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Final Environmental Impact Statement for the Kaibab National Forest Land and Resource Management Plan

Coconino, Yavapai, and Mojave Counties, Arizona

Cover: collage of four images—Kanab Wilderness, Abert squirrel, Ponderosa pine, and aspen.

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Final Environmental Impact Statement for the Kaibab National Forest Land and Resource Management Plan

Coconino, Yavapai, and Mohave Counties, Arizona

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Summary

This final environmental impact statement (FEIS) documents the analysis of alternatives developed for the programmatic management of approximately 1.6 million acres of the Kaibab National Forest (NF). The selected alternative will replace the 1988 "Kaibab National Forest Land and Resource Management Plan," as amended (KNF 1988), which guides all natural resource management activities on the forest. The revised land management plan (LMP), hereafter referred to as the "plan," is intended to address new information and concerns raised since the 1988 forest plan was published; meet the objectives of federal laws, regulations, and policies; address the changes in management anticipated to be needed over the next 15 years identified in the analysis of the management situation; provide for clear direction in the form of desired conditions, objectives, standards, guidelines, suitability, management areas, and monitoring; incorporate the best available science; and provide a framework for adaptive management.

Four alternatives (or programmatic strategies) for revising the Kaibab NF LMP are described, compared, and analyzed in detail in this FEIS. The analysis displays the anticipated progress toward the desired conditions as well as the potential environmental and social consequences of implementing each alternative. Alternative A is the no action alternative; it represents the 1988 forest plan (as amended) and is referred to as the current plan, current management, or no action alternative. Alternative B is the proposed plan, and Forest Service preferred alternative. The proposed action includes a reorganization and restructure of the forest plan; more sustainable, ecologically based and descriptive desired conditions (goals); updated objectives; a reevaluation of suitable uses, changes to standards and guidelines; new management areas; recommendations for designating about 6,400 acres of additional wilderness; and a recalculation of the allowable sale quantity (ASQ) and long-term sustained yield (LTSY) of timber resources. The proposed action focuses on the Priority Needs for Change identified in the analysis of the management situation (AMS). Those priority needs are to (1) modify stand structure and density of forested ecosystems toward reference conditions and restore historic fire regimes; (2) protect and regenerate aspen; (3) protect and restore natural waters; and (4) restore grasslands by reducing tree encroachment in grasslands and meadows. In addition to the Priority Needs for Change, the proposed plan provides direction for uses, goods and services including diverse recreation opportunities, traditional use, livestock grazing, energy transmission and development, mineral and mining activities, and special uses.

Alternative C is similar to the proposed action, but includes a guideline that would not cut trees with physical characteristics typical of those established prior to 1890, adds a management area called the North Kaibab Wildlife Habitat Complex that would not be managed for timber production, and recommends six additional wilderness areas. Alternative D is similar to alternative C, except that no lands would be managed for timber production across the entire forest. Overall, the analysis performed for this EIS indicates that the proposed action (alternative B) would be most effective at meeting management needs and achieving desired conditions.

The proposed action and draft environmental impact statement were published for comment in the Federal Register on April 20, 2012, which initiated a 90-day comment period. During the comment period, additional public meetings were held in Williams and Fredonia, and presentations were made for government, tribal, and citizen groups. In response to comments from 56 individuals, organizations, agencies, and tribes, minor changes were made throughout the proposed plan and environmental impact statement, all of which were within the scope of the analysis in the draft environmental impact statement.

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Chapter 1. Purpose of and Need for Action

Document Structure

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

- **Chapter 1. Purpose of 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 involved the public regarding 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. 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.
- **Literature Cited.**
- **Glossary.** This section contains definitions of many of the resource specific terms used in this document.
- **Appendix.** The appendix consists of several parts (Appendices A through N) and provides more detailed information to support the analyses presented in the environmental impact statement such as the public comments and responses, analysis methods, suitability determinations, wilderness evaluation, etc.

Additional documentation, including more detailed analyses of project area resources, may be found in the project planning record located at the Kaibab National Forest (hereafter referred to as the Kaibab NF or the forest) Supervisor's Office. Key analysis documents can be found online at: *http://fs.usda.gov/goto/kaibab/plan_revision.*

Summary of Changes from the Draft Environmental Impact Statement and Proposed Plan

Changes made in the FEIS and proposed plan were driven by specific comments from the public and other agencies (FEIS Appendix A) on the draft environment impact statement (DEIS) and proposed plan. Changes made to the FEIS include:

- Additional alternatives were considered but not given detailed study, as disclosed in Chapter 2.
- The analysis was updated to reflect changes resulting from the 2013 Regional Forester's sensitive species list.
- Appendix M was added to provide greater transparency on how key existing plan direction (e.g. standards and guidelines) were incorporated into the revised plan.
- Other changes to the FEIS include relatively minor corrections or additions to terminology, methodology, and effects to improve clarity.

Changes made to the proposed forest plan include:

- Increased alignment between the plan's desired conditions and the 2012 Mexican spotted owl recovery plan;
- Separating out plan direction for threatened, endangered, and sensitive species;
- Clarifying language to better include invasive animal species. The plan direction for invasive species previously focused on invasive plants;
- Other relatively minor changes to provide increased clarity or emphasis for resources of interest.

Location

The Kaibab NF is one of six national forests in Arizona. It covers about 1.6 million acres in north-central Arizona, and is located in Coconino, Yavapai, and Mohave Counties. The forest is broken into three geographically separate ranger districts: the North Kaibab Ranger District lies north of Grand Canyon National Park, the Tusayan Ranger District is south of Grand Canyon National Park, and the Williams Ranger District is southernmost, separated from the Tusayan Ranger District by private and Arizona State lands (figure 1). The forest shares boundaries with Grand Canyon National Park, the Prescott and Coconino National Forests, Bureau of Land Management-Arizona Strip District, Navajo and Havasupai Indian Reservations, the city of Williams, the town of Tusayan, Camp Navajo (a National Guard training site), and private lands.

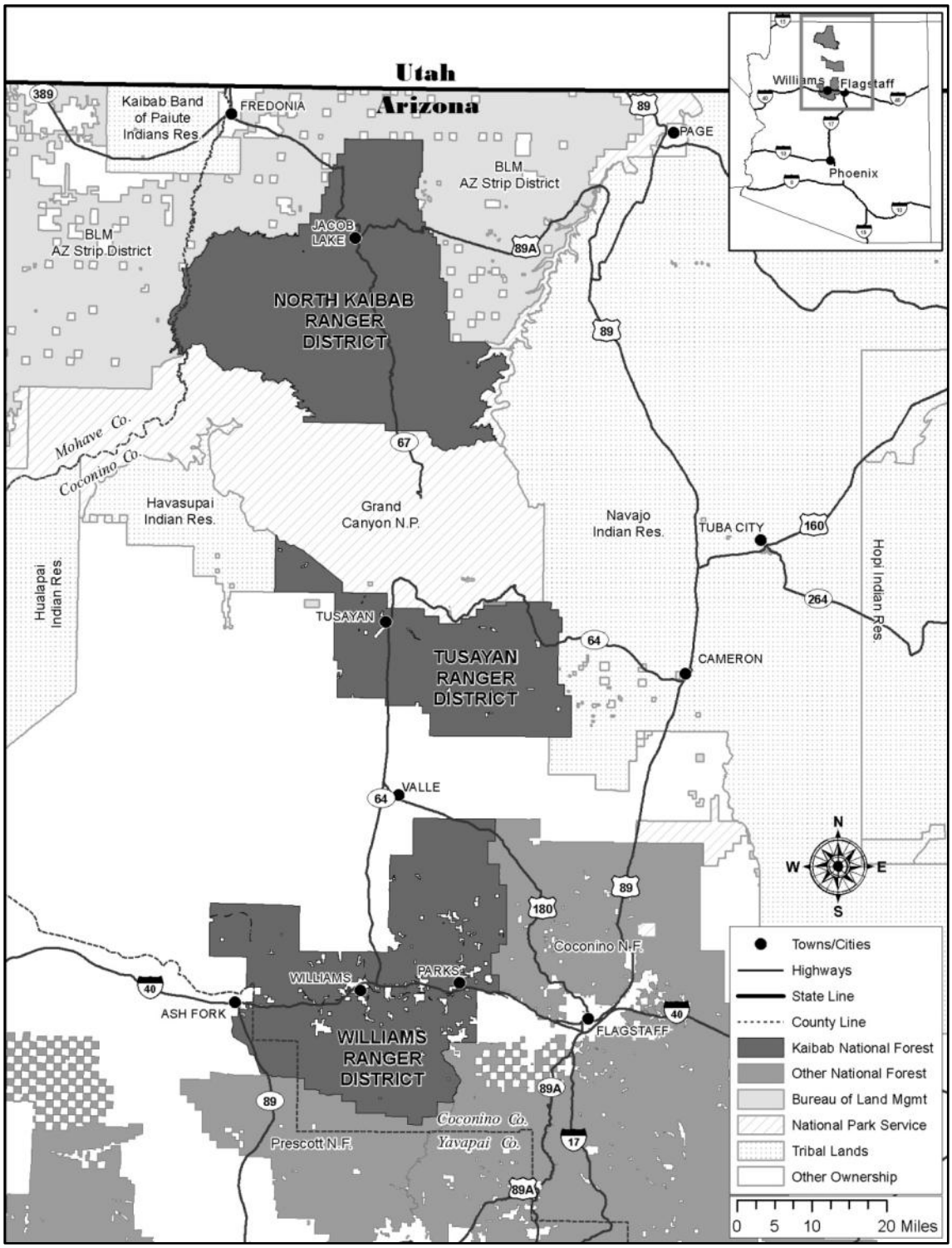


Figure 1. Vicinity map of the Kaibab National Forest

Purpose of and Need for Action

The Kaibab NF is revising its 1988 forest plan as required by the National Forest Management Act (NFMA) of 1976. The revised plan is designed to meet the legal requirements of the NFMA and to incorporate new scientific and traditional cultural knowledge on topics including ecology of fire-adapted systems; vegetation management; species viability; soils, insects and diseases; known changes in forest conditions; and user trends and preferences. Additionally, the revised plan represents the forest level direction that guides the forest in meeting the mission of the Forest Service and managing its lands to provide for healthy, resilient ecosystems that meet the diverse needs of the American people.

The NFMA directs that forest plans be revised on a 10- to 15-year cycle. Almost twenty-six years have passed since the regional forester approved the original forest plan on April 15, 1988; this plan has been amended 10 times since. The last 26 years have provided new scientific information and understanding, and changes in economic, social, and ecological conditions resulting in a shift in management emphasis from outputs to outcomes. A complete revision of the 1988 forest plan is needed to: (1) meet the legal requirements of NFMA and the provisions of the 1982 Planning Rule, (2) guide natural resource management activities on the forest for the next 10 to 15 years, and (3) address the needed changes in management direction.

This forest plan revision process was conducted in accordance with 1982 Rule Provisions as provided for in the transition language of the 2012 Land and Resource Management Planning Rule (36 CFR 219.17(b)(3) (hereafter referred to as 2012 Rule). This plan revision was initiated prior to the availability of the 2012 Rule, and as a result, the responsible official has chosen to use the 2012 Rule's transition provisions to revise the Kaibab NF forest plan. These provisions require that an EIS be prepared for a proposed action to revise a forest plan.

The Kaibab NF conducted an analysis of the management situation (AMS), which evaluated the need for changes in management in light of how current management under the 1988 forest plan was affecting ecological and socioeconomic conditions and trends. This analysis is documented in the AMS, which is composed of the comprehensive evaluation report (CER) and CER supplementary document. Supporting analysis can be found on the Kaibab NF Web site in the Socioeconomic Sustainability Report, Ecological Sustainability Report, and Potential Wilderness Evaluation Report. The AMS and subsequent management reviews identified four Priority Needs for Change that served to focus the scope of this plan revision:

1. **Modify stand structure and density of forested ecosystems toward reference conditions and restore historic fire regimes.** In ponderosa pine and mixed conifer vegetation types, tree cover and fuels are far denser and more continuous across the landscape than reference conditions. When wildfires occur under current conditions, they are increasingly likely to result in severe fire effects and kill large and old trees, which take many years to replace. The multiple ecological, social, and economic benefits of restoring historic stand structure and reducing the risk of uncharacteristic fires are primary areas of focus.
2. **Protect and regenerate aspen**. Protection and regeneration of aspen is a priority because of the important role aspen plays in providing local habitat diversity and scenery. Aspen stands are currently in decline throughout most of the Southwest. On the Williams Ranger District, most aspen stands are generally unhealthy because they are being overtopped by

conifers, and there has been little to no recruitment of young trees due to ungulate browse and lack of fire.

3. **Protect natural waters.** The Kaibab NF is one of the driest forests in the Nation. With the exception of one perennial stream that is less than two miles in length, most of the natural waters in the forest are small springs and ephemeral wetlands. The current forest plan offers little guidance for managing these rare and ecologically important resources. Natural waters are centers of high biological diversity, have traditional cultural significance, and are popular recreation destinations.
4. **Restore grasslands by reducing tree encroachment in grasslands and meadows.** There has been significant tree encroachment into grasslands over the past 100 years. This change has reduced the quantity and quality of available habitat for grassland-associated species. The montane/subalpine grasslands on the North Kaibab Ranger District are at particular risk of loss because they are linear and, due to their shape, encroachment occurs more quickly.

Plan Decisions

The forest plan makes the following types of decisions:

- Desired conditions, goals, and objectives express an aspiration and form the basis for projects, activities, and uses that occur under the forest plan.
- Suitability determinations, standards, and guidelines set requirements to limit or guide forest uses or activities that are expected to occur under the forest plan.
- Management area and special designations, or recommendations for special designations, identify areas with differing desired conditions, uses, standards, and/or guidelines than the forest-wide plan direction.
- Monitoring and evaluation framework to assess forest conditions and plan implementation in support of adaptive management.

The plan is strategic in nature and does not specifically authorize any projects or activities. Site-specific decisions are made following project-specific proposals and analysis, with additional opportunities for public involvement.

Proposed Action

Proposed changes to the forest plan include a reorganization and restructure of the forest plan; more sustainable, ecologically based and descriptive desired conditions (goals); updated objectives; a reevaluation of suitable uses, changes to standards and guidelines; new management areas; recommendations for potential wilderness areas; and a recalculation of the allowable sale quantity (ASQ) and long-term sustained yield (LTSY) of timber resources. The proposed action (proposed plan) focuses on the most critical issues identified in the AMS.

The proposed plan defines desired conditions for each potential natural vegetation type including: species composition; vegetation structural characteristics such as density and arrangement of tree groups; and disturbance patterns such as frequency, severity, intensity, and size of fire. It also describes the strategies in the form of objectives, standards, and guidelines that will define the “when,” “where,” and “how” to achieve the desired conditions. Objectives focus on restoration activities such as thinning and burning in high priority areas. Standards and guidelines provide sideboards to focus and constrain activities.

The proposed plan defines desired characteristics for aspen including regeneration, recruitment, structural composition, understory plants, and disturbance processes. Strategies for achieving desired conditions focus on thinning encroaching conifers, protecting aspen from browse, and reintroducing fire.

The proposed plan provides desired conditions and includes strategies to restore and protect natural waters. More than 160 springs and spring-fed wetlands support rich plant and animal life on the Kaibab NF. Many of these springs have been degraded due to trampling and water development modifications. The plan defines desired conditions and provides objectives for protecting and restoring springs and wetlands.

The proposed plan defines desired conditions and objectives for grasslands, which would restore natural patterns of abundance, composition, and distribution. Strategies focus on reducing tree density, reintroducing fire to the ecosystem, and modifying fences that would improve habitat connectivity for pronghorn antelope.

Besides the priority needs for change, the proposed plan provides direction for uses, goods and services including diverse recreation opportunities, traditional use, livestock grazing, energy transmission and development, mineral and mining activities, and special uses.

This proposed plan can be found electronically on the Kaibab NF Web site at: *http://fs.usda.gov/goto/kaibab/plan_revision.*

Additionally, as part of the forest plan revision process, the forest completed a potential wilderness area (PWA) evaluation, an evaluation of potential research natural areas, and reviewed the eligibility of Kanab Creek as a wild and scenic river (see appendices E, F, and G).

Decision Framework

The regional forester for the Southwestern Region will make the final decision on the selected alternative for the revised forest plan. The regional forester will review the proposed action, the other alternatives, and the environmental consequences; then decide which plan alternative best meets the desired conditions, multiple-use concept, diverse needs of people, and sustainable management of the forest as well as the requirements of the National Forest Management Act (NFMA) of 1976 and the Multiple-Use Sustained-Yield Act of 1960.

Public Involvement and Collaborative Planning

Recognizing that our partners and publics have valuable ideas, knowledge, opinions, and needs that can inform and improve management of the Kaibab NF, a variety of opportunities for meaningful dialogue and collaboration were provided throughout the plan revision process. To initiate plan revision, the Kaibab NF hosted multiple public meetings in Williams, Tusayan, Flagstaff, Phoenix, Fredonia (all in Arizona), and in Kanab, Utah, as well as focused meetings on ecological sustainability and special areas. The forest sponsored a series of collaborative stakeholder meetings through a third-party facilitator. The purpose was to collaboratively identify high-priority treatment areas and develop guidance for restoring fire-adapted ecosystems that was supported by spatial modeling and analysis. The forest also hosted five topic-based

"collaborwriting[1]" sessions and an online discussion forum that focused on drafting actual plan content around revision topics including grasslands, springs/wetlands, aspen, mixed conifer forests, and recreation.

The notice of intent to prepare an EIS was published in the Federal Register on April 23, 2010. The notice of intent asked for public comment on the proposal through June 7, 2010; however, the forest considered substantive comments that were received after this date. Comments were used to modify the proposed plan and develop alternatives. With the release of the notice of intent, general public meetings were held in Fredonia and Williams. The forest also hosted several workshops to facilitate focused discussions on development of alternatives, wildlife components, and the monitoring and adaptive management strategy. Each of the workshops provided specific information that was incorporated directly into the proposed forest plan.

Tribal coordination and collaboration with area tribes has been ongoing, with over 35 face-to-face meetings over the past five years. The forest held meetings with tribal elders, tribal government representatives, and community members. Additionally, the forest hosted four multi-tribal meetings where members from different tribes were brought together to discuss shared topics of interest. Forest plan revision had a full day dedicated at the first meeting and was a topic at the other three.

Following the release of the DEIS, a notice of availability was published in the Federal Register that initiated the formal 90-day comment period on the DEIS and proposed forest plan as required by Forest Service NFMA regulations at 36 CFR 219. The formal 90-day comment period provided additional opportunities for public involvement in the NEPA review and plan revision processes. During the comment period, the planning team hosted public meetings in Williams and Fredonia, Arizona. Presentations were given to the Williams City Council, Tusayan Town Council, Fredonia Town Council, Kane County (Utah) Commissioners, Southwest Utah Planning Authorities Council, Kaibab Paiute Tribe, Hopi Tribe, Cameron and Bodaway-Gap Navajo Chapters, Grand Canyon National Park, livestock grazing permittees, and the Williams Rotary Club. Additionally, the forest hosted a focused topic collaborwriting session on monitoring and adaptive management.

During the 90-day comment period, comments were received from 56 individuals, organizations, agencies and tribes. Eligibility to appeal the regional forester's decision regarding the proposed action is limited to individuals and organizations that commented on the DEIS or otherwise expressed an interest in the project during the formal 90-day comment period. Appendix A summarizes comments received during the 90-day comment period and provides the Kaibab NF's response to these comments. Appendix N provides copies of comment letters received from governmental entities. Appendix L describes the public involvement process in greater detail.

Issues Leading to Alternative Development

The public, other agencies, and tribes submitted comments in response to the notice of intent and working draft plan. Comments were analyzed to identify issues and frame their associated cause and effect relationships. Issues were separated into two groups: significant and nonsignificant. Significant issues are those used to develop alternatives and modify the proposed action. Nonsignificant issues are identified as those: (1) outside the scope of the proposed action; (2)

[1] "Collaborwriting" is a process that uses a computer-based collaboration tool with multiple keyboards that functions like an electronic flipchart.

already addressed by law, regulation, the proposed 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.

Of the comments received during the initial scoping of the plan, more than 1,500 were identical, or nearly identical, form letters that did not raise any significant issues, but expressed general concerns that reinforced provisions already found in law, regulation, and policy, such as habitat protection for threatened and endangered species, viability of species, monitoring, and a climate change adaptation strategy.

Issues that served as the basis for alternative development:

1. The proposed plan does not adequately protect existing and provide for future old growth.
2. Lands of high conservation value such as the Kaibab Squirrel Area National Natural Landmark and the surrounding ephemeral drainages are critical wildlife core and linkages contributing to the native biodiversity of the greater landscape. Because regular mechanical disturbance can adversely affect wildlife, soils, and other resources, this area should not be managed for timber or biomass production.
3. The negative effects associated with periodic mechanical disturbance outweigh the benefits. Restoring the natural fire regimes to forested landscapes provides greater overall benefit to ecosystems, communities, and economies.
4. Areas should not be excluded from wilderness consideration just because they have evidence of past human activity, provided they are substantially unnoticeable, or could be rendered as such through restoration.
5. Livestock grazing by cattle and sheep causes watershed, stream, and grassland degradation.

Issues that were addressed through modifications or additions to the proposed action:

1. Recreation and commercial activities have the potential to adversely affect traditional cultural properties.
2. Vegetation management activities should be done in a strategic way that spatially disconnects large expanses of excessive fuels to reduce the risk of large-scale uncharacteristic fires.

Issues and concerns that are outside the scope of the decision to be made:

1. Reintroduction of strongly interactive species may be needed for species such as wolves.

   Rationale*: This is outside the authority of the Forest Service. Should the U.S. Fish and Wildlife Service initiate species reintroductions, they would be supported by the desired conditions in the proposed plan which "strives to create and maintain natural communities and habitats in the amounts, arrangements, and conditions capable of supporting viable populations of existing native and desired nonnative plants, and aquatic and wildlife species."*

2. The existing memorandum of understanding (MOU) with the Arizona Game and Fish Department needs to be modified to reconsider the ecological and economic costs of continued management for bison. Bison are not staying within the area identified in the MOU, and they have the potential to cause impacts to sensitive resources such as springs.

Rationale*: MOUs are one of the tools that help to facilitate working with other entities to achieve and maintain desired conditions. However, interagency agreements are not within the scope of the plan decision. The proposed plan contains guidance for addressing the potential impacts of authorized activities and protecting sensitive resources.*

3. The plan should close more roads and must prohibit cross-country travel.

   Rationale*: The scope of the Kaibab* NF *plan revision did not revisit the recent travel management decisions conducted in accordance with the Travel Management Rule.*[1] *Site-specific decisions were made on all three districts that have already closed the forest to cross-country travel and closed many roads. The transportation section of the plan incorporates these decisions through a transportation standard that prohibits motor vehicle use off of the designated system of roads and the desired condition that states "designated routes open to wheeled motorized vehicles are shown on a motor vehicle use map (MVUM)."*

4. Uranium mining can have adverse effects to public health, water quality, and other natural resources.

   Rationale*: The decision to authorize mining of locatable minerals is subject to the General Mining Law of May 10, 1872, as amended, and is outside the authority of national forest planning. The North Kaibab and Tusayan Ranger Districts, as well as Kendrick Wilderness on the Williams Ranger District are currently withdrawn from locatable mineral entry. Withdrawal prevents the establishment of new mining claims on public domain lands, but has no effect on existing valid claims. On acquired lands where the forest does have mineral rights, the action alternatives contain a guideline that hard rock mineral activities should not be authorized for more than 50 pounds of materials. Where mining may occur, there is existing law, regulation, policy, and forest plan guidance that would minimize adverse effects to public health, water quality, and natural resources.*

5. Allowing the use of lead ammunition on the forest could prevent the establishment and recovery of the California condor.

   Rationale*: The regional forester has the authority to prohibit actions on the forest for the purposes of protecting endangered species per 36 CFR 261.70. However, such a prohibition would require following the rule making procedures established in 5 U.S.C. 553. Rulemaking would require additional analysis and documentation for compliance with the National Environmental Policy Act and is outside the scope of the plan revision EIS analysis. Further, additional protections for the condor are not needed for the purposes of the forest plan. Under all plan alternatives, the viability of the California condor is maintained while implementing forest management activities, as documented in the viability analysis in chapter 3.*

6. The Kaibab NF land management plan should expressly authorize the voluntary, permanent retirement of grazing allotments by permittees for conservation purposes, including endangered species recovery.

   Rationale*: Resource management decision authority on National Forest System (NFS) lands is retained by the Forest Service. Delegations of authority are outside the scope of*

the plan revision decision. The proposed plan has a guideline for livestock grazing that states "as grazing permits are waived back to the forest, they should be evaluated for conversion to forage reserves to improve flexibility for restoring fire-adapted ecosystems and in response to other range and resource management needs." Additionally, all grazing projects are designed to comply with the Endangered Species Act, provide for endangered species habitat where they occur, and protect natural and cultural resources.

Already decided by law, regulation, or policy:

The lack of direction for threatened and endangered species could result in adverse effects to threatened and endangered species, as well as their habitat.

Rationale*: The forest follows the recommendations in recovery plans and works closely with the U.S. Fish and Wildlife Service for species recovery in accordance with the Endangered Species Act. The plan does not reiterate existing law, regulation, or policy.*

Not supported by scientific evidence:

The plan could result in removing too much fuel, which can make forests hotter, drier, and windier, which increases fire hazard and decomposition rates, both of which counter carbon storage and other objectives.

Rationale*: The planning team could not find any peer-reviewed literature to support this statement.*

Chapter 2. Alternatives, Including the Proposed Action

Introduction

This chapter describes each alternative considered for revising the 1988 forest plan. It also presents the alternatives in comparative form, describing the differences between each and providing a basis for choice among options by the responsible official. The information used to compare the alternatives is focused on the plan decisions (which are also referred to as plan components e.g., objectives, guidelines, special areas) and the expected environmental consequences or outcomes of implementing each alternative.

Alternatives Considered in Detail

The Kaibab NF analyzed four alternatives in detail: no action, proposed action, and two alternatives developed in response to issues raised by the public.

Alternative Development

The following input was used in developing the alternatives:

- Collaborative workshops and meetings that built plan content, identified issues, and developed alternative ways to address those issues.
- Comments from the public, interest groups, forest employees, State and Federal agencies, and local and tribal governments.
- Analysis of the management situation and associated scientific information.
- Sideboards provided by the forest supervisor and the forest's leadership team (e.g., the alternatives must be realistic, implementable, and able to be monitored).
- Wilderness evaluation results (appendix E) as conducted in accordance with Forest Service Handbook (1909.12, chapter 70), and Southwestern Region guidance.
- Wild and scenic river evaluation results (appendix F) as conducted in accordance with Forest Service Handbook 1909.12, Chapter 80.

These alternatives include management direction for inventoried roadless areas (IRAs) identified in the 2001 Roadless Area Conservation Rule. The preferred alternative includes direction that retains the undeveloped character of these areas. Comments received in the scoping process and between the draft and final EIS helped the Agency determine the scope of issues related to roadless area management and guide the analysis of environmental effects.

Elements Common to the Action Alternatives

Three action alternatives are analyzed in this FEIS (alternatives B, C, and D), which respond to the priority needs for change and issues identified in chapter 1. All action alternatives share the same forest-wide desired conditions and objectives. These include provisions that:

- Provide for and maintain diversity of plant and animal communities to meet overall multiple-use objectives;
- Provide for species' viability by providing appropriate habitat that is well distributed across the planning area;

- Conserve soil and water resources and do not allow significant or permanent impairment of the productivity of the land;
- Provide direction to control, treat, and eradicate nonnative invasive plant and animal species;
- Protect heritage resources;
- Maintain air quality that meets or exceeds applicable Federal, State and/or local standards or regulations;
- Manage the inventoried roadless areas to maintain their roadless character; and
- Assume the use of monitoring and adaptive management principles.

Alternative A, No Action – Current Plan

Under the no action alternative, the current management plan would continue to guide management on the Kaibab NF. The current plan emphasizes producing timber products; providing quality habitat for Mexican spotted owls, the northern goshawk, and its prey; providing recreation opportunities to meet demand; livestock grazing; and improvement of soil resources. The current plan has no articulated desired conditions for grasslands, wetlands, springs, traditional cultural use, or air quality. There are very few desired conditions for other resources; however, there are standards and guidelines that in some cases imply desired conditions. Although the current plan contains very few desired conditions, the analysis in this FEIS evaluates the effectiveness of each of the alternatives, including the no action alternative (current plan) for how well they meet the same set of desired conditions that are specified in the proposed action.

The forest is currently implementing approximately 2,000 acres per year of mechanical thinning and roughly 13,000 acres of burning within the ponderosa pine type, with small amounts of treatments in the mixed conifer. In addition, the forest is currently implementing roughly 200 acres per year of grassland restoration projects. Aspen restoration has been occurring, but at a low and variable rate. Protection of ephemeral wetlands has also been occurring, but spring protection and restoration have been minimal. While the current plan allows for higher rates of implementation, their lack of emphasis has resulted in low and variable results.

Alternative B, Proposed Forest Plan – Preferred Alternative

This alternative was developed focusing on the four Priority Needs for Change:

1. **Modify stand structure and density of forested ecosystems toward desired conditions and restore historic fire regimes**. The multiple ecological, social, and economic benefits of reducing the risk of uncharacteristic fires made this a primary area of focus. The proposed forest plan defines desired characteristics of forested ecosystems including: species composition; structural characteristics such as spacing tree groups and tree density; and disturbance patterns such as frequency, severity, intensity, and size of fire.

