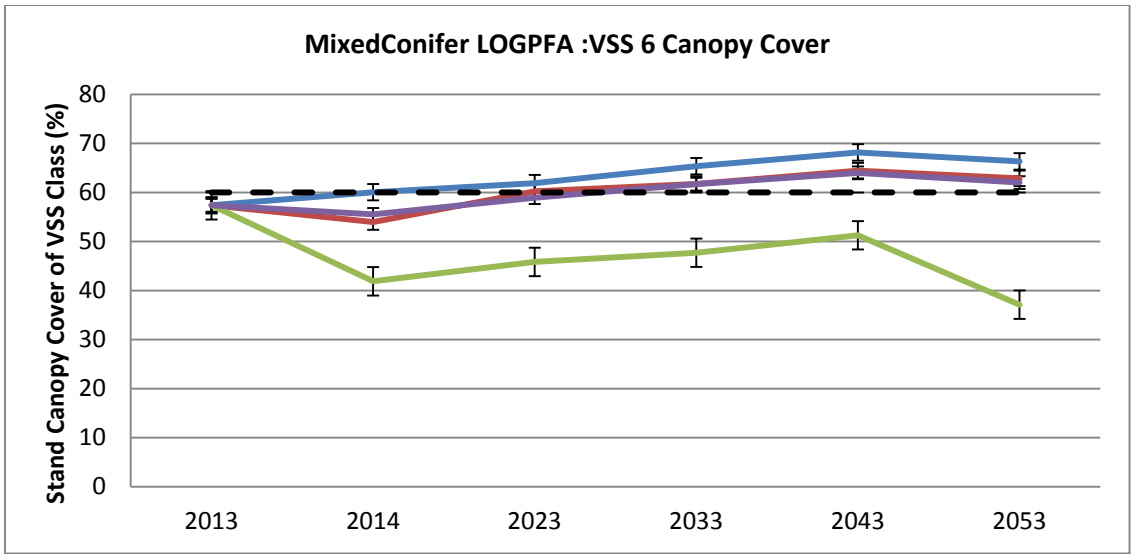


Figure 3.2-30 Mixed Conifer Canopy Cover for LOGPFAs (tree group, stand and EMA Level): VSS 6 (Use legend in 3.2-24)

Woodlands

Approximately 2,464 acres of woodlands are being managed as LOGPFA. This area includes pinyon juniper, juniper woodland, oak woodlands, and other hardwood cover types.

The no action alternative will allow these sites to continue to become denser with overstory vegetation overtime. The productivity of grasses, forbs and shrubs in the understory will continue to decline as overstory trees become denser and outcompete understory vegetation for sunlight, moisture, and available nutrients (Moore et al 2008). Over time, overstory vegetation in woodland sites will become less diverse for the following reasons:

- Development of new age classes of trees will be impeded as the density of mid-aged trees increases. (Moore et al 2008)
- The longevity of large older trees will be decreased as they have to compete with an increasing density of mid-aged trees. (Moore et al 2008)
- Some tree species will be forced out over time as more aggressive, faster growing species overtop and outcompete these declining species for moisture and nutrients. (Moore et al 2008)
- As these woodland cover types become denser over time, many stands will be placed at a higher risk of having larger stand replacement fires than would normally occur within these vegetation types.

The action alternatives will reduce tree density in woodland sites. This will have the following effects on these sites:

- Production of grasses, forbs, and shrubs will increase in the understory.
- A mix of trees of different ages and species will be allowed to develop over time.
- The longevity and vigor of larger older trees will increase over time because there will be less competition from mid-aged trees (ERI 2006).
- Risk of large stand replacement fires will be reduced.

The action alternatives will release more understory vegetation and new age classes of trees in woodland cover types than alternative 1 because there will be more trees removed. The action alternatives will

create more openings along with a more mixed mosaic of vegetation in woodland cover types because some mid-aged woodland trees will be removed. The action alternatives will be much more effective in restoring woodland cover types closer to desired conditions by reducing competition and creating a historic condition conducive for frequent fire. Due to no treatment in alternative 1 of woodland cover types, a greater number of larger diameter trees would persist on the landscape than alternative 2. Snags and large downed logs for woodland sites are discussed in the wildlife section.

Grasslands

There are 64 acres of grassland cover type within the project area. Under alternative 1 more trees will continue to regenerate and develop within this cover type. The increasing density of trees over time will lead to the following effects within the grasslands of the project area:

- Productivity of grasses and forbs will continue to decrease as trees start to out compete understory plants for light, moisture, and nutrients.
- The size of open grasslands will continue to decrease as trees invade grasslands from the edges and continue to move towards the grasslands center. Some smaller grassland sites may be completely converted to forest (Moore and Huffman 2004).
- Grass cover will decrease. When the encroaching trees are junipers, there will be more erosion in the upper soil layers as grass coverage declines. If the tree encroachment is ponderosa pine, the increasing pine litter will offset the potential increased erosion that could occur with decreasing grass coverage. When a wildland fire burns through this cover type, areas where pine litter has replaced grasses will have greater potential for surface erosion, at least temporarily, over areas where grass coverage is greater.

The action alternatives propose treatments to reduce tree density in grasslands that will lead to the following effects:

- Production of grasses and forbs will be increased.
- Grasslands will be maintained at or close to their historic distributions and sizes.
- Grass cover will be increased. This will minimize erosion problems, particularly within grasslands that are being encroached upon by junipers.

The action alternatives better restores grasslands because it reducing competition from the over story to understory grassers by providing more sunlight and nutrients to existing grasses. Diameter growth of trees in grasslands is often very rapid because grasslands are often found on more productive sites with deeper soil and there are fewer trees per acre thereby reducing competition that slows growth. Leaving trees in grasslands in alternative 1, maintains seed source which increases the opportunities for further new tree regeneration. The action alternatives will bring seed sources away from grasslands.

Aspen

There are 140 acres of aspen cover type within the project area. Under the no action alternative, most of the aspen cover type will continue to decline for the following reasons:

- Conifer species will continue to develop within aspen sites. As these conifers overtop and outcompete the aspens, the conifer will start to replace the aspen. Many of the aspen sites will be completely replaced by conifers (Cooper 1960).
- Heavy elk and deer browsing within aspen sites will impede development of aspen sprouts. Sprouts will not develop into trees. Most aspen sites will vanish from the landscape as older aspen die off and younger aspen are not allowed to develop (Fairweather et al 2008).

The action alternatives provide for removing conifer encroachment within aspen sites and protecting newly developing aspen sprouts from elk and deer browsing with fencing and jackstrawing of activity slash. These strategies would also be used in smaller aspen clones found within other cover types that are not identified as aspen cover types. These alternatives will attempt to restore aspen within some dead aspen sites that are no longer sprouting by planting aspen and fencing. These proposed treatments will maintain aspen clones in the project area. These treatments will increase the vigor and longevity of existing aspens while providing for development of new aspen trees over time. Alternative 2 will best meet project purpose and need relative to aspen management.

Forest Health

Ponderosa Pine and Pine-Oak Bark Beetle Risk

Figure 3.2-31 illustrates how bark beetle risk changes by alternatives r based on stand density, basal area (BA). All the action alternatives directly decrease bark beetle risk after treatment. An additional decrease to all action alternatives after the treatment year is due to the prescribed burn that was simulated in 2017. This slight reduction in BA was enough to bring all action alternatives below the moderate bark beetle risk threshold into 10 years after treatment. In the action alternatives, additional slash created from burning, (creation of snags, burned limbs and needle cast) is not a concern for increasing bark beetle populations due the increased tree vigor from the treatments (Fettig 2006). Activity slash would not create an increased bark beetle risk due to mitigation measured to treat slash. If a wildfire would happen under the no action alternative, additional slash would create a condition for bark beetle populations to rise (Fettig 2007). With a combined of decreased vigor in residual trees, resistance to an epidemic would be unlikely under alternative 1.

Through time bark beetle risk remains under the high hazard threshold for all 40 years for alternatives 2-4. Alternative 2 remains the lowest bark beetle risk throughout the simulation.

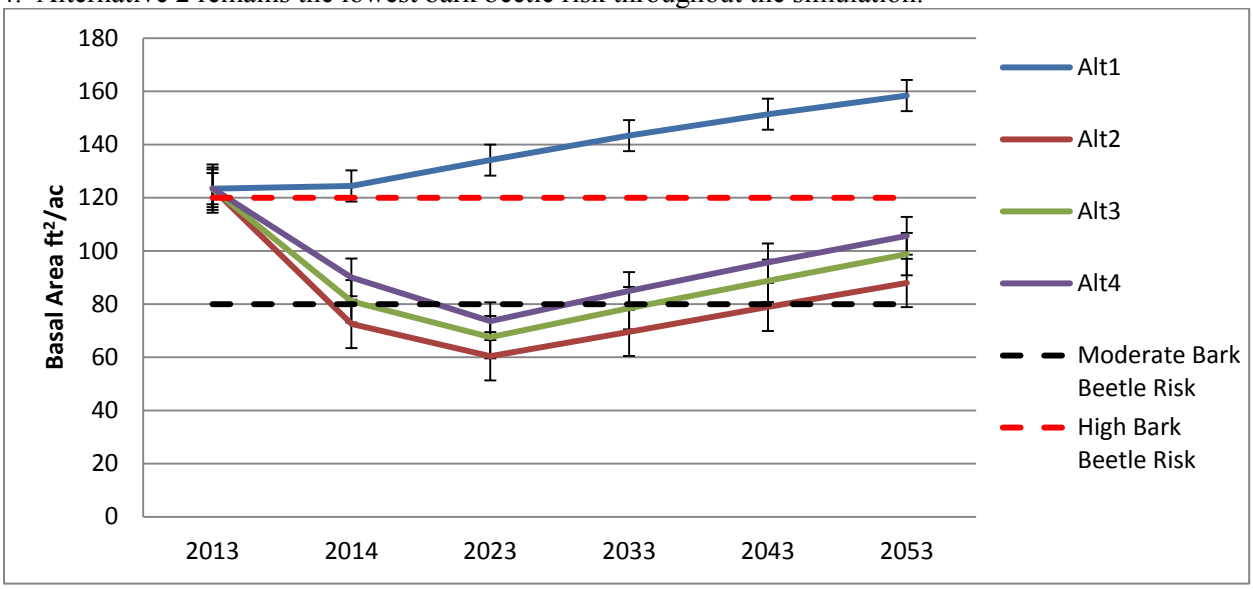


Figure 3.2-31 40 year Measure of Bark Beetle Risk and Sustainability for all Alternatives in the Ponderosa Pine Cover Type

Mixed Conifer Bark Beetle Risk

Figure 3.2-32 displays how bark beetle risk changes by the different alternatives in the mixed conifer forest type based on BA. All the action alternatives result in decreased bark beetle risk after treatment

with alternative 3 being the lowest. This is due to the prescriptions focusing on thinning to a 9" diameter limit. An additional decrease to all action alternatives after the treatment year is due to the prescribed burn that was simulated in 2017. This slight reduction in basal area was enough to bring all action alternatives below the moderate bark beetle risk threshold into 10 years after treatment, except alternative 2. Alternative 2 remains slightly above the moderate risk threshold after treatment. This gradual reduction in basal area from the burning treatment is due to alternative 2 having the optimal structure for minimal mortality during a prescribed burning event (Sánchez Meador et al 2010). Alternative 4 shows a slight reduction after thinning treatment and large increase after the burning event. The large reduction after burning treatment is due to most of the mixed conifer in alternative 4 not being thinned due to non-operability. This type of reduction, at a minimum, can be expected if there is a low intensity wildfire under alternative 1. Alternative 3 shows a large decrease in risk after thinning treatment and a slight decline after burning. The concern with major reductions after a burning event is due to the increased slash and dead standing trees providing an optimal habitat for bark beetle populations to increase (Fettig 2006). Trees weakened by burning have increased susceptibility to attack by bark beetles, particularly Douglas-fir trees. Epidemics are likely with the combination of decreased tree vigor, increased populations and tree competition (Fettig et al. 2007).

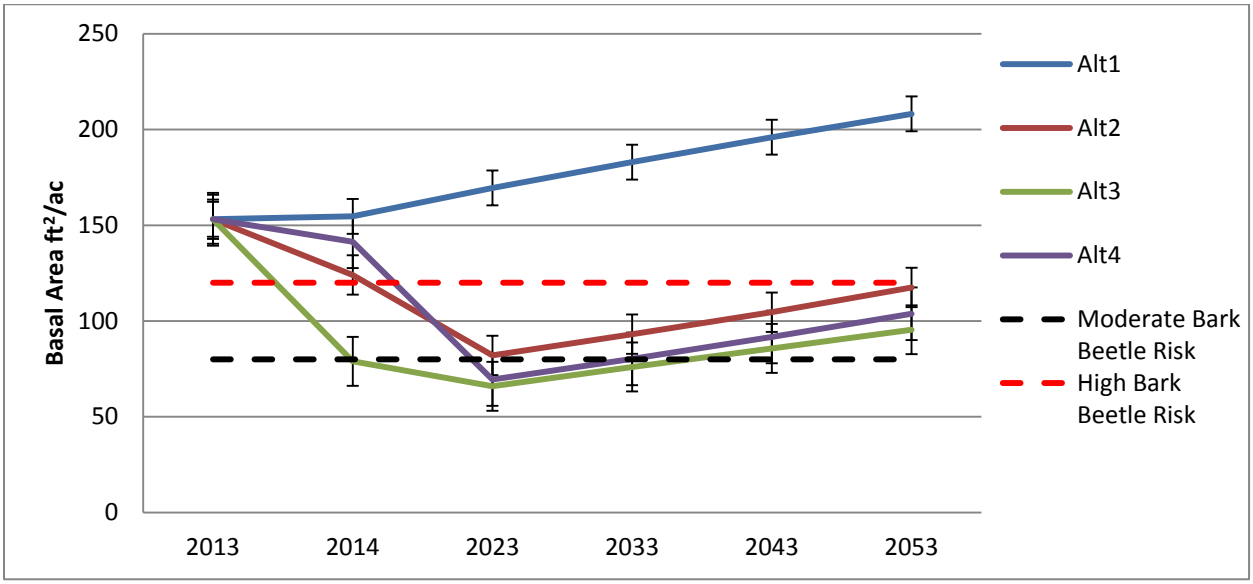


Figure 3.2-32 40 year Measure of Bark Beetle Risk and Sustainability for all Alternatives in the Mixed Conifer Cover Type

Ponderosa Pine and Pine-oak Dwarf Mistletoe

The following dwarf mistletoe (DM) analysis does not analyze DM outside of extremely infected stands. This is because the analysis recognizes DM has ecological and a wildlife value, therefore eradication was not an objective. To meet desired conditions, treatments and the analysis focused on extremely infected stands. Figure 3.2-33 demonstrated how the alternatives changed the intensity of DM within the ponderosa pine cover type based on percent of TPA infected amongst stands extremely infected. Due to the different nature of dwarf mistletoe focus and prescriptions by alternative, trends are different amongst alternatives. Alternative 3 and 4 show similar trends, of decreased % of TPA infected. This is due to vegetative cuts focusing on DM in extremely infected areas. Alternative 3 and 4 drop down to 30% of the host trees, not desired for uneven aged management, and increase through time (Conklin and Fairweather

2010). This happened because the diameter limit of 24" in pine oak MSO habitat prevented some removal. Due to Alternative 2 focusing on pre-settlement evidence and historic forest structure of a pine savanna, DM remained highly represented in the stand structure. The percentage of TPA infected rises and trends close to Alternative 1. Even though these two alternatives have similar trends, one major difference between the alternatives is how alternative 2 will isolate DM tree groups ultimately reducing the spread of infection (Conklin and Fairweather 2010). Frequent fire through time, not modeled, will maintain grassy openings between groups, preventing regeneration between groups, reducing the spread. The interactions of DM and fire and desired conditions for DM are explained in detail in Conklin and Fairweather (2010). They explain where DM currently exist is similar to the historic distribution. The increased amount of trees on the landscape increased the intensity and spread. They recognize that burning in DM area have a symbiotic relationship by thinning in lower limbs, torching and bark beetle. They also express that today's current departure from historic DM conditions are the decreased amount of older trees infected with DM. Their recommendations have the caveat that historic DM conditions might not be desirable in areas critical for fire abetment. In the scenario of alternative 2, this is a situation where both fire abetment and development of large trees with DM can be met. Even though Alternative 1, 3 and 4 maintains the existing old infected trees, and provides for maintaining smaller diameter trees next to old infected trees, the development of old trees infected with DM into the future is questionable due to fire risk.

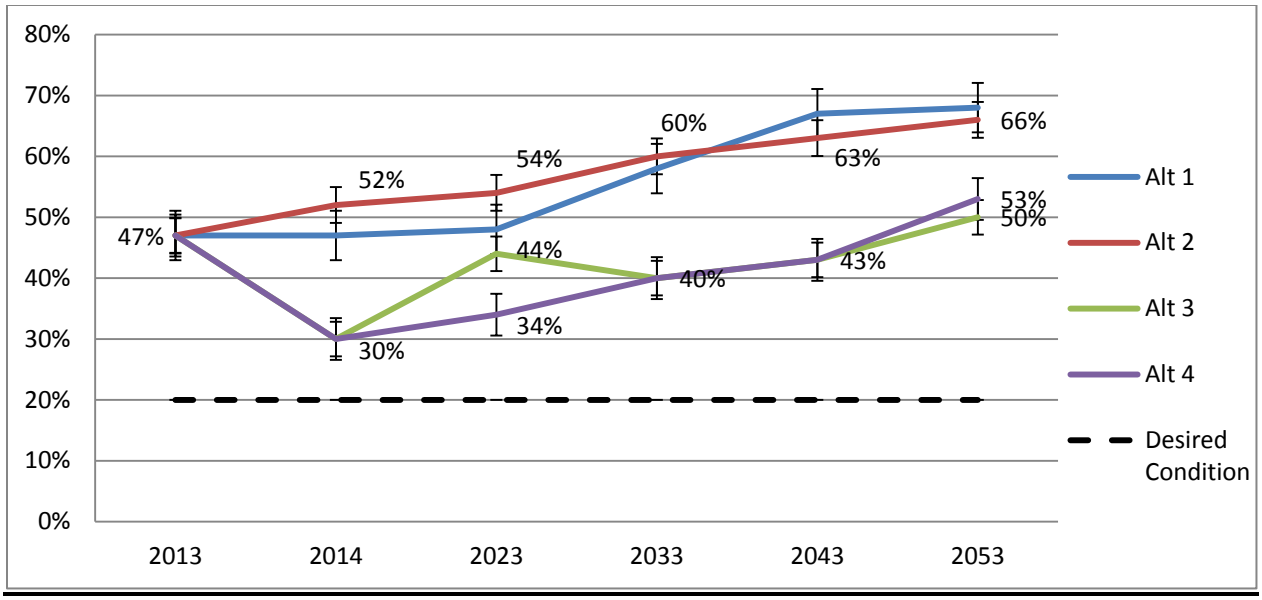


Figure 3.2-33 Percent of TPA infected of extremely infected DM Stands (Ponderosa Pine Cover Type)

Figure 3.2-34 demonstrates how the alternatives changed the severity of DM within the ponderosa pine cover type based on DMR. The similar trends from percent TPA infected can be seen in DMR. Alternative 2 maintains a high infection level and gradually increases to extreme at the end of the simulation. Alternative 3 and 4 reduce to moderate levels and slowly increase to high, 40 year in the future. It is likely with future burning events, the DMR for alternative 2 would stabilize at moderate to high levels.

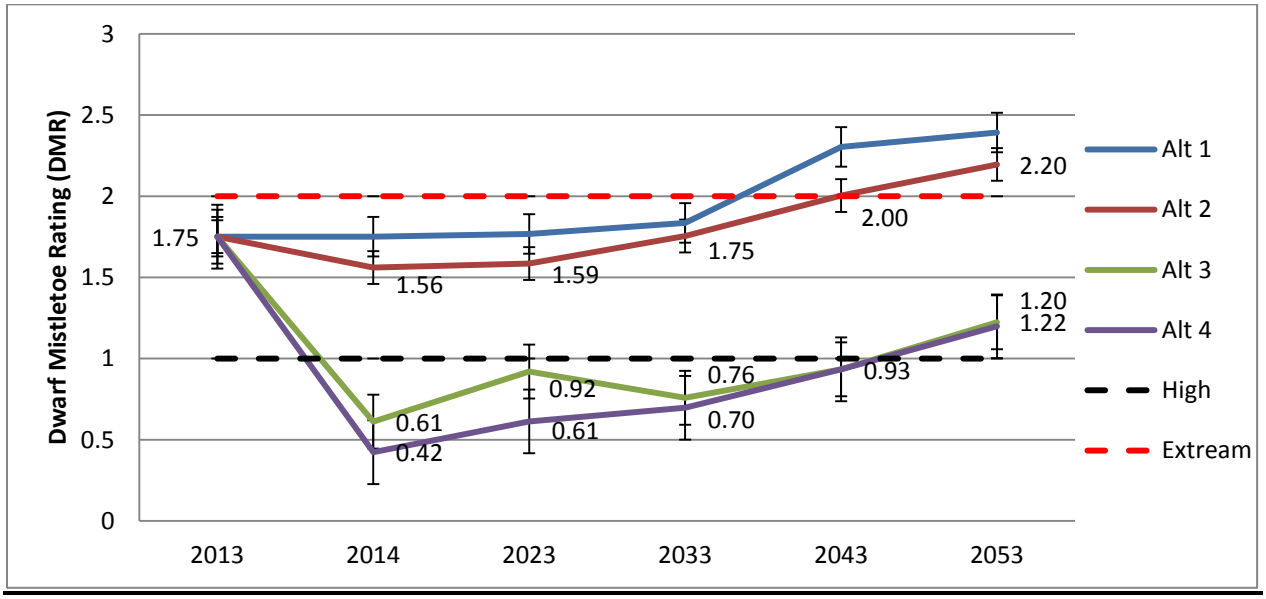


Figure 3.2-34 Dwarf Mistletoe Rating of Extremely Infected DM Stands (Ponderosa Pine Cover Type)

Mixed Conifer Dwarf Mistletoe

The following DM analysis does not analyze DM outside of extremely infected stands. Figure 3.2-35 demonstrates how the alternatives changed intensity of DM for ponderosa pine within the mixed conifer cover type based on percent of TPA infected amongst stands extremely infected. Alternative 3 moves the closest to the desired condition and stabilizes by the end of the simulation. The percent infected doesn't fall any lower due to the variety of diameter limits in MSO protected, restricted and Arizona bugbane habitat. Alternative 2 and 4 fall below alternative 1 through time but steadily increase. The results of alternative 4 are directly due to deferral of vegetative treatments in most mixed conifer stands. The results for alternative 2 are directly due to maintaining uneven aged groups and not focusing as much on DM infection as alternative 3.

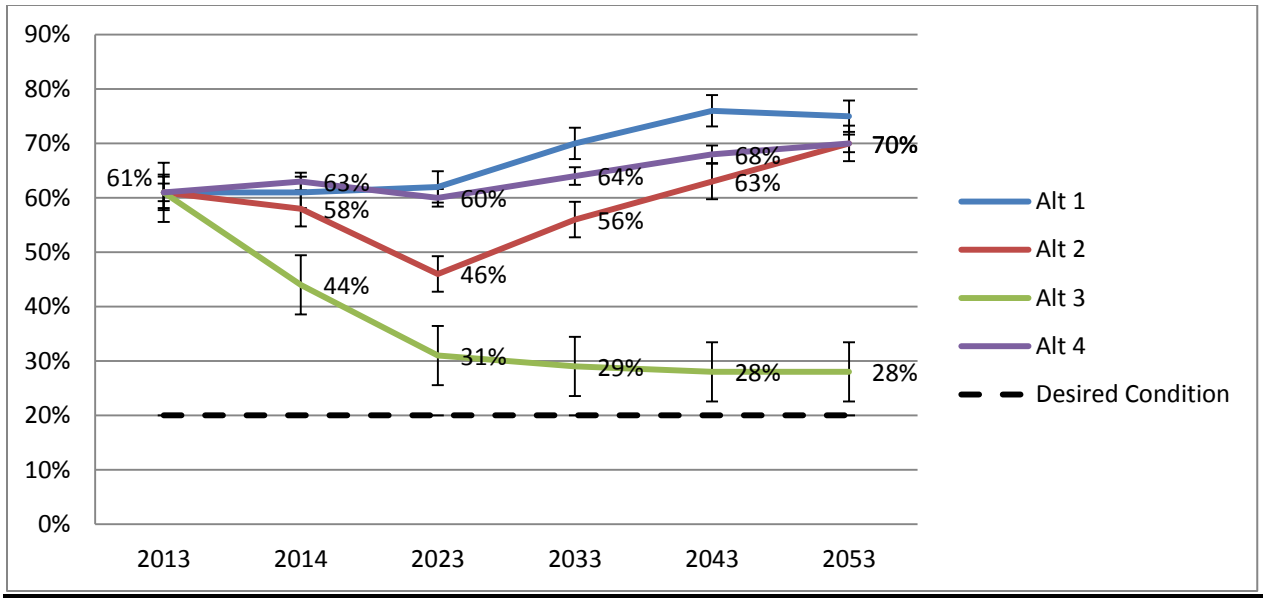


Figure 3.2-35 Mixed Conifer % of TPA infected of extremely infected DM Stands (Ponderosa Pine)

Figure 3.2-36 demonstrates how the alternatives change intensity of DM for Douglas-fir within the mixed conifer cover type based on percent of TPA infected amongst stands extremely infected. In general, the action alternatives trend close or above alternative 1. This is due to diameter limitations from MSO protected, restricted and Arizona bugbane habitat management directions. Alternative 4, burn only, remains a higher % infected due to the mortality of younger and smaller trees from the burn. This changed the population size to have a higher percentage of infected trees. The common reduction after 2023 was due to regeneration establishing. Then slowly becoming infected over time.

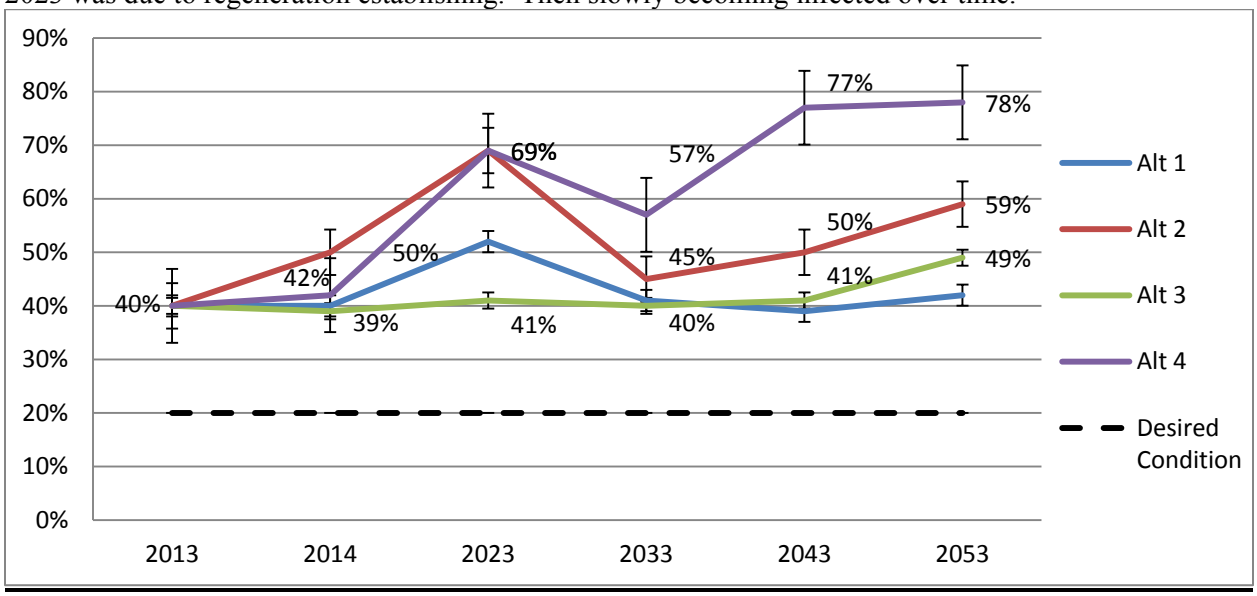


Figure 3.2 – 36 Mixed Conifer % of TPA infected of extremely infected DM Stands (Douglas-fir)

Figure 3.2-37 demonstrates how the alternatives changed the severity of DM for ponderosa pine within the mixed conifer cover type based on DMR. Alternative 2 and 3 bring the DMR below extreme but don't move below the high DMR because of the diameter limits on MSO protected, restricted and

Arizona bugbane habitat. Alternative 3 has the best DMR through time. Alternative 2 slowly recovers to extreme levels.

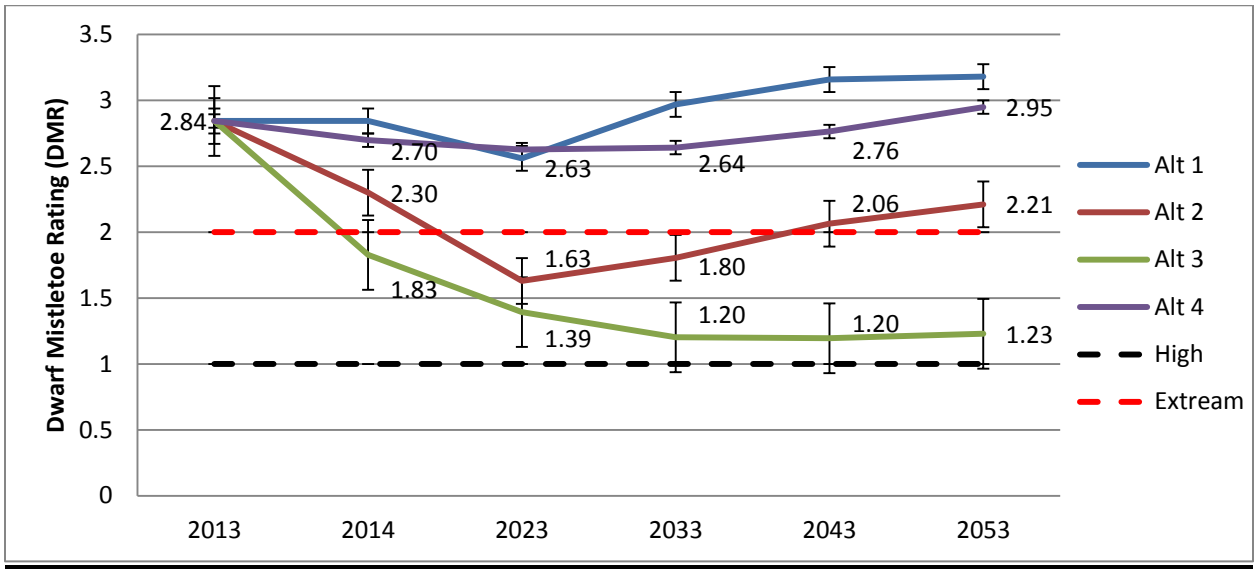


Figure 3.2- 37 Mixed Conifer Dwarf Mistletoe Rating of Extremely Infected DM Stands (Ponderosa Pine)

Figure 3.2-38 demonstrates how the alternatives change the severity of DM for Douglas-fir within the mixed conifer cover type based on DMR. After treatment, in alternative 2 and 4, DMR increases. Alternative 2 increases due to prescriptions focusing on multi age development of groups. Conversely DM was targeted in in alternative 3 resulting in a decrease of DMR. Alternative 3 doesn't decrease below high due to diameter constraints in MSO and Bugbane habitats. Alternative 4 with the minimal amount of thinnings in some mixed conifer and a prescribed burn, DMR increase the highest. The area that was thinned in alternative 4 would have been minimal at a small scale which increases the overall DMR after the treatment year. The second increase in alternative 4 is due to additional mortality from burning, reducing stand densities and leaving trees with severe DMR, resulting in a high stand DMR. The major decrease in DMR for alternative 2 and 4 is due to the added regeneration after mortality. As the stands regenerated with younger age classes, infection levels of DMR decreased due to regeneration not being infected. By the end of the simulation period, the regeneration becomes more infected, causing severity to increase.

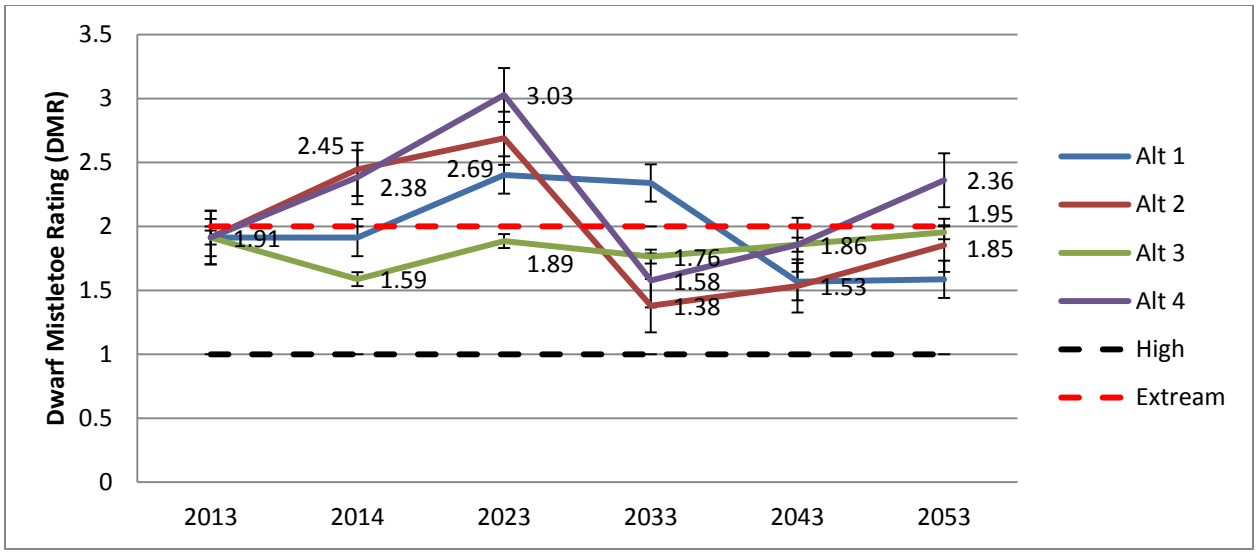


Figure 3.2- 38 Mixed Conifer Dwarf Mistletoe Rating of Extremely Infected DM Stands (Douglas-Fir)

Aspen

Each alternative presents different effects toward aspen health. Alternative 1 would promote minimal aspen recruitment within stands. The loss of aspen vigor within a stand would make the clone susceptible to disappearing after being affected by insects, diseases or fire. Alternative 2 would promote aspen health and longevity the best. For alternative 2, 3, and 4 any treatments proposed around aspen stand would promote aspen health by encouraging stand vigor and recruitment. This type of release increases aspen resilience to fire, frost events, insects and diseases. Alternative 2 is the best because it is anticipated to reduce browsing pressure from aspen due to the increased vigor of shrubs, grasses and forbs from the treatments. Alternative 3 is not anticipated have the same ungulate response to the released aspen. However aspen in alternative 3 would be equivalent to alternative 2 with ungulate enclosures around clones. Aspen effects in treatment areas of alternative 4 would be similar as alternative 3. Areas not being mechanically treated but burned only would have similar effects as alternative 1. Burning alone will stimulate sprouting of seedlings but recruitment of saplings will be questionable. Coupled with the anticipated overstory aspen mortality from only prescribed burning, alternative 4 could reduce aspen health.

<u>Old Growth</u>

Direction from the forest plan standard states to "allocate no less than 20% of each forested EMA to old growth" as depicted in forest plan Table 15 (Old Growth Habitat Characteristics Table). The forest plan also states in a standard to "manage old growth in patterns that provide for a flow of functions and interactions at multiple scales across the landscape through time". "Allocations will consist of landscape percentages meeting old growth conditions and not specific acres". According the Webster dictionary, allocate is defined as "apportion for a specific purpose". This analysis will apportion more at least 20% of the EMA for the purpose of managing for old growth habitat characteristics in forest plan table 15.

Currently, 20% of the forested area in the project area does not fully meet old growth characteristics as specified in the forest plan. The most common reason that the forested areas do not fully meet old growth characteristics is because very few areas meet the minimum number of trees that are of the specified age

or greater. Mitigation measures are in place for the project area to maintain and protect pre-settlement trees, the old trees that lived during the time period where natural functions such as frequent fire events persisted naturally under historic fuel loadings. The placements of these old trees across the landscape help define old growth on the ground. Many areas may meet some of the specified old growth characteristics. The average number of old trees per acres that meet old growth age specifications is the primary characteristic that drops most areas below fully meeting these characteristics. For this reason, most allocated old growth areas do not necessarily fully meet specified old growth characteristics but are being managed towards these old growth characteristics.

Analysis of old growth is done at 3 scales for this report: at the Stand level, at the EMA, and at the GA level. The project area is used to represent an ad hoc EMA for this analysis. This analysis focuses on the effects of spatial arrangement of old growth function from groups to landscapes including de facto allocations of MSO protected steep slopes, MSO target threshold, MSO PAC, Goshawk Nest, and Arizona Bugbane Botanical Area. De facto is a term that defines areas managed for other habitats which can also be managed for old growth. Table 3.2-7 to Table 3.2-8 demonstrates the de facto acres of old growth habitat based on MSO, goshawk and Arizona bugbane habitat.

Table 3.2-7 de Facto acres of Ponderosa pine stands Allocated for Old Growth Habitat

Ponderosa Pine MSO Protected Steep Slopes: 376 Acres	376
Ponderosa Pine MSO PAC: 109 Acres	109
Ponderosa Pine MSO Target Threshold:	173
Ponderosa Pine Goshawk Nest: 695 Acres	695
Ponderosa Pine Bugbane Botanical Area(excluding PAC):100 Acres	100
TOTAL de facto Allocated Ponderosa Pine Stands	**1,453**

Table 3.2-8 de Facto White Fir stands Allocated for Old Growth Habitat

White fir MSO Protected Steep Slopes: 157 Acres	808
White fir MSO PAC: 110 Acres	656
White fir MSO Target Threshold:22 Acres	47
TOTAL de facto Allocated White fir Stands	**1,511**

Table 3.2-9 de Facto Douglas-fir stands Allocated for Old Growth Habitat

Douglas-fir MSO Protected Steep Slopes: 157 Acres	157
Douglas-fir MSO PAC: 110 Acres	110
Douglas-fir MSO Target Threshold:22 Acres	22
TOTAL de facto Allocated Douglas-Fir Stands	**289**

Additional allocated old growth was calculated based on forested areas outside of de facto old growth stands. Forested areas outside of de facto old growth stands were treated to the most conservative prescription based on their habitat designation. At a minimum, goshawk VSS 6 groups would be managed for 20% of each stand. 20% of forested areas outside of de facto old growth stands represent old

growth allocations. The amount of forested areas outside of de facto old growth stands are listed in Table 3.2-10.

Table 3.2-10 Entire stands NOT Allocated as de facto Stands

Ponderosa Pine Not Allocated as de facto Stands	9,101
Douglas-fir Not Allocated as de facto Stands	10
White Fir Not Allocated as de facto Stands	108
Pinion-Juniper Not Allocated as de facto Stands	1,619

At least 20% of the forested area's cover types for areas that are not de facto stands are demonstrated by acres in Table 3.2-11. Ponderosa pine for alternative 2 differed from alternative 3 and 4 by having a reduction of allocated area. This is due to the alternative 2 dominant ponderosa pine prescription for restoration of historic ponderosa pine savanna conditions. Estimates were derived from Table 3.2-6, where approximately 50% of a change to early seral stages changing the ponderosa pine forested area to a forested savanna represented from historic times.

Table 3.2-11 Allocated Old Growth Habitat from non de facto Stands

	Ponderosa Pine Alternative 2	Ponderosa Pine Alternative 3 and 4	White Fir	Douglas-Fir	Pinion-Juniper
Allocated Old Growth Habitat from non-de facto Stands	910	1,820	22	2	810

Acres from de facto stands old growth habitat stands and allocated old growth habitat from non de facto stands were added. Totals were divided against the total cover type acreage and displayed in Table 3.2-12. Table 3.2-12 shows that the alternatives conserved, developed, and retained old growth habitat on at least 20 percent of the naturally forested area by cover type. Even though Table 3.2-12 represents the stand and EMA scale.

Table 3.2-12 Percent of Allocated Old Growth Within Each Cover Type

Ponderosa Pine Alternative 2	22%
Ponderosa Pine Alternative 3 and 4	31%
White Fir	95%
Douglas-Fir	97%
Pinion-Juniper	25%

Table 3.2-13 demonstrates that the forest standard to allocate at least 20 percent of the forested EMA to old growth habitat was met under all alternatives.

Table 3.2-13 EMA Allocation of Old Growth in all Forested Areas

	All Forested Old Growth under Alternative 2	All Forested Old Growth under Alternative 3 and 4
Percent of Allocated old Growth With the EMA	22%	27%

Extrapolating the old growth percentages by cover type to the GA 2 would not decrease percent of old growth allocated. Management direction for in GA 2 will maintain at least 20% of each covers types forested area for old growth. GA 2 consists primarily of ponderosa pine. Old growth ponderosa pine habitat analysis is displayed in Table 3.2-14.

Table 3.2-14. Current Old Growth Allocation of Ponderosa Pine within GA 2

A. Site Designation	B. Structure	C. VSS	D. Mistletoe Infection Level	E. Acres	F. % Allocated to Old Growth	G. Acres Allocated to Old Growth (E X F)
Ponderosa Pine - General	Uneven-Aged	N/A	Mod-hi	19,840	0	0
Ponderosa Pine - General	Uneven-Aged	N/A	Low	71,279	40	28,512
Ponderosa Pine - General	Even-aged	1 - 3	Mod-hi	10,288	0	0
Ponderosa Pine - General	Even-aged	1 -3	Low	35,823	0	0
Ponderosa Pine - General	Even-aged	4 - 6	Mod-hi	6,246	0	0
Ponderosa Pine - General	Even-aged	4 - 6	Low	40,232	80	32,186
MSO PAC	N/A	N/A	N/A	726	100	726
MSO Target/threshold	N/A	N/A	N/A	4,090	100	4,090
Goshawk Nest	N/A	N/A	N/A	6,760	100	6,790
MSO Pine/oak >= 40% Slopes	N/A	N/A	N/A	142	100	142
TOTAL				195,456		72,446
Current % of Ponderosa Pine Allocated as Old Growth (72,446/195,456 x 100)					**37%**	

Mixed conifer species reside toward the base of Kendrick Mountain, and to top of Sitgraves Mountain and Newman hill. Allocated de facto old growth stands exist in these areas based on the similar habitat designations within the project area. Management direction in GA 2 will maintain at least 20% of mixed conifer for old growth habitat.

Due to the aspen decline on the Williams Ranger District from the factors identified in the Fairweather et al 2008. A major effort is underway for protecting the existence of aspen across the Williams Ranger District. The majority of the aspen resides in GA 2. 2011 Aspen CE to restore aspen sites is currently being implemented. These activities do not involve removing old growth aspen but focus on creating recruitment for future aspen clones and old growth.

Large Tree Retention

This analysis measures large tree retention as numbers of trees remaining after treatment, growing space for allocated large tree and longevity of large trees. Large tree for this analysis will be defined as 18" + DBH trees due to the equivalence of VSS 5 groups starting with starting average diameters of 18" DBH. VSS 5 group average diameter limits provide an ecological tie to a diameter number.

Ponderosa Pine

LOGPFA is analyzed because it represents the majority of the ponderosa pine, excluded PFAs. Table 3.2-15 provides landscape averages of just ponderosa pine > 18" DBH per acre. There are slight changes between the alternatives. Due to alternative 1 depending on a static insect and fire state, promotes a higher risk to the loss of large trees due to mortality. Amongst the action alternatives, alternative 3 represents the largest trees though time and alternative 1 represents the large trees directly after 2013. Same trends of large tree retention can be observed in MSO habitat by SDI allocation of 18"+ trees. These tables are shown in the wildlife section.

Table 3.2-15 Ponderosa Pine LOGPFA 18"+ Trees Per Acre

	2013	2014	2023	2033	2043	2053
Alt1	8.1	8.3	10.4	13.4	16.4	18.2
Alt2	8.4	7.6	9.3	12.4	14.8	17.0
Alt3	8.3	7.5	9.3	13.5	17.3	20.1
Alt4	8.2	7.6	9.0	13.2	16.5	19.8

Mixed Conifer

LOGPFA is analyzed because it represents mixed conifer as a whole. Table 3.2-16 provides landscape averages of just ponderosa pine > 18" DBH per acre. There are slight changes between the alternatives. Due to alternative 1 depending on a static insect and fire state makes it less desirable for an alternative of large tree retention. Alternative 4 promotes a higher risk to the loss of large trees due to mortality from unknown future insect and fire risk in the no thinned area or induced morality for prescribed burning. Amongst the action alternatives, alternative 1 and 2 represents the largest trees though time and alternative 2 and 3 represents the most large trees directly after 2013. Same trends of large tree retention can be observed in MSO habitat by SDI allocation of 18"+ trees. These tables are shown in the wildlife section.

3.2-16 Mixed Conifer LOGPFA 18"+ Trees Per Acre

	2013	2014	2023	2033	2043	2053
Alt1	12.4	12.5	14.0	15.8	19.9	23.0
Alt2	12.4	12.6	11.9	14.4	18.9	21.5
Alt3	12.4	12.6	11.9	12.9	16.4	18.9
Alt4	12.4	12.5	8.3	9.9	12.2	14.9

Treatment Longevity

Treatment longevity out lines future predictions of future management needs within the project area. Different alternatives per cover type pose different needs based on the actions of all the alternatives.

Alternative 1 poses a scenario that will keep the ponderosa pine cover type at its current state and allow the current state to perpetuate through time. Treatment longevity of this approach would depend on insect and disease epidemics and risk of loss from catastrophic wild fires (Donovan et al 2008, Fulé 2008).

Due to the forest plan amendment in alternative 2 producing timber on these stands would not have a timber production emphasis and have a regulated output timber for the future in the majority ponderosa pine type. The option to maintain desired conditions using prescribed or natural fire would readily be an option. The use of maintaining desired condition with fire can rapidly treat the project area under minimal cost (Fulé 2008).

Alternative 3 and 4 maintains the purpose of timber suitability for ponderosa pine. Alternative 3 and 4 maintains the option for timber management. The levels managed under alternative 3 and 4 presents a condition that would need to be recognized with in the future (Strom and Fulé 2007). Approximately up to to 40 years into the future, additional efforts would need to be met to create additional regeneration areas under group selection silvicultural uneven aged systems (Grahan et al 2006). This would require the use of timber harvesting and prescribed burning.

Conclusions of Direct and indirect effects

The following tables are a summary of how alternatives best meet desired conditions for the project and forest plan. Yes and no classification are based on analysis, most recent available science and professional experience.

Table 3.2-17 Conclusion Table Part 1

		Alt 1	Alt 2	Alt 3	Alt 4
Forest Health	PP Bark Beetle Risk	N	Y	Y	Y
	MC Bark Beetle Risk	N	Y	Y	Y
	PP DM Levels	N	Y	Y	Y
	MC DM Levels	N	Y	Y	N
	Aspen Health	N	Y	Y	N
Old Growth	20 % of EMA	Y	Y	Y	Y
	3 scales of Analysis	Y	Y	Y	Y
Large Tree Retention	Short Term	Y	Y	Y	Y
	Mid term	N	Y	Y	Y
	Long Term	N	Y	N	Y
Treatment Longevity	Short Term	N	Y	Y	Y
	Mid term	N	Y	Y	Y
	Long Term	N	Y	N	N

Table 3.2-18 Conclusion Table Part 2

			Alt 1	Alt 2	Alt 3	Alt 4
Vegetative Structure	PP LOGPFA	VSS1 and2	N	Y	Y	Y
		VSS 3	N	Y	Y	Y
		VSS 4	Y	Y	Y	Y
		VSS 5	Y	Y	Y	Y
		VSS 6	N	Y	Y	Y
		VSS 4 CC	Y	Y	Y	Y
		VSS 5 CC	Y	Y	Y	Y
		VSS 6 CC	Y	Y	Y	Y
	MC LOGPFA	VSS1 and2	Y	Y	Y	N
		VSS 3	N	Y	Y	Y
		VSS 4	Y	Y	Y	Y
		VSS 5	N	Y	Y	N
		VSS 6	N	Y	Y	N
		VSS 4 CC	Y	Y	Y	Y
		VSS 5 CC	Y	Y	Y	Y
		VSS 6 CC	Y	Y	Y	Y
	PP PFA	VSS1 and2	N	Y	Y	Y
		VSS 3	N	Y	Y	Y
		VSS 4	Y	Y	Y	Y
		VSS 5	Y	Y	Y	Y
		VSS 6	N	Y	Y	Y
		VSS 4 CC	Y	Y	Y	Y
		VSS 5 CC	Y	Y	Y	Y
		VSS 6 CC	Y	Y	Y	Y
	PP Nest	VSS 5	Y	Y	Y	Y
		VSS 6	Y	Y	Y	Y
		VSS 5 CC	Y	Y	Y	Y
		VSS 6 CC	Y	Y	Y	Y
	Woodlands		N	Y	Y	Y
	Grasslands		N	Y	Y	Y
	Aspen		N	Y	Y	Y

3.2.3 Cumulative Effects

This section addresses the cumulative effects of the action alternatives combined with past, present, and reasonably foreseeable future actions on the forest composition and structure in GA 2. GA 2 was used for this cumulative effects analysis because of the upcoming 4Fri proposals. The cumulative effects analysis area for this cumulative effects analysis is the predominately ponderosa pine. The cumulative effects analysis area is approximately 324,558 acres in size.

There are approximately 15,000 acres that have had some sort of vegetative treatment over the past 10 years within the cumulative effects analysis area. Vegetative treatments are defined as a variety of silvicultural treatments that involve felling trees. These treatments included low thinnings, sanitation cutting, group selection cuts, and individual tree shelterwood cuts. The vegetative treatments were commercial logging or noncommercial thinning/sanitation, or often a combination of both. Vegetative treatments were often combined with follow-up activity slash treatments that included lopping, piling and burning, and/or prescribed broadcast burning. Due to the upcoming 4Fri contract, the following calculations include potential thinnings from the initiative. In the next 5 years, approximately 19,000 acres of vegetative treatments are planned within the cumulative effects analysis area. For the 15-year period, beginning 10 years ago and ending 5 years from now, an approximate total of 34,000 acres of vegetative treatments will be accomplished. This is approximately 10% percent of the cumulative effects analysis area.

Over the past 10 years, approximately 35,000 acres of the cumulative effects analysis area have been prescribed burned, have had an unplanned ignition managed for resource objectives, or have had a wildfire. In the next 5 years, 26,000 acres of these wildland fires are expected to occur within the cumulative effects area (this includes 6,000 acres planned for prescribed burning and an estimate based on the previous 10 year past occurrences of 20,000 acres of unplanned ignitions managed for resource benefits; it does not include an estimate for wildfires). Over a 15 year period, approximately 60,000 acres have had or will have a wildland fire. This represents 18 percent of the cumulative effects analysis area. Some of these burn areas will also have vegetative treatments during the 15 year analysis period.

The greatest change in the cumulative effects analysis area over the past 150 years has been the transition from very open pine forests or woodlands dominated by larger trees to much denser forests or woodlands dominated by small to moderate sized pine or other tree species. Trends in forest conditions over this time period for the cumulative effects area include:

- A greatly increased risk of catastrophic stand-replacing fires
- A vast reduction in forest openings and meadow/savannah areas along with associated understory vegetative species
- A more uniform vegetative condition with limited diversity
- Reduced forest health and vigor
- An increase in the amount and distribution of dwarf mistletoe-infected pine

Vegetative treatments and wildland fires over the past 10 years and during the next 5 years have and will alter the trends listed above for portions of the cumulative effects area. Vegetative treatments and wildland fires for this 15-year period are promoting the following trends in recent forest conditions for the cumulative effects analysis area:

- Reduced risk of catastrophic stand-replacement fires by opening up forest canopies and reducing understory fuels
- Creation of more openings in the forest canopy; restoration of natural meadows and savannahs; increased development of understory grasses/forbs/shrubs; increased vigor and sustainability of aspen clones
- A more diverse forest structure with a broader distribution of tree age classes
- Increased stand vigor; increased forest resiliency; faster growth and development of individual trees
- Decreased levels of dwarf mistletoe infections

The above trends are localized throughout the cumulative effects area. Vegetative treatments generally have more of an impact in promoting the above trends than wildland fire alone. A combination of both vegetative treatments and wildland fire would have the greatest impact in promoting the above trends. In

Lou of the upcoming 4Fri contract projected to implement shelf stock the future for timber markets to accomplish multiple acres that are projected. Limited budgets, poor timber markets, and other management constraints historically have reduced the ability to treat as much of the area as necessary to move towards desired conditions. Future vegetative treatment projections may vary substantially based on demand for timber and variations in available budget. In 15 years with current trends and foreseeable events, only 15% of the cumulative effects analysis area would receive vegetative treatment and 40% of the area would have wildland fire occur; the rest of the analysis area would remain untreated even though much of it has treatment needs to reduce the risk of catastrophic loss to wildfire, to improve forest health, and to increase stand diversity. Many negative trends related to forest condition would still develop through the 15-year time period in untreated areas. Scattered treatments throughout the analysis area will limit the size and intensity of wildfires.

The number of large mature pines in the cumulative effects analysis area has been decreasing over the last 60 years. This has been the result of past harvest practices, increased mortality from heavy competition with dense smaller pine, and some loss from wildfires and prescribed burning. This decline has been slowed significantly as management direction has moved away from overstory removal cutting and selective overstory thinning. During the last 20 years, management in the cumulative effects analysis area has concentrated on maintaining large mature pine while rapidly developing pine in the smaller diameter classes to act as future replacements for these large trees. Management direction has also moved toward increasing the longevity of existing large oak, older large pine, and large juniper by reducing understory competition around these trees. Modeling in the areas receiving vegetative treatment in the last 20 years shows that current management techniques are actually increasing the number of large trees across the landscape and are also increasing the longevity of mature pine. Prescribed burning techniques have been refined over the past 20 years resulting in mitigation measures designed to reduce loss of large trees, these measures are incorporated into burn plans.

Climate Change

All background information on climate change is from Malmsheimer et al. 2008. The Bill Williams Restoration project is proposed on a local scale and is not intended to have cumulative effects that are measurable on a global scale in regards to climate change; however management of the Bill Williams Restoration project has a small scale effect on mitigating climate change when combined with other management actions regionally. Most of the Bill Williams Restoration project area is currently considered overstocked and at risk for stand-replacing fires which are the greatest cause of carbon release or greenhouse gases. The action alternatives reduce the risk potential for stand-replacing fires.

3.3 Fire and Fuels Management

3.3.1 Introduction

Fire behavior is the manner in which a fire reacts to available fuels, weather, and topography. A change in any of these components results in a change in fire behavior (DeBano et al 1998). Fire behavior is complex, with many contributing factors in the categories of topography (slope, aspect, elevation), weather (climate, air temperature, wind, relative humidity, atmospheric stability) and fuels (size, type, moisture content, total loading, arrangement) (Agee 1993). These three elements comprise the fire environment, surrounding conditions, influences, and modifying forces that determine fire behavior (NWCG 2004).

Topography and weather at a given location are beyond the ability of management to control. Fuel hazard is the only controllable factor. Weather conditions such as drought, high temperature, low humidity, and high wind play a major role in the spread of wildfires and are influenced by topography and location of mountains as well as global influences such as La Niña and El Niño. Weather conditions are a major factor in the initiation and spread of all wildfires, but Omi and Martinson (2002), and Strom and Fulé (2007) found that stands with prior fuel treatments experienced lower wildfire severity than untreated stands burning under the same weather and topographic conditions. Fuel management modifies fire behavior, fire effects, and reduces fire suppression costs and danger (DeBano et al 1998). Manipulating fuels reduces fire intensity and severity, allowing firefighters and land managers more control of wildland fires by modifying fire behavior in the fire environment (Pollet and Omi 2002).

Fuel management can include reducing the loading of available fuels, lowering fuel flammability, or isolating or breaking up large continuous bodies of fuels (DeBano et al 1998). Fuels contribute to the rate of spread of a fire, intensity, flame length, fire residence time, and the size of the burned area (Rothermel 1983). Two contributing factors to stand destroying crown fire are surface fuels and canopy fuel distribution. Surface fuels play an important role within an ecosystem. Litter and duff layers help protect soil from erosion and provide nutrients to the soil. However, layers of duff and litter that are too thick suffocate soil and burn with high intensities which create longer flame lengths and residence time (amount of time fire is present in one spot). This causes higher severity or damage to existing vegetation. Coarse woody debris also has an important ecological role in soil erosion mitigation and for the wildlife habitat, but can also contribute to more severe fire behavior. Large diameter woody fuels or coarse woody debris have little influence on rates of spread of fire but burn with higher intensity and with longer duration that could result in greater damage to soil (Brown et al. 2003, DeBano et al. 1998, Harmon et al. 1986). The existing surface fuel loading is measured to be approximately 18 tons per acres in ponderosa pine and pine-oak forest types. This increases in the dry mixed conifer forest to 30 tons per acre. Desired conditions for surface fuels are less than 7 tons per acre in pine-oak and Ponderosa pine forests and less than 15 tons per acre in dry mixed conifer forests.

Canopy fuel distribution and the risk of stand replacing crown fire can be measured by looking at average canopy bulk density and canopy base height across an area. Canopy bulk density (CBD) is defined as the mass of available canopy fuel per unit volume (Scott and Reinhardt 2001). For any given tree species, widely spaced trees have a lower CBD, which makes it more difficult to maintain a crown fire. Stands with high CBD can also sustain a crown fire that initiated outside of the stand and becomes independent of surface fire intensity. While no definitive single CBD threshold exists, canopy bulk densities below 0.10kg.m3 are unlikely to support crown fire (Agee et al. 2000).

Canopy base height (CBH) is the lowest height above the ground at which there is sufficient amount of canopy fuel to propagate fire vertically into the canopy (Scott and Reinhardt 2001). The lower the canopy base height the easier it is for a surface fire to initiate a crown fire (Van Wagner 1977). Canopy base height coupled with canopy bulk density allow managers to understand how likely a crown fire is to initiate and sustain itself across a stand. Exiting conditions in the Bill Williams Mountain project area demonstrate canopy base height near 10 feet in pine type areas coupled with canopy bulk densities of 0.07kg/m3. Mixed conifer type area average a canopy base height of 4 feet and a canopy bulk density of .16kg/m3. Desired conditions for the Bill Williams Mountain project area would be to have average stand canopy base heights above 18 feet with canopy bulk densities below .05kg/m3 in ponderosa pine forest

types and CBH above 10 feet with CBD of .08kg/m3 in dry mixed conifer types. These stand averages would mean that groups of trees can have higher densities if surrounded by areas of lower densities which would break up the continuity of canopy fuels and therefore crown fire. The desired condition would reduce the percent of the Bill Williams Mountain project landscape with potential to burn as passive and active crown fire. Passive crown fire refers to fire that does not carry continuously through the crown fuels, but burns crown fuels intermittently, such as when individual trees or groups of trees torch. Active crown fire carries continuously through the canopy of trees. Current conditions show 61% of the area having the potential to burn as an active crown fire and another 21% of the area with potential for passive crown fire.

FlamMap analysis results

The effect of changes in canopy openings and distribution of tree groups and clumps on potential fire behavior can be seen by looking at maps of potential fire type for the area. The following four maps demonstrate the changes in fire behavior type and distribution based on the management alternative. Alternative 1, the No Action alternative, would also represent current conditions for this landscape. Alternative 1 demonstrates much of the Bill Williams Mountain project area exhibiting active or passive crown fire (21% Passive, 61% Active). Alternative 2 shows a marked reduction in active crown fire (18%), which would indicate much less resistance to control and less spotting potential. It can also be seen that some areas with active crown fire are interspersed with surface fire types which could lead to opportunities for fire control during a wildfire. Alternative 3 also exhibits a reduction in active crown fire (27%), but includes additional areas south of Bill Williams Mountain as well as on the mountain proper than alternative 2. This is important because wind direction is primarily southwest and a fire would be lined up with the southern aspect slopes. When wind and slope are aligned, fire spread potential is increased. Southern aspects are typically drier (more time exposed to solar radiation) and therefore tend to have lower fuel moistures which directly effects combustion. Alternative 4 also shows a decrease in crown fire potential, but exhibits a greater area of continuous crown fire, especially on the slopes of Bill Williams Mountain.

Table 3.3-4. Percent of the Bill Williams area demonstrating potential for types of fire by alternative.

% of Bill Williams Area With Each Fire Type Potential Post Treatment				
Potential Fire Type	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3	Alternative 4
No Fire	1	1	1	1
Surface Fire	17	54	42	31

Passive Crown Fire	21	27	30	33
Active Crown Fire	61	18	27	35

The increase of passive crown fire in alternatives 2, 3 and 4 can be assumed that it is areas that have transitioned from active crown fire after the proposed treatments (the treatment changed the landscape structure in a way that changed it enough to not allow active crown fire, but not enough change to make it a surface fire only). Although in general an increase in torching behavior is perceived as potential fire control problems, it does represent a change from conditions prudent to active crown fire which has much more safety and control issues related to it.

Surface fires typically allow direct firefighting tactics in a safe manner. It should be noted that rates of spread would increase over current conditions with more open canopy conditions although fire intensities and tree mortality would be much lower. More open canopy conditions allow for additional fine fuels to grow (grasses, forbs). Ecologically, this represents historic conditions but also equates to faster moving fires. In alternative 1, 15% of the area represents a rate of spread one type 3 engine crew could pick up in an hour. With alternative 2, 52% of the area is represented with that rate of spread. Alternative 3 produces 41% of the area and alternative 4 is 30% of the area. This is assumed equal grass crop production which could fluctuate over moist or dry years and produce different results. Fire management for the project area would need to take this in to account and aim to have fire represented over parts of the landscape on historic mean intervals to eliminate unnatural accumulations of fine fuels that would advance fire rates of spread to levels typical district crews could not quickly contain. The increase of fire rates of spread would mean potential to spread to areas with values at risk more quickly. Prescribed fire or managing wildfires under low or moderate weather and fuel conditions would help alleviate these issues. The action alternatives provide managers increased ability to consider these options.

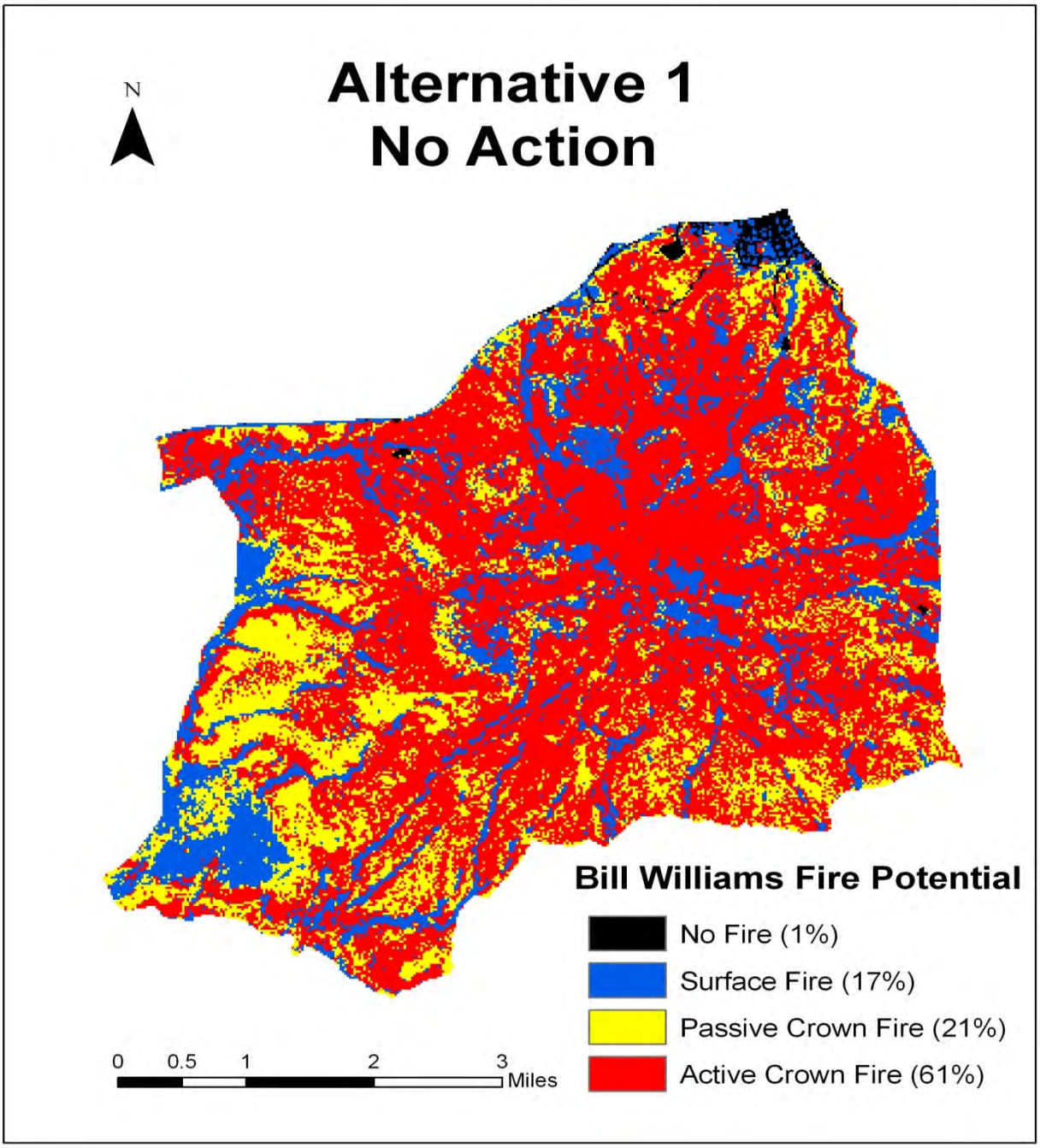


Figure 3.3-1 Map of the Bill Williams Mountain project area demonstrating the distribution of fire potential for Alternative 1.

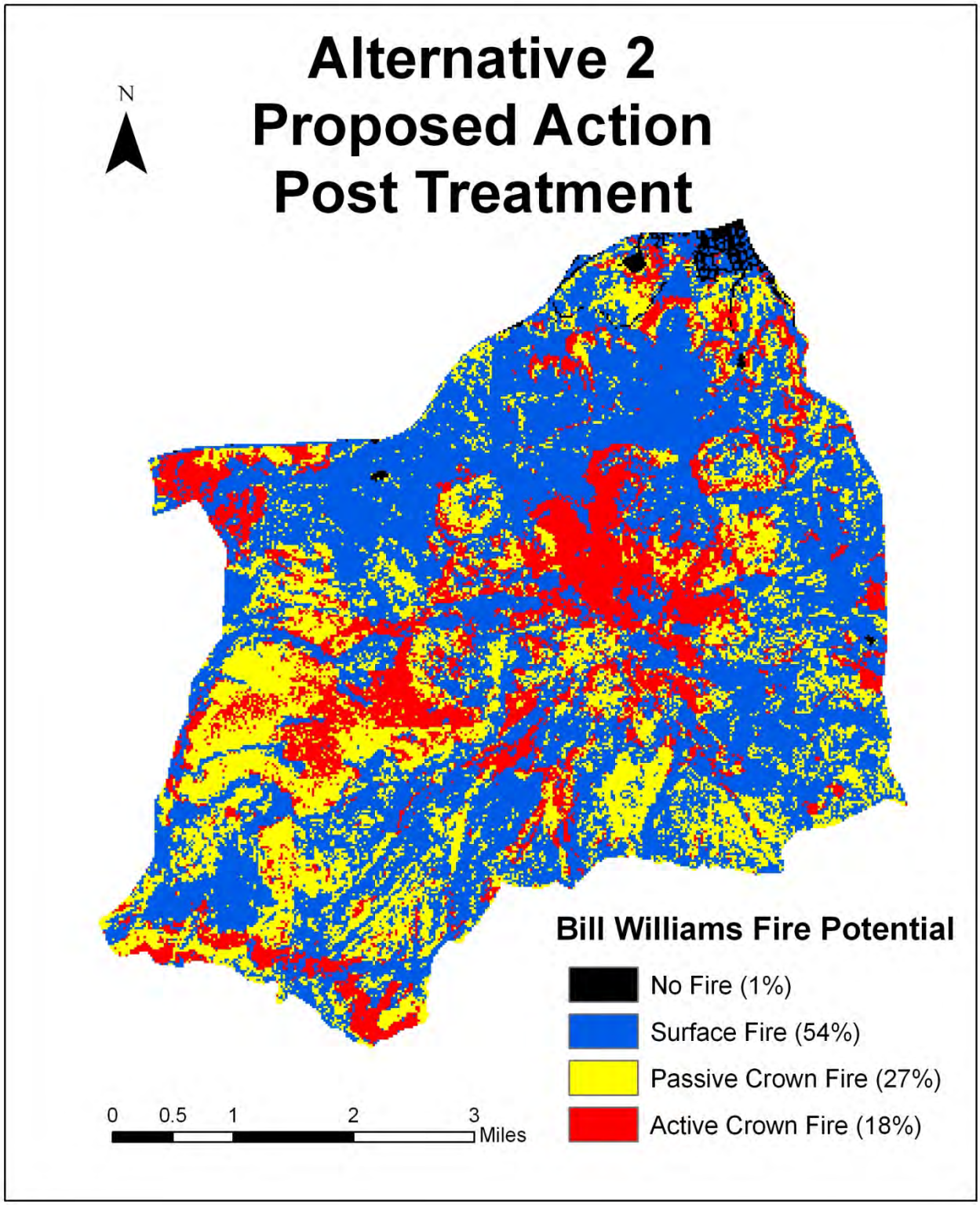


Figure 3.3-2 Map of the Bill Williams Mountain project area demonstrating the distribution of fire potential for Alternative 2.

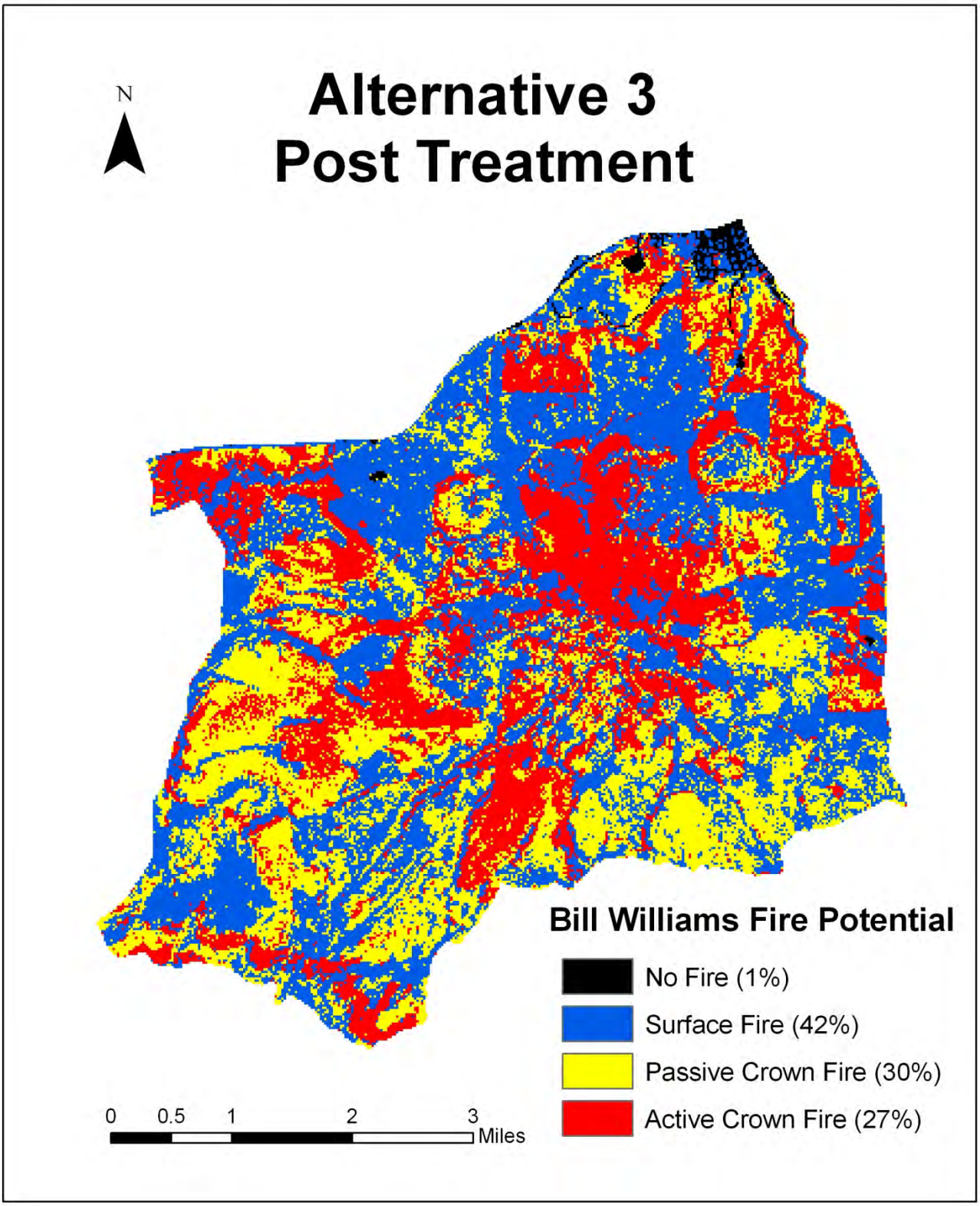


Figure 3.3-3 Map of the Bill Williams Mountain project area demonstrating the distribution of fire potential for Alternative 3.

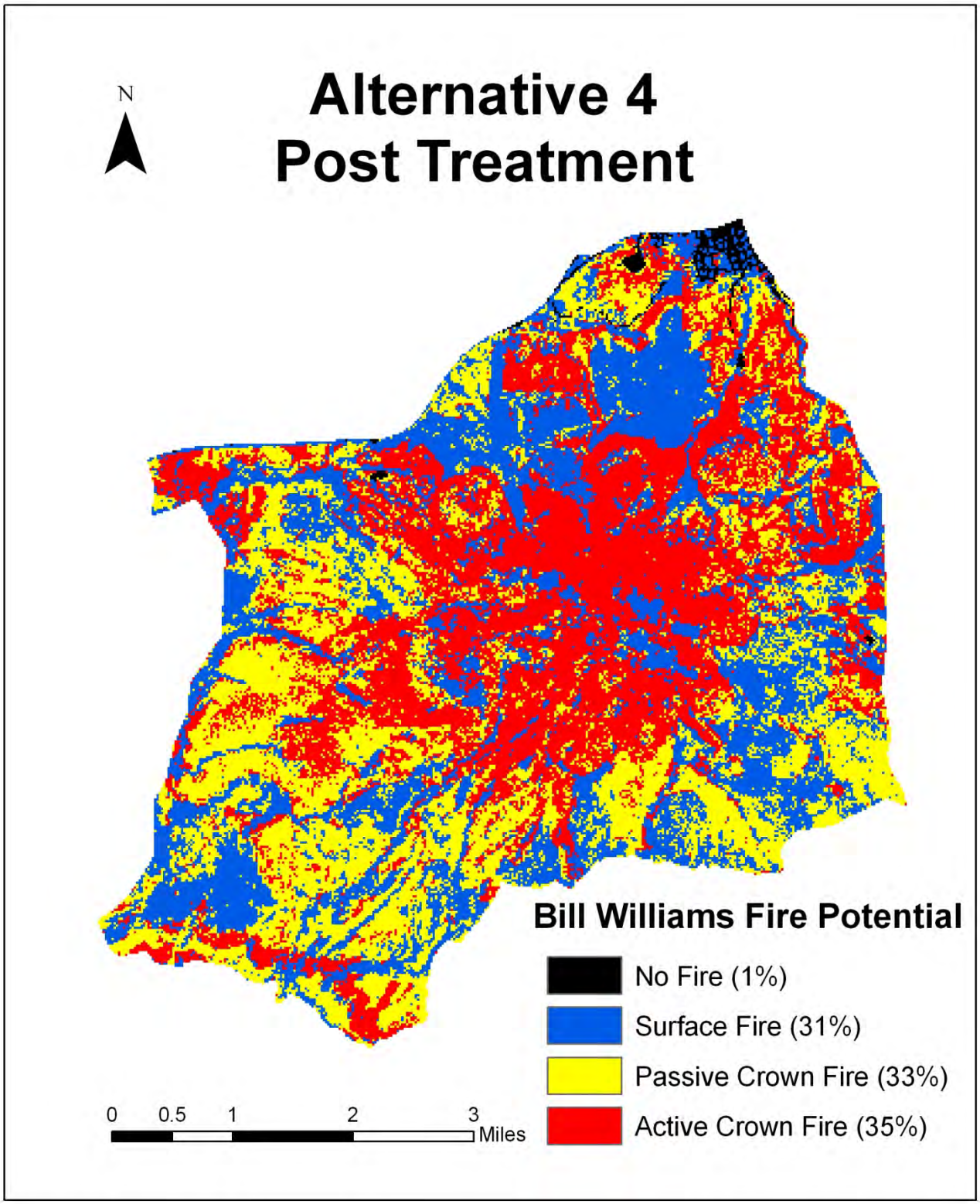
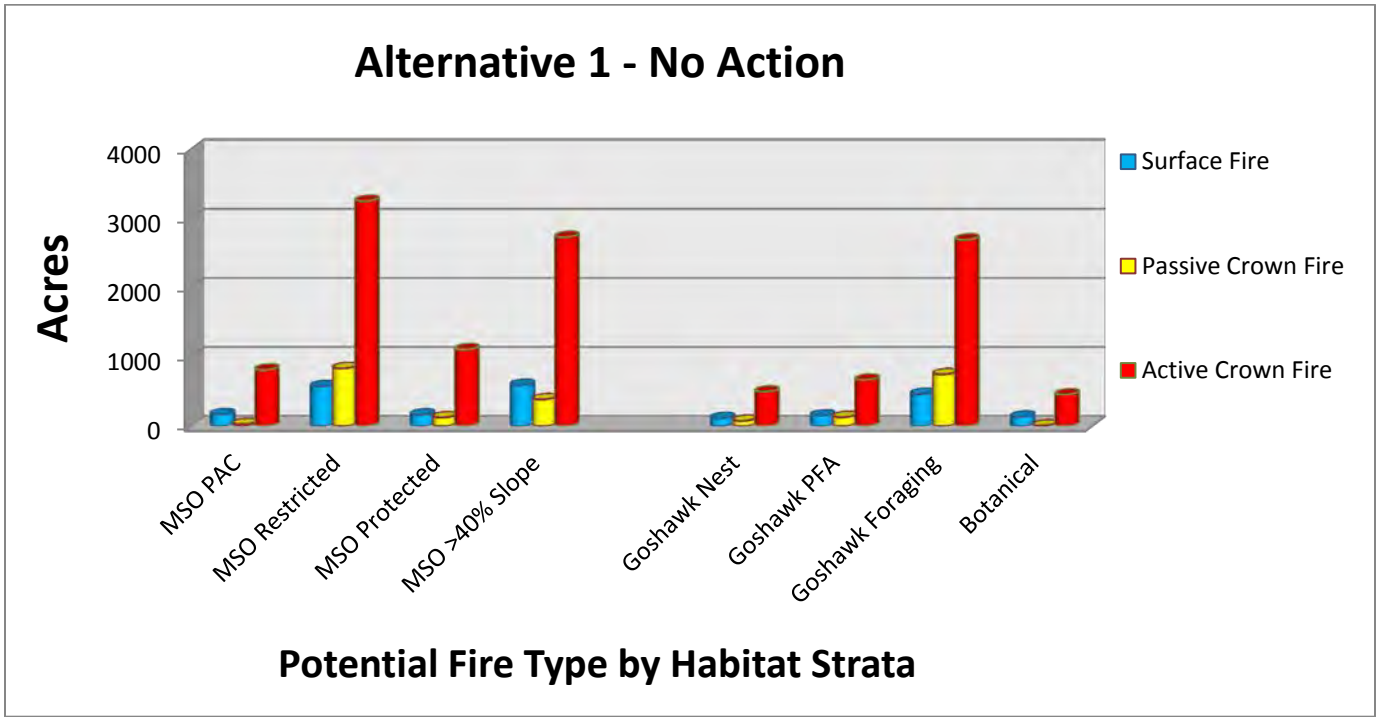


Figure 3.3-4 Map of the Bill Williams Mountain project area demonstrating the distribution of fire potential for Alternative 4.

Wildlife attributes are an important consideration in the project area. Figure 3.3-5 breaks out some of the key wildlife strata within the project area and graphically illustrates potential changes per alternative to each feature. The Mexican Spotted Owl (MSO) Protected Activity Center (PAC) is a key feature of importance as identified in the Kaibab National Forest plan. If no treatment takes place (alternative 1), 83% of the PAC exhibits potential for crown fire. Also, with its location (slope), fires becoming established below it are likely to adversely affect most or all of the PAC. A consideration of leaving the PAC at a dense forest with a heavy accumulation of fuels on the forest floor needs to be weighed against the survivability of the PAC as a whole if fire were to become established into it, either directly or from downslope. A trade off would have to be recognized in order to meet either of the above desired conditions and an understanding of the tradeoffs realized.

The Botanical area can also be compared from Figure 3.3-5. The area consists of *Cimicifuga arizonaica* (Arizona bugbane). Under alternatives 1, 3 and 4, little or no treatment would take place because the Land Management Plan directs 1/10 acre maximum allowable burning annually. With no treatment taking place, it can be assumed the plant would unlikely be radically altered by human disturbance. The future condition of the plant's landscape cannot be determined, but its vulnerability to mass loss of current vegetation due to wildfire can be assumed. Current conditions of the botanical area are dense stands of mostly mixed conifer forest with interlocked crowns and high fuel loadings on steep slopes, conducive to crown fires even under moderate fire danger conditions. These are factors directly related to loss of vegetation and soil erosion in many fires in the southwest. The tradeoffs to the value must be considered and weighed.



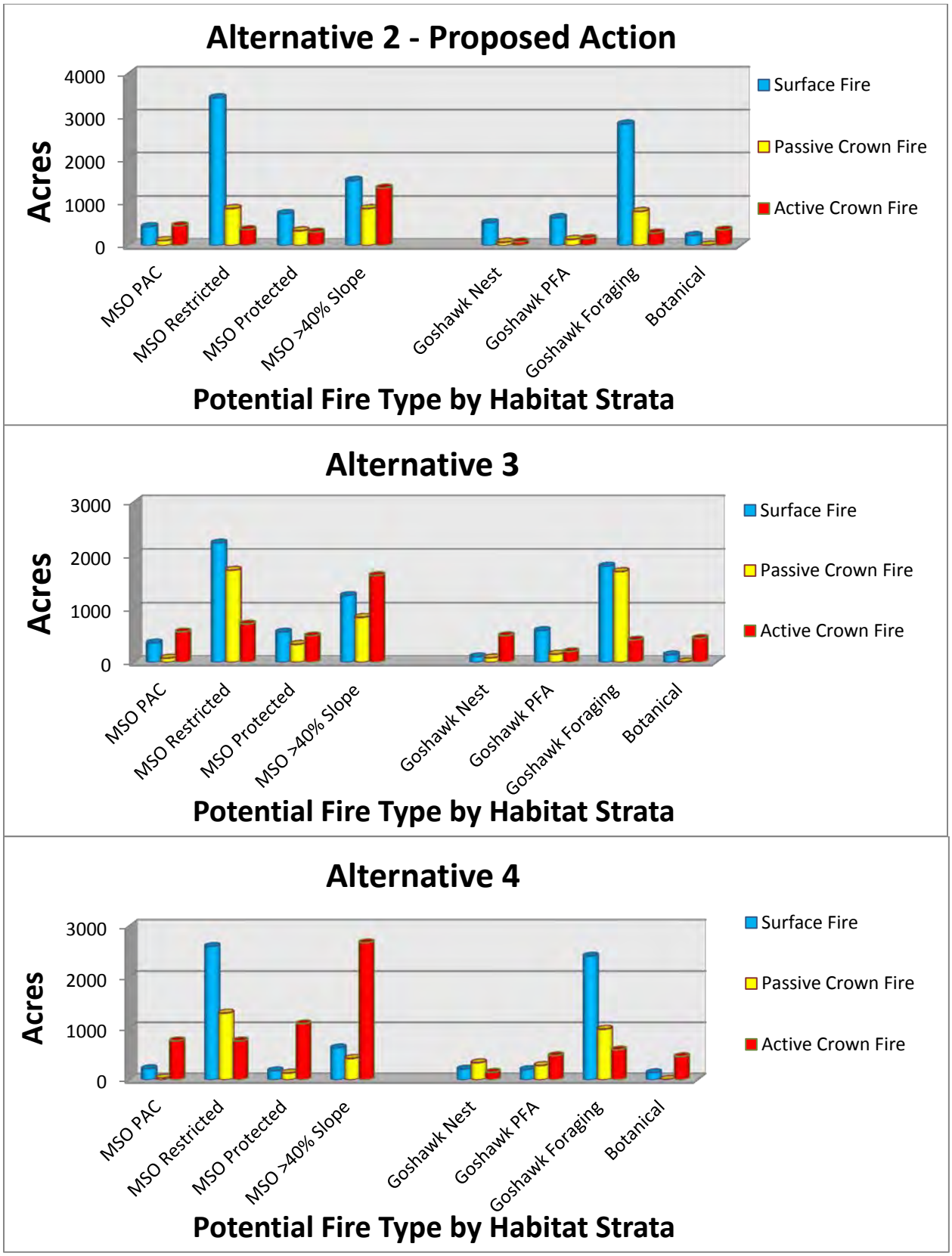


Figure3.3-5. Habitat Stratum Fire Type Potential.