   It also describes the strategies in the form of objectives or guidelines that define “when” and “how” the desired conditions would be achieved. Objectives in the proposed plan would increase the amount and rate of mechanical thinning and managed fire treatments to reduce the risk of uncharacteristic fire and to improve forest resiliency in the face of climate change. Reducing the risk of uncharacteristic wildfire would also provide

increased protection to communities, infrastructure, and watersheds, including a 26,000-acre watershed that provides water for the City of Williams.

Objectives under the proposed forest plan would increase mechanical thinning to between 11,000 and 19,000 acres annually in ponderosa pine and between 1,200 and 2,100 acres annually in frequent fire mixed-conifer forests. Objectives would also treat up to 55,000 acres annually with a combination of prescribed fire and naturally ignited fire in ponderosa pine and up to 13,000 acres annually in frequent fire mixed conifer. Vegetation management guidelines provide direction to focus and constrain treatment activities.

The mechanical thinning associated with the restoration of ponderosa pine and frequent fire mixed conifer ecosystems could provide a wood supply that would to sustain a forest products harvesting and utilization industry. This could more than double the forest's contribution of jobs (currently estimated at approximately 700), and add diversity to an economy that has become increasingly dependent on tourism and recreation.

2. **Promote aspen regeneration and establishment.** Aspen has been in serious decline in the lower elevations on the forest. Aspen supports high levels of plant and animal diversity and has important recreation and scenery values. The proposed forest plan defines desired conditions for aspen including regeneration, recruitment, structural composition, understory plants, and disturbance processes.

   Strategies for achieving desired conditions focus on removing encroaching conifers, protecting aspen from browse, restoring forest structure and understory across the landscape which should help to disperse ungulates, and reintroducing fire. The plan objectives reflect the differences in how aspen occurs between the North Kaibab, Tusayan, and Williams Ranger Districts and addresses the primary needs.
3. **Protect natural waters**. The Kaibab NF has little natural water. With less than two miles of perennial stream, it is one of the driest forests in the Nation. Most of the natural waters are springs and wetlands that occur as isolated features in the arid landscape. Waters are important centers of biological diversity, have traditional cultural significance, and are popular recreation destinations. Actions to protect springs and wetlands are relatively inexpensive and would provide important ecological and social benefits. The proposed forest plan provides desired conditions and includes objectives and strategies for restoring and protecting springs, wetlands, and natural waters.
4. **Restore grasslands by reducing tree encroachment in grasslands and meadows**. Tree encroachment into grasslands over the past 100 years has occurred due to the absence of fire. This has reduced the quantity and quality of available habitat for grassland associated species. The montane/subalpine meadows on the North Kaibab Ranger District are at a higher risk of loss because they are linear and encroachment occurs more quickly. The proposed forest plan contains desired conditions and objectives to restore the natural patterns of abundance, composition, and connectivity of grasslands. Objectives focus on removing conifers from areas where they have encroached, restoring fire to the ecosystem, and modifying fences that would improve habitat connectivity for pronghorn antelope.

The proposed plan would also provide:

- Continued availability and access to resources for traditional cultural use and guidance for managing traditional cultural properties.

- A range of high quality scenery and recreation opportunities, with an emphasis on dispersed recreation opportunities within limits of the administrative and resource capacity. Dominant recreation activities are sightseeing, hiking, camping, picnicking, and hunting. High visitation occurs on summer weekends and holidays as people from nearby desert communities come to the cool pines to escape the heat.
- Continued opportunities to graze livestock consistent with other desired conditions. The forest uses adaptive management to balance use with capacity and address relevant resource concerns.
- Objectives and guidelines provide a consistent and efficient management response after large uncharacteristic wildfires. Following these types of events, the desired conditions generally remain the same, but management actions are often needed to set the burned areas on a trajectory toward the desired conditions.
- Guidance for mineral exploration and development, special-use management, and forest products collection.
- The proposed plan identifies four potential wilderness areas (PWAs) for wilderness recommendation (figures 2 and 3) that rated high for capability and at least medium for availability in the wilderness evaluation (see appendix E). These PWAs would be managed to protect their wilderness values until Congress acts on the recommendation. One PWA is on the Williams Ranger District, adjacent to Sycamore Canyon Wilderness, at the head of Jacks Canyon (about 160 acres). Three are located on the North Kaibab Ranger District: one PWA is comprised of eight separate areas bordering the Kanab Creek Wilderness (totaling about 4,700 acres), one adjacent to the Saddle Mountain Wilderness that includes a unique landform commonly referred to as the "Cockscomb" (approximately 1,300 acres); and one adjacent to Grand Canyon National Park that includes the upper reaches of Grassy and Quaking Aspen Canyons (about 230 acres). The PWAs adjacent to the Grand Canyon National Park, Kanab Creek Wilderness, and Sycamore Canyon Wilderness would bring the boundary of the area managed as wilderness to the rim, which would be more recognizable and manageable.

Alternative C

Alternative C is similar to the proposed action, but has the following differences in response to three issues raised:

1. In response to the issue that "the proposed plan does not adequately protect existing and provide for future old growth," alternative C would replace the proposed vegetation management guideline "Project design and treatment prescriptions should generally not remove…large, old ponderosa pine trees with reddish-yellow wide platy bark, flattened tops, with moderate to full crowns and large drooping or gnarled limbs (e.g., Thomson's age class 4 (Thomson 1940), Dunning's tree class 5 (Dunning 1928) and/or Keen's tree class 4 (A and B) (Keen 1943))" (see appendix K), with "Project design and treatment prescriptions should generally not remove trees with physical characteristics typical[2] of those that were established prior to 1890 (i.e., generally larger than 16 inches diameter at breast height, with yellowing platy bark)."

   This guideline was developed following a collaborwriting session that explored the issue raised during scoping that the proposed plan did not have sufficient guidance to protect

[2] Typical characteristics would vary somewhat depending on site quality.

old growth. Participant comments focused on the lack of guidance for protecting old trees rather than large trees. Subsequent follow-up discussions and comments focused on "presettlement trees" or those that were 120 to 150 years old. It was agreed that an "established prior to" year would better represent the time at which Euro-Americans disrupted the natural fire regime. It was also agreed that while coring trees would help to establish physical characteristics typical of a 120 year-old tree at a given site, it would not be practical or necessary to core a majority of the trees, which could be required if the guideline specified an age. As a result, the guideline specified not cutting "trees with physical characteristics typical of those established prior to 1890."

2. In response to the issue that "lands of high conservation value such as the Kaibab Squirrel Area National Natural Landmark should not be managed for timber or biomass production because regular mechanical disturbance can have adverse effects to soils and other resources," alternative C would establish a management area on the North Kaibab Ranger District (figure 2). The management area, called the North Kaibab Wildlife Habitat Complex would be approximately 260,000 acres and include most of the Kaibab Squirrel National Natural Landmark, and eight linked ephemeral riparian valleys and canyons. This management area would have a desired condition that the wildlife habitat complex provides effective wildlife linkages and core areas for wide ranging species, and a guideline that states "Mechanical thinning would be used initially to restore the desired forest structure to the extent possible. Thereafter, the desired conditions should primarily be maintained with fire and other natural disturbances." Because this area would not be managed for timber or biomass production, it would be not be included in the suitable timber base.

   The North Kaibab Wildlife Habitat Complex Management Area provision in this alternative was developed in response to the above issue raised by a consortium of environmental groups. It also addresses the key aspects of a management area proposal provided by the Grand Canyon Wildlands Council during initial plan development.

3. In response to the issue that "areas should not be excluded from wilderness consideration just because they have evidences of past human activity, provided they are substantially unnoticeable, or could be rendered as such through restoration," six additional PWAs totaling about 38,000 acres would be recommended for wilderness designation under alternative C.

Several suggestions and comments were made regarding possible recommended wilderness areas during the plan and alternative development. All of the areas corresponded to PWAs that were considered during the wilderness evaluation process. In discussions about the additional areas that would be recommended for wilderness designation, the leadership team specified that that recommended areas must be capable of being managed as wilderness, possessing at least a moderate level of wilderness character (natural, undeveloped, opportunities for solitude, special features, manageability) and be reasonably available based on information about the tradeoffs of current and potential uses, outputs, and trends for the various resources. The Wilderness Evaluation Report identified six areas that met the criteria. In addition to the PWAs recommended in the proposed action, alternative C would recommend the following PWAs: Burro Canyon, Seegmiller, South Canyon Point, and Willis Canyon on the North Kaibab Ranger District, the Coconino Rim on the Tusayan District, and the Sycamore Canyon Addition on the Williams District (figures 2 and 3). The Sycamore Canyon Addition is contiguous to potential wilderness identified in an alternative developed by the Prescott National Forest during their plan revision process. Although this area ranked "high" for capability and availability in the PWA evaluation

process, due to its small size it was only to be recommended by the Kaibab NF for wilderness designation if the adjacent section on the Prescott NF was recommended in the Prescott's revised forest plan. This portion of the Prescott NF was not included in that National Forest's proposed forest plan, so the Sycamore Canyon Addition is not recommended as a PWA under the Kaibab NF's Alternative B (proposed action), but is was retained in alternative C, so that it would remain within the scope of the alternatives evaluated in detail.

Alternative D

Alternative D was developed in response to the issue that "the negative effects associated with regular mechanical disturbance outweigh the benefits. Restoring the natural fire regime to forested landscapes provides greater overall benefit to ecosystems, communities, and economies." Alternative D would contain the following forest-wide guideline: "Mechanical thinning would be used initially to restore the desired forest structure to the extent possible. Thereafter, the desired conditions should primarily be maintained with fire and other natural disturbances." Because no areas on the forest would be managed for timber or biomass production, there would be no lands identified as suitable for timber production. Alternative D also includes the same presettlement tree retention guideline and recommended wilderness as alternative C.

Resource Planning Act Alternative

The provisions of the 1982 Planning Rule regulations at 219.12(f)(6) require forest plans to respond to and incorporate the Renewable Resource Planning Act Program objectives for each national forest as displayed in regional guides. There is no longer a regional guide for the Southwestern Region. This was withdrawn as required by the 2000 Planning Rule at 219.35(e). The last Renewable Resource Planning Act Program was developed in 1995. In lieu of the Renewable Resource Planning Act Program, the Forest Service Strategic Plan 2007–2012 provides broad overarching national guidance for forest planning and national objectives for the agency as required by the Government Performance Results Act. All alternatives in this FEIS address these broad strategic objectives.

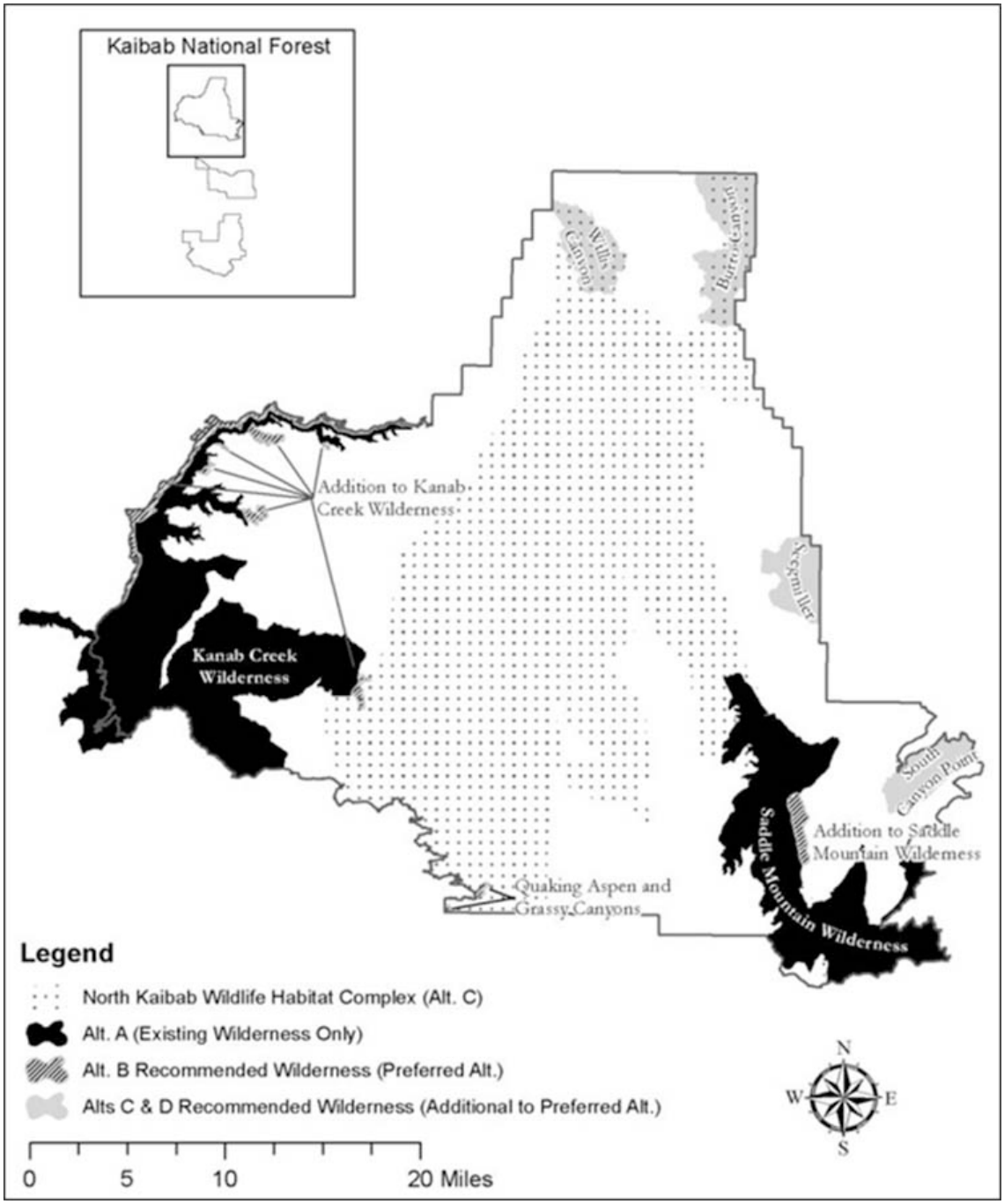


Figure 2. North Kaibab Ranger District existing and recommended wilderness areas under each alternative, plus the North Kaibab Wildlife Habitat Complex (alternative C only)

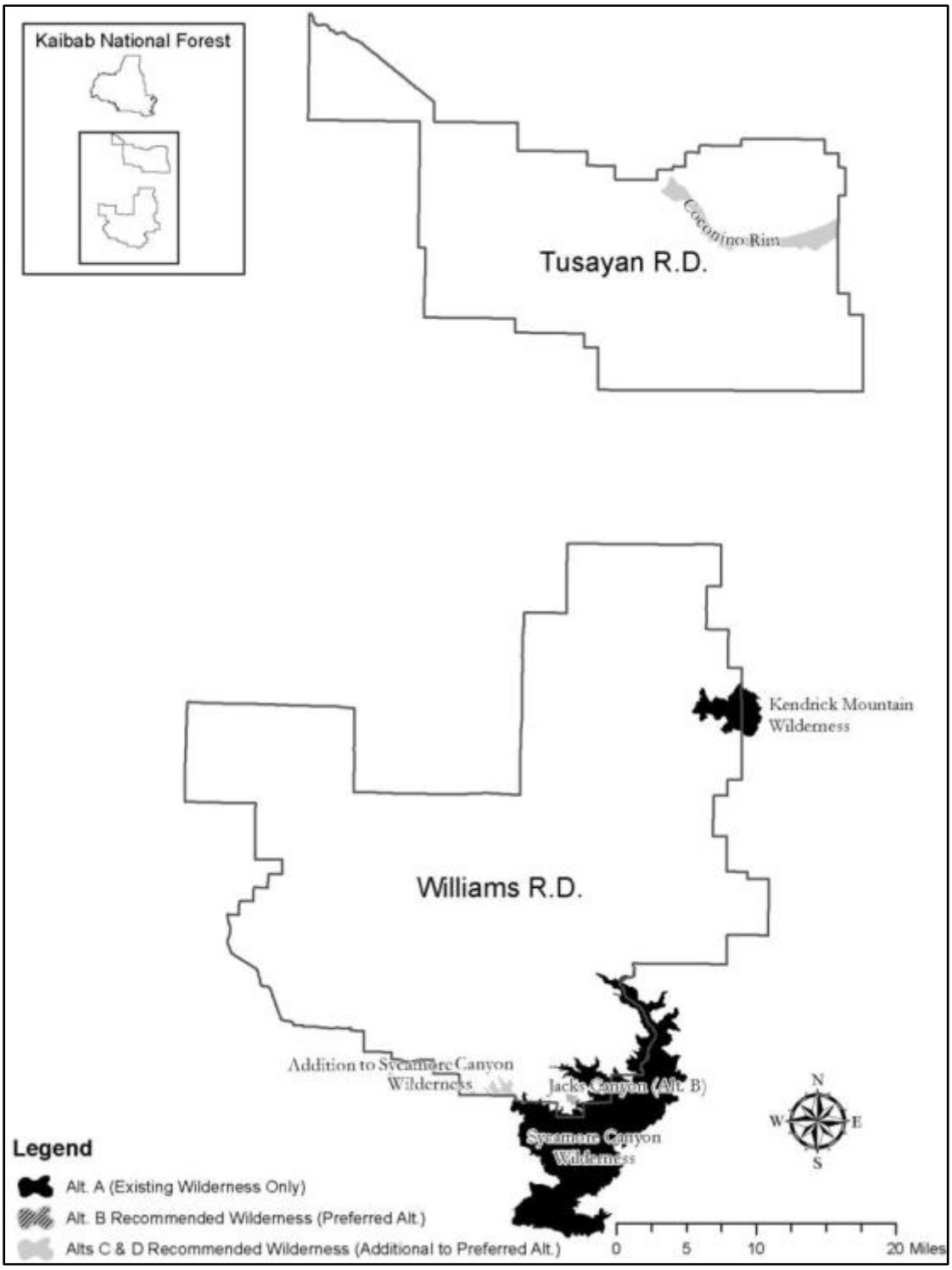


Figure 3. Tusayan and Williams Ranger Districts existing and recommended wilderness areas under each alternative

Alternatives Considered But Not Analyzed in Detail

NEPA requires Federal agencies 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 plan revision process or already addressed by the alternatives considered in detail. The following alternatives were considered, but dismissed from detailed consideration for reasons summarized below.

Alternative that Would Reduce Grazing

In response to the issue that "Livestock grazing by cattle and sheep causes watershed, stream, and grassland degradation," the forest considered a reduced grazing alternative, but concluded that it was not necessary because under all of the alternatives, the livestock grazing program has multiple mechanisms to evaluate, review, and adapt management as needed to effectively protect resources and respond to changing conditions. Some language was added to the plan to ensure that the adaptive management process was clearer.

The effects from grazing in each range allotment are evaluated and adjusted (1) throughout the season, particularly when pasture rotation is being determined; (2) in detail at the beginning of the season when the annual operating instructions are determined; and (3) comprehensively on 10-15 year intervals, or more frequently when needed, as grazing is periodically re-authorized through the NEPA process. This allows for any needed adjustments to be made on a site specific basis to maintain and move toward desired conditions for watersheds, wildlife habitat, and other resources.

For these reasons, an alternative that would eliminate or have a reduced level of grazing across the forest was not studied in detail.

Alternative that Would Recommend All Five of the Inventoried Roadless Areas for Wilderness Designation

Comments were received that supported recommending all five of the inventoried roadless areas identified in the 2001 Roadless Area Conservation Rule (RACR) for wilderness designation. All of the IRAs on the Kaibab NF were evaluated during the potential wilderness evaluation process. Three of the IRAs were included in alternatives C and D, and two were considered, but not analyzed in detail. The Big Ridge and Red Point IRAs were not analyzed in detail in the FEIS because they received a low capability and availability ratings, partly from severe fire effects and subsequent noxious weed invasions resulting from the 2006 Warm Fire. These areas would benefit from restoration and weed treatments that would be more efficient and effective if mechanical options were available. Although the Red Point and Big Ridge IRAs were not recommended for wilderness, the IRAs will continue to be managed to retain their roadless character.

Alternative That Would Use a Hands-off Approach to Manage Long-term Vegetative Health

This alternative was considered but not analyzed in detail because it would not address the priority needs for change. The greatest need for change is to restore fire-adapted ecosystems toward the desired reference conditions. Current conditions in the ponderosa pine and frequent fire mixed conifer forests have accumulations of live and dead woody material that can lead to uncharacteristic and undesirable fire effects. With a “hands-off approach”, fire and other natural disturbances are the only available mechanisms for making progress toward reference conditions. Under current conditions, when wildfires occur, they typically either do not do enough to lift tree crowns and open up tree density, or they burn with high intensity, resulting in the loss of ecosystem diversity, structure, and process. A hands-off approach would also not make progress toward restoring grasslands, aspen, or natural waters except over very long time frame, if ever.

Alternative That Would Include a Road Density Standard

An alternative was suggested that would include a road density standard, which would limit the road system to two miles of road per square mile of land. This alternative was considered but not analyzed in detail because recent site specific analysis and decisions have been made on all three of the forest’s districts that identified the open road system during the travel management process. Under the travel management process, alternatives were developed and analyzed based on issues including the effects of sedimentation and erosion. The resulting decisions were based on a collaborative process and scientifically based information. While it is desirable to minimize new roads and naturalize /rehabilitate unneeded roads, a road density standard would be arbitrary and would not meet the purpose and need.

Comparison of Alternatives

This section provides a summary comparison of the alternatives. Table 1 focuses on differences in management direction and anticipated outputs that can be compared quantitatively or qualitatively. Table 2 is a summary of how well each of the alternatives is expected to achieve the management needs and key desired condition concepts as analyzed and disclosed in chapter 3, which contains the detailed analysis.

Table 1. Primary differences between alternative content and outputs

Plan Decision	Alternative A	Alternative B	Alternative C	Alternative D
Mechanical thinning in ponderosa pine	No objectives, but occuring at ~2,100 acres per year	11,000 to 19,000 acres per year		
Mechanical thinning in frequent fire mixed conifer	No objectives, but occuring at ~ 200 acres per year	1,200- 2,100 acres per year		
Prescribed fire and naturally ignited wildfire*	No objectives, but occuring at ~20,000 acres per year	14,000 to 68,000 acres per year (ponderosa pine and frequent fire mixed conifer combined)		
Protect and restore natural waters	There are no desired conditions or objectives. Some fencing has been occurring to protect ephemeral wetlands.	Provides desired conditions for natural waters. Provides objectives that would protect 10 springs in 5 years, and restore native vegetation and waterflow patterns on 6 acres of wetlands in 5 years.		
Protect and restore aspen	There are no desired conditions or objectives. Treatments have been occurring, but at a low and variable rate.	Provides desired conditions for aspen and objectives that would fence 200 acres and reduce conifer encroachment on 800 acres within 10 years on the Williams and Tusayan Ranger Districts.		
Restore grasslands	There are no desired conditions and no objectives. Treatments have been occurring at a low and variable rate.	5,000 to 10,000 acres per year		
Existing wilderness	A total of 116,249 acres in the plan area and 114,839 acres within the Kaibab NF proclaimed boundary. (Note all of KendrickMountain Wilderness is managed under the Kaibab NF forest plan although about half is on the Coconino National Forest, and the portion of Sycamore Canyon Wilderness within the Kaibab NF boundary is managed under the Coconino forest plan.)			
Recommend wilderness	0	6,394 acres	44,282 acres	44,282 acres
Recommend research natural areas	Garland Prairie	No RNAs are being recommended. Garland Prairie would be managed as a management area and continue to serve as a reference area for the study of ecological changes and as a control for other habitats being manipulated for management or research purposes.		
Wild and scenic river	The existing eligible 20-mile segment would continue to be eligible. No new segments are being recommended. Management under all alternatives would maintain the eligibility of the Kanab Creek segment until a suitability study can be completed.			
Suitable timberlands	400,959 acres	381,517 acres	230,556 acres	0
Allowable sale quanity (ASQ)	152,300 CCF	107,815 CCF	60,970 CCF	0
Long-term sustained yield (LTSY)	216,200 CCF	74,737 CCF	45,148	0
Present net value	$-127,300,925	$-156,637,754	$-151,264,490	$-166,022,727

*Acres of lightning-caused wildfire counted toward this objective are only those that make progress towards or maintain desired conditions.

Table 2. Summary of the ability of each alternative to achieve management needs and key desired condition concepts as analyzed and disclosed in chapter 3

Management Need	Desired Conditions	Ability to Achieve Desired Conditions			
		Alt. A	Alt. B	Alt. C	Alt. D
Reduce tree density in ponderosa pine and frequent fire mixed conifer to achieve desired conditions (open, uneven-aged) with mechanical thinning	Vegetative structure within historic range of variation	x	✓✓	✓	✓
	Robust understory	x	✓✓	✓	✓
	High soil integrity and productivity (long term)	x	✓✓	–	–
	High soil integrity and productivity (short term)	–	x	x	x
	Water yield supports ecosystem and human needs	–	✓✓	✓	✓
	Forest products provide a source of employment and income over the plan period	xx	✓✓	x	x
	High scenic integrity (long term)	–	✓	✓	✓
	High scenic integrity (short term)	–	x	x	x
	Recreation opportunities (long	–	✓✓	✓	✓
	Recreation opportunities (short	–	x	x	x
Restore historic fire regime through combination of low intensity wildland fire and prescribed fire	Fine scale heterogeneity	–	✓	✓	✓
	Satisfactory soil hydrologic	–	✓✓	✓	✓
	Satisfactory nutrient cycling	x	✓✓	✓	✓
	Minimize impacts from prescribed fire emissions (adverse health effects to sensitive persons)	–	x	x	x
Reduce the risk of uncharacteristic wildland fire by restoring stand structure PP: ponderosa pine MC: frequent fire mixed conifer	Protection of watershed/soil	x PP xx MC	✓✓ PP ✓✓ MC	✓ PP ✓ MC	✓ PP ✓ MC
	Protection of water quality				
	Protection of habitat				
	Low threat to communities and infrastructure				
	Protection of recreation setting				
	Protection of heritage resources				
	Prevention of uncharacteristic, high emission-producing fire (smoke)				
	Fires burn as low-intensity surface fires allowing for direct attack				
	Low fire suppression/rehabilitation				

Management Need	Desired Conditions	Ability to Achieve Desired Conditions			
		Alt. A	Alt. B	Alt. C	Alt. D
Protect and restore springs and wetlands	Satisfactory availability of riparian habitat	–	✓	✓	✓
	Water quantity/quality sufficient to support ecosystem and human needs	–	✓	✓	✓
	Prevent trampling of vegetation and soils	x	✓	✓	✓
	Protection of rare and endemic species	x	✓	✓	✓
	Protection of areas of traditional cultural use	x	✓	✓	✓
Protect and restore aspen	Aspen regenerating successfully	x	✓	✓	✓
	Competition from conifers similar to historic conditions	x	✓✓	✓	✓
	High habitat diversity	–	✓✓	✓	✓
	High scenic integrity	x	✓	✓	✓
Restore grassland by reducing encroaching conifers	Grass, forb, and shrub diversity and cover	x	✓	✓	✓
	Grasslands present in historic extent	x	✓	✓	✓
	High quality habitat for grassland species	x	✓	✓	✓
	Satisfactory nutrient cycling	–	✓✓	–	–
	Habitat connectivity for pronghorn	x	✓	✓	✓
Guidance for consistent, efficient scientifically based response following large-scale disturbance	Threats to human safety and property are promptly addressed	–	✓	✓	✓
	Effective ground cover (stabilized soils)	–	✓	✓	✓
	Planting establishes future seed sources needed for restoring desired	✓	✓✓	x	xx
	Drainages stabilized, water quality protected	–	✓	✓	✓
Establish new management areas	Increased guidance for unique natural resources	–	✓	✓	✓

Management Need	Desired Conditions	Ability to Achieve Desired Conditions			
		Alt. A	Alt. B	Alt. C	Alt. D
	Increased protection for unique cultural resources	–	✓✓	✓✓	✓✓
	Minimal risk of adverse impacts from uncharacteristic wildfire (wildland-urban interface)	x	✓✓	✓	✓
Plan guidance developed for wildlife habitat needs *Not MIS under current plan	Habitat for species w/high viability risk	–	✓✓	✓	✓
	Protection of rare and endemic species	–	✓	✓	✓
	Habitat provided for western bluebird*	–	✓	✓	✓
	Habitat provided for Grace's warbler*	–	✓✓	✓	✓
	Habitat provided for ruby-crowned kinglet*	–	✓	✓	✓
	Habitat provided for pronghorn	x	✓	✓	✓

KEY: ✓✓ = very effective at achieving desired conditions

✓ = effective at achieving desired conditions

– = neutral (maintaining current conditions)

x = ineffective at achieving desired conditions

xx = very ineffective at achieving desired conditions

Chapter 3. Affected Environment and Environmental Consequences

Introduction

This chapter summarizes the physical, biological, social, and economic environments of the project area and the potential environmental consequences of implementing each alternative on that environment. The kinds of resource management activities allowed under each of the alternatives are reasonably foreseeable future actions to achieve the goals and objectives in the plan. However, the specific location, design, and extent of such activities are generally not known. Therefore, the discussions in this chapter refer only to the potential for an effect to occur. The intent is to provide scientific analysis and information that will allow for a comparison of the alternatives and provide the basis for an informed decision.

Assumptions

- The Kaibab NF Land and Resource Management Plan (plan) provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carry out any project or activity (including ground-disturbing actions). As a result, it does not result in direct effects. However, there may be implications, or longer term indirect or cumulative environmental consequences from managing the forests under this programmatic framework.
- Before any ground-disturbing actions take place, they must be authorized in a subsequent site-specific environmental analysis. Therefore, none of the alternatives would cause unavoidable adverse impacts or an irreversible or irretrievable commitment of resources.
- The plan decisions (desired conditions, objectives, standards, guidelines, management areas, and monitoring) will be followed when planning or implementing site-specific projects and activities.
- Law, regulation, and policy regulations will be followed when planning or implementing site-specific projects and activities.
- Funding levels will be similar to the past 5 years.
- The planning timeframe for the effects analysis is 10 to15 years; although other timeframes may be specified in the analysis, depending on the resource and potential consequences.
- Monitoring identified in the plan's monitoring chapter will occur.
- The land management plan will be amended, as needed, during the life of the plan.

For the following analysis, all alternatives are evaluated in terms of how well they achieve the same set of desired conditions, regardless of whether the alternative articulates those desired conditions. For example, alternative A, no action (current plan) does not specify many desired conditions, but it is still evaluated using the same common set of criteria. Appendix B provides greater detail about the methodologies used in these analyses.

Vegetation and Fire

Healthy, resilient landscapes have a greater capacity to survive natural disturbances and large-scale threats to ecological sustainability, especially under changing and uncertain future environmental conditions, such as those driven by changing climate and increasing human uses (FSM 2020). Fire has long played a role in shaping the vegetation of the Kaibab NF. The

resiliency of much of the forest is dependent upon fire as a frequent disturbance process; the structure and function of vegetation are closely intertwined with the role of fire. As a result, vegetation and fire are examined together in this section. Additional information can be found in the Vegetation and Fire Specialist Report (KNF 2013a).

Vegetation Affected Environment

Three major vegetation types dominate the landscape. Pinyon-juniper woodlands cover 40 percent of the forest and are found at lower elevations. As elevation increases, pinyon-juniper transitions to ponderosa pine forests, which cover 35 percent of the forest. At higher elevations, mixed conifer forests predominate, occurring on the crest of the Kaibab Plateau on the North Kaibab Ranger District, and the tops of Kendrick, Sitgreaves, and Bill Williams Mountains on the Williams Ranger District. Mixed conifer forests cover 8 percent of the forest. Due to the forest's range of elevation and soil types, there is a wide diversity of other vegetation types including spruce-fir, grasslands, sagebrush shrublands, Gambel oak shrublands, and desert communities. Riparian and wetland vegetation is present in small but important areas (see figure 4 and table 3).

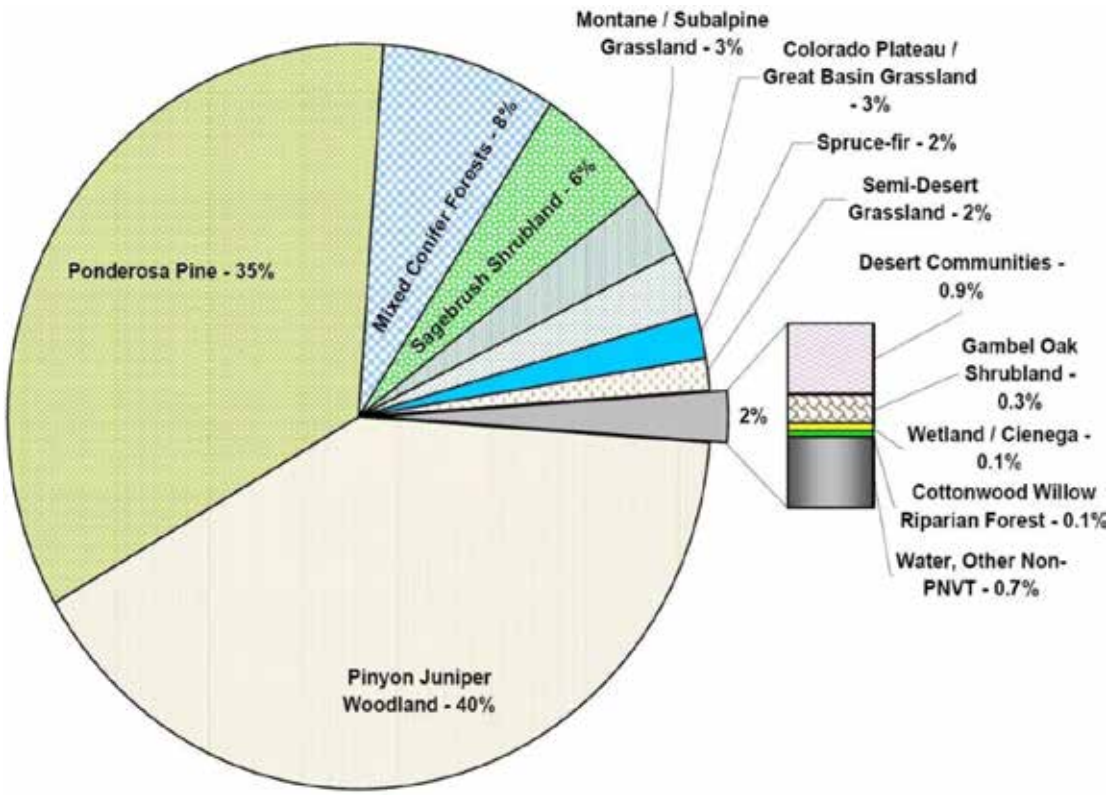


Figure 4. Percentage of Kaibab National Forest in each potential natural vegetation type (PNVT)

Table 3. Potential natural vegetation types (PNVT) that occur on the Kaibab National Forest. Acreage and percentage are displayed by forest and ranger district.

PNVT	Acres on Forest[a]	Percent of Forest	Acres on NKRD[b]	Percent of NKRD	Acres on TRD	Percent of TRD	Acres on WRD	Percent of WRD
Pinyon/ juniper communities	629,199	40.4%	247,062	37.7%	186,943	57.2%	195,194	12.5%
Ponderosa pine	541,159	34.7%	156,121	23.9%	103,248	31.6%	281,790	18.1%
Mixed conifer forests	127,854	8.2%	113,662	17.4%	0.0	0.0%	14,193	0.9%
Sagebrush shrublands	88,646	5.7%	57,735	8.8%	30,910	9.5%	1	0.0%
Montane/ subalpine grasslands	40,760	2.6%	6,479	1.0%	2,184	0.7%	32,097	2.1%
Colorado Plateau/Great Basin grasslands	44,198	2.8%	69	0.0%	3,740	1.1%	40,389	2.6%
Spruce-fir forests	29,119	1.9%	28,974	4.4%	0.0	0.0%	145	0.0%
Semi-desert grasslands	24,970	1.6%	24,965	3.8%	0.0	0.0%	5	0.0%
Desert communities	13,742	0.9%	13,742	2.1%	0.0	0.0%	0	0.0%
Gambel oak shrublands	5,368	0.3%	3,939	0.6%	0.0	0.0%	1,429	0.1%
Wetland/ cienega	1,478	0.1%	612	0.1%	0.0	0.0%	866	0.1%
Cottonwood-willow riparian forest	1,196	0.1%	1,196	0.2%	0.0	0.0%	0	0.0%
Water, urban, agriculture, and other PNVTs	11,314	0.7%	1	0.0%	0.0	0.0%	11,312	0.7%
Totals:	**1,559,003**	**100%**	**654,557**	**100%**	**327,025**	**100%**	**577,421**	**37%**

[a]Acreages exclude private lands within the forest boundary.
[b]NKRD = North Kaibab Ranger District, TRD = Tusayan Ranger District, and WRD = Williams Ranger District

Fire Ecology

Most of the vegetation on the forest is adapted to recurrent wildland fires started by lightning during spring and summer thunderstorms. In these vegetation communities, frequent, low intensity fire plays a vital role in maintaining ecosystem health. In the 1800s, intensive grazing by domestic livestock removed the grasses that previously carried low-intensity surface fires. Early settlers suppressed fires to protect their livelihood and homes. As a result, the condition and structure of most of northern Arizona's forests, woodlands, shrublands, and grasslands have

changed. Fuels, in the form of dead woody material, continued to build up because when fires were started, they were usually extinguished quickly.

With a significantly reduced understory and no fire, conifer seedlings survived at unprecedented rates. In ponderosa pine, frequent fire mixed conifer, and grassland vegetation communities, conifer seedlings invaded forest openings and encroached into grasslands and savannahs. Many large, old trees were harvested for lumber. Today, the Kaibab NF contains uncharacteristically dense forests with many more young trees than were present historically. The forested types are deficient in grasses, forbs, and shrubs due to tree competition and shading from the denser canopy; they are at high risk for uncharacteristic wildfires due to the accumulated buildup of live and dead woody material, increased crown bulk density, and increased canopy continuity. Grasslands have decreased in size due to conifer encroachment from the edges.

The probability and occurrence of large uncharacteristic, stand-replacing fires continues to increase. These fires cause high tree mortality, degrade watersheds, sterilize soils, and threaten homes and communities. While the average number of fire starts has been stable over the past 30 years, there has been a dramatic increase in the total number of acres burned by uncharacteristic, high-severity wildfire across the Kaibab NF, particularly since 1996 (figures 5 and 6).

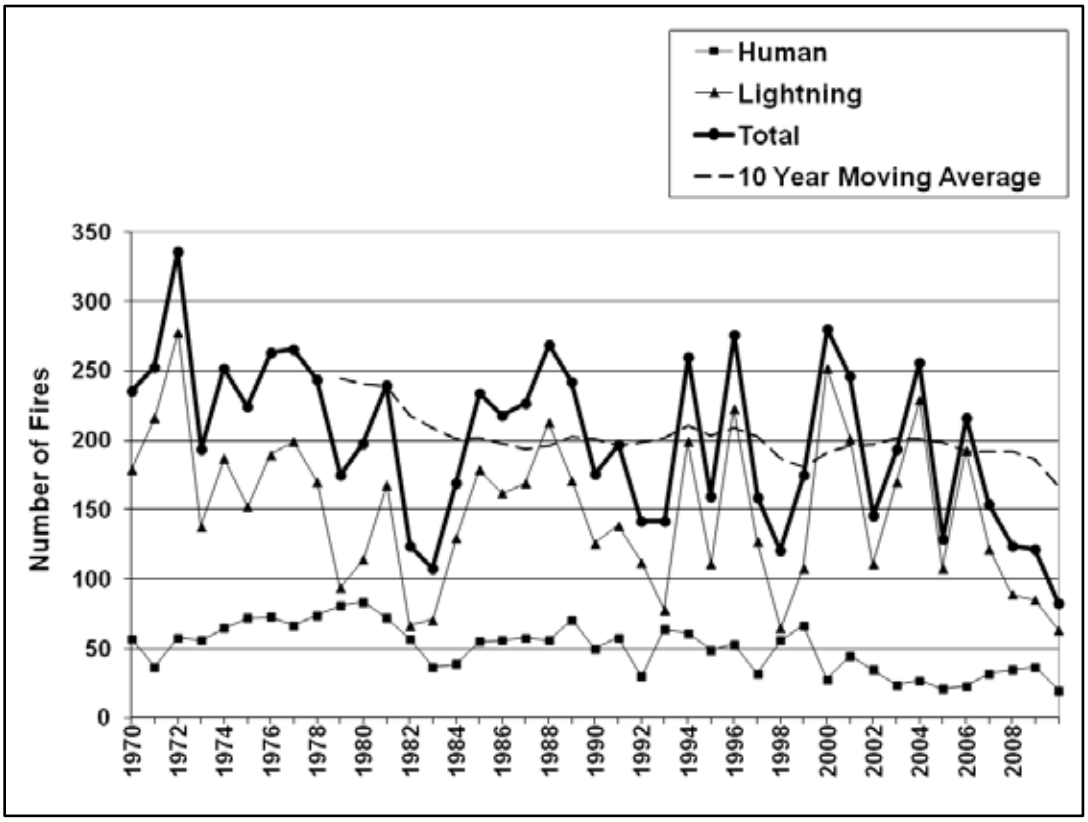


Figure 5. Number of fires in Kaibab National Forest per year from 1970 through 2010. The 10-year moving average number of starts is around 200 per year.

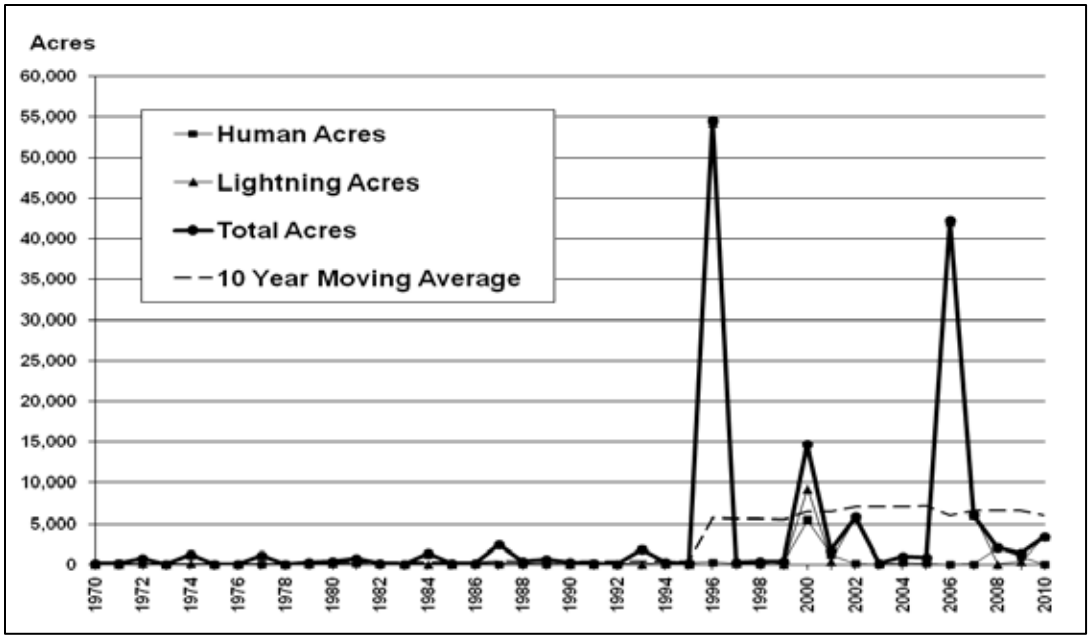


Figure 6. Number of Kaibab National Forest acres burned by wildfires from 1970 through 2010

This indicates that the fuel conditions, particularly in forested vegetation types, have increased so that they support increasingly extreme fire behavior, resulting in more severe fire effects, especially in dry years, which may become more common with changes to climate. Extreme fire behavior and the resulting severity are uncharacteristic and well outside the historic range of variability.

Forest-wide Current Condition and Trends

Table 4, conditions, trends, and primary departures for each potential natural vegetation type (PNVT) on the Kaibab NF, displays the key findings from the Ecological Sustainability Report (KNF 2008a). The current departure from reference conditions and the projected trend toward or away from reference conditions on the forest is presented here for each vegetation community. Note that the trend for ponderosa pine is static. This reflects what percentage of the vegetation type is departed, rather than how far vegetative structure and function is departed from reference conditions. The trend is static because nearly all of the type is not in reference conditions, and there is very little of the type that is currently in reference conditions that could become departed in the future.

The departures of ponderosa pine, frequent fire mixed conifer, the aspen component of those vegetation types, and the grasslands are the focus of this analysis. The forest has a limited capacity, in the anticipated 10- to 15-year lifespan of the revised plan to reverse trends in all vegetation types, and move them all toward desired conditions. Limitations are imposed by limited and fluctuating funding, current lack of a market for small-diameter biomass to offset cost of treatments, and length of time required to accomplish and approve planning for treatments. Acknowledgement of limited capacity necessitated the development of priority needs for change to focus efforts during the planning period. Objectives in the revised plan alternatives are designed to address these priority needs for change.

The full description of the desired condition for ponderosa pine, frequent fire mixed conifer, aspen, and montane/subalpine grasslands used in this analysis can be found in the Kaibab NF Land and Resource Management Plan. The plan can be accessed at the following link: *http://fs.usda.gov/goto/kaibab/plan_rev_docs.*

The current conditions and trends for ponderosa pine, frequent fire mixed conifer, and montane/subalpine, Great Basin, and semidesert grasslands are described below. More information on current condition and trends in these, and other vegetation types, can be found in the Kaibab NF's Ecological Sustainability Report (KNF 2008a), and in the Vegetation and Fire Ecological Need for Change Report (KNF 2008b).

Table 4. Conditions, trends, and primary departures for each potential natural vegetation type (PNVT) on the Kaibab National Forest

PNVT	Departure from Reference Condition	Projected Future Trend Under Current Management	Primary Departures
Pinyon-juniper woodland	Moderate	Static to away	Increased tree density, reduced understory cover and diversity, insect/drought related die-off, and invasion of exotic plants.
Ponderosa pine	High	Static	Increased tree density, reduced understory, increased risk of uncharacteristic, high-severity fire, decline of aspen.
Frequent fire mixed conifer	High	Away	Increased tree density, species shifts toward more shade-tolerant species, increased risk of uncharacteristic, high-severity fire.
Mesic mixed conifer/spruce-fir forest	High	Static	Increased tree density, species shifts toward more shade-tolerant species, and increased fuel continuity.
Sagebrush shrubland	Moderate	Away	Lack of characteristic fire disturbance, limited nutrient cycling, closed shrub states, tree encroachment.
Montane/ subalpine grassland	Moderate	Away	Lack of characteristic fire disturbance, limited nutrient cycling, closed shrub states, tree encroachment.
Colorado Plateau/Great Basin grassland	Moderate	Away	Lack of characteristic fire disturbance, limited nutrient cycling, closed shrub states, tree encroachment.
Semidesert grassland	Low	Away	Lack of characteristic fire disturbance, limited nutrient cycling, closed shrub states, tree encroachment.
Desert communities	Moderate	Away	Invasion of exotic plant species, closed shrub states, tree encroachment.
Gambel oak shrubland	High	Away	Lack of fire disturbance, conifer encroachment.
Wetland/ cienega	Low	Slowly Away	Lack of characteristic fire disturbance, limited nutrient cycling, reduced water input, woodland tree species encroachment.

PNVT	Departure from Reference Condition	Projected Future Trend Under Current Management	Primary Departures
Cottonwood willow riparian forest	High	Away	Upstream water diversions and impoundments, tamarisk, and exotic plant species invasion.

Ponderosa Pine

Ponderosa pine occurs at elevations from 7,000 to 9,300 feet, and covers about 550,000 acres of the forest. It occurs extensively on all three districts. The dominant species in this system is ponderosa pine (*Pinus ponderosa*), which makes up at least 80 percent of the overstory. Other trees, such as Gambel oak (*Quercus gambelii*), Douglas-fir (*Pseudotsuga menziesii*), pinyon pine (*Pinus edulis*), and juniper (*Juniperus* spp.) may be present. Aspen (*Populus tremuloides*) may occur in patches, or as a nearly codominant species as on the North Kaibab Ranger District. This vegetation community is adapted to drought and has evolved several mechanisms adapted to tolerate frequent, low-intensity surface fires, which is characteristic for this vegetation type.

Canopy cover is far denser and more continuous across all developmental states than the desired conditions, and fuel loads have accumulated on the forest floor. The primary threat is uncharacteristic, high-severity wildfire. Insect epidemics and drought represent secondary threats. When wildfires occur under the current dense conditions, they are more likely to kill many of the large and old trees, moving the vegetation structure further from desired conditions. This would greatly increase the time departure, or time it would take to grow and restore the vegetation to desired conditions after such a fire, rather than from current condition. There is a moderate risk of insect and/or disease outbreaks, which is also a function of increased tree density and is exacerbated by drought.

Frequent Fire (Dry) Mixed Conifer

Mixed conifer vegetation communities are found between 7,200 feet and 10,418 feet. Ponderosa pine dominates, making up approximately 57 to 80 percent (Fulé et al. 2002; Fulé et al. 2003) of the overstory. Other species present are Douglas-fir, white fir (*Abies concolor*), and aspen. Aspen may be present either in patches, or as a nearly codominant species. Mixed conifer occurs on the North Kaibab Ranger District, and on the north-facing aspects of Bill Williams, Sitgreaves, and Kendrick Mountains, and other north-facing cinder cones and canyon walls on the Williams Ranger District. The presettlement (characteristic) fire regime in dry mixed conifer is similar to that of ponderosa pine (Fulé et al. 2003). At the highest elevations of the Kaibab Plateau, dry mixed conifer is intermingled with infrequent fire (wet) mixed conifer and spruce-fir with mixed severity fire regimes. Even in these mixed fire regime areas, large stand-replacing fires are uncharacteristic. The historic size of stand-replacing fires on the Kaibab Plateau is less than 240 acres, with a median size of 15 acres (Vankat 2004).

In the frequent fire mixed conifer forests, canopy cover is denser and more continuous across developmental states than desired conditions. The primary threat is uncharacteristic, high-severity wildfire. As with ponderosa pine, when fires occur under current conditions, they are more likely to result in high mortality of large and old trees, and further departure from desired conditions. Testimony of this risk can be seen in the fire effects of the Outlet and Warm Fires. The Outlet Fire in 2000 burned most of its 15,500 acres during the initial burning period pushed by high winds

from Grand Canyon National Park through NFS lands. The 40,500-acre Warm Fire in 2006, exhibited plume-dominated fire behavior and burned over 30,000 acres in one burning period in late June as the fire transitioned from the ponderosa pine type into dry mixed conifer. The time it would take to grow and restore the vegetation to desired conditions after such a fire, rather than from current condition, would be greatly increased. Insect or disease epidemics and drought represent secondary threats, which are also functions of increased tree density.

Aspen

Aspen is an important component of ponderosa pine, frequent fire mixed conifer, wet mixed conifer, and spruce-fir communities, where biophysical conditions are conducive. The desired conditions for aspen within these communities shift from smaller, more permanent patches at lower elevations to larger, more ephemeral patches at higher elevations. Aspen frequency and regeneration is rapidly declining and trending away from desired conditions due to increased conifer encroachment and dominance, drought, fire exclusion, and ungulate herbivory.

The decline and loss of the aspen component in the ponderosa pine vegetation type is of particular concern on the Williams Ranger District. The Tusayan Ranger District has only a few scattered aspen clones, which are also of concern, particularly because they are so rare. With the combined effects of ungulate browsing, insects, disease, severe weather events, and lack of fire disturbance, aspen decline is expected to continue. Aspen appears to be much less departed on the North Kaibab Ranger District. On the North Kaibab Ranger District, following stand-replacing events (shelterwood seed cuts and high-severity wildfires in ponderosa pine and frequent fire mixed conifer), aspen has expanded. Great Basin grasslands are mostly found at the lowest elevations of the Williams and Tusayan Ranger Districts, and are surrounded by sagebrush or pinyon-juniper. They occupy 44,200 acres of the forest. Semidesert grasslands cover about 25,000 acres on the lower and west and east sides of the North Kaibab Ranger District.

These grasslands range from small patches less than 10 acres to large areas covering thousands of acres. They contain several plant associations with varying dominant grasses and herbaceous species. The reference fire regime for grasslands is typically driven by the fire regime of the surrounding forest type. Those adjacent to ponderosa pine or frequent fire mixed conifer have a high frequency fire return interval of less than 35 years. Those surrounded by wet mixed conifer and spruce-fir likely only burned at the edges (Johnson 1998) and far less frequently.

Grasslands are much less abundant than they were historically, which reduces the amount of available habitat for grassland-associated species. Primary threats to this vegetation community are conifer encroachment d and regenerated in apparently uncharacteristically large patterns. These responses probably enhance rather than threaten the aspen population over time.

Grasslands

Three primary grassland PNVTs appear on the Kaibab NF. Montane/subalpine grasslands on the forest range in elevation from below 7,200 feet to above 10,000 feet, and are found primarily on the North Kaibab and Williams Ranger Districts. They occupy about 40,800 acres of the forest. Great Basin grasslands are mostly found at the lowest elevations of the Williams and Tusayan Ranger Districts, and are surrounded by sagebrush or pinyon-juniper. They occupy 44,200 acres of the forest. Semidesert grasslands cover about 25,000 acres on the lower and west east side of the North Kaibab Ranger District.

These grasslands range from small patches less than 10 acres to large areas covering thousands of acres. They contain several plant associations with varying dominant grasses and herbaceous species. The reference fire regime for grasslands is typically driven by the fire regime of the surrounding forest type. Those adjacent to ponderosa pine or frequent fire mixed conifer have a high frequency fire return interval of less than 35 years. Those surrounded by wet mixed conifer and spruce-fir likely only burned at the edges (Johnson 1998) and far less frequently.

Grasslands are much less abundant than they were historically, which reduces the amount of available habitat for grassland-associated species. Primary threats to this vegetation community are conifer encroachment, lack of characteristic fire disturbance, and limited nutrient cycling. The montane/subalpine grasslands on the North Kaibab Ranger District are long and narrow. As a result of their shape, encroachment from the edges is of particular concern, as they could transition from grassland to forested area at a rapid rate. Under the current disturbance regime and current rate of management, further departures are expected. Excessive ungulate pressure may also play a role in some areas.

Revision Topics Addressed in this Analysis

The Comprehensive Evaluation Report (CER) (KNF 2009) was prepared in April 2009 to evaluate the needs for change in light of how management under the current Kaibab NF forest plan was affecting the current conditions and trends related to sustainability. This CER is based upon the Ecological Sustainability Report (KNF 2008a), and the Social and Economic Sustainability Report (KNF 2008c) which describe the social, economic, and ecological conditions and trends across the forest.

An internal management review of this CER was conducted in December 2008 to determine which needs for change issues would be carried forward into plan revision. The forest leadership team identified four priority topics that focus the scope of the Kaibab NF's plan revision. These topics reflect the priority needs and potential changes in program direction that are emphasized in the development of the revised forest plan components. They are:

- Modify forest structure and species composition to restore or maintain sustainability and restore historic fire regimes.
- Regenerate aspen to ensure long-term healthy aspen populations.
- Restore natural waters and wetlands to ensure healthy riparian communities.
- Restore grasslands by reducing tree encroachment and restoring fire.

The priority need for change to protect seeps, springs, and ephemeral wetlands is not addressed directly in this analysis. However, the objectives in the action alternatives for modifying stand structure and density toward desired conditions and restoring historic fire regimes, which is addressed in this section, plays an indirect role in protecting seeps and springs under the action alternatives as they would make progress toward the desired vegetation surrounding seeps and springs, thereby promoting hydrologic function (Baker and Ffolliot 2003).

Though not identified in the CER, the management review by the forest leadership team identified several additional items to address in the proposed forest plan. Only one is addressed in this section, as it has strong ties to fire and vegetation condition:

- Management response in the years immediately following large disturbance events.

A brief discussion of each revision topic follows, identifying the needs for change from the current condition.

1. Modify Stand Structure and Density Toward Desired Conditions and Restore Historic Fire Regimes

This need for change addresses the following current conditions:

- Ponderosa pine is more even-aged and less multistoried than the desired conditions.
- The larger and older trees (greater than 24 inches) are less frequent than desired in many areas, especially on the Williams and Tusayan Ranger Districts.
- Tree density has increased in all but the largest size classes of trees over the past 100 years in much of the ponderosa pine and frequent fire mixed conifer vegetation type on the Kaibab NF.
- There has been an increase in shade-tolerant species over the past 100 years in frequent fire mixed conifer vegetation communities. This has resulted in a shift in the dominant tree species, which was historically ponderosa pine.
- Spatial homogeneity is greater than the desired conditions for ponderosa pine and most mixed conifer.
- Understory vegetative cover and diversity are much lower than reference conditions.
- Increases in ladder fuels (generally small suppressed trees), canopy bulk density, canopy cover, and fuel loading have resulted in a marked increase in the total number of acres burned by uncharacteristic, high-severity wildfire.
- Areas affected by large, high-severity fires usually have significantly reduced seed sources and are unable to regenerate on their own without planting.
- There is a moderate risk of uncharacteristic insect and/or disease outbreaks, which is also a function of increased tree density.

The major vegetation communities addressed in this analysis are ponderosa pine and frequent fire (dry) mixed conifer, the second and third largest vegetation communities on the forest. Together they cover around 43 percent of the forest. The aspen component of ponderosa pine and mixed conifer, and grasslands are also addressed.

This analysis does not address the pinyon-juniper, mesic mixed conifer, spruce-fir, or other 14 vegetation types on the forest. No objectives were developed for any of the alternatives for these vegetation types. This is because the forest has a limited capacity for implementing treatments during the planning period and has prioritized where the work is most needed. It does not prevent treatments from being planned and implemented in these areas as funding and personnel become available. Since no objectives were developed for these other vegetation types and there are no differences between alternatives, no quantitative comparison of alternatives was conducted.

Resiliency and Adaptation to Climate Change

Modifying forest structure toward desired conditions and restoring historic fire regime is more important in light of the uncertainty of climate prediction. The alternative that makes the most progress toward this need for change would likely provide the best resiliency and adaptation in ponderosa pine and frequent fire mixed conifer in the face of a changing climate.

Uncertainty here does not refer to unlikelihood or to lack of knowledge, but rather the possibility of more than one outcome (West et al. 2009). Climate models provide a range of possibilities that vary according to assumptions in the climate model used, and the social assumptions about future greenhouse emissions. Modeling done for the southwestern United States, however, does show consistency in several areas. Current drought levels may become the norm; water-stressed forests would be more prone to large-scale pathogen attacks; at the lower elevations of the vegetation types where they are most stressed, uncharacteristic disturbances may occur; hotter, drier environments are likely to enhance the size and severity of wildfires, and fire disturbance would increase; post-fire vegetation is likely to be less like the historical forest as severe disturbances favor states such as grasslands and shrublands over pine forest. The ponderosa pine and mixed conifer vegetation types are likely to migrate northward and upward in elevation (Fulé 2008).