FVS/FFE Results

All results from FFE are stand averages (but weighted by acres*) and therefore can give a general idea of what stand conditions look like but cannot address the spatial distribution of specific metrics. The desired conditions are for stand averages and therefore allow for some areas within a stand to be outside of the desired condition range but be surrounded with conditions closer to overall desired conditions. For example Crown Bulk Density is desirable below .08kg/m3 as an average over a mixed conifer stand. This could mean that many patches within the stand have much higher CBD but have interspaces between these dense clumps of trees where CBD is much lower than .08 and therefore the average for the stand is within acceptable limits. Where CBD is high, it is important to also have higher CBH (crown base height). Surface fuel loading is managed with fire and felling techniques to increase or decrease woody debris in different size classes.

Pinyon and juniper woodlands account for less than 10% of the project area. These areas were analyzed with FVS/FFE and recorded here to assist the wildlife biologists with their habitat analysis on the Forest's Management Indicator Species.

* The numbers in Table 3.3-5 were weighted by acre rather than stand to better represent actual data. For example, 1 stand could be 10 acres and another 100 acres. The average of the 2 stands is 50 acres. That doesn't represent the landscape as well as weighting the 100 acre stand as more (as it is physically on the landscape).

Table 3.3-5 Fire and Fuels Extension to the Forest Vegetation Simulator post treatment results by alternative.

FVS/FFE Calculation Results Post Treatment						
Forest Type	**Criteria**	**Desired Condition**	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Dry Mixed Conifer	**Canopy Base Height (feet)**	>10	4	12	20	10
	Canopy Bulk Density (kg/m3)	<.08	0.15	0.06	0.05	0.07
	Surface Fuel Loading (tons/acre)	<12	30	16	15	19
Ponderosa Pine /Pine-Oak	**Canopy Base Height (feet)**	>18	10	22	22	21
	Canopy Bulk Density (kg/m3)	<0.05	0.07	0.03	0.03	0.03
	Surface Fuel Loading (tons/acre)	<6	19	8	8	8
Pinyon-Juniper Woodlands	**Canopy Base Height (feet)**	>10	14	15	15	15
	Canopy Bulk Density (kg/m3)	<.05	0.04	0.01	0.01	0.01
	Surface Fuel Loading (tons/acre)	<6	8	3	3	3

It is important to consider the model assumptions over time and space as well as the scenarios when looking at the outputs in Table 3.3-5. The numbers represent modeling predictions that can be used as a comparison after different treatments (since the only differences are the treatments by alternative). The table numbers are shown at a common year once all the proposed treatments have been implemented (silvicultural thinning, pile burns and broadcast burns). They are used as a tool for potential effects comparisons. More discussion of this table and the results outputted by FVS/FFE can be found in Appendix D.

FRCC Results

The Bill Williams Mountain project area exhibits three distinct vegetation types in relation to FRCC; ponderosa pine vegetation (includes pine-oak types), dry mixed conifer vegetation and juniper woodlands (including pinyon pine intermix). Ponderosa pine type ecosystems are composed primarily of ponderosa pine, oak, and juniper depending on the stands development. Mixed conifer stands are composed of ponderosa pine, Douglas fir, white fir and aspen, with Douglas fir dominating in late stages of succession. Pinyon-Juniper vegetation conisists of equal populations of pinyon pine and juniper with open, grassy areas intermixed.

According to the western United States Biophysical Settings Key (Comer et al. 2003), ponderosa pine and dry mixed conifer forests in the southwest have a dominant fire regime of I and a mean fire interval of 2 to 10 years in Ponderosa pine and 5 to 25 years in dry mixed conifer. A fire regime I has a frequent fire interval with low to mixed severity. Fires typically maintained open areas and replaced or opened up areas that exhibited a more closed canopy. With the absence of fire both the Ponderosa pine and the mixed conifer stands have accumulated unnatural amounts of fuel primarily in the form of dense trees that would cause a natural fire to exhibit more extreme fire behavior. Both the Ponderosa pine and the mixed conifer have missed multiple natural mean fire intervals. With the combination of missed burn intervals, the encroachment of mixed conifer, and the accumulation of surface fuels, these areas are currently best represented as a condition class 3. Under a no action alternative these areas would remain as a condition class 3 over time and could be expected to burn with uncharacteristic fire severity. The pinyon-juniper woodlands are identified with longer return intervals of mixed severity. These areas are experiencing loss of grasses, shrubs and pinyon pine due to drought tolerant juniper trees encroaching and establishing.

In these vegetation types defined by Comer et al. (2003) the ability to create canopy openings, redistribute dominance to fire resistant tree species and allow for diversity in age classes are essential in moving stands towards a naturally functioning fire regime and therefore FRCC 1. Furthermore, forests in a fire regime I are maintained in that state by understory vegetation. Much of the forest structure was open canopy which resulted in healthy and vigorous understory plants that served as fuel to carry surface fire through these stands. Stands in FRCC 1 would demonstrate little potential for active crown fire and would experience relatively little overstory mortality post wildfire.

Areas where some canopy openings can be created and some sunlight can penetrate and invigorate understory forbs and grasses would have decreased threat of crown fire and would have a re-established understory that could support surface fire. If these areas do not contain a well balanced mix of strata with reproducing fire resilient species they are still considered departed but not as departed as stands with closed canopy. These areas are classified as FRCC 2.

Continuous areas in an even aged condition with closed canopy are considered very departed from historical conditions. These areas will not be able to support understory vegetation and have potential for continuous crown fire.

Using data from the silviculture report and looking at FFE and FVS stand data outputs it was determined that the action alternatives all alter the current condition class of the project area.

Within the dominant vegetation categories shown in Table 3.3-6, there are distinct habitat features with specific attributes linked to them. Within the design of the project, some of these features' desired conditions or restrictions by alternative may not meet historic fire regime characteristics. High density requirements (including Mexican Spotted Owl PAC, Restricted, Protected, Target and Threshold habitats as well as Northern Goshawk post-fledgling family areas and nest stands) in these areas will decrease the ability to reduce canopy fuel continuity or for understory vegetation to respond to treatment. Habitat would be subject to diameter limits or basal area requirements which would constrict the ability to open canopy gaps and remove much of the uncharacteristic species as well as meet historic fire regime characteristics. This limits the potential to move it to a FRCC 1. Some areas have fire intolerant species trees that have encroached the understory of the stands and are larger than potential diameter parameters. This would remain or continue towards FRCC 3. Allowing for smaller diameter fire intolerant species to be removed and have small effects on canopy fuel discontinuity would move to a FRCC 2. No removal will meet and stay at FRCC 3 and be unsustainable over time. This section of the report is designed specifically towards comparisons to fire regime condition class and not to the potential desired habitat condition. Management implications in not returning those areas to historic conditions will be discussed in section 3.3.6 – Discussion and Management Implications.

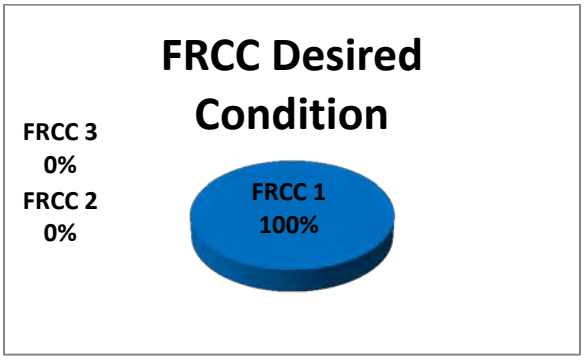
Table 3.3-6 displays the resulting approximate percentage of area in each fire regime condition class one year post treatment.

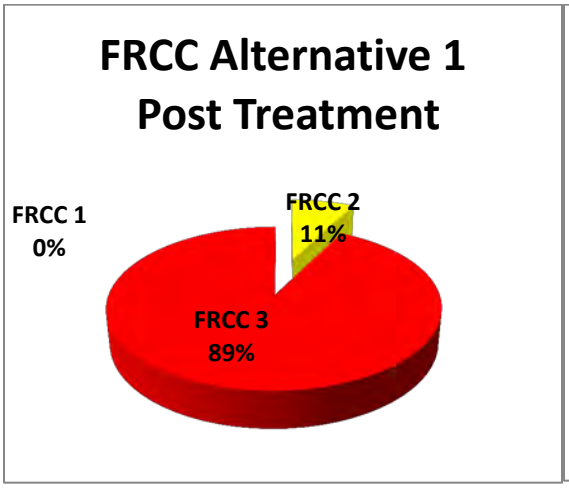
Table 3.3-6. Percent area in each FRCC by Alternative post treatment.

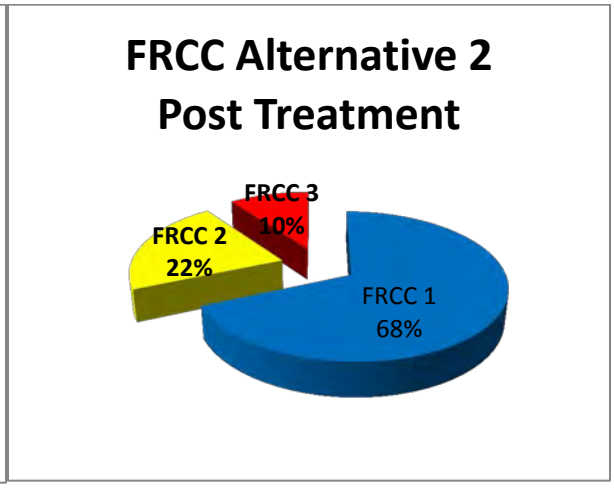
Approximate Percent of Area by Fire Regime Condition Class						
Dominant Vegetation Type	FRCC	Desired Condition	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3	Alternative 4
Dry Mixed Conifer	FRCC 1	100	0	40	20	10
	FRCC 2		10	20	15	15
	FRCC 3		90	40	65	75
Ponderosa - Pine - Oak	FRCC 1	100	0	80	53	53
	FRCC 2		0	20	10	10
	FRCC 3		100	0	37	37
Juniper -	FRCC 1	100	0	50	46	46

	FRCC 2		100	50	54	54
	FRCC 3		0	0	0	0
Private or Non-Vegetated	FRCC 1	FRCC not analyzed.				
	FRCC 2					
	FRCC 3					

The pie charts on page 19 of this report (figure 3.3-6) demonstrate changes in FRCC distribution for the entire Bill Williams Mountain Project area for each alternative one year post completion of treatments. Alternative 1 (No Action) would maintain the area to 89% significantly altered from their historical range. It is likely that this percentage would continue to grow and likely be 100% in condition class 3 within 20 years. Alternative 2, the proposed action, restores 68% of the landscape to historic states and leaves only 10% of the area in danger of vegetative condition conversion or potential extreme change due to wildfire characteristics. Alternative 3 converts 45% of the area back to historic referenced conditions, but leaves 42% of the area still in condition class 3. Alternative 4 meets the desired condition the least of the action alternatives by moving 42% back to condition class 1 and 45% continuing in condition class 3.







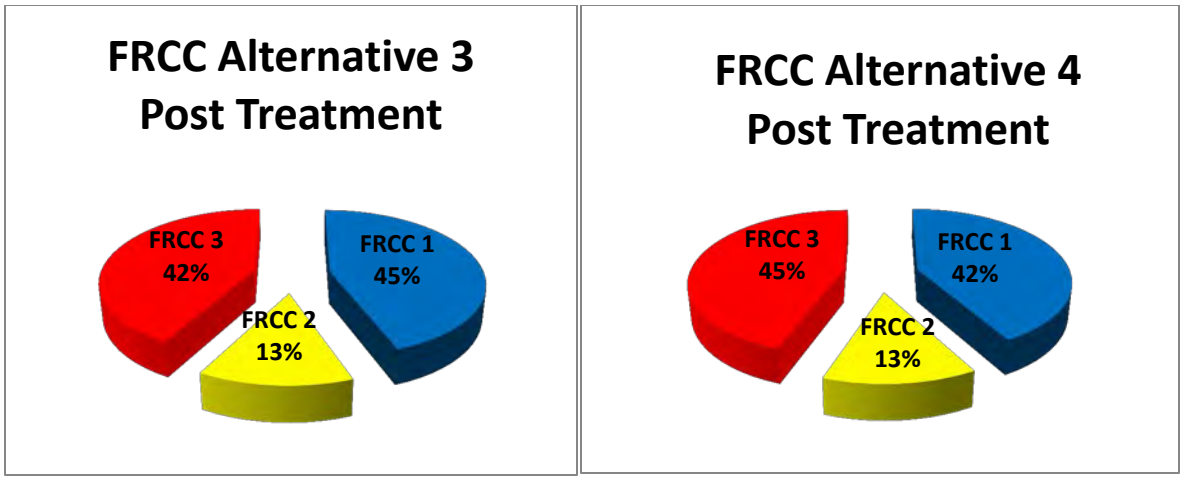


Figure 3.3-6. Percent FRCC for each alternative.

FOFEM Results - Air Resources

The Arizona Department of Environmental Quality closely monitors, coordinates, and regulates prescribed burning to ensure emissions do not exceed federal and state ambient air quality standards. Pursuant to Arizona Revised Statute 18-2-15, federal and state land managers must submit an ADEQ Burn Plan, smoke dispersion map, and smoke modeling for all burn projects. Daily burn request must be submitted and approved prior to any prescribed burning. The Bill Williams Mountain Project area lies within the Verde River Airshed. The area contains several smoke sensitive receptors including the City of Williams, Sycamore Canyon and the Verde Valley. PM 2.5 estimates were modeled with FOFEM (First Order Fire Effects Model) version 5.21. The software default settings were used for equitable comparisons. Each of the four alternatives was run using the two main vegetative types and their corresponding acreages (ponderosa pine types and mixed conifer).There were some assumptions made with the modeling. Under prescribed burning conditions in alternatives 2, 3 and 4, the project would likely be burned in blocks. An estimate of 1000 acres in the ponderosa pine type and 500 acres in the mixed conifer was used. Under the no action alternative (Alternative 1), no prescribed burning would take place. However, if a wildfire would start in typical summer conditions, heavy resistance to control would be likely. It is conceivable the entire area would burn in a couple days. Prescribed fire would likely take multiple years to achieve the entire project area. The table comparison is for the total acres that would be burned within a week. It needs to be noted that the amount of smoke 1000 acres of prescribed fire produces is considerably less than 15,200 acres of wildfire smoke in the same short time period. Wildfire estimates in the table in the action alternatives is estimated for a wildfire post treatment. Alternative 3 and Alternative 4 allow for minimal cutting on steep slopes. Without the reduction of fuels via mechanical treatment, it is likely more of the tree crowns would burn due to increased ladder fuels (vertical propagation) as well as tighter and denser tree canopies. An estimate of 10% was used for alternative 2, 15% for alternative 3 and 35% canopy consumption was used to illustrate this.

In addition to the amount of raw material released into the atmosphere, ventilation, unit size, wind speed and direction, and proximity also affect smoke impacts. Ventilation is the degree to which smoke disperses into the atmosphere. Proximity is the distance from the source of smoke to the impacted area (generally residences). Ventilation would be improved during prescribed fire operations because ignition is usually limited to the best ventilation hours of the day. Conversely, wildfires burn during all hours of

the day, including evenings and mornings, compounding smoke impacts. In addition, the burn day would be selected when wind speed and direction would minimize smoke impact. Smoke impacts from prescribed burns would be further reduced by burning on days with good ventilation and safe appropriate winds.

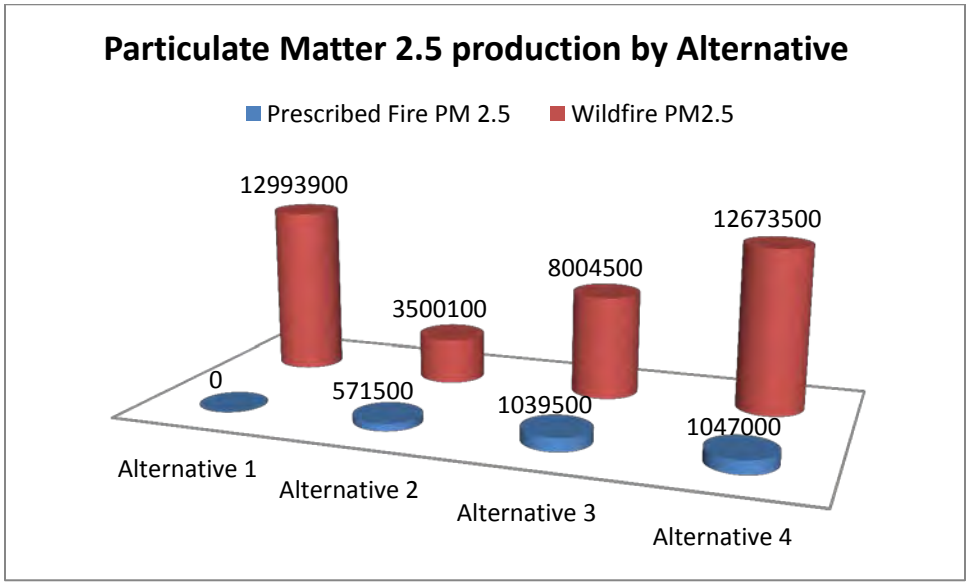


Table 3.3-7 Particulate Matter 2.5 in pounds per acre of emissions for Prescribed Fire and Wildfire by alternative.

3.3.4 Cumulative Effects

Vegetation treatments, and lack of treatments, on the Williams Ranger District have contributed to the current vegetation conditions for the area. Over the past 25 years, management surrounding the Bill Williams Mountain project area has included prescribed burning, pile burning, mechanical thinning and various harvests as well as grazing and wildlife focused projects. Within the Kaibab National Forest boundary, three projects are adjacent or in close proximity to the Bill Williams Mountain project area. The City Project area (within the north part of Bill Williams Mountain project continuing north of Bill Williams Mountain), the Twin project (on the south and west sides of the Bill Williams Mountain Project area) and Dogtown project area 2 miles east of the Bill Williams Mountain Project area. All three of these areas are being treated for wildland urban interface protection from wildfire. These projects include mechanical thinning and prescribed burning in phases over the next several years. The 17,000 acre McCracken project area is proposed and currently being analyzed. It lies immediately south of the Bill Williams project area. The combined effect of these ongoing projects and many foreseeable projects on the Williams Ranger District for restoration and fuel reduction provide for a mosaic of stand conditions, allowing for wildlife habitat and vegetative diversity. This same mosaic would allow for a diversity of fire effects thereby increasing opportunities for the maintenance of forest structure and function using wildfire and prescribed fire in the long term future. All the action alternatives proposed in the Bill

Williams Mountain project area would continue to create a mosaic of fuel conditions on the Williams Ranger District and therefore be taking a step in protection of communities and important features of the forest. Each project is managed to monitor and evaluate cumulative effects and considered prior to site specific implementation.

Alternative 1 would not be consistent with the past and current work of reducing fire severity potential in the wildland urban interface.

The ability to use natural wildfire to maintain desired conditions would likely be used in the future management of this project. The cumulative effects of this type of management could greatly decrease future impacts to the surrounding area by maintaining fuels and vegetation in a natural state, decreasing smoke production from heavy amounts of accumulated fuels as well as lessen the need for future large scale mechanical treatments.

3.3.5 Air Resources

The Bill Williams Mountain area is heavily used as a recreation area for many people. This area represents clear and clean air for many visitors and is important to the continued health of surrounding communities both economically and physically. Smoke, in general, is a nuisance and can be adverse to health, but is also part of the natural disturbance associated with these types of ecosystems. Two criterion pollutants, carbon monoxide and particulate matter, are produced in wood smoke and are regulated by the Clean Air Act. The Arizona State Smoke Management Rule implements the Clean Air Act and contains regulations that all State and Federal natural resource agencies must follow before a prescribed burn is ignited.

Both prescribed fire and wildfire will create smoke, however the amount and timing of these smoke events can be mitigated with prescribed fire. Any prescribed burning will be conducted only with approved site specific burn plans with standard smoke management mitigation and approvals. Burning would be conducted in favorable atmospheric conditions so as to minimize effects from smoke to nearby communities, class 1 airsheds and recreationists. All burning will be conducted according to the Arizona State Smoke Management rule to mitigate smoke impacts. These regulations ensure that effects from all burning within the area are mitigated and that Clean Air Act requirements are met. The scenarios used in the FOFEM analysis of smoke impacts can be used as a benchmark of the types of conditions and fuel loading burns should be conducted in. In general, days with good transport winds and ventilation categories are ideal to burn on. The community of Williams will have the most smoke impacts due to the proximity to the project area and lie line with prevailing winds, therefore measures to mitigate long durations of smoke should be implemented. Prescribed fires are initiated under conditions that allow managers control and favorable effects. Prescribed fires will be conducted when conditions are such that overstory tree mortality will be low, which leaves much of the live-tree carbon pool intact. These results in less biomass being combusted than if the area were to burn under higher severity wildfire, therefore less carbon emissions are expected in controlled situations (Wiedinmyer and Hurteau 2010).

Smoke impacts from wildfires are less easily mitigated. Wildfires primarily occur during summer months when the Williams Ranger District is most used by recreationists and therefore would most likely have more of an impact on recreation values. The amount of biomass consumed during a wildfire is also not easily mitigated. The more biomass consumed by fire, the more smoke will be produced. When

comparing alternatives, all action alternatives propose prescribed burning which will have an impact on surrounding communities but in a controllable manner. The outcome of these alternatives would also reduce the amount of biomass available to fire during wildfire which would reduce the impact of smoke from such a wildfire. The No Action alternative does not propose any prescribed burning; however, it will continue to maintain large amounts of biomass available for consumption in the event of a wildfire which will have direct and most likely uncontrollable impacts on recreation and surrounding communities.

Prescribed fire is regulated through a permitting process with the Arizona Department of Environmental Quality, which considers the overall effect and timing of such activities within each airshed. Following the permitting process will ensure that this project does not create regionally significant adverse effects on air quality.

Air Resources Cumulative Effects

The cumulative effects analysis area includes much of northern Arizona. The project area itself lies within the Verde Valley Airshed, which covers much of the Williams Ranger District of the Kaibab National Forest, part of the Prescott National Forest, the west half of Coconino National Forest, as well as tribal, state, and private lands west of the Kaibab (see Figure 3.3-7).

The cumulative analysis of air resources is unique in that impacts are transient, and past impacts to air quality are usually not evident. On any given day, however, the cumulative impact of the smoke from a prescribed burn, combined with impacts from other prescribed burns, wildfires, residential wood combustion, traffic exhaust, fugitive road dust, and other sources of pollution can be substantial. In 1999, for example, over 200,000 acres in Arizona were treated with prescribed fire, producing about 35,000 tons of PM-10 emissions. At certain times of the year, especially in the Fall, consideration of the cumulative impact is critical, as weather and fuel conditions are most conducive to prescribed burning, and multiple federal and state land management agencies are trying to meet their annual burning targets. Therefore, each project is managed to monitor and evaluate cumulative effects and considered prior to site specific implementation.

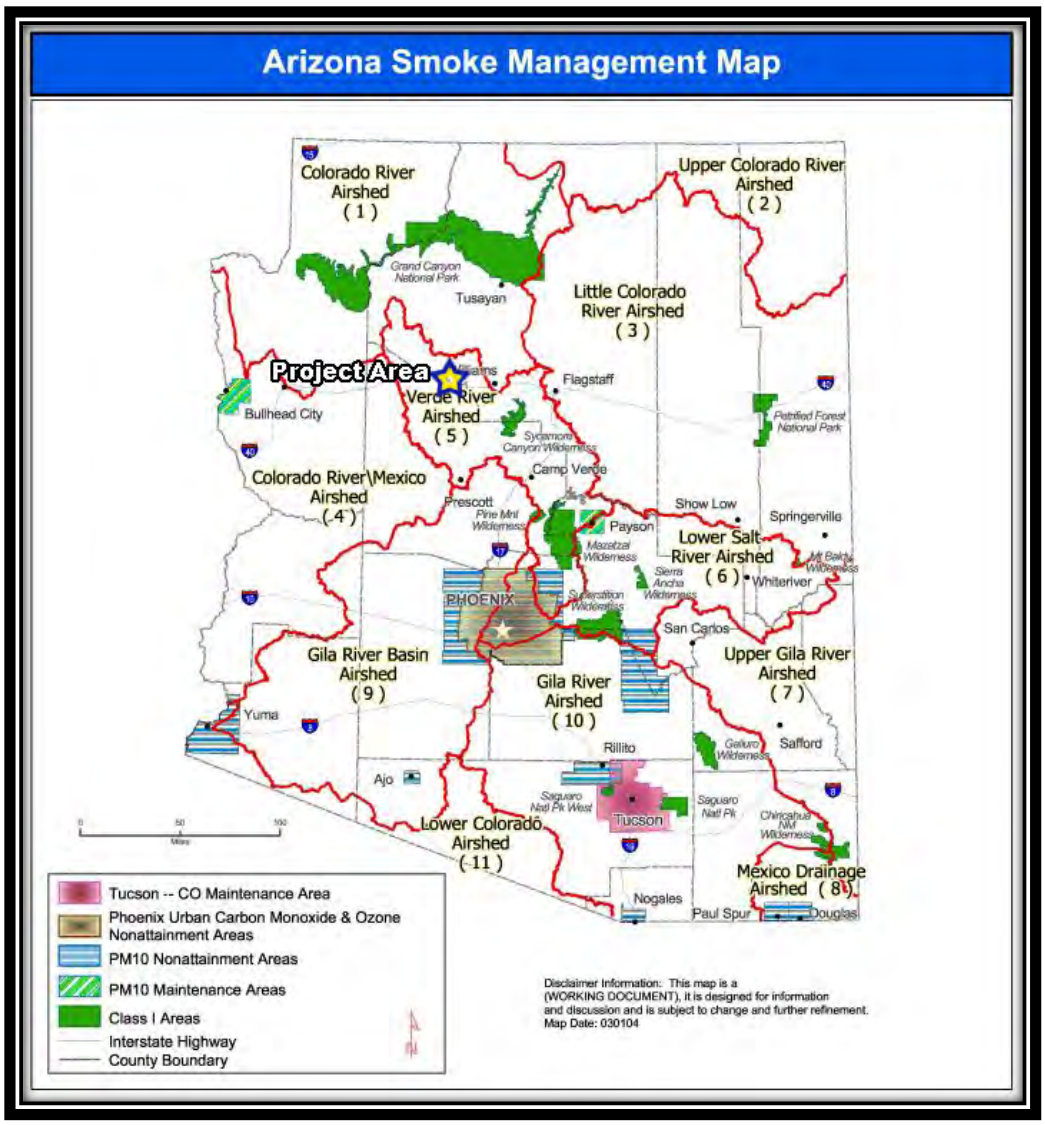


Figure 3.3-8. Arizona Smoke Management Map

3.6.6 Discussion and Management Implications

All three Action alternatives move the Bill Williams project area toward desired conditions. Alternative 1, the no action alternative, continues the regression of the ecosystem toward more unsustainable characteristics. Canopies will continue to close and provide more continuous fuel across the landscape, increasing the potential for high severity crown fires. This can be concluded when comparing the amount of passive and active crown fire potential in Alternative 1 compared to Alternative 2, 3 and 4. Alternative 1 would maintain 82% of the area with potential for high severity fire effects, while Alternative 2, 3 and 4 reduce this potential to 45%, 57% and 68% respectively. The canopy fuel accumulation has negative effects on understory vegetation and will continue to suppress the production of forbs, grasses and shrubs. Over time it can be expected that most of the forest will have little to no understory due to sunlight not

penetrating the canopy. The combination of abundant and continuous canopy fuels, the lack of understory vegetation and high severity fire potential maintains the area in a Fire Regime Condition Class of 3 into the foreseeable future. Alternatives 2, 3 and 4 begin to restore the area toward the desired condition of Fire Regime Condition Class 1. The analyses in this report demonstrate that all action alternatives are preferable to the no action alternative; therefore, consideration of each action alternative should be weighed carefully.

When comparing the three action alternatives being proposed, a major difference in proposals on steep slopes becomes the ability to cut larger trees versus being limited to only cutting trees less than 9" in diameter or not cutting at all. From the silvicuture analysis, the ability to cut trees greater than 9" dbh increases the ability to create openings. Alternative 3 is expected to create less than 10% opening on steep slopes. Alternative 4 is expected to create 0% openings while Alternative 2 will create 30%-40% openings. Several factors are important to consider when looking at management of the Bill Williams Mountain Project area and canopy openings. The following are just a few forest ecosystem components of importance in the analysis for Bill Williams Mountain project; Canopy continuity, understory vegetation and fire behavior. In general canopy openings have been greatly reduced during the 1900's by posettlement trees (Moore and Huffman 2004). Canopy openings provide for wildlife habitat, understory diversity (kerns et al. 2003, Moore et al. 1999) and discontinuous canopy fuels, which in turn effect fire behavior. In this sense all three of these ecosystem components are interconnected. The ability to create canopy opening becomes very important to restoring the function and resiliency of the ecosystem. Having tree removal restrictions limits capabilities to create these openings. In looking at the FlamMap analysis results, the major difference between Alternative 2 compared to 1, 3 and 4 is the amount of crown fire. Alternative 4 exhibits more areas with potential crown fire due to the inability to affect canopy fuels without removing more trees. The lack of reduction of canopy spacing is illustrated with the FlamMap runs. This will in turn effect how the area can be managed when faced with natural occurring wildfires. Fires that exhibit torching (passive crown fire) are more likely to produce lofted embers to start more fires, and generally burn hotter than a fire burning only surface fuels. These types of fires will cause higher severity and more ecosystem damage.

Canopy openings and discontinuous canopy fuels also are an integral part of how well ecosystems that exhibit frequent low severity fire can be restored to a Fire Regime Conditions Class of 1. Each action alternative moves the Bill Williams Mountain ecosystem away from 100% of the area in FRCC 3. However, Alternative 2 restores and may maintain 68% of the area in FRCC 1 compared to 45% in Alternative 3 and 42% in Alternative 4. Furthermore, of the 13% of the area under Alternative 3 and 4 that is restored to FRCC 2 immediately post treatment, it is foreseeable some of it will regresses back to FRCC 3 over 20 years as canopy cover closes. This difference over 20 years is a function of the ability to create canopy openings that are large enough and frequent enough to be maintained in an open state after 20 years of tree growth.

When looking at a smaller scale of the project, Bill Williams Mountain retains potential of damage to severe wildfires with each alternative. Alternative 2 restores approximately 40% of the mountain. This is greatly reduced in Alternatives 3 and 4 (20% and 10% respectively). The lack of the alternatives to allow for sufficient canopy openings will affect the ability to move or retain FRCC 1 in the future. Leaving vast areas in FRCC 2 and 3 will add difficulties both in safety and meeting objectives for mangers treating

with prescribed fire as well as opportunities to manage wildfires to meet resource objectives and perform their natural role in the ecosystem.

Alternatives 3 and 4 do not allow prescribed fire in the Botanical area. This could have direct effects to larger areas not receiving prescribed fire due to terrain and features not conducive to keeping fire from spreading into the Botanical Area. Every acre in the project not treated is another opportunity for forest health degradation and increased risk for uncharacteristic, undesirable fire behavior. Even where areas are treated, fires from untreated areas gaining intensity and exhibiting extreme behavior can move into them and have more severe fire effects than a fire starting in the treated stand. Without removal of canopy density and reducing surface fuel loadings, the Botanical area and adjacent slopes continue to have high potential for extreme fire behavior.

Alternative 4 does not allow thinning on the slopes of Bill Williams Mountain. This limits the ability to reduce canopy density and create openings that would alter fire behavior and potentially transition a crown fire back to the surface. Prescribed burning on the mountain would be very difficult without the reduction of smaller diameter trees and the breakup of interlocked crowns. Tree mortality would be more likely without mechanical treatment and removal of slash, leaving the area in a state as likely, if not more likely, for potential extreme fire behavior and landscape dilapidation.

Alternatives 2, 3 and 4 would increase surface fine fuels in the form of understory vegetation (grasses and forbs) due to canopy openings. Much of the species diversity in ponderosa pine forests is contained in understory vegetation (Moore et al. 1999). Understory vegetation can be >10 times higher in restored openings than under even sparse ponderosa pine cover (Clary 1975). This understory vegetation is important in supporting fire spread similar to that under which southwestern forests have evolved. This carrier of fire is needed in order to maintain forests over time with fire. Surface vegetation will also affect fire behavior. More fine surface fuels would increase surface fire rates of spread. Reducing stand density can increase surface fire behavior. “Modifying canopy fuels as prescribed in this method may lead to increased surface fire intensity and spread rate under the same environmental conditions, even if surface fuels are the same before and after canopy treatment. Reducing CBD to preclude crown fire leads to increases in the wind adjustment factor (the proportion of 20-ft windspeed that reaches midflame height). Also, a more open canopy may lead to lower fine dead fuel moisture content. These factors increase surface fire intensity and spread rate. Therefore, canopy fuel treatments reduce the potential for crown fire at the expense of slightly increased surface fire spread rate and intensity. However, critical levels of fire behavior (limit of manual or mechanical control) are less likely to be reached in stands treated to withstand crown fires, as all crown fires are uncontrollable. Though surface intensity may be increased after treatment, a fire that remains on the surface beneath a timber stand is generally controllable.” (Scott 2003).

Alternative 3 and 4 will increase the difficulty to protect trees, including those greater than 24” DBH as directed in the Kaibab National Forest Plan. Areas with heavier ladder fuels, greater tree densities and canopy characteristics are more likely to increase fire behavior during prescribed fire operations. Mortality could drastically increase, putting the trees desired at higher risk. Smaller trees may receive fire caused mortality as well. Initially, the crowns of these trees dry out and become a fully cured fine diameter fuel. This increases the potential for vulnerability of consumption (highly flammable) and initiating fire in the canopy during a wildfire. After a couple years of aging, the needles fall and increase

the surface fuel loading. Several years later, the trees fall and once again increase the surface fuel loading. These conditions do not go towards the desired condition and increases the potential for fire caused mortality to all existing vegetation, including the >24" trees, if a wildfire were to enter the area. Alternative 1 does not have the chance of fire caused mortality by prescribed fire, but could reasonably encounter high levels of mortality in the event of a wildfire.

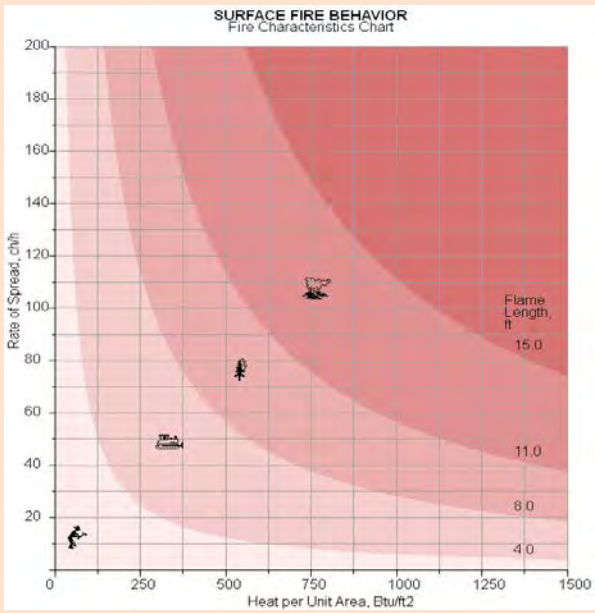
Alternative 1 leaves fire managers with little opportunity of multiple management strategies other than full suppression if a wildfire were to establish in the project area or enter the project area. Safety would preclude the chances of fighting the fire from the head, ultimately limiting success of containing the fire spread quickly. Wildfires would unlikely be able to be managed for any objectives other than suppression, adding cost vs. benefit deficit. Alternative 3 and 4 would have increased difficulty meeting objectives for prescribed burning than alternative 2, especially on the slopes of Bill Williams Mountain. The FVS/FFE stats shown in Appendix D reflect numbers relating to the increased mortality potential of prescribed fires. Without reducing ladder fuels, the fire has an increased opportunity to rise vertically into the tree canopy. There, dense canopies transfer heat easier and passive or active crown fire may initiate, creating greater tree mortality. These trees eventually fall and become increased surface loading. Over time, the increased surface loading along with the residual trees reproducing (adding ladder fuels again) sets the stand dynamics back to increase fire behavior and tree mortality. At any of these stages, high mortality or intense burning of surface fuels could cause soil erosion, flash flooding to downslope residences, degradation of the City of Williams watershed and sediment fill up to water sources used by area wildlife and cattle.

Part of the Bill Williams Mountain area falls under Mexican Spotted owl management guidelines. These guidelines require that no tree above 24 inches in diameter be cut in restricted habitat and no tree above 9 inches in diameter be cut in protected habitat (alternative 2 does allow a plan amendment. See silviculture report for specifics). Restricted habitat also requires stands to retain high basal area. Under these guidelines, protected habitat will have less to no canopy openings. High density requirements will reduce the ability to decrease canopy fuel continuity or for understory vegetation to respond to treatment. Areas in protected and restricted habitat will remain as FRCC 3 or move to FRCC 2 in situations where some canopy can be affected without losing the desired BA. Some habitat can be restored to a FRCC of 1 where the species composition, structure and function of these stands would be in concert with a surface fire regime. Restricted habitat would be subject to diameter limits in Alternative 3 and 4 which would constrict the ability to open canopy gaps and remove much of the uncharacteristic species. Therefore, in restricted habitat alternative 3 and 4 would not move towards the desired condition of FRCC 1. Areas with trees of fire intolerant species that have encroached the understory of the stands and are larger than identified cutting diameters would remain as FRCC 3, while those where some smaller diameter fire intolerant species could be removed and have small effects on canopy fuel discontinuity would move to an FRCC 2. MSO also requires course woody debris as a desirable attribute. None of the action alternatives eliminate all course woody debris. A stand replacement type fire could potentially have this effect. Alternative 1 would be the most likely to experience this type of fire behavior.

Alternative 2 moves the area the most to conditions that are more likely to allow its maintenance with fire. This is an ideal way of management due to its relative decrease in cost compared to mechanical type treatments on the same amount of acres.

Flame lengths less than 8 feet can generally be attacked by engines and dozers, and those flame lengths less than 4 feet by hand personal. This is another measure we can use to assess the differences between alternatives. FlamMap data computed that currently only 16% of the area likely to burn with flame lengths under 8 feet during summer conditions. Alternative 2 alters the landscape to 59% while Alternative 3 is 46% and Alternative 4 is 33%. This is a useful factor to consider in understanding the chances district resources may have in containing an undesirable fire at a small scale with minimal impacts to the landscape.

Table 3.3-7. Flame Lengths under 8 feet in the Project Area.



Flame Lengths under 8 feet	Acres (% of area)
Alternative 1	2525 (16%)
Alternative 2	9114 (59%)
Alternative 3	7016 (46%)
Alternative 4	5121 (33%)

Particle Matter 2.5 (produced in smoke) from prescribed fires would be inevitable. Alternative 2 allows for the removal of more secondary layer canopy than alternative 3 or 4 and therefore produces less consumption produced emissions in smoke. This is due to a large percentage of the fire being surface fire. Alternative 3 limits tree removal to 9” dbh. This will likely increase the amount of crowns that will be consumed during burning operations. Alternative 4 would likely have the most amount of additional emissions from crowns burning of the 3 action alternatives.

Below is a relative rating by alternative table for quick comparison of how each alternative meets the desired condition. A point value of 1 was assigned to the alternative that most closely met the proposed action for each element. The other alternatives were given a value of 0. If alternatives had equal values in meeting the proposed action, they were both assigned a 1 value. Alternative 2 rates out as the alternative that most closely meets the desired condition.

Table 3.3-9. Relative ranking for each alternative.

Relative Rating for Each Alternative				
Criteria	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Canopy Base Height in mixed conifer	0	1	1	1
Canopy Bulk Density in mixed conifer	0	0	1	0
Surface Fuel Loading in mixed conifer	0	1	1	0
Canopy Base Height in ponderosa pine	0	0	1	0
Canopy Bulk Density in ponderosa pine	0	1	1	1
Surface Fuel Loading in ponderosa pine	0	0	1	0
Surface Fire percentage	0	1	0	0
FRCC 1 in mixed conifer	0	1	0	0
FRCC 1 in ponderosa pine	0	1	0	0
PM2.5 emissions	0	1	0	0
Flame Lengths under 8'	0	1	0	0
TOTAL:	**0**	**8**	**6**	**2**

In conclusion the Bill Williams Mountain project area would benefit from each of the action alternatives from a potential fire severity perspective. The overall ecosystem health in the form of restoring the vegetation types to resilient and historic conditions would also benefit from all action alternatives although Alternative 2 provides the most opportunity to meet desired conditions.

3.4 Soils and Watershed

3.4.1 Affected Environment

Soils

Elevations within the project area range from 6,460 feet above mean sea level (amsl) to 9,256 feet amsl. Slopes range from 5 to 120 percent with steeper slopes generally occurring at higher elevations on Bill Williams Mountain, Bixler Mountain and on hillsides of less prominent knolls within the project area.

Figure 3.4.1-1 displays the locations of TES map units and their current condition. Table 3.4.1-1 provides a summary of the taxonomic classifications of TES map units in the project area and their associated acreages.
There are 16,107 acres of TES map units within the project area are in satisfactory condition. These soils are functioning properly with regard to soil stability, hydrologic regimes and nutrient cycles. Approximately 10 percent (1,538 acres) of the TES map units within the project area are in unsatisfactory condition. Currently, TES map units 320, 402, 407, 525, 539, and 564 within the project area are in unsatisfactory condition due to erosion rates that are exceeding tolerance thresholds. By reducing stand densities and increasing the amount of fine to medium woody debris and litter, these map units are expected to respond in a positive manner through increased vegetative ground cover which improves soil aggregate stability and porosity, decreases soil bulk densities, increases soil water holding capacities, and contributes to development of soil A horizons.

Within the project area, there are approximately 8,064 acres of soils having slight erosion hazard, about 3,212 acres of soils having moderate erosion hazard, and about 3,932 acres of soils having severe erosion hazard (Table 3.4.1-2, and Figure 3.4.1-2). Technical definitions of erosion hazard ratings can be found in the Soils and Watershed Specialist's Report (MacDonald 2012). Acres presented in Table 3.4.1-2 are for each map unit as a whole. There can be, and often are inclusions of different soil types within each TES map unit. Soils having single taxonomic classifications rarely, if ever, are mapped without including some areas of soils having other taxonomic classifications. As a result, most soils map units are comprised of the primary soil for which the unit is categorized and some soils that belong to other taxa. These latter soils are called inclusions or included soils.

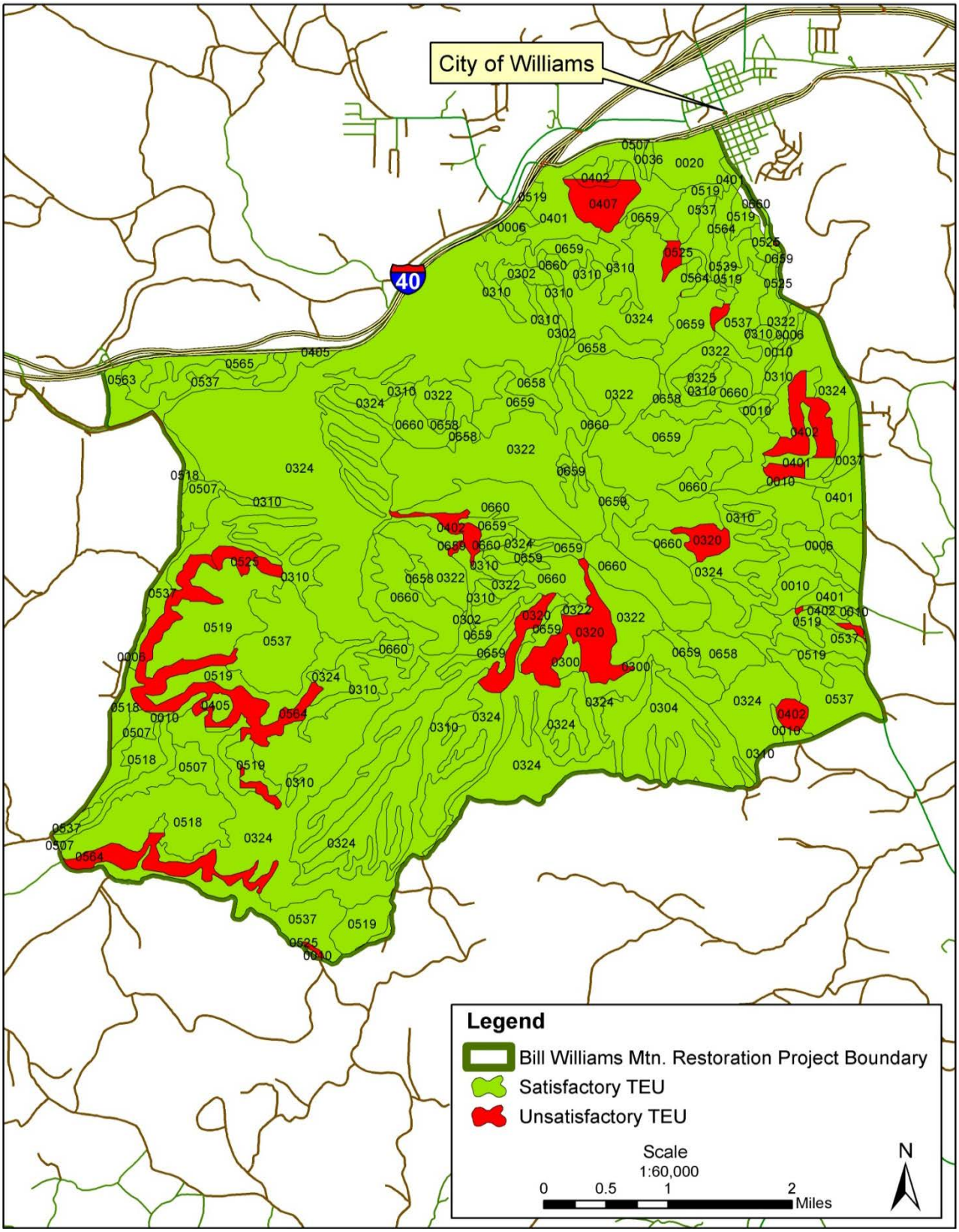


Figure 3.4.1-1. Terrestrial Ecosystem Units within the Bill Williams Mountain Restoration Project analysis area (Brewer et al, 1991).

Table 3.4.1-1. Terrestrial Ecosystem Units located within the Bill Williams Mountain Restoration Project, Kaibab National Forest, Arizona (Brewer et al 1991).

MAP UNIT SYMBOL	SOIL TAXONOMIC CLASSIFICATION	SOIL PHASE	ACRES
006	Pachic Argiborolls	Deep clay loam	137
010	Typic Argiborolls	Deep loam	262
20	Vertic Haplaquolls	Deep clay	144
036	Pachic Argiustolls	Deep gravelly clay loam	14
037	Aquic Haploborolls	Deep gravelly very fine sandy loam	44
300	Udic Ustochrepts	Very gravelly sandy loam	179
302	Typic Dystrochrepts	Very gravelly sandy loam	88
304	Typic Eutroboralfs	Moderately deep very gravelly loam	248
310	Typic Eutroboralfs	Moderately deep very cobbly clay loam	2,008
320	Lithic Ustorthents	Very gravelly sandy loam	328
322	Typic Dystrochrepts	Moderately deep very gravelly sandy loam	1879
324	Typic Eutroboralfs	Very gravelly loam	5,206
325	Udic Ustochrepts	Deep gravelly loam	24
401	Mollic Eutroboralfs	Gravelly clay loam	464
402	Mollic Eutroboralfs	Moderately deep very cindery loam	327
405	Mollic Eutroboralfs	Very gravelly clay loam	25
407	Typic Vitrandepts	Moderately deep very cindery loam	114
507	Vertic Argiborolls	Deep very gravelly clay loam	212
518	Lithic Argiborolls	Very cobbly clay loam	463
519	Lithic Eutroboralfs	Very cobbly clay loam	874
525	Typic Argiborolls	Moderately deep very cobbly loam	118
537	Mollic Eutroboralfs	Moderately deep very cobbly clay loam	1,177
539	Typic Argiborolls	Moderately deep very cobbly loam	52
563	Mollic Eutroboralfs	Moderately deep very cobbly clay loam	130
564	Typic Argiborolls	Moderately deep very cobbly clay loam	599
565	Lithic Argiborolls	Very cobbly clay loam	80
658	Eutric Glossoboralfs	Cobbly loam	416
659	Eutric Glossoboralfs	Cobbly loam	909
660	Typic Eutrochrepts	Moderately deep very stony fine sandy loam	1,124
N/A	Open water/wetland		17
Total			17,662

Typically inclusions have properties and behavioral characteristics that are similar to those of the dominant soil or soils in the map unit, and therefore do not affect use and management. These are referred to as noncontrasting inclusions. They may or may not be noted in the map unit descriptions. Other inclusions may have properties and behavioral characteristics that deviate enough to influence use or management. These are referred to as contrasting inclusions. They generally occupy small areas and are inseparable on the soil maps due to the scale at which soils are mapped. The inclusions of contrasting soils are typically discussed in map unit descriptions. Sometimes inclusions are not mapped as they were not observed in the field. This typically occurs where soil patterns are so complex as to preclude a sufficient number of observations to identify all of the soils that occur within a given landscape.

Table 3.4.1-2. Predicted Soil Erosion Hazard by TEU within the Bill Williams Mountain Restoration Project Analysis Area (Brewer et al, 1991). (acres are approximate)

MAP UNIT	SOIL CONDITION	EROSION HAZARD	CURRENT EROSION RATE TONS/AC/YR	TOLERANCE EROSION RATE TONS/AC/YR	POTENTIAL EROSION RATE TONS/AC/YR	SLOPE (%)	ACRES
6	Satisfactory	Slight	0.65	2.71	2.10	0-5	137
10	Satisfactory	Slight	0.53	2.71	2.47	0-5	262
20	Satisfactory	Slight	0.12	3.64	0.93	0-5	144
36	Satisfactory	Slight	0.36	2.71	0.85	0-5	14
37	Satisfactory	Slight	0.24	3.64	0.85	0-5	44
300	Satisfactory	Moderate	2.35	2.71	13.56	15-40	179
302	Satisfactory	Severe	2.14	2.71	15.50	15-40	88
304	Satisfactory	Slight	0.16	2.71	0.93	0-15	248
310	Satisfactory	Moderate	1.70	2.71	12.38	15-40	2,008
320	Unsatisfactory	Severe	1.94	1.82	16.75	40-80	328
322	Satisfactory	Severe	1.42	2.71	19.59	40-80	1,879
324	Satisfactory	Slight	0.20	2.71	0.93	0-15	5,206
325	Satisfactory	Slight	0.20	2.71	1.25	0-15	24
401	Satisfactory	Slight	0.16	2.71	0.93	0-15	464
402	Unsatisfactory	Moderate	1.70	2.71	9.96	15-40	327
405	Satisfactory	Slight	0.20	2.71	0.61	0-15	25
407	Unsatisfactory	Severe	3.60	2.71	14.37	15-40	114
507	Satisfactory	Slight	0.16	2.71	0.28	0-15	212
518	Satisfactory	Slight	0.24	1.82	0.61	0-15	463
519	Satisfactory	Slight	0.20	1.82	25.09	0-15	874
525	Unsatisfactory	Severe	3.40	2.71	0.61	15-40	118
537	Satisfactory	Slight	0.12	2.71	0.61	0-15	1,177
539	Unsatisfactory	Severe	7.49	2.71	14.37	40-120	52
563	Satisfactory	Slight	0.20	2.71	0.61	0-15	130
564	Unsatisfactory	Severe	3.64	2.71	12.38	15-40	599
565	Satisfactory	Slight	0.36	1.82	0.61	0-15	80
658	Satisfactory	Slight	0.12	2.71	1.58	0-15	416
659	Satisfactory	Moderate	2.71	2.71	24.04	15-40	909
660	Satisfactory	Severe	1.86	2.71	14.29	40-120	1,124
Total							17,662

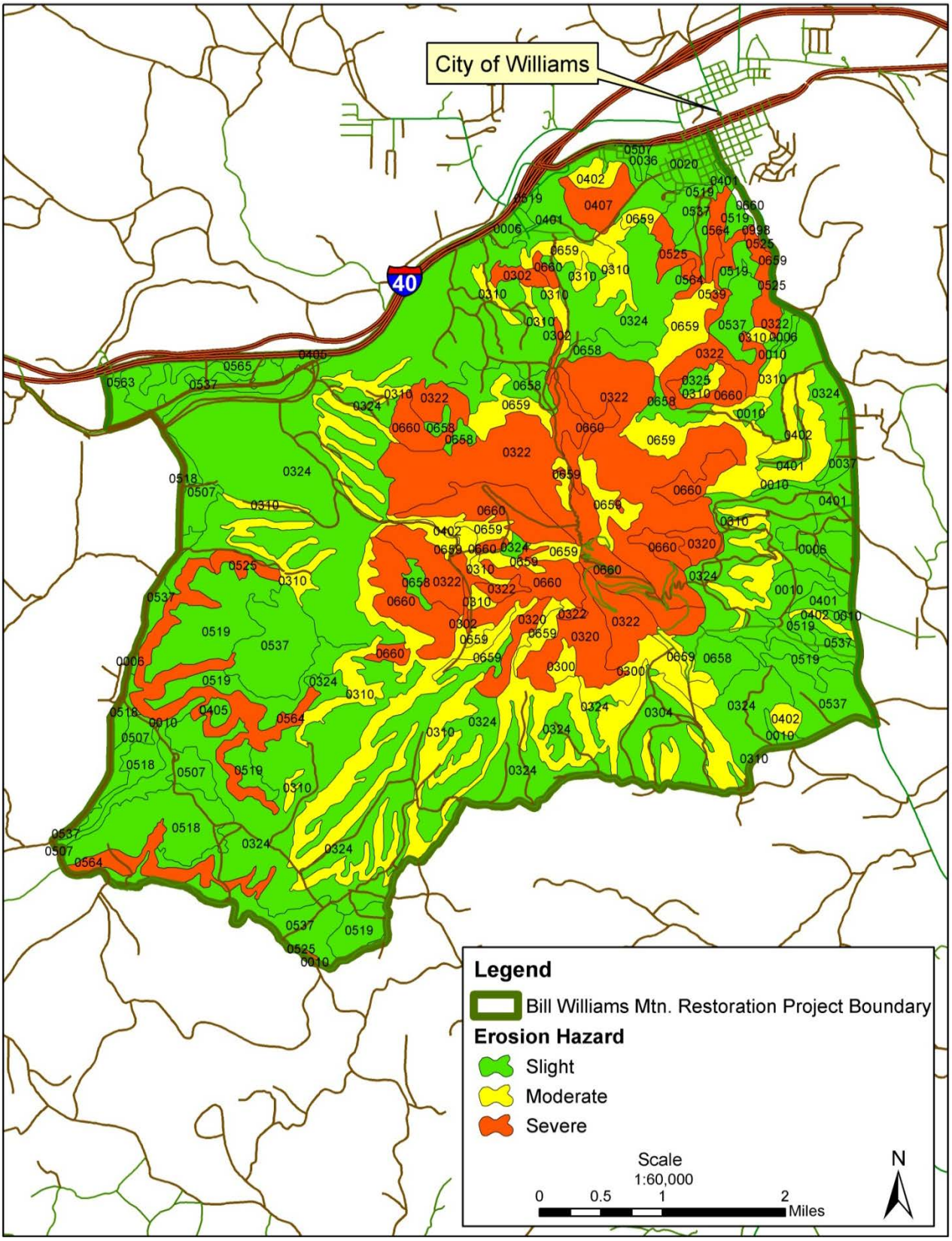


Figure 3.4.1-2. Predicted Soil Erosion Hazard within the Bill Williams Mountain Restoration Project analysis area (Brewer et al, 1991).

Hydrologic Soil Groups

Soils are classified into hydrologic soil groups (HSGs) to indicate the minimum rate of infiltration and runoff potential obtained for bare soil after prolonged wetting. This information is important to project and watershed planning since runoff determines, to a large extent, the flood hazard, the character and amount of stream flow, and the hazard of erosion from rainwater and snowmelt. The HSG designations are A, B, C and D, and are defined by Natural Resources Conservation Service (NRCS) as follows: Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission (greater than 0.30 in/hr). Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr). Group C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr). Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr). Table 3.4.1-3 below lists the HSGs for soils that occur within the Bill Williams Mountain Restoration Project area and their associated acreages. For the analysis area, approximately 1% (114 acres) of the soils are in hydrologic soils group A; 26% (4,619 acres) are in hydrologic soils group B; 61% (10,811 acres) are in hydrologic soils group C; and 12% (2,101 acres) are in hydrologic soils group D. Figure 3.4.1-3 displays the location and extent of soils by their associated hydrologic soils groups.

Table 3.4.1-3. Hydrologic Soil Groups and associated acreages for the Bill Williams Mountain Restoration Project analysis area (Brewer et al, 1991). (acres are approximate).

HYDROLOGIC SOIL GROUP	TES MAP UNIT	ACRES
A	0407	114
B	0300	179
	0302	88
	0322	1,879
	0325	24
	0658	416
	0659	909
	0660	1,124
C	0006	137
	0010	262
	0036	14
	0037	44
	0304	248
	0310	2,008
	0324	5,206
	0401	464
	0402	327
	0405	25
	0525	118
	0537	1,177

HYDROLOGIC SOIL GROUP	TES MAP UNIT	ACRES
	0539	52
	0563	130
	0564	599
D	0020	144
	0320	328
	0507	212
	0518	463
	0519	874
	0565	80

Vegetative Ground Cover

Vegetative ground cover is important for protecting soil surfaces from erosion and invasion by noxious weeds. The TES includes values for vegetative ground cover for each TES mapping unit. These values include both vegetation basal area and litter. Table 3.4.1-4 lists vegetative ground cover and associated acreages for each TES mapping unit in the proposed project area.

Soil Organisms

Knowledge of specific fungal, bacterial, and arthropod populations is not available for analysis in this project. Biological soil crusts, commonly found in arid or semi-arid environments (USDA NRCS 1997) are not known to exist in the project area. However, cryptogamic crusts have been identified in the same ecosystems as those found in the project area, including mixed conifer forests and pinyon-juniper woodlands (Beymer and Klopatek 1992). It is possible that biological soil crusts occur within the proposed treatment areas.

In arid and semi-arid native vegetation communities, plants often exhibit patchy distributions that result in discontinuous fuel conditions and mosaics of fire intensities (Whisenant 1990). Biological soil crusts do not provide adequate fuel to carry a fire through interspaces, thereby serving as “refugia” to decrease the spread of fire and its intensity (Rosentreter 1986). The remaining unburned islands of vascular vegetation and biological soil crust provide propagules for reestablishment in burned areas. Johansen et al. (1993) observed that the structural matrix of soil biological crusts remained intact following low-intensity fire, indicating that lightly burned crusts still function to provide stability against erosive forces.

Populations of other soil organisms include mycorrhizal fungi, soil-dwelling arthropods, gastropods, nematodes and bacteria. All of these types of organisms are expected to occur within the proposed treatment areas.

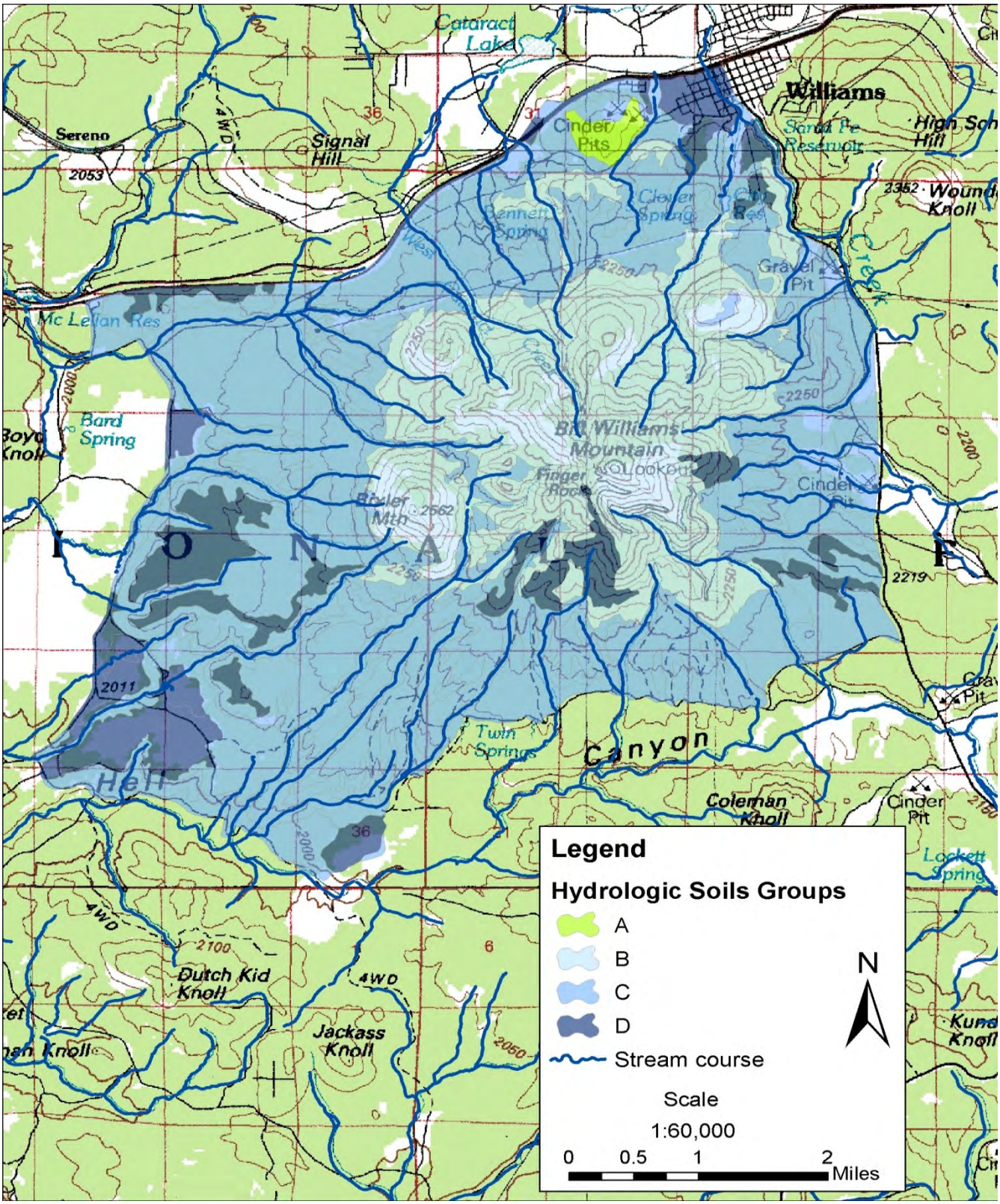


Figure 3.4.1-3. Hydrologic soil groups within the Bill Williams Mountain Restoration Project analysis area.

Table 3.4.1-4. Estimated Vegetation, Litter, and Total Vegetative Ground Cover within the Bill Williams Mountain Restoration Project Analysis Area (Brewer et al, 1991).

MAP UNIT	VEGETATION (Basal Area)	LITTER (%)	TOTAL VEGETATIVE GROUND COVER (%)	NATURAL GROUND COVER (%)
6	25	5	30	80
10	5	35	40	80
36	15	5	20	85
37	25	5	30	80
300	5	40	45	85
302	10	40	50	70
304	10	35	45	85
310	10	40	50	85
320	3	55	55	85
322	8	60	65	85
324	5	35	40	80
325	10	35	45	75
401	10	45	55	75
402	10	35	45	70
405	10	20	30	80
407	12	22	35	75
507	10	5	15	75
518	20	5	25	70
519	5	25	30	70
525	5	30	35	85
537	5	40	45	85
539	10	20	30	65
563	10	20	30	70
564	10	20	30	70
565	10	5	15	65
658	8	50	60	85
659	11	45	55	85
660	4	45	50	85

Organic Matter

Organic matter in its various forms contributes to soil productivity. Humus is decomposed organic matter while duff, or litter, consists of relatively undecomposed or partially decomposed leaves, needles, and twigs that are still recognizable on the surface of soils. Coarse woody debris (CWD) consists of woody stems greater than 3 inches in diameter. Decomposing coarse woody debris can supply moisture to plants and animals after soils have dried. All organic matter provides water and nutrients for soil organisms and plants. Because CWD is an important component of a functioning ecosystem, a portion of this material must be maintained (Graham et al. 1994). However, excessive accumulations of woody debris can result in fires that are extremely hot, resulting in large losses of soil organic matter (Harvey 1994). Currently, most soils within the project area exhibit an abundance of organic matter in a variety of size classes. Some map units that are currently rated unsatisfactory (i.e., 320, 402, 407, 525, 539, and 564) generally exhibit less organic matter than required to maintain soil productivity and prevent soil loss. The locations of unsatisfactory TES units are depicted in Figure 3.4.1-1 and their areal extents are summarized in Table 3.4.1-2.

Revegetation Potential

Revegetation potential refers to the probable success and ease in the establishment of native grasses. This potential rating is influenced by climate, soil characteristics, and slope. The rating system is based on use of a rangeland drill, broadcast seeder (hand held), and aerial seeding with no consideration for site preparation (removal of trees, etc.).

A low or moderate rating alerts the land manager to potential limitations for successful artificial revegetation of an area. Soils associated with a "high" rating offer the best opportunity for success. The udic/frigid combination offers the optimum soil climate for establishment of vegetation. Conversely, the aridic/thermic combination offers the most limiting soil climate for the establishment of vegetation. For the project area, Table 3.4.1-5 below displays the artificial revegetation potential. It is important to note that these potentials correspond to no site preparation or removal of trees. It is very likely that natural revegetation potentials would be higher than these values following vegetation treatments since soil moisture and light penetration to the forest floor would be increased. Practices that minimize soil disturbance such as churning of soil profiles would preserve native seed banks, thus improving natural revegetation.

Table 3.4.1-5. Revegetation potential within the Bill Williams Mountain Restoration Project analysis area (Brewer et al.1991). (acres are approximate)

REVEGETATION POTENTIAL	MAP UNIT SYMBOL	ACRES
Moderate	6	44
	10	127
	300	179
	302	50
	304	248
	324	4,705
	325	24
	401	269
	405	25
	407	104
	507	11
	537	1,074
	563	130
	658	416
	659	854
Moderate Total		8,260
Low	310	1,934
	320	328
	322	1,779
	518	169
	519	743
	525	74
	539	12
	564	477
	565	80
	660	1,109

Low Total		6,705
Grand Total		14,965

Timber Harvest Limitations

Timber harvest limitations are limits to be considered when evaluating the impact of timber harvest with regard to maintenance of soil productivity. Limits relate to year round or seasonal concerns and use of equipment as they relate to climate, soils characteristics, and landforms. A moderate or severe rating directs the land manager to areas that require mitigation in order to avoid impairment of soil productivity. Logging systems are proposed for this project that will adequately overcome most timber harvest limitations. Timing of logging operations can often be used to mitigate soil moisture problems. For example, logging can be performed during frozen ground or dry conditions to minimize risk of soil compaction and rutting and consequential erosion. Table 3.4.1-6 below summarizes timber harvest limitations by map unit within the Bill Williams Mountain Restoration Project area. Figure 3.4.1-4 depicts the locations of TEUs and their associated timber harvest limitations.

Table 3.4.1-6. Timber harvest limitations within the Bill Williams Mountain Restoration Project analysis area (Brewer et al, 1991). (acres are approximate)

TIMBER HARVEST LIMITATIONS	MAP UNIT SYMBOL	REASON	ACRES
Severe	6	Seasonally wet	44
	10	Seasonally wet	127
	36	Wetland soil	<1
	37	Seasonally wet	<1
	320	Severe erosion hazard, shallow soils, steep slopes	328
	322	Severe erosion hazard, shallow soils, steep slopes	1,779
	407	Severe erosion hazard, inherently unstable cindery soils	104
	507	Trafficability problems when wet	11
	539	Steep slopes, large surface rocks and rock outcrops common	12
	565	Shallow soil depth and rock content inhibits regeneration	80
	660	Severe erosion hazard, steep slopes, large rock common	1,109
Severe Total			**3,594**
Moderate	300	Risk of accelerated erosion	179
	302	Risk of accelerated erosion	50
	304	Trafficability problems, risk of compaction	248
	310	Moderate erosion hazard, high rock content	1,934
	324	Low bearing strength/trafficability problems when wet	4,705
	325	Low bearing strength/trafficability problems when wet	24
	401	Low bearing strength/trafficability problems when wet	269
Moderate (cont'd)	402	Erosion hazard increases with removal of ground cover	247
	405	Trafficability problems when wet, churning damages soil	25
	519	Large rock fragments common, shallow soils	743
	525	Trafficability problems when wet, rock outcrops common	74
	537	Trafficability problems when wet, large rock fragments common	1,074
	563	Trafficability problems when wet, churning damages soil	130

TIMBER HARVEST LIMITATIONS	MAP UNIT SYMBOL	REASON	ACRES
	564	Severe erosion hazard, trafficability problems when wet, churning damages soil productivity	477
	658	Trafficability problems when wet, churning damages soil	416
	659	Churning damages soil productivity	854
Moderate Total			**11,446**
Slight	518	Large rock fragments and rock outcrops common	169
Slight Total			**169**
Grand Total			**15,210**

Effects of Roads to Soils and Watershed Resources

Currently, National Forest System roads within the Bill Williams Mountain Restoration Project area occupy approximately 60 miles or 87.27 acres based on an average road width of 12 feet, including Forest Roads 108 and 122 which generally serve as the western and southern boundaries of the project area, respectively. In addition to National Forest System, non-system roads occur within the project area. Most of these roads are the result of indiscriminate route proliferation caused by disbursed camping, hunting, fuelwood gathering, and similar activities.

Forest roads are classified by Maintenance Levels (ML) in accordance with Forest Service Handbook (FSH) 7709.58,10,12.3. Maintenance levels are defined by the USDA FSH as the level of service provided by, and maintenance required for, a specific road. Maintenance levels must be consistent with road management objectives, and maintenance criteria. The following criteria are considered when selecting road maintenance levels:

a. Resource program needs, environmental and resource protection requirements, visual quality objectives, and recreation opportunity spectrum classes.
b. Road investment protection requirements.
c. Service life and current operational status.
d. User safety.
e. Volume, type, class, and composition of traffic.
f. Surface type.
g. Travel speed.
h. User comfort and convenience.
i. Functional classification.
j. Traffic service level.

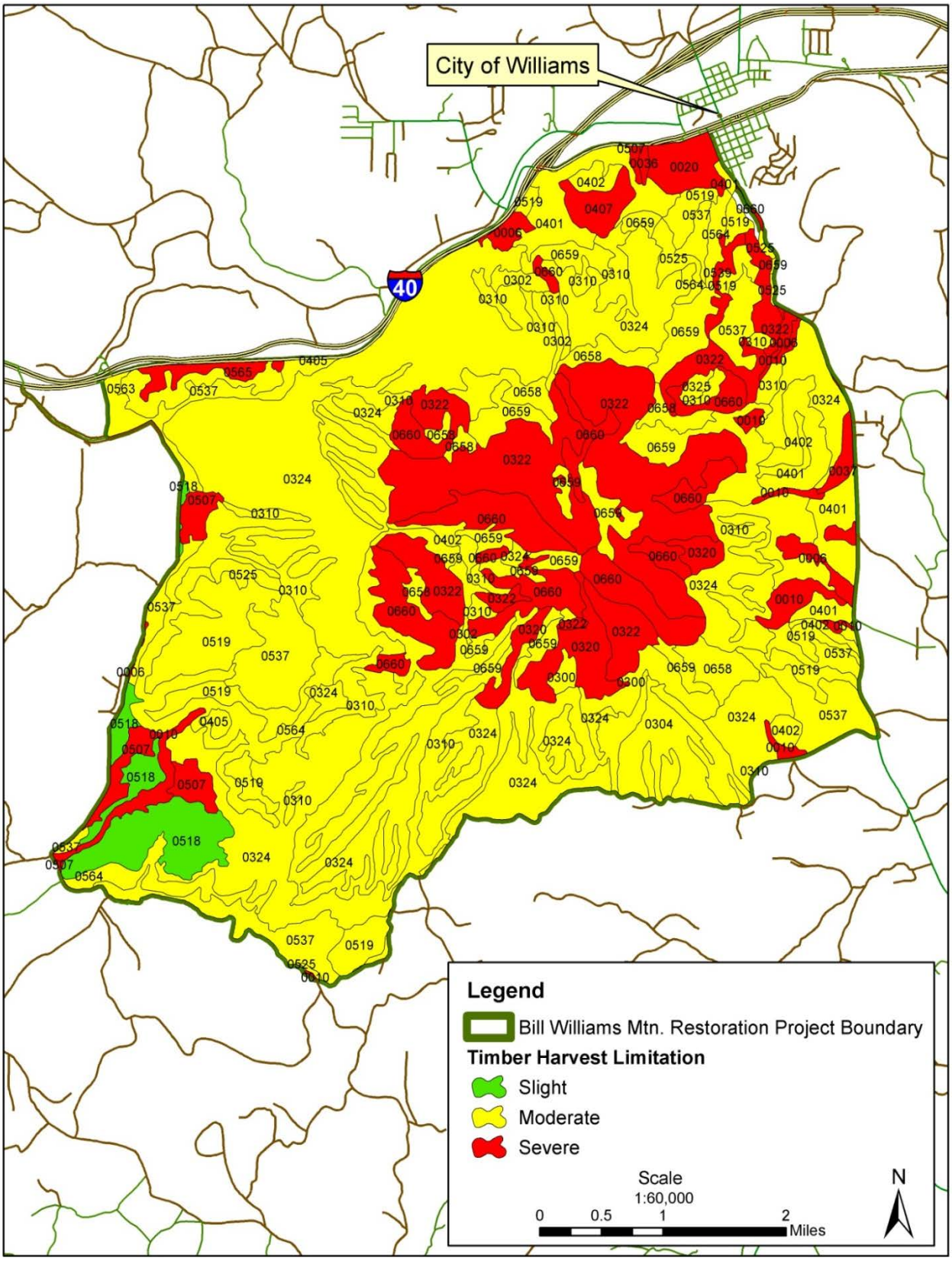


Figure 3.4.1-4. Terrestrial Ecosystem Units and their associated Timber Harvest Limitations within the Bill Williams Mountain Restoration Project analysis area (Brewer et al, 1991).

All roads within the Bill Williams Mountain Restoration Project area are classified as Maintenance level 1, 2, or 3. Maintenance level 1 roads are closed to vehicular traffic. The closure period must exceed 1 year. Basic custodial maintenance is performed to keep damage to adjacent resources to an acceptable level and to perpetuate the road to facilitate future management activities. Emphasis is normally given to maintaining drainage facilities and runoff patterns. Planned road deterioration may occur at this level. Appropriate traffic management strategies are "prohibit" and "eliminate." Roads receiving level 1 maintenance may be of any type, class or construction standard, and may be managed at any other maintenance level during the time they are open for traffic. However, while being maintained at level 1, they are closed to vehicular traffic, but may be open and suitable for nonmotorized uses. There are approximately 20 miles of ML-1 roads within the project area. Maintenance level 1 roads have the following attributes:

- Vehicular traffic is eliminated, including administrative traffic.
- Physically blocked or entrance is disguised.
- Not subject to the requirements of the Highway Safety Act.
- Maintenance is done only to minimize resource impacts.
- No maintenance other than a condition survey may be required so long as no potential exists for resource damage.

Maintenance level 2 roads are open for use by high-clearance vehicles. Passenger car traffic is not a consideration. Traffic is normally minor, usually consisting of one or a combination of administrative, permitted, dispersed recreation, or other specialized uses. Log hauling may occur at this level. Appropriate traffic management strategies are either to (1) discourage or prohibit passenger cars or (2) accept or discourage high-clearance vehicles. There are approximately 31 miles of ML-2 roads within the project area. Maintenance level 2 roads have the following attributes:

- Roads have low traffic volume and low speed.
- Typically local roads.
- Typically connect collectors or other local roads.
- Dips are the preferred drainage treatment.
- Not subject to the requirements of the Highway Safety Act.
- Surface smoothness is not a consideration.
- Not suitable for passenger cars.

Maintenance level 3 roads are open and maintained for travel by prudent drivers in standard passenger cars. User comfort and convenience are low priorities. Roads in this maintenance level are typically low speed, single lane with turnouts, and spot surfacing. Some roads may be fully surfaced with either native or processed material. Appropriate traffic management strategies are either "encourage" or "accept." "Discourage" or "prohibit" strategies may be employed for certain classes of vehicles or users. There are approximately 9 miles of ML-3 roads within the project area. These include FR108 which forms the western boundary of the project area, FR111 which provides access to the top of Bill Williams Mountain, and FR106 which provides access to the Elk Ridge Ski Area. Maintenance level 3 roads have the following attributes:

- Subject to the requirements of Highway Safety Act and MUTCD.
- Roads have low- to moderate-traffic volume.
- Typically connect to arterial and collectors roads.
- A combination of dips and culverts provide drainage.
- May include some dispersed recreation roads.
- Potholing or washboarding may occur.

It is likely that the majority of ML-1 and ML-2 roads are the result of historic logging practices and user-created recreational access routes. As a result, many of these roads are inadequately engineered, poorly located on the landscape and are consequently in a state of disrepair. Some of these roads are located near drainage channels or on ridge tops and are subject to erosion and sediment transport. Roads near drainages are contributing to degradation of surface water quality during snowmelt and following short duration high intensity monsoon storms. Some roads have eroded to the point where roads surfaces are below the grade of the surrounding landscape, resulting in stormwater runon that then pools on road surfaces or flows down the travelway eroding the roadbed and entraining sediment in the storm flow. Where water pools in road surfaces, rutting is a problem. Where stormwater flows down road surfaces, rills and gullies are compromising road surfaces and water quality.

System roads convert productive soils to an essentially non-productive condition in the long-term (i.e., greater than fifty years). Most of the precipitation that falls on the compacted surfaces becomes surface runoff. Implementation of effective Best Management Practices (BMPs) and Soil and Water Conservation Practices (SWCPs) as outlined in Forest Service Handbook 2509.22 during road construction and maintenance activities facilitates road drying, redirects surface runoff onto undisturbed areas of the forest floor, and prevents runoff from entering watercourses.

Road conditions were reviewed during field assessments. Many roads in the project area would not provide adequate access for mechanical vegetation treatments. Rutting, compaction, puddling, and erosion were observed on several roads in the project area. In some cases, these conditions were found to be adversely impacting water quality as a result of inadequate road surface drainage.

Water Resources

Watersheds

The Bill Williams Mountain Restoration Project occurs within six sixth-level (HUC12) hydrologic units or subwatersheds as shown in Figure 3.4.1-5. A watershed condition assessment was recently conducted for all subwatersheds in the project area as part of a Forest-level assessment of watershed condition. This assessment is used to: 1) prioritize watersheds for restoration, 2) identify specific on-the-ground activities and the associated costs to maintain or improve watershed condition, and 3) manage the data appropriately. Watershed conditions for the subwatersheds in the Bill Williams Restoration Project analysis area were classified using a core set of national watershed condition indicators that were updated with local data and interpreted by Forest interdisciplinary (ID) teams. These indicators were grouped according to four major ecosystem process categories: (1) aquatic physical; (2) aquatic biological; (3) terrestrial physical; and (4) terrestrial biological. These categories represent terrestrial, riparian, and riverine ecosystem processes or mechanisms by which management actions can affect the condition of watersheds and associated resources. Each indicator was evaluated using a defined set of attributes whereby each attribute was scored by the Forest interdisciplinary team as GOOD (1), FAIR (2), or POOR (3) using written criteria and rule sets and the best available data and professional judgment. Attribute scores for each indicator were summed and averaged to produce an overall indicator score. The indicator scores for each ecosystem process category were then averaged to arrive at a process category score. The overall watershed condition score is computed as a weighted average of the four process category scores based on the relative contribution that each process category provides toward watershed condition. The watershed condition scores are tracked to one decimal point and reported as Watershed Condition Classes 1, 2, or 3. Class 1 scores are from 1 to 1.6 and represent good, or properly functioning condition; class 2 scores are from 1.7-2.2 and represent fair or functioning at risk condition, and class 3 scores are from 2.3-3.0 and represent poor or impaired function condition (Potyondy and Geier, 2011).

Twelve core watershed condition indicators were evaluated for the watersheds in the project area. Aquatic physical indicators included: 1) water quality condition, 2) water quantity (flow regime) condition, and 3) stream and habitat condition. Aquatic biological indicators included: 4) aquatic biota condition and 5) riparian vegetation condition. Terrestrial physical indicators included: 6) road and trail condition, and 7) soil condition. Terrestrial biological indicators included: 8) fire effect and regime condition, 9) forest cover condition, 10) rangeland, grassland and open area condition, 11) terrestrial non-native invasive species condition, and 12) forest health condition. A summary of watershed conditions for the six watersheds in the Bill Williams Mountain Restoration Project area is included in Table 3.4.1-7 below.

Table 3.4.1-7. Subwatershed (HUC12) names, codes, condition ratings, acreages, and associated percentages of total project area.

WATERSHED NAME	HYDROLOGIC UNIT CODE (HUC12)	CONDITION RATING	WATERSHED ACRES	PROJECT AREA ACRES
Cataract Creek Headwaters	150100040502	Functioning-at risk	16,694	5,148
Devil Dog Canyon	150602020202	Functioning-at risk	11,192	1,331
Dogtown Wash	150100040501	Functioning-at risk	11,659	816
Johnson Creek	150602010302	Functioning-at risk	30,847	2,719
Meath Wash	150602020203	Properly functioning	37,522	1,639
Upper Hell Canyon	150602020204	Impaired	29,239	6,007
Total			**137,153**	**17,660**

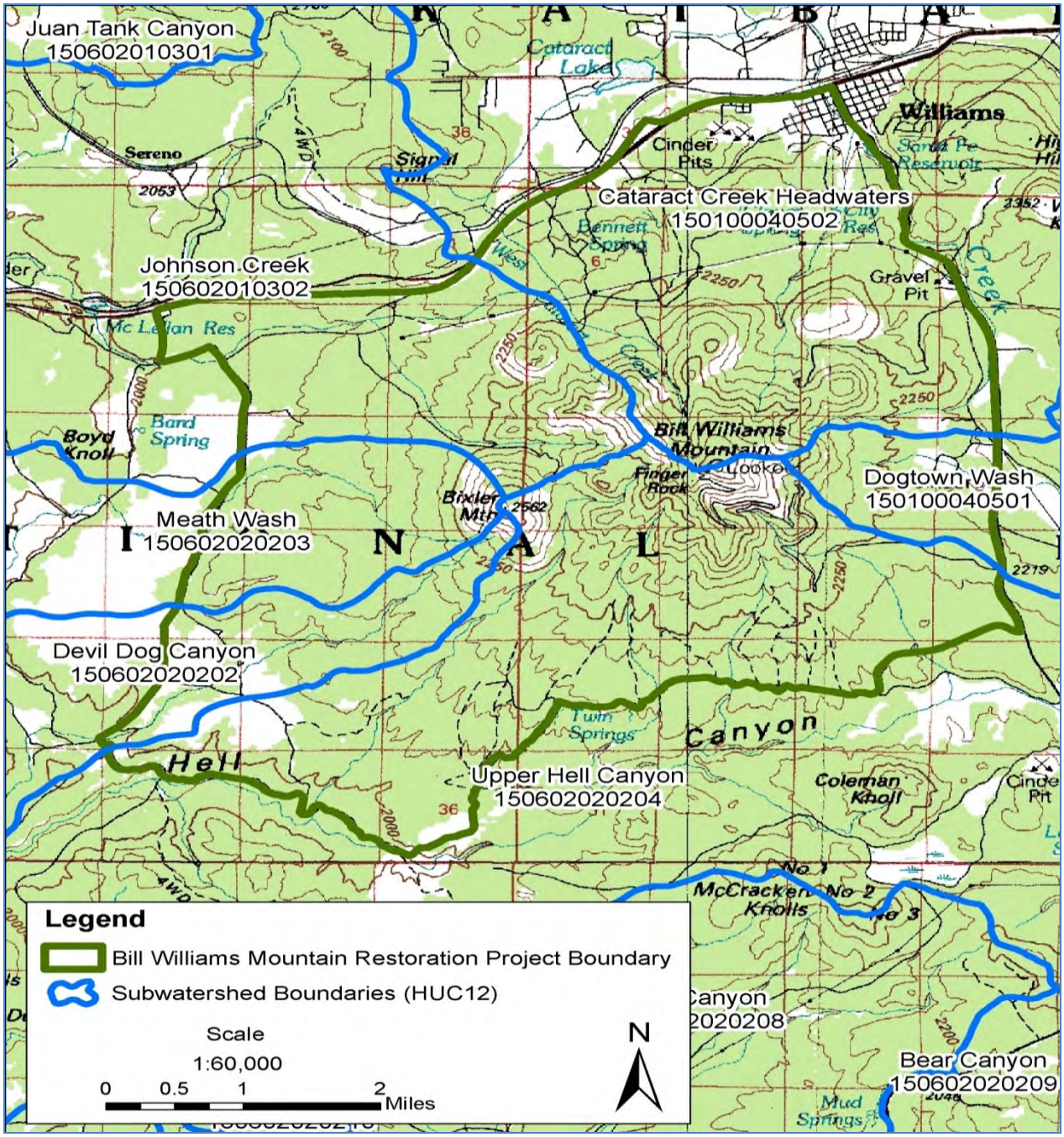


Figure 3.4.1-5. Bill Williams Mountain Restoration Project in relation to subwatersheds (HUC12).