Some have questioned if restoration toward reference conditions is relevant or useful at a time when climate may change dramatically. Fulé (2008) suggests that reference conditions should not be regarded simply as a snapshot of what existed for a couple thousand years prior to human-caused degradation, but in a long-term functional view as the result of evolutionary processes. Prior to recent fire suppression, fire-adapted pine forests of western North America were among the most frequently burned in the world. From this perspective of evolutionary history, frequent fire played a role in developing fire adaptations in pine species. Fire will likely continue to play a role as an agent of ecosystem maintenance, as with surface fire, or as an agent of change, as with stand-replacing fire. Ponderosa pine and frequent fire mixed conifer, have already exhibited great flexibility and adaptation over the millennia, occupying a variety of climates, and are not necessarily fragile. As we move into what is predicted to be a more fire-prone environment, “it makes sense to use fire and fire-related characteristics of structure and composition to enhance resistance to loss and facilitate migration” (Fulé 2008).

Management approaches that enhance ecosystem resiliency and ability to adapt during climate change include (Fulé 2008, West et al. 2009):

- Reducing uncharacteristic disturbances.
- Allowing disturbances that promote adaptation and biodiversity.
- Reducing anthropogenic stresses.

The primary anthropogenic stress to ponderosa pine and mixed conifer vegetation communities has been a century of fire suppression in conjunction with past unsustainable grazing practices. The result is that the ponderosa pine and dry mixed conifer vegetation communities are highly departed from reference conditions on the Kaibab NF and other forests in the Southwest. These forest types are denser, with greater canopy bulk density and canopy continuity, making them more susceptible to uncharacteristic stand-replacing fires. Restoring the historical high-frequency, low-intensity fire regime would counter this anthropogenic stress.

Modifying stand structure reduces the canopy bulk density, reduces canopy continuity with the creations of interspaces, or openings, and promotes an abundant grass/forb understory that, in turn, promotes the high-frequency, low-intensity historic fire regime. “Restoration of patterns of burning and fuels/forest structure that reasonably emulate historical conditions prior to fire exclusion is consistent with reducing the susceptibility of these ecosystems to catastrophic loss” (Fulé 2008). In the reference conditions, stand-replacing fires do not occur even during periods of elevated fire danger. The beneficial effects of more open stands and restoring historic fire regimes are already being realized on the Tusayan Ranger District. The ponderosa pine type on this

district is less highly departed than on the other two districts, and the majority of the pine type has had one to several fire entries in the past 15 years. In areas that have already seen one fire disturbance or more in that time period, wildfires have been able to perform their natural role as a disturbance factor even during the traditional peak of fire season in late June. This is true in parts of the Williams Ranger District as well. It is not uncommon on the forest to have wildfires and prescribed burns being used to achieve resource benefits on one part of the forest, while suppression action is being taken on multiple or large wildfires in other more departed areas.

Continued application of wildland fire, from both prescribed burns and wildfires, mimicking the historic fire regime allows fire to continue to enhance resistance to loss and to facilitate natural (evolutionary) adaptation and migration as climate changes.

2. Protect and regenerate aspen.

This need for change addresses the following current conditions:

- Aspen is declining as a component of the ponderosa pine and frequent fire mixed conifer vegetation communities, particularly on the Williams Ranger District. With the combined effects of ungulate browsing, insects, disease, severe weather events, and lack of fire disturbance, aspen decline on the Williams and Tusayan Ranger Districts is expected to continue.

3. Restore grasslands by reducing tree encroachment in grasslands and meadows.

This need for change addresses the following current conditions:

- Grasslands are less abundant than they were historically due to limited nutrient cycling and conifer encroachment associated with the lack of characteristic fire disturbance.
- Tree encroachment is of particular concern in the montane/subalpine grasslands on the North Kaibab Ranger District. Because the montane/subalpine grasslands are long and narrow in shape; even limited tree encroachment from the edges can rapidly transition the area from grassland to a forested type.

4. Management response in the years immediately following large disturbance events.

The current plan contains limited guidance for responding to large disturbance events. Because there has been a trend toward larger, high-severity, uncharacteristic fires, this emerged as a priority need for change from the current plan. The size of these disturbed areas inhibits natural regeneration due to the distance to seed sources. The time to regenerate, grow, and return to reference conditions is indefinite and likely measured in centuries.

Disturbance events large enough to inhibit natural regeneration, other than high-severity fires, have not been documented on the forest, with the possible exception of one or two tornado paths on the Kaibab Plateau. In the case of tornadoes, the narrowness of the paths of disturbance may have allowed natural regeneration from seed sources along the edges, but the areas were reforested with planted trees, so natural regeneration rates in these narrower areas is still uncertain.

Insects and disease outbreaks, drought, and other stressors accompanying climate change may play a larger role in the future as large-scale disturbances may also create areas which do not regenerate naturally.

Short- and long-term adverse outcomes from stand-replacing fire in the ponderosa pine and frequent fire mixed conifer communities include:

- Substantial soil loss (over 2 inches on the Point Fire in 1993, for example).
- Associated soil productivity loss.
- Associated flooding, damage to water diversions and other improvements.
- Displacement of native understory species by nonnatives.
- Little or very slow recovery of desired tree species and stand structure.
- Uncharacteristically high accumulations of large fuels in frequent fire PNVTs.

Description of Alternatives

Alternative A, Current Plan, and Current Management (No Action)

Under alternative A, no changes would be made to the current Kaibab NF Land and Resource Management Plan and management practices would continue at current rates. The current plan contains very few goals that describe the desired conditions for any of the forest's vegetation resources.

Guidelines for vegetative management in the current plan include recommendations for managing northern goshawk habitat and its prey. These guidelines specify that the forest manage for uneven-aged stand conditions, and retain live reserve trees, snags, downed logs, and woody debris levels throughout woodland, ponderosa pine, mixed conifer, and spruce-fir forest cover types. The current plan has guidelines with implied desired conditions for a specific size class distribution, which uses vegetative structural stage (VSS) to describe dominant tree size in six diameter size classes: VSS1 (0 to 0.9 inch) or regeneration, VSS 2 (1 to 4.9 inches), VSS 3 (5 to 11.9 inches), VSS 4 (12 to 17.9 inches), VSS 5 (18 to 23.9 inches), and VSS 6 (greater than 24 inches). VSS class is determined by the predominance of the tree size class. The guideline for a specific distribution of VSS for ponderosa pine, mixed conifer, and spruce-fir forests is 10 percent each in VSS 1 and VSS 2, and 20 percent each in VSS 3, VSS 4, VSS 5, and VSS 6, where all VSS classes are within 3 percent of the desired distribution. Ponderosa pine canopy cover outside post-fledging family areas should average 40 percent or more in VSS 4, VSS 5, and VSS 6 forest. Inside post-fledgling family areas, VSS 4 should have one-third 60 percent or more and two-thirds 50 percent or more. In VSS 5 and VSS 6, canopy cover should average 60 percent or more. The plan also describes opening size and reserve tree requirements (a specified number of trees retained according to opening size) by forest type. These guidelines have had differing interpretations, which has resulted in difficulty with implementation.

Alternative A identifies about 400,000 acres of land that is managed for timber production. Currently, the forest mechanically thins about 2,100 acres a year in ponderosa pine and around 200 acres per year in frequent fire mixed conifer to alter or restore stand structure.

The current plan was signed before the 1995 Federal Wildland Fire Policy was enacted, and does not have objectives for acres to be treated with prescribed burns or wildfires exhibiting beneficial

fire effects. In the late 1970s, the understanding and acceptance of the role of fire in the ecosystem emerged, and fire managers on the Kaibab NF began to implement prescribed burns. Currently, fire managers burn an average of 8,500 acres per year with prescribed fire and manage wildfires to achieve multiple objectives on an average of 11,700 acres per year, totaling an average of 20,000 acres per year that receive beneficial fire disturbance.

In Mexican spotted owl critical habitat on the North Kaibab Ranger District, which includes all the mixed conifer vegetation type, suppression action must be taken on all wildfires in accordance with the terms and conditions associated with the wildland fire use amendment to the plan in 2000. On the Williams Ranger District, the wildland fire use amendment of the current plan (2000) includes prescriptive restrictions defining when wildfires must be suppressed in Mexican spotted owl habitat.

Other restrictions of wildfire management in the current plan include suppressing all wildfire starts within a 2-mile radius of North Canyon Spring in Saddle Mountain Wilderness on the North Kaibab Ranger District, within the 145-acre Frank's Lake Geologic-Botanical Area (also on the North Kaibab Ranger District), and within the 490-acre Arizona Bugbane Area on the north aspect of Bill Williams Mountain on the Williams Ranger District.

The current plan does not contain objectives for restoring or monitoring aspen. However, aspen restoration projects have been occurring and are expected to continue because aspen is recognized as an important and declining resource on the Williams Ranger District. Also, the current plan contains no objectives for restoring grasslands. Grassland restoration has been occurring at a slow and variable rate.

In ponderosa pine and frequent fire mixed conifer forests, uncharacteristic openings following large disturbance events, such as high-severity fires, are so slow to recover desired forest structure that some management effort is required to begin the progress toward desired conditions. The current plan contains no objectives or guidelines to provide direction for actions in the years immediately following large disturbance events.

Description of Alternative B, Preferred Alternative

The preferred alternative would accelerate the rate of mechanical treatment, and shift the focus of mechanical thinning treatments over the next decade to larger scale dense forest areas where effective modification of stand structure toward reference conditions can be implemented.

Objectives under this proposal would increase the rate of mechanical thinning (primarily using group selection cuts with matrix thinning) to average 11,000 to 19,000 acres annually in ponderosa pine and 1,200 to 2,100 acres annually in frequent fire mixed conifer. This alternative includes the following guidelines for vegetation management in all forested communities and guidelines for forestry and forest products:

- Projects in forested communities that change stand structure should generally retain at least historic frequencies of trees by species across broad age and diameter classes at the mid-scale. As such, the largest and oldest trees are usually retained.
- On suitable timberlands, projects should retain somewhat higher frequencies of trees across broad diameter classes to allow for future tree harvest.
- Project design should manage for replacement structural stages to assure continuous representation of old growth over time.

- Project design and treatment prescriptions should generally not remove:
  - Large, old ponderosa pine trees with reddish-yellow, wide platy bark, flattened tops, with moderate to full crowns and large drooping or gnarled limbs (e.g. Thomson's age class 4, Dunning's tree class 5 and/or Keen's Tree Class 4, A and B [proposed plan appendix C]).
  - Mature trees with large dwarf mistletoe induced witches' brooms suitable for wildlife nesting, caching, and denning, except where retaining such trees would prevent the desired development of uneven-aged conditions over time.
  - Large snags, partial snags, and trees (>18 inches d.b.h.) with broken tops, cavities, sloughing bark, lightning scars >4″ wide, and large stick nests (>18 inches in diameter).
  - Gambel oak >8 inches d.r.c.
  - Known bat roost trees.
- The location and layout of vegetation management activities should effectively disconnect large expanses of continuous predicted active crown fire.
- Vegetation *management prescriptions* should provide for sufficient canopy breaks to limit crown fire spread between groups, allow for the redevelopment and maintenance of a robust understory, and mimic the spatial arrangement of the reference conditions.
- Vegetation management activities in mixed conifer forests should incorporate experimental design features and monitoring to accelerate learning and adaptive management.
- Trees established after 1890 should generally not be retained in areas where biophysical conditions would have supported stable openings over time.
- Vegetation management activities should meet or exceed goals for scenic beauty (*scenic integrity objectives*) by creating natural patterns, structure and composition of trees, shrubs, grasses, and other plants.
- Vegetation management should favor the development of native understory species in areas where they have the potential to establish and grow.
- *Even aged silvicultural practices* may be used as a strategy for achieving the desired conditions over the long term, such as bringing dwarf mistletoe infection levels to within a sustainable range, or old tree retention.
- Seed and plants used for revegetation should originate from the appropriate PNVT and general ecoregion (i.e. southern Colorado Plateau) as the project area.
- Timber harvest activities should be carried out in a manner consistent with maintaining or making progress toward the desired conditions in this plan.
- Harvesting systems should be selected primarily for their ability to meet desired conditions and not on their ability to provide the greatest dollar return, although cost efficiency and practicality in terms of transportation and harvest requirements should also be considered.
- On suitable timber lands, timber harvest activities should only occur when there is reasonable assurance of restocking within 5 years after final regeneration harvest.
- On suitable timber lands, even-aged stands should have reached or surpassed 95% of the culmination of mean annual increment prior to having a regeneration harvest, unless it is needed to reduce fire hazard within the wildland-urban interface, or would contribute toward achieving the desired uneven aged vegetation conditions over the long term.

- On lands classified as not suited for timber production, timber harvesting should only be used for making progress toward desired conditions or for salvage, sanitation, public health, or safety. Heavy equipment and log decks should not be staged in montane meadows.

This alternative includes wildland fire objectives for the ponderosa pine and mixed conifer vegetation communities. In ponderosa pine, an average of 13,000 to 55,000 acres per year would be treated with wildland fire, whether from prescribed burns or wildfires exhibiting beneficial fire effects. In mixed conifer, an average of 1,000 to 13,000 acres would be treated with wildland fire. The only guideline directing suppression action on wildfires would be for fires in the desert communities of Kanab Creek Wilderness. The desert communities PNVT did not evolve with fire. Suppression in this area would also limit further noxious weed invasion, particularly cheatgrass. In all other areas, wildfires could be allowed to function in their natural role as a disturbance process when weather and fuel conditions are appropriate, and current and expected fire effects are desirable.

The preferred alternative includes objectives to fence 200 acres of aspen within 10 years of plan approval and reduce conifer encroachment on 800 acres of aspen within 10 years of plan approval.

The preferred alternative identifies 6,238 acres of potential wilderness areas, all of which would be recommended additions to existing or proposed wilderness.

The preferred alternative identifies about 381,309 acres of land to be managed for timber production. This is about 19,000 acres less than alternative A. The differences are those areas that would be restored and maintained as grasslands, areas that are not cost efficient, and areas managed for recommended wilderness (see appendix C, Timber Suitability Calculation.)

The preferred alternative includes an objective to replant an average of 300 to 700 acres annually to restore forest structure in uncharacteristic openings following large-scale disturbances in ponderosa pine and frequent fire mixed conifer forests.

Description of Alternative C

Alternative C is the same as the preferred alternative, except:

- Alternative C would replace the proposed old tree retention guideline with “Projects should not cut trees with physical characteristics typical of those that were established prior to 1890 (i.e., generally larger than 16 inches in diameter at breast height, with yellowing platy bark).” The differences between the old tree retention guidelines in alternatives B and C are subtle; they have the same intent to generally retain large old trees, but implementation of this Alternative C guideline would result in leaving all presettlement trees regardless whether they would meet other desired conditions such as uneven aged stands, reduced risk of stand-replacing wildfire, or insect and diseases within endemic levels.
- It would establish a new management area on the North Kaibab Ranger District called the North Kaibab Wildlife Habitat Complex. This area is approximately 260,000 acres and includes most of the Kaibab Squirrel National Natural Landmark, and eight linked ephemeral riparian valleys and canyons. In this management area there would be a guideline that states “Mechanical thinning would be used initially to restore the desired

forest structure to the extent possible. Thereafter, the desired conditions should primarily be maintained with fire and other natural disturbances." Because this area would not be managed for timber or biomass production, it would be removed from the suitable timber base.

- In addition to the wilderness recommended in the proposed action (6,238 acres), this alternative proposes five new potential wilderness areas and one small addition to adjacent potential wilderness (37,888 acres), for a total of 44,126 acres.
- Because the area in the North Kaibab Wildlife Habitat Complex and recommended wilderness would not be managed for timber production, the acres of suitable timber would be reduced from 381,309 to about 230,349 (see appendix C).

Description of Alternative D

Alternative D is the same as the preferred alternative, except:

- Forest-wide, the stand structure would be restored to desired conditions using a combination of mechanical thinning treatments and wildland fire, to the extent possible. Thereafter, desired conditions would be largely maintained with wildland fire. No lands would be managed for timber or biomass production (see appendix C).
- This alternative proposes the same presettlement tree retention guideline and recommended wilderness areas as alternative C.
- This alternative proposes the same recommended wilderness areas as alternative C.

Methodology and Analysis Process

Vegetation composition and structure are used to evaluate or predict a number of ecosystem functions related to the priority needs for change. These include the likelihood of various types of disturbance and succession, species habitats, and social and economic values. A number of sources were used to inform current conditions. Various models were used to predict trends in vegetation and disturbances in response to natural and anthropogenic forces by alternative. Alternatives are evaluated in relation to their progress toward priority needs for change and associated desired conditions.

The primary sources for existing vegetation conditions are:

- A potential natural vegetation type (PNVT) classification, based primarily upon the map units from the terrestrial ecosystem survey was developed and used to compare existing vegetation to characteristic vegetation. Characteristic vegetation is the vegetation composition and structure that would exist under a natural disturbance regime, and is considered to be ecologically sustainable and more resilient to climate change.
- A mid-scale vegetation map of existing vegetation, completed in 2008 across the Coconino and Kaibab NF s provided geospatial polygons with characteristics of life form (tree, shrub, grass/forb), size class (for trees), and canopy cover class.
- Forest inventory and analysis (FIA) plot data were used primarily to calibrate the Vegetation Development Dynamics Tool (VDDT) model, to estimate relative proportions of even- and uneven-aged conditions on the forest, and to estimate proportions of various types within pinyon-juniper systems.
- Field-sampled vegetation data gathered on the Kaibab NF.

- Stand-replacing fire area over time (frequency) for the Kaibab NF and across the national forests along the Mogollon Rim.

The VDDT was the primary model used to evaluate trends. VDDT is a state and transition modeling tool that provides a framework for examining the role of various disturbance agents and management actions on defined vegetation state changes. The interaction of human activity, fires, insects, pathogens, growth, and competition is complex, and the combined effects are difficult to predict over long periods. VDDT allows for testing of the sensitivity of the ecosystem to a variety of activities and agents of disturbance to enable a comparison of alternatives.

The outcomes for all alternatives were compared against the desired conditions in the Kaibab NF proposed plan, which consist of the Forest Service Region 3 desired conditions, and some additional Kaibab NF specific desired conditions. To compare how well each alternative addresses the priority needs for change, evaluation criteria were developed for each priority need for change.

Assumptions

In addition to the assumptions made for all of the effects analyses in this chapter, the vegetation analysis makes the following assumption:

- The population and calibration of VDDT using FIA plots and Forest Vegetation Simulator (FVS) modeling of growth and disturbances represents the response of forested PNVTs well enough to compare these responses in a relative way to mid- and landscape-scale desired condition attainment.
- Alternative B is modeled using group matrix thinning. Alternatives C and D are modeled for thinning to a 16-inch diameter cap because of the large tree retention guideline that calls for generally retaining all pre-settlement trees established prior to 1890. Pre-settlement trees can often be identified by having the plated yellow bark frequently exhibited by these large old trees, rather than the rougher black bark exhibited by younger pines. The models used for comparing alternatives do not have the ability to select on bark characteristics. As a result, these alternatives were modeled with a 16-inch diameter maximum as a conservative surrogate for age. Additionally, it is likely that prescriptions developed to meet this guideline would be written as a diameter cap because size is easier than age to determine in the field. Group selection matrix thinning and thinning to a diameter cap are equally effective in stands where there is a lack, or a desired number, of large trees. However, when thinning to a diameter cap in stands that already have many large trees, it becomes necessary to remove most or all the smaller trees to achieve the desired openness of a stand.

Evaluation Criteria

The environmental consequences for each alternative were evaluated using criteria that reflect how well each alternative addresses the priority needs for change and desired conditions for the vegetation community. For more detail about the processes and assumptions of this analysis, see appendix B.

Evaluation criteria for **Modify stand structure and density toward desired conditions and restore historic fire regime:**

The mid-scale desired condition for these communities includes an open, uneven-aged forest with all age classes and structural stages present. Evaluation criteria for ponderosa pine and frequent fire mixed conifer communities are:

- **Frequency of the desired structural state** (state K in the VDDT analysis) is one of the 14 vegetative structural states developed for ponderosa pine and dry mixed conifer VDDT models. It represents the large, open, multistoried state in the mid-scale desired conditions. This is expressed as the percentage of the vegetation type in the desired structural state at each time mark for each alternative.
- **Time Departure Index**. This index is a measure of the relative time to attainment of desired structural state from all other VDDT states. The principle behind this index is that it takes more time for some states to grow or be treated to attain the desired structural state than it does others. For example, an open state with only seedlings and saplings would take much longer to grow and develop into the desired structural state than it would to thin a closed, multistoried, uneven-aged stand to achieve the same state. The highest value possible is 1 if all the vegetation types were in state K. The higher the value for this index, the less time that alternative is expected to take to move toward the desired condition.
- **Density Departure Index**. This relative index is an indicator of the relative risk of uncharacteristic loss of forest structure using an index sensitive to tree density and to dominant tree size selection. This index represents the potential for an immediate threat posed from density dependent disturbance, such as active crown fire. The highest value is 1, which would indicate the least density departure.

The fine-scale desired conditions for these communities include a composition of irregularly spaced groups of trees surrounded by openings composed of a grass-forb-shrub mix. Trees within groups have similar or variable ages, and groups are typically less than 1 acre in size. The fine-scale states, therefore, have high interspersion of clumps of trees and openings. The evaluation criterion is:

- **Interspersion Creation Index**. This index is an indicator of the relative frequency of application of treatments, such as group selection with matrix thinning or burning with moderate fire effects that create the fine-scale structural state interspersion in the desired conditions. Currently, there is much less interspersion (fine-scale heterogeneity) than desired. The highest value of this index is 4, indicating a very high frequency of treatment application likely to produce the desired fine-scale heterogeneity of structural states.

Percent of potential understory abundance is an important indicator of the ability to carry frequent surface fire. Understory vegetative cover is lower than historic conditions. The evaluation criterion is:

- **Understory Abundance Index**. This index is based on tree overstory basal area and canopy cover relationships to understory productivity. It is expressed as a percentage of potential understory productivity, where the highest rating would be 100 percent.

The desired fire behavior is the same for ponderosa pine and frequent fire mixed conifer. Fires burn as a surface fire under all weather scenarios, but single tree torching and isolated group torching are not uncommon (passive crown fire). Fire does not spread from group to group as active crown fire. Canopy bulk density and canopy cover

continuity determine the potential for undesirable active crown fire. Lower crown bulk density, and gaps and interspaces among groups of trees, inhibit the spread of active crown fire from group to group. The evaluation criterion for desired fire behavior is:

- **Percent of Open States**. This criterion is the sum of the percentage of the vegetation type modeled to be in the VDDT open states (states A, B, C, D, E, J, K, and N), with 30 percent crown cover or less at each year mark. Open states promote surface fire over active crown fire. It is also an indicator of the amount of particulate emissions that would result from a wildfire, with surface fires producing less than crown fires. The latter is addressed in depth in the Air Quality section of this chapter.

All criteria above are evaluated at the current, 10-year, 15-year, 50-year, and 250-year time marks.

Evaluation criteria for **Protect and Regenerate Aspen:**

- Acres of aspen fenced (with elk-proof construction) in ponderosa pine on the Williams and Tusayan Ranger Districts.
- Acres of reduced conifer encroachment on aspen in ponderosa pine vegetation communities.

Aspen clones in ponderosa pine and frequent fire mixed conifer across the Kaibab NF are likely to be more resilient—able to withstand droughts, regenerate in place, and to move gradually—when the surrounding forest is in a more characteristic condition than it currently is. State K is the larger, open, multistoried state that represents the characteristic condition. State J is similar to state K except the dominant trees are the next smaller tree size class in the model and nearing the characteristic condition. This evaluation criterion is evaluated at the current, 10-year, 15-year, 50-year, and 250-year time marks.

Evaluation criterion for **Restore Grasslands by Reducing Tree Encroachment:**

- Acres of grassland communities with tree canopy cover reduced below 10 percent. This evaluation criterion is evaluated at the current and 10-year time-marks.

Evaluation criterion for **Management Response in the Years Immediately Following Large Disturbance Events:**

Experience on the Kaibab NF has shown little success in recovery of forest structure following stand-replacing fire by relying upon natural regeneration processes. Conversely, planting has been quite successful, with about 69 percent success with any individual planting event in ponderosa pine (Higgins 2008). The evaluation criterion is:

- Acres planted reduces the time to achieve the desired stand structure.

This evaluation criterion is evaluated at the current, 10-year, 15-year, 50-year, and 250-year time marks.

Environmental Consequences

Table 5 presents the alternatives' predicted responses to the evaluation criteria for this need for change currently and at four future time marks for ponderosa pine. Table 6 does the same for

frequent fire mixed conifer. The values presented either come directly from the VDDT model outputs or from indices that use input directly from the model and other values derived from research (when available) or professional judgment. Additional information on the indices is documented in the VDDT analysis process in the Vegetation Specialist Report (KNF 2013a). Criteria indicators for tables 5 and 6 are:

Percent state K = percent of vegetation type in desired state

Time departure index = the relative time to attainment of the desired structural state

Density departure index = percent area at high risk of a density dependent disturbance, such as active crown fire

Interspersion creation index = fine-scale structural state interspersion of openings

Percent potential understory abundance = index of potential understory productivity based on tree overstory basal area and canopy cover relationships to understory productivity.

Percent in an unnatural open state = percent area in an “uncharacteristic” state following a high-intensity wildfire event

Percent in desired open states = total percent of vegetation at low risk of high-intensity wildfire

Table 5. Summary of the alternative vegetation responses for each criterion in ponderosa pine at four time marks. The response best meeting the desired conditions is shaded.

Criteria	Alternative	Time Mark (years)				
		0	10	15	50	250
Percent state K (mid-scale desired condition)	A	2	4	5	10	13
	B		16	20	28	29
	C		3	4	8	11
	D		3	3	10	12
Time departure index	A	0.55	0.55	0.55	0.58	0.58
	B		0.60	0.61	0.62	0.62
	C		0.54	0.55	0.59	0.58
	D		0.54	0.55	0.60	0.57
Density departure index	A	0.52	0.58	0.59	0.66	0.69
	B		0.67	0.70	**0.75**	0.76
	C		0.57	0.59	0.73	0.71
	D		0.57	0.60	0.76	0.68
Interspersion creation index	A	2.71	2.74	2.72	2.75	2.80
	B		3.73	3.71	3.68	3.71
	C		2.42	2.43	2.50	2.47
	D		2.42	2.43	2.60	2.69
Percent potential understory abundance	A	32	32.1	32.5	33.7	35.6
	B		35.9	36.5	37.4	37.9
	C		31.1	31.2	34.5	36.2
	D		31.3	31.4	35.8	38.4
Percent in an unnatural open state	A	2	2.1	2.1	2.1	3.7
	B		1.8	1.6	1.3	1.9
	C		1.9	1.8	1.7	4.2
	D		1.8	1.8	1.6	6.7
Percent in desired open states	A	36	46	48	59	67
	B		64	68	76	78
	C		42	46	68	70
	D		44	47	75	71

Table 6. Response of alternatives to evaluation criteria in frequent fire mixed conifer. The most desirable response is shaded.

Criteria	Alternative	Time Marks (years)				
		0	10	15	50	250
Percent state K (mid-scale desired condition)	A	0.5	3	4	7	9
	B		9	11	15	15
	C		4	5	7	8
	D		4	5	8	8
Time departure relative index	A	0.48	0.47	0.47	0.47	0.47
	B		0.49	0.49	0.49	0.48
	C		0.46	0.46	0.46	0.45
	D		0.46	0.45	0.45	0.44
Density departure relative index	A	0.43	0.43	0.44	0.45	0.45
	B		0.50	0.52	0.53	0.54
	C		0.49	0.50	0.51	0.51
	D		0.50	0.51	0.51	0.51
Interspersion creation index	A	1.6	2.5	2.5	2.6	2.6
	B		3.0	3.1	3.1	3.1
	C		2.4	2.4	2.6	2.6
	D		2.5	2.4	2.7	2.6
Percent potential understory abundance	A	34.4	29.0	29.2	30.0	29.6
	B		33.0	33.7	34.1	33.9
	C		32.3	32.7	32.9	32.7
	D		33.4	33.7	33.8	33.5
Percent in an unnatural open state	A	12.0	11.5	11.4	12.1	21.5
	B		11.4	11.2	11.5	19.0
	C		11.4	11.2	12.0	20.1
	D		11.4	11.2	13.0	24.1
Percent in desirable open states	A	33	28	30	34	43
	B		43	47	52	59
	C		41	44	46	50
	D		44	47	47	53

Environmental Consequences for Vegetation, Fuels, and Fire

Alternative A – Current Plan, Current Management (No Action)

Under alternative A, there is progress toward the desired open, multistoried, uneven-aged condition at the mid-scale in ponderosa pine, but the rate is not sufficient to reduce the threat of uncharacteristic wildfire, or to open the canopy to allow for a response in understory production.

In ponderosa pine, the percent of the area in the desired structural state increases from the current condition of 2 percent to 4 percent in 10 years. At the 50-year time mark, the area in state K increases to 10 percent. In frequent fire mixed conifer, the percent of the area in the desired structural state rises 0.5 percent to almost 3 percent within 10 years. At the 50-year time mark, it increases to 7 percent.

The percentage of the ponderosa pine and frequent fire mixed conifer in the desired state K is 12 to 18 percent lower at all time marks than in alternative B, the preferred alternative. This is due to the lower rate of mechanical thinning treatments under current management practices to achieve desired stand structure.

The temporal departure index is lower than the preferred alternative at all time marks indicating that the relative time to attain the desired open, uneven-aged condition is longer. This, again, is due to the lower application of mechanical thinning treatments.

The density departure index is also lower than the preferred alternative at all time marks in ponderosa pine and frequent fire mixed conifer. This indicates a greater risk of density-dependent uncharacteristic disturbance, such as active crown fire. The rate of treatment to improve stand structure in alternative A is too slow to make a difference, so density does not improve over time.

The interspersion creation index is lower than the preferred alternative at all time marks, because alternative A has a lower rate of application of treatments that create fine-scale heterogeneity.

The percentage of relative potential understory productivity is somewhat lower at all time marks than in the preferred alternative. The abundance of fine fuels that carry the desired low-intensity, high-frequency fires would be lower than under the preferred alternative.

This alternative has a lower percentage of area in open states that promote surface fire over active crown fire than the preferred alternative. It has the least percentage in desirable open states of all alternatives at the 50- and 250-year time marks in ponderosa pine, and at all time marks in frequent fire mixed conifer. The percentage of area in the ponderosa pine type in open states is 11 to 20 percent lower under this alternative than in the preferred alternative, and 15 to 18 percent less of the area is in open states in frequent fire mixed conifer. The higher percentage of closed states, with canopy cover greater than 30 percent, under this alternative indicates a corresponding high risk of uncharacteristic wildfire. Lower understory abundance diversity and abundance is also indicated by this criterion.

Under alternative A, the guideline in the current plan for vegetation structural state intended to provide for uneven-aged stands with sustainable age and size class distribution over time, has had differing interpretations, which has resulted in difficulty in implementation. Project design has often used more conservative prescriptions to ensure the guidelines are met, which has resulted in

leaving tree densities that are higher than in the desired range, and this trend would be expected to continue.

Suppression action would continue to be taken on all wildfires in Mexican spotted owl critical habitat on the North Kaibab Ranger District, which includes all the mixed conifer vegetation type, in accordance with the terms and conditions associated with the wildland fire use amendment to the plan in 2000. The risk of transitioning most or all of this vegetation type to an uncharacteristic open state, with minimal natural regeneration, as the result of one or several high-severity wildfire incidents is high, as demonstrated by several large wildfires with undesirable stand-replacing results that have occurred during the past 15 years. The immediate risk of converting the entire mixed conifer type on the North Kaibab Ranger District to aspen or grassland as a result of one or a few high-severity fires would persist. These current plan restrictions would also reduce the ability to manage fires across administrative boundaries burning on the Kaibab Plateau between Grand Canyon National Park and the forest that could be used to reduce the risk of stand-replacing fires within both jurisdictions.

The prescriptive restrictions defining when wildfires must be suppressed in Mexican spotted owl habitat on the Williams Ranger District would continue to limit the opportunities to restore the historic fire regime, and to reduce the threat of high-severity wildfire to Mexican spotted owl habitat by managing wildfires to consume accumulated fuels when fire weather and fuel moisture conditions are appropriate.

Fires would continue to be suppressed within a 2-mile radius of North Canyon Spring in Saddle Mountain Wilderness on the North Kaibab Ranger District; within the 145-acre Frank's Lake Geologic-Botanical Area (also on the North Kaibab Ranger District); and within the 490-acre Arizona Bugbane Area on the north aspect of Bill Williams Mountain on the Williams district. Wildfires could not be managed to reduce the threat of high-severity wildfire to these biologically unique areas by managing wildfires to consume accumulated fuels when fire weather and fuel moisture conditions are appropriate.

Protect and Regenerate Aspen

Under alternative A and current management, there would be no objectives to fence areas of aspen on the Williams and Tusayan Ranger Districts, and no objectives for reducing conifer encroachment in aspen in the ponderosa pine type. Some aspen restoration treatments are occurring under the current plan and would continue under the no action alternative, but the rate of implementation is expected to be variable due to limited funding and competing resource needs. There are no guidelines for retaining large, old trees under the current plan, so the effectiveness of the treatments that would occur is expected to be good as competing conifers could be adequately removed during aspen restoration treatments.

As previously discussed, stands at or approaching the desired characteristic states J and K for ponderosa pine and frequent fire mixed conifer, promote the retention and regeneration of aspen. Table 7 presents by alternative the predicted frequency of these larger, open, multistoried states currently and at four future time marks.

Alternative A has considerably less area in states J and K than the preferred alternative at all time marks (table 6), with 20 to 25 percent less ponderosa pine area in states that promote the retention and regeneration of aspen, and 3 to 9 percent less area in states J and K in frequent fire mixed conifer.

Alternative A does not allow wildfires to play a natural role as a disturbance agent in the mixed conifer type on the Kaibab Plateau. Wildfires could not be used under appropriate conditions to encourage the regeneration of aspen in smaller, more ephemeral patches.

Table 7. Percent area in large, open, multistoried states over time for ponderosa pine and frequent fire mixed conifer. The greatest percent area in the desired states is highlighted.

Vegetation Type	Alternative	Percent Area at Time Mark (years)				
		0	10	15	50	250
Ponderosa pine	A	9	12	13	15	17
	B		32	36	40	40
	C		8	8	10	13
	D		9	9	11	16
Frequent fire mixed conifer	A	1	6	12	14	16
	B		15	18	20	19
	C		7	8	11	12
	D		8	9	13	12

Restore Grasslands

Under alternative A and the current plan, there would continue to be no specific plan direction or objectives governing the removal of encroaching trees from grasslands. Some grassland restoration would likely be accomplished without plan objectives if funding is available, but probably not to the extent that is expected under the action alternatives.

The 8,174 acres of grassland currently managed for timber production would continue to be managed as part of the suitable timber base.

Management Response to Large Disturbance Events

The current plan has no objectives for planting after large disturbance events. The current rates of planting would not meet the need for making progress toward the desired stand structure following stand-replacing fire under the estimated probability of occurrence. If the climate gets warmer and drier, trends away from desired conditions are anticipated to be exacerbated.

Environmental Consequences for Vegetation, Fuels, and Fire: All Action Alternatives

Modify Stand Structure Toward Desired Conditions and Restore Historic Fire Regime

Objectives under all action alternatives would mechanically thin 11,000 to 19,000 acres annually in ponderosa pine; and 1,200 to 2,100 acres annually in frequent fire mixed conifer. This increased rate of treatment in ponderosa pine and mixed conifer would change the trajectory from “static/away” to “toward” the desired conditions of open, multistoried, uneven-aged stand structure. The more open canopy would promote an increase in understory diversity and abundance. Openings in the canopy would break up continuous live fuels and promote surface

fire behavior, which would reduce the risk for high-severity wildfires and uncharacteristic large openings that do not regenerate naturally.

Ground disturbance and associated effects to understory vegetation would occur to varying degrees under all alternatives from the implementation of mechanical treatments. Related effects of ground disturbance are further discussed in the Nonnative Plant Specialist Report (KNF 2013b) and in the Soil and Watershed Specialist Report (KNF 2013e).

Objectives under all action alternatives would treat an average of 13,000 to 55,000 acres in ponderosa pine, and an average of 1,000 to 13,000 acres annually in frequent fire mixed conifer using a combination of prescribed fire and naturally ignited wildfires. Increased management of low intensity wildland fire, both prescribed fire and managed wildfires, would restore the historic fire regime, increase resistance to uncharacteristic disturbances, enhance and maintain stand structure, and facilitate natural (evolutionary) adaptation and migration as climate changes. The full range of management responses to wildfires would be available across the forest, except in the desert communities where wildfire is not a characteristic disturbance. In fire-adapted ecosystems, fires could be managed for resource objectives when fuel and weather conditions are appropriate.

Smoke is a byproduct of prescribed burns and wildfires under all alternatives. While all alternatives are expected to meet the desired conditions for air quality in complying with State and Federal emissions regulations, the public tolerance for smoke is often reached long before health and visibility standards are exceeded. Air quality impacts are discussed further in the Air Quality Specialist Report (KNF 2012a).

All action alternatives have guidelines to retain at least historic frequencies of trees by species across broad diameter classes to provide for uneven-aged conditions with sustainable size-class distribution over time. Additionally, all action alternatives would generally not remove large, old trees (although to different degrees). These guidelines would support creating and retaining exist old growth as described in the desired conditions.

Protect and Regenerate Aspen

Under all the action alternatives, there are objectives to fence 200 acres of aspen and reduce conifer encroachment on 800 acres of aspen within 10 years of plan approval. Additionally, aspen regeneration and mortality are components in the monitoring plan. The objectives and guidelines in the action alternatives for aspen restoration would help to improve and maintain the aspen on the Williams and Tusayan Ranger Districts.

Restore Grasslands

Under all the action alternatives, there are objectives to reduce tree and shrub density in grasslands to less than 10 percent on 5,000 to 10,000 acres of historic grasslands annually. This emphasis on grassland restoration would make it a priority on the Williams and North Kaibab Ranger Districts. Overall, the amount of grassland restoration treatment is not expected to be different between the action alternatives and is not expected to be a driver for selecting one alternative over another.

Management Response to Large Disturbance Events

All action alternatives include the following guideline for management response to large disturbance events, “Where extensive mortality results from fires, insect epidemics, or wind events, and sufficient timber value exists, salvage of dead trees should be considered where it would facilitate meeting public safety objectives, and long-term restoration.” Economically, receipts from the sale of disturbance-killed trees can facilitate restoration work by offsetting the cost of such efforts. However, there is much conflicting research regarding the ecological value of salvage harvest and its associated impacts. The guideline for alternatives B, C, and D is worded such that salvage operations would be evaluated on a site-specific basis using the best available science post-disturbance.

All action alternatives include an objective to replant an average of 2,500 acres annually disturbances in ponderosa pine and frequent fire mixed conifer vegetation types. This would help to restore forest structure in uncharacteristic openings where seed sources are depleted. Planting would decrease the time to achieve the desired structural conditions by augmenting natural generation.

Environmental Consequences for Vegetation, Fuels and Fire: Alternative B – Preferred Alternative

Modify Stand Structure Toward Reference Conditions and Restore Historic Fire Regime

In ponderosa pine, the percent of area in the desired structural state at the middle and landscape scale would go from its current condition of 2 percent of the vegetation type to more than 15 percent within 10 years. Within 50 years, this area is anticipated to nearly double, but then level off. In frequent fire mixed conifer, the percent of the area in the desired uneven-aged open, multistoried condition at the middle and landscape scale would move from its current condition of 0.5 percent of the vegetation type to almost 10 percent within 10 years. At the 50-year time mark, it is expected to increase to about 15 percent and then level off (table 5). Alternative B has nearly double the area in state K at all time marks of all other alternatives.

The index for time departure for alternative B indicates the least time for attainment of desired conditions at all time marks for both ponderosa pine and frequent fire mixed conifer. Overall, the differences between the alternatives are smaller for this evaluation criterion than other mid-scale desired condition attainment differences. This difference is due to modeling for group selection matrix thinning in alternative B versus diameter cap treatments. With thinning from below, it takes longer to achieve a multistoried state, if it is ever achieved. This is because when the smallest size classes are removed over time, it results in less age diversity in the stand.

The preferred alternative has the lowest density departure from the mid-scale desired conditions at all time marks except for at the 50-year time mark in ponderosa pine. Alternative B shows the least risk of density-related uncharacteristic disturbance, such as active crown fire over the four time marks. In alternative A, the rate of treatment to restore stand structure is too slow to decrease density over time. In alternatives C and D, without reentry with mechanical treatment into stands treated once with a diameter cap, trees continue to grow and become more dense over time.

This alternative has more fine-scale interspersion created at all time marks for both ponderosa pine and frequent fire mixed conifer. Differences between the preferred alternative and other alternatives are relatively large for ponderosa pine and moderate for mixed conifer. Group selection matrix thinning is more effective at creating uneven-aged groups of trees with interspaces and openings. Diameter cap thinning works against creating interspersion, as larger trees are retained in what could otherwise become an interspace. With reference condition interspaces, maintaining desired stand structure with fire alone might be possible. Without interspaces created and trees continuing to grow in interspaces, the forest becomes more dense, canopy bulk density and canopy cover increase, and the probability of active crown fire increases. In denser, departed states, fire is not effective at creating or maintaining stand structure on its own. Under low and moderate fire severity conditions, very few trees above the seedling size are thinned; under high-severity fire conditions, too many or all trees are removed.

The preferred alternative has the highest percentage of potential understory abundance at three of four time marks in ponderosa pine, and at all four in mixed conifer. This is a function of having the greatest amount of characteristic open states, such as interspaces between groups at the fine scale, and the most open states with less than 30 percent canopy cover. This understory abundance would best support the desired high-frequency, low-intensity fire regime. Differences for this evaluation criterion are smaller in mixed conifer than in ponderosa pine due to lower rates of treatment to create desired stand structure with interspaces.

Since alternative B has the highest percentage of open states, with 30 percent canopy cover or less at all time marks in both ponderosa pine and frequent fire mixed conifer, it also best promotes surface fire over active crown fire. Open states in ponderosa pine increase in 10 years from 36 percent of the vegetation type to 64 percent, and continue to gradually increase after that. In frequent fire mixed conifer, open states increase in 10 years from 33 percent to 43 percent, and again continue to gradually increase over time. It should be noted that the preferred alternative also has the least percentage of the unnatural open state from high-severity wildfire at all time marks.

This alternative contains a tree retention guideline to protect and retain large old trees with structural characteristics desirable for wildlife habitat to increase the numbers of these trees over time. This guideline is included in the preferred alternative because in many areas these types of trees are less abundant than in reference conditions and can take more than a century to replace if removed.

Protect and Regenerate Aspen

Alternative B includes the objectives to fence 200 acres of aspen and reduce conifer encroachment on 800 acres of aspen within 10 years of plan approval. This emphasis on aspen restoration would make it a priority on the Williams and Tusayan Ranger Districts.

This alternative has considerably more area in large, open states at all time marks than the other alternatives that would promote the retention and regeneration of aspen since aspen is a shade-intolerant species. The percent of ponderosa pine in these desirable states increases from 9 percent to 32 percent in 10 years, and continues to gradually increase over time. In frequent fire mixed conifer, the area in these states moves from 1 percent to 15 percent in 10 years, and again gradually continues to increase over time (table 6).

The tree retention guideline in alternative B is based on structural characteristics. This guideline only applies to a small percentage of trees and would not likely reduce the effectiveness of treatments in achieving the desired conditions

Restore Grasslands

Alternative B includes the objective to reduce tree density to less than 10 percent on 5,000 to 10,000 acres of historic grasslands annually, as do alternatives C and D. Overall, the amount of grassland restoration treatment is not expected to be different among the action alternatives.

The differences in the large tree retention guidelines between the action alternatives could result in more effective grassland restoration treatments under alternative B than under C or D. The tree retention guideline in alternative B applies only to very large trees. Because there are few of these trees in the encroached grasslands, retaining these trees is not expected to reduce the effectiveness of grassland restoration treatments.

Environmental Consequences for Vegetation, Fuels and Fire: Alternatives C and D

Modify Stand Structure Toward Reference Conditions and Restore Historic Fire Regime

In ponderosa pine, the percent of area in the desired structural state at the middle and landscape scales increases from the current condition of 2 percent to 3 percent in both alternatives C and D in 10 years. Within 50 years, the area in state K increases to 8 percent in alternative C and 10 percent in alternative D.

In frequent fire mixed conifer, the percent of the area in the desired uneven-aged open, multistoried condition at the middle and landscape scale rises 0.5 percent to almost 4 percent for both alternatives C and D within 10 years. At the 50-year time mark, it increases to 7 percent in alternative C and 8 percent in alternative D.

Alternatives C and D have less area in the desired condition—state K—at all time marks than in the preferred alternative. In ponderosa pine, these alternatives have 13 to 20 percent less area in state K; in frequent fire mixed conifer they have 5 to 8 percent less area in state K. The differences between the preferred alternative and alternatives C and D are large for this measure. The difference is due to the effects of modeling for group selection matrix thinning in the preferred alternative versus modeling for thinning to a 16-inch diameter cap in alternatives C and D.

Alternatives C and D are modeled for thinning to a 16-inch diameter cap because of the large tree retention guideline that would retain all presettlement trees established prior to 1890. Implementation of this retention guideline would likely result in thinning from below to reduce tree density to desired condition. Group selection matrix thinning and thinning to a diameter cap are equally effective in stands where there is a lack, or a desired number, of large trees. However, when thinning to a diameter cap in stands that already have many large trees, it becomes necessary to remove most or all the smaller trees to achieve the desired openness of a stand. This would be the case in areas where there are continuous dense old trees as occurs in some areas on the North Kaibab Ranger District. This results in a more single-storied state. This is why group

selection matrix thinning is more effective at creating multistoried, uneven-aged states than treatments with an imposed diameter cap.

The temporal departure index is lower in both alternatives C and D than the preferred alternative at all time marks indicating that the relative time to attain state K is longer due, again, to the single-storied state that results from thinning from below.

The density departure index is also lower than the preferred alternative at all time marks in ponderosa pine and in three of four time marks in frequent fire mixed conifer, indicating a greater risk of density dependent uncharacteristic disturbance, such as active crown fire. In these alternatives, with reduced mechanical treatment over time in stands that were previously thinned from below, trees continue to grow and become denser.

The interspersion creation index is lower than the preferred alternative at all time marks indicating less fine-scale heterogeneity. Thinning to a diameter cap works against creating interspersion, as it results in a more single-storied state, and because larger trees are retained in what could otherwise become an interspace. Without interspaces being created, and trees continuing to grow in interspaces, the forest becomes more dense, canopy bulk density and canopy cover increase, and the probability of active crown fire increases.

Understory abundance in ponderosa pine in these alternatives is expected to remain stable through the first 15 years and to continue to increase gradually over time. Alternative D has the highest potential understory abundance at the 250-year time mark because it has the most state N, the uncharacteristic state resulting from stand-replacing fire. Because state N is open and unshaded, understory abundance is high. For frequent fire mixed conifer, understory abundance would slightly decrease and remain stable for the long term. The differences between alternatives are fairly small for this evaluation criterion. The percentage of relative potential understory productivity is somewhat lower at all time marks than in the preferred alternative, indicating that the fine fuels that are the carrier of the desired low-intensity, high-frequency fires would be less abundant than under the preferred alternative.

There is a marked increase in the percentage of area in open states from the current condition to the 10-year time mark. This is due to the increased rate of mechanical treatments to modify stand structure modeled in these alternatives until areas are transferred out of the suitable timber base. In ponderosa pine, open states increase from 36 to 42 percent for alternative C, and from 36 to 44 percent in alternative D. In frequent fire mixed conifer, open states increase from 33 to 41 percent under alternative C, and from 33 to 44 percent under alternative D. The percentage of area in open states continues to gradually increase over time, though some of this increase is in state N, particularly in alternative D at the 250-year time mark.

These alternatives have a lower percentage of area in open states than the preferred alternative. In ponderosa pine, the difference is large at first and decreases over time; the difference at the 10- and 15-year time marks is 20 to 22 percent less area in open states, but by year 50 is only 1 to 8 percent less open. The differences in frequent fire mixed conifer are not as large, as the rate of mechanical treatment is lower in this vegetation community; they range from 1 to 6 percent less area in open states than the preferred alternative. The higher percentage of closed states, with canopy cover greater than 30 percent, under these alternatives indicates a corresponding higher risk of uncharacteristic wildfire and lower understory abundance.

Protect and Regenerate Aspen

Alternatives C and D also include the objectives to fence 200 acres of aspen and reduce conifer encroachment on 800 acres of aspen within 10 years of plan approval. This emphasis on aspen restoration would make it a priority on the Williams and Tusayan Ranger Districts.

These alternatives have considerably less area in states J and K that would promote the retention and regeneration of aspen at all time marks than the preferred alternative. In ponderosa pine, these alternatives have 23 to 30 percent less area in states J and K than the preferred alternative, and 7 to 10 percent less area in frequent fire mixed conifer. Alternative C has the least area in states J and K of all alternatives at all but one time mark (table 6).

The differences in the presettlement tree retention guideline in alternatives C and D may result in less effective treatments for reducing shade and competition from conifers because fewer conifers would be removed. This is because the tree retention guideline in alternatives C and D, based on the age of the tree cannot be accurately determined visually, and coring individual trees to determine age is labor and cost intensive. Prescription implementing this guideline may use a diameter cap to facilitate implementation. Because all coniferous trees above the diameter cap would be retained, treatment would likely result in less effective grassland restoration treatments than alternative A or B.

Restore Grasslands

Alternatives C and D include objectives to reduce tree density to less than 10 percent on 5,000 to 10,000 acres of historic grasslands annually. The differences in the presettlement tree retention guideline in alternatives C and D may result in less effective treatments for reducing conifer encroachment than in alternative B because all presettlement trees would be retained.

Comparison of Alternatives for Vegetation and Fire

Modify Stand Structure Toward Reference Conditions and Restore Historic Fire regime

Alternative B is more effective overall at meeting the evaluation criteria for this priority need for change than all others and would best promote resiliency in the face of a changing climate. This is the case for both ponderosa pine and dry mixed conifer.

Alternative B is more effective in achieving the desired stand structure—state K—than all other alternatives, with more than double the area in the mid-scale desired condition in ponderosa pine at all time marks. The same is true for frequent fire mixed conifer at the 10-, 15-, and 50-year time marks.

The index for time departure for alternative B indicates the least time for attainment of mid-scale desired conditions at all time marks for both ponderosa pine and frequent fire mixed conifer. Overall, the differences between the alternatives are smaller for this evaluation criterion than other mid-scale desired condition attainment differences. Alternative A takes more time to reach desired conditions because the current rate of treatment is lower than in alternative B. Alternative B responds better than alternatives C and D for this evaluation criterion because of group selection matrix thinning in alternative B versus thinning from below in alternatives C and D, which takes longer to achieve a multistoried state.

Alternative B scores the highest on the density departure index indicating the least relative risk of uncharacteristic loss of forest structure from density-dependent disturbance such as active crown fire. Again, in alternative A, the rate of treatment to modify stand structure is lower than in the action alternatives. In alternatives C and D, mechanical treatment decreases over time, and trees continue to grow and stands become denser. Overall, the differences among the alternatives are intermediate compared to other mid-scale desired condition attainment differences.

Fine-scale heterogeneity is expected to be higher under alternative B, providing more of the fine-scale desired condition of irregularly spaced groups of trees with variable spacing that are surrounded by openings, and the mix of similar or variable ages within groups. Alternative A has a lower implementation rate of treatments that create fine-scale heterogeneity. The presettlement tree retention guideline in alternatives C and D, which is likely implemented by thinning from below or thinning to a diameter cap, results in more single-storied states and more trees retained in potential interspaces than with the large tree retention guideline in alternative B. Differences among alternatives are intermediate for this criterion.

The difference between the preferred alternative and other action alternatives is large for this evaluation criterion. The difference is due to the effects of modeling for group selection matrix thinning under the preferred alternative versus thinning to a 16-inch d.b.h. cap in alternatives C and D. In stands where there are a lack of—or a reference condition number of—large trees, both group selection matrix and diameter cap are equally effective. However, with a d.b.h. cap treatment in stands that already have many large trees, it becomes necessary to remove most or all of the smaller trees to achieve the desired openness of a stand. This results in a more single-storied state. This is why group selection matrix thinning is more effective at creating multistoried, uneven-aged states than treatments with an imposed diameter cap.

In ponderosa pine, alternative B has the highest relative potential understory abundance at three of four time marks. Alternative D has the highest at year 250 because it has the most state N, the uncharacteristic state resulting from stand-replacing fire. In frequent fire mixed conifer, alternative D has the highest percentage of potential understory abundance at the 10-year time mark, the same percentage as alternative B at the 15-year time mark, with alternative B having the highest at the 50- and 250-year time marks. Differences among alternatives for this criterion are fairly small. Differences are smaller in mixed conifer than in ponderosa pine due to the lower rates of treatment to create stand structure with interspaces.

In ponderosa pine, alternative B is expected to have more area in characteristic open states with 30 percent canopy cover or less, than all other alternatives. With less canopy continuity, the risk of uncharacteristic high-severity fires would be the least under this alternative. Alternative B has the highest percentage of open states at all time marks. In frequent fire mixed conifer, all the action alternatives have more area in open states than in alternative A; in alternative A the treatment rate is too slow to create and maintain open states in a dynamic environment. Alternative D has the most area in open states at the 10-year time mark, the same as alternative B at the 15-year time mark, with alternative B having the highest at the 50- and 250-year time marks. Differences among alternatives for this criterion are fairly small.

Alternative A would continue to require suppression action on wildfires within the mixed conifer type of the North Kaibab Ranger District, within a 2-mile radius of North Canyon Spring, in the Frank’s Lake Geologic-Botanic Area, and in the Arizona Bugbane Conservation Area. It also places prescriptive criteria on when wildfires must be suppressed in the pine-oak habitat type on

the Williams Ranger District; wildfires could not be managed to reduce the threat of high-severity wildfire to these biologically unique areas by managing wildfires to consume accumulated fuels when fire weather and fuel moisture conditions are appropriate. In all action alternatives, the full range of management responses to wildfires would be available across the forest, except in desert communities where wildfires would be suppressed.

Protect and Regenerate Aspen

All action alternatives have objectives for fencing and reducing conifer encroachment in aspen stands which would make this work a priority on the Williams and Tusayan Ranger Districts, but alternative A does not. Treatments would likely continue under alternative A, but perhaps not to the extent under the action alternatives.

Effectiveness of treatments is likely to be greatest under alternatives A and B; shading and competition from conifers could be more effectively removed.

Under alternatives C and D, trees meeting the presettlement tree retention guidelines would not be cut. This would likely result in more conifers being retained than alternatives A or B. As a result, treatment effectiveness is expected to be higher under alternatives A and B.

Alternative B is expected to have more area in desired and nearing desired conditions in ponderosa pine and frequent fire mixed conifer than the other alternatives, where aspen clones are likely to be more resilient—able to withstand droughts and regenerate in place. Alternative A has 20 to 25 percent less area in states J and K in ponderosa pine, and 3 to 9 percent less area in these states in frequent fire mixed conifer. Alternatives C and D have 23 to 30 percent less area in states J and K in ponderosa pine than the preferred alternative, and 7 to 10 percent less area in these states in frequent fire mixed conifer.

Restore Grasslands

All action alternatives have objectives for reducing tree and shrub encroachment in grasslands which would make this work a priority on the Williams and North Kaibab Ranger Districts, but alternative A does not. Treatments would likely continue under alternative A, but perhaps not to the extent under the action alternatives.

Overall, the amount of grassland restoration is not expected to be very different among alternatives. Effectiveness of treatments is likely to be somewhat higher for alternative A than for alternatives B, C, and D which have large tree retention guidelines. Alternatives C and D would likely be less effective than B, as all presettlement trees would be retained.

Management Response Following Large Disturbance Events

In alternative A, there is limited direction for planting to move stand structure on a trajectory back toward desired conditions following uncharacteristic, large-scale disturbances, such as stand-replacing wildfire. Planting does occur, but not at a rate sufficient to counter loss of forest structure from uncharacteristic disturbance.

All action alternatives contain an objective to plant an average of 2,500 acres annually in ponderosa pine and frequent fire mixed conifer.

Alternative D and the wildlife habitat complex in alternative C are not to be managed for timber production once stand structure is restored. Current policy calls for planting following stand-replacing fire in areas that are in the suitable timber base. Because these areas would not be managed for suitable timber, it is less likely that they would be planted following uncharacteristic fire. Without planting, the time to return to the desired condition is significantly increased, which also reduces recovery from uncharacteristic open states associated with high-intensity fire.

Cumulative Environmental Consequences for Vegetation and Fire

Cumulative effects to vegetation and fire behavior are examined from the larger landscape-level spatial context as the contribution of the forest's vegetation and fire management practices to the surrounding landscape.

The Kaibab NF is inherently connected to its surrounding landscape, regardless of administrative boundaries. To compare the effects of proposed forest management to the surrounding landscape in the spatial context, they are evaluated considering the management actions of other entities within shared sections from Bailey's Ecoregion Units (Bailey et al. 1994, McNab and Avers 1994). For cumulative effects, each of the three sections that contain NFS lands is considered separately.

Bailey's Ecoregions is a hierarchal system for classifying ecosystems and commonly used for ecosystem analysis at middle to large scales. This system divides the United States into domains, then divisions, and then further divides them into provinces and sections. Sections are described by broad areas of similar subregional climate, geomorphic process, geology, geomorphic origin, topography, and drainage networks.

The Kaibab NF is located in the Dry Domain that covers much of the western United States. Table 8 displays the distribution of Kaibab NF lands within Bailey's Ecoregion Sections in that domain.

Table 8. Relationship of the land area between the Kaibab National Forest (KNF) ranger districts and Bailey's Ecoregion Sections (Bailey et al. 1994)

Section No.	Total Section Acreage	KNF Ranger District	KNF Acres in Section	Percent of KNF in Section	KNF Percent of Section
Grand Canyon (313A)	19,556,212	North Kaibab	655,078	41	3.3
Painted Desert (313D)	8,934,546	Tusayan	331,428 *	21	3.7
White Mountains - San Francisco Peaks - Mogollon Rim (M313A)	13,471,798	Williams	613,459 *	38	4.6

*Less than 5 percent of the Tusayan and Williams Ranger Districts fall within the Mohave Desert Section and the Tonto Transition Section. Since there are no objectives analyzed for the vegetation types in this limited area, all acres on the Tusayan Ranger District are analyzed as part of the Painted Desert Section, and all acres of the Williams Ranger District are analyzed as part of the White Mountains–San Francisco Peaks–Mogollon Rim Section.