Table 3.4.1-8 below provides a summary by watershed of indicator ratings that resulted in the corresponding watershed condition rating found in Table 3.4.1-7.

Table 3.4.1-8. Watrshed condition indicator summary for watersheds that occur in the Bill Williams Mountain Restoration Project area.

WATERSHED NAME	REASON FOR CONDITION RATING
Cataract Creek Headwaters	Functioning at risk due to reduced flows to springs and riparian areas; high road density; infrequent road maintenance; private septic systems present
Devil Dog Canyon	Functioning at risk due to low road maintenance; many stock tanks present
Dogtown Wash	Functioning at risk due to fire regime departed from reference condition; high road density; infrequent road maintenance; cinder pits and septic systems present; many stock tanks; 3 water wells and 2 reservoirs present.
Johnson Creek	Functioning at risk due to reduced flows to springs and riparian areas; high road density; infrequent road maintenance; many roads near water courses; cinder pits present; many stock tanks, 1 well, and 4 reservoirs present.
Meath Wash	Infrequent road maintenance; many stock tanks present.
Upper Hell Canyon	Impaired due to unsatisfactory soils in watershed; reduced flows to springs and riparian areas; high road density; infrequent road maintenance

City of Williams Municipal Watershed

The City of Williams Municipal Watershed is approximately 26,061 acres in size (Figure 3.4.1-6). Table 3.4.1-9 below lists the eight subwatersheds and their associated acreages that occur within the Williams Municipal Watershed. Two of these subwatersheds, Cataract Creek Headwaters and Dogtown Wash, encompass more than 96 percent of the total municipal watershed area.

Table 3.4.1-9. Subwatershed (HUC12) names, acreages, and associated percentages of each that comprise the City of Williams Municipal Watershed. (acres are approximate).

WATERSHED NAME	HYDROLOGIC UNIT NUMBER (HUC12)	TOTAL WATERSHED ACRES	PERCENT OF WILLIAMS MUNICIPAL WATERSHED	ACRES IN PROJECT AREA	PERCENT OF PROJECT AREA
Dogtown Wash	150100040501	10,627	40.8	816	8.7
Cataract Creek Headwaters	150100040502	14,616	56.1	5,148	33.8
Upper Red Lake Wash	150100040503	681	2.6	0	0
Upper Cataract Creek	150100040504	23	<0.3	0	0
Johnson Creek	150602010302	70	<0.3	2,719	17.9
Upper Hell Canyon	150602020204	25	<0.3	1,639	10.7
Pitman Valley-Scholz Lake	150602020305	3	<0.3	0	0
Big Spring Canyon	150602020307	9	<0.3	0	0

Citizens of Williams, Arizona depend on the Williams Municipal Watershed as a source of public drinking water and for other benefits that multiple use management of this watershed provides. The objective in managing the Williams Municipal Watershed is to recognize its water supply values and to provide management of its lands and resources to harmonize present and foreseeable resource uses with domestic water supply needs, protection of its water supply facilities and protection of the citizens of Williams from catastrophic floods (Elson 1972).

Runoff impounded in reservoirs serves as the main water supply for the City of Williams. Seven primary reservoirs surrounding the City are the source of surface water for municipal uses. These reservoirs have a combined water storage capacity of 2,755 acre-feet (897 million gallons) of water. Approximately 2,026 acre-feet or 73.6 percent of the available water storage occurs in the two largest impoundments, Dogtown Reservoir and Kaibab Lake. However, the majority of the City's water supply (i.e., approximately 90 percent) originates from Dogtown Reservoir and City Dam. Groundwater from wells located near Dogtown Reservoir supplements surface water in the City municipal water supply. Table 3.4.1-10 provides a summary of reservoirs used for the municipal water supply for the City of Williams and their associated water storage capacities and percentage of total water storage capacity. Water from these reservoirs originates from snow melt and summer precipitation.

The annual water demand of the City of Williams is approximately 198,184,868 gallons or 101.37 acre-feet which includes billed water to customers, unmetered water used at city-owned facilities and landscapes, unaccounted-for water, process water used at the drinking water treatment plant, raw water used for golf course irrigation, and reclaimed water used for golf course irrigation. Process water used at the drinking water treatment plant is non-potable raw water used for filter backwash, sediment removal, and chemical feed, which amounts to approximately four percent additional water above total production (Pinkham and Davis 2002). Since the City of Williams does not recycle this water back into the water supply system, it is considered a water use. Monthly municipal water demand is highly variable. However, the months of highest water demand are typically June, July, and August of most years. Water demand is lowest during winter months and increases through spring, with highest usage occurring during summer. There has been an upward trend (11 percent) in water usage by the City of Williams between 2005 and 2010.

Table3.4.1-10. Reservoirs, associated water storage capacities, and percentages of total municipal surface water in the City of Williams Municipal Watershed.

RESERVOIR NAME	WATER STORAGE CAPACITY (Million Gallons)	WATER STORAGE CAPACITY (Acre-Feet)	PERCENT OF TOTAL WATER STORAGE CAPACITY
Dogtown Reservoir	360	1,105	40.2
Kaibab Lake	300	921	33.4
Cataract Lake	109	335	12.2
Santa Fe Reservoir	70	215	7.8
City Dam	36	111	4.0
Upper and Lower Saginaw	22	68	2.4

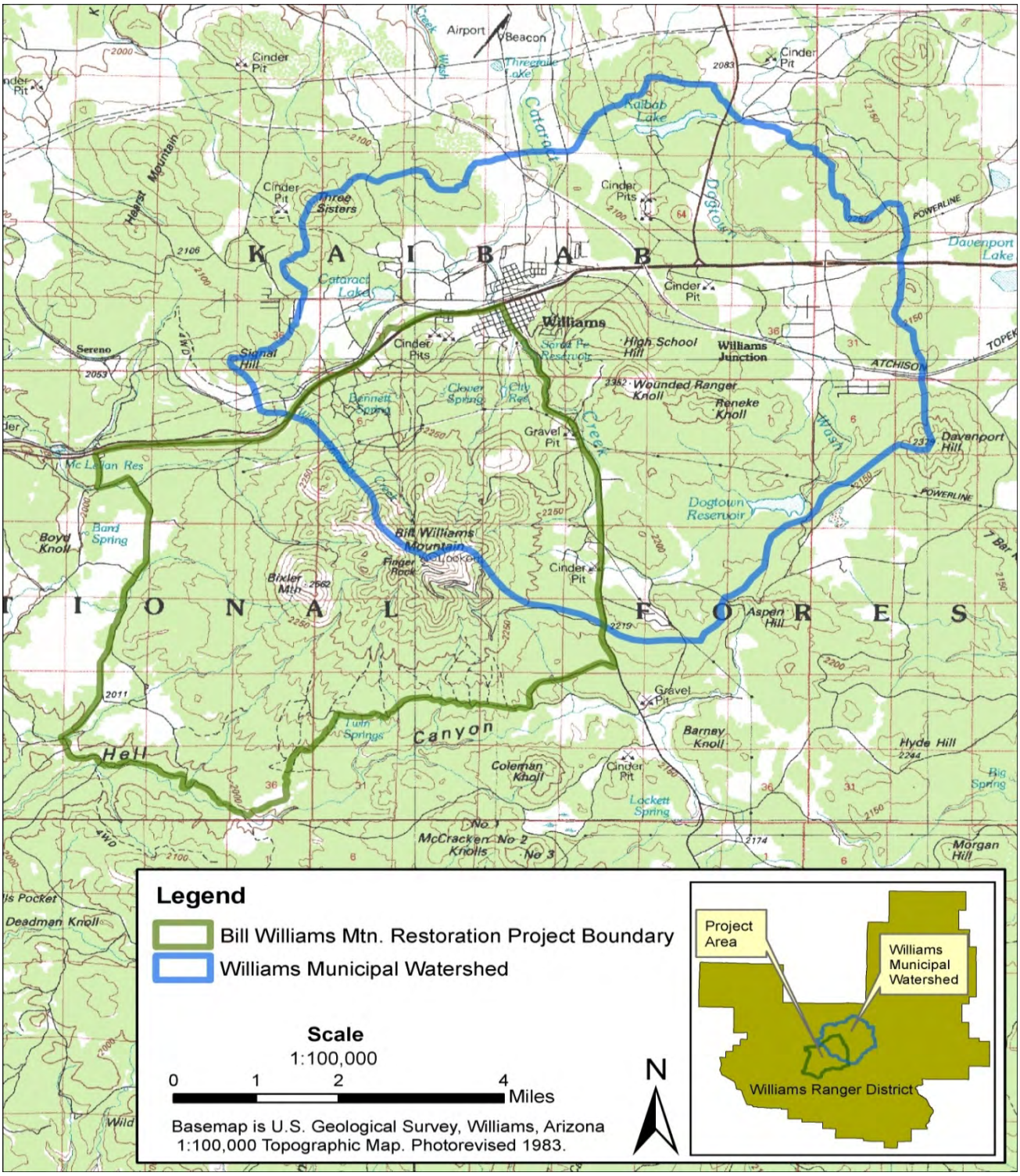


Figure3.4.1-6. Bill Williams Mountain Restoration Project area in relation to the City of Williams Municipal Watershed

Water that enters reservoirs either remains in storage, is withdrawn for use, is lost through dam spillage, or is lost through evaporation and infiltration. Evaporation and infiltration from the reservoirs is substantial every year. These losses exceed the city's current annual water use (Pinkham and Davis 2002). When the reservoirs are full, they provide a 2.5 year water supply, given current average rates of water use. A two year drought results in significant stress on the City of Williams surface water supply. This occurred in 1996-1997, and again in 1999-2000. Most of the water lost as spillage from reservoirs is lost from the water supply system. Although Kaibab Lake is downstream from Dogtown Reservoir on the same drainage, or stream channel, it is usually filled by surface runoff at approximately the same rate as Dogtown Reservoir. Most of the water that spills from Dogtown Reservoir is therefore subsequently spilled from Kaibab Lake (Thomsen 1969).

Since the 1996-1997 drought, the City of Williams has aggressively pursued development of reliable groundwater supplies. This program exemplifies the risks and costs of groundwater supply development in the region. The first well boring targeted a expected perched aquifer at 500-600 feet deep located west of the City. The well was dry. A second attempt, below the Santa Fe Dam, resulted in technical difficulties at approximately 2,000 feet of depth and was subsequently abandoned. A third attempt nearby struck water at 1,400 feet. This well is now producing at a peak flow of 110-120 gallons per minute (GPM), but only 20-25 GPM at maximum pumpage for more than 12 hours. A fourth boring on KNF Land in the vicinity of Dogtown Reservoir was also successful and now produces 220-240 GPM. The most recently developed well was drilled on the city's rodeo grounds. This well produces approximately 220-230 GPM. The Dogtown and rodeo grounds wells are over 3,000 feet deep. To date, Williams has spent roughly seven million dollars for three producing wells and three dry wells. The three successful wells produce a combined 500 GPM. Williams intends to continue well development in coming years, depending on the City's growth rate.

Some regional water stakeholders, including the Havasupai Tribe, have expressed concern regarding impacts of the City of Williams well development program on springs and seeps in the Grand Canyon area. The City of Williams and the Havasupai Tribe have entered into an agreement regarding regional ground water management and water conservation efforts by the City of Williams. The agreement includes discussions of tribal sovereignty, the significance of the Coconino Plateau to the tribe, the importance of water on the Coconino Plateau, the importance of water conservation, and the affect of drought on the water resources of the City of Williams. Specific agreement clauses address conditions under which the tribe would not contest or may contest well permits from the U.S. Forest Service and the city's right to respond to opposition, monitoring of well levels and production, restrictions on provision of water by the city to residents outside the city, city opposition to Coconino County allowing home development in areas without water supply, mutual support for development of other water supplies, mutual opposition to large-scale development proposals that rely on groundwater development, continuation of water conservation efforts by the City of Williams, and the City's support in principle for the tribe's position that any decrease to the natural flow of Havasu Creek cannot be tolerated (Pinkham and Davis 2002).

Water Quality

Section 305(b) of the Clean Water Act requires states to assess and report on the water quality status of waters within the states. Section 303(d) requires states to list waters that are not attaining water quality standards. This is also known as the list of impaired waters. This information is reported to Congress on a nationwide basis. Arizona Department of Environmental Quality is responsible for conducting monitoring, assessment, reporting under CWA Sections 303(d) and 305(b), and TMDL development for the State of Arizona.

Arizona's most recent Integrated Report (305(b) Water Quality Assessment and 303(d) list) is available from the Arizona Department of Environmental Quality (ADEQ). The Arizona Impaired Waters List can be found at:

http://www.azdeq.gov/environ/water/assessment/download/2008/2006_2008.pdf

There are no perennial running waters within the project area; there is therefore no surface water quality data for the project area. No water bodies are listed as impaired within the project area on the Arizona 2006/2008 Impaired Waters List.

Stream Channels

Due to the relatively steep terrain, the Bill Williams Mountain vicinity exhibits a radial drainage pattern with high-gradient ephemeral and intermittent drainages flowing in all directions from the upper slopes of Bill Williams Mountain. Approximately 68.92 miles of streamcourses occur within the analysis area, with none having riparian reaches. Most of the streamcourses in the proposed project area are best characterized as ephemeral, or dry washes. However, three drainages that exhibit intermittent flow do occur within the project area. These include Cataract Creek, Dogtown Wash, and West Cataract Creek. These washes flow primarily during spring snowmelt and, to a lesser extent, during the summer monsoon. Refer to Table 1 in Appendix A of the Soils and Watershed Specialist's Report for a summary of stream reaches and their associated lengths and names within the Bill Williams Mountain Restoration Project area.

Wetlands and Springs

There are 32 livestock ponds, reservoirs, and natural depressions within the project boundary that impound water for a sufficient duration to exhibit some wetland characteristics and are therefore listed in the National Wetlands Inventory database of the U.S. Fish and Wildlife Service. Table 3.4.1-11 lists these water bodies and their associated size and wetland habitat classification. Twenty one of the listed water bodies occur on the Kaibab National Forest while eleven (highlighted in the table) occur on other land ownerships inside the overall project boundary.

Table3.4.1-11. Wildlife and livestock watering ponds and reservoirs within the Bill Williams Mountain Restoration Project area. (acreages are approximate)

NAME	WETLAND HABITAT CLASSIFICATION	SIZE (Ac.)	LOCATION
Bear Tank	Palustrine, unconsolidated shore, seasonally flooded, diked/impounded	0.13	112°14'14.97" W 35°11'11.87" N
Berham Tank No. 1	Palustrine, emergent, persistent, seasonally flooded, diked/impounded	1.14	112°10'23.54" W 35°11'58.29" N
Berham Tank No. 2	Palustrine, unconsolidated shore, seasonally flooded, diked/impounded	0.61	112°10'26.83" W 35°12'1.01" N
Bixler Tank	Palustrine, unconsolidated shore, temporarily flooded, diked/impounded	0.15	112°13'28.31" W 35°11'42.63" N
Black Mesa Tank	Palustrine, unconsolidated shore, temporarily flooded, diked/impounded	0.41	112°13'51.29" W 35°10'13.57" N
Borrow Tank	Palustrine, unconsolidated shore, seasonally flooded, diked/impounded	0.35	112°12'41.92" W 35°10'19.10" N
Caffrey Tank	Palustrine, unconsolidated shore, temporarily flooded, excavated	0.08	112°16'15.61" W 35°10'14.28" N

NAME	WETLAND HABITAT CLASSIFICATION	SIZE (Ac.)	LOCATION
City Reservoir	Palustrine, unconsolidated bottom, permanently flooded, diked/impounded	6.14	112°11’24.62” W 35°13’57.30” N
Coyote Tank	Palustrine, unconsolidated shore, temporarily flooded, excavated	0.43	112°10’41.69” W 35°10’56.21” N
EK Tank	Palustrine, unconsolidated shore, seasonally flooded, excavated	0.31	112°16’0.66” W 35°10’42.48” N
FS Tank	Palustrine, unconsolidated shore, seasonally flooded, diked/impounded	0.13	112°13’10.63” W 35°14’10.39” N
Hat Tank No. 1	Palustrine, unconsolidated shore, seasonally flooded, diked/impounded	0.19	112°15’40.24” W 35°12’21.91” N
Hat Tank No. 2	Palustrine, unconsolidated shore, temporarily flooded, diked/impounded	0.07	112°15’38.90” W 35°12’23.17” N
Heiffer No. 1	Palustrine, unconsolidated shore, seasonally flooded, excavated	0.15	112°15’56.05” W 35°10’33.87” N
Heiffer No. 2	Palustrine, unconsolidated shore, seasonally flooded, excavated	0.08	112°15’56.19” W 35°10’32.42” N
JC Tank	Palustrine, unconsolidated shore, seasonally flooded, diked/impounded	0.41	112°15’10.81” W 35°9’51.38” N
JJ Tank	Palustrine, unconsolidated shore, temporarily flooded, diked/impounded	0.19	112°14’6.70” W 35°9’44.63” N
Saginaw Reservoir 1	Palustrine, unconsolidated shore, seasonally flooded, diked/impounded	1.40	112°11’20.34” W 35°14’25.52” N
Saginaw Reservoir 2	Palustrine, unconsolidated shore, seasonally flooded, diked/impounded	1.93	112°11’20.96” W 35°14’18.89” N
Mesa Tank	Palustrine, unconsolidated shore, temporarily flooded, diked/impounded	0.63	112°11’6.25” W 35°10’20.69” N
Mountain Spring Tank No. 1	Palustrine, unconsolidated shore, temporarily flooded, excavated	0.17	112°13’22.87” W 35°14’09.21” N
Mountain Spring Tank No. 1	Palustrine, unconsolidated shore, temporarily flooded, excavated	0.12	112°13’26.21” W 35°14’09.32” N
Santa Fe Reservoir (Upper Portion)	Palustrine, scrub-shrub, broad-leaved deciduous, temporarily flooded, diked/impounded	0.59	112°11’0.15” W 35°14’15.35” N
Santa Fe Reservoir (Lower Portion)	Palustrine, unconsolidated bottom, permanently flooded, diked/impounded	14.12	112°11’5.52” W 35°14’25.73” N
Stump Tank	Palustrine, unconsolidated shore, temporarily flooded, excavated	0.14	112°16’34.61” W 35°12’49.32” N
Unnamed	Palustrine, unconsolidated shore, temporarily flooded, excavated	0.13	112°10’33.02” W 35°13’27.55” N
Unnamed	Palustrine, unconsolidated shore, seasonally flooded, excavated	0.21	112°15’45.16” W 35°10’29.25” N
Unnamed	Palustrine, unconsolidated shore, intermittently flooded, diked/impounded	0.21	112°11’58.54” W 35°14’45.19” N
Unnamed	Palustrine, emergent, persistent, temporarily flooded, diked/impounded	0.69	112°10’42.27” W 35°13’39.15” N

NAME	WETLAND HABITAT CLASSIFICATION	SIZE (Ac.)	LOCATION
Unnamed	Palustrine, unconsolidated shore, temporarily flooded, diked/impounded	0.12	112°10'13.28" W 35°12'55.41" N
Unnamed	Palustrine, emergent, persistent, seasonally flooded, diked/impounded	0.63	112°13'14.49" W 35°14'12.84" N
XA Tank	Palustrine, unconsolidated shore, seasonally flooded, excavated	0.21	112°15'56.10" W 35°10'22.11" N

There are three known springs located within the Bill Williams Mountain Restoration Project analysis area. These include Clover Spring (112°12'12.94"W, 35°13'53.48"N), Bennett Spring (112°12'46.80"W, 35°13'52.94"N), and Andrews Spring (112°15'22.76"W, 35°9'33.18"N). There is no information available regarding historic flow or water quality from these springs. The springs are best characterized as rheocrene – they flow directly from the ground resulting in a small stream. The three springs were surveyed on October 13, 2011 to assess spring conditions. Clover Spring has been altered through installation of a spring box. This infrastructure helps protect the spring source from potential contamination. Clover Spring flows for approximately 35 feet from the spring box to a small, oblong basin approximately 6 feet long and 4 feet wide. Water continues to flow at the surface for an additional 45-50 feet in a narrow channel before water infiltrates into the soil. Hydrophytic (i.e., wetland) vegetation occurs within and along the fringe of the channel and for an additional 15-20 feet below the location where surface flow terminates. Bennett Spring is undeveloped with no surface flow evident at the time of site investigation. Andrews Spring is also undeveloped with no observed surface flow at time of site visit. It is possible that Bennett and Andrews Springs flow only after winter snowpack has recharged groundwater and during or shortly after the summer monsoon season.

Flood Zones

Flood zones are geographic areas defined by the Federal Emergency Management Agency (FEMA) according to varying levels of flood risk. These zones are depicted on a community's Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map. Each zone reflects the severity or type of flooding in the area. Moderate to low risk areas in the project vicinity are identified as flood zone X and C and X. Flood zones B and X are defined as areas of moderate flood hazard, usually these areas are between the limits of the 100-year and 500-year floods. These designations include base floodplains of lesser hazards, such as areas protected by levees from 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than 1 square mile. Flood zones C and X are areas of minimal flood hazard, usually depicted on FIRMs as above the 500-year flood level. High risk areas are designated as zones A, AE, AH, and AO. Flood zone A includes areas with a 1 percent annual chance of flooding and a 26 percent chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas; no depths or base flood elevations are shown within these zones. Flood zone AE are areas of the base floodplain where base flood elevations are provided. Flood zone AH includes areas with a 1 percent annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26 percent chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones. Flood zones AO are river or stream flood hazard areas, and areas with a 1 percent or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26 percent chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.

Within the Bill Williams Mountain Restoration Project boundary, there are approximately 17,511 acres of flood zone X (minimal flood hazard), 68 acres of flood zone A (high flood risk, depth and base flood elevation unknown) and 69 acres of flood zone AE (high flood risk, depth and base flood elevation

known). Flood zone A is located in the southwestern portion of the project area and is associated with Devil Dog Canyon. Flood zone AE is located near the northeastern boundary of the project area in the City of Williams and is associated with Cataract Creek.

3.4.2 Direct and Indirect Effects

Direct effects of an action are caused by the action and occur on site and affect only the area where they occur. Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. In general, direct and indirect effects to soils and forest hydrology as a result of the Action Alternatives include:

- Reduction of the forest canopy would decrease interception (precipitation captured by leaves, branches, and boles) and increases net precipitation reaching the soil surface.
- Partial removal of the forest overstory reduces transpiration (water lost from plants to the atmosphere).
- Reductions in interception and transpiration increase soil moisture content, water available for plant uptake, and water yield.
- Increased soil moisture and loss of root biomass can reduces slope stability.
- Increases in water yield after forest thinning are transitory and decrease over time as forests regrow unless subsequent treatments maintain initial post-treatment conditions.
- When young, dense forests with high interception rates (or higher annual transpiration losses) replace mature forests with lower interception rates (or lower transpiration losses), water yield is reduced until the young forest matures and thins naturally or is thinned in treatments.
- Impervious surfaces (roads and trails) and altered hillslope contours (cutslopes and fillslopes) modify water flowpaths, increase overland flow, and deliver overland flow directly to stream channels.
- Impervious native surfaces increase soil erosion.
- Altered hillslope contours and modified water flowpaths along roads increase risk of landslides.

Alternative 1 – No Action

Since no activities are proposed under Alternative 1, there would be no direct or indirect effects to soils or watershed conditions as a result of this Alternative. Trends indicate that fuel loading would continue to increase in both living biomass and woody detritus through natural forest ingrowth and tree encroachment into existing openings, resulting in increased risk of high severity wildfire. Ingrown understories can create ‘ladder fuels’ which allow ground fires to ascend and spread quickly as crown fires. Coarse woody debris would be expected to increase over time as small, medium, and large diameter material falls to soil surfaces and begins to decay. While the increased organic matter would improve soil quality in some regards (organic matter accumulation in subsurface horizons, microhabitat for soil organisms, increased short-term water holding capacity, improved nutrient status, etc.) it would also result in an increased risk of high severity wildfires where fuel loading becomes excessive. The location, size and intensity of future wildfires cannot be estimated with reasonable accuracy, although some generalizations can be made. High intensity wildfires tend to occur in areas where fuel loading and fuel distributions are sufficient to carry a fire. Typically, uncontrolled wildfires occur during the drier times of the year, yielding higher severity fires than would occur under prescribed fire conditions. The adverse effects of a

high severity fire, such as the loss of forest floor organic matter, increased soil erosion, and changes in soil biota would be more widespread in an uncontrolled wildfire than under prescribed fire conditions where the size and intensity of the fire can be controlled. The primary impact of high intensity fire on soil productivity is the removal of surface organic matter, exposing soils to erosion by wind and rain. If surface organic matter is reduced (as happens with a high-intensity, long-duration fire) the cation exchange capacity, a measure of soil fertility, is also reduced and the ability of the soil to retain nutrients leached from ash decreases.

There have been many examples of recent catastrophic wildfires occurring in the southwestern United States in areas that were originally open, fire-maintained forests (Rodeo-Chediski, Schultz, Horseshoe 2, Wallow, Las Conchas, etc.). Such events can have profound negative effect to soil properties and watershed conditions including: a) decreased soil productivity through loss of nutrient sources, b) soil hydrophobicity (i.e. the inability of soils to absorb water following precipitation resulting in increased overland flow c) increased susceptibility of soils to erosion by both wind and rainfall, d) sediment delivery to stream channels, e) surface water quality degradation, and f) downstream flooding, to name a few. Large stand-replacing fires on the Kaibab National Forest historically have 10-25% of the burn acreage exhibiting high severity fire conditions. Therefore, if a 10,000 acre wildfire were to occur within the analysis area, approximately 1,000 to 2,500 acres of high severity fire would be expected to adversely affect soil properties.

The introduction of weeds and unwanted flora following a wildfire could lead to increased competition between less desirable invasive and noxious weeds and desirable native vegetation. Weeds can increase erosion, reduce soil moisture, and deplete nutrient levels (DiTomaso 2000). Because the roots of many noxious weeds are deeper than native grasses, they also contribute less organic matter near the soil surface than native vegetation.

Under the No Action alternative, there would be no obliteration of roads that are currently contributing to loss of soil productivity and degradation of water quality. These roads would remain at risk of unauthorized use, further contributing to soil destabilization, loss of productivity, and adverse impacts to surface water quality. Ongoing road maintenance of ML-2 and ML-3 roads within the project area would continue as it has in the past.

This alternative would result in no additional acres of ground disturbance from mechanical vegetation treatments, piling of activity-related woody debris, construction and maintenance of permanent or temporary roads, construction and maintenance of trails and trailheads, fireline clearing, and the use of prescribed fire.

Direct and Indirect Effects to Soils and Water Resources Common to All Action Alternatives

Potential effects of the Action Alternatives on soil productivity would include soil compaction, puddling, displacement, erosion, areas of high soil burn severity, loss of soil organic matter, short-term changes in soil moisture content, changes in nutrient cycles, changes in soil fauna, and introduction of invasive and noxious weeds. These effects can result from mechanical and non-mechanical vegetation treatments (i.e., forest thinning), mechanical and non-mechanical piling of activity-related debris, fireline installation, use of prescribed fire, fuelwood gathering, and road construction, maintenance, and obliteration activities. Mechanical forest vegetation treatments and fuelwood gathering have the potential to adversely affect water quality through introduction of sediment and additional nutrients from decomposing woody debris, particularly in thinned areas adjacent to stream courses. Implementation of BMPs and SWCPs as specified in Table 3.4.4-1 would minimize adverse impacts to soils and water quality from these activities.

Soil compaction, puddling and displacement would primarily be limited to the transportation systems and high traffic areas within mechanical vegetation treatments such as existing National Forest System roads, temporary access roads, skid trails, log landings, debris piling areas, and areas where fireline construction and dispersed fuelwood gathering occur. Road closures and curtailment of mechanical vegetation treatments during wet weather conditions, implementation of timing restrictions for fuelwood gathering during wet weather, and designation of authorized access routes (skid trails and temporary roads) and log landing sites within the project area prior to project implementation would minimize adverse effects to soil productivity caused by these activities. With implementation of applicable BMPs and SWCPs as outlined in Table 3.4.4-1, most adverse effects to soils would be minimized or mitigated. Additionally, pedoturbation of soils caused by seasonal wetting and drying, freezing and thawing, and soil organism activity would naturally ameliorate some adverse effects to soils caused by the proposed Action Alternatives.

The effects of the proposed forest restoration activities on erosion and sediment yields depend on methods and equipment used, skills of the equipment operators and personnel conducting the treatments, site-specific conditions, storm event timing and intensity, and prescribed fire locations and burn severities.

The risk of short-term accelerated soil erosion would be expected to increase in areas where forest thinning and use of prescribed fire results in soil disturbance or complete removal of vegetative ground cover. These areas are expected to include skid trails, log landings, temporary access roads, cable yarding corridors, obliterated roads, areas where dispersed fuelwood gathering occurs, installed firelines and strategic fuels treatment areas to support prescribed burning efforts, and National Forest System roads. Since forest vegetation treatments would be conducted using both mechanical and non-mechanical means, adverse impacts to soils resulting from vegetation treatments would be minimized or mitigated to the greatest extent practicable through use of appropriate treatment methods and machinery designed for site-specific conditions. As previously noted, operability zones have been developed to illustrate the operational feasibility of mechanical treatments. Operability zones share common attributes such as topography (slope steepness) and terrain (surface roughness) and therefore guide the type of harvesting operation and equipment to be used within each zone. With appropriate and effective implementation of BMPs and SWCPs as outlined in Table 3.4.4-1, most adverse effects to soil productivity caused by forest vegetation treatments would be minimized or mitigated.

The removal of forest cover can decrease raindrop interception and evapotranspiration, which can increase water yields from treated areas (Bosch and Hewlett 1982, Stednick 1996). In areas where the annual precipitation is less than 20 in (500 mm), removal of the forest canopy does not typically increase annual water yields (Bosch and Hewlett 1982). In drier areas, such as the proposed project site, the decrease in interception and transpiration caused by forest thinning is usually offset by the increase in soil evaporative losses, resulting in no net change in runoff as long as factors affecting runoff processes are not changed (for example, soil compaction which causes a shift from subsurface flow to overland flow) (MacDonald and Stednick 2003). Evapotranspiration rapidly recovers with vegetative regrowth in partially thinned forests. Increases in runoff due to thinning operations rarely persist for more than 5 to 10 years.

Thinning of forest cover on soils currently characterized as unsatisfactory would improve soil conditions over the long-term by improving soil moisture and allowing greater sunlight penetration to the forest floor (i.e., sunflecks) resulting in an increase in grasses, forbs and shrubs in the forest understory. The increased herbaceous vegetation would reduce soil erosion rates by providing vegetative and litter ground cover that would intercept rain before it can reach soil surfaces and detach and entrain soil particles in runoff water. Woody debris from forest thinning (i.e., slash) would be lopped and scattered where doing so would not result in excessive fuel loads and increased wildfire risk, further mitigating potential adverse effects to these soils. Fine woody debris that is incidental to forest vegetation treatments (i.e., needles,

leaves, twigs, cones, bark, etc.) would also remain on the ground following mechanical treatments to protect soil surfaces from wind and water erosion.

Prescribed fire has the potential to impact water quality by increasing sediments, dissolved solids, and nutrients in streams. Dissolved nutrients in stream flow primarily originate from weathering of parent materials and soils, decomposition of plant material and other organic matter, and anthropogenic sources. Vegetative communities accumulate and cycle nutrients (Tiedemann et al. 1979, 1980). Fire can disrupt nutrient cycling and cause nutrient volatilization, leaching, and transformations. When vegetation is consumed by fire, some of the soil and organic matter nutrients such as nitrogen, phosphorus, copper, iron, manganese, and zinc are volatilized and lost from the system, while other nutrients such as calcium, magnesium, and potassium are converted into oxides and accumulated in ash (DeBano et al. 1998).

The mobility and concentration of nutrients in soils determines whether or not nearby water sources are at risk of contamination when prescribed fire is used. Nitrate is highly mobile and is therefore subject to risk of being leached from burned areas and transported to either surface or ground water. Phosphorus adsorbs readily to sediment and organic materials. Thus, phosphorus is usually transported to streams and water bodies through soil erosion. Rates of soil erosion and phosphorus contamination are generally dependent on soil characteristics and topographic relief of the site.

Prescribed fire has the potential to alter short- and long-term soil productivity and moisture content by changing the amount and type of vegetation, the amount of forest floor organic matter, and surface soil texture and wettability. Prescribed fires typically leave greater amounts of organic matter (duff, forest litter, and large and small woody debris) on soil surfaces than uncontrolled fires. These materials serve as nutrient sinks, prevent soil particle detachment caused by raindrop impact, and capture sediments that would otherwise be transported to stream channels and waterbodies. Following low-intensity prescribed fires, an increase in grasses and other herbaceous vegetation often occurs. This rapid regrowth of ground cover further immobilizes nutrients in plant material.

Prescribed fires that remove large amounts vegetation from a site have potential to alter watershed hydrology. As vegetation is removed, evapotranspiration in the watershed decreases, thus providing greater stream flow and overall water yield within the watershed. Water uptake from trees is species-specific. Conifers, which are the dominant vegetation type within the Bill Williams Mountain Restoration Project area, generally transpire greater quantities of water than hardwoods such as oaks and aspen. Dense foliage and longer growing seasons promote the higher overall water uptake in conifers. Additionally, conifers have relatively dense crowns that intercept rainfall and allow for greater evaporative losses.

Once a site has undergone loss of vegetation and removal of the litter layer, surface water can cause erosion problems and result in higher stream discharges. Fires not only consume portions of the litter layer, but at high temperatures fires can also cause hydrophobic soil conditions, thus making soils more susceptible to erosion. DeBano and Krammes (1966) and Robichaud (2000) observed that water repellency was dependent on the heating temperatures of the soils. At typical wildfire soil profile temperatures (less than 500°F) when the soil was dry, soil hydrophobicity occurs at shallow depths (less than 1 inch). When soils are moist (i.e. conditions that commonly occur during prescribed fire in the spring and fall), soil hydrophobicity was less pronounced and only occurred after long heating times which would typically only occur during smoldering fires. Therefore, soil hydrophobicity under a prescribed fire scenario would likely be minimal throughout the majority of the treatment area.

Fire in southwestern ponderosa pine forests has been shown to generally increase soil moisture content (Ryan and Covington 1986, Ower 1985, Haase 1986). In a review of literature, Hungerford and others (1991) reported that burning can kill many kinds of bacteria, fungi and arthropods but the extent of this

effect is dependent on the amount of heat generated by the fire and soil moisture content. To what extent these changes result in an impairment or degradation of soil productivity is not clearly understood. Hungerford suggests that low to moderate intensity prescribed fires may have minimal long-term negative effect on soil microorganisms. Kaye and Hart (1998) found that microbial nitrogen transformation rates increased under restored forest conditions, relative to the controls, suggesting higher microbial activity in the restored areas. Neary and others (1999) caution against the adverse effects to soil microorganisms caused by fires that become intense or are too frequent. Researchers have recommended maintaining soil carbon pools to maintain biologic activity (Stark and Hart, 1997), and recommend maintaining heterogeneity in burned areas to provide suitable sites from which the microflora and microfauna can reestablish in burned areas (Moldenke, 1999). Prescribed fires proposed under the action alternatives are expected to be of low severity with small areas of medium and high severity, retaining unburned islands and creating a mosaic of fire effects. Low and medium severity fires burn only a portion of the surface organic matter – leaving adequate soil cover over much of the burned area. In general, low severity prescribed fire does not cause excessive erosion or sediment transport since soil cover is retained in a discontinuous pattern across the landscape. This type of prescribed fire would not have a long-term adverse impact on soil moisture content or biota. The increase in understory vegetation would improve long term soil structure and porosity through increased fine root volume and vegetative litter, which are important habitat components for soil fauna that then incorporate organic matter into soil profiles and facilitate nutrient cycling.

Installation of firelines where they do not currently exist would expose soil surfaces, increasing the risk of erosion by both wind and rain. Areas of high severity fire may consume forest floor organic matter, leaving soil surfaces hydrophobic (i.e., repellant to water) and susceptible to erosion. Initially, the greatest risk of soil erosion would be expected to occur in areas where prescribed fire is implemented prior to forest thinning treatments. This is due to greater amounts of woody debris on the ground, higher stand densities and crown bulk densities at these locations, resulting in increased risk of high severity fire. Rehabilitation of firelines installed during prescribed burning would minimize adverse impacts to soil productivity from fireline installation. Implementing prescribed burning under conditions that would minimize high severity fire would minimize areas where soil organic matter is totally consumed and prevent hydrophobic soil conditions.

Piling of activity-related debris (slash) would disturb soil surfaces, exposing them to direct raindrop impact and wind. On steep terrain this would increase localized, short-term erosion rates in areas where pile burning is conducted. These areas will constitute a very small percentage of the overall treatment area (i.e., less than 5 percent), so these impacts are expected to be minor. Use of appropriate BMPs and SWCPs as outlined in Table 3.4.4-1 would mitigate most adverse effects from piling of woody debris created during forest thinning operations. Additionally, use of excavators with hydraulic bucket thumb attachments would minimize soil disturbance resulting from machine piling more effectively than dozer piling.

Burning of slash piles has been shown to negatively affect soil biotic and chemical properties due to intense soil heating (Korb et al, 2004 and Seymour and Tecle, 2004). It can result in soil sterilization, increased erosion risk and an increased risk of invasive and noxious weeds that displace native vegetation. Pile burning sites would constitute a very small portion of the project area (i.e., less than 5 percent). Monitoring of these sites for the presence of invasive or noxious weeds following pile burning, and treatment of any infestations found would mitigate most adverse effects to soils caused by pile burning of slash.

Soil organic matter serves as the long-term nutrient supply for all vegetation occupying a site. It also provides microhabitat for most soil organisms and improves soil chemical and physical properties including soil aggregate stability, increased porosity, improved water holding capacity, lower bulk

densities, and nutrient cycling. Initially, there would be an expected short-term increase in soil organic matter as a result of mechanical vegetation treatments as woody debris is deposited on soil surfaces during treatments. Forest thinning would also allow greater light penetration to soil surfaces resulting in warmer soil temperatures. The reduction in tree vegetative cover as a result of forest thinning would decrease evapotranspiration rates and therefore increase soil moisture. Warmer soil temperatures and greater soil moisture content would result in increased soil biological activity. Increased soil biological activity results in a proportional decrease in soil organic matter as organisms consume soil detritus. The eventual increase in understory vegetation would result in increased litterfall and deposition of organic matter onto soil surfaces. Broadcast prescribed fire would result in rapid oxidation of surface organic matter and living understory biomass, causing a release or transformation of some soil nutrients.

Runoff from road surfaces can detach and transport the fine material from road prisms and ditches. Sediment delivery directly from road surfaces to water courses is difficult to estimate since it occurs as non-point runoff. Sediments delivered to streams from roadside ditches may have originated from sheet or rill erosion prior to entering road surfaces or drainage ditches. In the absence of vehicle traffic, sediment concentrations in road runoff decreases over time. However, vehicle traffic, particularly trucks, can pulverize road surface aggregates, resulting in more fine particles that are easily transported in runoff. Additionally, the pressure of vehicular tires on saturated road surfaces can force fine particles from below the surface to move upward to the surface (Truebe and Evans 1994). Road proximity and connectivity to drainages can strongly influence sediment delivery to watercourses and peak flows in streams. Roads within the project area intersect numerous ephemeral drainages. These points of intersection occur as both culverted crossings and low-water crossings. Road-stream intersections are the primary location where sediments are delivered to stream courses.

Approximately 28 miles of poorly located and infrequently maintained roads would be decommissioned under all Action Alternatives. Road decommissioning would entail obliteration whereby road surfaces would be ripped and seeded or mulched, inside ditches would be filled, road prisms outsloped, culverts and fill materials removed, stream crossings re-contoured, unstable sidecast or cutslopes removed or stabilized, and entrances blocked to prevent future access. These activities would return unproductive or marginally productive soils to a more stable, productive status over the long term by improving water infiltration and vegetative ground cover and reducing erosion hazards. Sixteen stream crossings would be returned to a more natural condition, thus reducing runoff and sediment delivery into ephemeral stream channels. Adverse impacts to surface water quality caused by stormwater runoff from road surfaces would also be minimized. Current erosion rates for roads proposed for obliteration are at or above tolerance erosion rates. Upon completion of road obliteration activities, erosion rates for these roads are expected to approach natural erosion rates for TEUs where these roads occur. Approximately 40 acres currently occupied by roads would be returned to productive status under all Action Alternatives. Table 3.4.2-2 summarizes TES units and their associated acreages and erosion hazard ratings that would be improved through road obliteration. Based on the values in Table 3.4.2-2, an estimated 100 tons of soil loss per year could be eliminated as a result of road obliteration activities. With implementation of appropriate BMPs and SWCPS as outlined in Table 3.4.4-1, sediment delivery to water courses from road construction and maintenance can be minimized, but not eliminated entirely.

An additional indirect effect may result from the spraying of noxious weeds as a mitigation measure prior to or following proposed vegetation treatments that may affect water quality, however the lack of perennial flowing water in the analysis area limits direct effects of spraying. The effects of spraying noxious weeds are covered in the Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds (2005).

While there would likely be some short-term, localized adverse effects to watersheds from the Action Alternatives in the project area in the form of increased runoff from treated areas, increased sediment

delivery to ephemeral drainages, and increased turbidity in surface water; long-term direct and indirect effects to watersheds would be improved of soil and watershed function due to greater ground cover of grasses, forbs, and shrubs which would improve soil stability, water holding capacity, increase sediment capture in surface runoff, and minimize runon to travelways and roadside ditches. Since treatments would be temporally sequenced (i.e., not occurring simultaneously, but instead implemented over time), the likelihood of large-scale soil erosion or sediment delivery to streams is minimal.

Table 3.4.2-2. Predicted soil erosion hazard by TEU where road obliteration would occur within the Bill Williams Mountain Restoration Project Analysis Area (Brewer et al, 1991). (acres are approximate)

MAP UNIT	EROSION HAZARD	CURRENT EROSION RATE TONS/AC/YR	TOLERANCE EROSION RATE TONS/AC/YR	POTENTIAL EROSION RATE TONS/AC/YR	NATURAL EROSION RATE TONS/AC/YR	ACRES
300	Moderate	2.35	2.71	13.56	0.28	0.75
304	Slight	0.16	2.71	0.93	0.04	2.93
310	Moderate	1.70	2.71	12.38	0.68	7.26
320	Severe	1.94	1.82	16.75	0.36	0.13
322	Severe	1.42	2.71	19.59	0.44	0.33
324	Slight	0.20	2.71	0.93	0.04	24.16
401	Slight	0.16	2.71	0.93	0.04	1.14
402	Moderate	1.70	2.71	9.96	0.26	0.39
507	Slight	0.16	2.71	0.28	0.00	0.21
518	Slight	0.24	1.82	0.61	0.04	0.05
519	Slight	0.20	1.82	25.09	0.00	0.88
525	Severe	3.40	2.71	0.61	0.23	0.35
537	Slight	0.12	2.71	0.61	0.00	0.40
658	Slight	0.12	2.71	1.58	0.04	0.94
659	Moderate	2.71	2.71	24.04	0.52	0.17
660	Severe	1.86	2.71	14.29	0.33	0.16
Total						40.26

Alternative 2 – Proposed Action

Forest thinning

Under the Proposed Action, ground based logging systems would be used to treat up to 11,000 acres on slopes less than 40 percent in operability zones 1, 2, and 6 and approximately 200 acres in operability zones 3 and 4. Cable yarding would be employed in operability zone 5 to treat approximately 350 acres and helicopter logging would be used in operability zone 7 to treat up to 3,500 acres. Ground disturbing activities such as construction and maintenance of permanent and temporary roads, clearing of log landings, and use of skid trails and cable yarding corridors would be necessary to effectively implement mechanical treatments.

Approximately 23 miles of permanent roads, 16 miles of temporary roads, 230 acres of log landings (based on an estimated average of one log landing of 0.25 acres in size per 12 acres of land treated), and 1,377 miles (1,669 acres) of skid trails and cable yarding corridors (based on estimated area of disturbance of 15 percent) would be necessary in these seven operability zones to complete proposed mechanical vegetation treatments. Cable yarding corridors are estimated to be 12 feet wide with 80 feet between corridors. Additionally, helicopter logging would require a log landing of approximately 2 acres

in size and a service landing for helicopter fueling and maintenance of approximately 1 acre.

Mechanized felling can disturb and compact soils, and the use of such machines is a potential source of erosion. However, since felling machines do not skid logs on the ground, they typically produce less potential for soil erosion than tractor or rubber-tired log skidders. The effects of felling on soil erosion rates are not usually studied independent of skidding and yarding. Soil disturbance caused by trees striking the ground during felling is generally considered negligible.

Soil erosion rates resulting from forest thinning treatments tend to be positively correlated with the percentage of bare soil and the amount of surface soil disturbance, and these two factors are typically proportional to the number of trees being harvested (Haupt and Kidd 1965). In general, soil erosion rates are acceptably low when the proportion of bare soil is less than 30 percent (Robichaud 2010, Benavides-Solorio and MacDonald 2005; Swank et al 1989). In northern New Mexico, a series of rainfall simulations (6 in per hr. for one hour on successive days) was performed on control plots, lightly thinned plots with the slash piled, and lightly thinned plots with the slash scattered (Madrid 2005). The results indicate that thinning had no effect on runoff or the amount of bare soil, but the mean sediment yields from the second (wet) simulation on the thinned plots was up to three times higher than the mean sediment yield of 1.8 tons per acre from the control plots.

The amount of soil disturbance caused by fuel reduction thinning will depend, to a large degree, on the amount and type of skidding and yarding activities. Tractor skidding generally requires an extensive network of skid trails and roads, while full suspension cable yarding causes substantially less ground disturbance and typically requires a less dense road network. Helicopter logging typically results in the least soil disturbance since trees are lifted from the sites where felled and fully suspended over the ground until placed at the log landing. In a review of detrimental soil disturbance associated with timber harvest systems in the northern region of the USFS, Reeves, et al. found that the frequency of detrimental soil disturbance was greatest for ground-based logging systems followed by skyline, then helicopter logging systems (USDA 2011). Tractor skidding, therefore, is expected to produces the greatest amount of soil disturbance during logging, followed by excaline/high lead cable, then helicopter yarding (Rice and others 1972; Stednick 1987). While thinning a stand of trees to a desired residual density requires access to the entire stand, pre-commercial thinning typically requires little or no yarding and can be one of the least disturbing forest management practices (Robichaud 2010). The amount of disturbance caused by skidding and yarding will depend on site-specific characteristics, timing of operations, and the percentage of each stand that is thinned. Table 3.4.2-3 below summarizes modeled hillslope erosion and sediment delivery rates by TES mapping unit based on slope classes for forest thinning treatments under the Proposed Action. Table 3.4.2-4 provides a summary of hillslope erosion and sediment delivery for each watershed in the project area as a result of forest thinning activities.

Table 3.4.2-3. Predicted soil erosion rates and sediment yield by TES mapping unit in the Bill Williams Mountain Restoration Project area where forest thinning treatments would be conducted (USDA 2010).

MAP UNIT	SLOPE (%)	ACRES	PREDICTED SEDIMENT DELIVERY IN YEAR OF DISTURBANCE (TONS/SQ MI)	AVERAGE ANNUAL HILLSLOPE EROSION (TONS/SQ MI/YR)
6	0-5	38	0.0	0.0
10	0-5	126	0.0	0.0
37	0-5	179	0.0	0.0
300	15-40	50	0.0 – 6.4	0.0 - 0.3
302	15-40	248	0.0 – 6.4	0.0 - 0.3
304	0-15	1,934	0.0	0.0

MAP UNIT	SLOPE (%)	ACRES	PREDICTED SEDIMENT DELIVERY IN YEAR OF DISTURBANCE (TONS/SQ MI)	AVERAGE ANNUAL HILLSLOPE EROSION (TONS/SQ MI/YR)
310	15-40	328	0.0 – 6.4	0.0 - 0.3
320	40-80	1,779	6.4 – 12.8	0.3 – 0.6
322	40-80	4,687	6.4 – 12.8	0.3 – 0.6
324	0-15	24	0.0	0.0
325	0-15	238	0.0	0.0
401	0-15	247	0.0	0.0
402	15-40	25	0.0 – 6.4	0.0 - 0.3
405	0-15	104	0.0	0.0
407	15-40	8	0.0 – 6.4	0.0 - 0.3
507	0-15	167	0.0	0.0
518	0-15	737	0.0	0.0
519	0-15	73	0.0	0.0
525	15-40	1,070	0.0 – 6.4	0.0 - 0.3
537	0-15	12	0.0	0.0
539	40-120	130	6.4 – 12.8	0.3 – 0.6
563	0-15	477	0.0	0.0
564	15-40	80	0.0 – 6.4	0.0 - 0.3
565	0-15	416	0.0	0.0
658	0-15	854	0.0	0.0
659	15-40	1,109	0.0 – 6.4	0.0 - 0.3
660	40-120	38	6.4 – 12.8	0.3 – 0.6

Table 3.4.2-4. Predicted soil erosion rates and sediment yield for watersheds in the Bill Williams Mountain Restoration Project area where forest thinning treatments would be conducted (USDA 2010).

WATERSHED NAME	PROPOSED TREATMENT ACRES	TOTAL SEDIMENT DELIVERY IN YEAR OF DISTURBANCE (TONS/WATERSHED)	AVERAGE ANNUAL HILLSLOPE EROSION (TONS/WATERSHED)
Cataract Creek Headwaters	3,726	34.52	1.83
Devil Dog Canyon	868	4.89	0.41
Dogtown Wash	553	4.46	0.27
Johnson Creek	2,630	18.46	1.32
Meath Wash	1,564	8.83	0.74
Upper Hell Canyon	5,797	46.14	9.14
Grand Total	**15,138**	**117.30**	**13.71**

Modeled soil erosion rates indicate that forest thinning could result in a slight increase in short term erosion for TEUs within treated areas followed by improved soil stability ove the long term (Table 3.4.2-3). A predicted maximum of 117.3 tons of sediment delivered to ephemeral stream courses throughout the entire treatment area (15,138 acres) could occur as a result of forest thinning treatments under the proposed action (Table 3.4.2-4). These erosion rates do not exceed tolerance erosion rates for any of the TES units within the project area as outlined in the Kaibab National Forest TES (Brewer et al. 1991). As grasses, forbs, and shrubs begin to occupy openings, a proportional decrease in accelerated erosion is

expected. Many of the proposed vegetation treatment areas currently have relatively dense overstory conditions with ground cover consisting primarily of forest litter, including coarse woody debris, rather than herbaceous vegetation. These conditions do not afford the level of soil protection as provided by vegetative ground cover and the associated fine root biomass that tends to bind soil aggregates and prevent soil particle detachment and transport. Forest thinning would provide more open tree canopies and stand structures that encourage development of vegetative ground cover, and logging debris such as tree limbs, tops, and non-merchantable woody material would add to existing surface organic matter. Forest canopy openings would allow sunlight and wind to penetrate, warm, and dry the debris, which could increase potential fire intensity and severity until the residual woody debris is treated or sufficiently decomposed to abate fire hazard. Overall, the long-term risk of stand-replacing wildfire that adversely affects soils would be reduced. Use of appropriate BMPs and SWCPs as outlined in Table 3.4.4-1 during project implementation would minimize or mitigate any adverse effects to soils or watersheds from forest vegetation treatments. It is very unlikely that all thinning treatments would be conducted concurrently, minimizing the potential for soil erosion from large areas and associated sediment delivery to ephemeral stream channels.

Permanent and Temporary Roads

Roads represent the greatest risk of accelerated soil erosion throughout the proposed project area. Although some roads within the project area have been installed and are maintained using Best Management Practices designed to prevent and minimize erosion and sedimentation from road surfaces, some roads in the project area exhibit excessive erosion and sediment delivery due to poor location and design of some roads combined with infrequent road maintenance. Practices such as broad-based dips, waterbars, lead-out ditches (turnouts), aggregate fill on road surfaces, filter fabric, sediment traps, seeding of ditches with native grasses, and filter barriers/check dams are commonly used to minimize soil particle detachment from road prisms and prevent surface water quality impacts from roads. These practices have been shown to be effective at mitigating erosion from road surfaces and protecting water quality (Burroughs and King 1989).

Permanent road construction would require activities such as clearing, grubbing, sidecasting, cutting and filling, grading, compacting, and piling and burning of woody debris. Permanent road construction would commit areas incorporated into road prisms to non-productive status for the forseeable future (i.e., at least 50 years). Based on a traveled way width of 14 feet and a clearing width of 6 feet on each side of the traveled way for ditches and fill slopes, approximately 72 acres of land would be removed from timber and forage production within the project area under the Proposed Action. Road surfaces typically have much lower infiltration rates than undisturbed forest soils (Robichaud 2000) and therefore contribute to increased overland flow which can detach and entrain soil particles in stormwater runoff.

Temporary roads are generally minimum-standard roads designed for short-term use during a specific project. Usually, temporary roads are simply a bladed lane pushed into the project area with BMPs and SWCPs installed during construction. Use of temporary roads is typically limited to dry or frozen conditions to minimize rutting and compaction. Temporary roads would be stabilized and obliterated upon completion of activities. Based on a traveled way width of 12 feet and a clearing width of four feet on each side of the traveled way, approximately 27 acres of land would be temporarily removed from timber and forage production. Obliteration activities such as decompacting, removal of temporary fill material, recontouring, placement of woody debris, and seeding with native grasses and forbs would facilitate rapid return of temporary roads to productive status.

Tables 3.4.2-5 and 3.4.2-6 provide predicted sediment delivery from construction and maintenance of permanent and temporary roads in the project area, respectively. The range of values given for road sedimentation represent the amount of sediment delivered across a buffer, and the amount delivered to a

stream crossing. Roads with buffers greater than 1 ft. will generate less sediment. The summary table shows that roads generate significant amounts of sediment within a watershed, even when traffic is low. Road management strategies such as minimizing rutting, minimizing stream crossings, maximizing the use of buffers between roads and streams, and implementation and maintenance of BMPs and SWCPs have been shown to minimize soil erosion and sedimentation. Another alternative to reduce sedimentation from the road network is to reduce the road density within the watershed by removing roads that are no longer needed for modern timber operations. Sediment delivery associated with fuel management activities can be offset with a decrease in sediment from improved road management or a reduction in road density. Note that average annual erosion rates are the same as those for the year of disturbance. This is because roads generally have no protetive ground cover, so erosion rates from road surfaces generally remain constant throughout the life of the road. Temporary roads would be stabilized with BMPs and SWCPs designed to prevent erosion of road surfaces and sediment delivery to ephemeral channels. Therefore, average annual erosion rates following decommissioning of temporary roads are expected to be substantially lower than those predicted by the model.

Table 3.4.2-5. Predicted soil erosion rates and sediment yield for Terrestrial Ecosystem Units where permanent roads would be constructed and maintained (USDA 2010).

MAP UNIT	SLOPE (%)	ACRES OF ROADS	PREDICTED SEDIMENT DELIVERY IN YEAR OF DISTURBANCE (TONS/SQ MI)	AVERAGE ANNUAL HILLSLOPE EROSION (TONS/SQ MI/YR)
0010	0-5	0.24	0.0 – 7.7	0.0 – 7.7
0300	15-40	0.75	7.7 – 28.2	7.7 – 28.2
0302	15-40	0.12	7.7 – 28.2	7.7 – 28.2
0304	0-15	0.16	7.7 – 9.3	7.7 – 9.3
0310	15-40	24.38	7.7 – 28.2	7.7 – 28.2
0320	40-80	1.00	18.5 – 56.8	18.5 – 56.8
0322	40-80	0.81	18.5 – 56.8	18.5 – 56.8
0324	0-15	33.43	0.0 – 9.3	0.0 – 9.3
0518	0-15	0.25	0.0 – 9.3	0.0 – 9.3
0519	0-15	0.52	0.0 – 9.3	0.0 – 9.3
0537	0-15	2.49	0.0 – 9.3	0.0 – 9.3
0564	15-40	5.20	7.7 – 28.2	7.7 – 28.2
0658	0-15	1.78	0.0 – 9.3	0.0 – 9.3
0659	15-40	0.65	7.7 – 28.2	7.7 – 28.2

Table 3.4.2-6. Predicted soil erosion rates and sediment yield for Terrestrial Ecosystem Units where temporary roads would be constructed and maintained (USDA 2010).

MAP UNIT	SLOPE (%)	ACRES OF ROADS	PREDICTED SEDIMENT DELIVERY IN YEAR OF DISTURBANCE (TONS/SQ MI)	AVERAGE ANNUAL HILLSLOPE EROSION (TONS/SQ MI/YR)
0010	0-5	0.82	3.6 – 7.7	3.6 – 7.7
0310	15-40	1.76	7.7 – 28.2	7.7 – 28.2
0320	40-80	0.19	18.5 – 56.8	18.5 – 56.8
0322	40-80	0.09	18.5 – 56.8	18.5 – 56.8
0324	0-15	11.02	0.0 – 9.3	0.0 – 9.3

MAP UNIT	SLOPE (%)	ACRES OF ROADS	PREDICTED SEDIMENT DELIVERY IN YEAR OF DISTURBANCE (TONS/SQ MI)	AVERAGE ANNUAL HILLSLOPE EROSION (TONS/SQ MI/YR)
0401	0-15	0.45	0.0 – 9.3	0.0 – 9.3
0402	15-40	0.17	7.7 – 28.2	7.7 – 28.2
0405	0-15	0.18	0.0 – 9.3	0.0 – 9.3
0507	0-15	0.08	0.0 – 9.3	0.0 – 9.3
0518	0-15	1.36	0.0 – 9.3	0.0 – 9.3
0519	0-15	4.58	0.0 – 9.3	0.0 – 9.3
0537	0-15	3.16	0.0 – 9.3	0.0 – 9.3
0563	0-15	0.37	0.0 – 9.3	0.0 – 9.3
0564	15-40	0.49	7.7 – 28.2	7.7 – 28.2
0565	0-15	0.14	0.0 – 9.3	0.0 – 9.3
0658	0-15	1.73	0.0 – 9.3	0.0 – 9.3
0659	15-40	0.19	7.7 – 28.2	7.7 – 28.2
0660	40-120	0.01	18.5 – 63.7	18.5 – 63.7

Predicted hillslope erosion and sediment delivery rates would not exceed tolerance thresholds for any TEUs within the project area as a result of road construction, maintenance or use. Decommissioning of 28 miles of poorly located and infrequently maintained roads and temporary roads would improve overall soil condition within the project area by returning unproductive areas to productive status.

Bixler Trailhead and Trail

Conversion of approximately 1 mile of Forest Service Road (FSR) 45 (from Bixler saddle south) to a non-motorized trail would improve soil condition by eliminating motor vehicle traffic from this road segment, which occurs in TES map units 302 (0.31 ac.), 310 (0.26 ac.), 322 (0.12 ac.), 659 (0.06 ac.), and 660 (0.003 ac.). Pulverization of soil aggregates on the road surface and entrainment of soil particles in stormwater runoff would therefore be decreased on approximately 0.77 acres, or half of the existing road width of this segment of FSR 45 under this alternative. Implementation of recreational trail BMPs and SWCPs during construction and maintenance of the trail would minimize or mitigate any adverse effects to soils or watershed resources.

The proposed Bixler Trailhead and parking area would be approximately 0.25 acres in size and constructed in TES map unit 537. This portion of TES map unit 537 would therefore be removed from productivity for the foreseeable future (i.e., 50 years). The parking area would consist of native fill material and would be constructed using appropriate BMPs and SWCPs to minimize adverse impacts to surface water.

Prescribed Fire Treatments

Strategic fuel treatments to reduce surface, ladder, and canopy fuels would extend for up to 300 feet on each side of prescribed fire control lines. An estimated 2,500 acres would receive non-commercial vegetation treatments such as hand-felling techniques or, where practical, treatments would be conducted using mechanized equipment. These treatments would be necessary to prepare stands on steeper slopes for prescribed burning. Where strategic fuels treatments are conducted using mechanical means, effects to soils resources would be approximately the same as mechanical forest thinning treatments.

Table 3.4.2-7 below summarizes approximate TES map unit acreages where strategic fuel treatments would be implemented. These treatments would result in removal of much of the woody vegetation and woody debris that contributes to soil stability and nutrient availability. However, these treatments would also reduce soil burn severity by removing materials that contribute to smoldering fire conditions resulting in soil hydrophobicity and increased stormwater runoff. Long term soil conditions would be improved as strategic fuels treatment areas naturally revegetate with grasses, forbs and shrubs following use of prescribed fire.

Sediment delivery rates for prescribed fire within each HUC12 watershed were modeled using the Erosion Risk Management Tool (ERMiT) (Robichaud et al. 2006). Tables 3.4.2-8 through 3.4.2-10 provide a summary of predicted erosion rates and associated acreages within each HUC 12 subwatershed based on soil burn severities that bracket the possible range of effects from prescribed burning. Sediment yield estimates are based on a ten percent probability that calculated sediment yield rates would be exceeded in any given year following treatment for the five years modeled. This means that over the long term approximately 10 percent of precipitation events would result in sediment yields above those predicted. It does not mean that one out of every 10 events would result in sediment yields above those predicted by the model.

Table 3.4.2-7. Terrestrial Ecosystem Survey map unit acreages and associated erosion hazard ratings for areas where strategic fuels treatments would be conducted (Brewer et al, 1991). (acres are approximate)

MAP UNIT	SOIL CONDITION	EROSION HAZARD	CURRENT EROSION RATE TONS/AC/YR	TOLERANCE EROSION RATE TONS/AC/YR	POTENTIAL EROSION RATE TONS/AC/YR	SLOPE (%)	ACRES
10	Satisfactory	Slight	0.53	2.71	2.47	0-5	9
300	Satisfactory	Moderate	2.35	2.71	13.56	15-40	104
302	Satisfactory	Severe	2.14	2.71	15.50	15-40	29
304	Satisfactory	Slight	0.16	2.71	0.93	0-15	2
310	Satisfactory	Moderate	1.70	2.71	12.38	15-40	206
320	Unsatisfactory	Severe	1.94	1.82	16.75	40-80	135
322	Satisfactory	Severe	1.42	2.71	19.59	40-80	778
324	Satisfactory	Slight	0.20	2.71	0.93	0-15	248
401	Satisfactory	Slight	0.16	2.71	0.93	0-15	1
402	Unsatisfactory	Moderate	1.70	2.71	9.96	15-40	40
537	Satisfactory	Slight	0.12	2.71	0.61	0-15	7
539	Unsatisfactory	Severe	7.49	2.71	14.37	40-120	2
658	Satisfactory	Slight	0.12	2.71	1.58	0-15	132
659	Satisfactory	Moderate	2.71	2.71	24.04	15-40	377
660	Satisfactory	Severe	1.86	2.71	14.29	40-120	397
Total							2,467

The model resulted in 7,341 precipitation events and an annual average precipitation of approximately 22 inches based on 100-year mean annual averages. Approximately 650 precipitation events resulted in runoff estimates ranging from 1.3 inches to 2.0 inches. Annual runoff from winter snowmelt ranged between 0.65 and 1.4 inches.

As shown in Table 3.4.2-8, low severity prescribed fire would result in minor increases in sediment

delivery rates within each HUC12 subwatershed. Based on estimated sediment yield rates over the five year period following treatment, approximately 17,425 tons of soil loss is possible as a result of low severity prescribed fire treatments for the Bill Williams Mountain Restoration Project. Since prescribed burning treatments would be implemented in phases and not all within a single year, it is unlikely that large pulses of sediment would be transported from treated areas to drainages or downslope locations. Also, since forest thinning would be conducted in some of the prescribed fire treatment areas prior to burning, resulting in increased size and extent of forest openings and increased ground cover of grasses and forbs that help to carry fire and provide a mosaic of fire effects, recovery of areas treated with low severity prescribed fire is expected to be rapid. Low severity fire rarely consumes all of the forest floor litter, leaving some protective ground cover intact. Some of the nutrients contained in the organic matter would be converted to inorganic forms which are then available for plant uptake. The increase in plant available nutrients would improve short-term soil productivity, resulting in a rapid growth response of herbaceous vegetative cover. Low severity prescribed fire is therefore expected to result in a minor short-term increase in soil erosion rates followed by long-term improvement in the stability, function, and productivity of forest soils in the project area. Since low severity fire has historically been a natural occurrence in these ecosystems, these impacts do not necessarily need to be construed as negative, as they could also occur after a naturally-caused wildfire. These vegetation types and associated soils are thus ecologically adapted to low severity fire, and to resulting fire impacts. Predicted five-year average erosion rates do not exceed tolerance erosion rates as outlined in Table 3.4.1-6 for any watersheds within the proposed project area.

Table 3.4.2-8. Predicted sediment delivery rates for watersheds in the Bill Williams Mountain Restoration Project area under low severity prescribed fire treatments (USDA 2010). Sediment delivery rates were modeled for the year of prescribed fire use and four years following prescribed fire treatments.

WATERSHED NAME	TOTAL ACRES	TOTAL SEDIMENT DELIVERY (TONS/WATERSHED)					FIVE YEAR AVERAGE (TONS/AC)
		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	
Cataract Creek Headwaters	5,148	2,899.04	2,424.25	556.42	526.25	259.64	0.26
Dogtown Wash	816	185.88	156.18	36.84	34.99	17.68	0.11
Johnson Creek	2,719	1,188.57	995.21	232.56	218.69	107.05	0.20
Upper Hell Canyon	6,007	3,334.53	2,770.03	618.63	577.63	284.64	0.25
Grand Total	**14,690**	**7,608.02**	**6,345.67**	**1,444.45**	**1,357.56**	**669.01**	**0.82**

The potential for moderate severity prescribed fire increases in areas where excessive fuel loads currently exist, where forest thinning does not adequately reduce tree density, and where forest thinning results in large amounts of woody debris within a given treatment area. There would be an increased risk of accelerated soil erosion where moderate severity prescribed fire occurs. Table 3.4.2-9 provides an estimate of sediment delivery based on moderate burn severity over 25 percent of the total prescribed burn treatment area with 75 percent representing low burn severity in each watershed. This is an unlikely scenario, but was included in this analysis since some areas may exhibit moderate burn severity and these potential impacts should be analyzed and disclosed. A more likely scenario would be the occurrence of small areas (0.10 – 3 acres) that exhibit moderate burn severity intermingled with areas dominated by low burn severity conditions. It cannot be predicted with accuracy where such conditions would occur within proposed treatment areas. With appropriate fuels management techniques such as lopping and scattering

of activity-related woody debris and piling and burning debris where necessary, adverse impacts to soils caused by moderate severity fire would be minimized.

As shown in Table 3.4.2-9, prescribed fire that results in an average of 25 percent of treated watersheds exhibiting moderate burn severity would result in a proportional increase in sediment delivery to water courses of approximately 12 percent above low burn severity prescribed fire conditions for the five year average following treatment. Sediment yields calculated by the ERMiT model indicate that erosion rates for moderate soil burn severity will begin to stabilize by the third year following treatment and become equal to sediment yields produced by low soil burn severity by year 3. Under this scenario, soil erosion rates would not exceed tolerance thresholds as outlined in Table 3.4.1-2 for any of the watersheds proposed for prescribed fire treatment.

Table 3.4.2-9. Predicted sediment delivery rates for watersheds in the Bill Williams Mountain Restoration Project area where 75 percent of each prescribed burn treatment results in low burn severity and 25 percent results in moderate burn severity (USDA 2010). Sediment delivery rates were modeled for the year of prescribed fire use and four years following prescribed fire treatments.

WATERSHED NAME	TOTAL ACRES	TOTAL SEDIMENT DELIVERY (TONS/WATERSHED)					FIVE YEAR AVERAGE (TONS/AC)
		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	
Cataract Creek Headwaters	5,148	3,336.19	2,840.96	556.42	526.25	259.64	0.29
Dogtown Wash	816	212.62	181.58	36.84	34.99	17.68	0.12
Johnson Creek	2,719	1,371.46	1,163.86	232.56	218.69	107.05	0.23
Upper Hell Canyon	6,007	3,871.80	3,279.80	618.63	577.63	284.64	0.29
Grand Total	**14,690**	**8,792.07**	**7,466.2**	**1444.45**	**1357.56**	**669.01**	**0.93**

High severity prescribed fire would result in considerable risk of accelerated soil erosion where such conditions occur. While very unlikely, this would represent a worst case scenario with regard to the use of prescribed fire and would more accurately reflect soils response to wildfire. It is possible that small, isolated occurrances of high severity burn conditions would occur where excessive fuel loads exist or where conditions result in atypical fire behavior for brief periods. Such areas would likely exhibit accelerated soil erosion for longer periods and at greater rates than low or moderate soil severity burn areas due to high levels of consumption of forest floor fuels, vegetative cover, and soil seed banks leaving such areas unprotected and potentially hydrophobic. Predicted accelerated soil erosion rates for watersheds where 25 percent of each treatment area is subjected to moderate soil burn severity and 25 percent is subjected to high soil burn severity, with remaining watershed acreages subjected to low soil burn severity are summarized in Table 3.4.2-10.

As outlined in Table 3.4.2-10, prescribed fire that results in 50 percent of treated areas subjected to low soil burn severity, 25 percent subjected to moderate soil burn severity, and 25 percent subjected to high soil burn severity would result in a proportional increase in sediment delivery to water courses of 40 percent above the low soil burn severity values. While these rates would not be above tolerance erosion threshold rates outlined in Table 3.4.1-2, they would result in substantial detrimental effects to soil productivity and stability as well as ephemeral and intermittent water courses and downstream waterbodies within and outside of the project boundary. These effects would include loss of soil A horizon thickness, soil hydrophobicity, increased stormwater runoff, stream sedimentation, channel embeddedness, increased surface water turbidity, and changes to surface water chemistry and temperature

in drainages and impoundments.

Table 3.4.2-10. Predicted sediment delivery rates for watersheds in the Bill Williams Mountain Restoration Project area where 50 percent of prescribed burn treatment results in low soil burn severity, 25 percent results in moderate burn severity, and 25 percent results in high burn severity (USDA 2010). Sediment delivery rates were modeled for the year of prescribed fire use and four years following prescribed fire treatments.

WATERSHED NAME	ACRES	TOTAL SEDIMENT DELIVERY (TONS/WATERSHED)					FIVE YEAR AVERAGE (TONS/AC)
		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	
Cataract Creek Headwaters	5,148	4,727.90	3,925.30	1,040.37	842.55	397.78	0.42
Dogtown Wash	816	309.79	260.73	72.95	59.46	30.34	0.18
Johnson Creek	2,719	4,727.90	3,925.30	1,040.37	842.55	397.78	0.42
Upper Hell Canyon	6,007	2,002.00	1,660.52	453.61	364.79	173.39	0.34
Grand Total	**14,690**	**11,767.59**	**9,771.85**	**2,607.3**	**2109.35**	**999.29**	**1.36**

Direct and indirect effects to soils and watershed resources from prescribed fire treatments in Ecosystem Management Area 6 – the Arizona Bugbane (*Actaea arizonica*) Botanical Area (490 acres) would be similar to the use of prescribed fire in other watersheds in the analysis area. However, site-specific design features and mitigation measures have been developed to minimize or mitigate adverse effects to soils, vegetation, and water quality in this special habitat. Table 3.4.2-11 provides a summary of TES units that occur in the Arizona Bugbane Botanical Area and their associated acreages and erosion hazard ratings. With implementation of BMPs, SWCPs, and site specific design features and mitigation measures, direct or indirect adverse effects to these TES map units are not anticipated.

Table 3.4.2-11. Terrestrial Ecosystem Survey map units within the Arizona Bugbane Botanical Area (Brewer et al, 1991). (acres are approximate)

MAP UNIT	EROSION HAZARD	CURRENT EROSION RATE TONS/AC/YR	TOLERANCE EROSION RATE TONS/AC/YR	POTENTIAL EROSION RATE TONS/AC/YR	SLOPE (%)	ACRES
302	Severe	2.14	2.71	15.50	15-40	4
322	Severe	1.42	2.71	19.59	40-80	280
324	Slight	0.20	2.71	0.93	0-15	10
658	Slight	0.12	2.71	1.58	0-15	41
659	Moderate	2.71	2.71	24.04	15-40	73
660	Severe	1.86	2.71	14.29	40-120	83
Total						490

Alternative 3

Forest thinning

Under Alternative 3, direct and indirect effects from forest thinning would be similar to those of Alternative 2 with the following exceptions: There would be no log landings, cable yarding corridors, or road use in operability zones 3, 4, and 5 where cable and excaline logging systems are proposed. There

would therefore be no soil disturbance associated with these logging systems within the project area. Cable yarding corridors would constitute approximately 15 percent of the area proposed for cable and excaline logging treatment under Alternative 2 (based on yarding corridor widths of 12 feet and distances between corridors of 80 feet). Therefore, a projected maximum of 72 acres of potential soil disturbance from cable and excaline yarding would not occur as a result of selection of Alternative 3. Additionally, 10 acres of soil disturbance from log landing installation and use (based on 0.25 acres of landings per 12 acres of land treated) would not occur under this alternative. If helicopter logging is employed in these operability zones in lieu of cable yarding systems, minimal damage to soils would be expected as a result of log extraction since logs would be fully suspended during transport from the sites where trees are felled to the log landing. Table 3.4.2-12 provides TES map unit acres and associated erosion hazard ratings in areas that would be excluded from treatment using cable and excaline yarding systems under Alternative 3.

Modeled hillslope erosion and sediment delivery rates for TES map units that would be excluded from cable and excaline yarding treatments under Alternative 3 are summarized in Table 3.4.2-13. Based on an anticipated area of disturbance of approximately 15 percent within each TES unit, predicted reductions in sediment delivery to water courses through exclusion of cable and excaline yarding would range from 0.62-1.34 total tons. Reduction in average annual hillslope erosion through exclusion of cable and excaline yarding treatments would range from 0.029 to 0.063 tons per acre per year.

Table 3.4.2-12. Terrestrial Ecosystem Units and associated erosion hazard ratings that would be excluded from cable and excaline yarding systems under Alternative 3 within the Bill Williams Mountain Restoration Project Analysis Area (Brewer et al, 1991). (acres are approximate)

MAP UNIT	EROSION HAZARD	CURRENT EROSION RATE TONS/AC/YR	TOLERANCE EROSION RATE TONS/AC/YR	POTENTIAL EROSION RATE TONS/AC/YR	PERCENT OF CABLE YARDING TREATMENT	SLOPE (%)	ACRES
300	Moderate	2.35	2.71	13.56	1.90	15-40	9
310	Moderate	1.70	2.71	12.38	0.16	15-40	1
320	Severe	1.94	1.82	16.75	14.89	40-80	70
322	Severe	1.42	2.71	19.59	55.94	40-80	264
659	Moderate	2.71	2.71	24.04	12.04	15-40	57
660	Severe	1.86	2.71	14.29	15.07	40-120	71
Total							472

As can be seen in Tables 3.4.2-12 and 3.4.2-13, adverse impacts to soils from cable yarding systems are minimal when compared to ground-based rubber tire and track skidding. Since no wheels or tracks are disturbing soils in cable yarding operations, area of disturbance is generally limited to areas where logs are dragged along the ground (approximately 4 feet wide) and log landings (0.25 acres per 12 acres treated). Cable yarding typically results in much smaller landing areas than other ground-based logging systems since logs are either landed adjacent to or directly on access roads and stacked high, thus limiting soil disturbance. Log landings for rubber tired and track skidding operations are typically larger in order to provide space for skidders to maneuver when landing logs.

Table 3.4.2-13. Predicted sediment delivery in year of disturbance and annual hillslope erosion by TES mapping unit where forest thinning treatments using cable and excaline yarding systems would be excluded (USDA 2010).

MAP UNIT	ACRES	PREDICTED SEDIMENT DELIVERY IN YEAR OF DISTURBANCE (TONS/SQ MI)	AVERAGE ANNUAL HILLSLOPE EROSION (TONS/SQ MI/YR)	PREDICTED SEDIMENT DELIVERY (TONS/AC)	PREDICTED HILLSLOPE EROSION (TONS/AC/YR)
300	8.89	0.0 – 6.4	0.0 - 0.3	0.0-0.1	0.000-0.001
310	0.78	0.0 – 6.4	0.0 - 0.3	0.0	0.0
320	70.28	6.4 – 12.8	0.3 – 0.6	0.11-0.22	0.005-0.010
322	264.04	6.4 – 12.8	0.3 – 0.6	0.40-0.81	0.019-0.038
659	56.84	0.0 – 6.4	0.0 - 0.3	0.0-0.9	0.000-0.004
660	71.15	6.4 – 12.8	0.3 – 0.6	0.11-0.22	0.005-0.010

It should be noted that under Alternative 3, forest restoration would not be fully achieved as removal of trees greater than 9 inches DBH in MSO PACs and pine/oak habitat where slopes exceed 40 percent would not occur. Soil stability and ecologic function in these areas would therefore not be improved. Soil stability would continue to depend primarily on forest litter to protect soil surfaces rather than vegetative ground cover. As previously discussed, vegetative ground cover provides better water infiltration, percolation, soil porosity, aggregate stability, and nutrient cycling than forest litter alone.

Permanent and Temporary Roads

Direct and indirect effects to soil resources from road construction, maintenance, and use would be similar to the Proposed Action. However, Alternative 3 would include construction of 22 miles of permanent roads, which is one mile less than under the Proposed Action. A one-mile-long road segment proposed under Alternative 2 for cable yarding access would not be required under this alternative since no cable yarding systems would be used. Based on a road width of 12 feet, soil disturbance for permanent road access in TES map units 320 (0.71 acres) and 322 (0.75 acres) under Alternative 3 would be 1.46 acres less than under Alternative 2. Therefore, a combined total of 1.46 acres in TES map units 320 and 322 would remain in productive status rather than being converted to unproductive status as a permanent road.

Direct and indirect effects to soils resources caused by obliteration of approximately 28 miles of poorly located roads would be the same as Alternative 2.

Bixler Trailhead and Trail

Since Alternative 3 is the same as the Proposed Action with regard to the Bixler trailhead and trail, direct and indirect effects to soils resources would be the same as the Proposed Action.

Prescribed Fire Treatments

Direct and indirect effects to soils resources from prescribed fire treatments would be similar to the Proposed Action with the exception that Ecosystem Management Area 6 – the Arizona Bugbane (*Actaea arizonica*) Botanical Area (490 acres) would not be subjected to prescribed fire. There would therefore be no direct or indirect adverse effects to soils or watershed resources within the Arizona Bugbane Botanical Area as a result of prescribed fire use under Alternative 3.

Alternative 4

Forest thinning

Under Alternative 4, a combination of commercial timber harvest and non-commercial mechanical treatments would occur on approximately 11,150 acres. Treatments would be conducted only in Operability Zones 1, 2 and 6 and would be limited to slopes less than 40 percent. Table 3.4.2-14 provides a summary of TES map unit acreages and their associated erosion hazard ratings for areas where fuel reduction treatments would be conducted under Alternative 4. Areas where slopes exceed 40 percent were excluded from the analysis of this alternative.

Table 3.4.2-14. Terrestrial Ecosystem Survey map units and associated erosion hazard ratings for operability zones 1, 2, and 6 with slopes less than 40 percent.

MAP UNIT	EROSION HAZARD	CURRENT EROSION RATE TONS/AC/YR	TOLERANCE EROSION RATE TONS/AC/YR	POTENTIAL EROSION RATE TONS/AC/YR	SLOPE (%)	ACRES
6	Slight	0.65	2.71	2.10	0-5	38
10	Slight	0.53	2.71	2.47	0-5	123
300	Moderate	2.35	2.71	13.56	15-40	113
302	Severe	2.14	2.71	15.50	15-40	17
304	Slight	0.16	2.71	0.93	0-15	247
310	Moderate	1.70	2.71	12.38	15-40	1,599
324	Slight	0.20	2.71	0.93	0-15	4,587
401	Slight	0.16	2.71	0.93	0-15	232
402	Moderate	1.70	2.71	9.96	15-40	179
405	Slight	0.20	2.71	0.61	0-15	25
407	Severe	3.60	2.71	14.37	15-40	76
507	Slight	0.16	2.71	0.28	0-15	8
518	Slight	0.24	1.82	0.61	0-15	166
519	Slight	0.20	1.82	25.09	0-15	725
525	Severe	3.40	2.71	0.61	15-40	46
537	Slight	0.12	2.71	0.61	0-15	1,059
563	Slight	0.20	2.71	0.61	0-15	130
564	Severe	3.64	2.71	12.38	15-40	444
565	Slight	0.36	1.82	0.61	0-15	79
658	Slight	0.12	2.71	1.58	0-15	336
659	Moderate	2.71	2.71	24.04	15-40	287
Total						10,514

Table 3.4.2-15 below presents modeled sediment delivery and hillslope erosion rates by TES map unit based on slope classes for forest thinning treatments under Alternative 4. Table 3.4.2-16 provides a summary of hillslope erosion and sediment delivery for each watershed in the project area as a result of forest thinning activities under Alternative 4.

Table 3.4.2-15. Predicted sediment yield in year of disturbance and annual hillslope erosion by TES mapping unit in operability zones 1, 2 and 6 (USDA 2010).

MAP UNIT	SLOPE (%)	TREATMENT ACRES	PREDICTED SEDIMENT DELIVERY IN YEAR OF DISTURBANCE (TONS/SQ MI)	AVERAGE ANNUAL HILLSLOPE EROSION (TONS/SQ MI/YR)
6	0-5	38	0.0	0.0
10	0-5	126	0.0	0.0

MAP UNIT	SLOPE (%)	TREATMENT ACRES	PREDICTED SEDIMENT DELIVERY IN YEAR OF DISTURBANCE (TONS/SQ MI)	AVERAGE ANNUAL HILLSLOPE EROSION (TONS/SQ MI/YR)
300	15-40	130	0.0 – 6.4	0.0 - 0.3
302	15-40	18	0.0 – 6.4	0.0 - 0.3
304	0-15	248	0.0	0.0
310	15-40	1,681	0.0 – 6.4	0.0 - 0.3
324	0-15	4,637	0.0	0.0
401	0-15	238	0.0	0.0
402	15-40	219	0.0 – 6.4	0.0 - 0.3
405	0-15	25	0.0	0.0
407	15-40	104	0.0 – 6.4	0.0 - 0.3
507	0-15	9	0.0	0.0
518	0-15	167	0.0	0.0
519	0-15	737	0.0	0.0
525	15-40	53	0.0 – 6.4	0.0 - 0.3
537	0-15	1,070	0.0	0.0
563	0-15	130	0.0	0.0
564	15-40	477	0.0 – 6.4	0.0 - 0.3
565	0-15	80	0.0	0.0
658	0-15	342	0.0	0.0
659	15-40	344	0.0 – 6.4	0.0 - 0.3

Table 3.4.2-16. Predicted soil erosion rates and sediment yield for watersheds in the Bill Williams Mountain Restoration Project area where forest thinning treatments would be conducted under Alternative 4 (USDA 2010).

WATERSHED NAME	ACRES	TOTAL SEDIMENT DELIVERY IN YEAR OF DISTURBANCE (TONS/WATERSHED)	AVERAGE ANNUAL HILLSLOPE EROSION (TONS/WATERSHED)
Cataract Creek Headwaters	2,261	42.70	7.11
Devil Dog Canyon	833	5.32	5.94
Dogtown Wash	476	4.81	5.48
Johnson Creek	1,884	18.46	4.72
Meath Wash	1,426	8.93	3.49
Upper Hell Canyon	4,243	46.37	1.92
Grand Total	**11,123**	**126.59**	**28.66**

Permanent and Temporary Roads

Alternative 4 would include constructing approximately 38 miles of temporary roads that would be obliterated after use as well as obliterating approximately 28 miles of poorly located roads within the project area.