Figure 7 displays the location of the Kaibab NF within the sections. Each of the three ranger districts falls almost entirely into a separate section, which highlights how different each ranger district is from the other

North Kaibab Ranger District in Context of the Grand Canyon Section

The North Kaibab Ranger District is in the Grand Canyon Section. This section includes lands administered by the Navajo Nation, Hopi Tribe, Kaibab Band of Paiutes Tribe, Arizona Strip Bureau of Land Management (BLM), Grand Canyon and other National Park Service area, the State of Arizona, slivers of the Dixie National Forest, and all of the North Kaibab Ranger District. In this section, the elevation of the Kaibab Plateau has led to its description as a green island in the midst of an ocean of desert. This “island” contains most of the ponderosa pine, mixed conifer, and other forested types in the section. The Grand Canyon National Park and Kaibab NF are the primary land management agencies. The North Kaibab Ranger District covers only 3 percent of the section, yet it has 28 percent of the ponderosa pine, 39 percent of the mixed conifer, and 44 percent of the spruce-fir vegetation type. The park implements limited mechanical treatments to modify stand structure, usually to protect human improvements and heritage resources. In the past two decades, however, the park has used wildland fire extensively—with a wide range of effects—to restore historic fire regimes and improve the resiliency of the forested types. On parts of the boundary between the agencies, this has reduced the risk of high-severity fires originating on the park burning onto the forest, pushed by predominant summer southwesterly winds, where until recently fuel loads were much higher and forest stands are much denser. This risk is still present and high on other parts of the boundary area. Isolated pockets of ponderosa pine on the park, such as on Powell Plateau, have seen little, if any, fire suppression and are used as a guide for reference conditions in the type. The forest uses both mechanical treatments and wildland fires.

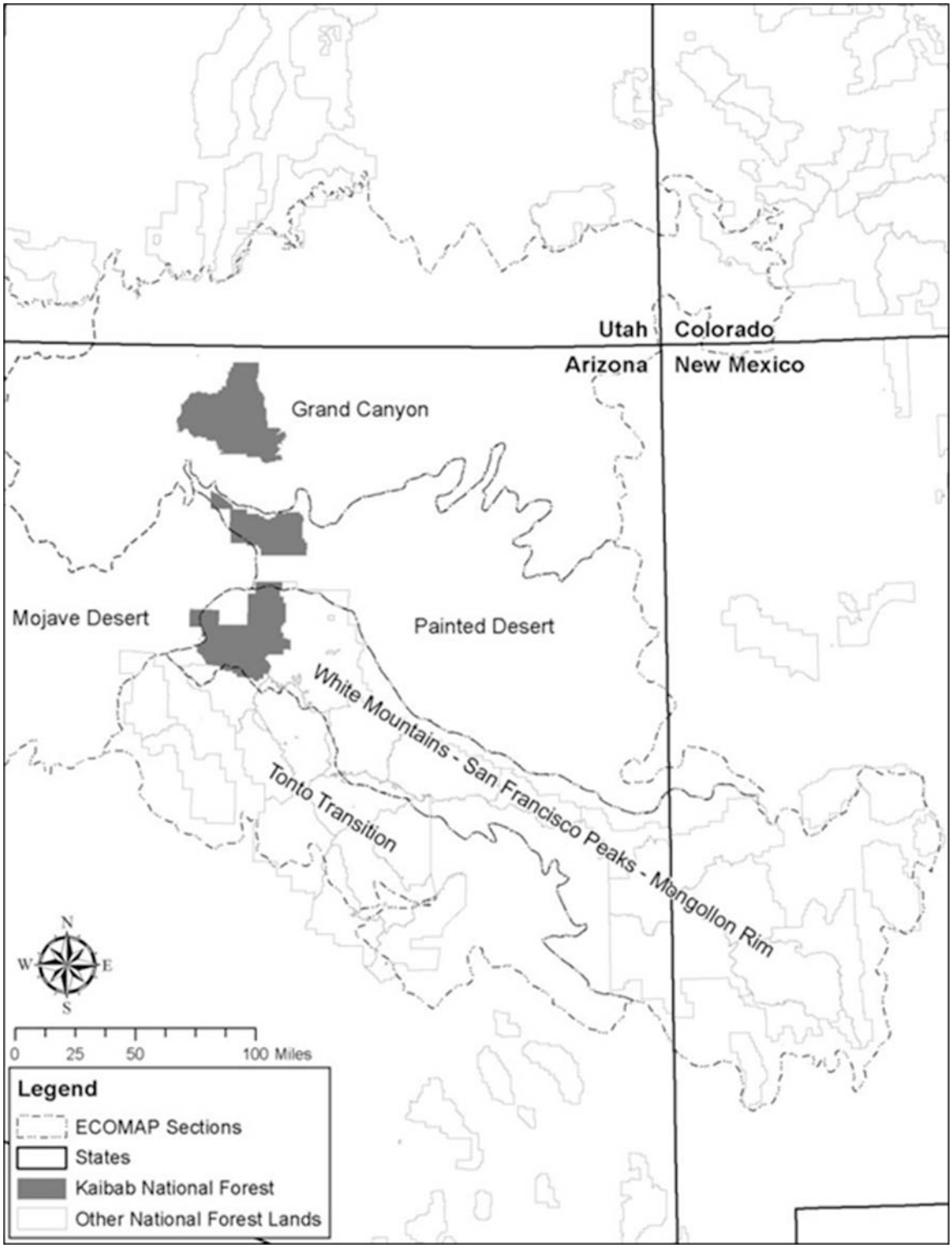


Figure 7. Bailey's ECOMAP sections, containing the Kaibab National Forest. Other National Forest System lands in or near the sections are also shown.

The use of wildland fire in mixed conifer types is limited to prescribed fires on the forest under the current plan, which limits the ability to manage wildfires across the boundary with the park to reduce the risk of stand-replacing fires. Under the action alternatives, wildfires could be managed across the boundary to achieve similar objectives of improving the resiliency of the mixed conifer type on the plateau. Outside of plan restrictions, few barriers to such cross-boundary management exist as there is one interagency fire management organization, composed of both National Park Service (NPS) and Forest Service personnel, responsible for all fire management on the Kaibab Plateau.

Objectives to accelerate the rate of modification to enhance or restore forest structure in the ponderosa pine and mixed conifer types under the action alternatives would improve the resiliency of these vegetation types to climate change. Because of their limited extent in the section, they provide the habitat for many species that do not exist elsewhere in the section. Such restoration would have positive outcomes in limiting susceptibility to stand-replacing fire. Using wildland fire to reduce large-scale uncharacteristic events is not without risk.

For lower elevation vegetation types also present on the forest and in the section, BLM and tribal lands are the predominant land management agencies, with the Park Service and Forest Service playing lesser roles. These vegetation types are all departed and little treatment is being done to improve departures from reference condition. The North Kaibab Ranger District contains 25 percent of the montane/subalpine grassland vegetation type in the section, and objectives to remove encroachment in the action alternatives would benefit this type in the larger context of the section. The cottonwood-willow vegetation type in Kanab Creek Wilderness is highly departed due to tamarisk invasion, and the lack of flood disturbances due to impoundments upstream and off the forest. Few options for management actions to improve conditions exist, so it did not rise as a priority need for change within the planning period, but would still likely provide refugia for species requiring a low-elevation riparian habitat within the section.

Tusayan Ranger District in Context of the Painted Desert Section

The Tusayan Ranger District is located in the Painted Desert Section. This section includes lands administered by the Kaibab NF, the Navajo Nation, the Hopi Tribe, a small portion of the Coconino National Forest, and the State of Arizona. The Tusayan Ranger District occupies about 4 percent of the section. Despite its limited extent, it contains 78 percent of the ponderosa pine vegetation type and 100 percent of the montane grasslands in the section.

The ponderosa pine vegetation on the south side of Grand Canyon National Park lies within the Grand Canyon Section, but shares borders with the Tusayan Ranger District. As on the Tusayan Ranger District, most of the park's ponderosa pine type has experienced one or several fire entries in past decades and is approaching the historic fire regime. Prescribed burning projects are coordinated across boundaries to complement each other to achieve maximum benefit in reducing the risk to highly valued human improvements, maintain reference fuel loads, and improve ecosystem resiliency to uncharacteristic fire. The first wildfire to be used to accomplish resource benefits across agency boundaries, the Ruby Complex, occurred in 2009. Objectives and tactics for the fire were slightly different on each agency's lands, but were successfully achieved with a single incident command structure and no adverse outcomes during peak fire season for the year. This cross-boundary management approach is included in the management approach in the action alternatives for the revised plan, as well as in the Federal Wildland Fire Policy.

Objectives in the action alternatives would promote continued modification of stand structure to reduce susceptibility to large uncharacteristic fire events. The first recorded large fire event over 1,000 acres—since shortly after the turn of the century—on the Tusayan Ranger District occurred in April 2007. The X-Fire was a human-caused fire originating from a campfire which burned 2,048 acres during a wind event after a dry March, with a high percentage of stand-replacing fire. This fire demonstrates that structural change to move toward reference conditions is a necessary complement to treatment with fire, as much of this area had been burned with prescribed fire within the last 15 years. Under 90th percentile fire weather conditions and above, wildfire can still exhibit uncharacteristic outcomes in departed stand structure despite reference fire return intervals.

Objectives for restoring grasslands in the action alternatives would continue and enhance refugia for grassland-related species, as this vegetation type does not occur elsewhere in the section.

Aspen clones on the Tusayan Ranger District are small and rare in that there are a dozen or less, and they are even rarer in the section. This is believed to be true under reference conditions as well. Objectives in the aspen alternatives to retain and regenerate aspen clones could be achieved with limited funds and resources. Though small, these tiny rare clones have high biodiversity, provide small pockets of refugia for aspen-related species, and are not found elsewhere in the section. Climate change may eliminate these rare components of the ponderosa pine type in the section despite management action.

Williams Ranger District in Context of the White Mountains – San Francisco Peaks – Mogollon Rim Section

This section is located on the Mogollon Plateau above the Mogollon Rim—a pronounced demarcation in elevation in northern Arizona. The Williams Ranger District on the Kaibab NF, as well as the Coconino National Forest, the Apache-Sitgreaves National Forests, Fort Apache Tribal lands, and Arizona State administer lands in this section. The Williams Ranger District occupies just over 4 percent of the section. Less than 5 percent of the ponderosa pine is on the district and has around 2 percent of the mixed conifer vegetation type. For montane/subalpine grassland, however, it has 23 percent of the vegetation type and 100 percent of the Gambel oak shrubland. The latter may be because this vegetation type on the Coconino National Forest was classified as another woodland type.

The Coconino and the Apache-Sitgreaves National Forests are in the process of revising their land management plans concurrently with the Kaibab NF, based upon the same regional vegetative desired conditions, standards and guidelines, and similar objectives for ponderosa pine and mixed conifer. Though the Kaibab NF has a small percentage of the ponderosa pine and mixed conifer types in the section, the cumulative restoration activities from the action alternatives from these plans could have a pronounced effect on modifying stand structure to be less susceptible to stand-replacing fire in these vegetation types across the section, and improving the resiliency and adaptability of these types to climate change. Additionally, they would contribute to carbon sequestration at this scale that would provide additional benefit.

It is recognized across agency boundaries that the current rate of stand structure modification is not sufficient to compensate for states increasingly departed from reference conditions. To accelerate structure modification, to get ahead of increasing departure, planning at scales large

enough to attract a market for small-diameter biomass, in areas where consensus from stakeholders is high, and desired states can be rapidly achieved through mechanical treatments is necessary. This means focusing on dense forest areas in larger states where effective mechanical structural modification can reduce stand structure to desired conditions, and away from areas where risk cannot be effectively treated due to limitations of law, regulation, or policy, such as Mexican spotted owl protected activity centers. It also diverts treatment from areas that may not be in the desired state due to low tree density, that are at low risk of stand-replacing fire, and that would take decades to grow to desired stand structure.

One such planning effort, already underway, is the Four Forest Restoration Initiative (4FRI). Stakeholders are actively participating in this planning process to complete landscape-scale planning over a 2.4-million-acre analysis area. The cumulative effect of structural modification of the ponderosa pine type toward desired conditions as part of this project, in conjunction with portions of the project on the Williams and Tusayan Ranger Districts, would have widespread beneficial outcomes in restoring the ponderosa pine type across the section and beyond. If successful, this effort could decrease susceptibility to large and uncharacteristic disturbances, increase water yields from winter snowfall through the creation of interspaces, and provide long-term carbon sequestration in large old trees at a scale meaningful to improving the resiliency and ability to adapt to climate change in the ponderosa pine type of the Southwest.

Objectives for aspen in the action alternatives would benefit the aspen component of ponderosa pine and mixed conifer that are declining throughout the section. Ungulate herbivory is accelerating aspen decline on the Williams Ranger District outside of other uncertain influences on aspen decline. The high biodiversity associated with this component of the vegetation type merits the limited planning, funding, and resource requirements to deter further aspen decline.

With 23 percent of the montane/subalpine grassland in the section, the objectives for reducing encroachment in this vegetation type would provide refugia for grassland-related species.

Wildland fire is widely used on all agency lands in the section, including some burning by the State on State lands and the Navajo Army Depot, and by the city of Flagstaff and other municipalities. Due to such widespread burning across the section, smoke management is critical to maintain public support for prescribed burns and the use of wildfires to achieve resource benefits. This topic is covered in the Air Quality section of this chapter.

Summary of Cumulative Effects for Vegetation and Fire

The sum of past management actions over time has resulted in the departure of most PNVTs from their characteristic states on and around Kaibab NF. These departures are largely due to fire suppression, in conjunction with past, unsustainable grazing practices, and other anthropogenic disturbances of natural processes. It has resulted in a dramatic increase in stand-replacing fires, particularly since the mid-1990s, decreases in water yields, degradation of aspen stands, and encroachment of grasslands, and resulted in the priority needs for change identified for forest plan revision. Departures from reference conditions exist in all vegetation types on the forest, and most continue to trend further from reference conditions.

The cumulative effects of proposed management actions on the Kaibab NF in the context of the larger landscape for the North Kaibab and Tusayan Ranger Districts are largely to provide refugia

for species in the section requiring ponderosa pine, mixed conifer (on the North Kaibab), aspen, and grasslands, as these vegetation types are rare elsewhere in the Grand Canyon and Painted Desert Sections of Bailey's Ecoregions.

The cumulative effects of proposed management actions on the forest in the context of the larger landscape for the Williams Ranger District include providing refugia for grassland-related species, and contributing its part to modifying stand structure in ponderosa pine toward reference conditions and restoring historic fire regimes at a broad scale across the White Mountain-San Francisco Peak-Mogollon Rim Section to reduce large-scale disturbance and increase resiliency and ability to adapt to climate change to a significant portion of the ponderosa pine type in northern Arizona.

Species Viability Analysis

The species viability analysis for wildlife and botany were conducted using the same process. It was initiated by compiling a comprehensive list of "forest planning species" with potential viability concerns for the Kaibab NF. This list was used to help develop desired conditions, standards, and guidelines for the revised forest plan. Forest planning species were identified only for forest plan revision purposes, and they hold no special regulatory status beyond existing State and Federal status. Further detail on this process and explicit criteria used to identify forest planning species is explained in the Species Diversity Report, v. 1.2.5 (KNF 2008d).

The forest planning species list, developed collaboratively in 2008, contains 148 plant and animal species (out of more than 1,800 species initially considered) and includes those species found, or potentially found, on the Kaibab NF. While developing the forest planning species list, a coarse filter/fine filter process was used to ensure the needs of all wildlife species were addressed and to determine the need for plan direction. The process considered habitat, habitat elements, and species-specific traits. The 148 analysis species were grouped first by habitat association, represented by water or the broadly defined vegetation types historically present in the planning area (i.e., PNVT). Potential natural vegetation types (PNVTs) represent the vegetation type and characteristics that would occur when natural disturbance regimes and biological processes prevail (Schussman et al. 2006). Further, PNVTs combine potential vegetation and historic fire regime to form ecosystem classes useful for landscape assessment. These same species were then secondarily grouped by habitat elements (e.g., snags, downed woody debris, understory vegetation) not specifically addressed by broad habitat associations. Species-specific plan direction was only developed where needed and only for those threats which the Forest Service could impact through management and for which the Forest Service has jurisdictional control.

In 2011, the 148 planning species underwent further analysis using a viability approach. Before assessing the abbreviated list of planning species, the NatureServe rankings for the original 1,835 species were reassessed to determine if any had changed since the original screening. A few NatureServe rankings had changed; however, these changes were not sufficient to warrant removing or adding a species to or from the planning list. Included in this reassessment were an additional 47 species found in the Arizona Game and Fish State Wildlife Action Plan (Arizona Game and Fish Department (AGFD) 2012).

The coarse-to-fine filter approach aided in plan development by helping identify desired conditions for all species as part of a two-step process. That is, broad direction was first developed to include those landscapes and ecological processes necessary to protect and

maintain, at a minimum, species. Viability conditions were then developed for each PNVT or habitat type. In some cases, however, such as for species with limited distributions or specific life requirements, an additional fine filter was applied. Additional forest plan components were developed to meet the needs of those species that fell through the initial coarse filter.

The viability analysis process consisted of the following steps, which are described in detail in the Wildlife Specialist Report (KNF 2013c) and the Botany Specialist Report (KNF 2013d):

1. Forest Service biologists and local species specialists developed Forest Ranks or F Ranks for the list of 148 forest planning species, as well as adding three federally listed and Region 3 sensitive species not included in the original forest planning list, for a total of 151 species reviewed. The ranking process generally follows the conventions used by NatureServe and others in defining State and Global Ranks. The F Ranks were used in the viability risk assessment as a categorical variable representing a species' current abundance.
2. A list of habitat elements important to each species in the analyses was developed. Each habitat element was defined and described in terms of its desired condition in the planning area.
3. Abundance values (consisting of rare, occasional, and common) were used to categorize the projected abundance of each habitat element after 50 years of implementing each forest plan revision alternative. Fifty years was considered the point in time for which the most progress is expected to be made toward achieving desired conditions in fire-adapted ecosystems. That is, the greatest percentage of the landscape (which is considered temporally relevant to this analysis) would be in the desired condition or moving toward the desired condition. This is also a reasonable scale at which the positive effects to most wildlife populations might be realized. While the life of the forest plan is considered to be 15 years, it would set a trajectory for continued habitat improvement into the foreseeable future.
4. Similarly, a future distribution variable of poor, fair, or good was defined as the distribution of the associated habitat element in 50 years if the alternative were selected and implemented over that 50-year period. In contrast to the abundance variable, distribution includes consideration of intermixed ownership patterns and conditions, and their general effects on movements and interactions of individuals among the suitable habitat patches found on NFS lands. This approach relies on the assumption that a habitat distribution similar to that which supported associated species during recent evolutionary history would likely contribute to their maintenance in the future, and that the further a habitat departs from reference distribution, the greater the risk to viability of associated species. Both abundance and distribution ratings were done as an interdisciplinary team with input from other resource specialists.
5. Habitat element abundance and distribution variables were then combined to create one variable to indicate the general likelihood that the habitat element would be limiting to populations of associated species. This "likelihood of limitation" was described as low, moderate, or high. In general, quality habitat elements that are rare and poorly distributed are those most likely to cause risk to viability of associated species; those that are common and well distributed are least likely to cause risk to viability of associated species. In this general context, habitat limitation refers to a habitat factor, quantity, distribution, or quality, that results in risk to continued existence of the species within the planning area (table 13).

6. Providing for species viability requires providing abundant and well distributed habitat in ways that allow existing populations to persist or expand. The ability of existing populations to respond to available habitat depends in part on the populations' current robustness, which is generally a function of size. In general, for a given habitat condition, small populations would be at greater risk than large populations. To reflect this fact, the likelihood of habitat limitation variable (step 5) was combined with a species' F Rank (step 1) for each species/habitat element interaction to generate a viability risk rating for each species/habitat relationship. These viability ratings are based only on the habitat elements. Other factors that could affect species are not included (e.g., disturbance during the breeding season).
7. Finally, once viability risk ratings were developed for each species/habitat relationship, habitat elements most commonly associated with risks to species viability were identified by counting the number of very high, high, and moderately high ratings associated with each habitat element. To assess the role of national forest management in minimizing viability risk associated with each habitat element, a management effects variable was assigned to each habitat element by alternative. The management effects variable categorized the goal of management for the habitat element, the expected resulting trend, and any additional opportunity for minimizing viability risk. Numbers of very high, high, and moderately high risk ratings were summarized by management effects variable by alternative to assess how well alternatives address viability related habitat needs.
8. Distribution of viability risk was also summarized by species status, i.e., federally listed under the Endangered Species Act (ESA), listed as regional forester's sensitive species, or identified as locally rare or of other concern. The species status summary highlights the relative role of other provisions included in law and policy that result in additional consideration of at-risk species during planning (table 15).

Wildlife

This analysis evaluates and discloses the potential environmental consequences on the wildlife resource that may result with the adoption of a revised land management plan. It examines, in detail, four different alternatives for revising the 1988 Kaibab NF Land and Resource Management Plan (KNF 1988). This is a summary of the information provided in the Wildlife Specialist Report (KNF 2013c) and the full analysis is within the specialist report. Further information on the use of best available science in wildlife analyses associated with the plan revision process can be found in Appendix J.

The initial species diversity analysis and subsequent report combined plants and wildlife. The focus of this analysis is on the non-plant species from the forest planning species list. Since the original list was developed in 2008, there have been a few changes. The bald eagle and Sonoran Desert bald eagle population have been lumped together. The USFWS determined that the Sonoran population is not a separate population and ESA protection was removed in 2010.

This analysis is based on the 65 forest plan species, as well as the addition of 4 federally listed and Southwestern Region sensitive species not included in the original forest planning list, for a total of 69 species. The Kaibab fairy shrimp was added after the DEIS due a new regional sensitive species signed on September 18, 2013 adding this species as sensitive on the forest. The other 82 forest planning species are plants, discussed later in the Botany section of this chapter.

Description of Affected Environment (Existing Condition) – Wildlife

The Vegetation and Fire section in this document discusses the current vegetation conditions on the forest and is not repeated here.

Wildlife Species Viability – Species Considered and Evaluated

Table 9 shows the current forest ranking of each of the 68 species. The viability analysis process described in the viability analysis section (step 1) describes the process used to develop the forest ranking.

The following is the key to the variables used in table 9.

F Rank: F? (Information insufficient to develop rank)
F1 (Extremely rare on the forest)
F2 (Very rare on the forest)
F3 (Rare and uncommon on the forest)
F4 (Widespread abundant on the forest)
F5 (Demonstrably secure on the forest)
FP (Possibly on the forest, documented occurrences not known to occur)
FN (Non-breeding population)
FO (Off forest)

PNVT Association: CWRF: Cottonwood-willow Riparian Forest; DC: Desert Communities; DMC: Dry Mixed Conifer; GBG: Great Basin Grassland; GOS: Gambel Oak Shrubland; MCA: Mixed Conifer with Aspen; MSG: Montane Subalpine Grassland; PJW: Pinyon-juniper Woodland; PPF: Ponderosa Pine Forest; SbS: Sagebrush Shrubland; SdG: Semidesert Grassland; SFF: Spruce-fir Forest; W/C: Wetland /cienega; W: Water; Multi: Multi-PNVT

Table 9. Wildlife, fish, and invertebrate species on the viability list, forest ranking and associated potential natural vegetation type (PNVT)

Scientific Name	Common Name	F Rank	PNVT Association
Accipiter gentilis	Northern goshawk*	F3	PPF, DMC
Amphispiza belli	Sage sparrow	FN	SbS
Aquila chrysaetos	Golden eagle	F2	SbS, MSG, GBG, SdG
Athene cunicularia hypugaea	Western burrowing owl	FN	MSG, GBG, SdG
Baeolophus ridgwayi	Juniper titmouse	F4	PJW
Buteo regalis	Ferruginous hawk	FN	SbS, GBG, SdG
Cardellina rubrifrons	Red-faced warbler	F4	DMC, MCA
Coccothraustes vespertinus	Evening grosbeak	F3	DMC, MCA
Contopus cooperi	Olive-sided flycatcher	F3	PPF, DMC, MCA, SF
Dendragapus obscures	Dusky (blue) grouse	F3	MCA, SF
Dendroica graciae	Grace’s warbler	F5	PPF

Scientific Name	Common Name	F Rank	PNVT Association
Dendroica nigrescens	Black-throated gray warbler	F5	PJW
Falco peregrines anatum	American peregrine falcon	F2	Multi
Gynmogyps californianus	California condor	F2	Multi
Gymnorhinus cyanocephalus	Pinyon jay	F5	PJW
Haliaeetus leucocephalus	Bald eagle	F2	PPF, W/C, W
Melanerpes lewis	Lewis' woodpecker	F3	PPF
Oporornis tolmiei	MacGillivray's warbler	F2	PPF, DMC, MCA
Oreoscoptes montanus	Sage thrasher	FP	SbS
Passerculus sandwichensis	Savannah sparrow	FP	MSG, GBG
Pipilo chlorurus	Green-tailed towhee	F4	PPF, DMC, SbS, GOS
Progne subis arboricola	Purple martin (western spp.)	F3	PJW
Regulus satrapa	Golden-crowned kinglet	F3	MCA, SF
Sphyrapicus nuchalis	Red-naped sapsucker	F3	MCA
Spizella breweri	Brewer's sparrow	F4	PJW, SbS
Strix occidentalis lucida	Mexican spotted owl	F2	PPF, DMC, MCA
Vermivora celata	Orange-crowned warbler	F3	DMC, MCA
Vireo vicinior	Gray vireo	F3	PJW
Meda fulgia	Spikedace	FO	Upland terrestrial
Oncorhynchus apache	Apache (Arizona) trout	F1	W
Tiaroga cobitis	Loach minnow	FO	Upland terrestrial
Bufo microscaphus	Arizona toad	FP	W/C, CWRF, W
Crotalus Cerberus	Arizona black rattlesnake	F4	PJW, PP, GBG, DC
Eumeces skiltonianus	Western skink	F3	PJW, PPF
Hyla wrightorum	Arizona (mountain) treefrog	F3	PPF, W/C, W
Lampropeltis pyromelana infralabialis	Utah Mountain kingsnake	F4	PJW, PP, SdG, GOS
Lampropeltis triangulum	Milksnake	F3	GBG, SdG
Rana pipiens	Northern leopard frog	F1	W/C, W
Spea intermontana	Great basin spadefoot	F3	PJW, SbS, GBG, SdG, W/C, W
Branchinecta kaibabensis	Kaibab Fairy Shrimp	F3	W/C, W
Acrolophitus nevadensis	Nevada point-headed grasshopper	FP	PPF, W/C, W
Aeshna Persephone	Persephone's darner	FP	PJW, SbS

Scientific Name	Common Name	F Rank	PNVT Association
Callophrys sheridanii comstocki	Desert green hairstreak	F?	PJW, SbS
Cicindela terricola kaibabensis	Kaibab variable tiger beetle	F?	MSG
Libellula nodisticta	Hoary skimmer	F?	W/C
Papilio indra kaibabensis	Kaibab Indra swallowtail	FP	PJW, DMC, GBG
Piruna polingii	Four-spotted skippering	FP	MSG, W/C
Speyeria Nokomis	Nokomis fritillary	F?	PPF, DMC, MCA
Speyeria nokomis nokomis	Nokomis fritillary ssp. nokomis	FP	PPF, DMC, MCA, W/C
Antilocapra Americana	Pronghorn	F4	SbS, MSG, GBG, SdG
Corynorthinus townsendii pallescens	Pale Townsend's big-eared bat	F3	Multi
Cynomys gunnisoni	Gunnison's prairie dog	F3	GBG, SdG
Dipodomys microps leucotis	House Rock Valley chisel-toothed kangaroo rat	F2	SdG
Euderma maculatum	Spotted bat	F3	SbS, MSG, GBG, SdG
Eumops perotis californicus	Greater western mastiff bat	FN	MSG
Idionycteris phyllotis	Allen's lappet-browed bat	F3	PPF, DMC
Microtus longicaudus	Long-tailed vole	F3	MSG
Lasiurus blossevillii	Western red bat	FO	Riparian Forest
Microtus mogollonensis navaho	Navajo Mogollon vole	F3	MSG, GBG
Myotis auriculus	Southwestern myotis	F4	PPF, DMC, MCA
Neotamias minimus consobrinus	Kaibab least chipmunk	F3	MCA, SFF
Nyctinomops macrotis	Big free-tailed bat	FN	PJW, SbS, MSG, DC
Ovis canadensis nelsoni	Desert bighorn sheep	F3	DC
Sciurus aberti	Abert's squirrel	F4	PPF
Sciurus aberti kaibabensis	Kaibab tree squirrel	F4	PPF
Sorex merriami	Merriam's shrew	F3	PPF, DMC
Sorex nanus	Dwarf shrew	F3	MSG
Tamiasciurus hudsonicus	Red squirrel	F4	MCA, SF
Thomomys talpoides kaibabensis	Kaibab northern pocket gopher	F3	MCA, MSG, SFF

*****The F3 ranking for the northern goshawk is a conservative measure for the goshawk population due to difficulties in conducting population level surveys across the forest. Project level surveys and monitoring indicate the goshawk is actually widespread across the forest. Local research on the North Kaibab Ranger District suggests territories are saturated and breeding pairs are relatively stable across years (Reynolds and Joy 2006).

Wildlife Habitat Elements

Habitat elements are the habitat components or features that are required to support wildlife species. The current conditions of many of the habitat elements are based on PNVT analyses included in the Kaibab NF Ecological Sustainability Report (KNF 2008a) and are not repeated here. Some wildlife habitat elements associated with fine-scale habitat features not necessarily captured by course PNVT descriptions include the following: snags, natural waters, constructed waters, caves, and connectivity. These are described in detail below.

Snags – Several studies have been conducted to determine snag densities in coniferous forests. Miller and Benedict (1994) found an average of 0.6 ponderosa pine snags (12 inches d.b.h. or greater) per acre. Ganey (1999) found a median of two snags per acre on the Kaibab and Coconino NF s. The forest inventory assessment (FIA) found 0.6 ponderosa pine snags (19 inches d.b.h. or greater) per acre across Arizona forests in 1995 (O'Brien 2002). For that same assessment, there was an average of 2.9 snags per acre greater than 11 inches d.b.h. on the forest; these were chiefly comprised of Utah juniper and two-needle pinyon. By comparison, repeat FIA surveys completed in 2007 found 6.8 snags per acre across the forest. In general, the FIA surveys completed in 1995 and 2007 show an overall increase in ponderosa pine and mixed conifer forest snag density across the forest.

Coarse Woody Debris – The distribution of downed wood across the landscape is spatially variable. Ganey and Vojta (2010) studied coarse woody debris in northern Arizona mixed conifer and ponderosa pine forest. Part of this study occurred on the Williams Ranger District and is the best information available at this time for these two habitat types. The study found coarse woody debris was well distributed across the landscape in both ponderosa pine and frequent fire mixed conifer. This study suggests that disruption of surface fires in the study area has resulted in a more continuous distribution of downed wood than occurred under historical conditions. Most mixed conifer plots met or exceeded Forest Service guidelines within the current forest management plan for retention of large logs with regard to wildlife. In contrast, large logs were sparse and patchily distributed in ponderosa pine forest. This is believed to be because the data representing a wide range of successional stages and large trees had been removed, so there were not as many present in the stand to produce large logs.

Water – Natural waters include perennial streams, springs, and wetlands. The only known historic perennial streams on the Kaibab NF are North Canyon Creek and Kanab Creek. Surface flow in the perennial reach of North Canyon Creek historically occurred in a 1- to 6-mile reach, depending on precipitation, before becoming subsurface flow. This stream channel is currently classified as "good condition." Historically, Kanab Creek was a perennial stream on the forest, but upstream water use and diversion have resulted in this stream no longer exhibiting perennial flow within Kaibab NF boundaries. Flooding disturbance has, therefore, been eliminated. Historically, livestock grazing contributed to departed conditions, but livestock have been excluded from grazing along the creek since 1996.

The forest contains 167 springs. Ninety-two of these occur on the North Kaibab Ranger District, 74 occur on the Williams Ranger District, and 1 has been identified on the Tusayan Ranger District. The historic extent and flow of springs and seeps are generally unknown, but are presumed to be approximately equal to their current extent and flow. Developed springs remove water from the site and reduce the extent of riparian vegetation. Several springs have been

documented to be at risk or nonfunctional riparian areas due to ungulate grazing, spring infrastructure maintenance needs, or recreational impacts.

Most of the constructed waters on the forest are in the form of stock tanks created for livestock and wildlife starting in the 1930s. There are approximately 490 reservoirs and stock tanks on the forest. Construction of these waters has increased the amount of the open water on the forest from the reference condition.

Caves and Mines – Compared to reference conditions, the distribution and abundance of caves on the forest have not changed. Mines have increased in abundance and distribution across all three districts from the reference time period.

Connectivity – Connectivity is important for both terrestrial and aquatic species. It connects adjacent habitat and promotes healthy movement of animals between foraging and wintering grounds, as well as genetic flow between populations. Connectivity can occur at different spatial scales and among similar and different habitat patches. It is reduced by habitat fragmentation, which can be caused by natural (e.g., wildfire) or unnatural (e.g., human development) processes. An animal's ability to move between optimal habitats is important in evaluating how well it responds to such disturbances over time. Before 1890, there were no real barriers to animal movement in northern Arizona. Since then, the State has had phenomenal population growth. The development of infrastructure, including roads, railroads, fences, canals, and, more recently, wind and solar energy developments have likely had an impact on Arizona's wildlife populations; changes which affect movement corridors and dispersal potential for many species, particularly wide ranging animals. Connectivity has also been affected by changes in vegetation; this includes encroachment of trees in grassland areas, or loss of movement corridors entirely as a result of uncharacteristic wildfire and human development.

Critical Habitat for Listed Wildlife Species

The forest has designated critical habitat for one federally listed wildlife species—the Mexican spotted owl. Critical habitat units (CHU) are found on North Kaibab and Williams Rangers Districts. There is one unit in Colorado Plateau (CP-10) Ecological Management Unit (EMU) and three units in Upper Gila Mountain EMU (UGM-13, UGM-15, and UGM-17). Table 10 describes the CHU acreage and how much of each unit is located on the forest. The table is displaying all the area within the units and the amount of critical habitat (CH) on the forest within the units. Within the CHUs boundaries, only areas that fit the definition of restricted or protected habitat in the 1995 Recovery Plan for the Mexican spotted owl (USFWS 1995) are considered as critical habitat. It is estimated there is approximately 127,630 acres of critical habitat within the units.

Table 10. Mexican spotted owl critical habitat units on the Kaibab National Forest

CHU Name	District	CH acreage on the KNF	Total CHU acreage	Acreage on Forest	Percent on Forest
CP-10	North Kaibab	70,350	918,847	230,710	25
UGM-13	Williams	52,060	253,341	127,050	50
UGM-15	Williams	2,390	22,531	17,810	79
UGM-17	Williams	2,830	10,914	10,914	100
Total Acres		**127,630**	**1,205,633**	**386,484**	**32**

The forest has potential to impact critical habitat for the loach minnow and spikedace which is located off-forest. Their critical habitat is located approximately 12 miles from the forest boundary on the Verde River in CHU 1 (USFWS 2012c). The forest occupies approximately 9% of the Verde River Watershed.

Amount of Occupied and Unoccupied Habitat for Listed and Sensitive Wildlife Species

The California condor has three basic habitat needs: feeding habitat with adequate food, roosting sites, and adequate nesting sites. The condor requires fairly open grassland habitat for feeding and spends much of its time roosting on cliffs or in tall conifers. A typical roost site has rock cliffs, dead conifer snags or both, and is located in an isolated or at least semi-secluded area. Condors nest in various types of caves, crevices, and potholes. In 2010, there was a failed nesting attempt on the forest. The only successful nesting for condors on the forest occurred during the 2011 nesting season. The forest is used primarily for foraging. While condors could forage across the entire forest, they have primarily only been found on the North Kaibab Ranger District and occasionally seen on Tusayan Ranger District (Peregrine Fund 2010). These two districts have approximately 37,632 acres of the grassland PNVT on them. Currently, the forest does not have data on the amount of cliff habitat on the forest. Most of this habitat is located in either canyons or on mountains.

The Williams and North Kaibab Ranger Districts are the only two districts that contain Mexican spotted owl habitat. There are six Mexican spotted owl protected activity centers on the forest, for a total of 4,485 acres of occupied habitat (also called protected habitat in the Revised Recovery Plan (USFWS 2012a)). A new pair of Mexican spotted owls was located in July 2013 on the Williams Ranger District. The forest is in the process of delineating the protected activity center for the pair. This would increase the occupied habitat by at least 650 acres in the near future. All of the protected activity centers are located on the Williams Ranger District. Unoccupied habitat for the owl is defined as recovery habitat using the habitat definition in the Revised Recovery Plan (USFWS 2012a). It is estimated there is 136,330 acres of recovery habitat on the forest. Based on VDDT modeling (see the Vegetation and Fire Specialist Report (KNF 2013a) for a detailed explanation of VDDT analyses) it is estimated that there are approximately 13,294 acres of ponderosa pine/Gambel oak habitat on the Williams Ranger District and 35,123 acres of mixed conifer habitat for a total of 48,417 acres of nesting and roosting habitat currently available.

The Apache trout is not native to the Kaibab National Forest; however, the Arizona Game and Fish Department introduced it to the forest in the 1940s. The Apache trout is found only in North Canyon Creek on the North Kaibab Ranger District. While the 2010 5-year review notes that there are 5 miles of habitat, the Apache trout is currently located within a 2-mile stretch of the creek.

Neither the loach minnow nor spikedace occur on the Kaibab NF. However, the proposed and current critical habitat for these species, while not occurring on the forest, could be affected by forest management in the form of downstream effects. Consequently, there is no direct effect to these species, only indirect effects because all effects would be off forest.

For sensitive species on the forest, the level of knowledge varies as to how much habitat is actually occupied. Table 11 shows districts where each species is located, the amount of habitat potentially available by PNVT, and the amount of known occupied habitat for species the forest

has occupancy information for. Occupied habitat is a subset of the total acres shown in the PNVT acres. Those species not tied to a PNVT are discussed separately. Not all acres of the associated PNVT can support habitat components for all species. The acreage is likely an overestimate of the amount of habitat that is truly available for different species. For the water PNVT, the number of springs, seeps, reservoirs, or tanks is shown.

To determine PNVT acreage, the CER (KNF 2009) was used for most species. Where possible, the VDDT models for ponderosa pine and mixed conifer were used to help estimate the amount of potential habitat available for certain species. The species whose acreage was determined by VDDT are the goshawk, bald eagle, Allen's lappet-browed bat, Kaibab least chipmunk, Kaibab tree squirrel and Kaibab northern pocket gopher (table 11). For the goshawk, the acreage shown is for nesting, roosting and post-fledging family areas since these are the most limiting features for the goshawk. For the Kaibab tree squirrel, the table shows both general habitat use as well as optimum nesting habitat (see appendix B for more details on use of VDDT model).

Three sensitive species are not tied to any particular PNVT: American peregrine falcon, pale Townsend's big-eared bat, and western red bat.

The peregrine falcon and pale Townsend's big-eared bat both forage in a variety of PNVTs. The primary limiting factor for the peregrine falcon is cliffs for nesting. The forest's current GIS layers provide crude estimates of potential cliff features and it is not currently known how many acres of suitable cliff habitat are located on the forest. In general this habitat is located on mountains or within canyon habitats. There are 16 occupied eyries on the forest.

Caves and mines are most limiting for the Townsend's big-eared bat; a species that needs specific habitat components within these structures. While Townsend's big-eared bat has been captured on the forest, there are only three records of different mine roosting sites.

The western red bat is associated with low-elevation deciduous riparian habitat and is believed to be found only in the Mogollon Rim area on the Williams Ranger District. There is a limited amount of this habitat in portions of Sycamore Canyon on the forest. While the western red bat has been found on the Coconino National Forest along the Mogollon Rim, it has not been found on the Kaibab NF and there is no known occupied habitat on the forest. There are approximately 21,000 acres in the Sycamore Canyon area, but it is not known how much of this is within deciduous riparian habitat. Note: while portions of Sycamore Canyon Wilderness are within the boundary of the Kaibab NF, management direction for this wilderness area is provided in the Coconino forest plan.

Table 11. Sensitive wildlife species and acres of associated potential natural vegetation type (PNVT) acres

Species	District	PNVT	Acres in PNVT or number of water features	Acres of Occupied Habitat
Northern goshawk	All	Ponderosa pine forest Dry mixed conifer	186,007 29,960 215,967 total	134,390
Western burrowing owl	All	Montane subalpine Grassland Great Basin grassland Semidesert grassland	48,584 44,181 25,115 117,880 total	Unknown

Species	District	PNVT	Acres in PNVT or number of water features	Acres of Occupied Habitat
Bald eagle	All	Ponderosa pine forest Wetland/Cienega Water	410,857 1,479 412,336 total 129 seeps/springs 492 reservoirs/tanks	One nest site on forest, mainly used in the winter
Northern leopard frog	All	Wetland/Cienega Water	1,479 129 seeps/springs 492 reservoirs/tanks	1 pond
Kaibab fairy shrimp	North Kaibab	Wetland/Cienega Water	Unknown number of wetland/cienage or water on district	Belk (2000) found species to be common in numerous melt-water pools and small lakes on the Kaibab Plateau
Four-spotted skippering	Williams	Montane subalpine Grassland Wetland/Cienega	39,828 871 40,699 total	No known occupied habitat on forest
House Rock Valley chisel-toothed kangaroo rat	North Kaibab	Semidesert grassland	25,115	12,300
Spotted bat	All	Sagebrush shrubland Montane subalpine Grassland Great Basin grassland Semidesert grassland	89,450 48,584 44,181 25,115 207,330 total	Unknown
Allen's lappet-browed bat	All	Ponderosa pine forest Dry mixed conifer	410,857 70,770 481,627 total	2 known maternity roost sites
Long-tailed vole	North Kaibab	Montane Subalpine Grassland	6,545	Unknown
Navajo Mogollon vole	Williams Tusayan	Montane subalpine Grassland Great Basin grassland	42,039 44,180 86,219 total	40,500
Kaibab least chipmunk	North Kaibab	Mixed conifer with aspen Spruce-fir forest	19,848 2,828 22,676 total	Unknown
Desert bighorn sheep	North Kaibab	Desert communities	13,777	13,777
Kaibab tree squirrel	North Kaibab	Ponderosa pine forest	102,785 (52,082 optimum habitat)	85,000 51,486
Merriam's shrew	All	Ponderosa pine forest Dry mixed conifer	131,299 14,606 145,905 total	Unknown

Species	District	PNVT	Acres in PNVT or number of water features	Acres of Occupied Habitat
Dwarf shrew	North Kaibab	Montane subalpine Grassland	6,545	Unknown
Kaibab northern pocket gopher	North Kaibab	Mixed conifer with aspen Spruce-fir forest Montane subalpine Grassland	19,848 2,828 6,545 29,221 total	Unknown

Environmental Consequences to Wildlife Viability

Table 12 lists the habitat elements required to support the species listed in table 9 and provides the likelihood of the habitat becoming a limiting factor for the species. It also displays the potential management effects for each habitat element under each alternative. To assess the role of national forest management in minimizing viability risk associated with each habitat element, a management effects variable was then assigned to each habitat element by alternative. The management effects variable categorized the goal of management for the habitat element, the expected resulting trend, and any additional opportunity for minimizing viability risk.

The following is the key to the variables used in table 12 (see the Wildlife Specialist Report for a full description of the habitat element and rating codes). The process is explained above in the Viability section, step 5. Habitat element abundance and distribution variables were combined to create one variable to indicate the general likelihood that the habitat element would be limiting to populations of associated species (likelihood of limitation). Everything else being equal, quality habitat elements that are rare and poorly distributed are those most likely to cause risk to viability of associated species; those that are common and well distributed are least likely to cause risk to viability of associated species.

Key to Variables – see Viability section for description of the rating codes

Abundance: R (rare) – found on less than 1 percent of the planning area
O (occasional) – found on 1 to 10 percent of the planning area
C (common) – found on more than 10 percent of the planning area

Distribution: P (poor) – the habitat distribution is greatly reduced from reference level
F (fair) – the habitat distribution is well distributed but not at reference level
G (good) – the habitat is similar or better distributed from reference level

Likelihood of limitation: L (low); M (moderate); and H (high)

Management Effects:

1 = Provide optimal protection and management for all habitat occurrences

2 = Improve habitat abundance and distribution through restoration

3 = Maintain habitat abundance and distribution that is currently on forest planning area

4 = Reduce habitat abundance and distribution as result of external factors

5 = Decline in habitat abundance and distribution as a result of management or lack of management.

Table 12. Summary of expected abundance, distribution, likelihood of limitation, and management effects for wildlife habitat elements by forest plan revision alternatives

Habitat Element	Alternatives			
	A	B	C	D
Ponderosa Pine – Uneven-aged Forest with Vertical Heterogeneity				
Abundance	C	C	C	C
Distribution	P	G	P	P
Likelihood of limitation	M	L	M	M
Management effects	3	2	5	5
Ponderosa Pine – Uneven-aged Forest with Horizontal Heterogeneity				
Abundance	C	C	C	C
Distribution	P	G	F	F
Likelihood of limitation	M	L	L	L
Management effects	3	2	5	5
Frequent Fire Mixed Conifer				
Abundance	O	O	O	O
Distribution	P	F	P	P
Likelihood of limitation	H	M	H	H
Management effects	4	3	5	5
Mesic Mixed Conifer/Spruce fir				
Abundance	O	O	O	O
Distribution	P	F	F	F
Likelihood of limitation	H	M	M	M
Management effects	4	3	3	3
Aspen - General				
Abundance	O	O	O	O
Distribution	F	F	F	F
Likelihood of limitation	M	M	M	M
Management effects	3	2	2	2
Aspen – Within Ponderosa Pine and Frequent Fire Mixed Conifer (MC)				
Abundance	O	O	O	O
Distribution	P	F	F	F
Likelihood of limitation	H	M	M	M
Management effects	3	2	2	2
Aspen – with Mesic Mixed Conifer and Spruce-fir				
Abundance	R	R	R	R
Distribution	G	G	G	G
Likelihood of limitation	M	M	M	M
Management effects	3	3	3	3

Habitat Element	Alternatives			
	A	B	C	D
Sagebrush Shrublands				
Abundance	O	O	O	O
Distribution	G	G	G	G
Likelihood of limitation	L	L	L	L
Management effects	3	3	3	3
Montane/subalpine Meadows and Grasslands				
Abundance	O	O	O	O
Distribution	F	G	G	G
Likelihood of limitation	M	L	L	L
Management effects	3	2	2	2
Grasslands (General)				
Abundance	O	O	O	O
Distribution	F	F	F	F
Likelihood of limitation	M	M	M	M
Management effects	3	2	2	2
Colorado Plateau/Great Basin Grasslands				
Abundance	O	O	O	O
Distribution	F	G	G	G
Likelihood of limitation	M	L	L	L
Management effects	3	2	2	2
Semidesert Grassland				
Abundance	O	O	O	O
Distribution	F	F	F	F
Likelihood of limitation	M	M	M	M
Management effects	4	4	4	4
Desert Communities				
Abundance	R	R	R	R
Distribution	F	F	F	F
Likelihood of limitation	H	H	H	H
Management effects	3	3	3	3
Woodlands and Savanna				
Abundance	R	R	R	R
Distribution	F	G	F	F
Likelihood of limitation	H	M	H	H
Management effects	3	2	2	2
Gambel Oak Shrublands				
Abundance	R	R	R	R
Distribution	F	F	F	F

Habitat Element	Alternatives			
	A	B	C	D
Likelihood of limitation	H	H	H	H
Management effects	3	3	3	3
Rocky Outcrops, Cliffs, and Canyons				
Abundance	C	C	C	C
Distribution	G	G	G	G
Likelihood of limitation	L	L	L	L
Management effects	3	3	3	3
Wetland/Cienega				
Abundance	R	R	R	R
Distribution	F	F	F	F
Likelihood of limitation	H	H	H	H
Management effects	3	2	2	2
Riparian Forest				
Abundance	R	R	R	R
Distribution	F	F	F	F
Likelihood of limitation	H	H	H	H
Management effects	3	3	3	3
Cottonwood-willow Riparian Forest				
Abundance	R	R	R	R
Distribution	P	P	P	P
Likelihood of limitation	H	H	H	H
Management effects	4	4	4	4
Snags				
Abundance	C	C	C	C
Distribution	G	G	G	G
Likelihood of limitation	L	L	L	L
Management effects	3	3	3	3
Downed Wood				
Abundance	C	C	C	C
Distribution	G	G	G	G
Likelihood of limitation	L	L	L	L
Management effects	3	3	3	3
Natural Waters				
Abundance	O	O	O	O
Distribution	F	F	F	F
Likelihood of limitation	M	M	M	M
Management effects	3	2	2	2

Habitat Element	Alternatives			
	A	B	C	D
Constructed Water				
Abundance	C	C	C	C
Distribution	G	G	G	G
Likelihood of limitation	L	L	L	L
Management effects	3	2	2	2
Caves and Mines				
Abundance	R	R	R	R
Distribution	G	G	G	G
Likelihood of limitation	M	M	M	M
Management effects	4	4	4	4
Connectivity or "Connectedness"				
Abundance	C	C	C	C
Distribution	F	F	F	F
Likelihood of limitation	L	L	L	L
Management effects	3	2	2	2

Wildlife species viability evaluation for the Kaibab NF included consideration of the species shown in table 9. The process is explained in detail in the Viability section above, step 6. Species with a forest ranking of F? and F1 through F3 were assessed for viability risk. Species ranked as F? were treated as F1 species to be conservative for those species for which abundance information is not available. For federally listed species and Forest Service sensitive species, even species rated as having no known breeding pairs (FN) on the forest or have potential downstream effect (FO) were analyzed and treated as F3 species. Species that are currently abundant on the forest (F4, F5) are assumed to be at low risk of losing viability within the next 50 years and, therefore, were not further evaluated for viability risk.

Of the 69 species in table 9, 38 had a rating of F? to F3 and were carried forward in this analysis. In addition, five federally listed or Forest Service sensitive species had a rating of FN or FO and were also carried forward for a grand total of 43 species. Of the 43 species carried forward, 5 are federally listed and 18 are regional forester sensitive species.

Providing for wildlife species viability requires providing abundant and well-distributed habitat in ways that allow existing populations to persist or expand. The ability of existing populations to respond to available habitat depends in part on their current robustness, which is generally a function of population size. In general, for a given habitat condition, small populations would be at greater risk than large populations. To reflect this fact, likelihood of habitat limitation variable (table 12) was combined with a species' F Rank (table 9) for each species/habitat element interaction to generate a viability risk rating (table 13).

Associations of very rare species with habitat elements that are likely to be most limiting were identified as those most at risk; associations of more common species with habitats less likely to

be limiting received lower risk ratings. Ratings include three levels of “high” risk to ensure results err on the side of caution.

Table 13. Viability risk rating for wildlife species/habitat interactions as a function of species’ F Rank and likelihood of habitat element limitation variables

Likelihood of Habitat Element Limitations	Species F Rank		
	F? or F1	F2	F3 or FN
High	Very High	High	Moderate High
Moderate	High	Moderate High	Moderate
Low	Moderate High	Moderate	Low

The following is the key to the variables used in table 14.

Status:

F (Federally listed or proposed as threatened or endangered)
S (Regional forester’s sensitive species list)
O (Locally rare and other)

F Rank:

F? (Information insufficient to develop rank)
F1 (Extremely rare on the forest)
F2 (Very rare on the forest)
F3 (Rare and uncommon on the forest)
FN (non-breeding population)
FO (off forest)

Viability Risk:

VH (Very High)
H (High)
MH (Moderately High)
M (Moderate)
L (Low)

Table 14. Risk to species viability for each wildlife species/habitat relation by forest plan revision alternative

Common Name	Status	F Rank	Habitat Element	Viability Risk by Alternative			
				A	B	C	D
Northern goshawk	S	F3	Ponderosa pine – bunchgrass	M	L	M	M
			Ponderosa pine – Gambel oak	M	L	M	M
			Ponderosa pine – vertical heterogeneity	M	L	M	M
			Ponderosa pine horizontal heterogeneity	M	L	L	L
			Frequent fire mixed conifer	MH	M	MH	MH
			Snags	L	L	L	L
			Downed wood	L	L	L	L

Common Name	Status	F Rank	Habitat Element	Viability Risk by Alternative			
				A	B	C	D
Golden eagle	O	F2	Sagebrush shrubland	M	M	M	M
			Montane/subalpine meadows/grasslands	MH	M	M	M
			Colorado Plateau/Great Basin grassland	MH	M	M	M
			Semidesert grassland	MH	MH	MH	MH
Western burrowing owl	S	FN	Montane/subalpine meadows/grasslands	M	L	L	L
			Colorado Plateau/Great Basin grassland	M	L	L	L
			Semidesert grassland	M	M	M	M
Evening grosbeak	O	F3	Frequent fire mixed conifer	MH	M	MH	MH
			Aspen – general	M	M	M	M
			Aspen – mesic mixed conifer and spruce-fir	M	M	M	M
Olive-sided flycatcher	O	F3	Ponderosa pine – bunchgrass	M	L	M	M
			Ponderosa pine – Gambel oak	M	L	M	M
			Ponderosa pine – vertical heterogeneity	M	L	M	M
			Ponderosa pine – horizontal heterogeneity	M	L	L	L
			Frequent fire mixed conifer	MH	M	MH	MH
			Aspen mesic mixed conifer and spruce-fir	M	M	M	M
Dusky (blue) grouse	O	F3	Aspen mesic mixed conifer and spruce-fir	M	M	M	M
			Snags	M	M	M	M
			Downed wood	M	M	M	M
American peregrine falcon	S	F2	Rocky outcrops, cliffs, and canyons	M	M	M	M
California condor	F	F	Rocky outcrops, cliffs, and canyons	M	M	M	M
Bald eagle	S	F2	Ponderosa pine – bunchgrass	MH	M	H	H
			Ponderosa pine – Gambel oak	MH	M	H	H
			Snags	M	M	M	M
			Constructed waters	M	M	M	M
Lewis' woodpecker	O	F3	Ponderosa pine – grassland	M	L	M	M
			Ponderosa pine – Gambel oak	M	L	M	M
			Ponderosa pine – vertical heterogeneity	M	L	M	M
			Snags	L	L	L	L
MacGillivray's warbler	O	F2	Aspen – general	MH	MH	MH	MH
			Aspen mesic mixed conifer and spruce-fir	MH	MH	MH	MH
			Natural waters	MH	MH	MH	MH
Purple martin (western spp.)	O	F3	Pinyon-juniper grasslands	L	L	L	L
			Pinyon-juniper shrublands	L	L	L	L
			Snags	L	L	L	L
Golden-crowned kinglet	O	F3	Aspen – mesic mixed conifer and spruce-fir	M	M	M	M
			Springs and streams	M	M	M	M
Red-naped sapsucker	O	F3	Aspen ponderosa pine and frequent fire mixed conifer	MH	M	M	M
			Aspen mesic mixed conifer and spruce-fir	M	M	M	M
			Snags	L	L	L	L

Common Name	Status	F Rank	Habitat Element	Viability Risk by Alternative			
				A	B	C	D
Mexican spotted owl	F	F2	Ponderosa pine – Gambel oak	MH	M	MH	MH
			Ponderosa pine – vertical heterogeneity	MH	M	MH	MH
			Ponderosa pine horizontal heterogeneity	MH	M	M	M
			Frequent fire mixed conifer	H	MH	H	H
			Mesic mixed conifer/spruce-fir	H	MH	MH	MH
			Snags	M	M	M	M
			Downed wood	M	M	M	M
Orange-crowned warbler	O	F3	Aspen (general)	M	M	M	M
			Aspen ponderosa pine and frequent fire mixed conifer	MH	M	M	M
			Aspen mesic mixed conifer and spruce-fir	M	M	M	M
			Natural waters	M	M	M	M
Gray vireo	O	F3	Pinyon-juniper grasslands	L	L	L	L
			Pinyon-juniper shrublands	L	L	L	L
Spikedace	F	FO	Pinyon-juniper communities (general)	L	L	L	L
			Ponderosa pine – bunchgrass	M	L	M	M
			Ponderosa pine – Gambel oak	M	L	M	M
			Grasslands (general)	M	M	M	M
Apache (Arizona) trout	F	F1	Natural waters	H	H	H	H
Loach minnow	F	FO	Pinyon-juniper communities (general)	L	L	L	L
			Ponderosa pine – bunchgrass	M	L	M	M
			Ponderosa pine – Gambel oak	M	L	M	M
Western skink	O	F3	Pinyon-juniper grasslands	L	L	L	L
			Pinyon-juniper shrublands	L	L	L	L
			Ponderosa pine – bunchgrass	M	L	M	M
			Rocky outcrops, cliffs, and canyons	L	L	L	L
			Downed wood	L	L	L	L
Arizona (mountain) treefrog	O	F3	Ponderosa pine – bunchgrass	M	L	M	M
			Ponderosa pine – Gambel oak	M	L	M	M
			Ponderosa pine – vertical heterogeneity	M	L	M	M
			Wetland/cienega	MH	MH	MH	MH
			Natural waters	M	M	M	M
			Constructed waters	L	L	L	L
Milksnake	O	F3	Colorado Plateau/Great Basin Grassland	M	L	L	L
			Semidesert grasslands	M	M	M	M
			Rocky outcrops, cliffs, and canyons	L	L	L	L
Northern leopard frog	S	F?	Wetlands/cienega	VH	VH	VH	VH
			Natural waters	H	H	H	H
			Constructed waters	MH	MH	MH	MH

Common Name	Status	F Rank	Habitat Element	Viability Risk by Alternative			
				A	B	C	D
Great Basin spadefoot	O	F3	Pinyon-juniper Communities	L	L	L	L
			Sagebrush shrublands	L	L	L	L
			Colorado Plateau/Great Basin Grassland	M	L	L	L
			Semidesert grasslands	M	M	M	M
			Wetlands/cienega	MH	MH	MH	MH
			Natural waters	M	M	M	M
			Constructed waters	L	L	L	L
Kaibab fairy shrimp	S	F3	Wetland/cienega	MH	MH	MH	MH
			Natural waters	M	M	M	M
Desert green hairstreak	O	F3	Pinyon-juniper Communities	L	L	L	L
			Pinyon-juniper grasslands	MH	MH	MH	MH
			Sagebrush shrublands	MH	MH	MH	MH
Kaibab variable tiger beetle	O	F?	Montane/subalpine meadows/grasslands	H	MH	MH	MH
Hoary skimmer	O	F?	Montane/subalpine meadows/grasslands	H	MH	MH	MH
			Natural Waters	H	H	H	H
Nokomis fritillary	O	F?	Ponderosa pine - bunchgrass	H	MH	H	H
			Ponderosa pine – Gambel oak	H	MH	H	H
			Frequent fire mixed conifer	VH	H	VH	VH
			Mesic mixed conifer/spruce fir	VH	H	H	H
			Wetland/cienega	VH	VH	VH	VH
Pale Townsend's big-eared bat	S	F3	Cave and mines	L	L	L	L
Gunnison's prairie dog	O	F3	Colorado Plateau/Great Basin Grassland	M	L	L	L
			Semidesert grassland	M	M	M	M
House Rock Valley chisel-toothed kangaroo rat	S	F2	Semidesert grasslands	MH	MH	MH	MH
Spotted bat	S	F3	Colorado Plateau/Great Basin Grassland	M	L	L	L
			Semidesert grassland	M	M	M	M
			Sagebrush shrublands	L	L	L	L
			Montane/subalpine meadows/grasslands	M	L	L	L
			Rocky outcrops, cliffs, and canyons	L	L	L	L
Allen's lappet-browed bat	S	F3	Ponderosa pine – bunchgrass	M	L	M	M
			Ponderosa pine – Gambel oak	M	L	M	M
			Frequent fire mixed conifer	MH	M	MH	MH
			Snags	L	L	L	L
			Cave and mines	L	L	L	L

Common Name	Status	F Rank	Habitat Element	Viability Risk by Alternative			
				A	B	C	D
Long-tailed vole	S	F3	Montane/subalpine meadows/grasslands	M	L	L	L
			Wetland/cienega	MH	MH	MH	MH
			Natural waters	M	M	M	M
Western red bat	S	FO	Riparian forest	MH	MH	MH	MH
Navajo Mogollon vole	S	F3	Montane/subalpine meadows/grasslands	M	L	L	L
			Colorado Plateau/Great Basin Grassland	M	L	L	L
			Downed wood	L	L	L	L
Kaibab least chipmunk	S	F3	Mesic mixed conifer/spruce-fir	MH	M	M	M
			Aspen mesic mixed conifer and spruce-fir	M	M	M	M
			Rocky outcrops, cliffs, and canyons	L	L	L	L
Desert bighorn sheep	S	F3	Desert communities	MH	MH	MH	MH
			Rocky outcrops, cliffs, and canyons	L	L	L	L
Merriam's shrew	S	F3	Ponderosa pine – bunchgrass	M	L	M	M
			Ponderosa pine – Gambel oak	M	L	M	M
			Ponderosa pine horizontal heterogeneity	M	L	L	L
			Frequent fire mixed conifer	MH	M	MH	MH
Dwarf shrew	S	F3	Montane/subalpine meadows/grasslands	M	L	L	L
			Rocky outcrops, cliffs, and canyons	L	L	L	L
Kaibab northern pocket gopher	S	F3	Mesic mixed conifer/spruce-fir	MH	M	M	M
			Aspen mesic mixed conifer and spruce-fir	M	M	M	M
			Montane/subalpine meadows/grasslands	M	L	L	L

In table 14, 26 species were found to have at least one element ranked as either very high, high, or moderate high viability risk. Table 15 summarizes those species and their associated habitat elements that received a very high, high, or moderately high rating in table 14. Factors that contributed toward these ratings are also summarized in table 15. For species that were ranked as moderate to low risk viability risk in all the alternatives, the proposed alternatives would provide for long-term viability of the species.