Based on a travelway width of 12 feet and a clearing width of four feet on each side of the travelway, approximately 55.3 acres of land would be temporarily removed from timber and forage production for temporary road access.

Table 3.4.2-17 provides a summary of modeled sediment delivery from construction, use, and maintenance of temporary roads under Alternative 4. As previously noted, the range of values given for road sedimentation represent the amount of sediment delivered across a buffer, and the amount delivered to a stream crossing.

As shown in Table 3.4.2-17, temporary roads would result in an increased risk of short-term hillslope erosion and sediment delivery to surface waters during project implementation under Alternative 4. Temporary roads would be stabilized with BMPs and SWCPs designed to prevent erosion of road surfaces and sediment delivery to water bodies during road use.

Table 3.4.2-17. Predicted sediment yield and hillslope erosion rates and for Terrestrial Ecosystem Units where temporary roads would be constructed and maintained under Alternative 4 (USDA 2010).

MAP UNIT	SLOPE (%)	ACRES OF ROADS	PREDICTED SEDIMENT DELIVERY IN YEAR OF DISTURBANCE (TONS/SQ MI)	AVERAGE ANNUAL HILLSLOPE EROSION (TONS/SQ MI/YR)
0010	0-5	0.81	0.0 – 7.7	0.0 – 7.7
0300	15-40	0.35	7.7 – 28.2	7.7 – 28.2
0302	15-40	0.06	7.7 – 28.2	7.7 – 28.2
0304	0-15	0.07	7.7 – 9.3	7.7 – 9.3
0310	15-40	12.78	7.7 – 28.2	7.7 – 28.2
0322	40-80	0.10	18.5 – 56.8	18.5 – 56.8
0324	0-15	24.95	0.0 – 9.3	0.0 – 9.3
0401	0-15	0.38	0.0 – 9.3	0.0 – 9.3
0402	15-40	0.15	7.7 – 28.2	7.7 – 28.2
0405	0-15	0.15	0.0 – 9.3	0.0 – 9.3
0507	0-15	0.07	0.0 – 9.3	0.0 – 9.3
0518	0-15	1.28	0.0 – 9.3	0.0 – 9.3
0519	0-15	4.17	0.0 – 9.3	0.0 – 9.3
0537	0-15	3.87	0.0 – 9.3	0.0 – 9.3
0563	0-15	0.32	0.0 – 9.3	0.0 – 9.3
0564	15-40	2.84	7.7 – 28.2	7.7 – 28.2
0565	0-15	0.12	0.0 – 9.3	0.0 – 9.3
0658	0-15	2.32	0.0 – 9.3	0.0 – 9.3
0659	15-40	0.47	7.7 – 28.2	7.7 – 28.2

Obliteration activities would be the same as those proposed under Alternatives 2 and 3 and would hasten recovery of temporary road surfaces and return them to productive status over the long term. As a result, average annual hillslope erosion and sediment delivery rates following decommissioning of temporary roads are expected to be substantially lower than those predicted by the model. Since temporary roads would not all be constructed at once, but instead would be constructed as access to treatment areas is necessary, it is very unlikely that large pulses of erosion and sediment delivery from temporary roads would occur over a short timeframe (i.e., within a single year).

Bixler Trailhead and Trail

There would be no construction of the new Bixler trailhead or proposed new trail segment under Alternative 4. There would therefore be no direct or indirect effects to soils resources as a result of these proposed activities under Alternative 4.

Prescribed Fire Treatments

Direct and indirect effects to soils as a result of strategic fuel treatments would be the same as Alternatives 2 and 3 while direct and indirect effects to soils from use of prescribed fire would be the same as Alternative 3 since the Arizona Bugbane Botanical Area would be excluded from prescribed fire under Alternative 4.

3.4.3 Cumulative Effects

Cumulative effects include the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other action (40 CFR § 1508.7). The geographic setting for the cumulative effects analysis for soils and watersheds includes all of the 6th-level (HUC12) hydrologic unit watersheds where the Bill Williams Mountain Restoration Project is located, which comprises approximate 137,153 acres. The timeframe for past actions is 10 years, based on soil productivity, vegetative response, and coarse woody debris recovery within treated areas. Surface disturbing activities that are older than 20 years are assumed to be contributing negligible or no measurable cumulative effect within the analysis area

Following is a partial listing of actions considered in the cumulative effects analysis for this project:

- Activities such as vegetation management, fuels management, livestock grazing, recreational activities, and other management activities (e.g. noxious weeds treatments) have occurred in the past, are occurring, and are reasonably foreseeable actions on the Williams Ranger District. These activities could occur on private lands as well.
- Firewood cutting has occurred in the past and would likely continue in the foreseeable future on the District and private lands within watersheds that include the project area.
- Private landowners may harvest timber on their lands for lumber, fuelwood, or to reduce fire hazards.
- Urban development and interface growth will continue on private lands.
- Road construction, maintenance and right-of-way clearing can be expected to continue on non-National Forest System land.
- Road maintenance, reconstruction, or decommissioning may occur with future vegetation management projects on National Forest System land.
- Recreation activities are expected to continue to increase on the Forest. Future recreation projects may be developed.
- There is a multi-million dollar electronics site on the top of Bill Williams Mountain that includes communications infrastructure for the Department of Public Safety, USDA Forest Service, Arizona State Land Department, Burlington Northern Santa Fe railroad and several other governmental and private enterprises. Several special use permits exist and continue to be requested for the communications site such as cell tower extensions, new outbuildings, etc.

- The north side of the mountain is home to a small ski and recreation area (Elk Ridge Ski and Outdoor Recreation Area) which operates periodically throughout the year with downhill skiing in the winter and tubing in the summer.

Tables 3.4.3-1 through 3.4.3-3 provide a summary of past, present, and reasonably foreseeable projects considered in the soils and watershed cumulative effects analysis for this project:

Table 3.4.3-1. Past projects in the Bill Williams Mountain Restoration Project Cumulative Effects Analysis Area.

Project	Year NEPA completed	Activities	Status
Williams High Risk Project		Non-commercial thinning	Completed
Clover High Fuels Reduction Project		Non-commercial thinning	Completed

Table 3.4.3-2. Current projects in the Bill Williams Mountain Restoration Project Cumulative Effects Analysis Area.

Project	Year NEPA completed	Activities	Status
City	2005	Veg. Mgt: TS, TSI, & BB; includes some temporary roads and dozer lines	Currently being implemented
Twin	2005	TSI & Fuel reduction; includes some temporary roads and dozer lines	Ongoing – Approx. 40% implemented
Bill Williams Cap	2009	Fuel reduction / Hazard Tree removal on 6 ac.	DN signed – implementation 2010
Williams Ranger District Travel Management Project	2010	Prohibit cross-country travel (except as designated on MVUM); close 380 miles of system roads to motor vehicle use.	Implemented in July 2011 with publication of MVUM
Hat Allotment Grazing Management	2010	Authorizes grazing	Ongoing
EIS for Treatment of Noxious or Invasive Weeds	2004	Treatment of Noxious or Invasive Weeds	Ongoing
Dogtown (Dogtown)		Timber Sale; Prescribed burning; Non-commercial thinning	Pending Sales; Ongoing burning

Table 3.4.2-3. Reasonably foreseeable projects in the Bill Williams Mountain Restoration Project Cumulative Effects Analysis Area.

Project	Estimated Year NEPA Completed	Activities	Status
McCracken (WRD)	2012	Thinning (15,200 ac), Burning (17,000 ac),	PA released in 2008; Decision signed in

Project	Estimated Year NEPA Completed	Activities	Status
		Grassland Restoration	Spring 2012.
Four Forest Restoration Initiative (Multiple Projects)	Multiple	Restoration of Ponderosa Pine ecosystem (thinning, burning)	Planning team and collaborative group developing strategy and initial PA.

Alternative 1 – No Action

The No Action Alternative would result in no vegetation or fuels reduction treatments being performed, no new road construction or road obliteration, and no unscheduled maintenance of existing roads in the project area. Therefore, there would be no direct effects to soils, water quality, ephemeral or intermittent stream channels, watershed condition, or changes to water yield as a result of the no-action alternative. However, land management activities and changing vegetative conditions throughout the last 100 years have produced an uncharacteristic accumulation of fuels and increased trees density within the project area. These conditions make wildfire a possibility and suppression exceedingly difficult.

A high-severity fire is not certain to occur within the project area during any given timeframe. However, the occurrence of a high-severity wildfire would have an increased potential for profound adverse impacts to hydrologic systems in project area watersheds and downstream locations. As previously discussed in this report, such a fire event would likely result in increased runoff and potential for soil erosion and sediment delivery to intermittent and ephemeral streams as a result of loss of forest interception of rainfall, reduced soil water infiltration rates, and the reduction of effective ground cover at the soil surface. The infrequent nature of ephemeral stream flow results in the potential for sediment and ash to be stored within these stream channels and then transported during surface runoff events. This, in turn, could pose detrimental effects to surface water quality and water storage capacity, including impoundments that are the sources of the City of Williams municipal water supply. Other potential detrimental effects to hydrologic conditions in the project area and downstream locations could include the destabilization of the geomorphic conditions of stream channels due to excessive sediment delivery and debris loading, increased peak flows, and overall increases in average annual water yield resulting from loss of upslope interception, infiltration, and evapotranspiration. Ephemeral stream channels within high burn severity areas would lose their ability to buffer runoff from large rainfall events, resulting in increased channel scour and incision caused by accelerated runoff and erosion from severely burned watershed areas. Increased bedloads in stream channels effectively raises the elevation of stream bottoms, causing flood flows to exceed channel capacities, resulting in overland flooding. These conditions could result in increased flooding risk within the 100-year floodplain of Cataract Creek located in the City of Williams and other downstream locations.

Another effect is sediment and ash deposition in downstream roads, stock tanks and meadows, even if such areas may not have burned. In addition, sediment and ash-laden overland flows may damage low lying roads by eroding road traveled ways and filling culverts and low water crossings with sediment and debris. These are examples of why post-wildfire watershed conditions are significantly different from pre-fire or low-severity prescribed fire conditions.

Additional cumulative effects of the No Action alternative include ongoing erosion and sediment delivery to ephemeral channels from roads proposed for obliteration under the Action Alternatives. When combined with other activities in the proposed project area, sediment production from these roads could contribute to adverse impacts to downstream surface water quality if these roads remain in an unstable, eroding condition.

Alternative 2 – Proposed Action

Other ongoing projects in the same watersheds as the proposed Bill Williams Mountain Restoration Project and their associated acreages in each watershed are summarized in Table 3.4.3-4.

Table 3.4.3-4. Current activities and associated acreages that occur in the same watersheds (HUC12) as the proposed Bill Williams Mountain Restoration Project.

Watershed Name (HUC12)	Cataract Creek Headwaters 150100040502		Devil Dog Canyon 150602020202		Dogtown Wash 150100040501		Johnson Creek 150602010302		Meath Wash 150602020203		Upper Hell Canyon 150602020204	
Watershed Acres (HUC12)	**16,694**		**11,192**		**11,659**		**30,847**		**37,522**		**29,239**	
Activity	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**	**% of WS**
City Project	6,772	41	----	----	2,492	21	2,422	8	----	----	25	<1
Dogtown Project	11	<1	----	----	2,280	20	----	----	----	----	184	<1
Four Forest Restoration Initiative	11,436	69	2,845	25	11,543	99	7,260	24	2,719	7	19,343	66
McCracken Project	----	----	----	----	811	7	----	----	----	----	8,575	29
Travel Management Rule	11,436	69	10,029	90	9,976	86	28,421	92	26,170	70	26,787	92
Twin Project	52	<1	821	7	435	4	1,141	4	1,567	4	8,180	28
Big Springs Allotment Grazing	----	----	----	----	----	----	----	----	----	----	1,092	4
Chalender Allotment Grazing	13	<1	----	----	1,700	15	----	----	----	----	4	<1
Corva Allotment Grazing	----	----	----	----	----	----	8,150	26	----	----	----	----
Davenport Lake Allotment Grazing	473	2	----	----	2,234	19	----	----	----	----	----	----
Double A Allotment Grazing	----	----	----	----	----	----	110	<1	----	----	----	----
Hat Allotment Grazing	2,730	16	10,920	97	3,658	31	13,028	42	20,570	55	25,809	88
Irishman Dam Allotment Grazing	----	----	----	----	----	----	5,440	18	5,787	15	----	----
Juan Tank Allotment Grazing	2,071	12	----	----	----	----	1,505	5	----	----	----	----
Pine Creek Allotment Grazing	1,893	11	----	----	1,628	14	----	----	----	----	----	----
Seven C Bar Allotment	----	----	----	----	----	----	----	----	294	<1	----	----

Watershed Name (HUC12)	Cataract Creek Headwaters 150100040502		Devil Dog Canyon 150602020202		Dogtown Wash 150100040501		Johnson Creek 150602010302		Meath Wash 150602020203		Upper Hell Canyon 150602020204	
Watershed Acres (HUC12)	**16,694**		**11,192**		**11,659**		**30,847**		**37,522**		**29,239**	
Activity	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**	**% of WS**
Grazing												
Sitgreaves Allotment Grazing	----	----	----	----	231	2	----	----	----	----	----	----
West Bear Allotment Grazing	----	----	----	----	----	----	----	----	----	----	12	<1

Ephemeral and intermittent drainages in the project area respond to seasonal surface runoff (usually during snow melt and the summer monsoon season). Surface runoff potentially carries varying amounts of sediment, contributing to water turbidity. Turbidity is the water quality standard that is most likely affected by land management activities. Turbidity is a measure of particulate matter suspended in water. Typically, in wildland settings, turbidity is the existence of fine to very fine soil particles and organic matter in water. Sediment delivery ratios normally decline with increasing watershed area, resulting in dilution of sediment delivered to streams from a given activity. The ADEQ 305(b) Assessment and 303(d) Listing Report for 2010 was consulted to determine water quality status of streams that flow from the project area. There are no exceedances or impairments noted on either the 305(b) Assessment or 303(d) List for any stream segments within the proposed project boundary or within 50 miles downstream of the Bill Williams Mountain Restoration Project area. It is unlikely that the Proposed Action would contribute enough sediment to ephemeral or intermittent drainages within the project area to result in impairment of any downstream waterbodies.

Vegetation Treatments and Timber Harvesting

Vegetation management projects such as commercial timber harvesting, precommercial forest thinning, and fuelwood gathering reduce overstory cover in the short-term but typically result in an increase in understory vegetation within three to five years following treatment. These projects would also cause an initial increase in soil organic matter in the form of residual woody debris from tree harvesting activities that improves surface roughness and improves nutrient cycling. As grasses and forbs increase in numbers, fine root material would contribute to soil organic matter accumulation, improve soil aggregate stability and soil porosity, and protect soil surfaces from erosion by wind and rain. Reduction of tree canopy and fuel loads would reduce the threat of high severity wildfire that could remove plant and litter cover, consume seed bank, sterilize soils, and create erosion and flooding hazards. Decreased interception of precipitation (rain and snow) would result in increased surface runoff following vegetation treatments.

Project objectives are typically designed to improve forest health by thinning overstocked stands and reducing the potential for high severity wildfire. These activities usually require the use of logging machinery with potential to disturb soils. Overall, forest thinning improves tree vigor, increases the diversity, distribution, and amount of herbaceous understory vegetation (including effective vegetative ground cover), and reduces the risk of uncharacteristic wildfire. Effects on soil productivity and stability are common to all harvest activities, but vary by silvicultural treatments, fuel treatments, and acres treated. Effects are generally related to roads, skid trails, log landings and fuels treatments resulting in varying degrees of soil displacement, compaction, and soil loss due to short-term reduction or complete

removal of vegetative ground cover. Adequate vegetative ground cover is the primary component that protects the soil from accelerated erosion.

It is assumed that between harvest and fuel reduction treatment activities, every acre in each proposed treatment unit would be affected. Therefore, the total acreage is assumed to be at risk for some level of soil disturbance. The risk of accelerated erosion from soil disturbance is expected to last until vegetative ground cover is sufficient to protect soil surfaces, which typically occurs within 3 to 5 years after fuel reduction treatments are completed. It is important that the reader understand that not all soil disturbance is detrimental. For example, a low severity prescribed fire disturbs soils by partially consuming and redistributing the surface organic fraction. This changes short term carbon-nitrogen ratios and increases available short term nutrient supplies, resulting in increased understory response which in turn provides improved protection of soils from erosion by wind and rain.

By identifying and implementing site-specific BMPs and SWCPs prior to and during project implementation, adverse effects to soils and watershed resources are minimized and are generally short term (3 to 5 years). Best Management Practices are designed to maintain soil productivity and surface water quality by minimizing soil loss and associated sediment delivery to waterbodies.

Soil Stability and Erosion Processes

Gullies and headcuts are a primary source of sedimentation. They channelize and accelerate sediment-laden water, resulting in soil movement to downslope locations or into drainages. Areas which are sensitive to gully erosion are long, narrow alluvial plains, alluvial fans, and low lying areas with moderate slopes and deep, fine-textured soils. Gullies are typically the result of historical management practices and are now in varying degrees of recovery. Poorly located roads proposed for obliteration are, in some cases acting as gullies, channelizing runoff into ephemeral drainages. As management practices have improved and watershed conditions have changed, some gullies are reaching more stable conditions through aggradation and widening, creating more favorable floodplains and gentle gradients. This adjustment process involves erosion of banks and headcuts in order to reach a point of equilibrium. Once this point is reached, erosion decreases, vegetation begins to grow where gully sidewalls have a more gentle angle of repose, and gullies stabilize. The effect of gully stabilization is reduced loss of soil productivity and downstream sedimentation.

Soil stability would be improved over approximately 15,000 acres through increases in surface roughness from additional woody debris at the soil surface. Slash would enhance the effective ground cover and thereby reduce soil particle detachment by raindrop impact. Enhanced ground cover from the addition of slash, and over the longer term from increased understory vegetation, particularly grasses and forbs would improve microhabitat conditions (i.e., shade, moisture, and available nutrients). These improvements would occur on most TES map units within the project area.

Nutrient Cycling

Nutrient cycling would improve over time on approximately 15,000 acres due to the addition of small and large woody material. The project would leave at least 5-7 tons per acre of CWD in the activity units. In addition, up to 1-3 tons per acre of fine fuels would be left as needles, twigs, small limbs, and other small woody material. The addition of CWD and other fine fuels would have a beneficial effect to long-term soil productivity. The effectiveness of woody debris retention has been proven to reduce and control adverse impacts to soil resources and water quality (Ice 2004, Rashin 1994, Seyedbagheri 1996, USDA Forest Service 2004b).

Soil Hydrology

Surveys of the project area indicate that the current existing percentage of landings, skid trails, and roads is approximately 5 to 10 percent of the proposed activity areas. As previously noted, several miles of roads proposed for obliteration are compacted, rutted, and are channelizing surface runoff and are not exhibiting substantial recovery. In order to mitigate any additional compaction and displacement of soils, temporary roads, skid trails, and landings would be stabilized using BMPs and SWCPs, which may include ripping or decompacting and seeding to alleviate reductions in porosity and infiltration capacity. Therefore, it is not expected that the percentage of compacted areas would increase substantially (i.e., beyond an additional 1 to 2 percent over the current condition).

Areas of water repellency, which form as a result of the prescribed fire use are expected to recover within 3 to 5 years as natural processes such as freeze-thaw, wetting and drying, natural revegetation, root elongation, and chemical weathering occur.

Watershed Response

The magnitude of change in water yield resulting from vegetation treatments and prescribed burning is most strongly related to the amount of precipitation and intensity of the treatments.

The hydrologic response of watersheds in the project area to proposed activities will depend on the summed effect of the changes in evaporation, transpiration, soil moisture storage, and snowpack accumulation and melt processes. This includes the degree to which vegetation treatments influence net precipitation that reaches soil surfaces through reduced canopy interception, changes to soil moisture evaporation rates, and changes to the amount of transpiration and soil water depletion. Changes to streamflow would depend on whether precipitation or snowmelt exceeds both evapotranspiration demand, soil moisture holding capacity, and groundwater recharge rates.

Changes in evapotranspiration following vegetation treatments would be the result of reduced soil moisture depletion during the growing season and decreased winter snowfall interception. Precipitation accumulates on Bill Williams Mountain over the winter as snowpack, with melting and sublimation occurring during warm phases throughout the winter. Much of the winter precipitation is intercepted by tree canopies. Some of this moisture evaporates or sublimates without contributing to soil moisture, while some is blown off of intercepting vegetation or simply falls off, thus reaching soil surfaces. When the remaining snowpack begins to melt in spring, melt water first recharges the soil by replacing the water that was depleted during the previous growing season. Once soil moisture storage capacity is at its maximum, remaining melt water is available to become stream flow. On north facing slopes, some of the snowpack remains almost continuously from December to April. While the evaporation rate is lower than south facing slopes, the relatively large surface area of snow permits a substantial amount of evaporative loss to occur. In contrast, on south facing slopes, intercepted snow quickly leaves the less dense forest canopy thus allowing less interception loss. For the first 1 to 3 years following vegetation treatments, a slight increase in stormwater runoff is expected since understory vegetation of grasses, forbs and shrubs will not have reached maximum ground cover levels, snowpack interception would be reduced, and there would be fewer trees to create evapotranspirational demand for soil moisture during the growing season.

Recreational Activities

Recreational activities within the proposed project area include: hiking, viewing wildlife, hunting, dispersed car-camping, backpack camping, orienteering, horseback riding, photography, picnicking, taking scenic drives, ORV/ATV use, bicycling, shooting, and gathering in family or social groups. The project area is part of the Arizona Game and Fish Department's Game Management Unit 10, and is popular for turkey, elk, mule deer, javelina, and pronghorn hunting. Other common uses within the project area include firewood cutting, Christmas tree cutting, collecting boughs and cones, gathering

antlers, and collecting food and medicinal resources such as berries, nuts, mushrooms, and medicinal plants. Of these, ORV/ATV use, dispersed camping, firewood collection and Christmas tree cutting have the greatest potential to result in adverse cumulative effects to soils through compaction, puddling, and displacement. These conditions would occur in areas where such activities take place. Wet weather cross country travel restrictions and designated routes for fuelwood and Christmas trees cutting would minimize these adverse impacts. Popular recreational trails within the project area include the Bill Williams Trail and the Bixler Trail.

Livestock Grazing

Cumulative effects from livestock grazing include minor, generally localized soil compaction, puddling, and erosion from livestock trailing and in areas where animals congregate such as stock tanks and areas where mineral supplements are placed. Individual wildlife and livestock trails were noted in the proposed treatment areas, but these trails make up a small percentage of the landscape and proposed treatment areas. Livestock grazing is not expected to increase the area of soils characterized as unsatisfactory within the project area.

Invasive and Noxious Weeds

The cumulative effect of the increased risk of spread on noxious weeds on soil productivity can only be described in general terms because of the large number of unknown variables. Areas where soil disturbance includes compaction, displacement, erosion, and excessive heating are at the greatest risk of invasion by noxious weeds. These include spur roads used for fuelwood gathering and Christmas tree cutting, and pile burning areas. Monitoring of these areas for the presence of invasive and noxious weeds and treating observed populations in a timely manner would mitigate these adverse effects. To minimize cumulative adverse effects if invasive and noxious weeds, observed infestations will be managed in accordance with the Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds on the Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona.

Fire Effects

In low burn severity areas, effects are mainly light ground char where the litter is scorched, charred, or partially consumed. The litter layer, or duff is largely intact, although it may be charred on the surface. Woody debris accumulations are partially scorched, charred, or consumed. Mineral soil properties are not adversely affected. In fact, low severity fire releases nutrients stored in surface organic matter and live vegetation. These nutrients facilitate rapid reestablishment of vegetative ground cover since root to shoot ratios are improved for grasses and forbs that survive fire, resulting in protection of soils from accelerated soil erosion soon after fire has occurred. Evidence of sheet and rill erosion as a result of low severity fire is minor. In forested areas, much of the tree overstory is green with some scorch at the base of the trees and in the lower branches following low severity fire. Most trees survive; however, pockets of seedlings, saplings, and mature trees can be killed or consumed where moderate to high severity fires occur. While most of the shrubs, forbs and grasses are affected under low severity fire conditions, in most cases, much of this vegetation survives. Areas identified as low burn severity may also contain large unburned areas, resulting in a mosaic of burned and unburned sites across the landscape.

Cumulative watershed effects

When combined with projects and activities listed in Table 37, cumulative watershed effects from implementation of the Proposed Action would include improved soils and watershed condition and restoration of the ecological interrelationships of soils, vegetation, and watersheds in the project area. Water impoundments and other infrastructure that depend on stable soils and watershed conditions would be better protected from potential adverse effects of high severity wildfire. The transportation system

within and around Bill Williams Mountain would provide necessary access for future management of the Mountain and would be more sustainable than the current transportation system.

Alternative 3

Cumulative effects of Alternative 3 would be similar to the Proposed Action with the exception that there would be no cable or excaline logging under this alternative. Additionally, there would be no removal of trees greater than 9 inches DBH in MSO PACs and pine/oak habitat where slopes exceed 40 percent. Approximately 472 acres would therefore not receive full restoration treatments. Utilizing helicopters would facilitate removal of some trees, however, diameter limits would still prevent full restoration of portions of MSO PACs and pine/oak habitat on steeper slopes.

While adverse cumulative effects to soils and watersheds from proposed restoration acitivites would be reduced slightly as compared to the Proposed Action since exclusion of cable and excaline logging systems would result in no potential adverse effects to soils or water quality, this reduction is minimal since cable logging systems generally result in less overall area of disturbance to soils and watershed resources than ground-based logging systems. If helicopter yarding is used to complete vegetation treatments in these areas instead of cable yarding systems, soil disturbance and potential adverse effects to water quality would be minimized. If these 472 acres are not treated to reduce tree density and fuel loads under this alternative, the risk of high severity wildfire would remain in these areas.

As summarized in Table 37, other fuels reduction and forest restoration activities are either completed, underway, or proposed within and surrounding the Bill Williams Mountain Restoration Project area. The effectiveness of such treatments would be offset by the marginal effectiveness of this Alternative to achieve desired soils and watershed desired conditions since forest restoration would not be fully achieved.

Alternative 4

Cumulative effects of Alternative 4 to soils and watershed resources would be similar to the Proposed Action and Alternative 3, with the exception that there would be no cable logging or helicopter use under this alternative, limiting acres to be treated to 11,150, or 4,050 acres fewer than the Proposed Action. Approximately 26 percent of the area proposed for treatment under the Proposed Action would therefore not receive forest restoration treatments. Additionally, as under Alternative 3, there would be no removal of trees greater than 9 inches DBH in MSO PACs and pine/oak habitat where slopes exceed 40 percent.

While short term adverse cumulative effects to soils and watershed resources would be reduced substantially under Alternative 4, it is through reduced acreage receiving forest restoration treatments that would protect and restore long term soils and watershed function. If these areas are not treated to reduce tree density and fuel loads under this alternative, the risk of high severity wildfire would remain on approximately 26 percent of the project area.

Climate Change

While it is currently not possible to discern climate change effects of the Proposed Action or other Action Alternatives, given the lack of effects that can be meaningfully evaluated under current science and modeling, one would expect an initial, short-term increase in atmospheric CO_2 and other greenhouse gases from the proposed treatments through burning of hydrocarbons to conduct mechanical vegetation treatments, rapid oxidation of vegetation and woody debris during prescribed burning, and increased decomposition of woody debris. However, long-term effects would be positive as the ground cover of grasses and forbs increases. Woody debris would provide long term nutrient sources and contribute to

surface roughness, decreasing potential erosion. Nutrients released in ash during prescribed burning and through decomposition of residual woody debris from forest thinning would also improve soil quality. As previously noted the increase in ground cover of grasses, forbs, and shrubs, which have higher fine root turnover rates than large woody plants would result in greater soil organic matter content over time. Soils within the project area would therefore sequester more carbon dioxide (CO2) over the long term.

The U.S. Environmental Protection Agency (EPA) has asserted that scientists know with virtual certainty that human activities are changing the composition of the Earth's atmosphere. It is also documented that "greenhouse" gases, including CO_2, methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons have been increasing (EPA, 2010). The atmospheric increase of these gases is largely the result of human activities such as the burning of fossil fuels. Greenhouse gases absorb infrared energy that would otherwise be reflected from the earth. As this infrared energy is absorbed, the air surrounding the earth is heated (CARB 2007).

The Southwestern Region of the Forest Service recently released "Southwestern Region Climate Change – Trends and Forest Planning: A guide for addressing climate change in forest planning on southwestern National Forests and Grasslands. The following information is summarized from excerpts of this publication:

In the Southwest, climate modelers agree there is a drying trend that will continue well into the latter part of 21st century (IPCC 2007; Seager et al. 2007). Climate modelers predict increased precipitation, but believe that the overall balance between precipitation and evaporation would still likely result in an overall decrease in available moisture. Regional drying and warming trends have occurred twice during the 20th century (1930s Dust Bowl, and the 1950s Southwest Drought). Current drought conditions "may very well become the new climatology of the American Southwest within a time frame of years to decades". According to recent model results, the slight warming trend observed during the last 100 years in the Southwest may continue into the next century, with the greatest warming to occur during winter. Climate models predict temperatures to rise approximately 5 to 8 degrees Fahrenheit by the end of the century (IPCC 2007). This trend would likely increase demand on the region's already limited water supplies, as well as increase energy demand, alter fire regimes and ecosystems, create risks for human health, and affect agriculture (Sprigg et al. 2000).

Average ambient air temperatures are rising, and it is possible that continued warming will increase the temperature difference between the Southwest and the tropical Pacific Ocean, enhancing the strength of westerly winds that carry moist air from the tropics into the Southwest region during the monsoon season. This scenario may increase the monsoon's intensity, or its duration, or both, in which case floods would occur with greater frequency (Guido 2008). While the region is generally expected to dry, it is possible that extreme weather patterns leading to more frequent destructive flooding would occur. Along with monsoons of higher intensity, hurricanes and other tropical depressions are projected to become more intense overall. Arizona typically receives 10 percent or more of the annual precipitation from storms that begin as tropical depressions in the Pacific Ocean. In fact, some of the largest floods in the Southwest have occurred when remnant tropical storms intersect frontal storms from the north or northwest (Guido 2008). Most global climate models are not yet accurate enough to apply to land management at the ecoregional or National Forest scale. This limits regional and forest-specific analysis of the potential effects of climate change.

Due to the spatial and temporal limitations of climate models, as stated above, site-specific analysis of climate change at the Forest level with regard to implementing fuels reduction treatments remains impractical. Several unknown factors further limit discussion and analysis of climate change at the Forest level. These include: lack of data on emissions from prescribed fire and wildfires, lack of data on emissions from logging machinery and traffic increases due to transportation of logs to processing

facilities, limited data on emissions from machinery used to construct, maintain, or obliterate roads, and limited knowledge of the contributions of surrounding areas to current and future climate impacts at the Forest level necessary to analyze cumulative effects. Impacts to climate change from implementation of the proposed project are therefore discussed in a qualitative manner.

Projected future climate change could affect Arizona in a variety of ways. Public health and safety could be compromised due to an increase in extreme temperatures and severe weather events. Agriculture would be vulnerable to altered temperature and rainfall patterns, increasing plant stress and susceptibility to insects and diseases. Forest ecosystems could face increased occurrences of high severity wildfires and may also be more susceptible to insects and diseases. Snowpack could decrease and snowmelt may occur earlier.

While the future of climate change and its effects across the Southwest remains uncertain, it is certain that climate variability will continue to occur throughout the region. Forest management activities should strive to promote ecosystem resilience and resistance to impacts of climate change. Forest management activities should focus on maintenance and restoration of native ecosystems, thereby reducing the vulnerability of these ecosystems to variations in climate patterns. Ecological diversity remains an integral component in native ecosystems. Projects should promote connected landscapes and endeavor to restore significantly altered biological communities, thus restoring their resilience to changes in climate.

3.5 Transportation

Affected Environment

The Bill Williams project area encompasses approximately 15,200 acres of national forest land system land immediately southwest of the City of Williams. The project area is bounded by Interstate 40 and Old Route 66 on the north, county highway 73, (The Perkinsville road) on the east, forest road 122 on the south and forest road 108 on the west. There are approximately 88 miles of Forest Service system roads, non-Forest Service jurisdiction roads, and unauthorized roads within the project area (Table 3.5-1).

Table 3.5-1. Approximate miles of existing roads within the Bill Williams Mountain Restoration Project Area

Forest Service System Roads	**60**
Maintenance Level 1 (ML-1) Roads	20
Maintenance Level 2 (ML-2) Roads	31
Maintenance Level 3 (ML-3) Roads	9
Maintenance Level 4 (ML-4) Roads	0
Non-Forest Service Jurisdiction	**15**
Known Unauthorized Roads	**13**
Total	**88**

Forest Service roads are classified by Maintenance Level (ML) on a 1 to 5 scale. ML-1 roads are closed roads that receive little to no maintenance; are planned/allowed to re-vegetate naturally; are not open to motor vehicle use, but may be open and suitable for non-motorized uses. ML-2 roads are maintained to allow for use by high clearance vehicles such as pick-ups and logging trucks. ML-3 roads are maintained to accommodate passenger cars. ML-4 and 5 are maintained for a higher level of passenger comfort. Forest Service road 108 is a ML-3 road while nearly all of the other existing roads in the project area are maintenance level 1 or 2 roads.

Portions of the project area have limited roaded access or are accessed by poorly located roads. There are approximately 28 miles of roads within the project area that are poorly located and lack adequate transportation planning and engineering design (Table 3.5-2). They are often found in drainage bottoms or on ridge tops, have steep grades in excess of 15% and run parallel to the slope. They are often below the grade of the surrounding area and are deeply rutted as a result of poor drainage.

The current road system was not located or designed properly to serve as a sustainable transportation system that facilitates land management, resource protection and user safety. Five miles of road in the project area that are currently open to motor vehicle use need to be closed for user safety.

The Kaibab National Forest Land Management Plan directs the forest to:
"Provide and manage a serviceable road transportation system that meets needs for public access, land management, resource protection, and user safety. Provisions are made for the construction and reconstruction, maintenance, seasonal and special closures of Forest roads; and obliteration of unnecessary roads."

Table 3.5-2. Approximate miles of roads within the project area that are poorly located and proposed for obliteration

Forest Service System Roads	**15**
Maintenance Level 1 (ML-1) Roads	9
Maintenance Level 2 (ML-2) Roads	6
Unauthorized Roads	**13**
Total	**28**

Environmental Effects

The transportation system that would be required to accomplish the objectives of the action alternatives has been closely analyzed and planned through field reconnaissance and extensive map analysis. The main goals of the transportation system are to minimize impacts to the environment while safely and efficiently accomplishing the goals of the action alternatives. The direct and indirect effects of the road systems on the various Forest resources are addressed in the individual resource specialist reports and sections of the EIS. A comparison of road mileages by category and alternative is shown in Table 3.5-3.

Table 3.5-3. Comparison of Road Mileages by Alternative

	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3	Alternative 4
Miles of new road construction	0	23	22	0
Miles of temporary roads constructed and obliterated after use	0	16	16	38
Miles of existing roads obliterated	0	28	28	28
Miles of road converted to trail	0	3	3	3
Post Implementation Road Miles				
Miles of closed roads (Maintenance Level 1)	20	36	35	16

Miles of maintenance level 2 roads	31	20	20	20
Miles of maintenance level 3 roads	9	9	9	9
Miles of maintenance level 4 roads	0	0	0	0

Transportation System Economics

Construction cost is broken out by construction phases such as clearing, excavation, etc. Under Alternatives 2 and 3, temporary roads would only be constructed on slopes less than 20% side slope, roads on side slopes over 20% were all permanent roads. Under alternative 4 all roads, both over and under 20% side slope would be temporary roads. Roads over 20% require more excavation and require placement of a number of corrugated metal pipes (CMPs). This increases total road cost per mile. Obliterating roads with CMPs adds additional cost per mile of road because all CMPs must be removed. Costs per mile of road for different types of road are shown in Table 3.5-4 and estimated road costs for the alternatives are shown in Table 3.5-5.

Table 3.5-4. Road Cost/Mile by Construction Phase and Road Type

Construction Phase	New Construction Permanent Road	New Construction Temporary Road Over 20% side slope with Obliteration	New Construction Temporary Road Under 20% side slope with Obliteration	Road Obliteration Existing Roads
Clearing	$6703	$6,703	$6,703	N/A
Excavation	$2,250	$2,250	$0	N/A
Drain Dips	$600	$600	$0	N/A
CMPs	$1,432	$1,432	$0	N/A
Finishing	$544	$544	$544	N/A
Seeding	$1,513	$1,513	$1,513	$1,513
Mobilization	$957	$957	$957	$957
Obliteration	$0	$1,056	$1,056	$1,056
Remove CMPs	0	$704	0	0
Total $/ Mile	$13,999.00	$15,759.00	$10,773.00	$3,526.00

Table 3.5-5. Road Cost by Alternative

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Miles of Permanent Road	0	23	22	0
Total Cost for Permanent Roads	$0	$321,977	$307,978	$0
Miles of Temporary Road Under 20% side slope	$0	16	16	16
Total Cost for Temporary Road Construction and Obliteration Under 20% side slope	$0	$172,368	$172,368	172,368
Miles of Temporary Road Over 20% side slope	0	0	0	22
Total Cost for Temporary Road Construction and Obliteration Over 20% side slope	$0	$0	$0	$346,698

Miles of Road Obliteration Existing Road	0	28	28	28
Total Cost Road Obliteration Existing Road	$0	$98,728	$98,728	$98,728
Total Alternative Road Cost	$0	$593,073	$579,074	$617,794

Alternative 1 – No Action

Direct and Indirect Effects

Under Alternative 1 the project would not be implemented. No harvesting would take place, no new or temporary road construction would occur. None of the poorly located, existing roads would be obliterated. There would be no costs incurred with this alternative and no changes would be made to the existing transportation system in the project area.

Cumulative Effects

There would be no cumulative environmental effect under this alternative.

Alternative 2 – Proposed Action

Direct and Indirect Effects

Under Alternative 2, approximately 23 miles of maintenance level 2 roads and approx. 16 miles of temporary roads would be constructed using best management practices and relevant mitigation measures. All temporary roads would be obliterated after use and all new roads constructed will be closed after use and placed into long-term storage. Closed roads (maintenance level 1 roads) will be allowed to re-vegetate naturally; will receive little to no maintenance (i.e. only when it is necessary to alleviate erosion or sedimentation from the roadway or roadside); and will not be open to motor vehicle use, but will be open and suitable for non-motorized uses. Post implementation of the project, approximately 29 miles of ML 2 – 4 roads would be left open for motor vehicle use and approx. 36 miles of roads would be closed to motor vehicle use[9]. The 28 miles of existing roads (3.5-2; Appendix A Map 4) that are poorly located and causing erosion would be obliterated following implementation of the project.

By re-designing the transportation system through the construction of new and temporary roads, Alternatives 2 would improve access around the base of Bill Williams Mountain and adequately facilitate treatment of the entire project area. Alternatives 2 would retain all of the newly constructed roads after implementation of the project because of the investment that would be required to build them. However, it would reduce maintenance needs in the project area by eliminating poorly located roads.

[9] A note on understanding the post implementation road system for Alternative 2: Table 1 shows the existing condition and Table 3 shows the post implementation road system. There is no change to non-Forest Service jurisdiction roads therefore they are not reflected in Table 3. Additionally the 13 miles of know unauthorized roads shown in Table 1 will be obliterated, and therefore are not shown in Table 3. Even though there is no change to ML 3 and 4 roads they are still displayed in Table 3 to reflect the post implementation Forest Service road system. To understand the post implementation road mileage for ML-1 roads we begin with 20 miles, convert 3 miles to a non-motorized trail (-3), obliterate 9 miles of poorly located roads (-9), close the 23 miles of newly constructed roads (+23), and close an additional 5 miles of road (currently open ML-2 roads) for user safety (+5); this results in 36 miles of ML-1 roads post implementation. To understand the post implementation road mileage for ML-2 roads we begin with 31 miles, obliterate 6 miles of poorly located roads (-6), and closed 5 miles of road for user safety (-5); this results in 20 miles of ML-2 roads post implementation.

Estimated cost for constructing 23 miles of ML-2 roads, constructing 16 miles of temporary roads, and obliterating 28 miles of roads under Alternative 2 is $593,073.

Cumulative Effects
Implementation of this alternative would result in five miles of road closed within the project area above what was closed under the Williams District Travel Management Project decision in 2010. This alternative would provide a permanent, sustainable road system for future access to the entire project area.

Alternative 3

Direct and Indirect Effects
The direct and indirect effects for Alternative 3 would be similar to Alternative 2 except that Alternative 3 has no cable logging involved which reduces the new road construction by 1 mile. Alternative 3 would construct approximately 22 miles of maintenance level 2 roads and approx. 16 miles of temporary road; it would also obliterate approximately 28 miles of existing road for a total cost of $579,074.

Cumulative Effects
The cumulative effects for Alternative 3 are the same as Alternative 2.

Alternative 4

Direct and Indirect Effects
Under Alternative 4, no new permanent roads would be constructed and treatment of the project area would be facilitated by the construction of a temporary road system; approximately 38 miles of temporary road would be constructed using best management practices and relevant mitigation measures. All temporary roads would be obliterated after use. The 28 miles of existing roads that are poorly located and causing erosion would be obliterated following implementation of the project. Post implementation of the project, approximately 29 miles of ML 2 – 4 roads would be left open for motor vehicle use and approx. 16 miles of roads would be closed to motor vehicle use[10].

Alternative 4 would make the least changes the existing transportation system and would, like all other action alternatives, reduce maintenance needs in the project area by eliminating poorly located roads. It facilitates treatment of the project area by only constructing only temporary roads. Roads that would be permanent under Alternatives 3 would be temporary under Alternative 4. Alternative 4 builds 38 miles of temporary road and obliterates 28 miles of existing road for a total cost of $617,794.

Cumulative Effects
Implementation of this alternative would result in five miles of road closed within the project area above what was closed under the Williams District Travel Management Project decision in 2010. This

[10] A note on understanding the post implementation road system for Alternative 4: Table 1 shows the existing condition and Table 3 shows the post implementation road system. There is no change to non-Forest Service jurisdiction roads therefore they are not reflected in Table 3. Additionally the 13 miles of know unauthorized roads shown in Table 1 will be obliterated, and therefore are not shown in Table 3. Even though there is no change to ML 3 and 4 roads they are still displayed in Table 3 to reflect the post implementation Forest Service road system. To understand the post implementation road mileage for ML-1 roads we begin with 20 miles, obliterate 9 miles of poorly located roads (-9), and close an additional 5 miles of road (currently open ML-2 roads) for user safety (+5); this results in 20 miles of ML-1 roads post implementation. To understand the post implementation road mileage for ML-2 roads we begin with 31 miles, obliterate 6 miles of poorly located roads (-6), and closed 5 miles of road for user safety (-5); this results in 20 miles of ML-2 roads post implementation.

alternative would not provide a permanent, sustainable road system for the project area as all new roads under this alternative would be temporary and the existing roads provide limited access.

3.6 Wildlife

See the Wildlife Specialist's Report for a description of the legal framework, direction from Forest Service Manuals, evaluation criteria for analysis, and a detailed biological evaluation and assessment of all affected species. **In order to assure compliance with NFMA, project implementers must consult the "Project Implementation Checklist for Wildlife Conservation" found in the Wildlife Specialist's Report when planning and conducting implementation.** This checklist copies direction from the Forest Plan that pertains to implementation of this project.

THREATENED, ENDANGERED, & FOREST SERVICE SENSITIVE (TES) SPECIES
If a TES species or its habitat occurs within the project in the project's action area, then it was analyzed it in this report (Table 3.6-1). See USDA (2011) for a Forest-level report on TES species to consider in Biological Evaluations. Effects of Alternatives were analyzed for only those species that are known to occupy the project area or have suitable habitat within the project area. See Table 3.6-1 for TES species considered and/or analyzed in this analysis, along with acres of habitat in the project area for each species. See Figures 3.6-1 and 3.6-2 for a depiction of habitat for Mexican spotted owls and northern goshawks within the project area.

Table 3.6-1. List of TES wildlife species considered in this analysis.

Species	Status	Suitable Habitat Present	Suitable Habitat Known to Be Occupied	Description of Habitat within Project Area	Approximate Acres of Affected Habitat in Project Area
Mexican spotted owl (*Strix occidentalis lucida)*	Threatened	Yes	Yes	Mixed-conifer and pine-oak forest.	7,123 (see MSO section for details)
Bald eagle (*Haliaeetus leucocephalus*)	Sensitive	Yes	Yes	Generalist; all habitats.	15,202 (Entire project area)
Northern goshawk (*Accipiter gentilis*)	Sensitive	Yes	Yes	Ponderosa pine, mixed-conifer forest, and woodlands.	15,068 (See goshawk section for details)
American peregrine falcon (*Falco peregrinus anatum*)	Sensitive	Yes	No	Grasslands and other open landscapes, with cliffs present for nest sites.	64

Species	Status	Suitable Habitat Present	Suitable Habitat Known to Be Occupied	Description of Habitat within Project Area	Approximate Acres of Affected Habitat in Project Area
Navajo Mogollon vole (*Microtus mogollonensis navaho*)	Sensitive	Yes	No	Meadows and grassy openings in ponderosa pine and mixed-conifer forests.	Meadows and openings (unquantified) within 12,462 acres.
Merriam's shrew (*Sorex merriami leucogenys*)	Sensitive	Yes	No	Wet meadows and other cool, grassy openings in ponderosa pine and mixed-conifer forests.	Wet meadows and cool, grassy openings (unquantified) within 12,462 acres.
Spotted bat (*Euderma maculatum*)	Sensitive	Yes	No	Pondorosa pine forest, pinyon-juniper forest, and other habitat below mixed-conifer forest.	13,284
Allen's lappet-browed bat (*Idionycteris phylliotis*)	Sensitive	Yes	No	Generalist; all habitats.	15,202 (Entire project area)
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	Sensitive	Yes	No	Generalist; all habitats.	15,202 (Entire project area)
Four spotted skipperling (*Pirunga polingii*)	Sensitive	Yes	No	Moist meadows, seeps, springs within ponderosa pine and mixed-conifer forest.	Moist meadows, seeps, springs (unquantified) within 12,462 acres.
California condor (*Gymnogyps californianus*)	Endangered	No	No	N/A (requires open landscapes with canyon habitat for nesting).	0
Black-footed ferret (*Mustela nigripes*)	Endangered	No	No	N/A (requires grasslands with prairie dog town or complexes of >200 acres in size. Complex consists of 2+ neighboring towns within 4.3 miles of each other).	0
Northern leopard frog (*Rana pipiens*)	Sensitive	No	No	N/A (requires perrennial wetlands or streams).	0
Burrowing owl (western) (*Athena cumicularia hypugaea*)	Sensitive	No	No	N/A (requires grasslands with burrows present).	0

Species	Status	Suitable Habitat Present	Suitable Habitat Known to Be Occupied	Description of Habitat within Project Area	Approximate Acres of Affected Habitat in Project Area
Western red bat (*Lasiurus blossevillii*)	Sensitive	No	No	N/A (requires deciduous riparian habitat).	0

Habitat acreage calculations are based on the Silviculturist's Report estimates of stand acres classified by cover type. One may assume that all acres of habitat listed in the last column on this table would be affected by the thinning and burning activities proposed under the different Action Alternatives.

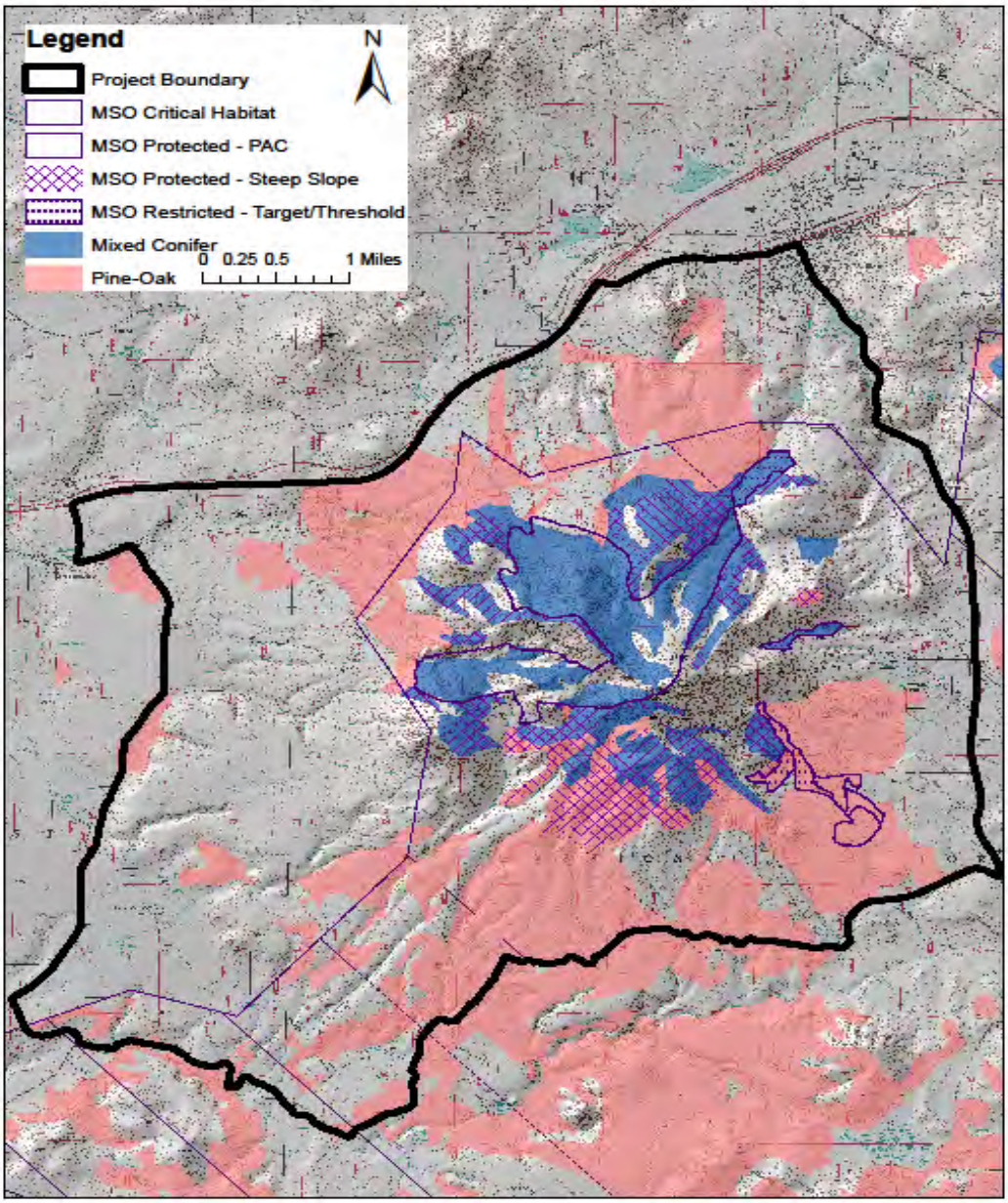


Figure 3.6-1. Habitat of Mexican spotted owls affected by the Bill Williams Mountain Restoration Project. Double-click image for high-resolution .pdf map.

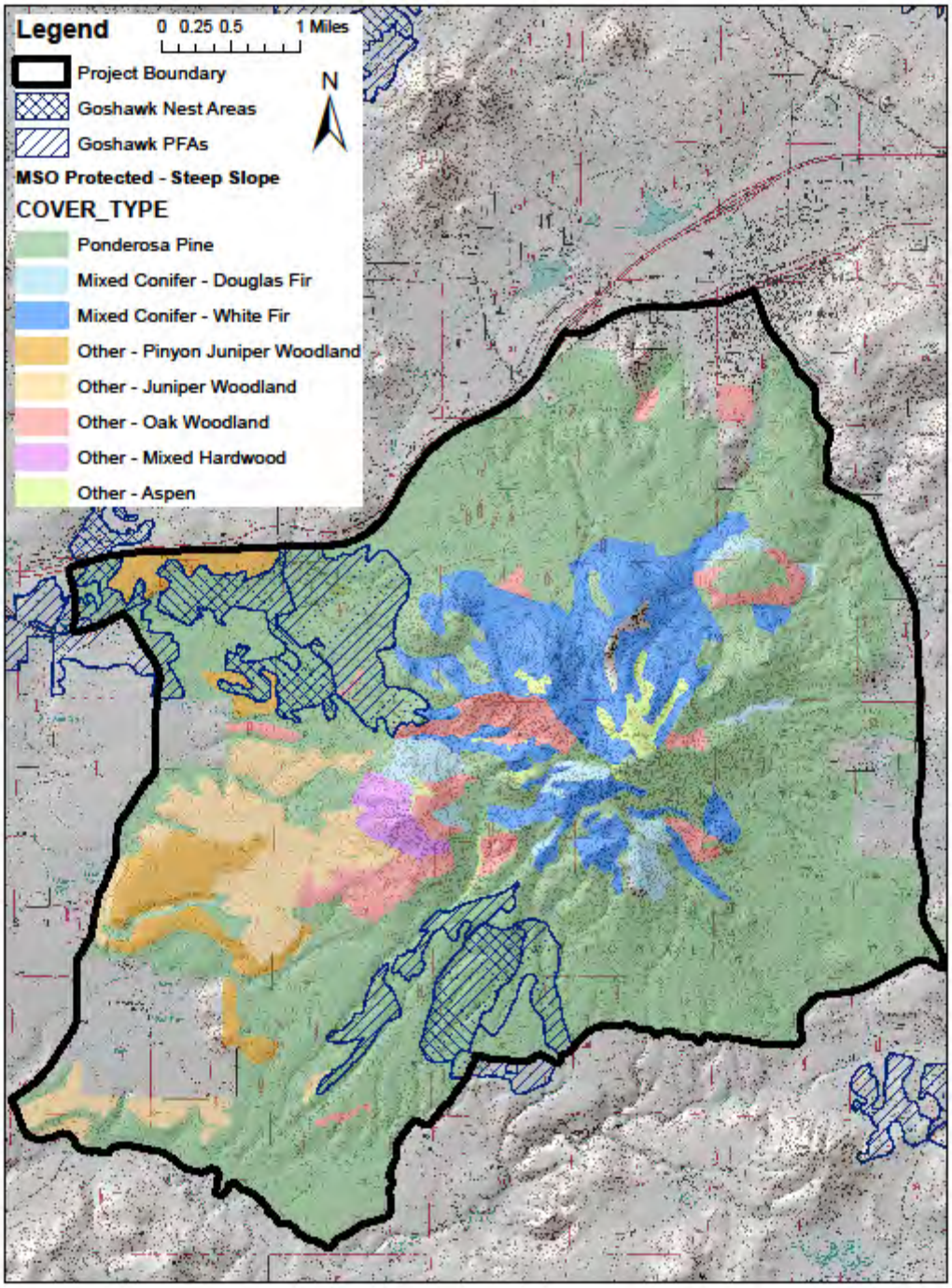


Figure 3.6-2. Habitat of northern goshawks affected by the Bill Williams Mountain Restoration Project. Double-click image for high-resolution .pdf map.

Mexican Spotted Owl

Existing Conditions

See the Wildlife Specialist's Report for a detailed description of survey effort, Protected Habitat, and Restricted Habitat within the project area, as well as more information on the background and natural history of the species' conservation. The Forest-wide population trend for MSOs is declining, as five of six historic PACs are considered occupied based on the most recent survey data (USDA 2010). See Ganey (2011) for regional population trends.

MSOs prefer habitat with cool microclimates, high canopy closure, high stem density, trees >18" DBH, multi-layered canopies, numerous snags, and abundant downed woody material (FWS 2011). On the Williams Ranger District, the MSO is known to nest and roost in mixed conifer forest and canyons. The USFWS also considers pine-oak forest to be MSO habitat within the Upper Gila Mountain Recovery Unit 13, the Critical Habitat Recovery Unit which MSOs occupy on the Williams Ranger District. However, data indicate that the species virtually never uses pine-oak forest on the Williams Ranger District: After more than 20 years of survey across the District, MSOs have only been detected on one occasion in pine-oak forest. See Figure 3.6-1 and Table 3.6-2 for more information on MSO habitat within the project area.

Wildlife biologists, wildland fire managers, silviculturalists, and the District Ranger of the Williams Ranger District corresponded and met with personnel from the FWS Ecological Services Office of Northern Arizona (including the MSO Recovery Team Leader) on several occasions to develop aspects of this project, especially those that pertain to conservation of MSO habitat. Participation by the FWS was integral in shaping desired conditions and mitigation measures for MSO conservation.

Table 3.6-2. Acres of MSO habitat within the project area, by habitat type.

Habitat Type	Acres in Pine-Oak Forest	Acres in Mixed conifer Forest	Total Acres
Protected Habitat	386	1,797	2,426*
Protected Activity Center	10	766	1018*
Meets Threshold Conditions according to 2011 draft Recovery Plan**	40	2	42
Restricted Habitat	4521	176	4697
Meets Threshold Conditions according to 1995 Recovery Plan**	0	22	22
Meets Threshold Conditions according to 2011 draft Recovery Plan	27	22	49
Designated as Target Habitat, in line with 1995 and 2011 Recovery Plans	173	45	218
Critical Habitat	4,128	1,973	6,101*

*Includes acreage of habitat within Bill Williams PAC that is not mixed conifer or pine-oak forest. **See Table 13 from the Forest Plan (USDA 1988) or Table III.B.1 from the 1995 Recovery Plan (FWS 1995).

Approximately 60% of the project area, including 80% of Protected Habitat and 70% of Restricted Habitat, is at risk of active crown fire, which would lead to long-term loss of all forest in these areas (see Fire/Fuels Report). Tables 3.6-3 through 3.6.14 provide quantitative estimates of the existing condition of habitat attributes important to the conservation of MSOs (see Silviculturist's report for details on methods of model estimates).

Existing Conditions in Protected Habitat
Protected Habitat is primarily managed to conserve nesting and roosting habitat. It includes protected activity centers (PACs); special areas such as Wilderness and Research Natural Areas; and all mixed conifer and pine-oak forest on slopes >40%. The Bill Williams PAC is the only PAC within the analysis area, and the entirety of this PAC occurs within the project boundary. The Bill Williams PAC consists of mixed conifer forest and other forest and woodland types (primarily oak woodlands). All other Protected Habitat consists of mixed conifer and pine-oak forest on slopes greater than 40%.

Protected Habitat within the project area has never been extensively timbered and therefore contains many trees >18" DBH, snags, down logs, and other key habitat variables for nesting and roosting owls. Protected Habitat within the project area is botanically diverse, contains several streams and springs, has rough topography, contains many large patches of pre-settlement trees, and is largely suitable for nesting and roosting owls. Protected Habitat on the northern, northeastern, and eastern sides of Bill Williams Mountain seems most suitable to nesting and roosting owls (JJD personal observation). Such habitat is rare across the Kaibab National Forest.

Due to decades of fire exclusion, Protected Habitat in the project area is also uncharacteristically dense and in an unsustainable state. Few openings exist, a desired condition that provides foraging habitat and regeneration areas (FWS 1995 and 2011). Without fire, trees have grown to abnormally high densities and inter-tree competition has reduced the health of trees. Although high basal areas are generally desirable for MSO conservation, there is a point at which basal areas can become so high that they actually inhibit MSO flight (S. Hedwall, personal communication). Such areas are common throughout the Protected Habitat of the project area. Uncharacteristic tree densities have led to recent epidemics of fir engravers (*Scolytus ventralis*) that killed many large white firs (*Abies concolor*) (JJD personal observation).

Existing Conditions in Restricted Habitat
Restricted Habitat is managed for a variety of purposes, including reducing fire hazard to PACs, providing foraging habitat, and providing for future nesting and roosting habitat. It includes all riparian areas, as well as mixed conifer and ponderosa pine-oak forest on slopes <40%. All of the Restricted Habitat in the project boundary consists of pine-oak and mixed conifer forest. At least 10% of Restricted Habitat in pine-oak forest and 25% in mixed conifer forest are to be managed as Target and Threshold Habitat. "Target/Threshold Habitat" is managed for future MSO nesting and roosting owls and provides for replacement nesting and roosting habitat (USDA 1988; FWS 1995).

Aside from those sites designated as Target/Threshold Habitat and those sites within drainages, the pine-oak Restricted Habitat within the project area is dominated by small to mid-sized trees (<18" DBH), has open to moderately closed canopies, is relatively even-aged, has very little topography, and exhibits low vegetative productivity (see Silviculturist's Report for details). Very little mixed conifer Restricted Habitat occurs in the project area. With the exception of Target/Threshold sites, the mixed conifer Restricted Habitat is moderately open and dominated by small to mid-sized trees (JJD, personal observation). The Target/Threshold Habitat in the project area exhibits favorable features for nesting/roosting owls, including an abundance of large conifers, large oaks and other hardwoods, snags, drainages, cool aspects, and connectivity with the Bill Williams PAC (JJD, personal observation).

<u>Direct and Indirect Effects for the No-Action Alternative (Alternative 1)</u>

Unnaturally dense forests increase the probability of stand-replacing wildfire (Tables 3.6-3 and 4) and epidemics of infestations by insects and disease. The No-Action Alternative would perpetuate this risk (see existing conditions section above). These uncharacteristically severe disturbances would degrade or destroy the mature forests, trees >18" DBH, and snags on which this species relies. Under the No-Action Alternative, approximately 90% of the mixed conifer forest and 100% of the ponderosa pine (including pine-oak) forest in the project area would remain highly departed from its historical fire regime (Table 3.6-3). The probability of active crown fire would only increase (currently at approximately 70% in Restricted Habitat and 80% in Protected Habitat; Table 3.6-4) under the No-Action Alternative.

Table 3.6-3. Percent of area in each Fire Regime Condition Class (FRCC). FRCC 1 is within the normal range of variability, FRCC 2 is somewhat departed from this range, and FRCC 3 is highly departed from this range. See Fire/Fuels Report for details.

Dominant Vegetation Type	FRCC	Desired Condition (%)	Alternative 1 (%)	Alternative 2 (%)	Alternative 3 (%)	Alternative 4 (%)
Dry Mixed Conifer	FRCC 1	100	0	40	20	10
	FRCC 2	0	10	20	15	15
	FRCC 3	0	90	40	65	75
Ponderosa Pine (including Pine-Oak)	FRCC 1	100	0	80	53	53
	FRCC 2	0	0	20	10	10
	FRCC 3	0	100	0	37	37
Pinyon - Juniper	FRCC 1	100	0	50	46	46
	FRCC 2	0	100	50	54	54
	FRCC 3	0	0	0	0	0
Private or Non-Vegetated	FRCC 1	FRCC not analyzed.				
	FRCC 2					
	FRCC 3					

Table 3.6-4. Probability of surface fire, passive crown fire (i.e., torching), and active crown fire (i.e., stand-replacement fire) within different habitat types of the project area. See Fire/Fuels Report for details.

Alternative 1 (No Action)			
Habitat Type	**Surface Fire**	**Passive Crown Fire**	**Active Crown Fire**
MSO PAC	12%	9%	79%
MSO Protected	12%	18%	70%
MSO Restricted	17%	3%	80%
Goshawk Nest	17%	11%	72%
Goshawk PFA	16%	14%	70%
Goshawk Foraging	12%	19%	69%
Entire Project Area	17%	21%	62%
Alternative 2 (Proposed Action)			
Habitat Type	**Surface Fire**	**Passive Crown Fire**	**Active Crown Fire**
MSO PAC	43%	11%	45%
MSO Protected	53%	24%	22%
MSO Restricted	74%	18%	8%
Goshawk Nest	77%	11%	12%
Goshawk PFA	68%	15%	17%
Goshawk Foraging	72%	20%	7%
Entire Project Area	54%	27%	19%
Alternative 3			
Habitat Type	**Surface Fire**	**Passive Crown Fire**	**Active Crown Fire**
MSO PAC	36%	8%	56%
MSO Protected	41%	24%	35%
MSO Restricted	48%	37%	15%
Goshawk Nest	15%	12%	73%
Goshawk PFA	63%	16%	21%
Goshawk Foraging	46%	43%	11%
Entire Project Area	42%	30%	27%
Alternative 4			
Habitat Type	**Surface Fire**	**Passive Crown Fire**	**Active Crown Fire**
MSO PAC	21%	3%	75%
MSO Protected	13%	9%	78%
MSO Restricted	56%	28%	16%
Goshawk Nest	30%	48%	21%
Goshawk PFA	21%	29%	50%
Goshawk Foraging	61%	25%	15%
Entire Project Area	32%	32%	36%

MSO Protected Habitat includes the Bill Williams PAC and all mixed conifer and pine-oak forest on slopes >40%. 170 acres within the project area are non-burnable; this was accounted in calculating these statistics.

Direct and Indirect Effects for Alternatives 2-4

Similarities in Vegetative Treatments Effects among the Action Alternatives

For the purposes of this analysis, it is assumed that all MSO Habitat within the Project Area (Table 3.6-2) would be mechanically thinned and burned. Stands that meet the definition of Threshold Habitat (under either the 1995 or 2011 [draft] Recovery Plans [FWS 1995 and 2011], and under the Forest Plan [USDA 1988]) would be conserved as Threshold Habitat. That is, manipulation of vegetation through mechanical treatments and prescribed fire would not cause the values of the attributes that constitute Threshold Habitat to be reduced below Table minimums (Table 13 in USDA 1988; Table III.B.1 in FWS 1995; Table C.2 in FWS 2011). Treatments would move Target stands toward favorable conditions for nesting/roosting owls while reducing fire hazard, with a high basal area dominated by a greater proportion of trees >18" DBH with a more sustainable degree of evenness of trees across the larger size classes.

Restricted Habitat outside Target/Threshold Habitat and within goshawk nest areas would be managed according to standards and guidelines for goshawk nest areas. Treatments (typically thin-from-below treatments) would leave these areas dense with high canopy cover, high basal areas, and mostly older age classes. These areas may serve as future nesting/roosting habitat for MSOs, as they would exhibit high canopy cover and would be dominated by many trees greater than 18" DBH.

Pine-oak Restricted Habitat outside Target/Threshold Habitat and within goshawk PFAs would be managed according to standards and guidelines for goshawk PFAs. Treatments would leave these areas moderately dense, with moderate-high canopy cover, moderate-high basal areas, and a diversity of age classes. Thinning and burning in these areas would conserve potential nesting and roosting habitat for MSOs and reduce fire hazard to the Bill Williams PAC.

Mixed conifer Restricted Habitat outside Target/Threshold areas would be managed for uneven-aged conditions and according to standards and guidelines for goshawk management outside PFAs in mixed conifer forest (at least 40-60 % canopy cover; 10% of the area managed toward VSS 1 and 2; 20% for VSS 3; 20% for VSS 4; 20% for VSS 5; 20% for VSS 6). Treatments would leave these areas relatively dense, with moderate canopy cover, moderate basal areas, and a diversity of age classes. In time, they may grow into suitable nesting/roosting habitat. Under Alternatives 2-4, these areas would not be managed toward pre-settlement conditions. This was incorporated in order to leave denser forest in habitat where owls may be more likely to forage.

Smoke from broadcast and pile-burning may disturb MSOs. MSOs are known to return to PACs after fires and smoke events have ceased (FWS 2011). Prescribed fire would be managed to minimize the accumulation of smoke in PACs (see Project Implementation Checklist). With this information in mind, along with the concept that the species presumably adapted and evolved to smoke from wildland fire, smoke-related effects would not be substantial.

Loss of mistletoe-infected trees would cause a loss of nesting microhabitat for the species and its prey. Although many mistletoe-infected trees would be removed, a mitigation measure specific to conservation of important wildlife trees will conserve this naturally occurring attribute of the ecosystem (see Section 2.3.1).

Alternatives 2-3 would involve the construction of one mile of trail on low slopes, but this would not occur in "pure" pine forest, not pine-oak or mixed-conifer forest. Obliterating existing, poorly placed roads would reduce sedimentation and improve watersheds, which may benefit the habitat of MSO prey and increase their populations. Road obliteration would restore more native habitat and reduce recreational disturbance by humans.

Construction of new, Maintenance-Level 1 roads and temporary roads would cause sedimentation, watershed degradation which may degrade the habitat of MSO prey and reduce their populations. The effects of temporary road construction would be minimal, as roads would be obliterated after use. The effects of Maintenance-Level 1 road construction would be more pronounced, as it may take many years before roads re-vegetate on their own. However, best management practices would minimize soil erosion and watershed degradation from newly constructed, Maintenance-Level 1 roads after implementation (e.g., culvert removal to restore natural water flows; see Soil and Watershed Specialist's Report for details).

Road construction would cause an incidental loss of trees >18" DBH. This analysis assumes that the average width of land cleared to create a roadbed is one chain (66 ft.), so approximately eight acres of land would be denuded of trees for every one mile of road. Approximately 11.7 miles (94 acres) of new, Maintenance-Level 1 roads would be constructed in MSO habitat under Alternative 2, with approximately 0.2 miles (1.6 acres) on the northwestern edge of the Bill Williams PAC, approximately 0.5 miles (4 acres) in Protected Habitat outside the PAC, and the remainder in Restricted Habitat. Approximately 11 miles (88 acres) of new, Maintenance-Level 1 roads would be constructed in MSO habitat under Alternative 3, with approximately 0.2 miles (2 acres) on the northwestern edge of the Bill Williams PAC and the remainder in Restricted Habitat. Alternative 2 would involve construction of approximately 6.8 miles (54 acres) of temporary roads (obliterated after treatments are completed) in MSO habitat, with approximately 0.1 miles (0.8 acres) in the PAC and 0.2 miles (1.6 acres) in Protected Habitat outside the PAC under Alternative 2 and the remainder in Restricted Habitat. Alternative 2 would involve construction of approximately 6.5 miles (52 acres) of temporary roads in MSO habitat, all in Restricted Habitat. Alternative 4 would not involve the construction of new, Maintenance-Level 1 roads; however, it would entail construction of approximately 17.5 miles (140 acres) of temporary roads in MSO habitat, with approximately 0.2 miles (1.6 acres) on the northwestern edge of the Bill Williams PAC and the remainder in Restricted Habitat.

Differences in Vegetative Treatments Effects among the Action Alternatives

Thinning above 9" DBH strengthens the ability of the Forest Service to reduce fire hazard to, while still retaining key habitat variables of, nesting/roosting habitat. It allows the agency to implement uneven-aged management, as recommended in both the existing and new, draft MSO Recovery Plans (FWS 1995 and 2011).

Alternative 4 would result in the least favorable effects on MSO habitat. For example, Alternative 4 would result in substantially fewer trees/acre > 18" DBH, lower general basal area, and lower representation of the largest trees as a proportion of total basal area in Protected Habitat than Alternatives 2 and 3 (Tables 3.6-5 through 7). Important components of habitat such as the number of trees/acre >18" DBH and percent of the forest represented in higher age classes would be lower under Alternative 2 than Alternative 3; however, Alternative 2 would result in a greater reduction in probability of active crown fire (Table 3.6-3 and 4) while still conserving desired conditions for MSO nesting and roosting habitat based on the best available science (Table C.1, FWS 2011). Thinning above 9" DBH promotes greater vertical and horizontal diversity within nesting/roosting habitat, the restoration of 1-2 acre openings (which do not exist across much of the existing nesting/roosting habitat, due to decades of fire exclusion), and other desired conditions as identified in the new, draft Recovery Plan (FWS 2011). In general, and in comparison to the other Alternatives, Alternative 2 would most closely meet desired conditions for nesting/roosting habitat based on the best available science (Table C.1, FWS 2011). It would most restore the landscape toward conditions to which MSOs adapted and evolved.

The only caveat to this statement is that side-effects of cable-logging operations (i.e., "cable-logging" and "exca-lining" as described in the EIS) would cause a loss of all snags and trees (including snags >18" DBH, trees greater than >24" DBH, and pre-settlement trees) across 15% of approximately 480 acres of

Protected Habitat (mostly mixed conifer forest). Cable-logging operations would entail cutting all vegetation in corridors of approximately 15' in width, spaced approximately every 100'. Approximately 15%, or 72 acres, of Protected Habitat treated with cable-logging operations would therefore be denuded under Alternative 2. Much of this area contains extremely large (>24" DBH) pre-settlement trees and snags (JJD, personal observation). In comparison to cable-logging operations, other possible systems (i.e., helicopter-logging or hand-thinning operations) under Alternative 2 would more closely meet desired conditions.

The ponderosa pine landscape on slopes <40%, including pine-oak Restricted Habitat, would be restored more toward pre-settlement conditions under Alternative 2 than Alternatives 3-4. However, mitigation measures would ensure that canopy cover would remain above 40% across pine-oak Restricted Habitat under all Action Alternatives (see section 2.3.1 of EIS). Drainages and areas on cooler/wetter aspects and with high vegetative productivity may serve as MSO habitat in the future. This mitigation measure would ensure that they are managed to be moderately closed to very closed. These areas would moderately reduce fire hazard to the Bill Williams PAC, and they would serve as future nesting, roosting, and foraging habitat for MSOs. Areas on warmer/drier aspects would be very open to moderately open. Generally, these areas of low vegetative productivity do not have the capacity to serve as MSO nesting habitat now or in the future. Treatments in these areas would provide foraging habitat for MSOs, and thinning treatments would reduce fire hazard to the Bill Williams PAC and the surrounding forest.

Pine-Oak Protected Habitat

Alternative 2 is virtually the same as Alternative 3 in terms of its effects on the number of trees >18" DBH/acre, although it most increases the % SDI of the three largest size classes of trees and leads to highest conservation of snags >18" DBH. Alternative 4 would cause a substantial loss of trees >18" DBH/acre in comparison to all other Alternatives. Differences in general basal area, oak basal area, and number of down logs/acre are negligible between Alternatives 2 and 4, but Alternative 3 would lead to substantially less basal area, fewer oaks, and fewer down logs. Differences in canopy cover are negligible among the Action Alternatives. It is important to note that although basal area decreases by approximately 20-40 sq. ft./acre, canopy cover still remains high under all of the Action Alternatives. Considering the high probability of widespread crown fire under the No-Action Alternative (see Table 3.6-3 and 4), and the differences of stand structure and probability of active crown fire resulting from the different Action Alternatives, Alternative 2 appears that it would most favorably affect pine-oak Protected Habitat. See table below for details (this table does not assume wildfire under Alternative 1; it does include prescribed fire under the Action Alternatives). Attributes analyzed in these and subsequent, similar tables include: basal area, percent stand density index (SDI), trees/acre >18" DBH snags/acre >18" DBH and >12" DBH, logs/acre >12" midpoint diameter, and shade canopy. See Silviculturist's report for details on methods used to calculate these results.

Table 3.6-5. Effects of Alternatives on pine-oak Protected Habitat.

Alternative 1 (No Action, Excludes Wildfire) Bill Williams Restoration Project Protected Pine-Oak Habitat										
Year	BA	Oak BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	144	14	20	8	2	9	2.0	8.4	6	69
2014	144	14	20	8	2	9	1.9	8.2	6	69
2033	155	23	20	9	2	14	0.7	5.2	11	71
2053	169	30	21	13	2	16	0.5	4.4	13	73
Alternative 2 (Proposed Action): Bill Williams Restoration Project MSO Protected Pine-Oak Habitat										
Year	BA	Oak BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	144	14	20	8	2	9	2.0	8.4	6	69
2014	112	14	20	8	2	9	1.9	8.1	3	63
2033	100	18	23	17	2	13	1.1	5.4	9	60
2053	121	22	22	25	3	21	1.0	4.1	11	65
Alternative 3: Bill Williams Restoration Project MSO Protected Pine-Oak Habitat										
Year	BA	Oak BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	144	14	20	8	2	9	2.0	8.4	6	69
2014	75	13	20	8	2	6	1.9	7.9	3	53
2033	72	11	22	24	4	12	0.7	2.4	7	52
2053	98	14	26	36	5	20	0.3	0.8	8	60
Alternative 4: Bill Williams Restoration Project Protected Pine-Oak Habitat										
Year	BA	Oak BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	144	14	20	8	2	9	2.0	8.4	6	69
2014	114	14	20	8	2	6	1.9	8.1	5	63
2033	98	17	24	16	3	9	0.7	4.6	9	59
2053	119	22	26	20	3	16	0.3	3.2	10	64

Mixed Conifer Protected Habitat

Differences in basal area and canopy are negligibly different among the Action Alternatives. Alternatives 2-3 are comparable in terms of conservation of trees >18" DBH and conservation of snags but Alternative 4 would lead to a loss of many more trees >18" DBH than any other Alternative. The number of snags and down logs per acre increases most under Alternative 4, as prescribed fire without first mechanically treating the area would lead to many fire-killed trees and consumed snags. Alternative 3 would promote representation and evenness among the largest size classes of trees more than Alternatives 2 and 4. Considering the high probability of widespread crown fire under the No-Action Alternative (see Table 3.6-3 and 4), and the differences on probability of active crown fire and stand structure of the different Action Alternatives, Alternative 2 appears that it would most favorably affect mixed conifer Protected Habitat. See table below for details (this table does not assume wildfire under Alternative 1; it does include prescribed fire under the Action Alternatives).

Table 3.6-6. Effects of Alternatives on mixed conifer Protected Habitat.

Alternative 1 (No Action, Excludes Wildfire): Bill Williams Restoration Project MSO Protected Mixed Conifer Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	153	22	9	9	12	3.2	15.0	19	71
2014	155	22	10	9	12	2.9	13.6	20	71
2033	184	22	10	9	15	1.2	4.1	26	76
2053	210	24	13	9	22	0.8	4.4	26	79
Alternative 2 (Proposed Action): Bill Williams Restoration Project MSO Protected Mixed Conifer Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	153	22	9	9	12	3.2	15.0	19	71
2014	126	22	10	9	13	3.0	13.5	9	66
2033	92	30	17	11	13	2.5	5.4	19	58
2053	117	23	22	15	21	1.3	2.6	22	64
Alternative 3: Bill Williams Restoration Project MSO Protected Mixed Conifer Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	153	22	9	9	12	3.2	15.0	19	71
2014	95	22	10	9	12	2.9	13.4	9	59
2033	99	37	17	17	16	1.3	3.5	16	60
2053	119	31	29	21	23	0.8	2.3	17	64
Alternative 4: Bill Williams Restoration Project MSO Protected Mixed Conifer Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	153	22	9	9	12	3.2	15.0	19	71
2014	145	22	10	9	12	2.9	13.5	20	70
2033	79	25	14	10	9	3.5	7.9	34	54
2053	103	26	16	11	13	1.8	2.9	37	61

Bill Williams Protected Activity Center

Alternative 4 would result in substantially less basal area, fewer trees >18" DBH/acre, and lower canopy cover than Alternatives 2-3. As fire would cause mortality of many trees >18" DBH, the number of large snags and down logs per acre would increase under Alternative 4, in comparison to Alternatives 2-3. Alternatives 2 and 3 would have comparable effects on basal area, trees >18" DBH, large snags, and canopy cover. The percent representation and evenness of SDI in the largest size classes would be greatest under Alternative 3. Considering the high probability of widespread crown fire under the No-Action Alternative (see Table 3.6-3 and 4), and the differences of probability of active crown fire and stand structure of the different Action Alternatives, Alternative 2 appears that it would most favorably affect mixed conifer Protected Habitat. See table below for details (this table does not assume wildfire under Alternative 1; it does include prescribed fire under the Action Alternatives).

Table 3.6-7. Effects of Alternatives on the Bill Williams PAC.

Alternative 1 (Excludes Wildfire): Bill Williams Restoration Project MSO PAC Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	163	25	12	8	15	3.6	17.8	26	72
2014	165	26	12	8	16	3.4	15.9	27	73
2033	196	26	13	8	19	1.5	4.5	33	77
2053	221	28	16	8	27	1.1	5.3	33	80
Alternative 2 (Proposed Action): Bill Williams Restoration Project MSO PAC Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	163	25	12	8	15	3.6	17.8	26	72
2014	131	26	12	8	16	3.4	15.8	12	67
2033	118	30	20	10	18	2.3	4.9	22	64
2053	148	25	23	14	27	1.3	2.9	24	70
Alternative 3: Bill Williams Restoration Project MSO PAC Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	163	25	12	8	15	3.6	17.8	26	72
2014	111	26	12	8	15	3.4	15.8	12	63
2033	123	37	22	14	19	1.3	3.2	20	65
2053	148	31	28	17	29	0.8	2.8	20	70
Alternative 4: Bill Williams Restoration Project MSO PAC Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	163	25	12	8	15	3.6	17.8	26	72
2014	157	26	12	8	16	3.4	15.9	26	72
2033	89	29	15	7	10	4.3	9.1	45	57
2053	114	31	17	8	15	2.5	4.2	47	63

Pine-Oak Restricted Habitat

The Action Alternatives would have negligibly different effects on general basal area, oak basal area, trees >18" DBH/acre, down logs/acre, and canopy cover. Conservation of snags, as well as the percent representation and evenness of SDI in the largest size classes of trees would be greatest under Alternative 2. Considering the high probability of widespread crown fire under the No-Action Alternative (see Table 3.6-3 and 4), and the differences on stand structure of the different Action Alternatives, Alternative 2 would most favorably affect pine-oak Restricted Habitat. See table below for details (this table does not assume wildfire under Alternative 1; it does include prescribed fire under the Action Alternatives).

Table 3.6-8. Effects of Alternatives on pine-oak Restricted Habitat.

Alternative 1 (No Action, Excludes Wildfire): Bill Williams Restoration Project MSO Restricted Pine-Oak Habitat										
Year	BA	Oak BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	121	14	29	9	4	7	0.5	2.9	13	65
2014	122	15	30	10	4	7	0.5	2.9	13	65
2033	138	17	32	12	5	12	0.5	3.7	13	68
2053	151	20	31	16	7	17	0.8	5.0	14	71
Alternative 2 (Proposed Action): Bill Williams Restoration Project MSO Restricted Pine-Oak Habitat										
Year	BA	Oak BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	121	14	29	9	4	8	0.5	2.9	13	65
2014	78	14	30	10	4	7	0.5	2.8	6	54
2033	73	12	33	25	8	12	0.7	3.5	7	52
2053	90	17	26	27	17	17	0.9	2.6	9	57
Alternatives 3-4: Bill Williams Restoration Project MSO Restricted Pine-Oak Habitat										
Year	BA	Oak BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	121	14	29	8	4	7	0.5	2.9	13	65
2014	83	15	30	10	4	7	0.5	2.8	6	55
2033	80	12	36	20	8	12	0.5	2.8	7	54
2053	100	16	30	28	14	18	0.6	1.7	8	60

Mixed Conifer Restricted Habitat

The Action Alternatives would reduce basal area and therefore probability of crown fire. Although the Action Alternatives would reduce the basal area in comparison to the No-Action Alternative, this difference is negligible as the Action Alternatives would still retain high densities of trees >18" DBH, high canopy cover, and a diversity of size classes. The Action Alternatives would increase the number of large snags/acre and a cause a marginal decrease in the number of down logs/acre. Considering the probability of active crown fire under the No-Action Alternative (see Tables 3.6-3 and 4), the Action Alternatives would most favorably affect this stand. See table below for details (this table does not assume wildfire under Alternative 1; it does include prescribed fire under the Action Alternatives).

Table 3.6-9. Effects of Alternatives on mixed conifer Restricted Habitat.

Alternative 1 (No Action, Excludes Wildfire): Bill Williams Restoration Project MSO Restricted Mixed Conifer Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	155	33	12	1	14	0.8	6.7	4	71
2014	155	31	13	1	15	0.8	6.7	5	71
2033	170	27	17	1	22	1.6	7.7	9	74
2053	189	23	23	4	32	2.1	6.8	15	76
Alternatives 2-4: Bill Williams Restoration Project MSO Restricted Mixed Conifer Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	155	33	12	1	14	0.8	6.7	4	71
2014	106	33	13	1	13	0.9	6.4	2	61
2033	100	37	30	3	25	2.2	6.3	8	60
2053	118	17	43	7	28	2.7	4.6	12	64

Mixed Conifer Threshold Habitat According to 1995 MSO Recovery Plan

Only one stand of Restricted Habitat meets the definition of Threshold Habitat under the 1995 MSO Recovery Plan, and it is a mixed conifer stand. I have personally visited this stand and discussed prescriptions with the project's silviculturist, and treatments would reduce ladder fuels while conserving those habitat elements important to nesting and roosting MSOs. Treatments under Alternatives 2-4 would reduce the number of trees >18" DBH, and canopy cover, but they would increase the representation of the largest size classes of trees within the stand. The Action Alternatives would cause a marginal decrease in the number of large snags/acre. Considering the probability of active crown fire under the No-Action Alternative (see Tables 3.6-3 and 4), Alternatives 2-4 would most favorably affect this stand. See table below for details (this table does not assume wildfire under Alternative 1; it does include prescribed fire under the Action Alternatives).

Table 3.6-10. Effects of Alternatives on Restricted Habitat which meets the definition of Threshold Habitat under the 1995 MSO Recovery Plan.

Alternative 1 (No Action, Excludes Wildfire): Bill Williams Restoration Project MSO Restricted Threshold Mixed Conifer Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	296	48	23	12	51	2.2	9.1	12	88
2014	296	48	23	12	51	2.2	9.9	13	88
2033	318	36	24	12	73	1.9	12.7	25	90
2053	337	35	37	13	93	4.4	11.7	36	91
Alternatives 2-4: Bill Williams Restoration Project MSO Restricted Threshold Mixed Conifer Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	296	48	23	12	51	2.2	9.1	12	88
2014	205	47	24	12	51	2.0	8.3	5	78
2033	215	17	42	22	68	3.1	6.7	23	80
2053	243	5	55	21	83	4.3	5.0	23	83

Mixed Conifer Threshold Habitat According to 2011 (Draft) MSO Recovery Plan

These areas include all mixed conifer stands that meet the 2011 (draft) MSO Recovery Plan's definition for Threshold Habitat, including those that lie on slopes greater than 40%. Alternative 2 would include thinning trees above 9" DBH in these stands, Alternative 3 would be limited to a 9" cap, and Alternative 4 would only allow thinning to construct fireline. Alternatives 3-4 are nearly identical, in terms of their effects. In comparison to Alternative 2, they would cause a substantially larger increase in the number of trees >18" DBH/acre and there would be greater evenness among the larger size classes. However, fire hazard would be much lower in mixed conifer forest under Alternative 2 than Alternatives 3-4, and Alternative 2 would still result in a high number of trees/acre >18" DBH. In comparison to Alternative 2, there would be a marginally higher number of large snags/acre under Alternatives 3-4. Differences of effects among the Action Alternatives on other habitat attributes are negligible. Considering differences in the probability of active crown fire under the No-Action Alternative (see Tables 3.6-3 and 4), and retention of important habitat attributes, Alternative 2 would most favorably affect this stand. See table below for details (this table does not assume wildfire under Alternative 1; it does include prescribed fire under the Action Alternatives).

Table 3.6-11. Effects of Alternatives on mixed conifer Restricted Habitat which meets the definition of Threshold Habitat under the 2011 (draft) MSO Recovery Plan.

Alternative 1 (No Action, Excludes Wildfire) Bill Williams Restoration Project 2011 Draft Recovery Plan Threshold MSO Mixed-Conifer Habitat											
Year	BA	% BA 12-18"	% BA 18"+	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs 12"+	% Shade
2013	284	57%	43%	47	23	11	49	2.0	9.3	16	87
2014	284	57%	43%	47	24	11	49	2.0	9.9	17	87
2033	306	41%	58%	35	25	12	70	1.8	12.0	27	89
2053	325	27%	73%	34	37	12	89	4.1	11.1	38	90
Alternatives 2 (Proposed Action): Bill Williams Restoration Project 2011 Recovery Plan Threshold MSO Mixed-Conifer Habitat											
Year	BA	% BA 12-18"	% BA 18"+	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs 12"+	% Shade
2013	284	57%	43%	47	23	11	49	2.0	9.3	16	87
2014	199	38%	61%	47	24	11	49	1.9	8.4	7	78
2033	209	17%	83%	18	42	21	66	2.9	6.4	23	79
2053	236	4%	96%	7	54	20	79	4.0	4.7	23	82
Alternative 3: Bill Williams Restoration Project 2011 Recovery Plan Threshold MSO Mixed-Conifer Habitat											
Year	BA	% BA 12-18"	% BA 18"+	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs 12"+	% Shade
2013	284	57%	43%	47	23	11	49	2.0	9.3	16	87
2014	281	56%	43%	47	24	11	49	2.0	9.9	14	86
2033	275	39%	60%	34	27	13	65	2.4	11.3	37	86
2053	304	12%	88%	21	51	13	107	4.4	7.6	44	88
Alternative 4: Bill Williams Restoration Project 2011 Recovery Plan Threshold MSO Mixed-Conifer Habitat											
Year	BA	% BA 12-18"	% BA 18"+	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs 12"+	% Shade
2013	284	57%	43%	47	23	11	49	2.0	9.3	16	87
2014	284	57%	43%	47	24	11	49	2.0	9.9	17	87
2033	278	40%	60%	35	26	12	65	2.4	11.3	39	86
2053	307	12%	87%	22	51	12	108	4.4	7.6	46	89

Pine-Oak Threshold Habitat According to 2011 (Draft) MSO Recovery Plan

These areas include all pine-oak stands that meet the 2011 (draft) MSO Recovery Plan's definition for Threshold Habitat, including those that lie on slopes greater than 40%. Differences of effects among the Action Alternatives on habitat attributes are negligible. Considering the probability of active crown fire under the No-Action Alternative (see Tables 3.6-3 and 4), Alternative 2 would most favorably affect these areas. See table below for details (this table does not assume wildfire under Alternative 1; it does include prescribed fire under the Action Alternatives). Note that managing for recommended Target/Threshold criteria under the 2011 (draft) Recovery Plan does not preclude management for Target/Threshold Habitat directed by the Forest Plan (USDA 1988) or recommended by the 1995 Recovery Plan (FWS 1995).

Table 3.6-12. Effects of Alternatives on pine-oak Restricted Habitat which meets the definition of Threshold Habitat under the 2011 (draft) MSO Recovery Plan.

Alternative 1 (No Action, Excludes Wildfire) Bill Williams Restoration Project 2011 Draft Recovery Plan Threshold MSO Pine-Oak Habitat											
Year	BA	% BA 12-18"	% BA 18"+	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	125	52%	34%	42%	15%	11%	15	0.09	2	23	66
2014	127	52%	34%	44%	16%	11%	15	0.1	3	23	66
2033	144	39%	47%	37%	23%	11%	25	0.6	6	22	69
2053	149	26%	58%	26%	33%	12%	31	1.9	9	22	70
Alternative 2 (Proposed Action): Bill Williams Restoration Project 2011 Recovery Plan Threshold MSO Pine-Oak Habitat											
Year	BA	% BA 12-18"	% BA 18"+	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	125	52%	34%	42%	15%	11%	15	0.09	2	23	66
2014	112	55%	41%	44%	16%	11%	16	0.1	2	10	63
2033	113	36%	62%	48%	31%	15%	26	0.8	7	11	63
2053	117	23%	75%	28%	42%	22%	30	2.4	7	13	64
Alternative 3: Bill Williams Restoration Project 2011 Recovery Plan Threshold MSO Pine-Oak Habitat											
Year	BA	% BA 12-18"	% BA 18"+	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	125	52%	34%	42%	15%	11%	15	0.09	2	23	66
2014	112	55%	41%	44%	16%	11%	16	0.1	2	10	63
2033	113	36%	62%	48%	31%	15%	26	0.8	7	11	63
2053	117	23%	75%	28%	42%	22%	30	2.4	7	13	64
Alternative 4: Bill Williams Restoration Project 2011 Recovery Plan Threshold MSO Pine-Oak Habitat											
Year	BA	% BA 12-18"	% BA 18"+	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	125	52%	34%	42%	15%	11%	15	0.09	2	23	66
2014	113	52%	40%	41%	19%	10%	17	1	4.8	23	63
2033	115	34%	62%	39%	34%	13%	28	0.7	5.4	18	64
2053	124	25%	70%	26%	43%	17%	31	1.7	5.3	20	65

Target Mixed Conifer Habitat

The Action Alternatives would reduce basal area and therefore probability of crown fire. Although the Action Alternatives would reduce the basal area and the number of trees >18" DBH in the area over time in comparison to the No-Action Alternative, these differences are negligible as the Action Alternatives would increase the number of large snags/acre while still retaining high densities of trees >18" DBH, high canopy cover, and a diversity of size classes. Considering the probability of active crown fire under the No-Action Alternative (see Tables 3.6-3 and 4), the Action Alternatives would most favorably affect this

stand. See table below for details (this table does not assume wildfire under Alternative 1; it does include prescribed fire under the Action Alternatives).

Table 3.6-13. Effects of Alternatives on mixed conifer Restricted Habitat managed as Target Habitat.

Alternative 1 (No Action, Excludes Wildfire): Bill Williams Restoration Project MSO Restricted Target Mixed Conifer Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	202	35	18	4	25	1.2	11.2	5	78
2014	202	35	17	4	25	1.3	11.4	5	78
2033	204	28	21	4	38	3.5	14.1	14	78
2053	214	24	27	4	44	4.2	11.1	25	79
Alternatives 2-4: Bill Williams Restoration Project MSO Restricted Target Mixed Conifer Habitat									
Year	BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	202	35	18	4	25	1.2	11.2	5	78
2014	154	35	18	4	25	1.3	10.9	2	71
2033	145	25	38	7	39	4.2	12.2	14	70
2053	159	19	45	7	39	5.8	9.1	22	72

Target Pine-Oak Habitat

The Action Alternatives would reduce basal area and therefore probability of crown fire. They would increase representation and evenness in the highest size classes of trees, as well as the number of trees/acre >18" DBH. Although the Action Alternatives would reduce the basal area, large snags/acre, and canopy cover in the area over time in comparison to the No-Action Alternative, these differences are negligible as the Action Alternatives would still retain high densities of trees >18" DBH, high canopy cover, and a diversity of size classes. Considering the probability of active crown fire under the No-Action Alternative (see Tables 3.6-3 and 4), the Action Alternatives would most favorably affect this stand. See table below for details (this table does not assume wildfire under Alternative 1; it does include prescribed fire under the Action Alternatives).

Table 3.6-14. Effects of Alternatives on pine-oak Restricted Habitat managed as Target Habitat.

Alternative 1 (No Action, Excludes Wildfire) Bill Williams Restoration Project MSO Target Pine-Oak Habitat										
Year	BA	Oak BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	167	39	30	12	4	12	0.8	2.2	0.6	73
2014	168	39	32	14	6	12	0.8	2.3	0.7	73
2033	183	40	34	14	7	13	0.5	1.8	2.3	75
2053	196	40	38	19	8	18	0.6	2.6	3.7	77
Alternatives 2-4 (Proposed Action): Bill Williams Restoration Project MSO Target Pine-Oak Habitat										
Year	BA	Oak BA	% SDI 12-18"	% SDI 18-24"	% SDI 24"+	TPA 18"+	Snags 18"+	Snags 12"+	Logs12"+	% Shade
2013	167	39	30	12	4	12	0.8	2.2	0.6	73
2014	125	40	32	14	6	11	0.8	2.1	0.3	66
2033	108	27	37	22	8	12	1.0	2.7	3.6	62
2053	128	32	36	21	14	20	0.7	2.0	5.7	66

Critical Habitat

Forest Structure:

- In general, the range of trees would improve under Alternatives 2-3 but would remain largely unchanged under Alternative 4 (see above tables). Restoration of structural diversity would create openings; retain large, uneven-aged patches dominated by trees >18" DBH; and retain pre-settlement trees.
- Shade would not fall below 40% at the stand- (typically 10-50 acres/stand) or project- scales under any of the Action Alternatives. Even though Alternative 2 involves restoration to pre-settlement conditions across the ponderosa pine forests of the project area (including pine-oak Restricted Habitat outside Target/Threshold Habitat and Goshawk PFAs and nest areas), a mitigation measure that was developed in collaboration with the FWS would leave more trees/evidence within more vegetatively productive pine-oak sites (section 2.3.1 of EIS). This would in turn ensure that canopy cover would be maintained above 40% across the project area.
- Reducing inter-tree competition would increase the growth of trees >18" DBH, which would cause an increase in future snags. Prescribed fire would result in the creation and consumption of snags. An especially high number of snags would be created under Alternative 4, as burning without first mechanically thinning would cause fire-induced mortality of many trees (see tables above). Project implementation of Alternatives 2-3 would increase the long-term sustainability of the forest within the project area, thereby better securing the long-term development of snags. However, cable-logging operations under Alternative 2 would cause a loss of existing and recruitment snags within denuded corridors.

Prey Species:

- Prescribed fire would result in the consumption and creation of fallen trees and woody debris. Alternative 4 would create the most fallen trees, as many fire-killed snags would collapse (see tables above).

- Thinning and burning treatments would increase the abundance and growth of oaks by reducing competition for sunlight, nutrients, and water. Prescribed fire may consume some oaks.
- Herbaceous plant cover (important for maintaining prey base of small mammals) may decrease within the first year after consumption by prescribed fire. However, fire would return nutrients to the soil and stimulate higher growth thereafter (Griffis et al. 2001).

Road construction, road decommissions, road closures, trail construction, thinning, and prescribed fire may degrade Critical Habitat, but such effects are too small to substantially affect Critical Habitat. Standards, Guidelines, Desired Conditions and Mitigation Measures (see Project Implementation Checklist above and Section 2.3.1 and Appendix E of EIS) ensure that the project would conserve Critical Habitat.

Cumulative Effects

Several past, ongoing, and reasonably foreseeable actions and events have contributed, are contributing, and will contribute to the fitness (i.e., survival and reproductive success) of MSOs on the Kaibab National Forest:

- The abundance of trees in the late seral stage remains largely unchanged from historical conditions on slopes greater than 40%. However, even-aged forest management led to a loss of large, old trees, generally on slopes less than 40% and primarily from the 1960s through the early 1990s. Recent projects in forest management (see appendix in EIS) emphasize restoration and fire hazard reduction, thereby promoting the sustainability of the species' habitat in and around the project area.
- The forests in the project area are far removed from their historical fire regime (Tables 3.6-3 and 4). The Forest Service excluded fire from and permitted overgrazing of the forests of the southwestern US throughout much of the twentieth century. This caused forests and woodlands to grow unnaturally dense and grasslands and savannas to become invaded with conifers. In turn, this has increased the occurrence and potential for uncharacteristically severe wildfire and insect and disease epidemics that threaten the species' habitat. The Twin Wildfire and recent outbreaks of fir engravers are examples of such uncharacteristic disturbances occurring within the project area in the recent past.
- Recreation (e.g., hiking, biking, and camping) may disturb the species. Recreational activities would continue to occur in the project area, resulting in a potential decrease in fitness.
- The removal of hazardous trees around the Bill Williams communication site and along powerlines and roads has reduced and will continue to reduce the number of snags and trees >18" DBH in the analysis area of the project, resulting in a decline in important habitat components for MSOs.
- Illegal fuelwood harvest has caused and will continue to cause a loss of snags.
- Climate change will cause a decrease in precipitation, an increase in drought, higher temperatures, and a longer wildfire season, which will increase the probability of stand-replacing wildfire causing habitat loss for the species. Climate change will also lead to more opportunities for invasive species to establish and spread, and invasive species may outcompete with these species or their prey, or they may alter the species' habitat (USGCRP 2009). Restoration projects such as this may help species be more resilient and adapt to climate change (USDA 2011).
- See appendix in EIS for a list of specific projects also considered in this cumulative effects analysis.

The No-Action Alternative would perpetuate the unnaturally dense conditions in the coniferous forests of the project area. It would exacerbate the reduction in habitat caused by historic land management

practices, recreation, illegal fuelwood harvest, and hazard-tree removal. The No-Action Alternative may therefore have an adverse effect on Mexican spotted owls.

Alternatives 2-4 may adversely impact the species in the short term but would cause a long-term beneficial impact. They would combine with the aforementioned past, ongoing, and reasonably foreseeable actions and events for a cumulative effect on the fitness of the species. In the context of these other factors, Alternatives 2-4 may impact the species, but their cumulative contribution would not cause a trend toward loss of viability.

Determination of Effects

The No-Action Alternative (Alternative 1) may affect, and is likely to adversely affect the MSO and its Critical Habitat. Although preferable to the No-Action Alternative in terms of MSO conservation and meeting desired conditions in MSO Habitat (see Appendix E of EIS), Alternatives 2-4 may affect, and are likely to adversely affect the MSO and its Critical Habitat. All Action Alternatives would allow the use of prescribed fire on steep slopes without first mechanically treating these areas. As the MSO habitat on steep slopes (including Bill Williams PAC) has uncharacteristically high fuel loadings, the probability of unintentionally torching large patches of trees (including large snags and pre-settlement trees) would be high in these areas if they did not first receive mechanical treatments. Alternatives 2-4 would allow prescribed fire to occur in MSO habitat when conditions of weather and fuel moistures are most favorable, so loss of important habitat components would be much less than if a wildfire were to occur under extreme conditions of weather and fuel moistures.

If mechanical treatments are implemented before prescribed fire on steep slopes, then Alternative 2 would best conserve MSO nesting and roosting habitat (Table C.1 in FWS 2011), as this Alternative would promote MSO habitat attributes in the PAC (Tables 3.6-5 through 14, especially 3.6.5; Table C.1 in FWS 2011) and most reduce the probability of active crown fire in and around the PAC (Tables 3.6-3 and 4). The only caveat to this statement would be that areas with cable-logging treatments would result in a substantial loss of snags and pre-settlement trees. Alternative 3 would have an intermediate effect on reducing fire hazard, and it would have the greatest effect on promoting individual MSO habitat attributes of importance; however, it would do little to promote long-term sustainability of the habitat, as a 9" diameter cap equates to even-aged management and very little structural diversity within nesting and roosting habitat. Alternative 4 would do little to reduce fire hazard (Tables 3.6-3 and 4) and it would result in the greatest loss of important habitat attributes of the Action Alternatives (Tables 3.6-5 through 14). However, Alternative 4 would have less road-related impacts on MSO habitat than Alternatives 2-3.

None of the Alternatives' effects are impactful enough to change Forest-wide habitat or population trends for MSOs or to cause a trend toward loss of viability. None of the Alternatives would cause an irreversible or irretrievable commitment of resources per section 7(d) of the ESA.

Navajo Mogollon Vole and Merriam's Shrew

Existing Conditions

The Arizonan distribution of the species occurs north of the Mogollon Rim, in open areas associated with ponderosa pine and other coniferous forests (meadows, riparian areas, and forested areas with low tree densities). Navajo Mogollon voles rely on grasses and other herbaceous vegetation for food and cover (Hoffmeister 1986). The species has not been detected in the project area but is likely to occur. Meadow openings within ponderosa pine and mixed-conifer forest serve as suitable habitat in the project area, and conifers have encroached upon areas that were historically meadows.

Merriam's shrew occurs throughout the west in a variety of habitats. In Arizona, the species occurs along the Kaibab and Mogollon plateaus. Merriam's shrew inhabits cool, grassy places, usually within or

alongside coniferous forests (including those with ponderosa pine, aspen, spruce, and/or fir). It usually occurs near water but not along streams. This insectivorous shrew uses herbaceous ground cover, moist soils, logs, and coarse, woody debris near water (Hoffmeister 1986). Grasslands (especially where they border forests with ponderosa pine), savannas, and meadow openings within ponderosa pine and mixed-conifer forest occur in the project area and serve as suitable habitat for the species. The species has not been detected in the project area but is likely to occur there.

Direct and Indirect Effects for the No-Action Alternative (Alternative 1)
The No-Action Alternative would not affect the Navajo Mogollon Vole or Merriam's Shrew (henceforth collectively referred to as "voles and shrews") in the short term. Habitat conditions for these species would not change, notwithstanding the effects of natural processes. However, the No-Action Alternative would degrade the habitat for voles and shrews in the long term. By not removing conifers which have encroached upon grasslands, meadows, and savannas, the No-Action Alternative would hinder restoration of habitat for voles and shrews.

Direct and Indirect Effects for Alternative 2-4
Alternatives 2-4 would benefit voles and shrews by restoring grasslands, meadows, and savannas toward conditions to which the species adapted and evolved. In comparison to Alternatives 3-4, Alternative 2 would restore more habitat of voles and shrews, as without a 9" diameter cap in MSO Protected Habitat and with the ability to restore much of the ponderosa pine forest to pre-settlement conditions, Alternative 2 has the most flexibility to restore the grasslands and savannas important to these species. Prescribed fire is likely to have negligible effects on the creation and consumption of down logs in the habitat of these species, as fire does not have much residence time in grasslands, meadows, and savannas. Prescribed fire may cause direct mortality of the species, although this is unlikely, as the species are able to escape into burrows and other refugia.

Road decommissions, road closures, and conversion of road to trail would restore more native habitat and reduce disturbance by humans. Construction of approximately 38-39 miles of temporary and Maintenance-Level 1 roads would clear trees and snags across approximately 304-312 acres. Construction of fireline would clear up to approximately 2,500 acres of snags and ladder fuels. Temporary Maintenance-Level 1 roads would cause degradation of habitat through soil erosion and sedimentation of waterways. Construction of fireline and temporary and Maintenance-Level 1 roads would cause loss of habitat where roads pass through grasslands, meadows or other areas used by these species. Maintenance-Level 1 roads, unlike temporary roads, would not be obliterated after implementation and would therefore have longer-term effects on habitat. Unlike Alternatives 2-3, which involve construction of 22-23 miles of Maintenance-Level 1 roads, Alternative 4 does not involve construction of any Maintenance-Level 1 roads. This Alternative would therefore have the least road-related degradation of habitat for the species. Mechanical treatment of hazardous fuels, prescribed fire, road construction, road decommissions, and trail construction may reduce the habitat of voles and shrews in the short term or cause direct mortality, but such effects would not cause a trend toward listing or loss of viability. See Tables 3.6-3 and 4 for a quantitative description of habitat attributes and fire hazard to the species' habitat under Alternatives 2-4.

Cumulative Effects
Several past, ongoing, and reasonably foreseeable actions and events have contributed, are contributing, and will contribute to the fitness of voles and shrews on the Kaibab National Forest:

- Voles and shrews require abundant and diverse herbaceous vegetation for protective cover and food. Sheep consume herbaceous vegetation. Historic overgrazing decreased the amount of cover and food for voles and shrews, which likely decreased the fitness of these species. Although current levels of grazing have improved, the presence of livestock still reduces herbaceous vegetation. The current, adaptive-management approach (see Rangeland Specialist's

Report and Hat Allotment Management Plan) to grazing across the National Forest System will increase the herbaceous vegetation available to voles and shrews. This will therefore increase their fitness.

- Grasslands, meadows, and savannas, including those in the Southwest, evolved to periodic disturbance from fire (USDA 2012). The Forest Service excluded fire from the Kaibab National Forest throughout much of the twentieth century, causing the encroachment of trees onto savannas, meadows, and grasslands; this reduced, fragmented, and degraded habitat for voles and shrews. Furthermore, it has increased the potential of high-severity wildfires, which could cause direct mortality of voles/shrews and a long-term loss of microhabitat (e.g., downed logs and woody debris). The Forest Service now embraces the natural role of fire on the landscape; current and future wildland fire management (including the use of wildfire) will increase, connect, and improve habitat for these species.
- Recreation (e.g., off-road vehicle driving, hiking, biking, and camping) and road travel reduce vegetation and compact soils. Recreational activities would continue to occur in the project area, resulting in decreased habitat for voles and shrews. Implementation of the Travel Management Rule will reduce off-road vehicle driving, restore habitat, and improve habitat for the species.
- Insect and disease outbreaks have killed and will continue to kill trees. Insect- and disease-related mortality creates more snags, and eventually, downed logs. Downed logs serve as protective cover for voles and shrews. Therefore, insect and disease outbreaks may increase protective cover for voles and shrews.
- Climate change will cause a decrease in precipitation, an increase in drought, and higher temperatures, which may cause desertification of grasslands. Climate change will also lead to more opportunities for invasive species to establish and spread, and invasive species may outcompete with these species or their prey, or they may alter the species' habitat (USGCRP 2009). Restoration projects such as this may help species be more resilient and adapt to climate change (USDA 2011).
- Past projects (e.g., those related to roads or vegetation management) have caused reductions and enhancements of the species' habitat. See appendix in EIS for a list of specific projects also considered in this cumulative effects analysis.

The No-Action Alternative would perpetuate the encroachment of grasslands, meadows, and savannas by trees. It would exacerbate the reduction in habitat for voles and shrews from historic overgrazing, historic fire exclusion, elk-grazing, and recreation. The No-Action Alternative may therefore have an adverse effect on voles and shrews. Alternatives 2-4 may adversely impact the species in the short term but would cause a long-term beneficial impact. They would combine with the aforementioned past, ongoing, and reasonably foreseeable actions and events for a cumulative effect on the fitness of the species. In the context of these other factors, Alternatives 2-4 may impact the species, but their cumulative contribution would not cause a trend toward listing or loss of viability.

<u>Determination of Effects</u>

Alternative 1 may have an adverse impact on Navajo Mogollon vole and Merriam's shrew but would not cause a trend toward listing or loss of viability. No action would perpetuate the process of forest and woodland encroachment of the open-land habitat which these species inhabit.

Alternatives 2-4 may adversely impact Navajo Mogollon vole or Merriam's shrew in the short term but would cause a long-term beneficial impact. Alternatives 2-4 would not cause a trend toward listing or loss of viability. More habitat would be restored for these species under Alternative 2 than under Alternatives 3-4, as there would be more flexibility to restore openings that existed in pre-settlement times. Alternative 4 would have less road-related impacts than Alternatives 2-3, as no Maintenance-Level 1 Roads would be constructed under this Alternative.

Spotted Bat, Allen's Lappet-Browed Bat, and Pale Townsend's Big-Eared Bat

Existing Conditions

Spotted bat inhabits a variety of ecosystems, including desert, open ponderosa pine forest, pinyon-juniper woodland, canyon bottoms, riparian areas, and rangelands. Spotted bats roost in caves and cracks in cliffs and canyons. The species appears to breed from May-August, and it primarily consumes moths (NatureServe 2012).

Allen's lappet-browed bats occur throughout all but the southwestern portion of Arizona. They use a variety of habitats, including ponderosa pine, pinyon-juniper, riparian areas, Mexican woodland, white fir forests, and Mohave desertscrub. The species associates with streams and ponds, which it uses for feeding and/or drinking. Allen's lappet-browed bats roost in snags, caves, abandoned mine shafts, rocky areas, large snags, and cliffs (Hoffmeister 1986; Hinman and Snow 2003; Solvesky 2008). The reproductive biology of this species remains poorly know, but the species is thought to breed from May-August (Hinman and Snow 2003). These bats primarily predate small moths, but they eat other insects as well. Population trends remain poorly known. In fact, the species may have only expanded its range into Arizona during the twentieth century (Hoffmeister 1986). The species occurs on the Williams and Tusayan Ranger Districts and is likely to occur within the project area.

Pale Townsend's big-eared bat occurs throughout the western U.S and south into Mexico (Hoffmeister 1986; Hinman and Snow 2003). The species occurs from approximately 500-7,500 ft., but most records occur above 3,000 ft. In summer, the species roosts in caves and mines at a variety of elevations and in variety of ecosystems, including desertscrub, oak woodland, pine-oak forest, pinyon-juniper forest, and mixed conifer forest. In winter, the species hibernates in cold caves, lava tubes, and mines in the uplands and mountains. These bats primarily predate small moths, but they eat other insects as well. They may forage up to five miles from the roost site. Breeding occurs from April-August. Population trends remain unclear; however, populations have declined or vanished in some maternity roosts (Hinman and Snow 2003). The species has been detected on the Williams and Tusayan Ranger Districts and is likely to occur within the project area.

Direct and Indirect Effects for the No-Action Alternative (Alternative 1)

The No-Action Alternative would not affect the Spotted, Allen's lappet-browed, or pale Townsend's big-eared bats (henceforth collectively referred to as "bats") in the short term. Habitat conditions for these species would not change, notwithstanding the effects of natural processes. However, the No-Action Alternative would degrade the habitat for bats in the long term. By not using mechanical treatments and prescribed fire to restore unnaturally dense ponderosa pine, mixed conifer, and pinyon-juniper forests, the No-Action Alternative would hinder restoration of habitat for bats. The density of small-diameter trees would continue to increase under the No-Action Alternative and existing high probabilities of fire hazard would persist. This would also exacerbate competition among trees, slow their growth into larger diameter classes, and thereby limit the development of larger trees (18"+ DBH) that Allen's lappet-browed bats use for roosting. This could adversely impact these species.

Direct and Indirect Effects for Alternatives 2-4

Alternatives 2-4 would benefit bats by moving ponderosa pine, mixed conifer, and woodland habitat toward pre-settlement conditions to which the species adapted and evolved. Prescribed fire and mechanical treatment of hazardous fuels may result in a loss of snags; however, mitigation measures include fire-lining snags 18" DBH and greater prior to broadcast burning. Prescribed fire may cause direct mortality of young bats that have not developed into a mobile state. Alternatives 2-4 may result in a slight short-term decrease in snags followed by an increase over the long term. Smoke may disturb the species, but effects should be negligible due to the use of best management practices that include aiming for high lift and dispersion of smoke. This short term loss of snags would not affect the overall

distribution of Allent's lappet-browed bats on the Forest. Mechanical treatments followed by prescribed fire would restore the native understory plant biomass and diversity of forests (Laughlin et al. 2008; Kane et al. 2010). This would create more foraging opportunities for moths and other prey, increase populations of prey, and ultimately improve the fitness of bats. Cable-logging operations under Alternative 2 would cause a loss of snags across 72 acres potentially used by nesting and roosting Allen's lappet browed bats.

Road decommissions (and for Alternatives 2-3, conversion of road to trail) would restore more native habitat and reduce disturbance by humans. They would improve the condition of the soil and watersheds in the species' habitat. Construction of approximately 38-39 miles of temporary and Maintenance-Level 1 roads would clear trees and snags across approximately 304-312 acres. Construction of fireline would clear up to approximately 2,500 acres of snags and ladder fuels. Fireline, temporary roads, Maintenance-Level 1 roads, and trail construction would cause loss of trees, soil erosion, and sedimentation of waterways, which may reduce the habitat (and ultimately, populations) of bats or their prey. This may, in turn, affect bat fitness. Maintenance-Level 1 road construction would have a more long-term impact on the habitat of bats and their prey, as Maintenance-Level 1 roads would not be obliterated. Alternative 4 would have less road-related impacts than Alternatives 2-3, as no Maintenance-Level 1 Roads or trails would be constructed under this Alternative.

Mechanical treatment of hazardous fuels, prescribed fire, road construction, temporary road construction, road decommissions, and trail construction may temporarily disturb bats, cause a loss of snags and trees >18" DBH important to these species, degrade habitat for the species and its prey, or cause direct mortality, but such effects would not cause a trend toward listing or loss of viability. See Tables 3.6-3 and 4 for a quantitative description of habitat attributes and fire hazard in bat habitat under Alternatives 2-4.

Cumulative Effects

Several past, ongoing, and reasonably foreseeable actions and events have contributed, are contributing, and will contribute to the fitness of bats on the Kaibab National Forest:

- The abundance of trees in the late seral stage remains largely unchanged from historical conditions on slopes greater than 40%. However, even-aged forest management led to a loss of large, old trees, generally on slopes less than 40% and primarily from the 1960s through the early 1990s. The Forest Plan currently does not permit the harvest of trees greater than 24" DBH in mixed conifer or pine-oak forest; harvest of pre-settlement trees rarely occurs anymore, and in this and recent thinning and burning projects, pre-settlement tree conservation has been included as a mitigation measure. Current management generally aims to restore the Forest to pre-settlement conditions. This will increase the amount of trees >18" DBH (which bats use for roosting), offsetting historic losses.
- Bats primarily eat small moths (Hinman and Snow 2003). Intensive grazing decreases the abundance and species richness of moths (Poyry et al. 2004; Littlewood 2008), thereby depleting the prey base of bats and potentially causing a decrease in bat fitness. Intermediate levels of grazing have been shown to produce the highest abundance of Lepidoptera (Poyry et al. 2004). Although current levels of grazing have improved, the presence of livestock still reduces herbaceous vegetation. The current, adaptive-management approach (see Rangeland Specialist's Report and Hat Allotment Management Plan) to grazing across the National Forest System will ameliorate historic practices of intensive grazing, increase moth diversity and abundance, and lead to fitter bat populations.
- The forests in the project area are far removed from their historical fire regime (Tables 3.6-3 and 4). The Forest Service excluded fire from the Kaibab National Forest throughout much of the twentieth century, causing ponderosa pine, mixed conifer, and pinyon-juniper forests to grow unnaturally dense and become at risk of stand-replacing wildfire. Fire exclusion reduced,

fragmented, and degraded habitat for bats. Furthermore, it increased the potential for high-severity wildfires, which could cause direct mortality of bats and a long-term loss of habitat (e.g., snags; riparian areas). The Forest Service now embraces the natural role of fire on the landscape; current and future wildland fire management (including the use of wildfire) will increase, connect, and improve habitat for bats.

- Recreation (e.g., caving, geocaching, hiking, biking, and camping) may disturb bats. Recreational activities would continue to occur in the project area, resulting in potential declines or abandonment of bat roosts. Implementation of the Travel Management Rule will reduce access to bat habitat and improve conditions for the species.
- The removal of hazardous trees along powerlines, roads, and fire control lines has reduced and will continue to reduce the number of snags and trees >18" DBH in the project area, resulting in a decline in roosting habitat for Allen's lappet-browed bat.
- Illegal fuelwood harvest has caused and will continue to cause a loss of snags, which serve as roost sites for Allen's lappet-browed bats.
- Insect and disease outbreaks have killed and will continue to kill trees >18" DBH. Insect- and disease-related mortality also creates snags. Therefore, these outbreaks may benefit bats by creating more roost sites.
- Climate change will cause a decrease in precipitation, an increase in drought, higher temperatures, and a longer wildfire season, which will increase the probability of stand-replacing wildfire causing habitat loss for the species. Climate change will also lead to more opportunities for invasive species to establish and spread, and invasive species may outcompete with these species or their prey, or they may alter the species' habitat (USGCRP 2009). Restoration projects such as this may help species be more resilient and adapt to climate change (USDA 2011).
- Past projects (e.g., those related to roads or vegetation management) have caused reductions and enhancements of the species' habitat. See appendix in EIS for a list of specific projects also considered in this cumulative effects analysis.

The No-Action Alternative would perpetuate the unnaturally dense stands of ponderosa pine, mixed conifer, and pinyon-juniper forests. It would exacerbate the reduction in habitat from historic timber management, historic overgrazing, historic fire exclusion, recreation, illegal fuelwood cutting, and hazard-tree removal. The No-Action Alternative may therefore have an adverse effect on bats.

Alternatives 2-4 may adversely impact the species in the short term but would cause a long-term beneficial impact. They would combine with the aforementioned past, ongoing, and reasonably foreseeable actions and events for a cumulative effect on the fitness of the species. In the context of these other factors, Alternatives 2-4 may impact the species, but their cumulative contribution would not cause a trend toward listing or loss of viability.

<u>Determination of Effects</u>
Alternative 1 may adversely impact spotted bat, pale Townsend's big-eared, and Allen's lappet-browed bats, but it would not cause a trend toward listing or loss of viability. No action would perpetuate the high fuel loadings and fire hazard in the project area and would eventually lead to stand-replacing fire in the habitat of these species.

Alternatives 2-4 may adversely impact bat, pale Townsend's big-eared, and Allen's lappet-browed bats in the short term but would cause a long-term beneficial impact. Alternatives 2-4 would not cause a trend toward listing or loss of viability. More habitat would be restored for these species under Alternative 2 than under Alternatives 3-4, as there would be more flexibility to promote the growth of the largest trees. Alternative 4 would have less road-related impacts than Alternatives 2-3.

Northern Goshawk

Existing Conditions

The northern goshawk uses a wide variety of vegetative structural stages in the Southwest, but it primarily inhabits ponderosa pine and to a lesser extent, mixed conifer, forests. Nest areas typically occur on cooler, moister aspects and in drainages. Nesting goshawks prefer forests in later successional stages, often dominated by pre-settlement trees. Post-fledging family areas (PFAs) have patches of dense trees, developed herbaceous or shrubby understories, snags, downed logs, and small openings which provide protective cover and habitat for prey. Goshawks generally prefer stands of intermediate to high canopy cover for nesting and more open areas for foraging. Although juniper or pinyon-juniper woodlands 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. Nesting habitat preference tends to increase with canopy cover, although many goshawks in Arizona nest in more open habitat. Small forest openings provide travel corridors, provide habitat for open-country prey, and encourage the dispersal of fledglings. Northern goshawks prey upon birds and mammals (Reynolds et al. 1992; BNA Online 2012).

Post-fledging Family Areas (PFAs) center on the nesting and foraging habitat of goshawks. Nest areas are designated within PFAs and center around those areas where goshawks breed. See the Forest Plan for details (USDA 1988). PFAs and nest areas within the project area are composed of ponderosa pine forest. Table 3.6-15 describes the goshawk habitat within the project area. See the Silviculturist's Report for a description of the distribution of Vegetative Structural Stages (VSS) in goshawk habitat. All potential nesting and foraging habitat in the project area and 0.5 miles beyond the boundary was surveyed for northern goshawks in 2011 according to protocol as directed in the Forest Plan (USDA 1988). No new PFAs were discovered during that survey period, although one adult goshawk was seen flying overhead in the vicinity of the southwestern PFA (Figure 3.6-2).

Northern goshawk is a management indicator species of late-seral ponderosa pine forest. The Forest-wide population trend for northern goshawks is assumed to be declining (see USDA 2010 for details). Monitoring and surveys are ongoing on the Forest.

Table 3.6-15. Acres of different goshawk habitat within the project area.

Total Goshawk Habitats	15,068
Goshawk PFAs(excluding nest)	965
Goshawk Nest Stands	695
LOGPFAs (Ponderosa Pine Stands)	8,902
LOGPFAs (Mixed Conifer Stands)	1,973
LOGPFAs (Other)	2,533

Direct and Indirect Effects for the No-Action Alternative (Alternative 1)

The No-Action Alternative would not affect northern goshawks in the short term. Habitat conditions for the species would not change, notwithstanding the effects of natural processes. However, the No-Action Alternative would degrade the habitat for goshawks in the long term; by not using mechanical treatments and prescribed fire to restore unnaturally dense forests, the No-Action Alternative would hinder restoration of habitat for the species. Vegetative Structural Stage (VSS) distributions as outlined in the Forest Plan would never be attained, as trees would not have the opportunity to grow into larger size classes (See Silviculturist's Report). Goshawk habitat would remain at high risk of active crown fire (Tables 3.6-3 and 4).

The number of down logs and woody tons of debris per acre currently meet or exceed desired conditions under the Standards and Guidelines of the Forest Plan in ponderosa pine and mixed conifer landscapes outside goshawk PFAs, within PFAs, and within nest areas (Figures 3.6-3 and 4). However, the current number of snags/acre >18" DBH is well below desired conditions under the Standards and Guidelines (Figure 3.6-5). Alternative 1 would move toward the desired conditions for snags/acre in ponderosa pine forests, but it would move away from this condition in mixed conifer forest. Figures 3.6-3 through 5 do not account for wildfire under Alternative 1. As active crown fire is currently highly probable in most goshawk habitat (Tables 3.6-3 and 4), more existing woody debris, down logs, and snags would likely be consumed by wildfire under Alternative 1 than the Action Alternatives. This would also create much woody debris and down logs, as well as a short-term flush of fire-killed trees turned into snags. See Silviculturist's Report for a quantitative analysis of Alternatives 1 on VSS structure and percent canopy cover by VSS.

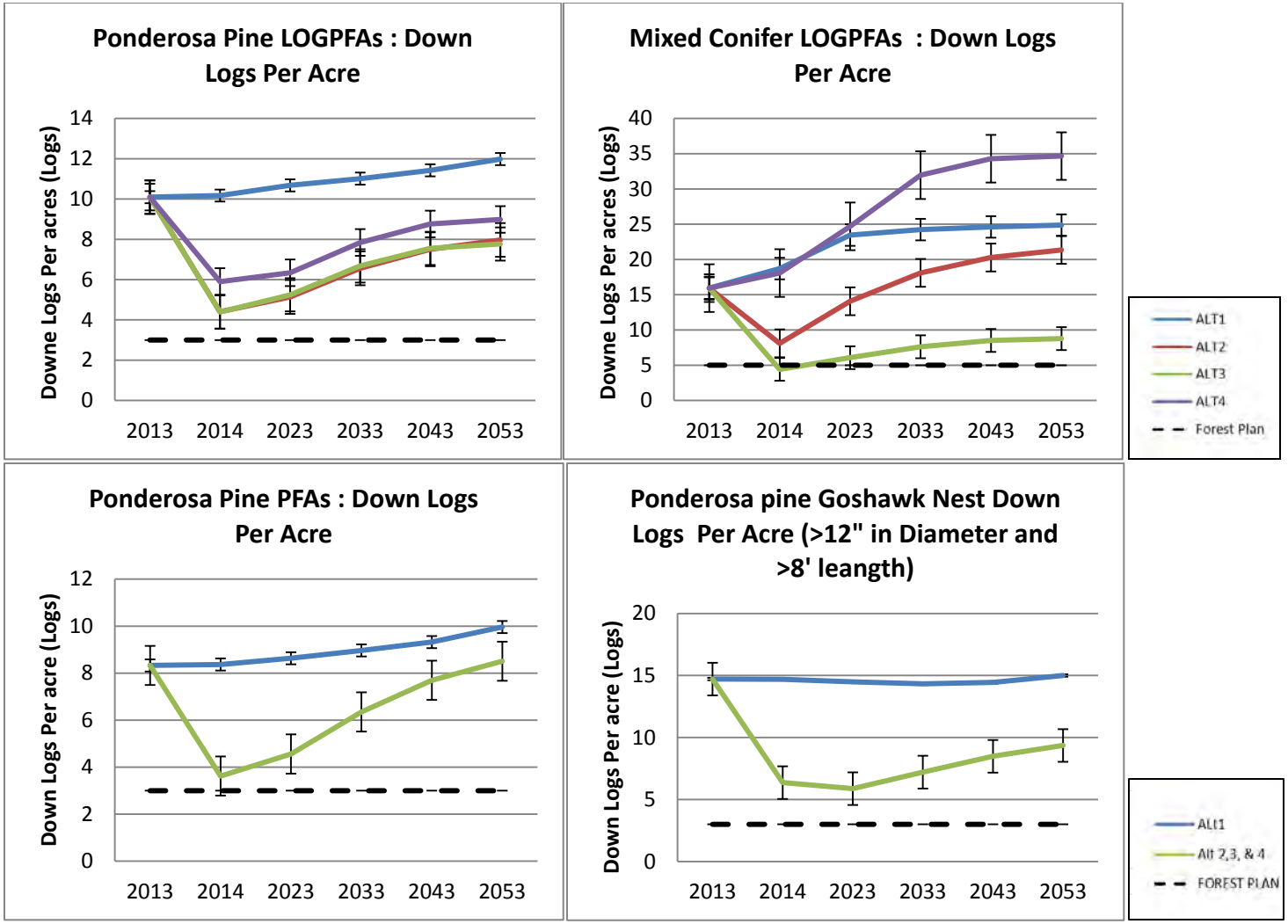


Figure 3.6-3. Effects of Alternatives on down logs/acre in landscapes out goshawk PFAs (LOGPFAs), PFAs, and nest areas in ponderosa pine and mixed conifer forests.

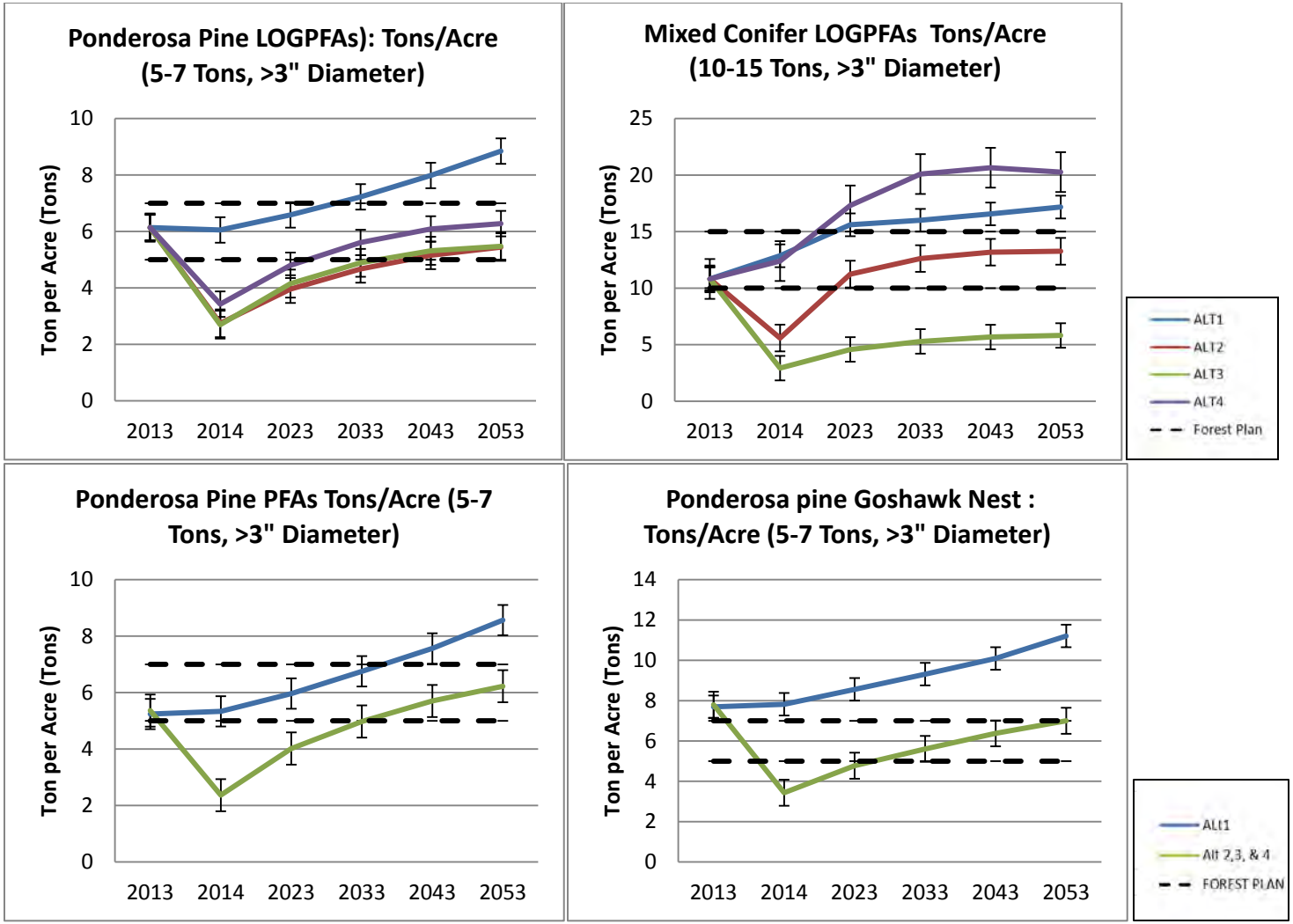


Figure 3.6-4. Effects of Alternatives on tons of woody debris/acre in landscapes out goshawk PFAs (LOGPFAs), PFAs, and nest areas in ponderosa pine and mixed conifer forests.

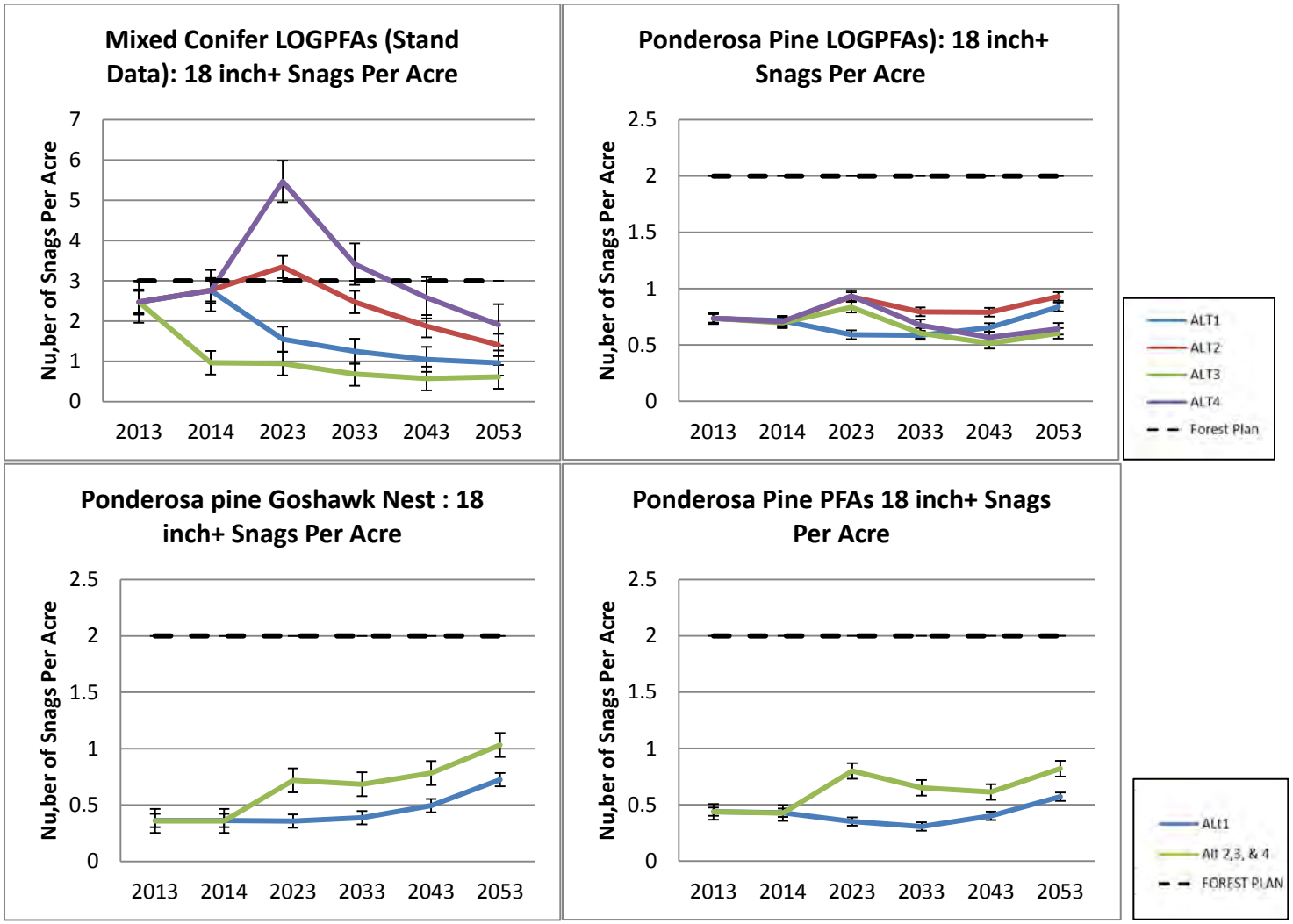


Figure 3.6-5. Effects of Alternatives on large snags/acre in landscapes out goshawk PFAs (LOGPFAs), PFAs, and nest areas in ponderosa pine and mixed conifer forest

Direct and Indirect Effects for Alternatives 2-4

Alternatives 2-4 would benefit goshawks by moving ponderosa pine forest, mixed conifer forest, and woodlands toward pre-settlement conditions to which the species adapted and evolved, while still conserving existing nest areas and PFAs regardless of historic conditions in these areas. Thinning treatments to restore unnaturally dense forests to historic conditions have been demonstrated to improve goshawk habitat (BNA Online 2012), so the mechanical treatments and prescribed fire under Alternatives 2-4 would benefit the species. Fuels-reduction treatments would develop a mosaic of uneven-aged forest across the landscape. Alternatives 2-4 would conserve groups of larger trees (typically 18" DBH or greater). By thinning unnaturally dense forests, Alternatives 2-4 would reduce competition among trees, thereby promoting the growth of larger trees. Growth of trees >18" DBH would be greatest under Alternative 2, intermediate under Alternative 3, and least under Alternative 4, as these alternatives have (in said order) progressively less flexibility in reducing competition around trees >18" DBH. Thinning and prescribed fire would reduce the probability of stand-replacing wildfire in forests, thereby conserving the mature forest, trees >18" DBH, and snags on which this species relies. Reductions in fire hazard to goshawk habitat are greatest under Alternative 2, intermediate under Alternative 3, and least under Alternative 4, as these alternatives have (in said order) progressively more mechanical treatment (Tables 3.6-3 and 4). More open habitat around PFAs and nest areas under Alternative 2 would reduce fire hazard to PFAs and nest areas, in comparison to Alternatives 3-4.

As Alternative 2 would most improve tree growth (see Silviculturist's Report) while still conserving nest areas and PFAs at high densities, it would most benefit the production of large live trees, recruitment of snags, and recruitment of down logs (habitat attributes important to goshawks and their prey). Groups of trees would occur in areas where historical evidences exist or where best group/clump structure exists at time of implementation. Snags and down logs would be conserved per Forest Plan direction. Woody debris would be conserved over the long term, although all of the Action Alternatives would cause a short-term reduction in woody debris below Forest Plan direction. The only exception is that mixed conifer landscapes outside PFAs would increase in woody debris, even the short term, although this is due to the high number of trees consumed by high-severity fire. A diverse age and size class and interlocking crowns would occur in clumps.

Loss of mistletoe-infected trees would cause a loss of nesting microhabitat for prey species. Although many mistletoe-infected trees would be removed, a mitigation measure specific to conservation of important wildlife trees will conserve this naturally occurring attribute of the ecosystem (see Section 2.3.1 of the EIS). Mitigations include conservation of pre-settlement trees wherever possible (including those with mistletoe infection), and conserving large, mistletoe-infected trees that occur within groups of pre-settlement trees that are infected with mistletoe already.

Smoke from broadcast and pile-burning may disturb goshawks, including nesting individuals. Smoke accumulation during times when goshawks are incubating eggs and tending nestlings and fledglings could cause adults to leave the area. Smoke tends to settle into low-lying areas, including drainages which goshawks inhabit. Due to prevailing winds from the southwest, smoke generally affects goshawks to the northeast of burning activities. Smoke may have short-term (3-5 days) effects. Smoke accumulation may cause goshawks to flush from nest areas or change their foraging behavior. This could cause goshawks to expend more energy or become more vulnerable to predators. However, fuels specialists would avoid burning all goshawk PFAs in the

project area at once, which would reduce the overall effect by providing refugia for the species. Impacts from smoke are reduced by the coordination of timing and type of burning with wind direction, topography, and time of year.

Prescribed fire and mechanical treatment of hazardous fuels may result in a loss of snags; however, mitigation measures include fire-lining snags 18" DBH and greater prior to broadcast burning. Throughout the project, torching may occur within treatment areas during broadcast burning activities. Torching would mimic gap-producing processes that occur under natural conditions. Alternatives 2-4 may result in a slight short-term decrease in snags followed by an increase over the long term. Alternative 4 (and Alternatives 2 and 3, if prescribed fire is used without first mechanically treating areas) would result in a higher loss of snags, as dense stand conditions would lead to more loss of forest and snags to torching. Noise from mechanical treatments would not likely directly affect nesting goshawks, as no thinning would occur within active PFAs during the breeding season.

Woody debris and snags provide habitat for small mammals and other prey. Indirect effects of reducing woody debris due to broadcast burning would decrease the abundance of prey on a short-term basis for approximately one year. However, herbaceous vegetation typically responds favorably to broadcast burning, and an increase in forage for small mammals is expected in years without drought (Jenness 2000). Model results indicated that the abundance of small mammals increases with the height of herbaceous growth, the diversity of shrubby vegetation, and the amount of downed logs (Ward 2001). Under Alternatives 2-4, prescribed fire would stimulate grass-forb growth and result in both a consumption and creation of downed logs.

See Figures 3.6-3 through 5 for a quantitative analysis of the effects of Alternatives 2-4 on snags, woody debris, and down logs.

As Alternatives 2-4 would entail identical treatments within goshawk PFAs and nest areas, they would have the same effect on snags, woody debris, and down logs. Snags would increase over time but still remain below desired levels according to the Standards and Guidelines of the Forest Plan. The Action Alternatives would increase snag conservation in nest areas and PFAs in comparison to the No-Action Alternative. There would be an initial decrease in down logs and woody debris (due to consumption by prescribed fire), but there would be a long-term increase. Down logs and woody debris would still be conserved at desired levels in PFAs and nest areas under the Standards and Guidelines of the Forest Plan, although there would be a short-term reduction in desired levels of woody debris.

In landscapes outside PFAs in pine forest, Alternative 2 would most conserve snags, and Alternatives 3 and 4 would have virtually the same effect on snag conservation. Alternative 4 would cause a short-term spike in snags in mixed conifer forest outside PFAs, and it would create and retain the most snags over time. Most mixed conifer forest occurs on steep slopes that would not receive mechanical treatment before prescribed fire. Therefore, many trees would die from prescribed fire, causing a flush of snag creation, followed by many snags falling and turning into down logs. Alternative 2 would result in more snags than Alternative 3.

Down logs and woody debris in landscapes outside goshawk PFAs would be much greater under Alternative 4 than Alternatives 2-3, as prescribed fire without first mechanically treating areas would cause consumption of trees and snags by fire, converting them to down logs (Figures 3.6-3 and 4).

Road decommissions (and for Alternatives 2-3, conversion of road to trail) would restore more native habitat and reduce disturbance by humans. They would improve the condition of the soil and watersheds in the species' habitat. These activities would not occur within active PFAs during the breeding season and therefore would negligibly affect the species. Construction of approximately 38-39 miles of temporary and Maintenance-Level 1 roads would clear trees and snags across approximately 304-312 acres. Construction of fireline would clear up to approximately 2,500 acres of snags and ladder fuels. Construction of fireline, temporary roads, Maintenance-Level 1 roads, and trail would cause a loss of trees and soil erosion and sedimentation of waterways, which may reduce the habitat (and ultimately, populations) of goshawk prey. This may, in turn, affect goshawk fitness. Maintenance-Level 1 road construction would have more impact on habitat of goshawk prey, as Maintenance-Level 1 roads would not be obliterated. Alternative 4 would have less road-related impacts than Alternatives 2-3, as no Maintenance-Level 1 Roads or trails would be constructed under this Alternative. Alternatives 2-3 would result in 0.7 miles (6 acres) of temporary road construction and 5.1 miles (4 acres) of Maintenance-Level 1 road construction within goshawk PFAs and nest areas. Alternative 4 would result in 5.8 miles (5 acres) of temporary road construction within goshawk PFAs and nest areas but no Maintenance-Level 1 road construction in PFAs or nest areas. All other road construction (see description of Alternatives) would occur in landscapes outside PFAs.

Under Alternative 2, cable-logging operations in goshawk foraging habitat would result in the loss of approximately 72 acres of snags >18" DBH and pre-settlement trees in mixed conifer landscapes outside goshawk PFAs. These features are important to goshawks and their prey.

Cumulative Effects

Several past, ongoing, and reasonably foreseeable actions and events have contributed, are contributing, and will contribute to the fitness of goshawks on the Kaibab National Forest:

- The abundance of trees in the late seral stage remains largely unchanged from historical conditions on slopes greater than 40%. However, even-aged forest management led to a loss of large, old trees, generally on slopes less than 40% and primarily from the 1960s through the early 1990s. Recent projects in forest management (see appendix in EIS) emphasize restoration and fire hazard reduction, thereby promoting the sustainability of the species' habitat in and around the project area. The standards and guidelines of the current, amended Forest Plan provide for management that encourages the dominance of larger, older trees across goshawk habitat (see Project Implementation Checklist and Section 2.3.1 in the EIS section for details). Many of the protections for MSO habitat also help to conserve goshawk habitat. For example, the Forest Plan does not permit the harvest of trees greater than 24" DBH in MSO Restricted Habitat (USDA 1988). Current management generally aims to restore the Forest to pre-settlement conditions and to increase the amount of trees >18" DBH and the number of snags.
- The forests in the project area are far removed from their historical fire regime (Tables 3.6-3 and 4). The Forest Service excluded fire from the Kaibab National Forest throughout much of the twentieth century, causing mixed conifer, ponderosa pine, and other forests to grow unnaturally dense and become at risk of stand-replacing wildfire. Fire exclusion has increased the potential for high-severity wildfires, which could cause direct mortality of goshawks, and a long-term loss of microhabitat (e.g., trees >18" DBH). The Forest Service now embraces the natural role of fire on the landscape; current and future wildland fire management (including the use of wildfire) will increase, connect, and improve habitat for goshawks. Furthermore, current fire and forest

management practices should improve the growth of trees >18" DBH by reducing competition, while still maintaining important canopy-cover and VSS attributes in nest areas, PFAs, and foraging habitat.

- Recreation (e.g., off-road vehicle use, hiking, biking, and camping) may disturb goshawks. Recreational activities would continue to occur in the project area, resulting in a potential decrease in fitness.
- The removal of hazardous trees along powerlines, roads, and fire control lines has reduced and will continue to reduce the number of snags and trees >18" DBH in the area of the project, resulting in a decline in important habitat components for goshawks.
- Illegal fuelwood harvest has caused and will continue to cause a loss of snags.
- Insect and disease outbreaks have killed and will continue to kill trees >18" DBH. Insect- and disease-related mortality also creates snags.
- Climate change will cause a decrease in precipitation, an increase in drought, higher temperatures, and a longer wildfire season, which will increase the probability of stand-replacing wildfire causing habitat loss for the species. Climate change will also lead to more opportunities for invasive species to establish and spread, and invasive species may outcompete with these species or their prey, or they may alter the species' habitat (USGCRP 2009). Restoration projects such as this may help species be more resilient and adapt to climate change (USDA 2011).
- Past projects (e.g., those related to roads or vegetation management) have caused reductions and enhancements of the species' habitat. See appendix in EIS for a list of specific projects also considered in this cumulative effects analysis.

The No-Action Alternative would perpetuate the unnaturally dense conditions in the coniferous forests of the project area. It would exacerbate the reduction in habitat from changes in historic timber management, historic fire exclusion, recreation, illegal fuelwood harvest, and hazard-tree removal. The No-Action Alternative may therefore have an adverse effect on northern goshawks.

Alternatives 2-4 may adversely impact the species in the short term but would cause a long-term beneficial impact. They would combine with the aforementioned past, ongoing, and reasonably foreseeable actions and events for a cumulative effect on the fitness of northern goshawks. In the context of these other factors, Alternative 2 may impact northern goshawks, but their cumulative contribution would not cause a trend toward listing or loss of viability.

Determination of Effects

The No-Action Alternative may adversely impact the northern goshawk, but it would not cause a trend toward listing or loss of viability. No action would perpetuate the high fuel loadings and fire hazard in the project area and would eventually lead to stand-replacing fire in the habitat of the species.

Alternatives 2-4 may adversely impact northern goshawks in the short term but would cause a long-term beneficial impact. Alternatives 2-4 would not cause a trend toward listing or loss of viability, and their impacts would not be enough to change Forest-wide population or habitat trends. More habitat would be protected and restored for the species under Alternative 2 than under Alternatives 3-4, as there would be less fire hazard and more flexibility to promote the growth of the largest trees that this species uses for nesting and which serve as recruitment snags and down logs on which prey species rely. Alternative 4 would have less road-related impacts than Alternatives 2-3.

Bald Eagle

Existing Conditions

Eagles are currently protected under the Bald and Golden Eagle Protection Act and are a Forest Service sensitive species. Bald eagles are only known to winter on the Kaibab National Forest, where they occupy all habitat types and elevations. Wintering eagles arrive in the fall (usually late October-early November), and leave in early to mid-April. Bald eagles have been detected within the project area, although the occurrence of habitually used winter roosts remains unknown.

Roosting: Small or moderately sized groups (usually 2-50) of bald eagles roost at night in clumps of large trees in locations such as drainages and hillsides (Grubb and Kennedy 1982, Dargan 1991). Eagles typically roost in ponderosa pine stands that vary in size (1-43 acres), often occur on north or northeast-facing slopes, and are close to daytime foraging areas (Dargan 1991). Roost trees are large (averaging 28" DBH) live or dead ponderosa pine trees that occur in groups (Dargan 1991).

Foraging: Eagles forage widely and opportunistically on carrion, waterfowl, fish, and terrestrial vertebrates. Eagles will use any open water that supports waterfowl. No large water bodies occur within the project area, so foraging eagles within the project area most likely target carrion and terrestrial vertebrates for food. Eagles likely forage from snags and dead-topped trees within and at the fringes of the project area.

Direct and Indirect Effects for the No-Action Alternative (Alternative 1)

The No-Action Alternative would not affect bald eagles in the short term. Habitat conditions for the species would not change, notwithstanding the effects of natural processes. However, the No-Action Alternative would perpetuate overly dense forest conditions in fire-dependent ecosystems. Such conditions increase the potential for high-severity wildfire in and around eagle habitat. This may reduce the amount of trees >18" DBH, snags, and other important habitat attributes for bald eagles.

Tree densities would continue to increase under the No-Action Alternative. This would exacerbate competition among trees, slow their growth into larger diameter classes, and thereby limit the development of larger trees (18"+ DBH) and recruitment snags that eagles use for roosting and foraging. By not reducing hazardous fuels and not allowing for tree growth, the No-Action Alternative would hinder the conservation of the habitat of bald eagles and their prey. This could result in an adverse effect on the species.

Direct and Indirect Effects for Alternatives 2-4

Alternatives 2-4 would benefit eagles by moving ponderosa pine forest, mixed conifer forest, woodlands, and grasslands toward pre-settlement conditions to which the species adapted and evolved. Mechanical treatments and prescribed fire under Alternatives 2-4 would benefit the species by restoring more open areas for foraging and by reducing fire hazard to trees >18" DBH, snags, and the general habitat of eagles. Fuels-reduction treatments would develop a mosaic of uneven-aged forest across the landscape. Alternatives 2-4 would conserve groups of larger trees (typically 18" DBH or greater). By thinning unnaturally dense forests, Alternatives 2-4 would reduce competition among trees, thereby promoting the growth of larger trees. Growth of trees >18" DBH would be greatest under Alternative 2, intermediate under Alternative 3, and least under Alternative 4, as these alternatives have (in said order) progressively less flexibility in reducing competition around trees >18" DBH (see Silviculturist's Report). Thinning and

prescribed fire would reduce the probability of stand-replacing wildfire in forests, thereby conserving the mature forest, trees >18" DBH, and snags on which this species relies. Reductions in fire hazard to eagle habitat are greatest under Alternative 2, intermediate under Alternative 3, and least under Alternative 4, as these alternatives have (in said order) progressively more mechanical treatment.

Openings important to foraging eagles would be scattered throughout ponderosa pine and woodland habitat with progressively more openings as one moves from nest areas to PFAs to foraging areas. Snags, downed logs, and woody debris would be conserved per forest plan direction. A diverse age and size class and interlocking crowns would occur in clumps. These conditions would benefit eagles by sustaining foraging perches and habitat for prey.

Smoke from prescribed fire and noise from mechanical treatments may disturb the species. These disturbances may cause the species to abandon areas and become more vulnerable to predators. Impacts from smoke are reduced by the coordination of timing and type of burning with wind direction, topography, and time of year.

Prescribed fire and mechanical treatment of hazardous fuels may result in a loss of snags; however, mitigation measures include fire-lining snags 18" DBH and greater prior to broadcast burning. Throughout the project, torching may occur within treatment areas during broadcast burning activities. Torching would mimic gap-producing processes that occur under natural conditions. Broadcast burning may decrease woody debris by up to approximately 50% of existing volume, and decrease the number of snags by 20% (Randall-Parker and Miller 2000). Alternatives 2-4 may result in a slight short-term decrease in snags followed by an increase over the long term. Alternative 4 (and Alternatives 2 and 3, if prescribed fire is used without first mechanically treating areas) would result in a higher loss of snags, as dense stand conditions would lead to more loss of forest and snags to torching.

Woody debris and snags provide habitat for small mammals and other prey. Indirect effects of reducing woody debris due to broadcast burning will decrease the abundance of prey on a short-term basis for approximately one year. However, herbaceous vegetation typically responds favorably to broadcast burning, and an increase in forage for small mammals is expected in years without drought (Jenness 2000). Model results indicated that the abundance of small mammals increases with the height of herbaceous growth, the diversity of shrubby vegetation, and the amount of downed logs (Ward 2001). Under Alternatives 2-4, prescribed fire would stimulate grass-forb growth and result in both a consumption and creation of downed logs.

Road decommissions (and for Alternatives 2-3, conversion of road to trail) would restore more native habitat and reduce disturbance by humans. They would improve the condition of the soil and watersheds in the species' habitat. Construction of approximately 38-39 miles of temporary and Maintenance-Level 1 roads would clear trees and snags across approximately 304-312 acres. Construction of fireline would clear up to approximately 2,500 acres of snags and ladder fuels. Construction of fireline, temporary roads, Maintenance-Level 1 roads, and trail would cause soil erosion and sedimentation of waterways, which may reduce the habitat (and ultimately, populations) of eagle prey. This may, in turn, affect eagle fitness. Maintenance-Level 1 road construction would have more impact on habitat of eagle prey, as Maintenance-Level 1 roads would not be obliterated. Alternative 4 would have less road-related impacts than Alternatives 2-3, as no Maintenance-Level 1 Roads or trails would be constructed under this Alternative.

Approximately 72 acres of forest would be denuded by cable-logging operations in forested areas under Alternative 2, resulting in the loss of snags >18" DBH and pre-settlement trees, features that are important to eagles and their prey.

See Tables 3.6-3 and 4 for a quantitative description of habitat attributes and fire hazard in eagle habitat under Alternatives 2-4.

Cumulative Effects

Several past, ongoing, and reasonably foreseeable actions and events have contributed, are contributing, and will contribute to the fitness of bald eagles on the Kaibab National Forest:

- The abundance of trees in the late seral stage remains largely unchanged from historical conditions on slopes greater than 40%. However, even-aged forest management led to a loss of large, old trees, generally on slopes less than 40% and primarily from the 1960s through the early 1990s. Recent projects in forest management (see appendix in EIS) emphasize restoration and fire hazard reduction, thereby promoting the sustainability of the species' habitat in and around the project area. The Forest Plan currently does not permit the harvest of trees greater than 24" DBH in mixed conifer or pine-oak forest; harvest of pre-settlement trees rarely occurs anymore, and in this and recent thinning and burning projects, pre-settlement tree conservation has been included as a mitigation measure. Current management generally aims to restore the Forest to pre-settlement conditions. This will increase the amount of large trees (which eagles use for nesting and roosting and as foraging perches), offsetting historic losses.
- Historic overgrazing has reduced protective cover and food for terrestrial vertebrates, which reduces their population size and the amount of prey for eagles. This could potentially reduce the fitness of eagles on the Forest. Although current levels of grazing have improved, the presence of livestock still reduces herbaceous vegetation. The current, adaptive-management approach (see Rangeland Specialist's Report and Hat Allotment Management Plan) to grazing across the National Forest System may increase the protective cover and food available for terrestrial vertebrates. This will increase prey populations for bald eagles and ameliorate potentially negative effects on the fitness of eagles in the project area. For example, current exclusion of sheep around water bodies in the project area will increase herbaceous growth around these water bodies. This would in turn provide protective cover and food for terrestrial vertebrates and waterfowl, which bald eagles eat.
- Past use of dichlorodiphenyltrichloroethane (DDT) caused a decrease in the population of raptor species, including bald eagles. A ban on this chemical has caused the species to continually grow in population size (BNA Online 2012).
- The removal of hazardous trees along powerlines, roads, and fire control lines has reduced and will continue to reduce the number of snags and trees >18" DBH in the project area.
- Illegal fuelwood harvest has caused and will continue to cause a loss of snags.
- Insect and disease outbreaks have killed and will continue to kill trees. Insect- and disease-related mortality creates more snags, and eventually, downed logs. Terrestrial prey use downed logs, and eagles use snags for nesting, roosting, and as foraging perches. However, eagles also use large, live trees that insects and disease kill.
- Climate change will cause a decrease in precipitation, an increase in drought, higher temperatures, and a longer wildfire season, which will increase the probability of stand-replacing wildfire causing habitat loss for the species. Climate change will also lead to more opportunities for invasive species to establish and spread, and invasive species may

outcompete with these species or their prey, or they may alter the species' habitat (USGCRP 2009). Restoration projects such as this may help species be more resilient and adapt to climate change (USDA 2011).

- Past projects (e.g., those related to roads or vegetation management) have caused reductions and enhancements of the species' habitat. See appendix in EIS for a list of specific projects also considered in this cumulative effects analysis.

By not reducing hazardous fuels, not allowing for tree growth, and not creating more waterfowl habitat, the No-Action Alternative would hinder the conservation of the habitat of bald eagles and their prey. It would exacerbate the effects of historic timber management, historic overgrazing, historic fire exclusion, past use of DDT, recreation, elk-grazing, illegal fuelwood harvest, and hazard-tree removal. The No-Action Alternative may therefore have an adverse impact on bald eagles.

Alternatives 2-4 may adversely impact the species in the short term but would cause a long-term beneficial impact. They would combine with the aforementioned past, ongoing, and reasonably foreseeable actions and events for a cumulative effect on the fitness of the species. In the context of these other factors, Alternatives 2-4 may impact the species, but their cumulative contribution would not cause a trend toward listing or loss of viability.

Determination of Effects

Alternative 1 may adversely impact the bald eagle, but it would not cause a trend toward listing or loss of viability. No action would perpetuate the high fuel loadings and fire hazard in the project area and would eventually lead to stand-replacing fire in the habitat of the species.

Alternatives 2-4 may adversely impact the bald eagle in the short term but would cause a long-term beneficial impact. Alternatives 2-4 would not cause a trend toward listing or loss of viability. More habitat would be restored for the species under Alternative 2 than under Alternatives 3-4, as there would be more flexibility to promote the growth of the largest trees that this species uses for roosting and foraging and which serve as recruitment snags and down logs on which prey species rely. Furthermore, Alternative 2 would restore more open areas that are important to foraging eagles. Alternative 4 would have less road-related impacts than Alternatives 2-3. Unintentional take of eagles would not occur under any of the Alternatives.

American Peregrine Falcon

Existing Conditions

Peregrine falcons require rock cliffs for nesting and expansive foraging areas. Suitable nesting sites on rock cliffs have a mean height of 200-300 ft. The species occurs statewide as a migrant, transient, and/or wintering individual (Corman and Wise-Gervais 2005; BNA Online 2012). The subspecies *anatum* permanently resides on the Kaibab National Forest and breeds on isolated cliff ledges. It is only known to currently or historically nest at three locations on the Williams Ranger District. Peregrine falcons historically nested on Bill Williams Mountain but have not been detected nesting in the area in several years. The locations of this nest area overlaps with the Bill Williams PAC. Prey species include bats, mammals, and birds; however, peregrine falcons mainly predate wetland birds in riparian areas, meadows, parklands, croplands, mountain valleys, and lakes within a 10-20 mile radius of the nest area. The species' breeding season occurs from March 1st to August 31st (Corman and Wise-Gervais 2005; BNA Online 2012).

Direct and Indirect Effects for the No-Action Alternative (Alternative 1)
The No-Action Alternative would not affect the peregrine falcon in the short term. Habitat conditions for falcons would not change, notwithstanding the effects of natural processes. However, the No-Action Alternative would degrade the habitat for falcons in the long term. By not removing conifers which have encroached upon grasslands, meadows, and savannas, the No-Action Alternative would prevent the conservation of foraging habitat for falcons. This could result in an adverse effect.

Direct and Indirect Effects for Alternatives 2-4
Alternatives 2-4 would treat around areas where Peregrine Falcons have been observed to nest in the past. As this is a cliff-nesting species and as the area around historic or potential nest sites are primarily rock, the Action Alternatives would not affect the nesting habitat of the species. However, mechanical treatments and prescribed fire would restore grasslands, meadows, and savannas toward pre-settlement conditions to which the species adapted and evolved and would therefore benefit the species. Alternative 2 would better restore more grasslands, meadows, and savannas than Alternatives 3-4, as more openings would be created.

The ecosystems within the project area have all adapted and evolved to periodic fire (USDA 2012), and it is reasonable to assume that the species within these ecosystems have also adapted and evolved to this disturbance. Herbaceous vegetation would increase in abundance and diversity with prescribed fire. This would cause an increase in the population of terrestrial prey, which would benefit peregrine falcons. Herbaceous growth and related benefits would be higher under Alternative 2 than Alternatives 3-4, as canopies would be more open across the project area, which would in turn promote higher herbaceous growth.

Noise from mechanical treatment of hazardous fuels may disturb falcons. However, timing restrictions around active nests would prevent noise disturbance from affecting reproductive success. Smoke from prescribed fire may disturb the species. These disturbances may cause the species to abandon areas and become more vulnerable to predators. Impacts from smoke are reduced by the coordination of timing and type of burning with wind direction, topography, and time of year.

Road decommissions (and for Alternatives 2-3, conversion of road to trail) would restore more native habitat and reduce disturbance by humans. They would improve the condition of the soil and watersheds in the species' habitat. Construction of approximately 38-39 miles of temporary and Maintenance-Level 1 roads would clear trees and snags across approximately 304-312 acres. Construction of fireline would clear up to approximately 2,500 acres of snags and ladder fuels. Construction of fireline, temporary roads, Maintenance-Level 1 roads, and trail would cause soil erosion and sedimentation of waterways, which may reduce the habitat (and ultimately, populations) of falcon prey. This may, in turn, affect fitness of the species. Maintenance-Level 1 road construction would have more impact on habitat of falcons' prey, as Maintenance-Level 1 roads would not be obliterated. Alternative 4 would have less road-related impacts than Alternatives 2-3, as no Maintenance-Level 1 Roads or trails would be constructed under this Alternative. See Tables 3.6-3 and 4 for a quantitative description of habitat attributes and fire hazard in falcon habitat under Alternatives 2-4.

Cumulative Effects
Several past, ongoing, and reasonably foreseeable actions and events have contributed, are contributing, and will contribute to the fitness of peregrine falcons on the Kaibab National Forest:

- Grasslands, meadows, and wetlands – including those in the Southwest – evolved to periodic disturbance from fire (USDA 2012). Historic fire exclusion from wetlands decreased the amount of open-water habitat for waterfowl. The Forest Service excluded fire from the Kaibab National Forest throughout much of the twentieth century, causing the encroachment of trees onto grasslands, meadows, and savannas; this reduced, fragmented, and degraded foraging habitat for falcons. The Forest Service now embraces the natural role of fire on the landscape; current and future wildland fire management (including the use of wildfire) will increase, connect, and improve falcon habitat.
- Historic overgrazing has reduced protective cover and food for terrestrial vertebrates, which reduces their population size and the amount of prey for falcons. This could potentially reduce the fitness of falcons on the Forest. Although current levels of grazing have improved, the presence of livestock still reduces herbaceous vegetation. The current, adaptive-management approach (see Rangeland Specialist's Report and Hat Allotment Management Plan) to grazing across the National Forest System may increase the protective cover and food available for terrestrial vertebrates. This will increase prey populations for peregrine falcons and ameliorate potentially negative effects on the fitness of eagles in the project area. For example, current exclusion of sheep around water bodies in the project area will increase herbaceous growth around these water bodies. This would in turn provide protective cover and food for terrestrial vertebrates and waterfowl, which peregrine falcons eat.
- Past use of dichlorodiphenyltrichloroethane (DDT) caused a decrease in the population of raptor species, including peregrine falcons. A ban on this chemical has caused the species to continually grow in population size (BNA Online 2012).
- Recreation (e.g., rock-climbing, hiking) around cliff habitat has occurred and continues to occur in and around the project area. Recreationists may disturb falcons and cause them to abandon suitable habitat (BNA Online 2012).
- Climate change will cause a decrease in precipitation, an increase in drought, higher temperatures, and a longer wildfire season, which will increase the probability of stand-replacing wildfire and desertification of open lands, causing habitat loss for the species. Climate change will also lead to more opportunities for invasive species to establish and spread, and invasive species may outcompete with these species or their prey, or they may alter the species' habitat (USGCRP 2009). Restoration projects such as this may help species be more resilient and adapt to climate change (USDA 2011).
- Past projects (e.g., those related to roads or vegetation management) have caused reductions and enhancements of the species' habitat. See appendix in EIS for a list of specific projects also considered in this cumulative effects analysis.

By not creating more foraging habitat, the No-Action Alternative would hinder the conservation of peregrine falcons. It would exacerbate the effects of historic overgrazing, historic fire exclusion, past use of DDT, elk-grazing, and recreation. The No-Action Alternative may therefore have an adverse impact on peregrine falcons.

Alternatives 2-4 may adversely impact the species in the short term but would cause a long-term beneficial impact. They would combine with the aforementioned past, ongoing, and reasonably foreseeable actions and events for a cumulative effect on the fitness of falcons. In the context of these other factors, Alternatives 2-4 may impact peregrine falcons, but their cumulative contribution would not cause a trend toward listing or loss of viability.

Determination of Effects
Alternative 1 may adversely impact the American peregrine falcon, but it would not cause a trend toward listing or loss of viability. No action would perpetuate the process of forest and woodland encroachment of the open-land habitat which these species inhabit.

Alternatives 2-4 may adversely impact the American peregrine falcon in the short term but would cause a long-term beneficial impact. Alternatives 2-4 would not cause a trend toward listing or loss of viability. More habitat would be restored for prey species under Alternative 2 than under Alternatives 3-4, as there would be more flexibility to restore openings that existed in pre-settlement times. Alternative 4 would have less road-related impacts on prey species than Alternatives 2-3, as no Maintenance-Level 1 Roads would be constructed under this Alternative.

Four-Spotted Skipperling
Existing Conditions
Biologists have not detected the four-spotted skipperling within the project area. However, suitable habitat exists within the project area. These butterfly species inhabit moist meadows, seeps, springs, and streams within ponderosa pine and mixed conifer forests.

Direct and Indirect Effects for the No-Action Alternative (Alternative 1)
The No-Action Alternative would not affect the four-spotted skipperling in the short term. Habitat conditions for these species would not change, notwithstanding the effects of natural processes. However, the No-Action Alternative would degrade the habitat for skipperlings in the long term. By not removing conifers which have encroached upon meadows, the No-Action Alternative would hinder restoration of habitat for skipperlings. Invading conifers would continue to take in water that would otherwise flow in seeps, springs, and wet meadows. This could adversely impact these species.

Direct and Indirect Effects for Alternatives 2-4
Alternatives 2-4 would benefit the species by restoring meadows and reducing the amount of water-consuming, invaded conifers in seeps, springs, and meadows. Alternative 2 would remove encroaching conifers from meadows, seeps, and springs more than Alternatives 3-4, as more areas would be restored to pre-settlement conditions. This would restore herbaceous growth (that serves as protective cover and food for skipperlings) and therefore increase the species' fitness. Prescribed fire may cause direct mortality of the species.

Road decommissions, road closures, and conversion of road to trail would restore more native habitat. Construction of temporary (and for Alternatives 2-3, Maintenance-Level 1) roads would cause degradation of habitat through soil erosion and sedimentation of waterways. Construction of approximately 38-39 miles of temporary and Maintenance-Level 1 roads would clear trees and snags across approximately 304-312 acres. Construction of fireline would clear up to approximately 2,500 acres of snags and ladder fuels. and temporary and Maintenance-Level 1 roads would cause loss of habitat where roads pass through meadows or other areas used by the species. Maintenance-Level 1 roads, unlike temporary roads, would not be obliterated after implementation and would therefore have longer-term effects on habitat. Unlike Alternatives 2-3, which involve construction of 22-23 miles of Maintenance-Level 1 roads, Alternative 4 does not involve construction of any Maintenance-Level 1 roads. This Alternative would therefore have the least road-related degradation of habitat for the species. Mechanical treatment of hazardous fuels, prescribed fire, road construction, road decommissions, and trail construction may reduce the habitat of skipperlings in the short term or cause direct mortality, but such effects would not

cause a trend toward listing or loss of viability. See Tables 3.6-3 and 4 for a quantitative description of habitat attributes and fire hazard to the species' habitat under Alternatives 2-4. Note that higher fire hazard indicates a higher probability of detrimental impacts to the species' habitat (e.g., soil erosion and sedimentation).

Cumulative Effects

Several past, ongoing, and reasonably foreseeable actions and events have contributed, are contributing, and will contribute to the fitness of skipperlings on the Kaibab National Forest:

- The species richness and abundance of invertebrates increases with the structural diversity of plants (Brose 2003; Remsburg and Turner 2009). Sheep consume herbaceous vegetation in meadows. Historic overgrazing decreased the amount of cover and food for skipperlings, which may have decreased their abundance. Although current levels of grazing have improved, the presence of livestock still reduces herbaceous vegetation. The current, adaptive-management approach (see Rangeland Specialist's Report and Hat Allotment Management Plan) to grazing across the National Forest System will increase the herbaceous vegetation available to skipperlings. This will therefore increase their fitness.
- Meadows, including those in the Southwest, evolved to periodic disturbance from fire (USDA 2012). The Forest Service excluded fire from the Kaibab National Forest throughout much of the twentieth century, causing the encroachment of conifers onto meadows; this reduced, fragmented, and degraded habitat for skipperlings. Furthermore, it has increased the potential of high-severity wildfires, which could cause direct mortality of skipperlings and a long-term loss of microhabitat (e.g., downed logs and woody debris). Fire exclusion has also contributed to the encroachment of conifers that invade meadows and take in water would otherwise flow in seeps, springs, and moist meadows. The Forest Service now embraces the natural role of fire on the landscape; current and future wildland fire management (including the use of wildfire) will increase, connect, and improve habitat for these species.
- Recreation (e.g., off-road vehicle driving, hiking, biking, and camping) and road travel reduce vegetation and compact soils. Recreational activities would continue to occur in the project area, resulting in decreased habitat for skipperlings.
- Climate change will cause a decrease in precipitation, an increase in drought, and higher temperatures which will increase the probability of desertification of grasslands, causing habitat loss for the species. Climate change will also lead to more opportunities for invasive species to establish and spread, and invasive species may outcompete with these species or their prey, or they may alter the species' habitat (USGCRP 2009). Restoration projects such as this may help species be more resilient and adapt to climate change (USDA 2011).
- Past projects (e.g., those related to roads or vegetation management) have caused reductions and enhancements of the species' habitat. See appendix in EIS for a list of specific projects also considered in this cumulative effects analysis.

The No-Action Alternative would perpetuate the encroachment of meadows by trees. It would exacerbate the reduction in habitat for skipperlings from historic overgrazing, fire exclusion, and recreation. The No-Action Alternative may therefore have an adverse effect on skipperlings.

Alternatives 2-4 may adversely impact the species in the short term but would cause a long-term beneficial impact. They would combine with the aforementioned past, ongoing, and reasonably foreseeable actions and events for a cumulative effect on the fitness of skipperlings. In the

context of these other factors, Alternatives 2-4 may impact skipperlings, but their cumulative contribution would not cause a trend toward listing or loss of viability.

Determination of Effects

Alternative 1 may adversely impact the four-spotted skipperling, but it would not cause a trend toward listing or loss of viability. No action would perpetuate the process of forest and woodland encroachment of the meadows, seeps, and springs which this species inhabits.

Alternatives 2-4 may adversely impact the four-spotted skipperling in the short term but would cause a long-term beneficial impact. Alternatives 2-4 would not cause a trend toward listing or loss of viability. More habitat would be restored for the species under Alternative 2 than under Alternatives 3-4, as there would be more flexibility to restore openings that existed in pre-settlement times, and more water would return to seeps, springs, and moist meadows. Alternative 4 would have less road-related impacts than Alternatives 2-3, as no Maintenance-Level 1 Roads would be constructed under this Alternative.

MANAGEMENT INDICATOR SPECIES

This section describes the effects of each project alternative on Forest-level population and habitat trends of Management Indicator Species (MIS) with indicator habitat or habitat components in the project's action area (Table 3.6-16). See the Botanist's Report for an analysis of effects on Arizona bugbane (*Cimicifuga arizonica*), a plant management indicator species that also occurs in the project area. The following MIS were considered but eliminated for analysis due to lack of currently or potentially suitable habitat in the project area: aquatic macroinvertebrates, cinnamon teal (*Anas cyanoptera*), Lucy's warbler (*Vermivora luciae*), Lincoln's sparrow (*Melospiza lincolnii*), and yellow-breasted chat (*Icteria virens*).

A living document summarizes current knowledge of population and habitat trends for species identified as Management Indicator Species of the Kaibab National Forest (USDA 2010). It contains detailed descriptions of the habitat of each MIS, including seral stage. Note that the concept of seral stage in this section may differ from the silvicultural concept of seral stage. The Arizona Game and Fish Department (AZGFD) annually estimate population trends for game species (i.e. elk, pronghorn, mule deer, white-tailed deer, and turkey), for each Game Management Unit (GMU) in the state, and these estimates help inform MIS analyses. See the Wildlife Specialist's Report for details on assumptions used to calculate habitat acreages for MIS.

Existing Conditions

All MIS but Red-naped Sapsucker have been confirmed to occur within the project area, although habitat for this species does exist. See Table 3.6-17 for a summary of existing conditions and the Wildlife Specialist's Report for a more detailed description of existing conditions.

Direct and Indirect Effects

Tables 3.6-16 and 17 summarize Forest-wide habitat and population trends, Forest-wide acreages of habitat component indicators, the existing condition of the habitat component indicator of each MIS, and the effects of each Action Alternative on the habitat component indicators within the project area.

For species that serve as a habitat component indicator for late-seral ponderosa pine (northern goshawk; pygmy nuthatch; wild turkey), thinning and burning the forest under Alternatives 2-4 would benefit these MIS and their habitat components for which they serve as an indicator.

Alternative 2 would most increase late-seral ponderosa pine forest, primarily by reducing inter-tree competition and fire hazard among groups of the largest trees. Alternative 3 would result in a larger increase in this habitat component than Alternative 4, primarily due to treatments on steep slopes that would reduce competition and fire hazard among the largest trees. The No-Action Alternative would perpetuate high risk of fire hazard and outbreaks of insects and disease, and inter-tree competition would continue to slow the growth of late-seral ponderosa pines. See the Biological Evaluation and Wildlife Specialist's Report for more detailed analysis.

For species that serve as a habitat component indicator for late-seral mixed-conifer forest (Mexican spotted owl; red squirrel), thinning and burning the forest under Alternatives 2-4 would benefit these MIS and their habitat components for which they serve as an indicator. Alternative 3 would most increase late-seral mixed conifer forest, primarily by reducing inter-tree competition through the removal of trees <9" DBH. However, fire hazard to mixed conifer forest would be lowest under Alternative 2 (Tables 3.6-3 and 4); Alternative 2 may therefore result in the highest acreage of late-seral mixed conifer forest, and greatest benefit to associated MIS, over the long term. The only caveat to this statement is that cable-logging treatments will result in a loss of all trees and snags across approximately 2 acres of late-seral mixed-conifer forest. Alternative 2 would result in a larger increase in this habitat component than Alternative 4, primarily due to treatments on steep slopes that would reduce fire hazard and competition among the largest trees. If no mechanical treatments other than fire-line construction occur on steep slopes before burning under Alternatives 2-3, then Alternatives 2-4 would have virtually identical effects on these MIS. The No-Action Alternative would perpetuate high risk of fire hazard and outbreaks of insects and disease, and inter-tree competition would continue to slow the growth of late-seral trees in mixed-conifer forest. See the Biological Evaluation and Wildlife Specialist's Report for more detailed analysis.

For species that serve as an MIS for snags (hairy woodpecker; red-naped sapsucker), Alternative 2 would most benefit these species by most reducing fire hazard in and around these species' habitat components (Tables 3.6-3 and 4), and for snag MIS, by most protecting recruitment snags (i.e., live pre-settlement and other large trees). The only caveat to this statement is that cable-logging treatments will result in a loss of all trees and snags across approximately 2 acres of late-seral mixed-conifer forest. Alternative 3 would be more preferable than Alternative 4, as the risk of stand-replacing fire would be lower under Alternative 3 than Alternative 4 (Tables 3.6-3 and 4). The No-Action Alternative would perpetuate high risk to snags, and inter-tree competition would continue to slow the growth of late-seral trees (recruitment snags). See the Biological Evaluation and Wildlife Specialist's Report for detailed analysis.

For species that serve as an MIS for early seral ponderosa pine forest (elk; Abert's squirrel), all of the Alternatives would result in a decrease in the forest type. The greatest decrease in early seral pine forest would occur under Alternative 3, followed by Alternative 4, Alternative 2, and last, Alternative 1. The Action Alternatives would reduce the density of trees in the ponderosa pine forest of the project area. A reduction in canopy cover would decrease the amount of interlocking crowns, infection levels of mistletoe, and number of mid-seral trees important to the species. This in turn may decrease fitness of the species. However, goshawk nest areas, PFAs, and pine-oak forest would maintain canopy cover levels of 40-70%, and these areas would continue to provide substantial amounts of nesting habitat. Alternative 2 would reduce fire hazard and protect snags, groups of trees >18" DBH, and other important habitat attributes more than Alternatives 3-4, as forest thinning would be more extensive. Alternatives 3-4 would be identical in terms of effects from thinning and burning.

Elk also serves as an MIS for early seral mixed-conifer forest. All of the Alternatives would result in an increase in this habitat component, and the Action Alternatives would have negligibly comparable effects on the acreage of early seral mixed-conifer forest, with Alternative 3 having the greatest increase, followed by Alternative 2, and last Alternative 4. If mechanical treatments are implemented before prescribed fire in the mixed conifer forest on steep slopes, then Alternative 2 would reduce fire hazard to forest more than Alternative 3, and Alternative 3 would reduce fire hazard more than Alternative 4. If mechanical treatments do not occur on steep slopes (i.e., only fireline and prescribed fire is implemented) under Alternatives 2-3, then Alternatives 2-4 would have identical effects on elk, with a substantially higher probability of large patches of trees being replaced to torching than if areas were first mechanically treated (Tables 3.6-3 and 4). This would lead to greater creation of early-seral mixed conifer forest and ultimately benefit elk.

Alternatives 2-4 would have similar direct effects on late-seral pinyon-juniper woodland (juniper titmouse), early- and late- seral grasslands (pronghorn antelope), and early- and late- seral aspen (mule deer and red-naped sapsucker, respectively). The No-Action Alternative would perpetuate high risk of fire hazard to pinyon-juniper woodland and aspen. Slightly more late-seral aspen may be lost (and more early-seral aspen may be created), under Alternative 4 than Alternatives 2-3, as aspen is adapted to a stand-replacing wildfire regime that causes mature trees to die and suckers and saplings to flourish, and Alternative 4 (which does not include mechanical treatment) would have the highest fuel loadings and therefore the highest-severity fire. That being said, if no mechanical treatments other than fire-line construction occur on steep slopes before burning under Alternatives 2-3, then Alternatives 2-4 would have virtually identical effects on red-naped sapsucker and mule deer MIS habitat. Also, Alternative 2 may indirectly conserve more late-seral pinyon-juniper woodlands than Alternatives 3-4, as fire hazard in the matrix around this habitat would be most reduced under this Alternative (Tables 3.6-3 and 4). (Tables 3.6-3 and 4), and it would perpetuate encroachment of conifers into historic grasslands. See the Biological Evaluation and Wildlife Specialist's Report for more detailed analysis.

Smoke from prescribed fire and noise from mechanical treatments may disturb the species. These disturbances may cause the species to abandon areas and become more vulnerable to predators. Impacts from smoke are reduced by the coordination of timing and type of burning with wind direction, topography, and time of year

Road decommissions (and for Alternatives 2-3, conversion of road to trail) would restore more native habitat and reduce disturbance by humans. They would improve the condition of the soil and watersheds in the species' habitat. Construction of approximately 38-39 miles of temporary and Maintenance-Level 1 roads would clear trees and snags across approximately 304-312 acres. Construction of fireline would clear up to approximately 2,500 acres of snags and ladder fuels. Firelines, temporary roads, Maintenance-Level 1 roads, and trail would cause soil erosion and sedimentation of waterways, which may reduce the habitat the species. This may, in turn, affect fitness. Maintenance-Level 1 road construction would have more impact on habitat, as Maintenance-Level 1 roads would not be obliterated. Alternative 4 would have less road-related impacts than Alternatives 2-3, as no Maintenance-Level 1 Roads or trails would be constructed under this Alternative.

Cumulative Effects

Many past, present, and reasonably foreseeable actions have affected and continue to affect MIS habitat. Historic timber management caused a reduction in the amount of late seral ponderosa pine forest within the project area. Historic fire exclusion increased fire hazard for all MIS habitat components. Recreational disturbance may affect the survival and reproductive success of MIS. Illegal fuelwood harvest may adversely affect late-seral ponderosa pine, mixed-conifer, and pinyon-juniper MIS and their habitat components. Insect and disease infestations (due to uncharacteristically dense forest and woodland conditions) has decreased the amount of late-seral forests and woodlands. Hunting affects wild turkey, elk, mule deer, and pronghorn antelope, although management by the AZGFD has maintained viable populations. Historic overgrazing by livestock has reduced herbaceous growth that serves as food and cover for all MIS and their prey and that would have historically carried low-intensity surface fire throughout forests and woodlands. Hazard-tree removal along power-lines, roads, and fire control lines has reduced habitat for late-seral pine and mixed-conifer species. Climate change has resulted in a warmer, drier climate, which has increased the probability of stand-replacing wildfire in forests and woodlands, desertification of grassland, and establishment of more invasive species in the project area. Such effects of climate change would result in a decrease in all MIS populations and/or habitat. Although these activities have reduced habitat within the Project Area and across the Forest, when considered in the context of the cumulative impact of these actions, none of the Alternatives result in a substantial increase or decrease in Forest-wide habitat or population trends for any MIS. See the Wildlife Specialist's Report for a detailed cumulative effects analysis for each MIS.

Alternative 1 may adversely impact MIS in the long term by perpetuating current high fire hazard and delaying restoration to pre-settlement conditions. However, such impacts are not substantial enough to change Forest-wide habitat or population trends for any MIS. In general, Alternative 2 would most favor MIS and their habitat, followed by Alternative 3, and Alternative 4, as fire hazard would be least under this Alternative, and restoration and maintenance of ecosystems at pre-settlement conditions would benefit most species (although see the Wildlife Specialist's Report for detailed comparisons of Alternatives). Alternatives 2-4 may adversely impact MIS species in the short term but would cause a long-term beneficial impact. Alternatives 2-4 involve changes to MIS habitat in terms of quantity and quality. These changes may adversely impact MIS species and their habitats, but not enough to change Forest-wide habitat or population trends for any MIS. See the Wildlife Specialist's Report for a detailed analysis of effects on each MIS.

Table 3.6-16. Management Indicator Species within the action area of the project, along with Forest-wide habitat component indicator and population trends.

Management Indicator Species	Habitat Component Indicator for which MIS serves	Habitats on Williams District (WD) and/or Tusayan District (TD) of Kaibab National Forest, Including Those for which MIS does not Serve as an Indicator	Forest-Wide Population Trend	Forest-Wide Trend for Habitat Component	Known to Occur in Project Area
Northern goshawk (*Accipiter gentilis*)	late-seral ponderosa pine	ponderosa pine, mixed conifer, spruce-fir, and aspen forests; pinyon-juniper woodland.	Declining	Decreasing	Yes
Hairy woodpecker (*Picoides villosus*)	snags in ponderosa pine, mixed conifer, and spruce-fir	ponderosa pine, mixed conifer, spruce-fir, aspen forests	Stable	Increasing	Yes
Red-naped sapsucker (*Sphyrapicus nuchalis*)	late-seral aspen and snags within late-seral aspen	ponderosa pine, mixed conifer, spruce-fir, aspen forests	Stable to increasing	Decreasing	No, but possible.
Juniper titmouse (*Baeolophus ridgwayi*)	late-seral pinyon-juniper, and snags in pinyon-juniper	pinyon-juniper woodland.	Declining	Increasing	Yes
Pygmy nuthatch (*Sitta pygmaea*)	late-seral ponderosa pine	ponderosa pine forest.	Stable to declining	Decreasing	Yes
Mexican spotted owl (*Strix occidentalis lucida*)	late-seral mixed conifer and spruce-fir	mixed conifer forest in Sycamore Canyon, Bill Williams Mtn, Sitgreaves Mtn., and Kendrick Mtn.	Declining	Decreasing	Yes
Wild turkey (*Meleagris gallopavo*)	late-seral ponderosa pine	ponderosa pine, mixed conifer, aspen forests; pinyon-juniper woodland.	Variable but overall increasing	Decreasing	Yes

Management Indicator Species	Habitat Component Indicator for which MIS serves	Habitats on Williams District (WD) and/or Tusayan District (TD) of Kaibab National Forest, Including Those for which MIS does not Serve as an Indicator	Forest-Wide Population Trend	Forest-Wide Trend for Habitat Component	Known to Occur in Project Area
Elk (*Cervus elaphus*)	early-seral ponderosa pine, mixed conifer, spruce-fir	all forest and woodland cover types and grassland.	Stable	Increasing	Yes
Mule deer (*Odocoileus hemionus*)	early-seral aspen and pinyon-juniper	all forest and woodland cover types and grassland.	Stable to increasing	Decreasing (aspen); Increasing (pinyon-juniper)	Yes
American pronghorn (*Antilocapra americana*)	early- and late-seral grassland	grassland, pinyon-juniper, open ponderosa pine forest.	Declining	Decreasing	Yes
Red squirrel (*Tamiasciurus hudsonicus*)	late-seral mixed conifer and spruce-fir	mixed conifer and spruce-fir forests.	Declining	Decreasing	Yes
Abert's squirrel (*Sciurus aberti*)	early-seral ponderosa pine	ponderosa pine forest.	Stable	Increasing	Yes

Table 3.6-17. Management Indicator Species within the action area of the project, along with acreage of each MIS's habitat component on the Kaibab NF, in the project area, and increased or decreased by each Action Alternative.

Management Indicator Species	Acreage of Habitat Component on the Kaibab NF	Existing Condition: Acres of Habitat Component Indicator Present in Project Area	Alt. 1 (No Action): Change in Habitat in Project Area	Alt. 2: Change in Habitat in Project Area	Alt. 3: Change in Habitat in Project Area	Alt. 4: Change in Habitat in Project Area
Northern goshawk (*Accipiter gentilis*)	27,921	1,897	1,400	5,500	4,800	4,300
Hairy woodpecker (*Picoides villosus*)	N/A	Approx. 2 snags/acre in mixed conifer; Approx. 0.5 snags/acre in pine.	Approx. 1 snag/acre in MC; Approx. 1 snag/acre in pine.	Approx. 1.5 snags/acre in MC; Approx 1 snag/acre in pine.	Approx. 0.5 snags/acre in MC and pine.	Approx. 2 snags/acre in MC; Approx. 0.5 snags/acre in pine.
Red-naped sapsucker (*Sphyrapicus nuchalis*)	28,500 acres of aspen	Up to 140 acres of late seral aspen. Snags/acre unknown.	Decrease in aspen and aspen snags.	Increase in aspen and aspen snags.	Increase in aspen and aspen snags.	Increase in aspen and aspen snags.
Juniper titmouse (*Baeolophus ridgwayi*)	657,900 acres of pinyon-juniper	Up to 654	Increase: PJ invasion would continue.	Stable; Pre-settlement PJ would be conserved.	Stable; Pre-settlement PJ would be conserved.	Stable; Pre-settlement PJ would be conserved.
Pygmy nuthatch (*Sitta pygmaea*)	27,921	1,897	1,400	5,500	4,800	4,300
Mexican spotted owl (*Strix occidentalis lucida*)	39,122*	345	100	400	600	300

Management Indicator Species	Acreage of Habitat Component on the Kaibab NF	Existing Condition: Acres of Habitat Component Indicator Present in Project Area	Alt. 1 (No Action): Change in Habitat in Project Area	Alt. 2: Change in Habitat in Project Area	Alt. 3: Change in Habitat in Project Area	Alt. 4: Change in Habitat in Project Area
Wild turkey (*Meleagris gallopavo*)	27,921	1,897	1,400	5,500	4,800	4,300
Elk (*Cervus elaphus*)	7,411	Pine: 4645; MC: 1074	Pine: -1600 MC: 200	Pine: -2300; MC: 460	Pine: -3200; MC: 499	Pine: -2600; MC: 422
Mule deer (*Odocoileus hemionus*)	28,500 acres of aspen; 657,900 acres of pinyon-juniper*	Up to 654 in pinyon-juniper; Up to 140 in aspen.	Decrease in aspen; Increase in pinyon-juniper.	Increase in aspen; decrease in pinyon-juniper.	Increase in aspen; decrease in pinyon-juniper.	Increase in aspen; decrease in pinyon-juniper.
American pronghorn (*Antilocapra americana*)	216,000	64	Decrease due to continued conifer invasion.	Increase due to removal of invading conifers in existing grasslands.	Increase due to removal of invading conifers in existing grasslands.	Increase due to removal of invading conifers in existing grasslands.
Red squirrel (*Tamiasciurus hudsonicus*)	39,122*	345	100	400	600	300
Abert's squirrel (*Sciurus aberti*)	7,411	4,645	-1,600	-2,300	-3,200	-2,600

***** With the best available stand data on aspen, pinyon-juniper woodlands, mixed conifer forest, and spruce-fir forest, it is not possible to determine at this time how much is early-seral stage vs. late-seral stage.

OTHER WILDLIFE CONCERNS

Golden Eagles

Existing Conditions

Golden eagles breed and winter on the Kaibab National Forest, where they primarily occupy grasslands (JJD personal observation, unpublished data). Only 64 acres of grasslands occur in the project area. They prefer tall cliffs, canyons, and trees (especially ponderosa pine) as nest areas. They require large openings in which to forage. At lower elevations, golden eagles can begin nesting in February, and as late as April at higher elevations. Fledging occurs as late as mid-June in Arizona. More than 75% of the diet of golden eagles consists of mammals (e.g., hares, rabbits, ground squirrels, prairie dogs). Humans easily disturb the species. Population trends remain unknown in Arizona, but the species appears to be declining as a whole in the West (Corman and Wise-Gervais 2005; BNA Online 2012). Only 12 historic or existing nests have been found on the Williams Ranger District. In 2011, only four pairs showed signs of breeding. The species likely occurs in the project area, and nesting individuals have been detected in the project area.

Direct and Indirect Effects for the No-Action Alternative (Alternative 1)

The No-Action Alternative would not affect golden eagles in the short term. Habitat conditions for the species would not change, notwithstanding the effects of natural processes. However, the No-Action Alternative would perpetuate overly dense forest conditions in fire-dependent ecosystems. Such conditions increase the potential for high-severity wildfire in and around eagle habitat. This may reduce the amount of trees >18" DBH and negatively affect other important habitat attributes for golden eagles.

Tree densities would continue to increase under the No-Action Alternative. This would exacerbate competition among trees, slow their growth into larger diameter classes, and thereby limit the development of larger trees (18"+ DBH) that eagles use for nesting. By not reversing conifer encroachment in grasslands, the No-Action Alternative reduces the amount of open land upon which golden eagles rely for foraging habitat. By not reducing hazardous fuels, not allowing for tree growth, and not creating more foraging habitat, the No-Action Alternative would hinder the conservation of the habitat of golden eagles and their prey. This could result in an adverse effect on the species.

Direct and Indirect Effects for Alternatives 2-4

Alternatives 2-4 would benefit the species by restoring grasslands, meadows, and savannas important to foraging eagles. Alternative 2 would remove encroaching conifers from grasslands, meadows, and savannas more than Alternatives 3-4, as more areas would be restored to pre-settlement conditions. This would restore herbaceous growth (that serves as protective cover and food for golden eagles' prey) and therefore increase the species' fitness.

Road decommissions, road closures, and conversion of road to trail would restore more native habitat. Construction of temporary (and for Alternatives 2-3, Maintenance-Level 1) roads would cause degradation of habitat through soil erosion and sedimentation of waterways. Construction of approximately 38-39 miles of temporary and Maintenance-Level 1 roads would clear trees and snags across approximately 304-312 acres. Construction of fireline would clear up to approximately 2,500 acres of snags and ladder fuels. Construction of fireline and temporary and Maintenance-Level 1 roads would cause loss of habitat where roads pass through grasslands or other areas used by the species. Maintenance-Level 1 roads, unlike temporary roads, would not be obliterated after implementation and would therefore have longer-term effects on habitat.

Unlike Alternatives 2-3, which involve construction of 22-23 miles of Maintenance-Level 1 roads, Alternative 4 does not involve construction of any Maintenance-Level 1 roads. This Alternative would therefore have the least road-related degradation of habitat for the species. Mechanical treatment of hazardous fuels, prescribed fire, road construction, road decommissions, and trail construction may reduce the habitat of golden eagles' prey in the short term or cause direct mortality. See Tables 3.6-3 and 4 for a quantitative description of habitat attributes and fire hazard to the species' habitat under Alternatives 2-4.

Cumulative Effects

Several past, ongoing, and reasonably foreseeable actions and events have contributed, are contributing, and will contribute to the fitness of golden eagles on the Kaibab National Forest:

- The abundance of trees in the late seral stage remains largely unchanged from historical conditions on slopes greater than 40%. However, even-aged forest management led to a loss of large, old trees, generally on slopes less than 40% and primarily from the 1960s through the early 1990s. Recent projects in forest management (see appendix in EIS) emphasize restoration and fire hazard reduction, thereby promoting the sustainability of the species' habitat in and around the project area. The Forest Plan currently does not permit the harvest of trees greater than 24" DBH in mixed conifer or pine-oak forest; harvest of pre-settlement trees rarely occurs anymore, and in this and recent thinning and burning projects, pre-settlement tree conservation has been included as a mitigation measure. Current management generally aims to restore the Forest to pre-settlement conditions. This will increase the amount of trees >18" DBH (which eagles use for nesting), offsetting historic losses.
- Land managers extirpated prairie dogs, a primary prey species of golden eagles, from much of their historic range. Conflicts between ranchers and prairie dogs may continue to pose a challenge for the conservation of golden eagles.
- Local permittees have killed eagles within the past 10 years, leading to a direct reduction in the population size of the species.
- Small mammals (i.e., the prey of golden eagles) and sheep compete for the consumption of grasses, forbs, and sedges (Hoffmeister 1986). Historic overgrazing decreased the amount of food for small mammals, which likely decreased the abundance of small-mammal populations and therefore decreased the fitness of golden eagle populations. Although current levels of grazing have improved, the presence of livestock still reduces herbaceous vegetation. The current, adaptive-management approach (see Rangeland Specialist's Report and Hat Allotment Management Plan) to grazing across the National Forest System will increase the biomass available for small mammals, thereby improving the foraging habitat for golden eagles.
- Most ecosystems of the Southwest evolved to periodic disturbance from fire (USDA 2012). The Forest Service excluded fire from the Kaibab National Forest throughout much of the twentieth century, causing the encroachment of trees onto grasslands, meadows, and savannas; this reduced, fragmented, and degraded foraging habitat for eagles. Fire exclusion increased the probability of stand-replacing wildfire, which would consume trees >18" DBH that eagles use as nesting habitat. The Forest Service now embraces the natural role of fire on the landscape; current and future wildland fire management (including the use of wildfire) will increase, connect, and improve eagle habitat.
- Historic overgrazing has reduced protective cover and food for terrestrial vertebrates, which may have reduced their population size and the amount of prey for eagles. This could potentially reduce the fitness of eagles on the Forest. Although current levels of

grazing have improved, the presence of livestock still reduces herbaceous vegetation. The current, adaptive-management approach (see Rangeland Specialist's Report and Hat Allotment Management Plan) to grazing across the National Forest System will increase the protective cover and food available for terrestrial vertebrates. This will increase prey populations for golden eagles and ameliorate potentially negative effects on the fitness of eagles in the project area.

- Recreation (e.g., use of off-highway vehicles, camping, hiking, biking) in and around lakes has occurred and continues to occur in and around the project area. Recreationists may disturb eagles and cause them to abandon suitable habitat (BNA Online 2012).
- The removal of hazardous trees along powerlines, roads, and fire control lines has reduced and will continue to reduce the number of snags and trees >18" DBH in the project area, which eagles use as nest areas.
- Illegal fuelwood harvest has caused and will continue to cause a loss of snags important for nesting, roosting, and foraging.
- Insect and disease outbreaks have killed and will continue to kill trees. Insect- and disease-related mortality creates more snags, and eventually, downed logs. Prey use downed logs, and eagles use snags for nesting, roosting, and as foraging perches. However, eagles also use large, live trees that insects and disease kill.
- Climate change will cause a decrease in precipitation, an increase in drought, and higher temperatures which may cause desertification of grasslands, causing habitat loss for the species. Climate change will also lead to more opportunities for invasive species to establish and spread, and invasive species may outcompete with these species or their prey, or they may alter the species' habitat (USGCRP 2009). Restoration projects such as this may help species be more resilient and adapt to climate change (USDA 2011).
- Past projects (e.g., those related to roads or vegetation management) have caused reductions and enhancements of the species' habitat. See appendix in EIS for a list of specific projects also considered in this cumulative effects analysis.

By not reducing hazardous fuels, not allowing for tree growth, and not creating more foraging habitat, the No-Action Alternative would hinder the conservation of the habitat of golden eagles and their prey. It would exacerbate the effects of historic timber management, historic overgrazing, historic fire exclusion, persecution of prairie dogs, recreation, and hazard-tree removal. The No-Action Alternative may therefore have an adverse impact on golden eagles.

Alternatives 2-4 may adversely impact the species in the short term but would cause a long-term beneficial impact. They would combine with the aforementioned past, ongoing, and reasonably foreseeable actions and events for a cumulative effect on the fitness of golden eagles. In the context of these other factors, Alternatives 2-4 may impact golden eagles, but their cumulative contribution would not cause a trend toward listing or loss of viability.

<u>Determination of Effects</u>

Alternative 1 may adversely impact golden eagles, but it would not cause a trend toward listing or loss of viability. No action would perpetuate the process of forest and woodland encroachment of the grasslands, meadows, and savannas which this species and its prey inhabits.

Alternatives 2-4 may adversely impact golden eagles in the short term but would cause a long-term beneficial impact. Alternatives 2-4 would not cause a trend toward listing or loss of viability. More habitat would be restored for the species under Alternative 2 than under Alternatives 3-4, as there would be more flexibility to restore grasslands, meadows, and forest

openings that existed in pre-settlement times. Alternative 4 would have less road-related impacts than Alternatives 2-3, as no Maintenance-Level 1 Roads would be constructed under this Alternative. Unintentional take of eagles would not occur under any of the Alternatives.

Migratory Birds

Existing Conditions

USFWS Birds of Conservation Concern and Arizona Partners in Flight priority species were evaluated. These birds require various habitats including ponderosa pine and mixed conifer forests, aspen, pinyon-juniper woodlands, and grasslands. Spruce-fir forest and perennial riparian areas do not exist within the project area, so species restricted to this habitat are not considered. See Table 3.6-18 for a list of migratory bird species of concern within the project area. For more information about migratory birds' habitat and existing conditions, refer to the Wildlife Specialist's Report.

Table 3.6-18. List of migratory birds of conservation concern that occur on the Kaibab National Forest, with notes on whether they occur or have habitat within the project action area.

Species*	Habitat	Seasonal Occurrence	Suitable Habitat Present and/or Occupied
Bald eagle	a variety of ecosystems, esp. wetlands	winter	Yes
Northern goshawk	mixed conifer and pine	year-round	Yes
Common black-hawk	riparian	summer/ rare	No
Swainson's hawk	grassland	summer	Yes
Ferruginous hawk	grassland	migrant/winter	Yes
Peregrine falcon	usually near cliffs and open areas	year-round	Yes
Flammulated owl	pine	summer	Yes
Mexican spotted owl	mixed conifer and pine-oak	year-round	Yes
Burrowing owl	grasslands with burrowing animals	summer	No
Lewis's woodpecker	open pine	year-round	Yes
Three-toed woodpecker	spruce-fir and mixed conifer	year-round	Yes
Red-naped sapsucker	mixed conifer and aspen	summer	Yes
Olive-sided flycatcher	mixed conifer and pine	summer	Yes
Gray flycatcher	pinyon/juniper	summer/migrant	Yes
Cordilleran flycatcher	pine	summer	Yes
Gray vireo	pinyon/juniper	summer	Yes
Pinyon jay	pinyon/juniper	year-round	Yes
Purple martin	pine	summer	Yes
Juniper titmouse	pinyon/juniper	year-round	Yes
Golden-crowned kinglet	spruce-fir	year-round	No
Swainson's thrush	spruce-fir	migrant	No
Bendire's thrasher	open brushy areas	summer/ rare	No
Sprague's pipit	short grass prairie	winter/migrant/ rare	No
Phainopepla	pinyon/juniper, pine	summer	Yes
Olive warbler	open conifer	summer/ rare	Yes

Species*	Habitat	Seasonal Occurrence	Suitable Habitat Present and/or Occupied
Lucy's warbler	low elevation riparian	summer	No
Yellow warbler	low elevation riparian and woodland	summer/ rare	No
Black-throated gray warbler	pinyon/juniper and dry oak woodlands	summer	Yes
Grace's warbler	tall pines	summer	Yes
Red-faced warbler	pine, pine-oak, fir	summer	Yes
Canyon towhee	open brushy areas	year-round/ rare	No
Yellow-breasted chat	low elevation riparian	summer	No
Black-chinned sparrow	grasslands; scrub	summer/ rare	Yes
Lark bunting	grasslands	winter/migrant/ rare	Yes
Grasshopper sparrow	grasslands; scrub	mostly migrant/ rare	Yes
Chestnut-collared longspur	grasslands; dry, open areas	mostly migrant / rare	Yes
Pine grosbeak	spruce-fir	Rare	No

*
The Southwestern Regional Office of the Forest Service recommends that all projects are developed in consideration of effects to the following: (1) Species of Concern listed by Arizona Partners in Flight; (2) U.S. Fish and Wildlife Service's List of Birds of Conservation Concern; (3) Important Bird Areas (IBAs); (3) Effects to important over-wintering areas. The following is an attempt to disclose the impacts, if any, of this project. This analysis considers said species and habitats. Names are standardized according to the American Ornithological Union.

Direct and Indirect Effects for the No-Action Alternative (Alternative 1)

The No-Action Alternative would not affect migratory birds of conservation concern (henceforth referred to as "birds"). Habitat conditions for birds would not change, notwithstanding the effects of natural processes. However, the No-Action Alternative would degrade the habitat for birds in the long term; by not using mechanical treatments and prescribed fire to restore unnaturally dense forests, woodlands, meadows, and grasslands, the No-Action Alternative would hinder restoration of habitat for birds. Furthermore, unnaturally dense forests increase the probability of stand-replacing wildfire. Such fire would degrade or destroy the mature forests and trees >18" DBH and snags on which many birds rely. The No-Action Alternative would perpetuate the high probability of active crown fire in the pinyon-juniper habitat of the pinyon jay, a globally threatened species (see Tables 3.6-3 and 4). The No-Action Alternative would not result in any unintentional take from management activities.

Direct and Indirect Effects for Alternatives 2-4

Treatments would benefit this diversity of species. Under Alternatives 2-4, thinning and prescribed fire would improve forest and woodland habitat for birds in the long term. These treatments would develop a mosaic of uneven-aged forest and woodland across the landscape, including habitat for a variety of birds. Prescribed fire would restore grasslands and meadows. Alternatives 2-4 would conserve groups of larger trees (typically 18" DBH or greater), especially important to cavity nesters and raptors. Alternative 2 would do the most to restore grassland meadow habitat, as much of the treatments in ponderosa pine forests would restore ecosystems to pre-settlement times, thereby restoring pine savannas. By thinning unnaturally dense forests,

Alternatives 2-4 would reduce competition among trees, thereby promoting the growth of larger trees. Furthermore, thinning and prescribed fire would reduce the probability of stand-replacing wildfire in forests, thereby conserving the mature forest and trees >18" DBH and snags on which many birds rely. Species that rely on montane forest and drainages would most benefit from Alternatives 2 or 3, as treatments would reduce fire hazard while still conserving canopy cover, trees >18" DBH, snags, and other important habitat attributes (Tables 3.6-5 through 14).

Under Alternatives 2-4, unintentional take may occur. When prescribed burning occurs during the spring and early summer, there could be some take of migratory birds from smoke impacting breeding birds and potentially impacting nesting success. Unintentional take could occur if nests are burned during implementation. All Alternatives may cause unintentional take from loss of eggs or nestlings to prescribed fire. Unintentional take may occur for all species but bald eagle, Swainson's Hawk, Ferruginous Hawk, Peregrine Falcon, and Lark Bunting. These exceptions exist because these species do not breed in the area *or* they nest on cliffs or high in trees within grasslands and the probability of fire entering or causing smoke-related asphyxiation in these fine, flashy fuels is so low that it is negligible.

Prescribed fire and mechanical treatment of hazardous fuels may result in a loss of snags and loss of eggs or nestlings for cavity-nesting species. Alternative 2 may result in a slight short-term decrease in snags followed by an increase over the long term. This short-term loss of snags would not affect the overall distribution of birds on the Forest.

Road decommissions (and for Alternatives 2-3, conversion of road to trail) would restore more native habitat and reduce disturbance by humans. They would improve the condition of the soil and watersheds in the species' habitat. Construction of approximately 38-39 miles of temporary and Maintenance-Level 1 roads would clear trees and snags across approximately 304-312 acres. Construction of fireline would clear up to approximately 2,500 acres of snags and ladder fuels., temporary roads, Maintenance-Level 1 roads, and trail would cause soil erosion and sedimentation of waterways, which may reduce the habitat of birds and their prey. This may, in turn, affect fitness. Maintenance-Level 1 road construction would have more impact on habitat of birds, as Maintenance-Level 1 roads would not be obliterated. Alternative 4 would have less road-related impacts than Alternatives 2-3, as no Maintenance-Level 1 Roads or trails would be constructed under this Alternative.

Under Alternative 2, approximately 72 acres would be denuded for cable-logging operations in forested areas, resulting in the loss of snags >18" DBH and pre-settlement trees, features that are important to many bird species and their prey.

Alternatives 2-4 would decrease the chance of stand-replacing wildfire in the pinyon-juniper habitat of birds of forests and woodlands, with Alternative 2 causing the greatest reduction in fire hazard (Tables 3.6-3 and 4).

See the Project Implementation Checklist and Section 2.3.1 of the EIS for details on measures to be taken to conserve bird habitat.

Cumulative Effects

Several past, ongoing, and reasonably foreseeable actions and events have contributed, are contributing, and will contribute to the fitness of birds on the Kaibab National Forest:

- The abundance of trees in the late seral stage remains largely unchanged from historical conditions on slopes greater than 40%. However, even-aged forest management led to a loss of large, old trees, generally on slopes less than 40% and primarily from the 1960s through the early 1990s. Recent projects in forest management (see appendix in EIS) emphasize restoration and fire hazard reduction, thereby promoting the sustainability of the species' habitat in and around the project area. This caused a reduction in habitat for birds of mixed conifer and ponderosa pine forest. The Forest Plan currently does not permit the harvest of trees greater than 24" DBH in mixed conifer or pine-oak forest; harvest of pre-settlement trees rarely occurs anymore, and in this and recent thinning and burning projects, pre-settlement tree conservation has been included as a mitigation measure. Current management generally aims to restore the Forest to pre-settlement conditions.
- The species richness and abundance of invertebrates increases with the structural diversity of plants (Brose 2003; Remsburg and Turner 2009). Sheep consume herbaceous vegetation, especially in grasslands, meadows, and savannas. Sheep use riparian areas as places to drink water. Historic overgrazing decreased the amount of protective cover for grassland birds; reduced the structural diversity of plants and thereby decreased the diversity and abundance of arthropod prey; and degraded riparian areas. This may have decreased the abundance and diversity of birds, especially those that use grasslands, meadows, and riparian areas. Although current levels of grazing have improved, the presence of livestock still reduces herbaceous vegetation. The current, adaptive-management approach (see Rangeland Specialist's Report and Hat Allotment Management Plan) to grazing across the National Forest System will ameliorate the effects of historic overgrazing.
- Historic conversion of "unproductive" pinyon-juniper woodlands to grazing lands caused a large-scale reduction in habitat for birds of this ecosystem (BNA Online 2012). The Kaibab National Forest now seeks to restore the land to its presettlement condition.
- Illegal fuelwood harvest in pinyon-juniper woodlands may cause a loss of seeding pinyon pines, a tree upon which the pinyon jay relies for food (BNA Online 2012).
- The forests, meadows, grasslands, and wetlands in the project area are far removed from their historical fire regime (Tables 3.6-3 and 4). The Forest Service excluded fire from the Kaibab National Forest throughout much of the twentieth century, causing ponderosa pine, mixed conifer, and pinyon-juniper forests to grow unnaturally dense and become at risk of stand-replacing wildfire. Furthermore, fire exclusion caused the encroachment of grasslands, meadows, and savannas by trees. Fire exclusion has increased the potential for high-severity wildfires, which could cause direct mortality of birds; a long-term loss of snags and large trees upon which cavity-nesters rely; and a mid-term loss of forests and woodlands. The Forest Service now embraces the natural role of fire on the landscape; current and future wildland fire management (including the use of wildfire) will increase, connect, and improve habitat for birds.
- Recreation (e.g., off-road vehicle driving, hiking, biking, and camping) and road travel may disturb birds. Recreational activities would continue to occur in the project area, resulting in a potential decrease in the fitness of birds. Implementation of the Travel Management Rule will reduce off-highway vehicle use, restore habitat, and therefore benefit birds.
- The removal of hazardous trees along powerlines, roads, and fire control lines has reduced and will continue to reduce the number of snags and trees >18" DBH in the project area, resulting in a decline in important microhabitat for many birds.

- Climate change will cause a decrease in precipitation, an increase in drought, higher temperatures, and a longer wildfire season, which will increase the probability of stand-replacing wildfire and may cause desertification of grasslands, causing habitat loss for the species. Climate change will also lead to more opportunities for invasive species to establish and spread, and invasive species may outcompete with these species or their prey, or they may alter the species' habitat (USGCRP 2009). Restoration projects such as this may help species be more resilient and adapt to climate change (USDA 2011).
- Past projects (e.g., those related to roads or vegetation management) have caused reductions and enhancements of the species' habitat. See appendix in EIS for a list of specific projects also considered in this cumulative effects analysis.

The No-Action Alternative would perpetuate the unnaturally dense conditions in the coniferous forests of the project area. It would exacerbate the reduction in habitat from changes in historic timber management, historic overgrazing, historic fire exclusion, historic conversion of pinyon-juniper woodlands, fuelwood harvest, recreation, and hazard-tree removal. The No-Action Alternative may therefore have an adverse effect on birds.

Alternatives 2-4 would combine with these past, ongoing, and reasonably foreseeable actions and events for a cumulative effect on the fitness of birds. In the context of these other factors, the cumulative contribution of Alternatives 2-4 are too small to alter Forest-wide habitat, population, or community trends for birds.

<u>Determination of Effect</u>
Alternative 1 may adversely impact birds, but it would not cause a trend toward listing or loss of viability, or change community trends for birds. No action would perpetuate the process of encroachment of and increasing fire hazard in the grasslands, meadows, savannas, woodlands, and forests on which these species rely.

Alternatives 2-4 may adversely impact birds in the short term but would cause a long-term beneficial impact. Alternatives 2-4 would not cause a trend toward listing or loss of viability, or change community trends for birds. In general, more habitat would be restored for birds under Alternative 2 than under Alternatives 3-4, as there would be more flexibility to restore grasslands, meadows, woodlands, and forests to their pre-settlement conditions. Alternative 4 would have less road-related impacts than Alternatives 2-3, as no Maintenance-Level 1 Roads would be constructed. Unintentional take may occur for all species but bald eagle, Swainson's Hawk, Ferruginous Hawk, Peregrine Falcon, and Lark Bunting. These exceptions exist because these species do not breed in the area *or* they nest on cliffs or high in trees within grasslands and the probability of fire entering or causing smoke-related asphyxiation in these fine, flashy fuels is so low that it is negligible. Although unintentional take may occur to some migratory bird species, the widespread distribution of these species over hundreds of thousands of acres (BNA Online 2012) precludes such take from causing a measurable effect to the population of the species. Furthermore, the level of incidental mortality caused by project implementation activities would be proportional to how many acres are treated during the spring nesting season of April, May, June, and July. Most of the prescribed burning on the Williams District occurs during the fall, outside of the spring nesting season. Since only a small percentage of habitats would be treated at any one time, the removal of any eggs or fledgling would not result in a measurable negative effect to the birds populations listed above.

3.7 Invasive Species

3.7.1 Affected Environment's Existing Condition

The scope of this analysis focuses on invasive plant species within a 1-mile buffer of the proposed project perimeter. A 1-mile buffer was used because of the potential for currently established invasive species outside of the projected treatment boundary to move within the project boundary. Several non-native plant species have been documented within the 1-mile buffer (Table 3.7.1, NRIS 2011). It is possible that other non-native species occur.

Table 3.7-3: Invasive plant species that have been documented within a 1-mile buffer of the project area perimeter.

Common Name	Scientific Name	Invasive	Noxious
bull thistle	*Cirsium vulgare*	x	x
cheatgrass	*Bromus tectorum*	x	x
common mullein	*Verbascum thapsus*	x	
dalmatian toadflax	*Linaria dalmatica*	x	x
diffuse knapweed	*Centaurea diffusa*	x	x
field bindweed	*Convolvulus arvensis*	x	
Mexican fireweed	*Kochia scoparia*	x	
redstem stork's bill	*Erodium cicutarium*	x	
Russian knapweed	*Acroptilon repens*.	x	x
Russian olive	*Elaeagnus angustifolia*	x	x
Siberian elm	*Ulmus pumila*	x	x
yellow salsify	*Tragopogon dubius*	x	
yellow sweetclover	*Melilotus officinalis*	x	

Following are species descriptions for those that have been documented within a 1-mile buffer of the project boundary (see Figure 3.7-1):

1. **Bull thistle** is a stout biennial thistle with purple flowers from Eurasia that commonly invades disturbed sites that include slash piles, log decks, burned areas, and roadsides. Regeneration occurs solely from short-lived seed. Bull thistle is widespread across the ponderosa pine vegetation type on Williams Ranger District where it can successfully establish.
2. **Cheatgrass** is an erect cool season annual grass that was introduced from Europe. Cheatgrass is a prolific seed producer that can quickly establish and persist following disturbances that increase resource availability (e.g., fire). The presence of cheatgrass can increase fire frequency, creating a positive feedback loop that can result in cheatgrass monocultures. Relatively small cheatgrass populations are likely to be widespread across the Williams Ranger District.
3. **Common mullein** can be biennial, perennial or, rarely, an annual with a deep tap root that is native to Europe and Asia. In its first year it produces a low vegetative rosette up to 60 cm in diameter which overwinters and is followed in the succeeding growing season by a stout flowering stem 5-18 dm tall.

An individual may produce 100,000-180,000 seeds, and seeds may remain viable for up to 100 years. Common mullein is likely to be widespread across the Williams Ranger District where appreciable disturbance has occurred.

4. **Dalmatian toadflax** is an ornamental, perennial introduced from the Mediterranean Region. It can grow up to 3 feet tall, and reproduces from both seed and vegetative reproduction from buds on creeping roots. One plant can produce up to 500,000 seeds, as well as lateral roots that can produce new individuals up to 10 feet from the parent plant. Dalmatian toadflax may crowd out native plants and reduce forage on rangelands. Dalmation toadflax has been documented in several areas of the Williams Ranger District, but is most prominent following disturbances in ponderosa pine.
5. **Diffuse knapweed** is an annual or short-lived perennial from the Mediterranean region, growing 1-2 feet tall. Knapweeds are members of the sunflower family, with a single strong taproot. It reproduces by seed, and seeds can remain viable to 12 years. Dead plants break off at ground level and tumble via wind, spreading seed as they move. It produces chemical compounds that inhibit other species (even other knapweeds) from growing around it. Diffuse knapweed populations are limited on the Williams Ranger District
6. **Field Bindweed** is a perennial vine arising from deep, persistent spreading roots. It reproduces by rhizomes and seeds. Field bindweed intertwines and topples native species. It is one of the most serious weeds of agricultural fields on temperature regions of the world. Field bindweed is common on the eastern portion of the Williams Ranger District where appreciable disturbance has occurred.
7. **Mexican fireweed** is an annual in the Chenopodium family. The plant reproduces by seed, and a single plant can produce up to 50,000 seeds annually under favorable conditions. Because of its low water requirements, Mexican fireweed can grow in warm, dry environments. It can spread long distances very rapidly, outcompeting and displacing natives along the way. Mexican fireweed populations are limited across the Williams Ranger District, and occur mostly in areas that have received appreciable disturbance
8. **Redstem stork's bill** is an annual or biennial native to Europe or Asia, and is now common around the world. It is grown for forage, and is usually only considered a serious problem when it crowds out more valuable crops. Redstem stork's bill populations are limited across the Williams Ranger District, and occur mostly in areas that have received appreciable disturbance.
9. **Russian knapweed** is a creeping, herbaceous perennial native to southern Ukraine, southeast Russia, Iran, Kazakhstan and Mongolia that reproduces from seed and vegetative root buds. Shoots, or stems, are erect, 18 to 36 inches tall, with many branches. It emerges in early spring, bolts in May to June (elevation dependent) and flowers through the summer into fall. It produces seeds sparingly, approximately 50 to 500 per shoot. Seeds are viable for two to three years in soil. Its primary method of reproduction is from vegetative propagation, with seed of secondary importance. The weed forms dense, single species stands over time due to competition and allelopathy. Russian knapweed populations are limited on the Williams Ranger District.
10. **Russian olive** is a woody species forming large shrubs to medium-sized trees. Until recently, this species was promoted for windbreaks and erosion control. It has been planted extensively in areas throughout northern Arizona and can invade riparian areas where it eventually replaces native tree species. Russian olive individuals are limited on the Williams Ranger District.
11. **Siberian Elm** is widely grown in many areas of northern Arizona as a shade tree. However, it is not appropriate in wildland settings where it can out-compete native tree species in riparian zones and other sensitive areas. The trees reproduce through winged seeds that can be transported long distances on the wind or by vehicles to new locations. The abundant

production of seed will make this species difficult to control under favorable growing conditions. Siberian Elm individuals are limited on the Williams Ranger District.

12. **Yellow salsify** Western Salsify grows as an annual or occasionally biennial forb, reaching a height of typically 20-60 cm. It is regarded as invasive in most states of the USA. Yellow salsify populations are limited on the Williams Ranger District.
13. **Yellow sweetclover** is an erect annual or biennial that grows from strong taproots; often forming colonies. It reproduces by seeds that are drought tolerant and cold hardy. It can outcompete native species by overtopping and shading. Yellow sweetclover populations are widespread on the Williams Ranger District.

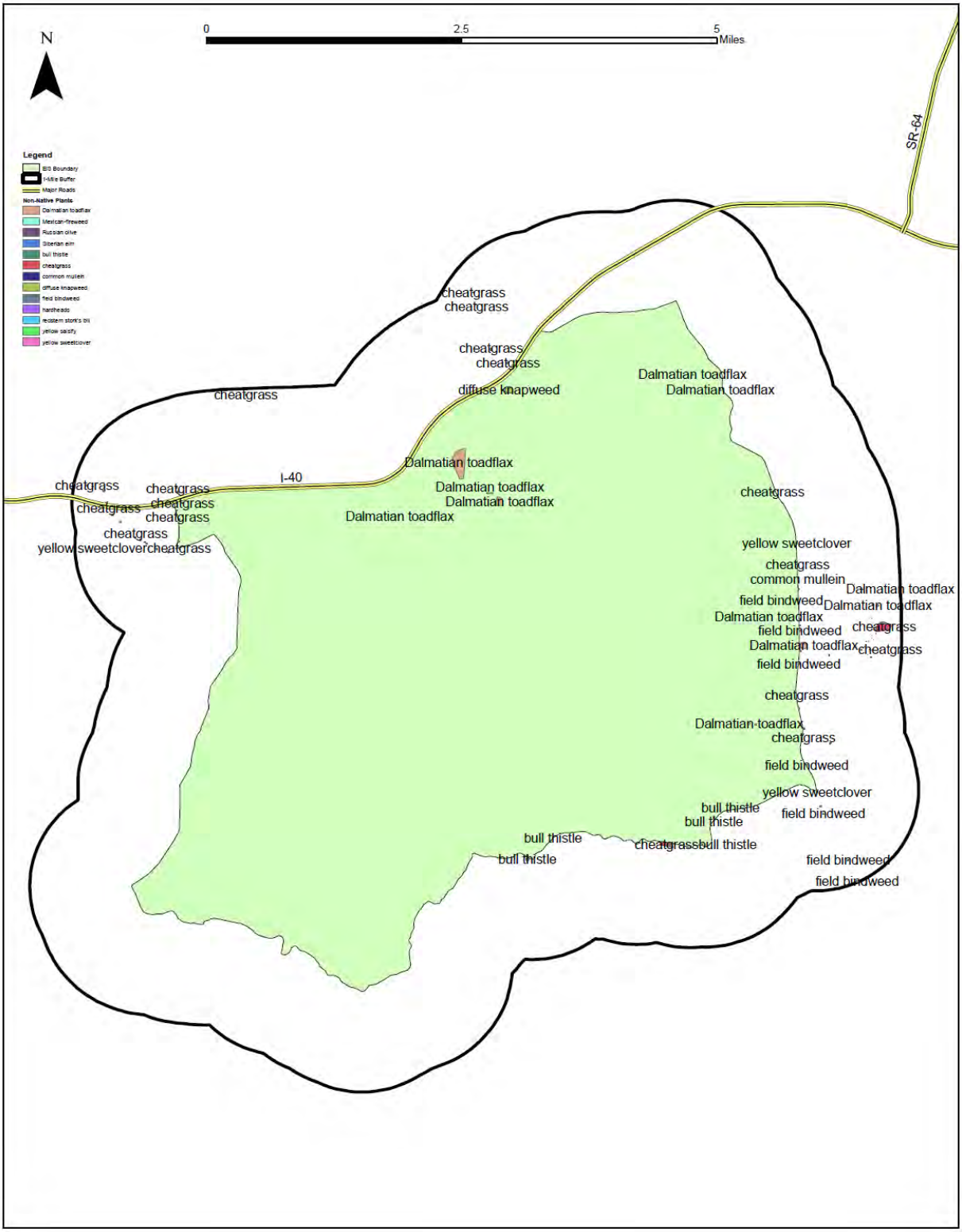


Figure 3.7-5: Invasive plants within a 1-mile buffer of the project areas.

Of these species, cheatgrass has the potential to be one of the most problematic following the proposed treatment. Cheatgrass is an opportunistic species that is very successful at maximizing available moisture and nutrients from the upper layer of soil, and it is capable of growing in years of drought and in poor soil conditions. Cheatgrass' ability to sequester resources prior to later emerging species, high seed production, and low resource requirements allows this species to become dominant following disturbances. Cheatgrass plants produce many seeds, depending on the environment and the spacing and size of the plants. Individual plants growing in high densities may produce about 25 seeds each, while a large, open-grown plant can produce about 400 seeds (Zouhar 2003). The design of the seed allows it to be easily transported via clothing, animals, and vehicles.

Other species of concern include non-native thistles, knapweeds, and dalmation toadflax. These species will be monitored and treated when possible prior to project initiation and monitored for the duration of the project and beyond.

3.7.2 Environmental Consequences

Effects Common to All Alternatives

The Williams Ranger District will continue its invasive species program, which includes inventory, treatment, and monitoring of invasive plant species, with those populations having the most significant ecological impact and those having the greatest chance of successful control being the highest priority. Implementation of Best Management Practices described in Appendix B (Design Features, Best Management Practices, and Mitigation Measures) in the Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds on the Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona (2004) would assist in the protection of habitat quality from non-native invasives within the project area.

Alternative 1

In the absence of severe wildfire, invasive species would continue to be introduced and spread at the current rate. However, with no action taken there is an inevitable risk of severe wildfire on Bill Williams Mountain (see Fire and Fuels Specialist Report for details). Hunter et al. (2006) found that severe wildlfire had a greater impact on the establishment of non-native species than did fuels treatments, and noted several other studies in which severe wildfires resulted in increased establishment of non-native species (e.g., Crawford et al. 2001; Griffis et al. 2001). Crawford et al. (2001) reported higher cover of cheatgrass on severely burned sites when compared to less severely burned sites in ponderosa pine forests in Arizona. Anecdotal evidence from relatively recent fires occurring on the Williams Ranger District (e.g., 2000 Pumkin Fire, 2004 Trick Fire, 2009 Cross Fire, 2009 Wildhorse Fire, 2010 Eagle Rock Fire) that had isolated patches of high burn severity is also consistent with these studies. Comparable results have also been found on the North Kaibab Ranger District (Kaibab National Forest) from the 1996 Bridger Knoll Fire (Dustin Burger, pers. comm.). Frequency data collected in 2003 in both pinyon-juniper and ponderosa pine forests found multiple high severity areas that were noted for having cheatgrass as the dominant species. In contrast, low burn severity areas had cheatgrass present, but at a lower frequency. The low burn severity areas also had a higher frequency of native species relative to high burn severity areas. Results from Hunter et al. (2006) also suggest that the

occurrence of large and severe wildfires may be one of the more important mechanisms for continued spread of non-native species in semi-arid forests in the west.

Effects Common to All Action Alternatives

Although mechanistic explanations for such are commonly inconsistent (e.g., Davis et al. 2001, Lonsdale et al. 1999), invasion ecology theory often suggests that there is an increased probability of invasive species recruitment and for the spread of existing infestations with increased disturbance. Without early detection and treatment, invasive species have the ability emerge and proliferate into disturbed areas, potentially outcompeting native understory species and redirecting a plant community's successional trajectory. Further, there is an increased threat of introducing new species via equipment and personnel that enter a project area. New and expanded invasions can be expected with all Action Alternatives. Invasive species monitoring and treatments will address invasive species issues for all Action Alternatives. Assuming that successful control of invasive plants occurs during project activities, all Action Alternatives can result in improved ground cover and vigor for native understory species (Moore et al. 2006, Abella 2004). The proposed treatments may also result in increased species richness and functional group diversity which can reduce site invasibility (Elton 1958, Davis et al. 2001). All Action Alternatives further reduce the potential for severe wildfire, where the risk of invasions is considerably higher.

Alternative 2

Alternative 2 would result in the greatest reduction of tree densities of all Action Alternatives, thus having the greatest impact on species abundance, and potentially species richness, of understory plant communities at the project scale. Alternative 2 would also result in the greatest reduction in the risk of severe wildfire compared to all other Alternatives, which would provide the greatest safeguard against the undesirable effects that are associated with such. The combination of the ground disturbing activities associated with timber harvesting and enhanced resource availability following treatments will likely result in Alternative 2 having the highest probability of short-term invasions relative to the other Action Alternatives. Because Alternative 2 has the highest probability of reducing the risk of severe wildfire, it may have the lowest probability of long-term invasions relative to other Alternatives.

<u>Mechanical Treatments</u>
While the effects of the thinning treatments would be positive with the implementation of the mitigation measures described above, the operational effects of the various logging methods vary. The operational effects of helicopter and ground based logging are not likely to have long-term adverse effects due to the limited level of disturbance associated with such. The effects of ground based and helicopter logging will likely result in short-term invasions by non-native plant species. Cable logging operations require cable corridors that are approximately 100 feet apart and 15 feet wide for the length of these operability zones that will be denuded of woody vegetation. Cable logging operations will result in appreciable disturbance along cable corridors that will result in the removal of resident vegetation and provide opportunities for non-native species to establish. Implementation of Best Management Practices may mitigate these issues. However, noxious weed infestations will be difficult to treat in areas where cable logging occurs due to accessibility.

<u>Strategic Fuels Treatments</u>

Strategic Fuels Treatments will occur under Alternative 2 using ground based logging methods and hand felling. These treatments will be consistent with the mitigation measures described above. The effects of ground based logging operations are described above.

Transportation and Trails

Alternative 2 includes the construction of 23 miles of new roads, 16 miles of temporary roads, and 1 mile of new trail. Although the direct loss of plant species habitat may be not be significant at this scale, roads and trails act as dispersal corridors for invasive species. Invasive species can negatively affect natives through direct competition that results in degraded habitat quality. Implementation of Best Management Practices described in Appendix B (Design Features, Best Management Practices, and Mitigation Measures) in the Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds on the Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona (2004) would assist in the protection of habitat quality from non-native invasives within the project area. Alternative 2 also includes 28 miles of road obliteration, which would improve understory conditions by limiting invasive species dispersal rates.

Alternative 3

Alternative 3 would remove fewer trees than Alternative 2 due to diameter caps that restrict the size of trees that can be removed and the exclusion of cable logging. Alternative 3 would have a less improved understory response at the project scale when compared to Alternative 2 due to the diameter cap; therefore would be less resistant to invasions. Alternative 3 would result in less of a reduction in the risk of severe wildfire compared to Alternative 2, which would provide less of a safeguard against the undesirable effects that are associated with such. Because Alternative 3 has a lower probability of reducing the risk of severe wildfire when compared to Alternative 2, it may be more susceptible to long-term invasions should a severe wildfire occur.

The exclusion of cable logging would result in less disturbance, in turn resulting in less risk of future invasions in these areas in the absence of severe wildfire.

The effects of the mechanical treatments, ground based and helicopter logging operations, strategic fuels treatments, and transportation and trails are described in detail above under Alternative 2.

Alternative 4

Alternative 4 would remove the fewest number of trees of all Action Alternatives due to diameter caps that restrict the size of trees that can be removed and the exclusion of both cable and helicopter logging. Alternative 4 would have a less improved understory response at the project scale when compared to Alternatives 2 and 3 due to the diameter cap; therefore would be less resistant to invasions. Excluding both cable and helicopter logging would result in 4,087 untreated acres within the project area. Areas proposed for these treatments are generally the steepest areas within the project area, thus the most susceptible to crown fires. Alternative 4 would result in the lowest level of disturbance at the project scale, thus would result in the lowest probability of short-term invasions of all Action Alternatives. Because Alternative 4 would result in the highest probability of severe wildfire of all Action Alternatives, it has the highest probability of long-term invasions of all Action Alternatives.

The effects of the mechanical treatments, ground based logging operations, strategic fuels treatments, and transportation and trails are described in detail above under Alternative 2. Items not addressed under Alternative 2 are discussed below.

Mechanical Treatments
The exclusion of cable and helicopter logging would result in less disturbance, in turn resulting in less risk of future invasions in these areas in the absence of severe wildfire. Excluding these areas will result in increased risk of severe wildfire, in turn increasing the risk of long-term invasions in the project area.

Transportation and Trails
Alternative 4 excludes the construction of 23 miles of new road construction in exchange for 38 miles of temporary roads. Excluding permanent roads would limit long-term invasive species expansion. Temporary roads may result in short-term invasions.

3.7.3 Cumulative Effects

Grazing
The project area falls within the Hat Grazing Allotment (See Rangeland Ecology and Management Specialist Report for detail). The proposed vegetation treatments will be managed in coordination with grazing management so that grazing within the project area is deferred or avoided during implementation, and a recovery period will follow for treated pastures if needed. Allowing treated pastures to fully recover prior to livestock re-entry will promote the establishment of a diverse native understory, thus reducing the invasibilty of the treated area (Elton 1958).

Livestock grazing before or after burning can influence invasive species establishment, persistence, and spread, but the interaction of grazing with invasive species and fire is poorly understood (Zouhar et al. 2008). However, the dispersal of invasive species propagule while stressing more palatable native species deserves consideration. Several studies have shown that heavy livestock use can lead to increases in aggressive invasive species establishment (Zouhar et al. 2008). There have also been studies that indicate that well managed grazing with low stocking rates can be comparable to grazing rest. On a seven year study performed in north central Arizona during drought conditions, Loeser et al. (2006) compared exotic species colonization on plots experiencing high impact grazing, moderate intensity, and livestock removal. Their study noted that high impact grazing resulted in a considerable increase in exotic species, especially cheatgrass, while moderate grazing and complete livestock removal plots experienced very similar results of only small increases in exotic species.

Currently the Hat Allotment is stocked appropriately for their annual forage production. Given that an anticipated effect of the treatment will increase understory growth, re-entry of livestock to areas treated after recovery should not have an adverse effect to continued understory species response. Combining sufficient understory recovery and planned aggressive weed monitoring and treatment, there is no anticipated effects of increases in non-native species once grazing pressure resumes. Adaptive management will be implemented to address the interaction of invasive plant and grazing (USDA 2009). Best Management Practices will be implemented within the project area, with those populations posing the greatest ecological threat and/or having the greatest likelihood of successful control being the highest priority for treatment to mitigate the treat of invasive species.

Fuels and Timber Management Activities
(Spring Valley, Pine-Aire, Beacon, Williams, Clover, City, Twin, Bill Williams Cap, Elk, Lee, Wright Hill, Horse Pine, Frenchy, Moose, Government 2, Dog Town, McCracken, 4FRI, KA, Ishman, Pomeroy, Community Tank)

Fuels and Timber Management Activities often result in recruitment of invasive plant species that can degrade habitat for native plant species. If neighboring fuels and timber management projects are currently invaded by invasive plants, the risk of invasion within the Bill Williams Mountain Restoration Project is likely increased due to high propagule pressure. Currently, known invasive plant populations within these project areas are being treated, and will continue to be treated until control is achieved. The mitigation measures described above are designed to limit invasions within the Bill Williams Mountains Restoration Project boundary. Best Management Practices will be implemented within the project area, with those populations posing the greatest ecological threat and/or having the greatest likelihood of successful control being the highest priority for treatment to mitigate the treat of invasive species.

Williams RD Travel Management Project
The cumulative effects of the Action Alternatives and Williams RD Travel Management Project are expected to have positive effects on invasive plant species management due to reductions in dispersal rates associated with fewer roads.

Recreation
Recreational activities often accelerate seed dispersal rates of invasive plants. This can be especially problematic in recently disturbed areas, such as areas where fuels and timber management activities have occurred. Best Management Practices will be implemented within the project area, with those populations posing the greatest ecological threat and/or having the greatest likelihood of successful control being the highest priority for treatment to mitigate the treat of invasive species.

Climate
Global climate change models project warmer, more arid conditions in the southwestern United States (Seager et al. 2007). However, the impact of global climate change on species' distributions is mostly uncertain (Thuiller et al. 2007). Climate change may result in more frequent and severe droughts, as well as more high-intensity wildfires. Drought and high-intensity wildfire may result in plant community conversions, habitat loss, and the loss of species viability. Restoration treatments that result in improvements to the understory plant community health may increase understory resistance and resilience to invasive plant invasions.

3.8 Rare Plants

3.8.1 Affected Environment's Existing Condition

The scope of this analysis focuses on Threatened, Endangered, Proposed, Candidate, Conservation Agreement, and Forest Service Sensitive Plant Species (rare plants, hereafter) within the project area perimeter. The analysis includes both known occurrences and potential habitat for rare plant species.

The Bill Williams Mountain Restoration Project area contains several cover types that range from Douglas fir and aspen at the upper range of elevations to grasslands at the lower range of elevations (Table 3.8-1). Because of the lack of data documenting the understory plant community component in the project area, it is difficult to provide a site specific assessment of its existing condition as it pertains to rare plant species. However, we can make some assumptions based on studies conducted in northern Arizona forests. Laughlin et al. (2011) found that ponderosa pine basal area increased from an average of 4m^2/ha in the early 1900s to 29 m^2/ha in 2007, which resulted in a decline of understory plant foliar cover by 21%, species richness by 2 species/m^2, and declines in functional richness. Bakker and Moore (2007) found that species density declined by 34%, herbaceous plant density by 37%, shrub cover by 69%, total herbaceous cover by 59%, graminoid cover by 39%, and forb cover by 82% between 1941 and 2004, and that these changes were negatively correlated with overstory vegetation. Arnold (1950) noted a 25% reduction in grass density in ponderosa pine stands near Flagstaff, Arizona between 1912 and 1947 due to establishment and growth of ponderosa pine trees. Covington and Moore (1994) projected similar trends using a simulation model that showed herbage production (lbs/ac) may have declined approximately 84 % in an untreated ponderosa pine forest between 1907 and 1947.

Repeat photography that was conducted in 2011 specific to the Bill Williams Mountain Restoration Project and for the Hat Grazing Allotment Environmental Assessment (USDA 2009), which is partially included within the Bill Williams Mountain Restoration Project boundary, indicates that both ponderosa pine and juniper species have increased within the project area. Therefore, it is appropriate to assume that the trends described above continue today in areas where tree encroachment and canopy closure continues to occur in northern Arizona forests, and that understory species, including rare plant species, are more competitively stressed than they were under pre-settlement conditions and are likely declining due to their inability to rapidly adapt to an altered environment (Laughlin et al. 2011).

More specific information for individual species is provided below in the Methodology and Analysis Process section.

Table 3.8-4: Cover types within the Bill Williams Mountain Restoration Project Area boundary.

Cover Type	Acres	% of Project Area
Douglas-fir	363	2.1
Aspen	102	0.6
Grasslands	887	5.0
Juniper Woodland	942	5.3
Mixed Hardwood	146	0.8
Mountain-Mahogany, Bitterbrush, Skunkbrush	40	0.2
Oak Woodland	657	3.7
Pinyon-Juniper	659	3.7
Ponderosa Pine	11,391	64.5
Rockland, Talus, Scree	23	0.1
Treeland	20	0.1
Urban Residential Areas	842	4.8

White Fir	1,593	9.0
Total	**17,665**	**100.0**

3.8.2 Direct and Indirect Effects

A review was conducted to determine if Threatened, Endangered, Proposed, Candidate, Conservation Agreement, Forest Service Sensitive, or Kaibab National Forest Management Indicator Species and/or habitats were known to occur within or near the Bill Williams Mountain Restoration Project area. The following references were used: USFWS Internet list of Threatened, Endangered, Proposed, Candidate, and Conservation Agreement species occurring in Coconino and/or Yavapai County; Arizona Game and Fish Department Heritage Data Management System; USDA Forest Service Region 3 Rare Species List; Arizona Rare Plant Field Guide; and Southwest Environmental Information Network (Appendix B).

A search of known locations of rare plant species was conducted using spatial data from Arizona Game and Fish Department Heritage Data Management System, US Forest Service rare plant database (NRIS), and Southwest Environmental Information Network (Appendix B). Arizona bugbane (*Cimicifuga arizonica*) and Flagstaff beardtongue (*Penstemon nudiflorus*) are known to occur within the project boundary. Potential habitat may also exist for Mt. Dellenbaugh sandwort (*Arenaria aberrans*) and Rusby's milkvetch (*Astragalus rusbyi*).

Arizona bugbane is both a Management Indicator Species and a Conservation Agreement Species. Most of the known populations are located along moist, shady canyon bottoms and lower canyon slopes (at times under overhangs) in association with Douglas fir, white fir, bigtooth Rocky Mountain maple, and sometimes aspen with a diverse herbaceous understory and abundant duff. Some populations are found on mountains at seeps and springs, in drainages and on shaded north slopes. It grows in moist, loamy soil of ecotone between coniferous forest and riparian habitat and stays close to the ecotone. It appears to require deep shade from forest or riparian overstory. Major threats include general disturbance to riparian areas, together with recreation, off-road vehicle use and grazing by livestock. Water transfers may also be a threat. A small number of populations and a small amount of area covered by each population render this species vulnerable (Arizona Game and Fish Department 2008). Only four population areas are known to occur; all of which occur in central Arizona (Phillips and Popowski 1995). A single population of Arizona bugbane occurs on the northern aspect of Bill Williams Mountain, and is the only known population to occur on the Kaibab National Forest. The population extends for approximately one-half mile and generally occupies a strip of habitat measuring 20 to50 feet wide on the slopes of Bill Williams Mountain (Warren 1991). In 1988, there were approximately 1,150 plants in this population (Galeano-Popp 1988). In 1998, there were at least 1,200 total plants (USDA 1998), suggesting a stable population. Data collected in 2007 by a Forest Service TEAMS Enterprise Unit and by Kaibab/Coconino National Forests between 1990 -2010 suggests a similar trend (TEAMS 2007 unpublished data, USDA Forest Service 2010 unpublished data).

At this time, there is less concern for the immediate bugbane population than there is for the health of the forest surrounding and supporting the population. Uncharacteristic wildfire currently threatens the habitat of Arizona bugbane in the Bill Williams Botanical Area due to low levels of successful regeneration of aspen and the loss of large old-growth conifers. Further, existing aspen trees are dying following a severe frost event weakened them, followed by infestations of secondary agents including cytospora canker, bronze poplar borer and other canker fungi and insects (Fairweather 2006, personal communication).

Flagstaff Beardtongue occurs in dry ponderosa pine forests in mountainous regions south of the Grand Canyon, Arizona at elevations ranging from 5,035 to 7,375 feet (Arizona Game and Fish Department 2003). Little is known about Flagstaff Beardtongue ecology. However, species responded favorably to low intensity fire in the Trick Fire on the Kaibab National Forest (USDA 2007). Two populations have been documented within the project area and occur at the top of Bill Williams Mountain.

Rusby's milkvetch occurs in open meadows in ponderosa pine forests and at edges of thickets and aspen groves. It occurs on dry, basaltic soils at elevations ranging from 7,000 to 8,000 feet (Arizona Rare Plant Committee 2001). There are no known populations of Rusby's milkvetch within or near the project boundary, but suitable habitat may exist. Rusby's milkvetch can be a dominant native perennial forb species in ponderosa pine stands (Laughlin et al. 2006, Moore et al. 2006), and a recent study has shown positive responses to thinning and burning treatments (Laughlin et al. 2008).

Mt. Dellenbaugh sandwort is poorly understood, and is one of twenty species in the genus *Arenaria* that occurs throughout the US. The species *aberrans* only occurs in Arizona. It occurs mainly in oak and pine forests. It is found in open pine and pine-pinyon woodlands, and among junipers (Arizona Game and Fish Department 2004). There are no known populations of Mt. Dellenbaugh sandwort within or near the projects boundary, but suitable habitat may exist.

This analysis is focused on those species listed above that either occur within the project boundary or those for which potential habitat exists.

Effects Common to All Alternatives

Both known populations and newly discovered populations of all Threatened, Endangered, Proposed, Candidate, Conservation Agreement, and Forest Service Sensitive Plant Species on the Kaibab National Forest will continue to be monitored and protected from management activities that may have adverse effects.

Alternative 1: No Action

Current management would result in a continuance of understory plant community habitat degradation. Trees would continue to increase in both density and size which will lead to more intense competition for understory plant species. More intense competition will result in lower levels of species abundance, productivity, and vigor, and potentially reductions in species richness. Competition in ponderosa pine forests can also result in understory plant community conversions that are dominated by shade- and stress-tolerant species (Laughlin et al. 2011). In addition, there is an extreme risk of uncharacteristic wildfire within the project area under the No Action Alternative. Severe wildfire in the project area may result in unprecedented levels of habitat loss for rare plant species, and perhaps complete conversions of habitat types. Severe wildfire in the Arizona Bugbane Botanical Area may result in the loss of this unique habitat (i.e., deep loamy soil and deep shade from overstory tree species) and may potentially displace the population. Severely burned areas may experience some level of reduction in site productivity, especially those with slope related erosion hazards (Bormann et al. 2008). Such losses can result in habitat loss for rare plant species, as well as their associates. Severe wildfire may also result in extensive non-native plant invasions that will further reduce the habitat quality for rare plant species.

Further, Kaye and Kirkland (1994) hypothesized that hardwood trees play an important role in forest dynamics that support tall bugbane (*Cimicfuga elata*). The deciduous trees where Arizona

bugbane is established are leafless in the spring allowing direct sunlight to reach the forest floor. Direct sunlight can heat the top layers of the soil, which may contribute to stimulated growth and enhanced germination and establishment. In the summer, leaves on the deciduous tree associates provide shade to maintain moisture and cooler temperatures. Under the No Action Alternative, shade-tolerant coniferous species have the potential to rise above the deciduous tree associates of Arizona bugbane and outcompete them in the absence of prescribed or natural fire, resulting in the degradation of habitat components that support Arizona bugbane's microenvironment.

The No Action Alternative may adversely affect the Arizona bugbane population due to habitat loss should a catastrophic wildfire occur within the Arizona Bugbane Botanical Area. In the absence of catastrophic wildfire, the No Action Alternative may also adversely affect the Arizona bugbane population due to habitat loss by allowing coniferous trees to outcompete its deciduous tree associates. Given that only four population areas are known to occur worldwide, such adverse effects could contribute to a trend toward federal listing and a loss of species and population viability.

The No Action Alternative is not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort, and will not likely contribute to a trend toward federal listing or a loss of species viability due to their limited occurrence and/or absence within the immediate project area.

Effects Common to All Action Alternatives

Plant communities in the western United States have been dramatically altered by fire exclusion, overgrazing by livestock, and selective timber harvesting; all of which have combined to form highly dense and unhealthy forests. Increased ponderosa pine density has resulted in a significant loss of the herbaceous understory due to alterations in resource allocation within the stand, which can adversely affect both structural and functional properties of the forest understory (Laughlin et al. 2011, Stoddard et al. 2011). Ecological restoration can be applied to convert high-density ponderosa pine forests to an open canopy structure similar to that found at the time of Euro-American settlement (Moore et al. 2006), potentially reestablishing understory properties to near pre-settlement conditions (Stoddard et al. 2011). Forest thinning and prescribed burning are often proposed and implemented to reverse the undesirable changes in ponderosa pine forests in Arizona (Abella 2004). Forest thinning and prescribed burning can make resources (e.g., light, nutrients, and water) more readily available for understory plant species. Increasing resource availability can provide the herbaceous component of a plant community the opportunity to capitalize, which can result in increased species abundance, vigor, and productivity, and potentially enhance species richness (Griffis et al. 2001, Abella 2004, Moore et al. 2006, Laughlin et al. 2008, Stoddard 2011). The proposed restoration treatments would provide structural diversity to promote suitable habitat for a host of understory species with differing resource requirements (e.g., shade-tolerant vs. shade-intolerant), and would have potential to increase the abundance of rare plant species.

All Action Alternatives include the implementation of the mitigations described above to ensure the protection and viability of rare plant species populations and their habitats.

Alternative 2

Alternative 2 would result in the greatest reduction of tree densities of all Action Alternatives, thus having the greatest impact on overall species abundance, and potentially species richness, of

understory plant communities at the project scale. Alternative 2 would also result in the greatest reduction in the risk of high intensity wildfire compared to all other Alternatives, which would provide the greatest safeguard against the undesirable effects that are associated with such.

Arizona Bugbane

Mechanical Treatments

Varying levels of mechanical treatments in the Botanical Area may provide opportunities for habitat enhancement. As stated above for tall bugbane (*Cimicfuga elata*), Kaye and Kirkland (1999) hypothesized that hardwood trees play an important role in forest dynamics. The deciduous trees where Arizona bugbane is established are leafless in the spring allowing direct sunlight to reach the forest floor. Direct sunlight can heat the top layers of the soil, which may contribute to stimulated growth and enhanced germination and establishment. In the summer, leaves on the deciduous tree associates provide shade to maintain moisture and cooler temperatures. Since shade-tolerant coniferous species have the potential to rise above the deciduous tree associates of Arizona bugbane and outcompete them in the absence of prescribed or natural fire, low intensity thinning of understory coniferous species in the Botanical Area may promote the health and sustainability of Arizona bugbane's deciduous tree associates. Coniferous and deciduous trees that are part of the upper canopy and contribute to this unique habitat, as well as deciduous trees/shrubs greater than 5 inches in diameter, would be left on site to promote and maintain the deep shading that facilitates factors contributing to the microenvironment (i.e., reduced temperature, increased moisture, and seasonal light) for which Arizona bugbane is thought to be dependent. Further, improving tree health through density reductions may also result in long-term resistance/resilience to disturbances (e.g., insect outbreaks, drought), thus enhancing the long-term sustainability of the microenvironment. Interestingly, Kaye (1994) found that tall bugbane populations in clearcuts and thinned stands were taller and produced more flowers than that in uncut forests or second growth (>70 years). While this isn't meant to advocate heavy thinning within the Botanical Area on Bill Williams Mountain, it does provide insight into treatment tolerance.

Cable, helicopter, and ground based logging are being proposed within the Arizona Bugbane Botanical Area under Alternative 2. While the effects of the thinning treatments in the Botanical Area would be positive with the implementation of the mitigation measures described above, the operational effects of the various logging methods vary. Within the Botanical Area, helicopter logging (416 acres, 67% of the Botanical Area) would result in the least amount of disturbance, followed by ground based (136 acres, 22%) and cable (67 acres, 11%) logging, respectively. With the implementation of the mitigation measures within the Botanical Area, the operational effects of helicopter and ground based logging are not likely to have long-term adverse effects on Arizona bugbane due to the limited level of disturbance associated with such. Cable logging operations require cable corridors that are approximately 100 feet apart and 15 feet wide for the length of these operability zones that will be denuded of woody vegetation. Trees will then be dragged through these corridors causing additional soil disturbance. Most important, the scale of disturbance associated with the operational requirements of cable logging within the Botanical Area could potentially disrupt the microclimate (i.e., patterns of temperature, moisture, wind, and light) of this unique ecosystem (Chen et al. 1999), and may adversely affect the Arizona bugbane population. It is unlikely that the required Mitigation Measures designed to protect the unique microenvironment and the operational requirements of cable logging within the Botanical Area can coincide.

Helicopter and ground based logging are not likely to adversely affect the Arizona bugbane population due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability.

Cable logging may adversely affect this Arizona bugbane population by altering its critical microenvironment. This may be especially problematic with projected climatic shifts towards a warmer and drier environment in the southwestern United States (Seager et al. 2007). Given that only four population areas are known to occur, such adverse effects could contribute to a trend toward federal listing and a loss of species and population viability.

Strategic Fuels Treatments

Strategic fuels treatments are proposed in the Botanical Area and consist of heavy thinning using ground based logging methods and hand felling. Given that the location of the proposed treatment within the Botanical Area is immediately adjacent to the Arizona bugbane population, the treatment may adversely affect the Arizona bugbane population by disrupting the microclimate. Variations in microclimates can be dramatic near edges of treatments up to several tree lengths (Chen et al. 1999). Such changes in microclimate condition near edges can modify or impair ecosystem functions (Chen et al. 1999), in turn having adverse effects on the Arizona bugbane population.

Strategic fuels treatments may adversely affect the Arizona bugbane population by altering its critical microenvironment. This may be especially problematic with projected climatic shifts towards a warmer and drier environment in the southwestern United States (Seager et al. 2007). Given that only four population areas are known to occur, such adverse effects could contribute to a trend toward federal listing and a loss of species and population viability.

Prescribed Fire

Prescribed fire may provide opportunities for habitat enhancement (Phillips and Popowski 1995). Monitoring in 2004 following the 2003 Fry Fire on the Coconino National Forest showed that Arizona bugbane populations had remained stable one year after the fire (USDA 2004). Additional monitoring of the Fry Fire conducted in 2010 had similar results seven years following the fire (B. Phillips, pers. comm.). A separate population occurring on the Coconino National Forest has also remained stable since a watershed-scale fire occurring in the 1970's (B. Phillips, pers. comm.). As mentioned above, restricting shade-tolerant coniferous species from rising above Arizona bugbane's deciduous tree associates and out-competing them within the Botanical Area may promote the health and sustainability of Arizona bugbane's deciduous tree associates; and therefore the health and sustainability of the Arizona bugbane population. Fire can also increase net nitrogen (N) mineralization, making N more readily available for plant uptake (Kaye and Hart 1998). Improved nutrient cycling following restoration treatments can increase production in remaining vegetation, resulting in enhanced plant community and ecosystem health. Fire can also consume surface litter where Arizona bugbane exists allowing for its seeds to reach mineral soil. Soil-seed contact may facilitate germination and recruitment of new Arizona bugbane individuals, as was evident at the Fry Fire population (B. Phillips, pers. comm.). Although the long-term effects of fire on Arizona bugbane are largely unknown due to a lack of long-term empirical data, anecdotal evidence and fire regime related inferences support positive effects of low to moderate intensity fire in these ecosystems.

Alternative 2 includes a Forest Plan amendment that would allow flexibility when burning within the Botanical Area. Currently, the Forest Plan restricts average annual burned areas to 1/10 acres.

Restricting burn accomplishments to this size annually would require approximately 6,180 years to treat the entire Botanical Area with fire. This Forest Plan Guideline will not reduce fuels in a timely manner, and will provide opportunity for high intensity wildfires within the Botanical Area. Given the projected climatic conditions (Seager et al. 2007), the risk of high severity wildfire within the Botanical Area can be considered inevitable. Following high intensity wildfire, there is potential for the permanent loss of Arizona bugbane on Bill Williams Mountain due to sedimentation and/or erosion within the drainage where it exists, as well as the permanent loss of its habitat. Sedimentation and/or erosion may also occur following prescribed fire, but the extent would be significantly less than that from a severe wildfire. The proposed Forest Plan amendment would deviate from these restrictions, and allow more progressive fuels management, ultimately protecting Arizona bugbane and its habitat. With the implementation of Mitigation Measures, burning areas greater than 1/10 acres/year would have a long-term benefit to the Arizona bugbane population by reducing fuels, thus reducing the likelihood for high intensity wildfire.

Prescribed fire (i.e., low to moderate fire intensity) is not likely to adversely affect the Arizona bugbane population due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability.

Transportation and Trails
No new roads or trails are proposed within the Botanical Area

Mt. Dellenbaugh sandwort, Rusby's milkvetch, Flagstaff Beardtongue

Mechanical Treatments
Mechanical treatments would provide structural diversity to promote suitable habitat for a host of understory species with differing resource requirements (e.g., shade-tolerant vs. shade-intolerant), and may increase the abundance of rare plant species. Although little is known about the ecology of the rare plant species specific to this project, it is thought that Mt. Dellenbaugh sandwort and Rusby's milkvetch prefer forest openings; therefore it would be expected that reductions in tree densities would favor these species. Laughlin et al. (2008) showed that Rusby's milkvetch increased in frequency following thinning treatments. Given that mechanical treatments would provide structural diversity at the project scale, treatments may increase Flagstaff beardtongue abundance and distribution at the project scale.

The overall effects of mechanical treatments on rare plant species would be positive with the implementation of the mitigations described above. Helicopter logging would result in the least amount of disturbance, followed by ground based and cable logging, respectively. With the implementation of the mitigation measures, the operational effects of helicopter and ground based logging are not likely to have long-term negative effects on rare plant species due to the limited level of disturbance associated with such. Cable logging would result in appreciable disturbance. However, cable logging makes up only 3% of the project area and the long-term effects of these treatments would benefit rare plant species at the project scale by diversifying structural properties in those areas where cable logging is being proposed and by reducing the risk of severe wildfire.

Mechanical treatments are not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures,

and will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

Strategic Fuels Treatments
Strategic Fuels Treatments will occur under Alternative 2 using ground based logging methods and hand felling. These treatments will be consistent with the mitigation measures described above; therefore the treatments are not expected to adversely affect rare plant species viability. Strategic Fuels Treatments will occur within the Botanical Area. The effects of ground based logging operations are described above.

Strategic fuels treatments are not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

Prescribed Fire
Given that these species evolved in a fire-adapted ecosystem, it is unlikely that prescribed fire of low to moderate intensities would negatively affect species viability. Both Flagstaff beardtongue and Rusby's milkvetch have shown positive responses to fire (USDA 2007, Laughlin et al. 2008). Laughlin et al. (2008) showed that Rusby's milkvetch showed an increase in frequency following prescribed fire. Prescribed fire has the potential to expand the current abundance and distribution of rare plant species by enhancing structural (e.g., variable shading) and functional (e.g., nutrient flow) ecosystem properties. Further, it is not reasonable to expect infinite fire exclusion on Bill Williams Mountain. This area will experience fire at some point in time, and prescribed fire would provide the greatest opportunity to protect rare plant species habitat when compared to an intense wildfire.

Prescribed fire is not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

Transportation and Trails
Road construction and trails would cause the direct loss of habitat for rare plant species. However, the land area that would be converted to roads and trails is minimal, and would not result in significant habitat loss for any particular species or threaten species viability. The design criteria for roads and trails would minimize negative impacts to rare plant species (see above mitigations). Roads and trails also provide opportunities for the establishment and spread of invasive plants. However, invasive plant mitigations would protect rare plant populations from the adverse effects associated with invasions (see Invasive Weeds Specialist Report for mitigation measures).

Road construction and trails are not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

Alternative 3

Alternative 3 would remove fewer trees than Alternative 2 due to diameter caps that restrict the size of trees that can be removed and the exclusion of cable logging. Given that cable logging makes up only 3% of the project area, its exclusion would not dramatically affect rare plant species at the project scale. Alternative 3 would have a less improved understory response at the project scale when compared to Alternative 2 due to the diameter cap. Alternative 3 would result in less of a reduction in the risk of severe wildfire compared to Alternative 2, which would provide less of a safeguard against the undesirable effects that are associated with such (see Alternative 2 for a description of severe wildfire effects on rare plant species).

Arizona Bugbane

Mechanical Treatments

Helicopter and ground based logging are being proposed within the Botanical Area containing Arizona bugbane under Alternative 3. The effects of mechanical treatments, as well as specific effects of helicopter and ground based logging operations, on Arizona bugbane are described in detail under Alternative 2. The exclusion of cable logging would result in approximately 11% of the Botanical Area being untreated, which would increase the risk of severe wildfire in the untreated areas.

Mechanical treatments under Alternative 3 are not likely to adversely affect the Arizona bugbane population due to the implementation of mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability. However, Alternative 3 would leave the Arizona Bugbane Botanical Area more vulnerable to high intensity wildfire relative to Alternative 2, which could result in adverse effects to the Arizona bugbane populations, and potentially contributing to a trend toward federal listing or a loss of species viability if a high intensity wildfire were to occur.

Strategic Fuels Treatments

Strategic Fuels Treatments are proposed for the Botanical Area using ground based logging methods and hand felling. Given that the location of the proposed treatment within the Botanical Area is immediately adjacent to the population, the treatment may adversely affect the Arizona bugbane population. Variations in microclimates can be dramatic near edges of treatments up to several tree lengths (Chen et al. 1999). Such changes in microclimate condition near edges can modify or impair ecosystem functions (Chen et al. 1999), in turn having negative impacts on the Arizona bugbane population.

Strategic fuels treatments may adversely affect the Arizona bugbane population by altering its critical microenvironment. This may be especially problematic with projected climatic shifts towards a warmer and drier environment in the southwestern United States (Seager et al. 2007). Given that only four population areas are known to occur, such adverse effects could contribute to a trend toward federal listing and a loss of species and population viability.

Prescribed Fire

The effects of prescribed fire on Arizona bugbane are described in detail under Alternative 2. Alternative 3 would restrict the average annual burned area within the Botanical Area to 1/10 acre per Forest Plan guidelines. Restricting burn accomplishments to this size annually would require approximately 6,180 years for the entire botanical area to experience fire. This guideline will not reduce fuels in a timely manner, and will likely result in a severe wildfire. Severe wildfire has the potential to cause unprecedented levels of disturbance on Bill Williams Mountain, resulting in the

loss of entire plant communities, including those associated with rare plant species. There is potential for the permanent loss of Arizona bugbane following severe fire due to sedimentation and/or erosion within the drainage where it exists, as well as the permanent loss of its habitat due to consumption of its associate species.

Prescribed fire (i.e., low to moderate fire intensity) is not likely to adversely affect Arizona bugbane individuals, and will not likely contribute to a trend toward federal listing or a loss of species viability. However, the limitations on prescribed fire under Alternative 3 would leave the Arizona Bugbane Botanical Area more vulnerable to high intensity wildfire relative to Alternative 2, which could result in adverse effects to the Arizona bugbane populations, and potentially contributing to a trend toward federal listing or a loss of species viability if a high intensity wildfire were to occur.

Transportation and Trails
No new roads or trails are proposed within the Botanical Area

Mt. Dellenbaugh sandwort, Rusby's milkvetch, Flagstaff Beardtongue

Mechanical Treatments
The effects of mechanical treatments, as well as helicopter and ground based logging operations, on rare plant species are described in detail under Alternative 2. The exclusion of cable logging under Alternative 3 would leave 3% of the project area untreated, which would increase the risk of severe wildfire in the untreated areas. Alternative 3 is not likely to adversely affect the rare plant species with the implementation of mitigation measures.

Mechanical treatments under Alternative 3 are not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

Strategic Fuels Treatments
Strategic Fuels Treatments will occur under Alternative 3 using ground based logging methods and hand felling. These treatments will be consistent with the mitigation measures described above; therefore the treatments are not expected to adversely affect rare plant species viability. The effects of ground based logging operations are described above.

Strategic fuels treatments are not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

Prescribed Fire
Given that these species evolved in a fire-adapted ecosystem, it is unlikely that prescribed fire of low to moderate intensities would negatively affect species viability. Both Flagstaff beardtongue and Rusby's milkvetch have shown positive responses to fire (USDA 2007, Laughlin et al. 2008). Laughlin et al. (2008) showed that Rusby's milkvetch showed an increase in frequency following prescribed fire. Prescribed fire has the potential to expand the current abundance and distribution of rare plant species by enhancing structural (e.g., variable shading) and functional (e.g., nutrient flow) ecosystem properties. Further, it is not reasonable to expect infinite fire exclusion on Bill

Williams Mountain. This area will experience fire at some point in time, and prescribed fire would provide the greatest opportunity to protect rare plant species habitat when compared to a severe wildfire.

Prescribed fire under Alternative 3 is not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

Transportation and Trails
Road construction and trails would cause the direct loss of habitat for rare plant species. However, the land area that would be converted to roads and trails is minimal, and would not result in significant habitat loss for any particular species or threaten species viability. The design criteria for roads and trails would minimize negative impacts to rare plant species (see above mitigations). Roads and trails also provide opportunities for the establishment and spread of invasive plants. However, invasive plant mitigations would protect rare plant populations from the adverse effects associated with invasions (see Invasive Weeds Specialist Report for mitigation measures).

Road construction and trails are not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

Alternative 4
Alternative 4 would remove the fewest number of trees of all Action Alternatives due to diameter caps that restrict the size of trees that can be removed and the exclusion of both cable and helicopter logging. Excluding both cable and helicopter logging would result in 4,087 untreated acres within the project area. Areas proposed for these treatments are generally the steepest areas within the project area, thus the most susceptible to crown fires. Alternative 4 would likely result in the least improved (i.e., enhanced abundance, vigor, productivity) understory of all Action Alternatives. Understory plant communities in areas identified for cable and helicopter logging would continue to degrade as tree densities and size increase. Alternative 4 would reduce the risk of severe wildfire the least when compared to all other Action Alternatives, which would provide the lowest level of safeguard against the undesirable effects that associated with such (see Alternative 2 for a description of severe wildfire effects on rare plant species).

Arizona Bugbane

Mechanical Treatments
Only ground based logging is being proposed within the Botanical Area containing Arizona bugbane under Alternative 4. The effects of ground based logging operations on rare plant species are described in detail above under Alternative 2. The exclusion of helicopter and cable logging would result in approximately 78% of the Botanical Area being untreated, resulting in high risk for severe wildfire. Alternative 4 is not likely to directly affect the Arizona bugbane population with the implementation of mitigation measures. However, there is potential for the permanent loss of Arizona bugbane following severe wildfire due to sedimentation and/or erosion within the drainage where it exists, as well as the permanent loss of its habitat due to consumption of its associate species.

Mechanical treatments under Alternative 4 are not likely to adversely affect the Arizona bugbane population due to the implementation of mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability. However, Alternative 4 would leave the Arizona Bugbane Botanical Area more vulnerable to high intensity wildfire relative to Alternatives 2 and 3, which could result in adverse effects to the Arizona bugbane populations, and potentially contributing to a trend toward federal listing or a loss of species viability if a high intensity wildfire were to occur.

Strategic Fuels Treatments

Strategic fuels treatments are proposed for the Botanical Area using ground based logging methods and hand felling. Given that the location of the proposed treatment within the Botanical Area is immediately adjacent to the population, the treatment may adversely affect the Arizona bugbane population. Variations in microclimates can be dramatic near edges of treatments up to several tree lengths (Chen et al. 1999). Such changes in microclimate condition near edges can modify or impair ecosystem functions (Chen et al. 1999), in turn having negative impacts on the Arizona bugbane population.

Strategic fuels treatments may adversely affect the Arizona bugbane population by altering its critical microenvironment. This may be especially problematic with projected climatic shifts towards a warmer and drier environment in the southwestern United States (Seager et al. 2007). Given that only four population areas are known to occur, such adverse effects could contribute to a trend toward federal listing and a loss of species and population viability.

Prescribed Fire

The effects of prescribed fire on Arizona bugbane are described in detail under Alternative 2. Alternative 4 would restrict the average annual burned area within the Botanical Area to 1/10 acre per Forest Plan guidelines. Restricting burn accomplishments to this size annually would require approximately 6,180 years for the entire botanical area to experience fire. This guideline will not reduce fuels in a timely manner, and will likely result in a severe wildfire. Severe wildfire has the potential to cause unprecedented levels of disturbance on Bill Williams Mountain, resulting in the loss of entire plant communities, including those associated with rare plant species. There is potential for the permanent loss of Arizona bugbane following severe fire due to sedimentation and/or erosion within the drainage where it exists, as well as the permanent loss of its habitat due to consumption of its associate species.

Prescribed fire (i.e., low to moderate fire intensity) is not likely to adversely affect Arizona bugbane individuals, and will not likely contribute to a trend toward federal listing or a loss of species viability. However, the limitations on prescribed fire under Alternative 4 would leave the Arizona Bugbane Botanical Area more vulnerable to high intensity wildfire relative to Alternatives 2 and 3, which could result in adverse effects to the Arizona bugbane populations, and potentially contributing to a trend toward federal listing or a loss of species viability if a high intensity wildfire were to occur.

Transportation and Trails

No new roads or trails are proposed within the Botanical Area

Mt. Dellenbaugh sandwort, Rusby's milkvetch, Flagstaff Beardtongue

Mechanical Treatments
Only ground based logging is being proposed under Alternative 4. The effects of mechanical treatments and ground based logging operations on rare plant species are described in detail above under Alternative 2. The exclusion of helicopter and cable logging would result in approximately 27% of the Project Area being untreated, which would increase the risk of severe wildfire in the untreated areas.

Mechanical treatments are not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

Strategic Fuels Treatments
Strategic fuels treatments will occur under Alternative 4 using ground based logging methods and hand felling. These treatments will be consistent with the mitigation measures described above; therefore the treatments are not expected to adversely affect rare plant species viability. The effects of ground based logging operations are described above.

Strategic fuels treatments are not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures, but will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

Prescribed Fire
Given that these species evolved in a fire-adapted ecosystem, it is unlikely that prescribed fire of low to moderate intensities would negatively affect species viability. Both Flagstaff beardtongue and Rusby's milkvetch have shown positive responses to fire (USDA 2007, Laughlin et al. 2008). Laughlin et al. (2008) showed that Rusby's milkvetch showed an increase in frequency following prescribed fire. Prescribed fire has the potential to expand the current abundance and distribution of rare plant species by enhancing structural (e.g., variable shading) and functional (e.g., nutrient flow) ecosystem properties. Further, it is not reasonable to expect infinite fire exclusion on Bill Williams Mountain. This area will experience fire at some point in time, and prescribed fire would provide the greatest opportunity to protect rare plant species habitat when compared to a severe wildfire.

Prescribed fire under Alternative 3 is not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

Transportation and Trails
Road construction and trails would cause the direct loss of habitat for rare plant species. However, the land area that would be converted to roads and trails is minimal, and would not result in significant habitat loss for any particular species or threaten species viability. The design criteria for roads and trails would minimize negative impacts to rare plant species (see above mitigations). Roads and trails also provide opportunities for the establishment and spread of invasive plants. However, invasive plant mitigations would protect rare plant populations from the adverse effects associated with invasions (see Invasive Weeds Specialist Report for mitigation measures).

Road construction and trails is not likely to adversely affect Flagstaff Beardtongue, Rusby's milkvetch, or Mt. Dellenbaugh sandwort due to the implementation of the mitigation measures, and will not likely contribute to a trend toward federal listing or a loss of species viability due to their relatively limited occurrence within the project area.

3.8.3 Cumulative Effects

Invasive Plant Species and Treatments
Timber management activities and prescribed burning remove portions of the overstory, understory, and/or litter cover, with the objective of maintaining or improving forest health and enhancing the herbaceous understory. Understory plant communities that are abundant and diverse can increase plant communities' resistance to non-native plant invasion (Elton 1958). Reducing fuels and tree canopy cover can also reduce the threat of severe wildfires that often times provide optimal conditions for weeds to establish. Invasive plants can degrade habitat for rare plant species, and can be spread by heavy equipment, vehicles, and personnel associated with these activities. All Action Alternatives may result in the recruitment/expansion of invasive plant species populations, and the extent of the invasions will likely be dependent on the level of disturbance. Alternative 2 would result in the greatest level of disturbance when compared to all Alternatives, followed by Alternative, 3, 4, and 1, respectively. Inventory, treatments, and monitoring, as well as Best Management Practices, will be implemented within the project area, with those populations posing the greatest ecological threat and/or having the greatest likelihood of successful control being the highest priority for treatment. See Invasive Weeds Specialist Report for more details on invasive plant mitigations. Precautionary measures will be taken to protect rare plant species from invasions and invasive plant treatments.

Livestock Grazing
Sheep grazing does occur within the project area. See the Rangeland Ecology and Management Specialist Report for more information. Livestock grazing does not occur in the Arizona Bugbane Botanical Area. Grazing ungulates may target rare plant species depending on their abundance, palatability, nutritional values, and availability of other forage species. If livestock grazing poses a threat to rare plant species viability, those areas where the populations are of concern will be deferred from grazing.

Fuels and Timber Management Activities (Spring Valley, Pine-Aire, Beacon, Williams, Clover, City, Twin, Bill Williams Cap, Elk, Lee, Wright Hill, Horse Pine, Frenchy, Moose, Government 2, Dog Town, McCracken, 4FRI, KA, Ishman, Pomeroy, Community Tank)

Fuels and Timber Management Activities often result in recruitment of invasive plant species that can degrade habitat for rare plant species. See Invasive Weeds Specialist Report for details on invasive plant mitigations. Precautionary measures will be taken to protect rare plant species from invasions and invasive plant treatments.

Williams RD Travel Management Project
The cumulative effects of the Action Alternatives and Williams RD Travel Management Project are not expected to affect rare plant species.

Climate

Global climate change models project warmer, more arid conditions in the southwestern United States (Seager et al. 2007). However, the impact of global climate change on species' distributions is mostly uncertain (Thuiller et al. 2007). Climate change may result in more frequent and severe droughts, as well as more high-intensity wildfires. Drought and high-intensity wildfire may result in plant community conversions, habitat loss, and the loss of species viability. Restoration treatments that result in improvements to the understory plant community health may increase understory resistance and resilience to disturbance.

Determination of Effects

Region 3 Sensitive Species

Based on the above information above it has been determined that all alternatives considered in the Bill Williams Mountain Restoration Project may impact individuals of Flagstaff beardtongue, Mt. Dellenbaugh sandwort, and Rusby's milkvetch, but are not likely to result in a trend toward Federal listing or loss of viability due to their limited presence within the project area.

Region 3 Sensitive Species and Management Indicator Species

Based on the information above, it has been determined that all alternatives considered in the Bill Williams Mountain Restoration Project may adversely affect Arizona bugbane, and because there is only a single known population on the Kaibab National Forest, all alternatives may also result in decreasing Forest-wide habitat or population trends for the species.

3.9 Rangeland Resources

3.9.1 Affected Environment

The scope of this analysis focuses on the understory plant communities that occur within the proposed project perimeter, as well as the affect that the project may have on grazing activities within the proposed project perimeter.

Understory Plant Community

Plant communities in the western United States have been dramatically altered by fire exclusion, overgrazing by livestock, and selective timber harvesting; all of which have combined to form highly dense and unhealthy forests. Increases in density in ponderosa pine forests have resulted in a significant loss of the herbaceous understory (understory, hereafter) due to alterations in resource allocation within the stand, which can adversely affect both structural and functional properties of a forest. Ecological restoration can be applied to convert high-density ponderosa pine forests to an open canopy structure similar to that found at the time of Euro-American settlement (Moore et al. 2006), and reestablish historical structural and functional ecosystem properties. Forest thinning and prescribed burning are often proposed and implemented to reverse the undesirable changes in ponderosa pine forests of Arizona (Abella 2004).

Forest thinning and prescribed burning can make resources (e.g., light, nutrients, water) more readily available for understory plant species by reducing overstory competition and enhancing nutrient cycling. Increasing resource availability can provide the herbaceous component of a plant community the opportunity to capitalize, which can result in increased species abundance,

vigor, and productivity; and potentially enhance species diversity. Diverse and abundant understory plant communities provide soil stability, enhanced habitat and forage for wildlife, forage for livestock, and increases resistance against non-native plant invasions.

The Bill Williams Mountain Restoration Project area contains several cover types that range from Douglas fir and aspen at the upper range of elevations to grasslands at the lower range of elevations (Table 3.9-1). Because of the lack of data documenting the understory plant community component in the project area, it is difficult to provide a site specific assessment of its existing condition. However, we can make some assumptions based on studies conducted in northern Arizona forests. Laughlin et al. (2011) found that ponderosa pine basal area increased from an average of 4m^2/ha in the early 1900s to 29 m^2/ha in 2007, which resulted in a decline of understory plant foliar cover by 21%, species richness by 2 species/m^2, and declines in functional richness. Bakker and Moore (2007) found that species density declined by 34%, herbaceous plant density by 37%, shrub cover by 69%, total herbaceous cover by 59%, graminoid cover by 39%, and forb cover by 82% between 1941 and 2004, and that these changes were negatively correlated with overstory vegetation. Arnold (1950) noted a 25% reduction in grass density in ponderosa pine stands near Flagstaff, Arizona between 1912 and 1947 due to establishment and growth of ponderosa pine trees. Covington and Moore (1994) projected similar trends using a simulation model that showed herbage production (lbs/ac) may have declined approximately 84 % in an untreated ponderosa pine forest between 1907 and 1947.

Repeat photography that was conducted in 2011 specific to the Bill Williams Mountain Restoration Project and for the Hat Grazing Allotment Environmental Assessment (USDA 2009), which is partially included within the Bill Williams Mountain Restoration Project boundary, indicates that both ponderosa pine and juniper species have increased within the project area. Therefore, it is appropriate to assume that the trends described above continue today in areas where tree encroachment and canopy closure continues to occur in northern Arizona forests, and that understory species are more competitively stressed than they were under pre-settlement conditions and are likely declining due to their inability to rapidly adapt to an altered environment (Laughlin et al. 2011).

Table 3.9-5: Cover types within the Bill Williams Mountain Restoration Project Area boundary.

Cover Type	Acres	% of Project Area
Douglas-fir	363	2.1
Aspen	102	0.6
Grasslands	887	5.0
Juniper Woodland	942	5.3
Mixed Hardwood	146	0.8
Mountain-Mahogany, Bitterbrush, Skunkbrush	40	0.2
Oak Woodland	657	3.7
Pinyon-Juniper	659	3.7
Ponderosa Pine	11,391	64.5
Rockland, Talus, Scree	23	0.1
Treeland	20	0.1

Urban Residential Areas	842	4.8
White Fir	1,593	9.0
Total	**17,665**	**100.0**

Grazing Management

Approximately 9,444 acres of the project area are within the 105,049 acre Hat Grazing Allotment (Figure 1, approximately 9 percent of the allotment), which allows grazing by up to 4,160 ewes from May 1-October 31 and 140 rams from June 1-July 15 that run in a minimum of two bands rotating throughout the Allotment. The grazing management system incorporates seasonal deferment, with an emphasis on spring deferment from May 1 to June 15, which minimizes the number of areas used during this time period to promote cool season plant development.

As with the loss of much of the understory, forage species are also on the decline as a result of management activities. Because of past overgrazing, increasing tree densities, and unfavorable climatic conditions, livestock numbers have been cut significantly on the Hat Allotment from approximately 21,000 animal unit months in 1945 to the current figure of approximately 5,000 animal unit months. Although increasing livestock numbers is not an anticipated result of the restoration treatments associated with this project due to climatic uncertainty, we can expect improved forage conditions for both livestock and wildlife in addition to improved watershed stability.

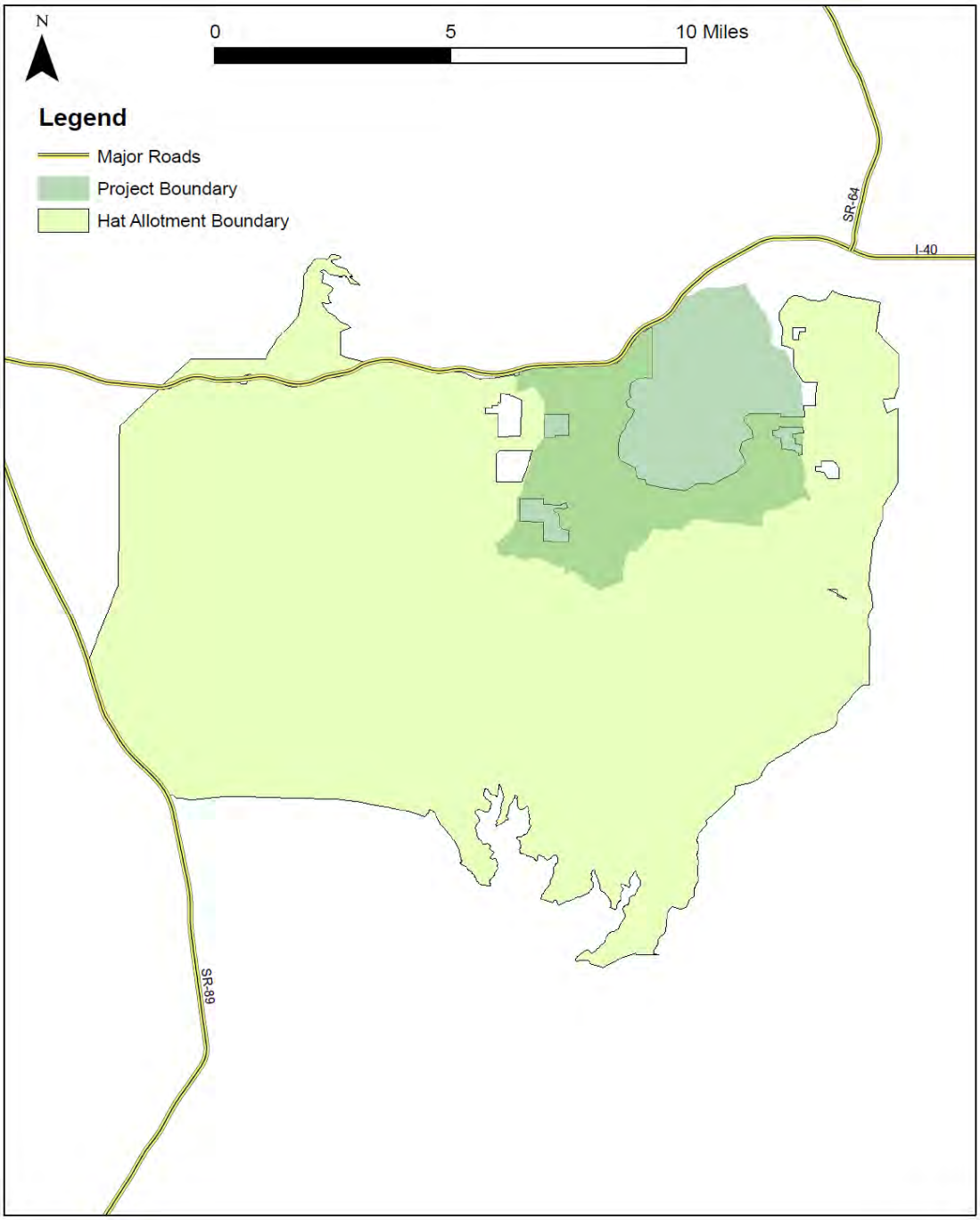


Figure 3.9-6: The Hat Grazing Allotment and the Bill Williams Restoration Project Boundary.

3.9.2 Direct and Indirect Effects

Alternative 1: No Action

Current management would result in a continuance of understory plant community habitat degradation. Trees would continue to increase in both density and size which will lead to more intense competition for understory plant species. More intense competition will result in lower levels of species abundance, productivity, and vigor, and potentially reductions in species richness. Competition in ponderosa pine forests can also result in understory plant community conversions that are dominated by shade- and stress-tolerant species (Laughlin et al. 2011). In addition, there is an extreme risk of uncharacteristic wildfire within the project area under the No Action Alternative. Severe wildfire in the project area may result in unprecedented levels of habitat loss for understory plant communities, and perhaps complete conversions of habitat types. Further, areas burned at high-severity may experience some level of reduction in site productivity, especially those with slope related erosion hazards (Bormann et al. 2008). Such losses can result in habitat loss for rare plant species, as well as their associates. Severe wildfire may also result in extensive non-native plant invasions that will further reduce the habitat quality for rare plant species.

At the present time, the grazing allotments are appropriately stocked for the average annual forage production. However, the understory plant community within the project area will continue to decline as competition becomes increasingly more intense due to the canopy closure. Grazing management will be in accordance with Allotment Management Plans until resources become limited to the point that available forage is reduced to a level where higher forage utilization occurs, at which time livestock numbers would be reduced.

Effects Common to All Action Alternatives

All Action Alternatives considered may ultimately result similar understory plant responses. Ecological restoration can be applied to convert high-density ponderosa pine forests to an open canopy structure similar to that found at the time of Euro-American settlement (Moore et al. 2006), potentially reestablishing understory properties to near pre-settlement conditions (Stoddard et al. 2011). Forest thinning and prescribed burning are often proposed and implemented to reverse the undesirable changes in ponderosa pine forests in Arizona (Abella 2004). Forest thinning and prescribed burning can make resources (e.g., light, nutrients, and water) more readily available for understory plant species. Increasing resource availability can provide the herbaceous component of a plant community the opportunity to capitalize, which can result in increased species abundance, vigor, and productivity, and potentially enhance species richness (Griffis et al. 2001, Abella 2004, Moore et al. 2006, Laughlin et al. 2008, Stoddard 2011). The proposed restoration treatments would provide structural diversity to promote suitable habitat for a host of understory species with differing resource requirements (e.g., shade-tolerant vs. shade-intolerant), and would have potential increase the abundance of rare plant species.

Comparisons in anticipated forage production increases for each management action is difficult to estimate, as specific forage production may be influenced by factors including soil type and condition, slope, moisture, and available propagules. It is appropriate to assume that tree removal and prescribed burning will improve both forage quantity and quality.

Soil disturbances associated with these projects may recruit/expand invasive plant species populations that degrade understory habitat quality. Livestock grazing after burning can influence invasive species establishment, persistence, and spread, but this interaction is poorly understood (Zouhar et al. 2008). The dispersal of invasive species propagules while stressing more palatable native species deserves consideration. Burned areas are usually rested from grazing until native plants have successfully established, thus no adverse affects are expected from grazing following prescribed burning. Once livestock are allowed to graze the burned area, the Forest Service monitors their effects and applies adaptive management when warranted. Best management practices and mitigation measures are implemented at project sites to reduce the introduction and spread of weed species.

Alternative 2

Alternative 2 would remove the highest number trees of all Action Alternatives due to the absence of diameter caps, and would likely result in the greatest understory improvement (i.e., enhanced abundance, vigor, productivity). More importantly, Alternative 2 would result in the greatest reduction in the risk of severe wildfire, which would provide the greatest safeguard against the undesirable effects that are associated with such. Severe wildfires on Bill Williams Mountain may result in irreversible effects to understory plant communities due to the erosion hazard on steeper slopes that may result in the loss of site productivity.

Mechanical Treatments
Ground-based logging operations will have minimal temporary impacts to the understory plant community with the implementation of Best Management Practices.

Cable logging operations will result in appreciable disturbance along cable corridors. Areas identified for cable logging will have swaths that occur approximately 100 feet apart and are approximately 15 feet wide for the length of these operability zones. These swaths will be denuded of woody vegetation. Trees will be dragged through these swaths causing soil disturbance that will result in the removal of resident vegetation and provide opportunities for non-native species to establish. Implementation of Best Management Practices may mitigate these issues. However, noxious weed infestations will be difficult to treat due to accessibility.

Helicopter logging operations will have minimal temporary impacts to the understory plant community with the implementation of Best Management Practices.

Strategic Fuels Treatments
Strategic Fuels Treatments will consist of heavy thinning in areas identified by Fuels Specialists. These treatments will improve the understory plant community with the implementation of Best Management Practices while reducing the risk of large-scale severe wildfire.

Transportation and Trails
Alternative 2 includes the construction of 23 miles of new roads, 16 miles of temporary roads, and 1 mile of new trail. Although the direct loss of plant species habitat may be not be significant at this scale, roads and trails act as dispersal corridors for non-native invasive species. Invasive species can negatively affect the native understory through direct competition and degraded habitat quality. Implementation of Best Management Practices described in Appendix B (Design Features, Best Management Practices, and Mitigation Measures) in the Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds on the Coconino,

Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona (2004) would assist in the protection of habitat quality from non-native invasives within the project area. Alternative 2 also includes 28 miles of road obliteration, which would improve understory conditions by limiting invasive species expansion and restoring roadbeds to native vegetation.

Alternative 3

Alternative 3 would remove fewer trees than Alternatives 2 due to diameter caps that restrict the size of trees that can be removed. Alternative 3 would limit harvested trees to less than 16”. This Alternative may have a similar or a slightly less improved understory response when compared to Alternative 2. Alternative 3 would result in less of a reduction in the risk of severe wildfire compared to Alternative 2, which would provide less of a safeguard against the undesirable effects that are associated with such. Severe wildfires on Bill Williams Mountain may result in irreversible effects to understory plant communities due to the erosion hazard on steeper slopes that may result in the loss of site productivity.

The effects of mechanical treatments, strategic fuels treatments, and transportation and trails are similar to Alternative 2; therefore not described in detail.

Alternative 4

Alternative 4 would remove the fewest number of trees of all Action Alternatives due to diameter caps that restrict the size of trees that can be removed and the exclusion of cable and helicopter logging. Similar to Alternative 3, Alternative 4 would limit harvested trees to less than 16”. Alternative 4 would likely result in the least improved (i.e., enhanced abundance, vigor, productivity) understory of all Action Alternatives. Understory plant communities in areas identified for cable and helicopter logging would continue to degrade as tree densities and size increase. Alternative 4 would reduce the risk of severe wildfire the least when compared to all other Action Alternatives, which would provide the lowest level of safeguard against the undesirable effects that associated with such. Severe wildfires on Bill Williams Mountain may result in irreversible effects to understory plant communities due to the erosion hazard on steeper slopes that may result in the loss of site productivity.

<u>Mechanical Treatments</u>
Ground-based logging operations will have minimal temporary impacts to the understory plant community with the implementation of Best Management Practices.

The exclusion of cable logging operations will result in less disturbance and may restrict the establishment of non-native species to accessible terrain, which would facilitate invasive plant treatments within the project area. The exclusion of helicopter logging operations may also restrict the establishment of non-native species to accessible terrain. Understory plant communities in untreated areas will continue to decline due to increasing tree densities and size. Untreated areas will also be at high risk for severe wildfire that will likely result in undesirable effects to site understory potential where erosion hazards are high. Understory habitat type conversions may occur following severe erosion.

Strategic Fuels Treatments
Strategic Fuels Treatments will consist of heavy thinning in areas identified by Fuels Specialists. These treatments will improve the understory plant community with the implementation of Best Management Practices while reducing the risk of large-scale severe wildfire.

Transportation and Trails
Alternative 4 excludes the construction of 23 miles of new roads, which would reduce invasive species expansion. The effects of temporary roads and road obliteration are similar for all Action Alternatives.

3.9.3 Cumulative Effects

Invasive Plant Species
Timber management activities and prescribed burning remove portions of the overstory, understory, and/or litter cover, with the objective of maintaining or improving forest health and improve the herbaceous understory. Understory plant communities that are abundant and diverse can increase the community's resistance to non-native plant invasion (Elton 1958). Reducing fuels and tree canopy cover can also reduce the threat of catastrophic wildfires that often times provide optimal conditions for weeds to establish. Weeds could be spread by heavy equipment, vehicles, and personnel associated with these activities. The Proposed Action may result in the recruitment/expansion of invasive plant species populations. Inventory, treatments, and monitoring, as well as Best Management Practices, will be implemented within the project area, with those populations posing the greatest ecological threat and/or having the greatest likelihood of successful control being the highest priority for treatment.

Recreation
Recreational activities often accelerate seed dispersal rates of non-native invasive plants which can negatively affect habitat quality of understory plant communities. Inventory, treatments, and monitoring, as well as Best Management Practices, will be implemented within the project area, with those populations posing the greatest ecological threat and/or having the greatest likelihood of successful control being the highest priority for treatment to mitigate the treat of invasive species.

Climate
Global climate change models project warmer, more arid conditions in the southwestern United States (Seager et al. 2007). However, the impact of global climate change on species' distributions is mostly uncertain (Thuiller et al. 2007). Climate change may result in more frequent and severe droughts, as well as more high-intensity wildfires. Drought and high-intensity wildfire may result in forage species mortality, habitat loss, and the loss of species viability. Improving understory plant communities may increase forage species ability to resist drought due to a well developed root system, resulting in the persistence of a native understory.

3.10 Recreation Resources

This report documents the analysis of effects of the proposed Bill Williams Project vegetation treatments on recreation resources located in the area.

3.10.1 Existing Condition

The following is a discussion of existing and expected trends in recreation use levels, recreation activities visitors engage in, current recreation facility developments located in and adjacent to the project area, and Recreation Opportunity Spectrum (ROS) settings in the project area.

Information on current recreation use levels and preferences is derived from public contacts, field observations, and surveys of visitors, local tourism businesses, and residents. Although exact figures are not known, recreation use in the project area is estimated by recreation managers to have high use. The National Visitor Use Monitoring Survey conducted on the forest in 2010 indicates that there are 757,000 visitors to the Kaibab National Forest yearly. The National Visitor Use Monitoring (NVUM, 2005 and 2010) and visitor survey conducted in 2000-2002 by Northern Arizona University (NAU- Boussard, 2002) indicate area visitors come from the local area, the surrounding region (Arizona, Colorado River, Las Vegas) and from across the nation and abroad. While local residents are consistent users of the project area, and have immediate access to the national forest, the project area receives a significant amount of recreational visitors from the lower-elevation, densely populated Phoenix Valley urban communities and Colorado River communities. There is also a fairly significant amount of recreation use in the project area by visitors from accross the US and abroad, as Williams is part of the "Grand Circle" Colorado Plateau region, and adjacent to the Grand Canyon, which brings 4-5 million visitors to the region annually. Known as "The Gateway to the Grand Canyon," Williams has a long history as a tourism destination, and tourism as an industry has received increasing emphasis in the past decades.

Within the project area there are several recreation sites, which include the Bill Williams, Benham, Bixler, Clover Spring Loop, City Link, and Buckskinner Trails. Immediately adjacent to the project area are some of the most heavily visited developed recreation sites on the Williams Ranger District. Sites found adjacent to this planning area include Dogtown Lake Recreation Complex, Overland Trail, Stage Station Loop Mountain Bike Trail, and Historic Route 66 Devil Dog Mountain Bike Loop. Privately and municipally operated recreation facilities under special use permit on National Forest System lands within the project area are the Elk Ridge Ski Area and Buckskinner Park. A number of private recreation-based businesses are also located adjacent to the area (Young Life's Lost Canyon Organizational Camp, the Grand Canyon Railway, and several RV parks, motels, etc.)

As recreation use increases, the types of recreation activities visitors engage in are likewise increasing and diversifying. The types of recreation activities visitors pursue in the project area are varied and occur in mostly dispersed settings in all seasons. These activities include camping, picnicking, hiking, mountain biking, boating, fishing, hunting, horseback riding, riding ATVs and motorcycles, driving, viewing wildlife and scenery, viewing historic features (such as Route 66), family gatherings, cross-country skiing, snowshoeing, sledding, and snow-play. General relaxing and escaping the heat of lower-elevations is one significant reason visitors mention for traveling to this area.

National Forest visitors are diverse in their preferences for recreational settings, experiences, and activities, and for the reasons mentioned above, as well as changing demographics, are becoming increasingly diverse. In order to provide a diversity of settings and opportunities the Forest Service uses the Recreation Opportunity Spectrum (ROS) as a management tool to inventory and describe recreation setting objectives for the National Forest System lands. Forest Plan ROS mapping was completed for the Kaibab National Forest south zone in 2004. The Bill Williams Project area encompasses four ROS classes: Rural on the far north end of the project area;

Roaded Natural forms a ring around the project area on the lower slopes of Bill Williams Mountain; Semi-primitive Motorized encompasses the middle slopes on the south and west side of Bill Williams; and Semi-primitive Non-motorized occurs on the highest slopes of the mountain. Forest Plan direction states that ROS classes are to be considered in the design of project activities and ROS classes maintained or enhanced.

Following are the total ROS acres for the Bill Williams Project area.

Table 3.10-1 shows the Recreation Opportunity Spectrum Classification by Acres for the Project Area.

ROS Class	Acres in Project Area	General Setting Description (Desired Condition)
Rural (R)	1,282	Landscapes may be highly modified but managed to maintain general scenic attractiveness, and may include culturally modified and extensively developed recreation sites. Rural settings are highly modified and managed; there is generally a natural appearing backdrop.
Roaded Natural (RN)	8,776	Landscapes are carefully managed to maintain or enhance recreation and scenic values, sites and features, to be natural appearing, with changes designed to appear in harmony with natural setting. May contain highly developed recreation sites and travel routes.
Semi-Primitive Motorized (SPM)	4,910	Maintain predominately undeveloped landscapes and scenic vistas and limited recreation developments. Recreation uses are non-motorized.
Semi-Primitive Non-motorized (SPNM)	2,698	SPNM

Desired Condition

A spectrum of high-quality outdoor recreation settings and opportunities will be available in the Bill Williams Project area; Roaded Natural ROS areas with high scenic and recreational values and use is high; and Semi-Primitive settings occur where use is lower and the setting is more natural-appearing. Recreation facilities and recreation trails will continue to be provided and maintained, and options for development of future facilities in response to public demand or need are analyzed and implemented if they meet Forest and ecosystem objectives.

The National Forest System lands surrounding Bill Williams Mountain will continue to provide high quality recreation opportunities and settings that compliment and support the City of Williams' tourism industry, and contribute to local residents' quality of life. Management activities on National Forest System lands are consistent with recreation setting objectives. Additional complimentary recreation facilities and services may be developed in the area over time.

The Forest manages for a wide spectrum of desired settings that provide opportunities for the public to engage in a variety of developed and dispersed recreational activities, in concert with other resource management and protection needs.

3.10.2 Direct and Indirect Effects Analysis

Alternative 1 – No Action

Under this alternative, forested lands in the Bill Williams Project area would not receive treatments to improve ecosystem health and sustainability, improve the vegetative age classes, species and structure; move stand condition towards pre-settlement fire regimes, nor reduce the risk of stand replacing fires.

Under the no-action alternative there would be little immediate direct or indirect effects on the existing recreational setting or facilities. Since no direct management actions would occur, the existing recreational setting would not change. However, the Bixler Trail would continue to be underutilized as access was limited under the 2011 decision for Travel Management. Hikers would have to hike up the closed Forest Road 45 to the existing trailhead in order to access the trail. Stand densities would remain unnaturally high, although some visitors are not aware of the unnatural condition of the forest, and their experience and perception of forest conditions would continue to be largely positive. However, due to unnaturally high stand densities and fuel loadings, there would continue to be the potential for disturbance processes to affect the landscape negatively, such as insect outbreaks, diseases, and wildfires.

Of great concern to maintaining high recreation values is a high potential for large, stand replacing wildfires to occur in the project area. If a large stand replacing wildfire swept through the area, it could seriously damage or completely destroy recreational settings in the Bill Williams project area along with many of the recreation sites that fall within the Bill Williams Mountain watershed (including, but not limited to Dogtown Lake and Campground, Santa Fe Reservoir, City Reservoir, Buckskinner Park, Cataract Lake and Campground). The quality of life of local residents and other national forest visitors who value forest recreation opportunities and facilities would be negatively affected for decades after a stand replacing wildfire on the mountain. Tourism could also be negatively affected if visitors decide not to visit the Williams area due to the negative effects a large wildfire could have on recreation resources.

Alternative 2 – Proposed Action

Under the proposed action, 15,200 acres in the Bill Williams Project area would be treated by a variety of mechanical treatments and prescribed fire in order to improve ecosystem health and sustainability; improve the vegetative age classes distribution, species and structure; move stand condition towards pre-settlement fire regimes; and reduce the risk of stand replacing fires.

Under this alternative, it is expected that there will be some short-term direct and indirect effects to the recreation setting. Directly affecting the SPM and the SPNM ROS character of the mountain is the percentage of land that will fall under treatment during project implementation. This alternative will treat 95% if the SPM and 100% of the SPNM ROS classification area. The standard direction for the SPM and SPNM ROS areas on the mountain is that up to 25% of an individual area may be mechanically treated at one time. However, exceptions to this standard may be made without requiring an amendment to the Forest Plan (Kaibab NF Forest Plan, as amended 11/04 pg. 34-1). Also directly affecting the SPNM ROS classification is the determination that approximately 2/3 of a mile of a re-opened maintenance level 1 (ML-1) road will be required for the project. The road will be closed to continued use and restored to original conditions when the project is completed.

Direct effects to recreation settings from mechanical treatments would be a short-term, temporary change in ROS setting quality, which would persist until activity slash is treated and the treated area recovers to an “undisturbed” appearance. The effects of low and even some moderate-intensity fires on outdoor recreation settings are not to be considered as negative, rather fire is recognized as an integral part of the forest landscape and setting.

Direct effects of mechanical treatments and prescribed burning have the potential for short-term displacement of recreationists during implementation (campers may need to be moved out, trail users may not be able to use certain trails during implementation, etc.), or reduced visitor satisfaction (seeing activities slash, experiencing smoky conditions while people are visiting the area). Also, there is the potential for those recreationists seeking a specific setting, especially a non-motorized experience, to not be able to achieve that on Bill Williams Mountain, even in the SPNM ROS classified area. Mitigation measures have been designed to ensure that the direct effects of the project activities are short term and important recreation values are protected long term.

This alternative better provides for the long-term protection of recreation settings and facilities by improving stand conditions and reducing fuel loading. Improving the forest manager’s ability to maintain healthy, green forests and reduce the risk of high-intensity stand replacing wildfires in the project area would have a positive effect on the ability to protect and maintain high quality recreation settings long into the future.

Table 3.10-2 shows the Acres for Alternative 2 by Recreation Opportunity Spectrum and Operability Zone

Operability Zone	Rural Acres	Roaded Natural Acres	Semi-Primitive Motorized Acres	Semi-Primitive Non-Motorized Acres
Conventional-01	323	5,168	3,059	192
Steep Conventional-02	59	147	383	200
Adverse Forwarder-03	0	23	0	45
Excaline with Forwarder Swing Skid-04	0	45	11	76
Skyline Yarding-05	0	168	134	47
Mixed Conventional-06	0	676	620	106
Helicopter-07	7	959	468	2,032
Total Acres	**389**	**7,196**	**4,675**	**2,698**

Alternative 3

Same as Alternative 2.

Alternative 4

Under Alternative 4, 11,150 acres in the Bill Williams Project area would be treated by a variety of mechanical treatments and prescribed fire in order to improve ecosystem health and sustainability; improve the vegetative age classes distribution, species and structure; move stand condition towards pre-settlement fire regimes; and reduce the risk of stand replacing fires.

Under this alternative, it is expected that there will be some short-term direct and indirect effects to the recreation setting. Directly affecting the SPM character for the mountain is the percentage of land that will fall under treatment during project implementation. This alternative will treat 83% if the SPM classification area. The standard direction for the SPM ROS areas on the mountain is that up to 25% of an individual area may be mechanically treated at one time. However, exceptions to this standard may be made, without requiring an amendment to the Forest Plan (Kaibab NF Forest Plan, as amended 11/04 pg. 34-1).

Direct effects to recreation settings from mechanical treatments would be a short-term, temporary change in ROS setting quality, which would persist until activity slash is treated and the treated area recovers to an “undisturbed” appearance. The effects of low and even some moderate-

intensity fires on outdoor recreation settings are not to be considered as negative, rather fire is recognized as an integral part of the forest landscape and setting.

Direct effects of mechanical treatments and prescribed burning have the potential for short-term displacement of recreationists during implementation (campers may need to be moved out, trail users may not be able to use certain trails during implementation, etc.), or decreased visitor satisfaction (seeing activities slash, experiencing smoky conditions while people are visiting the area). Also, there is the potential for those recreationists seeking a specific setting, especially a non-motorized experience, to not be able to achieve that on Bill Williams Mountain, even in the SPNM ROS classified area. Mitigation measures have been designed to ensure that the direct effects of the project activities are short term and that important recreation values are protected long term.

This alternative better provides for the long-term protection of recreation settings and facilities by improving stand conditions and reducing fuel loading. Improving the forest manager's ability to maintain healthy, green forests and reduce the risk of high-intensity stand replacing wildfires in the project area would have a positive effect on the ability to protect and maintain high quality recreation settings long into the future.

Table 3.10-3 shows the Acres for Alternative 4 by Recreation Opportunity Spectrum and Operability Zone

Operability Zone	Rural Acres	Roaded Natural Acres	Semi-Primitive Motorized Acres	Semi-Primitive Non-Motorized Acres
Conventional-01	323	5,172	3,059	192
Steep Conventional-02	59	337	383	200
Adverse Forwarder-03	0	0	0	0
Excaline with Forwarder Swing Skid-04	0	0	11	0
Skyline Yarding-05	0	0	134	0
Mixed Conventional-06	0	676	620	106
Helicopter-07	0	0	468	0
Total Acres	**389**	**6,175**	**4,059**	**498**

3.10.3 Cumulative Effects

The area chosen for the cumulative effects analysis of this project is bounded by the northern Williams Ranger District boundary, west to the forest boundary in Bellemont, Arizona, east to the forest boundary near Ash Fork, Arizona, and south to the forest boundary (the border with the north end of the Prescott National Forest). This area was chosen because the project area is the

view-shed of Bill Williams Mountain, a popular recreation area for local residents and out-of-town visitors and recreationists.

Recently implemented and current ongoing projects in this analysis area include: Clover High, Williams High Risk, Dogtown Fuels, and the Twin Burn. Potential future projects include McCracken Project and the Four Forest Restoration Initiative. There isn't enough information known about these projects at this time to predict the extent of the potential impact from these projects. With the increased emphasis for reducing hazardous fuels in the urban interface, it is estimated that at least 10-15% of the area of the cumulative effects analysis area could either be in the physical state of being mechanically treated, awaiting final slash treatment and prescribed burning, or in a post treatments recovery phase over the next 20 years.

The cumulative effects analysis extends 20 years from the first phases of implementation of the Bill Williams Project. Twenty years was chosen because large complex projects can take 10 or more years to complete treatments. Once activities are completed in a treatment unit it takes approximately one to three years for treated areas to recover until they are generally unnoticeable to the average forest visitor (one to two years of drying to dispose of slash after thinning projects, plus up to one more year for the visual effects of mechanical fire line preparation and prescribed burning to recover). Fuels reduction and stand improvement treatments including, thinning, non-commercial and commercial tree harvesting, fuelwood sales, and prescribed burning will occur over time and in phases within the different project areas; thus different project areas will be in varying stages of treatment or recovery over the 20-year time period across the cumulative effects analysis area. The effects of mechanical treatments are addressed in this analysis. Recurring maintenance burning is typically low intensity and the area usually recovers within one year of implementation and thus is considered to have minimal effects on recreation resources.

Alternative 1 - No Action

Recreation user displacement, noise and dust are effects from past, present, and reasonably foreseeable projects have and will affect the recreation resources on the district. Past experience has shown that these effects are usually short in duration and generally localized to the project area. When combined with the direct and indirect effects of implementing Alternative 1, the cumulative effects on recreation resources are minimal, as most recreationists do not recognize the unnatural state of the forest and have generally positive experiences in the pursuit of their recreational activities. In this alternative the threat to the mountain of a wildfire and the potential for a catastrophic wildfire would remain unchanged. Under the no action alternative recreationists would not be displaced by project activities in the Bill Williams Project area, but could be potentially be displaced by increase fire danger in the Bill Williams Watershed, closures of the watershed, and by fire activity on the mountain.

Alternative 2 - Proposed Action

The cumulative effects of the proposed action when combined with past, current, and future planned actions, would be to greatly increase the total number of acres being treated or recovering from treatment by approximately 5 – 7 %, throughout the cumulative effects analysis area, as described. It is difficult to determine exactly how much mechanical treatment will be accomplished in the cumulative effects analysis area in any given year. If the assumption is made that all of the projects' initial treatments will be completed in 5 - 20 years, the annual mechanical vegetation treatment acreages could range from 1,520 to 3,040 and from 5,000 to 10,000 acres burned each year. This would leave an approximate range of 17,296 – 26,336 acres treated and in

a physical state of recovery from mechanical treatment and final slash treatments, throughout the cumulative effects analysis area, at any one time.

The potential for displacement of recreationists during the project implementation is increased over the cumulative effects area, although the exact numbers cannot be determined. In this alternative, the greatest potential of displacement would be for those recreationists choosing to recreate in the SPNM setting, where there would be the greatest amount of disturbance during implementation inside of the SPNM area.

There are mitigation measures for the project that will minimize the impacts to the recreation setting in particular areas, such as along heavily used recreation roads, protecting the historic and recreational trails, and reducing the impact to the setting from treatment slash. However, outside of those areas the vegetation treatments in progress, or recently completed, will be evident for up to 5 years, having a short-term negative effect on the recreation setting. These treatment areas will be scattered across the landscape and in varying stages of recovery from year to year. There will be some short term negative effects to recreation settings, especially with regards to the percentage of the settings for SPM and SPNM in recovery from treatment. The long-term effects of reducing fuels and improved stand conditions are considered to be very beneficial; the improvements will provide for better long-term protection of forest health from potentially large and damaging stand-replacing wildfires, or from widespread damaging insect kill. Healthy forest are critical to providing high quality and highly desirable recreation settings and opportunities. The Bill Williams project would improve the cumulative effectiveness and overall ability to protect recreational resources in the long term across the cumulative effects analysis area.

Alternative 3
Same as Alternative 2.

Alternative 4
The cumulative effects of the proposed action when combined with past, current, and future planned actions, would be to greatly increase the total number of acres being treated or recovering from treatment by approximately 3 – 7 %, throughout the cumulative effects analysis area, as described. It is difficult to determine exactly how much mechanical treatment will be accomplished in any given year. If the assumption is made that all of the projects initial treatments will be completed in 5 - 20 years, the annual mechanical vegetation treatment acreages could range from 1,520 to 3,040 and from 5,000 to 10,000 acres burned each year. This would leave an approximate range of 17,296 – 26,336 acres treated and in a physical state of recovery from mechanical treatment and final slash treatments, throughout the cumulative effects analysis area, at any one time.

The potential for displacement of recreationists during the project implementation is increased over the cumulative effects area, although the exact numbers cannot be determined.

There are mitigation measures for the project that will minimize the impact to the recreation setting in particular areas, such as along heavily used recreation roads, protecting the historic and recreational trails, and reducing the impact to the setting from treatment slash. However, outside of those areas the vegetation treatments in progress, or recently completed, will be evident for up to 5 years, having a short-term negative effect on the recreation setting. These treatment areas will be scattered across the landscape and in varying stages of recovery from year to year. There will be some short term negative effects to recreation settings, especially with regards to the

percentage of the settings for SPM and SPNM in recovery from treatment. The long-term effects of reducing fuels and improved stand conditions are considered to be very beneficial; the improvements will provide for better long-term protection of forest health from potentially large and damaging stand-replacing wildfires, or from widespread damaging insect kill. Healthy forests are critical to providing high quality and highly desirable recreation settings and opportunities. The Bill Williams project would improve the cumulative effectiveness and overall ability to protect recreational resources in the long term across the cumulative effects analysis area.

3.11 Scenic Resources

3.11-1 Purpose and Need

The Bill Williams Mountain Restoration Project (shortened to BWMR) will thin vegetation and use prescribed fire to improve the health and sustainability of the forested conditions on and surrounding Bill Williams Mountain. There will be related road construction activities, and a trailhead and trail will be relocated.

Plant communities throughout the project area have changed significantly from their historic condition due to fire suppression, historic logging and other management activities. Historic vegetation components of quaking aspen and meadows have declined across the landscape because of fire suppression and conifer encroachment. The regeneration of aspen in the project area is poor due to dense forest conditions and browsing pressure on aspen saplings. Springs and seeps have reduced function due to drought, lack of fire and closed forest canopies. The Kaibab National Forest (KNF) has identified the needed road system for public and administrative motorized travel and roads and routes that should be decommissioned due to resource concerns.

The scope of this analysis focuses on scenery management within the approximately 18,000 acres Bill Williams Mountain project area.

This report documents the analysis of effects of proposed Bill Williams Project vegetation treatments on scenic resources located in the area.

Recreation and scenic resource are closely related resources, as high quality scenery is often very important to providing high quality recreation settings. This close relationship is reflected in Spectrum and Scenery Management System direction and mapping. Both of these cultural and social resources are extremely important to the City of William's tourism industry and on the local resident's quality of life.

3.11-2 Introduction

Viewing scenery is one of the most sought after recreation activities on the KNF (Forest Service 2012). Scenic quality within the Bill Williams Mountain Restoration (BWMR) project area is particularly important to those who enjoy the views from the City of Williams, Interstate 40, Highway 89A, adjacent Forest Roads, developed recreation sites and trails (USDA 2007). Scenery also contributes indirectly to local quality of life, tourism and economic vitality, and the KNF's scenic heritage.

The BWMR project will help achieve the desired conditions for scenery as defined in the forest plan (Forest Service 2010): "Protect and enhance the scenic and aesthetic values of the Kaibab National Forest".

3.11-3 Project Level Scenic Inventory

Sense of Place

Bill Williams Mountain serves as a backdrop to Williams, Arizona, and is the dominant element in forming the city's sense of place nestled at the base of the mountain on the north side. Bill Williams Mountain (BWM) has served as a local landmark from prehistory through the present. It has been a resource for humans through time providing water, forest products, forage for livestock, habitat that supports game and wildlife, and as a part of people's lives and culture. The mountain is a reminder of seasonal change, as well as viewing pleasure. The BWM is highly visible from major highways in the surrounding area including Interstate 40, US Highway 89A, and State Highway 64, as well as the BNSF railroad which includes Amtrak passenger train service. Thousands of people travelling through the area view the attractive picture of the small town in the mountainous setting. As such, Bill Williams Mountain is a part of the community's image and sense of place.

Bill Williams Mountain's forested character and role as a backyard forest is recognized and documented in the 2007 KNF Recreation Niche (Forest Service):

> "Settings, Special Places, and Values: … the Forest steps up through extensive forests of …ponderosa pine to forests of fir and spruce…The Kaibab National Forest is the traditional home of Native people and continues to play an important role in their lives. It is a backyard forest with generations of family connections and provides commodities and tourism's economic benefits for local businesses… Providing respite from the valley heat, the Forest is also a destination for those seeking a summer oasis to relax, and enjoy activities such as hiking, bird-watching, fishing and sightseeing.
>
> Oasis - Provide opportunity to escape the heat in the desert valleys. Higher elevation; includes the sky islands - Bill Williams Mountain, Sitgreaves Mountain, and the Kaibab Plateau, dominated by ponderosa pine forest and scenic meadows and prairies."

Existing Landscape Character

The following is the existing landscape character description from the Kaibab NF ROS/SMS Guidebook (Forest Service 2004). "The Bill Williams Project is located within the Flagstaff Character Type, a fairly un-dissected plateau with extensive lava flows and volcanic cones, drained by dry washes with a few natural and created reservoirs. Coniferous forest, primarily montane conifer, is the predominate vegetation. Mountain meadow grassland, aspen, plains grassland, and pinyon-juniper woodland are common to parts of the area. Stringers of riparian deciduous forest and woodland are common along watercourses."

Site Specific Characteristics

Landform: Bill Williams Mountain is the highest point on the KNF at an elevation of 9,256 feet above sea level. It is part of the San Francisco volcanic field (USGS 2001). Bill Williams Mountain is made of a cluster of lava domes. Lava domes are formed from viscous lava that piles up into dome-shaped mounds. Other dome-cluster mountains in the San Francisco volcanic field

include Sitgreaves Mountain and Kendrick Mountain (Forest Service 2011). The volcanic origins of the mountain result in rocky outcrops and formations. Finger Rock as depicted below in Figure 3.11-2 is found on the south side of Bill Williams Mountain. Many of the smaller outcrops and rocky terrain are not visible through the thick vegetative cover. Large rock formations are dominant features in the foreground and middleground of the mid and upper regions of BWM.

The landform has received minor modifications as forest roads have been built, trails constructed, utility corridors cleared, and structures erected. These structural features are noticeable and detract somewhat from the scenic integrity of the mountain.

Figure 3.11-2. Finger Rock formation on Bill Williams Mountain.

Waterform: Seeps, springs and ephemeral drainages are minor attributes of the landscape character. They contribute to the valued image of the landscape, but are less noticeable. Springs and seeps on the mountain provide isolated green oases where plant and animal life and activity occur. Many different plant species can be found in these places and they provide brief climatic relief and contrast to the surrounding coniferous forest. Springs are special for viewing wildflowers and moisture loving plants, butterflies, moths, bees and other insects, as well as birds and other wildlife. Springs have provided water for human occupants and visitors over time. In addition, a number of ephemeral drainages provide seasonal flowing water, a rare commodity on the KNF.

Vegetation: The overstory vegetation is the most dominant scenic attribute in the project area. The mountain has coniferous cover in most places. In the foothills of Bill Williams Mountain ponderosa pine trees prevail. Secondary components include white fir, Gambel oak, and alligator

juniper. At upper elevations, the vegetation changes to mixed conifer where components of Douglas fir and white fir increase and are mixed with scattered aspen and ponderosa pine. On the west side of the mountain, there is a pinyon-juniper unit included in the project area. Species include alligator juniper, scattered ponderosa pine, Gambel oak, Utah juniper, and pinyon pine.

Understory vegetation is currently a minor attribute. It includes small trees and shrubs such as choke cherry, maple, mountain mahogany and cliff rose, currant and wild rose, grasses such as Arizona fescue and mountain muhly, and forbs. In the pinyon-juniper forest types, the understory component changes to include different shrub, grass and forb species.

Aspen is an important visual component on the mountain, both for the contrasting color, scale and texture that stands provide and for the seasonal color change that attracts viewers to the area. Gambel oak is also an important hardwood visual component. Oak trees provide a contrast in color, texture and scale. Aspen and oak are minor attributes that contribute to the valued image.

Natural meadows, grasslands, open savannahs and forest openings within the project are notable visual components because of the contrast in color, texture, shape and scale they provide. Openings are minor attributes.

Scenic Identity

The BWMR project area's dominant scenic identity is its largely continuous, conifer forest and openings overlaying the moderate to steeply sloping volcanic landforms. The project area is viewed at all distances from inventoried sensitive roadways in and around the project area. The major positive scenery attribute of the project area is its coniferous forest vegetation, primarily composed of ponderosa pine, mixed conifer stands with meadows and openings. Pinyon and juniper occur at lower elevations. Aspen, oak trees, and other mixed hardwoods are interspersed (see Figures 3.11-3 and 4). Patterns of this vegetative mosaic are moderate to fine-scaled, with many irregular openings. Openings less than 5 acres in size are difficult to distinguish due to dense vegetation, yet some openings over 25 acres are distinguishable. Other scenery attributes include volcanic rocks and outcrops of all sizes. Seasonal changes including reliable winter snowfall accents the scenery as do wildlife sightings of birds and mammals. Research shows that such diversity of scenery attributes supports a positive viewing experience for people traveling through or recreating within the project area, and supports the quality of life for local residents and visitors (Ryan 2005).

Figure 3.11-3. Bill Williams Mountain in a background view from downtown Williams, AZ.

Figure 3.11-4 Foreground mixed conifer on top of Bill Williams Mountain, and looking to background at Williams, AZ.

Ecosystem Context

Vegetation is the dominant scenery attribute of the BWMR project area. Landform is a minor scenic attribute. Both offer significant opportunities for scenery. The steep slopes of the mountain make it a dramatic landscape feature. Rocky outcrops and formations contribute to the unique identity of the mountain, and contribute to the complexity of planning management activities that may occur there.

Reference conditions are those vegetative conditions that existed on this forest at a point of time prior to Euro-American settlement of the area. As explained in the Existing and Desired Conditions Report (Forest Service 2011) The analysis uses the year 1870 as a reference point because it is just prior to Euro-American settlement of the area and it is a point in time where past tree stocking can still be estimated by looking at presettlement evidence that still exists on the site (old trees, stumps, fallen trees, stump holes).

Research in Northern Arizona show that the average ponderosa pine basal area historically was about 40 square feet per acre (sf/ac). The current average basal area of ponderosa pine in the project area is 121 sf/acre, almost three times historic conditions (see BWMR EIS Section 3.2 Silviculture). The basal area of mixed conifer, pinyon and juniper vegetation types have also increased. The ponderosa pine and mixed conifer types on the project area are at high risk of declining forest health due to dense conditions and competition for sunlight and nutrients, as well as susceptibility to high intensity wildfire (see Appendix A Scenic Stability Analysis). In addition, the understory of these types is declining since its health is dependent upon forest stand openness. The understory is also at high risk due to these same ecological stressors.

Of the minor scenery attributes, aspen is at high risk due to conifer encroachment, lack of fires typical of the historic fire regime, and browsing by ungulates. As noted in Section 3-2 (BWMR DEIS Silviculture Section), the aspen cover type within the project area have been encroached and suppressed by conifer species resulting in a decline to the population (Fairweather et al 2008).

Due to the spatial arrangement of high density trees and fuels, the slopes of Bill Williams Mountain currently pose a high risk of stand replacement crown fire. Over 80% of the project area could carry crown fires and about 17% could carry surface fire (see BWMR DEIS Section 3-4 Fires and Fuels). Closed tree canopies with understory tree regeneration create “ladder fuels” to carry surface fires into the overstory. The ponderosa pine type and mixed conifer forest within the project area is at a high risk for stand replacing wildfires while the risk for the woodland types in the project area ranges from moderate to high. Stands on the slopes of the mountain are at high to extreme risk for crown fire.

The dense vegetation and risk of fire has departed from the natural historic range of variability in terms of fire history and vegetation condition. The project area’s Scenic Character is in need of widespread restoration, primarily through extensive reduction of forest canopy density, , and restoration of the historic fire cycle, to re-create historic ecologically diverse and resilient conditions that can best sustain desired scenery conditions.

Trends for these impaired vegetation conditions result in a continuing decline in forest health, and scenery attributes. Over time, the excessively dense conifer stands have and will increasingly experience competition for available light, water and nutrients, become more stagnant and subject to increased insect and disease risks, and gradually die or likely be consumed by wildfire. These conditions would further increase the risk of large and intense wildfires that would inevitably eliminate many vegetation scenery attributes within large portions of the project area. It is likely that large scale burn patterns will be inconsistent with the more historic patterns created by

natural wildfire cycles. Refer to the BWMR DEIS Silviculture and Fire and Fuels analyses for more specifics on vegetation trends (Sections 3.2 and 3.3).

Cultural Context

The project area is highly visible and viewed by large numbers of people form from important heavily used travel corridors, including Interstate 40, Highway 64, County Rd 73 (a.k.a. Perkinsville Rd, or South Rd), Forest Road (FR) 108 (a.k.a. Bill Williams Mountain Loop Rd.), FR 122 (a.k.a. Twin Springs Rd.) and secondary travel-ways through the forest. Beyond the project area, private landowners and campers at Dogtown Lake Campground view the planning area and the surrounding landscapes from the campground, backyards and porches. The landscapes they view on a daily basis is likely very important to their quality of life. Also of import are the "special areas" in the project area, which hold high value and meaning for visitors and local residents (spiritual, aesthetic, nostalgic, or other). Bill Williams Mountain, Elk Ridge Ski Area, Buckskinner Park, Bill Williams Mountain Loop Rd, Twin Springs Rd., and Vista Point were all identified specifically as "special places" by respondents of the 2000-2001 South Kaibab Visitor Survey (Forest Service). Most respondents to the survey also said they prefer an undisturbed natural area with no evidence of humans.

In the 2010 National Visitor Use Monitoring survey (Forest Service 2012), visitor satisfaction was measured. In the comparison of importance and level of satisfaction for condition of the environment and scenery, visitors reported the KNF was at or above the highest rating in these areas. The importance of the surrounding forested environment and attractive scenery are repeated themes mentioned in the Williams Strategic Plan for Economic Development (December 1994). The benefits of high-quality scenery are numerous despite the fact that a dollar value is seldom assigned to it, except in regard to real estate appraisals and overall tourism revenue to the town.

Desired Conditions

The desired Scenic Character for the BWMR project area would display a much more open and diverse forest canopy and vegetative mosaic. This would include representation of all age groups and size classes, especially large, old coniferous and deciduous trees. Trees would be arranged in groups with inter-tree space as well as openings around the groups. There would be a greater representation of aspen and meadows. The presence of tightly grouped intermediate-sized trees would be greatly reduced. Trees that have encroached into meadows and over-shaded aspen groves or large oak trees are thinned or removed, opening up these areas. Small and moderate sized irregularly shaped openings/grass-forb meadows would be more frequent, bounded by trees of all ages, including full-crowned, old, mature conifers and deciduous species (aspen, oak), accented by volcanic rock forms. The more open forest will provide improved views to of attractive understory vegetation, wildlife, volcanic rock forms, snow features, seasonal color changes and more distant views outward from the forest canopy. In some areas wildlife species require different habitat conditions, and these are accommodated. See the Wildlife Section 3.6 for specific information. Lastly, re-introduction of wildfire evidence into the scenery is desired, primarily within finely-scaled and irregularly-shaped, low- and moderate-intensity burn patterns that are consistent with historic conditions.

These scenery attributes described above would be distributed through time and space to offer increased attractiveness in terms of vegetative forms, colors, canopy texture and immediate foreground spatial variety, while improving the overall Scenic Character. These conditions shall be strategically arranged to increase the ecological resilience and stability of vegetation scenery

attributes which are central to Bill Williams Mountain's historic Scenic Character, image, and identity.

The Desired Scenic Character for the BWMR project includes two elements: (1) the desired Scenic Character described above, and (2) variations to that character as necessary to meet project objectives for wildlife habitat, heritage resources, fuels reduction, forest health and resiliency. These essential elements as a whole form the fully integrated, holistic Desired Scenic Character of the project, and would offer greater ecological resilience and long term stability of the Desired Scenic Character.

Scenic Integrity

At the lower foothills of BWM, ponderosa pine vegetation forms a dense coniferous cover. The pine trees have a somewhat spreading conical, upright form with brown to black tree boles and olive-green fine textured needles. Deciduous trees have a wider, shorter shape in contrast to the conical pine trees. Oak and aspen have moderately coarse textures and in growing seasons, a brighter green colors that is readily visible in contrast to the olive green conifers. This color contrast is even more noticeable in the fall when the deciduous tree leaves turn colors. In winter, the lighter grey bark color of the deciduous species contrasts with the brown/black of pine tree boles. Below the pine trees is sparse understory of grasses and forbs. The understory is mostly a low, fine textured form, although downed logs and rock outcrops provide contrast to the uniform texture. Understory colors include greens, tans, and shades of grey. In drainages there are shrubby species that add complexity in the midstory complexity of form, as well as contrasts in color, texture and pattern.

In the mixed conifer, the narrow, conical nature and varying colors of the different species is more noticeable. Less of the tree bole is visible and the tree branches extend down closer to the forest floor. There is little understory vegetation under the dense mixed conifer trees. Where openings are present, there is a grass-forb understory. In places, aspen is mixed with conifers and provides a contrast in color, texture and shape. Meadows provide welcome views as well as low, uniform and finely textured shapes.

The pinyon-juniper forest on the west side of BWM has rounder, shorter, less conical shapes. The colors of the trees are also different from either pine or mixed conifer forests ranging from a darker olive green to grey green. There are more interspaces around individual trees. Understory vegetation species change and are more connected and dense, and there is little or no layer of pine needles (duff) on the forest floor, bare ground can be seen. Volcanic outcrops and formations provide striking contrasts to the vegetation components. Dense conifer vegetation often obscures views of existing scenery attributes within and below the understory, and greatly restricts or prevents the visibility of many potential scenery attributes.

The vegetation offers opportunities for ecosystem improvement. The current excessive vegetation density and hazardous fuels conditions are inconsistent with the Desired Scenic Character and scenic sustainability.

Based on historic photographs, the forest structure, openings, meadows and other features have noticeably changed. Figures 3.11-5 and 6 illustrate an example of comparison photographs from 1910 and a reshoot of the same location taken in 2011. Note the openings, mature, old tree component, and sparse versus dense tree cover in the 1910 photo. Human constructed features visible include the road on the upper slopes of BWM and possibly a constructed structure at the top of the mountain. The ranch structures shown in 1910 no longer exist. In the 2011 photo, the

powerline corridor is dominant. Tree cover is much denser and obscures small openings and tree interspaces. The foreground trees almost completely block views into the forest. The road on BWM is less visible because of denser tree cover. Fewer openings and inter-tree spaces occur.

The photos found in Figure 3.11-7 don't have the benefit of a historic comparison, but helps to illustrate the pinyon-juniper vegetation type found on the west side of BWM. There are more interspace between trees, there is a bunchier understory component, and bare ground is visible (versus being covered with pine needles and duff at higher elevations).

Figure 3.11-5. Benham Ranch House ca. 1910 (Benham Collection).

Figure 3.11-6. Benham Ranch reshoot, 2011. (Weintraub)

Figure 3.11-7 Photo of the western slopes of Bill Williams Mountain.

Among the many potential scenery attributes that are under-represented are large, old trees, diverse age groups and mature forest structures (especially aspen and pines as individual trees and groups), and meadows with shrubs, grasses and forbs. Many meadow areas have decreased in size and are being encroached upon by conifers, and/or are obscured from view by dense coniferous vegetation in ponderosa pine, mixed conifer and pinyon-juniper types. Inter-tree spaces so evident in the 1910 photos have mostly disappeared. Aspen stands are old and in some cases decadent and reproduction has been hampered by fire suppression and ungulate browsing. Some aspen stands are encroached by conifers. Oak thickets are often overtopped or crowded by young conifers. The dense conifer vegetation obscures visibility to even nearby volcanic rock forms and outcrops, and the understory is often sparse and lacks diversity. Many "view windows" outward to adjacent areas of the KNF and to landforms are obscured by vegetation. In addition, human constructed features including buildings, recreation sites, roads, trails and utility corridors, as well as management activities such as logging, right-of-way clearing and fire suppression have interrupted and diminished scenic vegetation attributes in some places within the project area. The sum of these occurrences has resulted in forest canopy that is excessively dense and uniform, or, fragmented in patterns and shapes inconsistent with the historic, vegetative mosaic.

As noted in the Kaibab NF ROS-SMS Guidebook (Forest Service 2004), historic and more recent human disturbances have resulted in changes to the ecosystem: "The area is dominated by ponderosa pine type forest, which, although largely natural-appearing, has experienced significant changes since European settlement. Above 8,000 feet on Bill Williams Mountain there is mixed conifer, a combination of Douglas fire, white fir and blue spruce. Intensive livestock grazing,

forestry practices such as railroad logging, and fire suppression have all contributed to the changes in forest structure and ecosystem processes. The historic condition of scattered groups of yellow pines with abundant grassy understory and a few denser groups of black jack pines has changed to more dense thickets of sapling and pole sized stands of pines. The existing forest is less diverse and more prone to catastrophic change than historically, since the previous disturbance regime of frequent, low-intensity fires have been replaced by a regime of stand-replacing, high-intensity fires."

Some springs, such as Clover Spring, were piped to provide community water sources. Bill Williams Mountain is critical to the City of Williams watershed. Williams is dependent upon a number of constructed reservoirs that collect seasonal runoff, as well as groundwater wells that provide water for the community. No constructed reservoirs are included in the project area, but they are at risk from ecological stressors that could alter the conditions in the project.

Existing roads in the area also offer opportunities for ecosystem improvement. Many of the high clearance and closed roads (Maintenance Level 2 and 1) run straight up and down slopes, and a few go up drainages. County Road 73 and designated forest roads create linear features through the landscape. The roads and the recreation developments also provide viewing platforms into the project area as well as from the mountain into the surrounding landscape.

Hikers, mountain bikers and horseback riders use the trails that climb into the foothills at the base of, and climb up Bill Williams Mountain. Trails include Benham Trail, Clover Springs Trail, Bixler Saddle, and City Link. These provide linear features through the landscape, but are at a smaller scale, and can be more easily designed to work with topographic features.

Many recreationists enjoy camping along FR 122 and 108. In order to get off the forest roads, campers typically drive off the shoulder and have created a network of short routes to areas where they park and set up camp. Motorized travel management implemented in 2011 designates some of these short routes as roads open to public travel (and camping). These linear roads and cleared areas contrast with the characteristic landscape.

Elk Ridge Ski Area attracts winter enthusiasts and also provides some summer activities. It includes a series of cleared ski runs, a tow rope and ski lift, as well as a ski lodge and associated buildings. The linear, cleared runs and constructed features contrast with the forested landscape.

As noted in the purpose and need of the Bill Williams Mountain Restoration Project, the health and sustainability of forested conditions and hazardous fuels are currently outside of guidelines identified in the Kaibab Forest Plan. The proposed project would result in better forest plan compliance as well as improved watershed conditions contributing to the City of Williams water supply. This will meet Forest Plan direction for scenery is to "Protect and enhance the scenic and aesthetic values of the Kaibab National Forest." In order to reduce risks and enhance scenic values, the Forest Plan also encourages management activities "Where existing conditions do not meet mapped ROS or Scenic Integrity Objectives (SIOs), design and implement projects to move the area toward desired conditions" (Forest Service 2010). Reduction of risk to the scenic attributes will help to meet Forest Plan direction as well as ensuring that the valued scenery will be available into the future.

3.11-4 Analysis Questions to be Answered

The analysis questions 1-3 are the required scenery indicators that identify and measure scenic quality (Scenery Management System, Appendix J, NFMA/Forest Plan)

1. To what degree will the proposed restoration activities affect the scenic integrity of the project area? (Measure: Maintain or improve Scenic Integrity - acres)

2. Will the proposed restoration activities sustain the valued scenic character and its scenery attributes through time? (Measure: Maintain or improve scenic character – acres, Maintain or improve scenic attributes – number of attributes improved)

Analysis questions are related to Scoping/Public Involvement

3. In what ways would prescribed burning smoke affect the scenery? (Measure: Descriptive evaluation)

4. Are large, mature trees retained as part of the scenic character? (Measure: Maintain or improve scenic attribute – large, mature trees)

3.11-5 Direct, Indirect, and Cumulative Effects

Alternative 1 No Action

If the proposed action were not implemented, the project area would continue to be mostly natural-appearing for several years. Important scenery attributes such as open and diverse overstory vegetation and healthy understory would continue to have overly dense growing conditions and views into and out from the forest would be blocked by trees. Grasslands and mixed hardwoods would continue to be overtopped and encroached upon by conifers. The large, old tree character that historically contributed to the attractiveness of the area would be limited. Historic fire regimes would not be re-established, limiting nutrient recycling and allowing the density of forest fuels to increase. Declining aspen would become more and more decadent and could at some time disappear altogether from the project area.

At some point, overstocked vegetative conditions may be attacked by insects or disease, or experience an uncharacteristically large and intense wildfire that would burn much of the vegetation that is the primary scenic attribute. While some insect and disease activity occurs every day, the overly dense conditions combined with extreme weather events characteristic of climate change could allow these to escalate and become wide spread. Large, high intensity fires have become more common with increasing tree density and lack of a regular fire regime. Large scale events such as these would be outside the range of historic variability.

In the event of an uncharacteristic high severity wildfire such as the Schultz Fire, the existing landscape character would be suddenly altered with little opportunity to slow or control the change. The SIO's in the project area would have to be remapped and uncharacteristic high severity, large-scale wildfire would redefine and reshape the existing landscape character for decades if not centuries. The appearance and character of the area would shift from densely forested to patchy and open. The overstory component and green canopy would be absent or drastically reduced, depending on the severity of the fire. For a few decades, the landscape would be dominated by blackened, dead standing trees; if allowed to come down on their own, the trees would likely fall in a dense, jack-straw pattern. Although short term, smoke from high intensity wildfire would cause scenic quality to be diminished and if thick enough, would obscure views to scenic attributes.

In the short term following high intensity fire, emergency fire suppression actions such as fire lines and emergency post-fire rehabilitation treatments could result in unnatural scars on the

landscape. With rehabilitation and other mitigation measures, the immediate impacts of the suppression and emergency treatments should not be evident to the casual forest visitor within 2 to 3 years of completion, although effects from the fire itself would remain visible much longer. For two to three growing seasons, the blackened, exposed ground surfaces would be highly visible due to lack of vegetation. Sedimentation and erosion would increase, raveling soils that would take a long time to revegetate. Eventually these areas would be covered with spotty vegetation and invasive weeds until native material became established. Within 5 years, the effects of the fire would begin to be viewed in a somewhat more positive light as the shrubby understory, seedlings and saplings became more abundant. There is some risk that a vegetation type change could occur especially if there is wide spread drought, and/or if trends toward higher temperatures, and less annual precipitation continue. These changes would be visible throughout the project area in the foreground of Forest roads and trails, and as middle ground and background views from communities within the project area, and developed recreation sites.

Initial public reaction to a large-scale fire tends to be negative, as many people do not consider extensive, blackened landscapes to be natural or beneficial (Ryan 2005). These effects are often perceived by local residents as devastating to their community and way of life; non-local forest visitors may regard the effects of a catastrophic fire as interesting and something “to be seen” but also as a degradation of the scenic quality.

Indirect effects of high intensity wildfire include short term and temporary smoke that would affect nearby subdivisions, the City of Williams, and in large, high acreage blazes, could affect the City of Flagstaff, Sedona and Verde Valley, Grand Canyon and residents of the Navajo Nation. Effects would include smoky conditions and decreased visibility, and would last until the fire was contained and declared as “out”. Other indirect effects of high intensity wildfire could include damage to the Bill Williams watershed (see section 3.4 of the BWMRP DEIS) with subsequent effects to local reservoirs, the City of Williams water system, and the scenic character of locally important recreation sites such as Cataract Lake, Kaibab Lake and Dogtown Lake, as well as hiking trails, wildlife viewing opportunities and others.

Under this alternative there would be no opportunities to enhance and improve scenic resources or achieve the desired condition described in Section 2 since there would be no thinning or other treatments. It would maintain the existing landscape character in the short term, but in the long term the existing landscape character would decline.

This alternative would not meet the project’s desired conditions or forest plan direction. It would not move the project area toward scenic stability. Over time, scenic stability would decrease and move to very low. No action would result in continuation of current risks to scenic attributes and it is reasonable to assume that these risks increase each year and could be exacerbated by climate change. The No Action alternative would not meet long-term scenic integrity objectives since these are dependent upon improving the condition of scenic attributes so that they are more resilient to ecological stressors.

Since there is no change in existing condition with this alternative, there are no direct, indirect or cumulative effects.

Alternative 2 Proposed Action

Preparation of sale areas may have slight effects to scenery from marking trees and project boundaries. These will be mitigated by using butt marks on the side facing sensitive travel corridors (bole marks will be facing away from sensitive road corridors).

Mechanical Treatments

Approximately 15,200 acres of the project area would receive mechanical treatments including use of conventional ground based logging systems, cable logging and helicopter logging. In addition, approximately 2,500 acres in the strategic fuels treatment area would be thinned by hand or use of machinery equipped with cutting or grinding heads may be used.

Conventional ground based logging systems include, but are not limited to: use of chainsaws or feller-bunchers to cut trees and lop slash, skidders to move material to landings, bulldozers to pile slash, and specialized equipment such as feller-bunchers, and tree shears to cut, chop, break, and lop fuel material. Cable systems use a yarder equipped with a system of cables to pull logs to a landing, loaders to move logs and logging trucks to haul logs. Skyline cable systems lift the logs off the ground to transport them instead of dragging logs across the ground. Helicopter logging uses helicopters to remove cut and limbed trees from an area by lifting them on with cables attached to a helicopter. Logs are “decked” in a central area to be hauled away.

There would be light to extensive effects on scenic quality during and immediately following mechanical treatments.

- Hand thinning usually has little or no short term effects on scenery. Trees are cut down, then cut into segments that can be treated. Effects may include slash from limbing and topping trees. Project mitigations require slash to be treated.

- Conventional logging typically has moderate short term effects to scenery. During implementation, in most cases whole trees are cut and moved to a “landing” near a haul road. At the landing, the limbs and tops are removed, and the clean logs are decked to be loaded and hauled away. After vegetation has been thinned, the slash remains. Effects of logging operations typically include trampling of vegetation where equipment is operating, creation of linear skid trails where vegetation is trampled or completely removed exposing bare soil, creation of linear log landings where vegetation has been trampled or removed and bare soil is exposed, and piles of cull logs not suitable for commercial uses. After logs or useable material is removed, slash would be treated as per mitigation measures. This may include: bulldozers pushing slash into large piles (10-20 foot wide piles, often 10 feet tall) which can trample vegetation and cause bare soil to be exposed, hand piling, chipping, crushing, and lopping and scattering.

- Cable systems are used to transport cut logs to centralized processing areas and typically have extensive, short term effects to scenery. Trees are cut and limbed, then cables pull the trees to the landing area. Many cut trees are transported along a common corridor which can be up to 1000 feet long and are about 15 feet wide. In order to remove trees in a large area, corridors would be established about every 100 feet. Effects typically include scraping and loss of limbs on existing trees as a result of adjacent trees being felled or transported, creation of linear corridors, slash, creation of large, cleared landings where logs are decked and equipment can be accommodated (moved and turned). Following log removal, activity slash must be treated. Methods may include bunching and piling slash mechanically which can trample vegetation and cause bare soil to be exposed, hand piling, chipping, crushing, and lopping and scattering.

- Helicopter systems transport logs or trees to central log decks. Helicopter logging typically has moderate to extensive effects on scenery. Trees would be cut and limbed. Logs would have cables attached, then would be lifted up and transported away from the cutting area to central locations (log decks) where the logs are detached from the cables. Equipment such as grapplers are used at the log decks to stack logs and load them into trucks for transport. Effects include scraping and loss of limbs on existing trees as a result of adjacent trees being felled or transported, creation of large, cleared landings where logs are decked and equipment can be accommodated (moved and turned) and helicopters can be landed. Following log removal, activity slash must be treated which may include bunching and piling mechanically which can trample vegetation and cause bare soil to be exposed, hand piling, chipping, crushing, and lopping and scattering. The effects of slash treatment are short term depending on how slash is treated. Chipping has the least effects because the chips will begin to grey out and become less noticeable in one to two years. Hand piling creates noticeable piles, but after these are burned, there is a shorter recovery time than with mechanical piling. Lop and scatter results in untreated slash since it is allowed to remain in an area until it is burned. Ryan (2005) found this is not as acceptable as when slash is treated either by chipping or piling. Mechanical piling effects are found above under cable logging.

Road Construction would have moderate to extensive effects on scenic quality during and immediately following restoration treatments.

- Construction of approximately 23 miles of new roads to provide access for ground-based logging systems will have extensive short term effects on scenery. The new roads would add new, unnatural linear features into the landscape. Trees would be removed, soil exposed, and roadbeds constructed including minimal drainage features. Most of the new roads would be closed following restoration treatments. The status of the new roads that would be closed would change to intermittent. Mitigation measures would be used to close entrance points and Best Management Practices for watershed would ensure drainage is adequate and the roads would be allowed to naturalize. Mitigation measures and best management practices will be used to rehabilitate the road beds. The new roads would naturalize in 5 to 10 years and become less noticeable to the casual observer.

- Construction of approximately 16 miles of temporary roads would result in extensive short term effects on scenery. Effects are similar to new road construction noted above, although the temporary roads would be obliterated after use. Mitigation measures would be used to close entrance points and Best Management Practices for watershed would ensure drainage is re-established and the roads can rehabilitate. The temporary roads would begin to recover and should be mostly recovered and less noticeable to the casual observer in 5 to 10 years.

- Road obliteration of 28 miles of roads would entail obliteration whereby road surfaces would be ripped and seeded or mulched, inside ditches would be filled, road prisms outsloped, culverts and fill materials removed, stream crossings re-contoured, unstable sidecast or cutslopes removed or stabilized, and entrances blocked to prevent future access (see Soils/Watershed Section 3.4). These would have moderate short term effects to scenery. Mitigation measures would help return these roads to a more stable status. The obliterated roads would begin to recover after treatment and would be mostly recovered and less noticeable to the casual observer in 5 to 10 years.

Strategic fuels treatments would have low effects on scenic quality immediately after treatment.

- Strategic fuels treatments would enhance fire control lines enabling prescribed fire to be safely implemented. They include hand thinning or use of machinery equipped with cutting or grinding heads on 300 feet either side of control lines. Slash is treated within the cleared area, and this becomes the staging area for implementing prescribed burning blocks. Effects include short term introduction of linear features throughout the area. Upon completion of prescribed burning it is expected that the linear features will not be as noticeable because the density of trees on either side of the treatment areas would be thinned and/or burned reducing the number of trees.

Fuels reduction and reintroduction of fire would have moderate effects on scenic quality immediately after treatment, and low effects after repeat burning.

- Prescribed fire would be used on approximately 15,200 acres of the project areas within all Operability Zones. It may be used in conjunction with mechanical treatments or singly. The objective of prescribed burning is to reduce fuel loading, raise crown base heights and reduce live tree density. Repeat or maintenance burning would help maintain these objectives. Depending on fire severity, effects would include: charred soil and vegetation immediately following burning; charred bark up to 10 feet from the ground; needle and leaf scorch typically less than 20 feet from the ground; and, loss of understory trees, trees with old scars or trees with large accumulations of dead fuels at their base. In areas of moderate to high severity, openings may be created as a result of more extensive tree mortality. The presence of charred surface vegetation and red or black trees would present a contrast to the otherwise green surroundings. These contrasts would soften and become less noticeable within two or three growing seasons after project completion as the understory component (i.e., grass, aspen and oak seedlings, etc.) moved in, as singed but not dead trees recovered and greened up, and as dead standing trees fell down. Effects may last longer and be more pronounced in areas of moderate to high fire severity, but these areas would be localized and limited. Repeat burning would temporarily blacken the forest floor, some charred bark, and scorch or burning of some understory trees and shrubs. These effects typically soften after one year, and are less noticeable to the casual observer after 2 to 3 years.

- Effects from pile burning would be primarily limited to the immediate dead and live fuels of the slash pile, although some scorching and mortality of residual trees would be expected. Following burning, the bare areas are susceptible to invasive species. Mitigation measures for invasive species will monitor and treat infested areas. The areas are expected to revegetate within 1 to 3 years following burning.

- Smoke from pile burning and prescribed burning creates short term and temporary effects on scenic quality. During implementation, smoke would obscure views of the mountain. Effects to residents and visitors to the Williams area may be dissatisfied that their views are obstructed, and scenic features are obscured. Very smoky conditions typically occur during the first entry of prescribed burning due to heavy fuel loadings. There can be lingering smoke for two weeks to a month after burning as stumps, large logs and roots smolder. Smoke from repeat burns should be less than the initial prescribed burns, since there would be less fuel to be consumed.

There may be indirect effects of smoke as well since it drifts and is pushed by air currents. Nearby developed recreation sites, houses and subdivisions, and the community of Williams may experience reduced visibility and smoky conditions. Dispersed campers and other recreationists may experience reduced visibility and smoky conditions in some places near the project area.

Trails work in this project would have low to moderate effects on scenic quality.

- Activities would include construction of a new parking area and trailhead for Bixler Trail, conversion of a portion of FR 45 to a non-motorized trail, and constructing about 1 mile of new trail. Effects would include removal of vegetation and construction of new features including the parking lot and installation of trailhead signing, placement of barriers, and creation of new trail segments (new linear features). Mitigations would include the use of rustic materials (boulders, logs, local surfacing materials) or materials that will blend in with the surrounding landscape. The new trail section will be most visible immediately after construction when there is the greatest contrast between the bare soil and surrounding vegetation. These effects will soften as trailside vegetation is re-established. Conversion of FR 45 to trail will reduce the impact of the road since it will be narrowed to a trail. Slash, rocks, and logs will be used to obscure the non-trail road width, and over time vegetation will be re-established.

Aspen treatments would have moderate effects on scenic quality.

- Aspen treatments to stimulate new sprouting require fencing to protect the areas from ungulate browsing following treatments. Aspen outside of MSO habitat would have invading conifers removed. The project includes treatment of aspen and fencing. Fence materials proposed include wire and jack-strawing of trees. All would introduce unnatural linear features into the landscape that would not be natural appearing. Since these are isolated areas scattered around the project area, introduction of linear features would have low effects. Wire and metal posts can be shiny and the color can contrast with the natural surroundings. Mitigation measures will be used to introduce the fewest contrasting elements where wire fencing is used and effort would be made to locate the site of the fencing where it is least noticeable. Wire fencing would have low effects and would meet the SIO. Jack strawing has been used to a limited extent on the Coconino NF in order to protect aspen restoration projects from ungulate browsing. It involves cutting and stacking high numbers of cut trees in an irregular manner to form a wide, tall barrier surrounding the aspen stand. While natural materials would be used to create the jack straw, the shape and form created at this scale would not normally be found in the characteristic landscape. It would not be completely unnatural however, as it would be similar to large scale blow down events that may be caused by weather related events. Placement of jack straw treatment would not meet the requirements for foregrounds of high concern level roads in high SIO areas. Even if these sites were allowed to drop one SIO level, they would still not meet the basic definition of moderate SIO that "noticeable deviations must remain visually subordinate to the landscape character being viewed" (Forest Service 2000). Beyond the foreground 300 feet, jack straw piling may be suitable, and would be mitigated by carefully locating these barriers. These area would drop to moderate SIO until the jackstraw barrier begins to deteriorate or is burned in follow up prescribe burn activities. Once the aspen are large enough to withstand ungulate browsing, and the jackstraw barriers begin to decay, they are not as noticeable, these areas will improve to the mapped SIO. The timeline for use of the jack straw piling may exceed the projected recovery for the rest of the project area. There may be a need to drop to moderate SIO in jack straw piled aspen treatments until the trees are large enough to withstand browsing, this could be 15 to 20 years.

Scenic Integrity Objectives

The scenic integrity objectives for the BWMR project are shown in Figure 3.11-8. Seventy-six percent of the project is in high SIO.

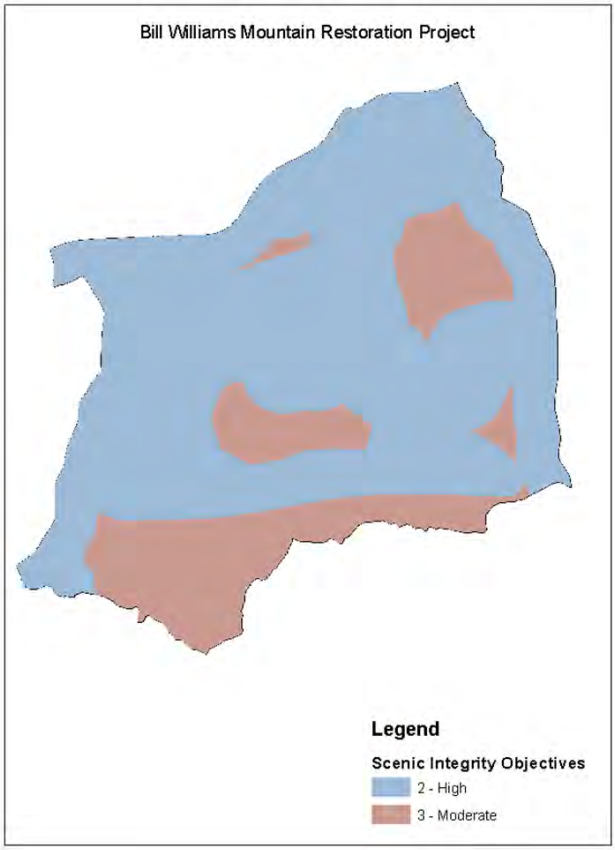


Figure 3.11-8 Forest Plan scenic integrity objectives.

Overall scenic integrity on Bill Williams Mountain will be lowered during project implementation. There will be evidence of new linear corridors as roads are constructed and cable logging is implemented trail work is completed, and mechanical treatments and prescribed burning are implemented. Table 3.11-3 presents the Scenic Integrity Objectives (SIO) by Operability Zone.

Table 3.11-3 Scenic integrity objectives in the proposed operability zones.

Operability Zone	SIO 2 Acres	SIO 3 Acres
Conventional-01	7,181	1,565
Steep Conventional-02	669	310
Adverse Forwarder-03	68	0
Excaline with		

Operability Zone	SIO 2 Acres	SIO 3 Acres
Forwarder Swing Skid-04	132	0
Skyline Yarding-05	338	9
Mixed Conventional-06	634	769
Helicopter-07	2,471	994
Total Acres*	11,493	3,647

*Acreage discrepancies are due to rounding errors.

Interim measures will be used during implementation activities whereby the 11,493 acres in SIO 2 (high) will drop to SIO 3 (moderate) until project completion and for 5 to 10 years following. This will ensure adequate time for closed and decommissioned roads to naturalize, evidence of logging activities to recover, trailside vegetation to re-establish and initial prescribed fire activities to soften.

Aspen treatments are the exception to the timeline for meeting SIO for the BWMR project. In areas where jack straw piling is used, these features must stay in place until the trees can withstand browsing. It is estimated that where aspen is treated and jack straw piles are used, these area will not meet desired SIO for 15 to 20 years after treatment.

Cable logging has not been widely used in the Southwest. It is proposed in Operability Zones 4 and 5. Figure 3.11-8 provides an example of corridors and haul roads created for cable logging in Montana. In this example, the corridors angle up to the haul roads and slash is piled by the edge of the haul roads. The downhill area has been thinned compared to no thinning uphill of the top haul road. Figure 3.11-9 looks down a corridor and shows a summer picture. There is a cleared corridor that is beginning to have vegetation re-established.

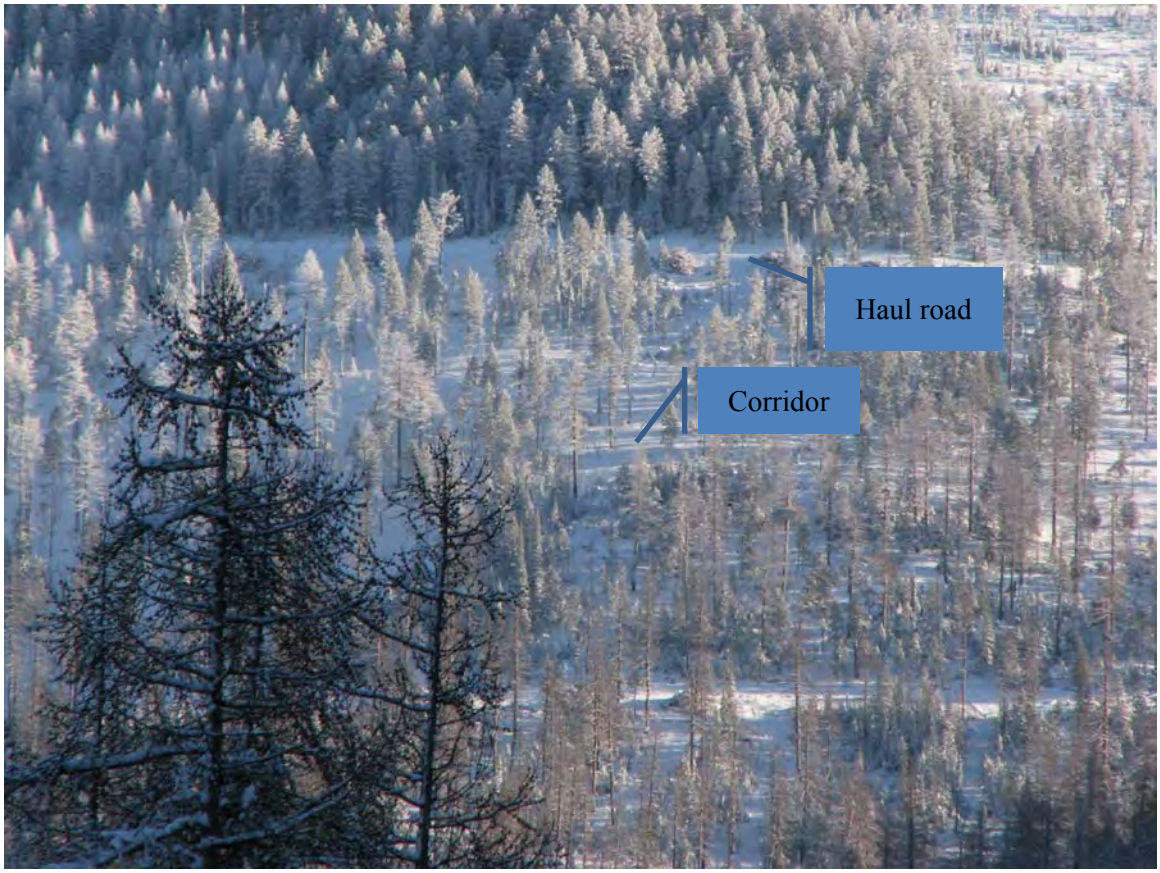


Figure 3.11-8 Cable corridor and haul road example from Montana.

Figure 3.11-9 Looking down a cable corridor in Montana the next summer post treatment.

It is anticipated that after 3-5 years when understory vegetation has recovered, the corridors will be less visible to the casual viewer.

Similarly, the presence of skid trails, landings, and piled or scattered slash would result in a moderate reduction of the scenic integrity for the duration of the project. The effects in these areas would not be long-term since skid trails would be rehabilitated and activity generated slash would be mitigated in foreground areas, and treated throughout the project area. The ground disturbance resulting from using machines to pile slash would be noticeable for up to 1 year after project completion, depending on how quickly the areas were rehabilitated and vegetation regenerated.

Areas receiving strategic fuels treatments will follow the interim measures and timeline as described above. Figure 3.11-10 shows an example of this type of treatment near Elk Ridge Ski Area just outside of Williams, AZ.

Figure 3.11-9 Example of strategic fuels treatment near Elk Ridge Ski Area (prior to burning).

Scenic Stability

Scenic Stability considers the condition of the valued scenery attributes identified in the scenic character description of the Bill Williams project. It evaluates whether their condition is within the historic range of variability reference conditions, the range of conditions that indicate a properly functioning ecosystem. For example, the forest vegetation related scenic attributes (stand

structure/density, species composition, fire return interval, etc.) give an indication of whether the ecosystem if functioning properly and if the scenic attributes can be sustained. Scenic Stability also considers stressors that can affect scenery such as wildfire, insects and disease, and infestations of noxious weeds. Stressors may not threaten scenic attributes when the forest is functioning within reference conditions, but may become detrimental when the forest functions outside of these ranges. The scenic stability analysis for this project can be found in Appendix A of this report.

The dominant vegetation types of ponderosa pine and mixed conifer and their understory components have been identified as dominant scenic attributes. Minor scenery attributes for vegetation include woodlands, grasslands and aspen. Water form is a minor scenery attribute and there are no proposals for activities related to springs or ephemeral channels, therefore water form will not be included. There are indirect actions that affect landform since changes are proposed in the road system. Landform is, typically a more stable attribute, roads represent a minor scenery attribute as it relates to road construction and decommissioning.

Of the scenery attributes evaluated for the existing condition, four are at high risk, three are at moderate risk, and two are at low risk as shown in table 3.11-4.

Table 3.11-4. Summary of risk rating.

Factor	Risk Rating for Existing Condition
Tree density, improvement of age class diversity and structure of woody vegetation	High risk
Large, old trees are well represented across the project area	High risk
Risk of high intensity wildfire is reduced and fire is reintroduced into the ecosystem	High risk
Aspen is retained as an important scenic attribute	High risk
Understory composition and productivity is improved	Moderate risk
Minor Attribute: Changes improve the motorized transportation system	Moderate
Minor Attribute: Mixed hardwoods are retained as important scenic attributes	Moderate
Minor Attribute: Pinyon-juniper and juniper woodland are retained as important scenic attributes	Low
Minor Attribute: Trailhead and parking construction, and new trail construction or conversion improve the non-motorized transportation system	Low

The result of the analysis is that there is HIGH risk to SOME (40-60% of dominant attributes) and SOME are stable. This fits into the LOW STABILITY level, some dominant scenery attributes of the valued scenic character are present and are likely to be sustained. Known scenery attribute conditions and ecosystem stressors may seriously threaten or have already eliminated others.

The proposed action would improve scenic stability on 15,200 acres within the project, reduce tree density, improve age class diversity and would make progress toward structure of woody

vegetation. The risk of high intensity wildfire would be reduced and fire would be reintroduced into the ecosystem helping to maintain the lower tree density. There would be some progress toward having large, old trees well represented, although the project area is deficit in this area, and it will take many decades to develop large, old trees to meet this attribute. Aspen would be retained as an important scenic attribute, although it will take a couple of decades for stands to regain their health. Understory vegetation is expected to improve through use of thinning and prescribed burning. The motorized transportation system would be well designed, and much of the new road construction would be reclosed after project implementation and allowed to naturalize. Mixed hardwoods would be retained and their health improved as a result of thinning activities. Pinyon-juniper and juniper woodland would receive minor treatments since they are at low risk and do not require intensive treatments to meet the purpose and need of the project. Similarly, the trailhead and parking lot construction and trail conversion and construction are at low risk and will meet project objectives.

The proposed treatments in the proposed action would meet the Forest Plan requirements for scenic integrity in the long term.

Cumulative Effects

The cumulative effects analysis area is the Williams Ranger District, Kaibab NF. The timeline for analysis is 20 years. The following is a partial listing of actions considered in the cumulative effects analysis for this project:

- Activities such as vegetation management, fuels management, livestock grazing, recreational activities, and other management activities (e.g. noxious weeds treatments) have occurred in the past, are occurring, and are reasonably foreseeable actions on the District. These activities could occur on private lands as well.
- Firewood cutting has occurred in the past and would likely continue in the foreseeable future on the District and private lands.
- Private landowners may harvest timber on their lands for lumber or to reduce fire hazards.
- Urban development and interface growth will continue on private lands.
- Road construction, road maintenance and right-of-way brushing can be expected to continue on non-National Forest System land.
- Road maintenance, reconstruction, or decommissioning may occur with future vegetation management projects.
- Recreation activities are expected to continue to increase on the Forest. Future recreation projects may be developed.

Past and present activities that created the current conditions include grazing, the evolving forest management practices related to timber harvest and fire suppression, drought, disease and insect infestations, developed and dispersed recreational use and associated developments, and private land in-holdings. The effects associated with this project combined with effects from past, present, and reasonably foreseeable future actions would not have a measurable cumulative effect on the scenic resources.

Past, present and future vegetation management activities and fuels management activities would have similar direct and indirect effects on scenic integrity objectives as found in this project and dotted across the Williams Ranger District. Cumulatively, it is expected there would be minor fluctuations in scenic quality as projects are implemented and recover. Overall, the result of

vegetation and fuels activities is to stabilize scenic attributes and assure their presence into the future.

Livestock grazing has minor cumulative effects on scenic integrity. Construction of fencing or other improvements may decrease scenic integrity in small, localized areas that would be distributed across the District.

Urban development and interface growth will continue on private lands as the population of Arizona continues to grow, but Williams, AZ has not grown as fast as cities near the Phoenix metro area or Tucson. These will have slight effects on scenic integrity but are limited to private land parcels in the area.

Recreation activities and developments have remained fairly stable on the District according to the National Visitor Use Monitoring surveys (Forest Service 2012). The effects of these activities, especially those related to motorized cross country travel are expected to decline. Travel Management has been implemented which prohibits motorized cross country travel and restricts travel to the designated system of roads, trails and areas. Dispersed camping will continue to be a popular activity, but will is restricted by Travel Management as well. Recreation opportunities will continue to be offered and it is expected that recreation use will grow slowly with minimal effects to scenic integrity.

Road construction and maintenance on forest and non-forest lands will continue. Travel Management reduced the number of roads open to motorized travel on forest lands. It is anticipated that there will be very little new road construction in the future. The cumulative effects of the existing road system and maintenance activities will have minor additional effects to scenic integrity. Decommissioning of roads will improve landscape character and scenic integrity.

Overall, the cumulative effects of this project and those analyzed will result in some improvement to the scenic integrity on the Williams Ranger District.

Alternative 3

Preparation of sale areas may have slight effects to scenery from marking trees and project boundaries. These will be mitigated by using butt marks on the side facing sensitive travel corridors.

Mechanical Treatments

Approximately 15,200 acres of the project area would receive mechanical treatments including use of conventional ground based logging systems, cable logging systems, and helicopter logging. In addition, approximately 2,500 acres in the strategic fuels treatment area would be thinning by hand or use of machinery equipped with cutting or grinding heads may be used.

Conventional ground based logging systems include, but are not limited to: use of chainsaws or feller-bunchers to cut trees and lop slash, skidders to move material to landings, bulldozers to pile slash, and specialized equipment such as feller-bunchers, and tree shears to cut, chop, break, and lop fuel material. Cable systems use a yarder equipped with a system of cables to pull logs to a landing, loaders to move logs and logging trucks to haul logs. Skyline cable systems lift the logs off the ground to transport them instead of dragging logs across the ground. Helicopter logging

uses helicopters to remove cut and limbed trees from an area by lifting them on with cables attached to a helicopter. Logs are “decked” in a central area to be hauled away.

There would be light to extensive effects on scenic quality during and immediately following mechanical treatments.

- Hand thinning usually has little or no short term effects on scenery. Trees are cut down, then cut into segments that can be treated. Effects may include slash from limbing and topping trees. Project mitigations require slash to be treated.

- Conventional logging typically has moderate short short-term effects to scenery, these would be the same as with Alternative 2.

- Cable systems are used to transport cut logs to centralized processing areas and typically have extensive, short-term effects to scenery, these would be the same as with Alternative 2.

- Helicopter systems transport logs or trees to central log decks. Helicopter logging typically has moderate to extensive effects on scenery, these would be the same as with Alternative 2.

Road Construction would have moderate to extensive effects on scenic quality during and immediately following restoration treatments. The effects are the same as for Alternative 2, the proposed action.

Strategic fuels treatments would have low effects on scenic quality immediately after treatment. The effects would be the same as for Alternative 2, the proposed action.

Fuels reduction and reintroduction of fire would have moderate effects on scenic quality immediately after treatment, and low effects after repeat burning.

Prescribed fire would be used on approximately 14,710 acres of the project areas within Operability Zones 1-7 except within the Arizona Bugbane Botanical Area. It may be used in conjunction with mechanical treatments or singly. The objective of prescribed burning is to reduce fuel loading, raise crown base heights and reduce live tree density. Repeat or maintenance burning would help maintain these objectives. Effects would be the same as for Alternative 2, the proposed action, but about 4 percent less of the area would show fire effects.

Trails work in this project would have low to moderate effects on scenic quality. The effects would be the same as for Alternative 2, the proposed action.

Aspen treatments would have moderate effects on scenic quality and the effects would be the same as for Alternative 2, the proposed action.

Scenic Integrity Objectives

Overall scenic integrity on Bill Williams Mountain will be lowered during project implementation. There will be evidence of new linear corridors as roads are constructed and cable logging is implemented, trail work is completed, and mechanical treatments and prescribed burning are implemented. Table 3.11-4 presents the Scenic Integrity Objectives (SIO) by Operability Zone for Alternative 3.

Table 3.11-4. Scenic Integrity Objectives by Operability Zone for Alternative 3

Operability Zone	SIO 2 Acres	SIO 3 Acres
Conventional-01	6,870	1,873
Steep Conventional-02	651	299
Adverse Forwarder-03	68	0
Excaline with Forwarder Swing Skid-04	0	0
Skyline Yarding-05	0	0
Mixed Conventional-06	620	783
Helicopter-07	2,925	1,023
Total Acres*	11,134	3,978

Interim measures will be used during implementation activities whereby the 11,134 acres in SIO 2 (high) will drop to SIO 3 (moderate) until project completion and for 5 to 10 years following. This will ensure adequate time for closed and decommissioned roads to naturalize, evidence of logging activities to recover, trailside vegetation to re-establish and initial prescribed fire activities to soften.

Aspen treatments are the exception to the timeline for meeting SIO for the BWMR project. In areas where jack straw piling is used, these features must stay in place until the trees can withstand browsing. It is estimated that where aspen is treated and jack straw piles are used, these area will not meet desired SIO for 15 to 20 years after treatment.

Effects for scenic integrity objectives are the same as for Alternative 2.

Effects for scenic stability are the same as for Alternative 2.

Cumulative Effects

Similar to Alternative 2.

Alternative 4

Preparation of sale areas may have slight effects to scenery from marking trees and project boundaries. These will be mitigated by using butt marks on the side facing sensitive travel corridors.

Mechanical Treatments

Approximately 11,150 acres of the project area would receive mechanical treatments including use of conventional ground based logging systems. In addition, approximately 2,500 acres in the strategic fuels treatment area would be thinning thinned by hand or use of machinery equipped with cutting or grinding heads may be used.

Conventional ground based logging systems include, but are not limited to: use of chainsaws or feller-bunchers to cut trees and lop slash, skidders to move material to landings, bulldozers to pile slash, and specialized equipment such as feller-bunchers, and tree shears to cut, chop, break, and lop fuel material. Cable systems use a yarder equipped with a system of cables to pull logs to a landing, loaders to move logs and logging trucks to haul logs. Skyline cable systems lift the logs off the ground to transport them instead of dragging logs across the ground. Helicopter logging uses helicopters to remove cut and limbed trees from an area by lifting them on with cables attached to a helicopter. Logs are "decked" in a central area to be hauled away.

There would be light to extensive effects on scenic quality during and immediately following mechanical treatments.

- Hand thinning usually has little or no short term effects on scenery. Trees are cut down, then cut into segments that can be treated. Effects may include slash from limbing and topping trees. Project mitigations require slash to be treated.
- Conventional logging typically has moderate short short-term effects to scenery. During implementation, in most cases, whole trees are cut and moved to a "landing" near a haul road. At the landing, the limbs and tops are removed, and the clean logs are decked to be loaded and hauled away. After vegetation has been thinned, the slash is piled using bulldozers. Effects typically include trampling of vegetation where equipment is operating, creation of linear skid trails where vegetation is trampled or completely removed exposing bare soil, creation of linear log landings where vegetation has been removed and bare soil is exposed, and piles of cull logs not suitable for commercial uses. After logs or useable material is removed, slash would be treated as per mitigation measures. This may include bulldozers pushing slash into large piles (10-20 foot wide piles, often 10 feet tall) which can trample vegetation and cause bare soil to be exposed, hand piling, chipping, crushing, and lopping and scattering.

Road Construction would have moderate to extensive effects on scenic quality during and immediately following restoration treatments.

- Construction of approximately 38 miles of temporary roads would result in extensive short term effects on scenery. Effects are similar to new road construction noted above, although the temporary roads would be obliterated after use. Mitigation measures would be used to close entrance points and Best Management Practices for watershed would ensure drainage is re-established and the roads can rehabilitate. The temporary roads would begin to recover and should be mostly recovered and less noticeable to the casual observer in 5 to 10 years.
- Road obliteration of 28 miles of roads would entail obliteration whereby road surfaces would be ripped and seeded or mulched, inside ditches would be filled, road prisms outsloped, culverts and fill materials removed, stream crossings re-contoured, unstable sidecast or cutslopes removed or stabilized, and entrances blocked to prevent future access (see Soils/Watershed Section 3.4). These would have moderate short short-term effects to scenery. Mitigation measures would help return these roads to a more stable status. The obliterated roads would begin to recover after treatment and would be mostly recovered and less noticeable to the casual observer in 5 to 10 years.

Strategic fuels treatments would have low effects on scenic quality immediately after treatment.

- Strategic fuels treatments would enhance fire control lines enabling prescribed fire to be safely implemented. They include hand thinning or use of machinery equipped with cutting or grinding heads on 300 feet either side of control lines. Slash is treated within

the cleared area, and this becomes the staging area for implementing prescribed burning blocks. Effects include short short-term introduction of linear features throughout the area. Upon completion of prescribed burning it is expected that the linear features will not be as noticeable because the density of trees on either side of the treatment areas would be thinned and/or burned reducing the number of trees.

Fuels reduction and reintroduction of fire would have moderate effects on scenic quality immediately after treatment, and low effects after repeat burning.

- Prescribed fire would be used on approximately 14,710 acres of the project area except in the Arizona Bugbane Botanical Area. It may be used in conjunction with mechanical treatments or singly. The objective of prescribed burning is to reduce fuel loading, raise crown base heights and reduce live tree density. Repeat or maintenance burning would help maintain these objectives. Effects are the same as for Alternative 2, but about 4% less area would be burned.

Aspen treatments would have moderate effects on scenic quality.

- Aspen treatments to stimulate new sprouting require fencing to protect the areas from ungulate browsing following treatments. Aspen outside of MSO habitat would have invading conifers removed. The project includes treatment of aspen and fencing. Fence materials proposed include wire and jack-strawing of trees. Effects would be the same as Alternatives 2 and 3.

Scenic Integrity Objectives

Overall scenic integrity on Bill Williams Mountain will be lowered during project implementation. There will be evidence of new linear corridors as roads are constructed and cable logging is implemented, trail work is completed, and mechanical treatments and prescribed burning are implemented. Table 3.11-5 presents the Scenic Integrity Objectives (SIO) by Operability Zone.

Table 3.11-5 Scenic integrity objectives by operability zone for Alternative 4.

Operability Zone	SIO 2 Acres	SIO 3 Acres
Conventional-01	6,892	1,850
Steep Conventional-02	656	323
Adverse Forwarder-03	6	0
Excaline with Forwarder Swing Skid-04	0	0
Skyline Yarding-05	0	0
Mixed Conventional-06	629	774
Helicopter-07	0	0
Total Acres	8,177	2,947

Alternative 4 would result in fewer acres showing effects to scenic integrity from mechanical thinning than either action alternative (2 or 3). Interim measures will be used during implementation activities whereby the 8,177 acres in SIO 2 (high) will drop to SIO 3 (moderate) until project completion and for 5 to 10 years following. This will ensure adequate time for closed and decommissioned roads to naturalize, evidence of logging activities to recover, trailside vegetation to re-establish and initial prescribed fire activities to soften.

Aspen treatments are the exception to the timeline for meeting SIO for the BWMR project. In areas where jack straw piling is used, these features must stay in place until the trees can withstand browsing. It is estimated that where aspen is treated and jack straw piles are used, these area will not meet desired SIO for 15 to 20 years after treatment.

The presence of skid trails, landings, and piled or scattered slash would result in a moderate reduction of the scenic integrity for the duration of the project. The effects in these areas would not be long-term since skid trails would be rehabilitated and activity generated slash would be mitigated in foreground areas, and treated throughout the project area. The ground disturbance resulting from using machines to pile slash would be noticeable for up to 1 year after project completion, depending on how quickly the areas were rehabilitated and vegetation regenerated.

Scenic Stability

Alternative 4 would improve scenic stability on 15,200 acres within the project but not to the extent that Alternatives A and B would. This alternative would make less progress in reducing tree density and improving age class diversity and would require mechanical treatment sooner than the other action alternatives. It would make progress toward structure of woody vegetation since logging would be prohibited on slopes steeper than 40%. The risk of high intensity wildfire would be reduced and fire would be reintroduced into the ecosystem helping to maintain the lower tree density, but in 4% less of the area. There would be less progress toward having large, old trees well represented, although the project area is deficit in this area, and it will take many decades to meet this attribute. Similarly, aspen will be retained as an important scenic attribute, although it will take a couple of decades for stands to regain their health. Understory vegetation is expected to improve somewhat, although since less of the area would be thinned, fewer openings would be created. There is also a chance that it there will be more trees killed and more large openings created from prescribed burning since less area will be thinned. The motorized transportation system will use more temporary roads and will continue to use the poorly placed existing road system. Temporary roads and those identified for obliteration will naturalize. Mixed hardwoods would be retained but there would be little improvement in their health since less area would be thinned. Pinyon-juniper and juniper woodland would receive minor treatments since they are at low risk and do not require intensive treatments to meet the purpose and need of the project. Similarly, the trailhead and parking lot construction and trail conversion and construction are at low risk and will meet project objectives.

Cumulative Effects

Similar to Alternatives 2 and 3.

3.12 Cultural Resources

3.12.1 Affected Environment

Archaeologists previously surveyed a total of 7819 acres in the proposed 15,200 acre (51%) Bill Williams Mountain Restoration Project (Woodard 2012). Previous cultural resource surveys on the Kaibab National Forest indicate low site density in the ponderosa and mixed conifer forests and on slopes greater than 40%. A portion of the project area consists of very rocky steep topography with greater than 40% slope, areas considered unsuitable for the occurrence of cultural resources. Removing this area from the coverage (and 327 acres previously surveyed within that area) archaeologists have surveyed 7492 of the 13,047 acres (57%) where cultural resources are most likely to occur. During the summer of 2011, archaeologists designed their surveys to target locations most likely to have heritage resources in unsurveyed portions of the project area. As a result of that 1069 acre survey, archaeologists found 18 new sites and brought the survey percentage to 66%. Overall, archaeologists have recorded 115 sites, or a "low" site density of 8.6 sites per square mile, which supports the previous model. This is below the Forest-wide average of 9.74 sites per square mile.

The dominant site types are prehistoric structures with 1 to 2 rooms. However, other site types documented included pit houses, rock shelters, food gathering and processing centers, lithic scatters, and agricultural features. Historic sites are associated with Route 66, the Bill Williams Lookout Tower and the historic Civilian Conservation Corps-built Clover Ranger Station. Bill Williams Mountain is also a Traditional Cultural Property and has cultural values to five of the Kaibab's consulting tribes. Through government to government consultation, these tribes have stated that the project will not adversely affect the TCP provided mitigation measures listed in Section 4.1 are followed. In fact, tribes have stated that decreasing the likelihood of catastrophic fire on the mountain will ensure the long term traditional and ceremonial use of the mountain.

3.12.2 Direct and Indirect Effects

No Action Alternative

Under the no action alternative, project managers would not implement prescribed burns or mechanical vegetation treatments that involve felling, killing or removing trees in the 15,200-acre project area. If activities associated with the Bill Williams project were not implemented, mitigation measures to address heritage resource issues and concerns would no longer be necessary. As a result, this analysis assumes that the no action alternative will lead to a high intensity catastrophic fire.

Direct Effect

The continued deposition of fuels in the area would increase the likelihood of a high intensity catastrophic wild fire on Bill Williams Mountain. It is likely that many of the prehistoric and especially the few with combustible features would suffer adverse effects from intense fire behavior.

Indirect Effect

Under this alternative, fuels would continue to accumulate on and around heritage resources sites increasing the likelihood that devastating fire on Bill Williams Mountain would occur.

As noted in the draft of the revised Kaibab National Forest Plan, "In recent years, most adverse impacts to heritage resources are caused by high-intensity, stand-replacing wildfire and increased erosion associated with such fires. The majority of archaeological sites on the Forest are prehistoric sites lacking combustible features and are considered to be non-fire sensitive under low to moderate intensity burning. However, all archaeological sites are susceptible to adverse impacts from high intensity burning as well documented after the recent Warm (Reid et al 2008) and Schultz fires (Haines 2010)."

Due to the steepness of the slopes above the archaeological and historic sites, those that survived a catastrophic fire would then be exposed to the threat of severe erosion and flooding. Post fire flooding and erosion have been shown to have adverse effects on archaeological sites, especially when a fire occurs on steep slopes. Kaibab archaeologists experienced this unforeseen erosion a year after the Pumpkin Fire (Weintraub et al. 2002).

Alternative 2 (Proposed Action)

Under the proposed action alternative, project managers would implement prescribed burns and mechanical vegetative treatments on 15,200 acres. Project managers could use mechanical timber harvesting and piling, pre-commercial thinning, roundwood, sawtimber thinning, and hand pilling, fuelwood sales, helicopter logging, cable logging, skidding, crushing, and prescribed burns to achieve forest health and sustainability and reduce the risk of uncharacteristically intense stand-replacing wild fire. In addition, Alternative 2 includes the construction of 23 miles of new roads and 16 miles of temporary roads that would be obliterated after use. Another 28 miles of roads would also be obliterated. Finally, a new 1 mile section of trail and trailhead parking lot area would be built along Forest Road 122.

Direct Effect

Reducing the amount of dead and down woody debris, ladder fuels, and unnaturally high tree density would greatly reduce the risk of effects to heritage resource sites from catastrophic wildfire. However, the ground disturbing activities associated with treatments under this alternative could potentially affect heritage resource sites adversely. Heritage staff has designed mitigation measures (see Section 2.3), that if followed will result in no adverse effects to heritage resources.

Indirect Effect

As noted above, fuels reduction throughout the project area would significantly reduce the possibility of a catastrophic wild fire throughout the project area. This action would also decrease the threat of fire on sites outside of the treatment area, especially on those with wooden components.

Alternative 3

Alternative 3 differs only very slightly from the proposed action. Cable logging is removed as a proposed activity on 480 acres of very steep rocky country. Project managers instead propose to treat those areas using helicopter logging. It also removes prescribed fire from 490 acres due to the Arizona Bugbane Botanic Area and creates 22 miles of new roads (one mile less than Alternative 2).

Direct and indirect effects to heritage resources are the same as those in Alternative 2.

Alternative 4

Alternative 4 differs from Alternative 3 because it does not include helicopter and cable logging activities on the steep slopes of Bill Williams Mountain. This also removes the logging of 70 acres near the top of the mountain. There would be no new road construction under this alternative; however, the main difference is that an additional 38 miles of temporary road construction would be required and then obliterated. The Bixler Saddle Trail would not be constructed.

The direct and indirect effects to heritage resources are similar to those in Alternative 2 and 3; however, because the steep slopes of Bill Williams Mountain would not be treated, most heritage resources would be vulnerable to the effects of post fire flooding and erosion.

3.12.3 Cumulative Effects

Projects have been ongoing within the Bill Williams area since 1969. Because there will be no adverse effects to cultural resources under any of the four alternatives, as none of the actions under the alternatives incrementally adds to the degradation of heritage resources, there should be no cumulative effects to cultural resources.

3.13 Implementation Economics

Introduction

This report evaluates and discloses the project implementation economics for four alternatives proposed for the Bill Williams Restoration Project.

Methodology and Analysis Process

Implementation of the Bill Williams Mountain project would require several types of activities. Costs to undertake these activities have been estimated using a variety of methods. The activities that have been analyzed for and the methodology that was used to estimate their costs are:

Net Timber Value- Net timber value is the value of the timber to be harvested as it stands on the stump; it is also referred to as stumpage value. This is the monetary amount that a contractor would be willing to pay the government for the timber or the amount that the contractor would need to be paid in order to harvest and haul the timber from the site. The analysis in this document does not consider the cost of road construction, road obliteration or any Forest Service costs as part of the net timber value calculations.
Recent past timber sales harvested by ground based logging methods on the Williams District have generated a positive value of approximately $3/CCF, (i.e. the contractor pays the Forest Service for the timber). Different types of logging systems have different costs associated with them. Ground based logging generally has the lowest cost per CCF harvested when compared to other logging systems such as cable, excaline or helicopter. Ground based logging in alternative 3 was considered to be the most similar from a cost standpoint of ground based methods recently used on Williams District. The logging costs for ground based logging in alternative 3 was used as a base value of $3/CCF. Logging costs for other harvest methods were then calculated and the cost difference between that cost and the cost for ground based logging in alternative 3 was used to adjust net timber values up or down. The cost of all logging systems were estimate by using the Forest Service's log cost program, (version 11.0).

Cultural Resource Survey Cost- Prior to project implementation, within logging units, archaeologists must mark known cultural resource sites for protection. In addition, archaeologists will survey all proposed road construction and/or roads to be obliterated, they will mark sites for protection from road construction and/or obliteration activities, and write a clearance report to assure no adverse effects to cultural resources. These costs were provided by the Williams District archaeologist, based on past experienced costs.

Sale Preparation Cost- Sale preparation costs are all costs associated with locating harvest units, timber marking and timber cruising. These costs were provided by the Williams District timber management officer based on past experienced costs.

Sale Administration Cost- This is the cost to supervise the logging done by a contractor and to administer the contract. These costs were estimated by the Williams District timber management office based on past experienced costs.

Road Engineering Cost- This is the cost to design and engineer the roads required to implement the project. It was estimated by using costs per mile found in the inter-regional road cost guide.

Road Construction/Obliteration Cost- This is the estimated cost for a contractor to actually build required roads and obliterate other roads that are not needed or are temporary roads. It was estimated using the costs provided in the inter-regional cost guide.

Road Construction/Obliteration Administration Cost- This is the cost to supervise the work of constructing and obliterating roads and to administer the contract with a contractor. It was estimated by the Coconino-Kaibab zone forest engineer.

Strategic Fuel Break Construction Cost- This is the cost to construct strategic fuel breaks on Bill Williams Mountain. They would also be used as control lines for proposed prescribed burning. It was estimated by the Williams District assistant fire management officer (fuels) based on past experienced costs.

Prescribed Burning Cost- This is the cost to carry out prescribed burning excluding the cost of constructing fuel breaks. It was estimated by the Williams District assistant fire management officer (fuels) based on past experienced costs.

3.13.1 Affected Environment

The Kaibab National Forest currently operates and funds programs for vegetation management, forest products, cultural resources, engineering, and fuels management, among others. Funding for these programs come from annual Congressional appropriations to the USDA Forest Service, and then is further allocated to the USFS Southwest Region and Kaibab National Forest. Funding levels in recent years have been generally flat to declining, although trends are somewhat variable between the various National Forest program areas. Receipts resulting from National Forest timber sale contracts are deposited in the federal treasury. As an alternative to timber sales, the Forest Service currently has Stewardship Contracting authority, which provides a legal mechanism for exchanging the value of goods (such as forest products) for service work (such as pre-commercial thinning). When the value of goods such as merchantable timber in a given stewardship contract is less than the cost of the service work in that project, agency appropriated federal funding can be available through an Integrated Resource Service Contract (IRSC). IRSCs allow for the Forest Service to pay a contractor to carry out work on National Forest lands when the value of the goods does not cover the cost of the service work, which can include logging costs.

3.13.2 Environmental Effects

Alternative 1- No Action

Direct and Indirect Effects

Net Timber Value

No logging would be done under this alternative and no cost incurred or timber value generated.

Cultural Resource Survey Cost
No heritage survey would be done under this alternative and no cost incurred.

Sale Preparation Cost
No sale preparation would be done under this alternative and no cost incurred.

Sale Administration Cost
No sale administration done would be under this alternative and no administrative cost incurred.

Road Engineering Cost
No road engineering would be done under this alternative and no cost incurred.

Road Construction
No road construction would be done under this alternative and no cost incurred.

Road Obliteration Cost
No road obliteration would be done under this alternative and no cost incurred.

Road Construction/Obliteration Administration Cost
No road construction or obliteration would be done under this alternative and no administrative cost incurred.

Strategic Fuel Break Construction Cost
No strategic fuel breaks would be constructed under this alternative and no cost incurred.

Prescribed Burning Cost
No prescribed burning would be done under this alternative and no cost incurred.

Cumulative Effects
There would be no cumulative environmental effect under this alternative.

Alternative 2- Proposed Action

Direct and Indirect Effects

Net Timber Value
Net timber value under this alternative is a negative $8,957,696. Logging cost calculations for Alternative 2 are shown in table 1

Table 3.13-1. Logging cost summary Alternative 2

Logging System	Stump to Truck Cost ($/CCF)	Volume/ac (CCF)	Acres	Total Volume (CCF)	Timber Value ($/CCF)	Net Timber Value by Logging System ($)
Ground-based Mechanical	70	7.0	11,150	78,050	+13	1,014,650
Cut To Length	95	0.4	70	28	-12	-336
Skyline	263	4.6	350	1,610	-180	-289,800
Excaline with forwarder swing	935	1.0	130	130	-852	-110,760
Helicopter	750	4.1	3500	14,350	-667	-9,571,450
Total						-8,957,696

Cultural Resource Survey Cost
Marking cultural resource sites- 160 hours @ $31/hour = $4,960
Surveying new road locations for cultural resources- 921 acres of road @$30/acre= $27,630
Total Cultural Resource Survey Cost = **$32,590**

Sale Preparation Cost
11,220 acres of ground based sale preparation @ $102/acre = $1,144,440
3,980 acres of cable or helicopter sale preparation @$143/acre = $569,140
Total sale preparation cost **=$1,713,580**

Sale Administration Cost
15,200 acres of timber sale to administer @ $120/acre = $1,824,000
Total Sale Administration Cost **= $1,824,000**

Road Engineering Cost
23 miles of new permanent road @ $3,500/mile = $80,500
16 miles of temporary road @ $500/mile = $8,000
Total Road Engineering Cost = **$88,050**

Road Construction/Obliteration Cost
New permanent road construction, 23 miles = $321,977
New temporary road construction and obliteration, 16 miles = $172,368
Existing road obliteration, 28 miles = $$98,728
Total road construction and obliteration cost = **$593,073**

Road Construction/Obliteration Administration Cost
39 miles of construction, permanent and temporary @$960/mile = $37,440

44 miles of obliteration, existing and new temporary @ $480/ mile = $21,120
Total Road Administration Cost = **$58,560**

Strategic Fuel Break Construction Cost
2,500 acres of strategic fuel breaks would be constructed with an estimated cost of $700/acre.
Total cost-**$1,750,000**

Prescribed Burning Cost-
11,150 acres of slopes under 30% @ $100/acre =$1,115,000
4,050 acres of slopes over 30% @ $250/acre = $1,012,500
Total prescribed Burn cost **= $2,127,500**

Cumulative Effects
There would be no cumulative environmental effect under this alternative.

Alternative 3
Direct and Indirect Effects
Net Timber Value
Net timber value under this alternative is a negative $47,802,207. Logging cost calculations for Alternative 3 are shown in table 2

Table 3.13-2. Logging cost summary Alternative 3

Logging System	Stump to Truck Cost ($/CCF)	Volume/ac (CCF)	Acres	Total Volume (CCF)	Timber Value ($/CCF)	Net Timber Value by Logging system ($)
Ground-based Mechanical	80	5.7	11,150	63,555	+3	190,665
Cut To Length	133	2.4	70	168	-50	-8,400
Helicopter	3,432	3.6	3980	14,328	-3,349	-47,984,472
Total						-47,802,207

Cultural Resource Survey Cost
Marking cultural resource sites- 160 hours @ $31/hour = $4,960
Surveying new road locations for cultural resources- 921 acres of road @$30/acre= $27,630
Total Cultural Resource Survey Cost = $32,590

Sale Preparation Cost
11,220 acres of ground based sale preparation @ $102/acre = $1,144,440
3,980 acres of cable or helicopter sale preparation @$143/acre = $569,140
Total sale preparation cost **= $1,713,580**

Sale Administration Cost
15,200 acres of timber sale to administer @ $120/acre = $1,824,000
Total Sale Administration Cost **= $1,824,000**

Road Engineering Cost
22 miles of new permanent road @ $3,500/mile = $77,000
16 miles of temporary road @ $500/mile = $8,000
Total Road Engineering Cost = **$85,000**

Road Construction/Obliteration Cost
New permanent road construction, 2 miles = $307,978
New temporary road construction and obliteration, 16 miles = $172,368
Existing road obliteration, 28 miles = $$98,728
Total road construction and obliteration cost = **$579,074**

Road Construction/Obliteration Administration Cost
38 miles of construction, permanent and temporary @$960/mile = $36,480
43 miles of obliteration, existing and new temporary @ $480/ mile = $20,640
Total Road Administration Cost **= $57,120**

Strategic Fuel Break Construction Cost
2,500 acres of strategic fuel breaks would be constructed with an estimated cost of $700/acre.
Total cost- **$1,750,000**

Prescribed Burning Cost
11,150 acres of slopes under 30% @ $100/acre =$1,115,000
3,560 acres of slopes over 30% @ $350/acre = $1,246,000
Total prescribed Burn cost = $2,361,000

Cumulative Effects
There would be no cumulative environmental effect under this alternative.

Alternative 4
Direct and Indirect Effects
Net Timber Value
Net timber value under this alternative is a positive $180,630. Logging cost calculations for Alternative 4 are shown in table 3

Table 3.13-3. Logging cost summary Alternative 4

Logging System	Stump to Truck Cost ($/CCF)	Volume/ac (CCF)	Acres	Total Volume (CCF)	Timber Value ($/CCF)	Net Timber Value by Logging system ($)
Ground-based Mechanical	80	5.4	11,150	60,210	+3	180,630
Total						180,630

Heritage Survey Cost
Marking cultural resource sites- 160 hours @ $31/hour = $4,960
Surveying new road locations for cultural resources- 897 acres of road @$30/acre= $26,910
Total Cultural Resource Survey Cost = $31,870

Sale Preparation Cost
11,150 acres of ground based sale preparation @ $102/acre= $1,137,300
Total Sale Preparation Cost **=$1,137,300**

Sale Administration Cost
11,150 acres of timber sale to administer @ $120/acre = $1,338,000
Total Sale Administration Cost **= $ 1,338,000**

Road Engineering Cost
38 miles of temporary road @ $500/mil = $19,000
Total Road Engineering Cost = **$19,000**

Road Construction/Obliteration Cost
New temporary road construction and obliteration, 38 miles = $519,066
Existing road obliteration, 28 miles = $$98,728
Total road construction and obliteration cost = **$617,794**

Road Construction/Obliteration Administration Cost
38 miles of construction, temporary @$960/mile = $36,480
43 miles of obliteration, existing and new temporary @ $480/ mile = $20,640
Total Road Administration Cost **= $57,120**

Strategic Fuel Break Construction Cost
2,500 acres of strategic fuel breaks would be constructed with an estimated cost of $700/acre.
Total cost- **$1,750,000**

Prescribed Burning Cost

11,150 acres of slopes under 30% @ $100/acre =$1,115,000
3,560 acres of slopes over 30% @ $350/acre = $1,246,000
Total prescribed burn cost = **$2,361,000**

Cumulative Effects

There would be no cumulative environmental effect under this alternative.

Alternative Comparison

A comparison of costs to implement this project is shown in table 4. All costs are subtracted from net timber value to arrive at a total cost to implement the project. Alternatives 2 and 3 show a negative net timber value, while alternative 4 shows a positive net timber value. All of the action alternatives analyzed require funding to implement.

Table 3.13-4. Estimated Implementation Costs by Alternative

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Net Timber Value	$0	$(8,957,696)	$(47,802,207)	$180,630
Cultural Resource Survey Cost	$0	$32,590	$32,590	$31,870
Sale Preparation Cost	$0	$1,713,580	$1,713,580	$1,137,300
Sale Administration Cost	$0	$1,842,000	$1,842,000	$1,338,000
Road Engineering Cost	$0	$88,050	$85,000	$19,000
Road Construction/Obliteration Cost	$0	$593,073	$579,074	$617,794
Road Construction/Obliteration Administration Cost	$0	$58,560	$57,120	$57,120
Strategic Fuel Break Construction Cost	$0	$1,750,000	$1,750,000	$1,750,000
Prescribed Burning Cost	$0	$2,127,500	$2,361,000	$2,361,000
Cost of Implementation, (not including net timber value)	$0	$8,187,353	$8,402,364	$7,312,084

Net Timber Value	$0	$(8,957,696)	$(47,802,207)	$180,630
Costs of Implementation, (not including net timber value)	$0	$8,187,353	$8,402,364	$7,312,084
Total Implementation Cost, Net Timber Value minus Cost of Implementation	$0	$17,145,049	$56,204,571	$7,131,454

3.14 Socio Economics

3.14.1 Affected Environment

The City of Williams is the closest incorporated community to the Bill Williams Restoration Project area. In fact, the city limits extends to the top of Bill Williams Mountain. There are many private landowners and residents that live within and adjacent to the project area. Many of these residents live next to forest conditions classified by the Forest Service as high fire risk due to high tree densities and unnaturally high fuel loads. Fuelwood cutters, hunters, grazing permittees, and recreationists use the project area. The principal economic activities in this area of Coconino County occur with federal, state, and local governments, retail trade, and the service sector. The trade and service sectors are oriented toward tourism. Commercial timber cutting and livestock grazing are enterprises that represent minor components of the economic environment.

The communication site on top of Bill Williams Mountain provides important communications to all of northern Arizona. This multi-million dollar site provides communications for a number of local, county, state and federal entities. A disruption in services could jeopardize public safety for several months. A dollar value was not estimated, but the disruption in services could cost tens of thousands of dollars for the building and tower owners, which includes the Federal Government building and tower. The situation immediately following a fire that destroyed or severely damaged the communication site would be chaotic to say the least.

Bill Williams Mountain is the primary watershed for the City of Williams and provides a major water source for residents. A high-intensity fire could result in reservoirs filling with sediment which would render the water system that depends on surface water useless for a year or more. Water would probably have to be trucked or brought in by rail cars to sustain the local residents.

Costs for implementing the project that remain fairly constant for the action alternatives include cultural resource surveys, sale preparation, sale administration, road engineering, road construction and obliteration, strategic fuel break construction and prescribed burning.

The cost that would vary would be the net value for the timber. Net timber value is the value of the timber to be harvested as it stands on the stump; it is also referred to as stumpage value. This is the monetary amount that a contractor would be willing to pay the government for the timber or the amount that the contractor would need to be paid in order to harvest and haul the timber from the site. Recent timber sales harvested by ground based logging methods on the Williams District

have generated a positive value of approximately $3/CCF, (i.e. the contractor pays the Forest Service for the timber).

Different types of logging systems have different costs associated with them. Ground based logging generally has the lowest cost per CCF harvested when compared to other logging systems such as cable, excaline or helicopter. Logging costs for other harvest methods were calculated and the cost difference between that cost and the cost for ground based logging was used to adjust net timber values up or down. The cost of all logging systems were estimated by using the Forest Service's log cost program, (version 11.0).

3.14.2 Direct and Indirect Effects

Not all benefits and costs to society can be quantified. Revenues from forest products such as sawtimber have been assigned dollar values based on current markets and are quantifiable. Other resources such as watershed health, riparian health, wildlife abundance and diversity, long-term habitat improvement, social benefits, and scenic resources cannot easily be assigned dollar values. Under any of the action alternatives, this proposed project would have a sustained economic impact rather than a changing economic impact.

Alternative 1 – No Action

Under this alternative, management and recreational activities in the area would continue, i.e., fuelwood gathering, hunting, and grazing. The risk of high-intensity stand-replacing wildfires would remain high, as well as the risk of the consequences that go along with such an event, including the loss of recreational settings and opportunities, loss of visual/scenery aesthetic values, loss of wildlife habitat, and the potential loss of public and private property. There would be no new economic benefits (i.e., new jobs, income, or tax revenue) associated with the no-action alternative.

Under the no-action alternative, there would be no thinning or prescribed burning. The project area would remain at risk for a high-intensity stand-replacing fire. High-intensity stand-replacing wildfires can incur high costs associated with suppression, post fire rehabilitation, and reforestation. Post-fire rehabilitation, including emergency soil stabilization and replanting, have high per-acre costs. Stand-replacing wildfires also cause losses to Forest resources, which can have economic effects in the form of reduced tourism dollars and loss of commercial wood products. For comparison, the Shultz Fire on the San Francisco Peaks north of Flagstaff, Arizona was approximately 15,000 acres in size, roughly the same size of our project area. Suppression costs for the wildfire were approximately $10 million. The Forest Service spent about $4.1 million on Burned Area Emergency Response (BAER) costs, with another $1 million to rehabilitate roads. They will spend another $500,000 to complete the rehabilitation in the next year. Coconino County spent $4-5 million to control sediment and erosion and has received a grant for an additional $8 million for flood control. The total expenditures to date are between $25-30 million. These figures do not include money spent by the utility companies and homeowner losses due to the flooding (Personal Communication with Mike Elson, Flagstaff District Ranger, May 2012). A similar fire on Bill Williams Mountain would be devastating to the City and the local economy for many years.

Alternative 2 - Proposed Action

Under Alternative 2, there would be some short-term (one to ten years in any one area) effects on the social environment while commercial sales and follow-up activities are under way. These primarily include: a modest increase in fire hazard until harvest-generated slash is cleaned up; minor noise and human disturbance to wildlife during timber sale operations; some noise disturbance to adjacent private land residents; light log truck traffic on haul routes; and potential decrease in the quality of recreational experiences due to noise and the presence of equipment. There would be economic benefits (i.e., new jobs, income, or tax revenue) associated with these alternatives. The estimated cost for implementing this alternative is approximately $17.1 million. These costs include the net timber value minus the cost of implementation. This alternative would reduce hazardous fuels and fire risk more than the other action alternatives and would result in the least potential loss of other resources (DEIS, Section 3.13).

Alternative 3

Alternative 3 differs from the Proposed Action in that less hazardous fuels would be removed from the project area. There would be no reference condition thinning around the base of the mountain and there would be no cable logging in Alternatives 3, but there could be an increase in the helicopter logging acres. This reduction in timber removed around the base of the mountain and the increase in helicopter use increases the total implementation costs to approximately $56.2 million (DEIS, Section 3.13).

Alternative 4

Alternative 4 is considered the “least mechanical” of the action alternatives. There would be no cable or helicopter logging, and no new road construction. Only temporary roads would be built and then obliterated under this alternative. There would be no reference condition thinning around the base of the mountain, as in Alternative 3. The reduction in the logging and road building activities decreases the total implementation costs to approximately $7.1 million (DEIS, Section 3.13).

3.14.3 Cumulative Effects

Alternative 1 - No Action

Implementing Alternative 1 would have no cumulative effect on the social and economic environment of the Williams Ranger District as there would be no changes in current management and recreational activities in the project area. The risks associated with taking no action within this project area would remain high until new vegetation management projects designed to reduce fuel loading and tree densities are implemented in this area.

Alternative 2 (Proposed Action), Alternative 3 and Alternative 4

When combined with the direct and indirect effects of past, present and reasonably foreseeable activities in the project area, implementation of either action alternative would have some minor short-term adverse impacts on the social environment. However, implementation of any action alternative in conjunction with past, present and reasonably foreseeable vegetation management projects would help the Forest reduce fuel loading and the risk of high-intensity fires. This would also help maintain or boost the timber industry in the State and in turn help generate jobs and tax revenues for local economies.

3.15 Lands and Minerals

3.15.1 Affected Environment

The scope of this analysis focuses on the Lands resource located on the steep portion (over 40% slope) of the mountain, specifically, the Bill Williams Mountain Communication Site on top of Bill Williams Mountain and the electrical transmission and fiber optic lines that support the communication site on the east side of the project boundary. There are no minerals resources affected by this project.

The top of Bill Williams Mountain has been used as a fire lookout and communication site since the 1950's and serves as a critical link in the communication and distribution networks of a wide variety of public safety, industrial and commercial users, as well as residents of Williams and Northern Arizona. Current development includes 11 buildings and 14 towers. Each of these facilities have a backup power source that include batteries (both wet and gel cell), and either hydrogen, propane or diesel powered generators. Some of these facilities are multiple-use, meaning they can house tenants, and some are single use. The building and tower owners include Niles Radio, Verizon Wireless, SBA Communications, the Burlington Northern and Santa Fe Railway, KTVK-TV, Century Link/Qwest Corporation, Arizona Public Service, Arizona Department of Public Safety and the United States Government building that houses the Forest Service, the Federal Aviation Administration, U. S. Customs and Border Protection and the Federal Bureau of Investigation. The current replacement value of each building and tower combination is estimated to be approximately $1.5 million dollars, which does not take into account the purchase of the lease site or the potential temporary disruption of service. This dollar figure only represents replacement value of the building and tower.

The use and occupancy of the non-Forest Service owned facilities are authorized by 10-year communications use leases issued by the Kaibab National Forest. Ownership and maintenance responsibility for the structures belong to the lessee, but the Kaibab National Forest manages and maintains responsibility for the land and surrounding vegetation.

There is an overhead 12.5kV electrical power line owned by Arizona Public Service and a fiber optic phone line owned by Century Link/Qwest Corporation located within the same 20-foot wide right-of-way on the east side of the mountain serving the communication site as an ancillary improvement. Both of the electrical and fiber optic lines are very fire and heat sensitive.

The most relavant past activity that has affected the existing condition is the Bill Williams Cap Project, which was a fuels reduction project implemented on 6 acres in 2010. The Cap Project resulted in fuels reduction on all species up to 9" diameter and several large trees over 9" diameter also were removed that impinged on the communication facilities. This was a move in the right direction, however, trees would need to be thinned and or grouped together upwards of one mile radius from the mountaintop to really reduce the wildfire threat from below.

Existing Condition

The existing condition for the communication site on top of the mountain can best be described as heavy fuel loadings due to dense stand conditions and a very high potential for damage or complete destruction from catastrophic wildfire from below (DEIS, Appendix E). Part of the communication site is located within a Mexican Spotted Owl (MSO) Protected Activity Center,

which has some of the highest basal areas on the mountain. There is much dead and downed fuels and continuous tree crowns which could lead to devastating crown fires. The Cap project helped to thin some of the trees surrounding the communication site, but large trees are still interfering with communications by restricting beam paths.

The electrical and fiber optic lines on the east side of the project area have a 20-foot right-of-way that has been cleared by APS, however, these lines are susceptible to smoke and heat from burning. There have been some thinning and prescribed burning projects on slopes less than 40% in this area (City and Twin), but there is still a threat from wildfire.

3.15.2 Direct, Indirect, and Cumulative Effects

Alternative 1 – No Action

The direct and indirect effects of implementing Alternative 1 are a continuation of the risk of catastrophic wildfire because of the high fuel loadings and dense stand conditions that exist under current conditions. There is a high probability that an uncontrolled wildfire will burn to the top of the mountain and damage or destroy one or more of the facilities at the communication site at the top. There is also a high probability that a wildfire will damage or destroy the electrical power and fiber optic lines on the east side of the mountain. If fuels are not reduced under a controlled manner, the risk of damage to the communication site and electrical and fiber optic lines increases over time.

The cumulative effects of implementing Alternative 1 are an increase in risk of damage or destruction to the communication site and the supporting power and fiber optic lines on the east side of the project area because fuel loading and dense stand conditions will increase over time on the steep (over 40%) part of the project area.

Alternative 2

The direct and indirect effects of implementing Alternative 2 are a greatly reduced threat to the communication site and electrical and fiber optic lines. This alternative reduces the largest amount of fuels on the steep part of the mountain which directly reduces the chance of a catastrophic wildfire that could damage or destroy the facilities on the mountaintop. The reintroduction of fire into the ecosystem as maintenance burning will continue to reduce fuel buildup leading up to the communication site and the power and fiber optic lines on the east side of the project area.

The cumulative effects of implementing Alternative 2 are a reduction of the risk of damage or destruction from catastrophic wildfire because stands will be thinned and fire will be reintroduced into the ecosystem.

Alternative 3

The direct and indirect effects of implementing Alternative 3 are the same as Alternative 2 because the only real change is in the logging systems used to reduce fuel loading.

The cumulative effects of implementing Alternative 3 are also the same as Alternative 2 because of the same reasons.

Alternative 4

The direct and indirect effects of implementing Alternative 4 are less likely to reduce fuel loading to an acceptable level because mechanized equipment will not be used, so a substantial amount of fuel will remain in place. The risk to the communication site and power and fiber optic lines will be less than Alternative 1, but greater than Alternatives 2 and 3.

The cumulative effects of implementing Alternative 4 are a reduction in fuel loading and risk to the communication site to a lesser degree than Alternatives 2 and 3 because there will still be high fuel loadings and a high risk to the communication site.

3.16 Other Disclosures

3.16.1 Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." This Executive Order was designed to focus the attention of federal agencies on the human health and environmental conditions in minority and low-income communities. It requires federal agencies to adopt strategies to address environmental justice concerns within the context of existing laws, including NEPA. The goal of Environmental Justice Analysis is not to shift risks among populations, but to identify potential disproportionately high and adverse effects, and to identify alternatives that may mitigate these impacts. One way that this is achieved is by providing an opportunity for minority and low-income populations to participate in planning, analysis, and decision making. Individual tribal members may use the project area for the personal collection of traditional or medicinal plants. Low-income groups may use the area for the collection of fuel wood. None of the alternatives would have disproportionate adverse effects on these uses or to low income and minority populations in the area. No concerns or issues related to Environmental Justice were raised during project scoping. Additionally, the American Indian Tribes listed in Chapter 4 were consulted regarding this proposal and potential effects were analyzed.

Alternative 1 – No Action

The no action alternative does not reduce the risk of high-intensity, stand-replacing wildfire. Although all communities, wealthy and poor, suffer direct economic consequences when there are large wildfires, normal commercial activity can be disrupted. Many of the low-income jobs in the area are connected to tourism. Even a temporary loss of work can overwhelm low-income individuals and families. Fires can also reduce the availability of native plants and building supplies that sustain many traditional and indigenous communities.

Alternative 2, 3 and 4

Any of the action alternatives would reduce fuel loading and the risk of high-intensity fires. Even though there could be direct economic consequences associated with fires, the disruption to normal commercial activity would be less than the no action alternative.

Direct and Indirect Effects

Alternatives 2, 3 and 4 – Action Alternatives

All action alternatives would reduce the risk of high-intensity stand-replacing wildfires, which would better protect the area resources and the communities that they serve.

Short-term Uses and Long-term Productivity

NEPA requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). As declared by the Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101).

The proposed project was developed to promote forest diversity on Bill Williams Mountain while reducing the risk of high intensity fire so the area will be ecologically sustainable and contribute to social and economic stability of the surrounding area. The biggest risks to Bill Williams Mountain are the effects associated with uncharacteristic stand-replacing fire (discussed in the "Fire and Fuels Management" section of this chapter) and resulting soil losses (discussed in the "Soil and Watershed" section of this chapter), degradation of the watershed for the City of Williams, reduced wood production (discussed in the "Silviculture" section of this chapter), loss of wildlife habitat (discussed in the "Wildlife" section of this chapter) and the potential interruption of important communications (discussed in the "Lands and Minerals" section of this chapter). There are differences in alternatives that would result in more or less modification of stand structure and fuel loading which correlates to ecosystem diversity and the risk of fire.

Unavoidable Adverse Effects

With the Proposed Action under Alternative 2 only, approximately 8,900 acres of ponderosa pine forest surrounding the base of Bill Williams Mountain would have reduced stand densities similar to pre-settlement reference conditions and would be removed from the KNF Forest Plan's designated suitable timber base by amending the Forest Plan (DEIS, Section 2.2). Alternative 2 also would result in the largest reduction in large trees initially, but then remaining trees would grow faster due to increased sunlight, nutrients and water (DEIS, Section 2.5).

Alternatives 3 and 4 move less than half of the project area to the historic fire regime range. Alternative 2 would result in more than half the area available for direct attack tactics and Alternative 3 and 4 would result in less than half the area available for direct attack tactics (DEIS, Sections 2.5 and 3.3).

All of the action alternatives would result in a short term increase in particulate matter from burning. There would also be short term increases in soil disturbance, erosion potential and soil compaction (DEIS, Sections 2.5 and 3.4).

The action alternatives would result in short term reduction of Mexican Spotted Owl habitat, but Alternative 2 moves toward the most sustainable conditions. Under Alternatives 2-4, the area moves from the most to least protection of nest area and PFA's from active crown fires (DEIS, Sections 2.5 and 3.6).

Cable logging associated with the proposed action may result in the loss of portions of the Arizona Bugbane population due to dragging trees through the plants (DEIS, Section 3.8).

The action alternatives would also result in a temporary reduction in forest visitors, and short term affects to Scenery Management due to the mechanical treatments (DEIS, Sections 2.5, 3.10 and 3.11).

Alternative 4 would result in the most increase in risk to cultural resource sites from flooding and erosion following high intensity fires (DEIS, Sections 2.5 and 3.12).

Alternative 2 would result in the greatest short term potential increase in weeds. This alternative would also result in the greatest long term potential reduction in bugbane habitat of any of the action alternatives (DEIS, Sections 2.5, 3.7 and 3.8).

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. Irretrievable commitments are those that are lost for a period of time such as the temporary loss of timber productivity in forested areas that are kept clear for use as a power line rights-of-way or road.

Alternative 2, the preferred alternative, will result in the temporary loss of approximately 8,900 acres of suitable timberland due to the nature of reference condition mechanical treatments around the base of Bill Williams Mountain. This means there will not be regulated timber production from this area, but we may still need to harvest timber in the future to move toward or maintain the desired conditions. However, the trade off for thinning to reference conditions will be the creation of groups of diverse age class stands with grassy openings between groups which

will not only promote stand diversity and make the area more resilient to mistletoe infection and bark beetle losses, but will greatly contribute to lowering the risk of high-intensity fire. The reduced threat of these fires will help protect the watershed for the City and wildlife habitat characteristics on the Mountain (discussed in the "Silviculture", "Fire and Fuels Management" and "Wildlife" sections of this chapter).

Alternatives 3 and 4 would not result in the temporary loss of 8,900 acres of suitable timberland, but would still contribute to improving stand diversity and forest health and would reduce the risk of fire.

Cumulative Effects

Cumulative effects for each resource area are addressed in their respective sections of Chapter 3. There are inter-relationships of cumulative effects between the Silviculture, Fire and Fuels Management and Wildlife sections.

Other Required Disclosures

NEPA at 40 CFR 1502.25(a) directs "to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with other environmental review laws and executive orders."

- Fish and Wildlife Service under the Fish and Wildlife Coordination Act for causing water to be impounded or diverted;
  This project will not result in water becoming impounded or diverted so consultation is not required under the Fish and Wildlife Coordination Act.
- National Historic Preservation Act for causing ground disturbing actions in historical places;

  Consultation with the Arizona State Historic Preservation Office is currently underway and concurrence on the project will be reached before the FEIS and Record of Decision are published.
- U.S. Fish and Wildlife Service and the National Marine Fisheries Service in accordance with the ESA implementing regulations for projects with threatened or endangered species;

  Consultation, coordination and discussions with the U.S. Fish and Wildlife Service have been ongoing since those discussions began in the Fall 2010. An informal brainstorming session was held in Flagstaff, AZ in mid-January 2011 to discuss and seek input about the project design. A formal comment letter was received on May 23, 2011 on the proposed action and a meeting was held in our office on June 23, 2011 to discuss their comments. A meeting was held in our office on July 13, 2011 to continue the coordination and development of the project and alternatives. There was a field trip to the project area to discuss Pine Oak Target/Threshold habitat and the Arizona Bugbane population on June 23, 2011 and August 23, 2011. Another meeting was held in our office on October 11, 2011 to discuss desired conditions and recommendations for MSO habitat.
- Any applicable State and county laws affected by the alternatives;

  There are no State or county laws affected by this project.

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Chapter 4 – Consultation and Coordination

Preparers and Contributors

The Forest Service consulted the following individuals, Federal, State, and local agencies, tribes and non-Forest Service persons during the development of this environmental assessment:

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Bob Rich	Logging Specialist, Regional Office
Martie Schramm	District Ranger
Mike Lyndon	Assistant Forest Archaeologist/Forest Tribal Liaison
Micah Grondin	Timber Staff
Sandra Moore	Fire Information Officer

Federal, State, and Local Agencies:

U. S. Fish and Wildlife Service
Arizona Game and Fish Department
City of Williams
Arizona Department of Transportation
Grand Canyon National Park

Tribes:

Hopi Tribe
Navajo Nation
Hualapai Tribe
Havasupai Tribe
Yavapai-Prescott Indian Tribe
Kaibab Band of Paiute
Pueblo of Zuni

Others:

Ponderosa Fire Advisory Council (PFAC)
Wildland Fire Advisory Council (WFAC)
Coconino County Board of Supervisors
Grand Canyon Trust
Bill Williams Mountain Communication Site Improvement Association
Northern Arizona University
Ecological Restoration Institute (ERI)

List of Agencies, Organizations and Persons to Whom Copies of the DEIS, Supplement and FEIS Were Sent

This environmental impact statement has been distributed to individuals who specifically requested a copy of the document [(**for final environmental impact statements only**) and those who submitted substantive comments on the draft environmental impact statement]. In addition, copies have been sent to the following Federal agencies, federally recognized tribes, State and local governments, and organizations representing a wide range of views regarding the Bill Williams Mountain Restoration Project:

United States Fish and Wildlife Service

Arizona State Game and Fish Department

City of Williams

Hopi Tribe

Navajo Nation

Hualapai Tribe

Havasupai Tribe

Yavapai-Prescott Indian Tribe

Kaibab Band of Paiute

Pueblo of Zuni

4.1 Tribal Consultation Summary

Government-to-government consultation with tribes is guided by existing law, regulation, and policy, including the National Environmental Policy Act (NEPA), the Archaeological Resources Protection Act (ARPA), the National Historic Preservation Act (NHPA), the American Indian Religious Freedom Act (AIRFA), the Native American Graves Protection and Repatriation Act (NAGPRA), the National Forest Management Act (NFMA) of 1976, the Religious Freedom Restoration Act (RFRA), Executive Order 13007-Indian Sacred Sites, Executive Order 13175-Consultation and Coordination with Indian Tribal Governments, and Executive Order 12898-Environmental Justice. The Kaibab National Forest has entered into Memoranda of

Understanding with the Havasupai Tribe, the Hualapai Tribe, the Hopi Tribe, and the Kaibab Band of Paiute Indians to establish a standard process for consultation with each tribe.

The Kaibab National Forest recognizes that area tribes have cultural ties and knowledge about the lands now managed by the Forest Service. Many tribal members regularly visit the Kaibab National Forest to gather traditional resources and to visit traditional cultural properties and sacred sites. Therefore, tribes share an interest in the management of Forest lands.

Due to the level of use of the forest by tribal members and the unique interests of area tribes, the Kaibab National Forest has conducted extensive tribal consultation and scoping of tribal communities throughout the environmental analysis process. This consultation process reflects a long-standing commitment by the Kaibab National Forest to share the stewardship of public lands with area tribes. For the current project, tribal consultation was conducted at the government-to-government level with concerned tribes according to established Memoranda of Understanding and pertinent laws and regulations. Additionally, the Forest scoped tribal communities that utilize the forest. The Kaibab initiated consultation with tribes in the earliest stages of analysis, and incorporated tribal comments into the development of the Alternatives.

A summary of tribal consultation regarding the project is included in Table 4.1-1.

Table 4.1-6: Summary of tribal consultation on the Bill Williams Restoration Project.

Date	Tribe	Location	
09/14/10	Havasupai, Hopi, Hualapai,	Flagstaff, AZ	At 4th Annual Intertribal Meeting, District Ranger Martie Schramm briefed tribal representatives on project and invited early participation from tribes in environmental analysis
11/03/10	Havasupai, Hopi, Hualapai, Kaibab Band of Paiute, Navajo, Yavapai-Prescott, Pueblo of Zuni	Letter	District Ranger Martie Schramm sent a letter to tribes with notification of the project and invitation for early involvement in planning process.
12/02/10	All Tribes and Chapters	Letter	Forest Supervisor Mike Williams sent a letter to tribes inviting them to participate in the early planning process.
2/15/11	Yavapai-Prescott	Prescott	Forest officials met with the Tribe and provided tribal representative with a list of known plants for circulation within the tribe. Yavapai-Prescott is supportive of reducing threats of catastrophic fire on mountain.
2/16/11	Hualapai Tribe	Peach Springs	Forest officials met with the Tribe and provided tribal representatives with a list of known plants for circulation within the tribe. Hualapai Tribe would be interested in conducting plant surveys in the project area.
2/23/11	Pueblo of Zuni	Zuni, NM	Forest officials met with the Tribe. Pueblo of Zuni expressed interest in project and requested field visit to project area. Pueblo of

Date	Tribe	Location	
			Zuni request common names for plants in project area.
2/24/11	Navajo Nation	Window Rock	Forest representatives met with the Navajo Nation. Navajo Nation supports a project to restore the mountain and voiced concerns about potential impacts from additional road construction. Navajo Nation request a field trip to project area and additional information on watershed impacts. Navajo Nation generally supports reducing fuels on Bill Williams Mt and other TCPs to prevent catastrophic wildfire.
3/7/11	Havasupai Tribe	Flagstaff	Forest representatives met with the Tribe regarding other issues. Forest representatives notified the Tribe of project.
4/21/11	Havasupai, Hopi, Hualapai, Kaibab Band of Paiute, Navajo, Yavapai-Prescott, Pueblo of Zuni	NA	Forest emailed Notice of Intent and invitation to public meeting. Forest invited tribes to conduct field visits of project area.
7/21/11	Hopi Tribe	Project Area	Williams District Ranger Martie Schramm and other Forest staff conducted a site visit to the project area with cultural advisors from the Hopi Tribe. Hopi voiced support for the project and stated it would protect the mountain and resources from future wildfire.
11/1/11	Havasupai Tribe	Project Area	Williams District Ranger Martie Schramm and other Forest staff conducted a site visit to the project area with the Havasupai Tribe. Havasupai representatives supported the project and requested specific mitigation measures as outlined below.
2/1/12	Navajo Nation	Flagstaff, AZ	Forest officials met with Navajo Nation to discuss the range of Alternatives and the proposal for new roads in the Preferred Alternative. Navajo Nation supports the Preferred Alternative. Navajo Nation requests mitigation measure to GPS plants with traditional significance during implementation.

Tribal Concerns with the Bill Williams Restoration Project

The Kaibab National Forest has been consulting with tribes on the management of Bill Williams Mountain for the last 20 years. During that time, tribal representatives have stated a number of general concerns related to the mountain. These concerns are summarized as follows;

> 1) Concerns with impacts to the visual quality of Bill Williams Mountain, 2) Concerns with commercial development of the mountain, 3) Disruption of ceremonial activities related to the mountain and ensuring access for those activities, 4) Impacts to important medicinal plants and other traditional use resources, 5) Protection of specific ceremonial sites, 6) Protection of ancestral sites/archaeological sites, 7) Overall forest health on the mountain, 8) Impacts to the integrity of the Bill Williams Mountain traditional cultural property, 9) Monitoring of important plant resources, 10) Impacts to threatened and endangered species.

During consultation on the Bill Williams Restoration Project, Tribes have stated three additional concerns regarding management of the mountain summarized as follows;

> 11) Concerns with impacts to the watershed, particularly to Cataract Creek, Havasu Creek and the village of Supai, AZ, 12) Direct monitoring of the project by Tribes, 13) Acquisition of cleared timber for fuelwood and traditional use.

Mitigation Measures to Address Tribal Concerns

Of the concerns stated above, # 2 is outside the scope of the analysis, numbers #'s 1, 4, 6, 8, 9, 10, and 11 are wholly or partially addressed with mitigation measures outlined in Section 2.3.1 and 2.3.2. Number 7 is directly addressed by the Purpose and Need of the Project. Given the concerns stated above, the following additional mitigation measures are proposed for all Alternatives.

1. The Kaibab National Forest will consider all requests to issue temporary closures within the project area to accommodate ceremonial use as authorized in the Food, Conservation, and Energy Act of 2008, SEC. 8104
2. The Kaibab National Forest will ensure that free-use permits for the collection of tree boughs, thinning slash, branches and other non-merchantable timber, are readily available to tribal members for fuelwood or personal ceremonial use.
3. The Kaibab National Forest will coordinate with the Hopi Tribe to provide timbers for the purpose of rebuilding kivas and clan houses, and for other traditional and cultural purposes. The Hopi Tribe will provide for the transport of all such materials. The Forest will work with additional tribes to provide forest products for similar requests.
4. The Kaibab National Forest will maintain the confidentiality of specific ceremonial sites and traditional collecting areas. Specific ceremonial sites will be avoided by project activities, or the Forest will work with the affiliated Tribe to develop site-specific mitigation measures.
5. The Havasupai Tribe will be invited to monitor the project during the first phase of implementation. The Forest will work with all tribes to coordinate project monitoring by tribal representatives upon request.
6. The Kaibab will contract with the Hualapai Tribe to perform plant surveys conducted within the project area under a grant funded by the Coconino County Resource Advisory Committee. This work is to begin in the fall of 2012 and continue into 2013 as funding allows.
7. The Forest will continue to work with tribes to identify traditionally important plant species and populations that occur within the project area, and facilitate the sustainable collection of these resources for traditional and cultural purposes. Monitoring of known collection sites will occur within the project area during implementation. Newly

documented populations will be recorded and mapped for consideration as collection sites.

Based on consultations with the above Tribes, all Tribes support the Purpose and Need for the project. No Tribe has recommended Alternative 1- the No Action Alternative. Indeed, Tribes agree with the Forest Service assessment that current conditions in the project area present an unacceptable long-term risk to cultural and traditional resources. While Alternatives 2, 3 and 4 propose active thinning treatments on the mountain, Tribes have stated that these activities will result in a long-term beneficial effect to the Bill Williams Mountain Traditional Cultural Property. The Navajo Nation has stated support for the Preferred Alternative. Provided the above mitigation measures are followed, implementation under any of the Alternatives is not expected to impact traditional tribal values or use areas associated with the project area.

Glossary

Cover type – This term refers to the most represented species within a stand. There can be multiple species within a cover type.
Crowns – Tree crowns are generally from the lowest live limb to the top of the tree. Crowns consist of leaves/needles and limbs.
Crown Closure- This is the interaction of trees as they start to compete for resources within a stand. As trees start to grow closer together, growing space and crown space become limited; this is when you get crown closure.
Density- This term refers to the density of trees generally measured in Trees per Acre and Stand Basal Area. Managers use other forms of forest/stand tree density measures to determine stand condition based on forest dynamics.
Encroachment- This is the movement of any living organism to an area where it has been previously excluded or had low populations that inhibits growth to another living organism. Encroachment can encourage higher stress levels and higher risk of fire within a stand.
Fuel loadings – Accumulation of dead and down woody material is generally what this term is referring but fuel loading can also means live trees.
Ladder fuels – Under certain conditions, fire that is burning on the forest floor can climb upward using latter fuels. These consist of smaller trees positioned under larger trees.
Mortality- Because trees within the forest grow as a group or in stands, mortality refers to multiple trees dying due to an impact of competition for sunlight, water and nutrients, stress, or insects and diseases.
Overstory competition – This term refers to the competition for resources such as sunlight, water and nutrients between the trees that are representing the overstory tree composition or canopy.
Pre-settlement evidence – This is evidence that is left behind to describe the forest structure and composition on a particular stand. Evidence includes but is not limited to, stumps, stump holes, snags, trees with fire scares and old living trees. Pre-settlement evidence provides a snapshot in time of the condition within the natural range of variability of trees generally alive prior to 1870.
Recruitment- This term refers to regeneration within the forest successfully avoiding mortality to become part of the stand. The forest can regenerate a lot of trees, depending on the contrition, only a certain amount will be recruited into the stand.
Restoration – There are many definitions of restoration. Typically restoration restores functions within the forest such as snags, logs, fire etc. Other types of restoration focus on structure and arrangement of trees within the natural range of variability.
Snags- Dead and standing trees that provide wildlife habitat and vertical dead fuel structure to a stand.
Stands – A stand is a delineation of a small portion of the landscape that is similar in cover type and overstory connectivity. Stands can range from approximately 150 acres to 1 acre in size.
Stand-replacement wildfires- This term refers to a type of fire that drastically changes the overstory arrangement of trees. Generally these fires kill all of the overstory and are replaced by tree regeneration in the future.
Stand Density Index- Any index that expresses relative stand density based on a comparison of measured stand values with some standard condition.
Slash – Dead and down material that is created naturally or mechanically.

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