The following is the key to the variables used in table 15.

Status:

F (Federally listed or proposed as threatened or endangered)
S (Regional forester's sensitive species list)
O (Locally rare and other)

Factors that contributed to the very high, high, and moderate high rating ("high rating"):

1 – Species are very rare species (F?, F1, F2)
2 – Abundance of habitat is limiting factor (rare to occasional abundance)
3 – Habitat distribution is limiting (poor to fair distribution)

Table 15. Summary of risk to species viability for wildlife species/habitat elements with a very high, high, or moderate high rating in any alternative

Common Name	Status	Habitat Element	Viability Risk by Alternative				Factors for "High Rating"
			A	B	C	D	
Northern goshawk	S	Frequent fire mixed conifer	MH	M	MH	MH	3
Golden eagle	O	Montane/subalpine meadows	MH	M	M	M	3
		Colorado Plateau/Great Basin grassland	MH	M	M	M	3
		Semidesert grassland	MH	MH	MH	MH	1,3
Evening grosbeak	O	Frequent fire mixed conifer	MH	M	MH	MH	3
Olive-sided flycatcher	O	Frequent fire mixed conifer	MH	M	MH	MH	3
Bald eagle	S	Ponderosa pine-bunchgrass	MH	M	MH	MH	1
		Ponderosa pine-Gambel oak	MH	M	MH	MH	1
MacGillivray's warbler	O	Aspen – general	MH	MH	MH	MH	1,2,3
		Aspen – mesic mixed conifer and spruce-fir	MH	MH	MH	MH	1,2
		Natural waters	MH	MH	MH	MH	1,2,3
Red-naped sapsucker	O	Aspen – ponderosa pine and frequent fire mixed conifer	MH	M	M	M	1,3
Mexican spotted owl	F	Ponderosa pine – Gambel oak	MH	M	MH	MH	1,3
		Ponderosa pine – vertical heterogeneity	MH	M	MH	MH	1,3
		Ponderosa pine – horizontal heterogeneity	MH	M	M	M	1,3
		Frequent fire mixed conifer	H	MH	H	H	1,2,3
		Mesic mixed conifer/spruce-fir	H	MH	MH	MH	1,2,3
Orange-crowned warbler	O	Aspen – ponderosa pine and frequent fire mixed conifer	MH	M	M	M	1,3
Apache (Arizona) trout	F	Natural waters	H	H	H	H	1,2,3
Arizona (mountain) treefrog	O	Wetland/cienega	MH	MH	MH	MH	2,3
Northern leopard frog	S	Wetlands/cienega	VH	VH	VH	VH	1,2,3
		Natural waters	H	H	H	H	1,2,3
		Constructed waters	MH	MH	MH	MH	1,2,3
Great basin spadefoot	O	Wetlands/cienega	MH	MH	MH	MH	2,3
Kaibab fairy shrimp	S	Wetlands/cienega	MH	MH	MH	MH	2,3
Desert green hairstreak	O	Pinyon-juniper communities	MH	MH	MH	MH	1
		Pinyon-juniper grasslands	MH	MH	MH	MH	1
		Sagebrush shrublands	MH	MH	MH	MH	1
Kaibab variable tiger beetle	O	Montane/subalpine meadows	H	MH	MH	MH	1

Common Name	Status	Habitat Element	Viability Risk by Alternative				Factors for "High Rating"
			A	B	C	D	
Hoary skimmer	O	Montane/subalpine meadows	H	MH	MH	MH	1,2
		Natural Waters	H	H	H	H	1,2,3
Nokomis fritillary	O	Ponderosa pine – bunchgrass	H	MH	H	H	1
		Ponderosa pine – Gambel oak	H	MH	H	H	1
		Frequent fire mixed conifer	VH	H	VH	VH	1,2,3
		Mesic mixed conifer/spruce-fir	VH	H	H	H	1,2,3
		Wetland/cienega	VH	VH	VH	VH	1,2,3
House Rock Valley chisel-toothed kangaroo rat	S	Semidesert grasslands	MH	MH	MH	MH	1,2,3
Allen's lappet-browed bat	S	Frequent fire mixed conifer	MH	M	MH	MH	2,3
Long-tailed vole	S	Wetland/cienega	MH	MH	MH	MH	2,3
Western red bat	S	Riparian forest	MH	MH	MH	MH	2,3
Kaibab least chipmunk	S	Mesic mixed conifer/spruce-fir	MH	M	M	M	2,3
Desert bighorn sheep	S	Desert communities	H	H	H	H	2,3
Merriam's shrew	S	Frequent fire mixed conifer	MH	M	MH	MH	2,3
Kaibab northern pocket gopher	S	Mesic mixed conifer/spruce-fir	MH	M	M	M	2,3

In table 15, two federally listed species, 11 Forest Service sensitive species, and 12 other species were found to have at least one element ranked as a "high rating" risk category. The species status highlights the relative role of other provisions included in law and policy that result in additional consideration of at-risk species during planning.

Environmental Consequences for Wildlife Viability Common to All Alternatives

Probable management activities that could potentially affect wildlife communities can be grouped into three broad categories: (1) changes in the type, quantity, quality, and spatial arrangement of suitable habitat; (2) direct mortality, reduced survival, or increased susceptibility to mortality; and, (3) increased disturbance.

For some habitat elements, there is very limited potential to affect current abundance or distribution. All four alternatives would maintain the current habitat abundance and distribution of all pinyon-juniper associated habitat elements; aspen with mesic mixed conifer and spruce/fir; sagebrush shrubland; semidesert grassland; desert communities; Gambel oak shrubland; rocky outcrops, cliffs, and canyons; riparian forest; snags; and downed wood because the conditions and trends in these habitat types did not raise significant concerns and did not emerge as a priority

need for change. Therefore, no objectives were developed for them. The forest has, however, identified desired conditions for these areas and would implement management to make progress toward desired conditions as capacity allows. For the species in table 15 (golden eagle, MacGillivray's warbler, desert green hairstreak, House Rock Valley chisel-tooth kangaroo rat, western red bat, and desert bighorn sheep) associated with these habitat elements, the current abundance and distribution would continue to provide for viable populations over time.

Five habitat elements emerged as having a high likelihood of being a limiting factor for all alternatives. These include desert communities, Gambel oak shrublands, wetland/cienega, riparian forest, and cottonwood-willow riparian forest. All of these habitat elements naturally occur on less than 1 percent of the landscape across the forest. It is not the forest's intent to make these naturally rare habitat features more common than they were historically.

Some species face an additional threat simply by virtue of their relatively limited range wide distribution. These species can be affected by localized and/or stochastic events and would likely have a high viability risk, regardless of management. A species is considered to have a restricted distribution if it occurs to a limited extent in the Southwest; a species is considered to be a narrow endemic if it has extremely limited distribution and/or habitat in northern Arizona. Table 16 shows the species that have either a restricted distribution or are considered a narrow endemic as determined in the Species Diversity Report, v. 1.2.5 (KNF 2008d). The Kaibab fairly shrimp was added after the Species Diversity Report was written and after the DEIS was published.

Table 16. Forest planning species classified as having restricted distributions or narrow endemic species

Species	Restricted Distributions	Narrow Endemic
California condor	X	
Apache trout	X	
Arizona black rattlesnake	X	
Utah Mountain kingsnake	X	
Persephone's darner	X	
Kaibab fairy shrimp		X
Kaibab variable tiger beetle		X
Kaibab Indra swallowtail		X
House Rock Valley chisel-toothed kangaroo rat		X
Kaibab least chipmunk		X
Kaibab tree squirrel		X
Kaibab northern pocket gopher		X

For most of these species listed in table 16, their habitat elements may be common on the forest, but the species are naturally limited in abundance or distribution. For these species, it is not the intent of the forest to increase their populations outside of areas they would naturally occur. Species that meet these criteria include the species listed in table 16 (except Apache trout) and the desert green hairstreak, hoary skimmer, Nokomis fritillary, four-spotted skippering and dwarf shrew.

For all the action alternatives, desired conditions and guidelines for managing rare and narrow endemic species were developed to help reduce the risk of removing habitat or refugia for these species.

- **Rare and Narrow Endemics Desired Conditions:** Habitat and refugia are present for narrow endemics or species with restricted distributions and/or declining populations. Location and conditions of rare and narrow endemic species are known.
- **Guideline:** Project design should incorporate measures to protect and provide for rare and narrow endemic species where they are likely to occur.

In collaboration with researchers at the Museum of Northern Arizona and Northern Arizona University, the forest is currently developing a guidebook, which consolidates information regarding rare and narrow endemic species along with the desert green hairstreak, hoary skimmer, and Nokomis fritillary. The intent of the guidebook is to help project specialists incorporate appropriate guidelines and design features that will better protect habitat for these species during project implementation. Protective measures incorporated into project design should help provide for continued viability of these species. While alternative A would not have the guideline for rare and endemic species, the forest would still use the guidebook to help maintain these species. The dwarf shrew and four-spotted skippering were not shown to have a high rating for viability risk under any alternative.

For several species, such as the Apache trout (which is found in less than 2 miles of natural waters on the forest), a limited amount of the habitat is available and the species has a low occurrence on the forest. As a result, these kinds of species would always have a high viability risk. Other species with both limited habitat abundance and low species occurrence include MacGillivray's warbler, Great Basin spadefoot, Arizona treefrog, long-tailed vole, northern leopard frog, House Rock Valley chisel-toothed kangaroo rat, western red bat, and desert bighorn sheep. The habitat elements for most of these species, along with the Kaibab fairy shrimp, with a high rating are wetlands/cienegas or natural waters. The threat to most of these species is the loss of habitat due to change in sediment flows or waterflows, or the introduction of nonnative species or disease. The following forest plan desired conditions were developed to reduce these risks:

- **Wetland/Cienega Desired Condition:** Wetlands conditions are consistent with their flood regime and flood potential. Native plant and animal species that require wetland habitats have healthy populations within the natural constraints of the particular wetland community. Wetlands infiltrate water, recycle nutrients, resist erosion, and function properly.
- **Natural Waters Desired Condition:** Stream channel stability and aquatic habitats retain their inherent resilience to disturbances and climate fluctuations. Stream channel morphology reflects changes in the hydrological balance, runoff, and sediment supply appropriate to the landscape setting. Springs and ponds have the necessary soil, water, and vegetation attributes to be healthy and functioning. Water levels, flow patterns, groundwater recharge rates, and geochemistry are similar to historic conditions. Within its capability, streamflow and water quality is adequate to maintain aquatic habitat and water sources for native and selected nonnative wildlife. The necessary physical and biological components, including cover, forage, water, microclimate, and nesting/breeding habitat, provide habitat for a diverse community of plant and wildlife species. Riparian dependent plant and animal species are self-sustaining and occur in

natural patterns of abundance and distribution. Within its capability, streamflow and water quality are adequate to maintain aquatic habitat and water sources for native and desired nonnative species. Native macroinvertebrates are appropriately abundant and diverse. Unwanted nonnative species do not exert a detectable impact on aquatic and wetland ecosystems. Native amphibians are free from or minimally impacted by nonnative predation and diseases. Springs, streams, and ponds have appropriate plant cover to protect banks and shorelines from excessive erosion. Hydrophytes and emergent vegetation exist in patterns of natural abundance in wetlands and springs in levels that reflect climatic conditions. Overhanging vegetation and floating plants such as water lilies exist where they naturally occur. Where springs or other natural waters have been modified for livestock and/or human consumption, developments are operational.

- **Constructed Waters Desired Condition:** Drinkers have escape ramps that provide safe access and egress for wildlife. Constructed waters do not contribute to the spread of chytrid fungus or unwanted nonnative species. Reservoirs maintain high water quality for parameters such as temperature, pH, and dissolved oxygen, and water levels are within the seasonal range of variable conditions. Desirable nonnative fish species provide recreational fishing opportunities in reservoirs and constructed lakes consistent with the needs of native species.
- **Wilderness and Recommended Wilderness Desired Condition:** A reproducing population of Apache trout is maintained in North Canyon Creek.

In the case of the desert bighorn sheep, desert communities, or the House Rock Valley chisel-tooth kangaroo rat, semidesert grasslands, the forest is not proposing management objectives for these habitat types in any of the alternatives that would affect these species. The desired condition for these PNVTs would help maintain viability for both sensitive species.

- **Desert Communities Desired Condition:** Desert communities are characterized by extensive grasses with a shrub cover less than 30 percent. Vegetation canopy cover ranges from 5 to 40 percent. Shrubs contribute to the native plant diversity and structure. Density of juniper and other shrubby species is maintained at levels that promote natural fire regimes and long fire return intervals. Fire occurrence is low and infrequent. Rocky outcroppings and shrubby plant species provide abundant browse and foraging opportunities for mule deer and bighorn sheep. Native ungulates are free from disease. Livestock are absent, except for recreation and administrative packing and riding animals.
- **Semidesert Grasslands Desired Condition:** Vegetation height and canopy cover are sufficient to carry fire under low wind conditions to support fire on a 10- to 30-year return interval.

Finally, proposed management activities would have very limited effects for some species. The desert bighorn sheep is limited to certain areas on the North Kaibab Ranger District. The biggest threats to this species are predators and disease that are typically associated with domestic goats and sheep. There are no domestic sheep or goat allotments on the North Kaibab or Tusayan Ranger Districts; therefore, there is no risk to bighorn sheep from current range management on the forest. Western red bat is associated with riparian habitat and is only believed to be found in the Mogollon Rim area on the Williams Ranger District. The habitat for this species is contained within the wilderness boundaries and is unlikely to be affected by management. For these two

species, the forest management would not affect their viability in the long term and none of the alternatives would lead toward Federal listing of these species.

Neither the loach minnow nor spikedace (both federally listed as endangered) occur on the Kaibab NF. However, the critical habitat is within an area that could be affected. There are no direct effects to these species; only indirect effects since all effects would be off-forest. The biggest threat to either fish or their critical habitat is a large uncharacterized wildfire in the portions of the Kaibab NF that is within the Verde River Drainage. See appendix H for desired conditions that would reduce the potential for these kinds of events. Generally, the overall intent of the desired conditions is to protect resources while maintaining multiple-use activities. Indirect effects from management actions such as vegetation management and fuel reductions would likely not be measureable or distinguishable from other off-forest activities due to the fact that downstream habitat is 12 miles away from the forest boundary. None of the alternatives would adversely affect the species or their critical habitat.

Risk to species viability is also reduced by provisions in existing law and policy. For all alternatives, the forest would continue to follow the intent of all recovery plans for federally listed species even if actions within those plans do not match the forest's desired conditions for the particular resource area. These include specific consideration of effects to federally listed species (proposed, threatened, and endangered species) and regional forester's sensitive species, in biological assessments and evaluations conducted as part of all national forest management decisions. These assessments and evaluations identify where additional protective measures are warranted to provide for continued existence of the species on NFS land. Projects that may affect federally listed or proposed species must be coordinated with the U.S. Fish and Wildlife Service during the planning stage to mitigate potential impacts to listed species under Section 7(a)(2) of the ESA. In addition, section 7(a)(1) of the ESA directs federal agencies to use their authorities to carry out programs for conserving threatened and endangered species. The forest currently fulfills this duty in the ways described below. The forest will continue these activities. Furthermore, desired conditions and some guidelines will provide additional conservation measures (see the biological assessment for listed species and appendix H for these additional conservation measures).

California Condor

The Kaibab NF is an active member of the Southwest Condor Workgroup and a cooperating partner on an MOU which includes representatives from other agencies and organizations. The North Kaibab wildlife biologist is the designated forest representative and participates regularly on conference calls and annual meetings. The purpose of the MOU is to establish a general framework for cooperation and participation among all cooperators to promote the recovery of the California condor. The MOU applies to the Southwest California condor reintroduction program and designated nonessential experimental population with three primary objectives:

1. Support a long-term program to reestablish a viable self-sustaining population of California condors in the southwestern United States through the release of captive-reared individuals and management of the wild population.
2. Achieve recovery goals for this species as cited in the California Condor Recovery Plan (USFWS 1996), following the current management recommendations established by the California Condor Recovery Team as authorized by the USFWS, and implement recommendations of the California Condor 5-year review (USFWS 2012b).

3. Address emerging issues through the Southwest Condor Working Group's representatives of the primary cooperators.

Public outreach and education is conducted in a variety of ways. The Kaibab NF maintains a Web link to The Peregrine Fund's California Condor Restoration Web site. This comprehensive Web site explains the goals of the restoration program, threats (e.g., health impacts posed by the use of lead ammunition and recommendations to reduce such impacts), and reintroduction and research efforts to date. It maintains a library of reports, presentations, and peer-reviewed literature relative to condors, as well as a contact list for key personnel and cooperating partners, which includes the Kaibab NF. Other outreach efforts include postings, signs, and information cards distributed by Forest Service personnel explaining the harmful effects of lead ammunition to the public. In August 2012, the forest entered into an agreement with the Arizona Game and Fish Department and provided $20,000 to help support the State's voluntary lead reduction program. This effort helps provide educational and outreach materials on the positive impacts of lead reduction on the condor.

Through the special use permitting process, outfitter guides on the North Kaibab Ranger District are urged to use non-lead ammunition for the hunts they provide to help reduce the risk to condors. These provisions include: within Game Management Units 12A and 12B, the Arizona Game and Fish Department offers non-lead rifle ammunition to big game hunters. It is recommended that hunters in these units consider using 100 percent copper bullets to reduce lead exposure to California condors. If the hunters choose to use lead ammunition, they are strongly encouraged to remove all shot animals and gut piles from the field, and when this isn't possible, to hide them with rocks and brush, or remove all blood-shot flesh.

The forest has worked with the USFWS to develop measures to minimize risk of harmful interactions with condors that could occur near project-related activities. These mitigation measures include:

- Project worksites will be cleaned up at the end of each day to avoid trash accumulation that may attract condors.
- If a condor shows up near project-related activities, a Forest Service wildlife biologist will be contacted immediately and any project-related activity likely to harm the condor will halt temporarily until the condor flies away or is driven away by permitted personnel.
- Project workers will be instructed to avoid any interaction with condors.
- The wildlife biologist will be notified if any project-related vehicle fluid leak or spill occurs that could result in condor poisoning.

The forest incorporated significant alterations to the Navajo Transmission Line EIS for the portion of the line crossing the Tusayan Ranger District. The EIS calls for high-visibility wire to minimize avian collisions and a monitoring/adaptive management approach to retrofit the line if collisions exceed stated limits for a variety of birds, including California condors.

Finally, the forest provides field, logistical, and funding support to The Peregrine Fund as needed during reintroduction and recovery actions. This includes providing equipment such as snowmobiles and personnel to help distribute winter feed for condors, as well as maintain numerous roads, which provide the necessary access for condor monitoring. In 2009, the forest

entered into a challenge-cost share agreement with The Peregrine Fund and provided critical and timely funding support for the North Kaibab Ranger District release efforts that year. The purpose of that agreement was to study the movement and locations of condors on the Kaibab NF and adjacent lands. Objectives were focused on increasing production, refining release techniques, and monitoring released birds, while minimizing mortality factors to establish a self-sustaining population. Additional goals included continuing education and public awareness regarding the deleterious effects of lead on condors, the environment, and human health implications. The results of that work were written up in a final report that provides valuable insight on movement and foraging behavior across the Kaibab Plateau and adjacent areas. The forest is currently working with Arizona Game and Fish Department along with The Peregrine Fund to provide support and funding for the further transmitter monitoring of the condors. The forest is providing $20,000 in 2013 toward this effort.

Mexican Spotted Owl

- The forest works with the USFWS to establish protected activity centers for Mexican spotted owls using criteria set forth in the recovery plan.
- The forest conducts fuels reduction projects which may benefit the Mexican spotted owl in the future. These projects focus on reducing the potential for stand-replacing, uncharacteristic wildfires that are a threat to the species while still maintaining or enhancing structural habitat features (e.g., large trees, snags, and downed woody materials). The forest is an active partner in the Four Forest Restoration Initiative (4FRI).
- The forest monitors protected activity centers and provides the USFWS with monitoring and project survey results annually.
- A new population and habitat monitoring approach was developed within the recently published Revised Recovery Plan (USFWS 2012a). The Forest Service has agreed to meet with the USFWS to discuss its future participation in the Recovery Plan Monitoring Plan, to be done in conjunction with the USFWS and other land management agencies. Initial discussions have taken place.

Apache Trout

- The forest partners with personnel from Arizona Game and Fish Department in monitoring Apache trout and their habitat in North Canyon Creek.
- In 2010, the Kaibab NF worked with the Arizona Game and Fish Department to improve in-stream structures within the Apache trout habitat. The check dams were old and failing, resulting in the loss of important pool habitat for the Apache trout population established in this stream. The new structures are providing the habitat structure required for the trout.
- Trail maintenance near the trout habitat has reduced sedimentation into the creek. The trails are checked annually to make sure they are in good conditions.
- The forest assesses all wildfires that start in the proximity of the North Canyon Watershed regarding potential impacts to the stream and the Apache trout.

In summary, the federally listed and sensitive species that were shown to have low or moderate viability risk due to habitat elements for all alternatives are the western burrowing owl, American peregrine falcon, California condor, spikedace, loach minnow, pale Townsend’s big-eared bat,

spotted bat, Navajo Mogollon vole, and dwarf shrew. For these species, the proposed alternatives would provide for long-term viability of the species.

Environmental Consequences for Wildlife Species Viability: Alternative A – Current Plan, Current Management (No Action)

Alternative A has the greatest number of species and associated habitat elements (43 total) with very high (4), high (10), or moderate high (29) viability risk (table 15). This alternative also has the greatest number of habitat elements that would be further departed from reference conditions (12 with fair rating and 8 with poor rating). Many of the risks associated with those species abundance and distribution under current management correspond with the vegetation types identified under "the priority needs for change" that have served to focus the forest plan revision effort (KNF 2009).

The current plan, as amended (KNF 1988), does not allow the use of managed wildfire in most of the mixed conifer types (frequent fire and mesic) to maintain or improve stand structure, stimulate aspen regeneration, maintain fuel loads, or to achieve other resource benefits. With the continued lack of fire disturbance, the risk of losing most or all of these vegetation types to stand-replacing wildfire, and the resulting uncharacteristic open state, increases with each passing year (Vegetation and Fire Specialist Report; KNF 2013a). In addition, the decline or loss of aspen as a component of the mixed conifer types on the North Kaibab Ranger District is due primarily to lack of fire disturbance. The potential loss of habitat components due to large, high-severity wildfires could have a negative effect on the Mexican spotted owl, red-faced warbler, evening grosbeak, olive-sided flycatcher, dusky grouse, MacGillivray's warbler, golden-crowned kinglet, red-naped sapsucker, orange-crowned warbler, Nokomis fritillary, Nokomis fritillary ssp. nokomis, southwestern myotis, Kaibab least chipmunk, red squirrel, and Kaibab northern pocket gopher.

Most of the standards and guidelines that have the potential to benefit wildlife in the current plan are also found in the action alternatives in the form of desired conditions, guidelines, or management approaches. In many places, the current plan reiterates existing law, regulation, or policy, but these are incorporated by reference in the action alternatives and are considered at the project level.

The current forest plan lacks a description of desired conditions for many of the habitat elements. This lack of description makes it harder to ensure projects are implemented in a consistent manner and that projects are moving toward a common set of desired conditions. Alternative A does not contain guidelines that would retain wildlife habitat components such as mistletoe brooms and partial snags; promote interconnected habitats for wide ranging species; and provide guidance for rare and narrow endemic species. It also does not include prevention measures for the spread of certain wildlife diseases (e.g., white nose syndrome, chytrid fungus) or guidance that influences animal movement, such as wildlife friendly fence improvements (e.g., pronghorn), or bat gates.

The current plan has very prescriptive (restrictive) standards and guidelines that make it difficult to apply adaptive management based on our understanding about management effects on ecosystems and wildlife. Adaptive management will be essential to effectively manage for climate change and invasive species in changing and uncertain conditions. As a result the action

alternatives include a monitoring plan designed to better inform the effects and effectiveness of management and progress towards desired conditions."

The Wildlife Society with the Inkley et al. report (2004) recommended several actions to help wildlife adapt to changing climate and its potential effects on wildlife. Most of these recommendations are not easily implemented under the current plan. These include: (1) managing for diverse conditions; (2) reducing nonclimate stressors on ecosystems; (3) reducing the risk of uncharacteristic high-intensity fires; (4) conducting medium- and long-range planning; (5) ensuring ecosystem processes; and (6) employing monitoring and adaptive management. Another recommendation is the control of invasive plant species. Impacts to invasive species prevention and control would initially remain similar to alternative B forest-wide, with potential increases over time to invasive species populations correlating with increased stand-replacing fires (see Nonnative Invasive Plant section). Climate change has the potential to affect all wildlife species, and influences the likelihood of large-scale disturbance (e.g., fire, bark beetle outbreaks) across the landscape. The current forest plan (alternative A) does not recognize climate change, and offers limited guidance associated with management activities (e.g., salvage logging) related to such disturbance events. The forest would continue to follow existing law, regulation, policy and best management practices to address species viability concerns in areas affected by large-scale disturbance.

In addition to federally listed species and Forest Service sensitive species, the evening grosbeak, olive-side flycatcher, golden eagle, red-naped sapsucker, and orange-crowned warbler all had a moderate high viability rating for the current plan (table 15). All of these wildlife species are found in multiple habitat elements with most of the habitat elements having a low to moderate viability rating. The evening grosbeak and olive-sided flycatcher both have the high rating in frequent fire mixed conifer habitat element. The golden eagle high rating was for both montane/subalpine meadows and Colorado Plateau/Great Basin grasslands. The red-naped sapsucker and orange-crowned warbler high rating was for aspen in ponderosa pine and frequent fire mixed conifer habitat elements. For all the species, except for the golden eagle, this rating is based on the limited amount of habitat improvement (progress toward desired conditions) expected under the current forest plan. For golden eagle, the rating is due to the rarity of the species and the limited amount of work occurring within grasslands and montane meadows. For these habitat elements, the forest currently has ongoing habitat improvement projects, such as removing pinyon-juniper in historic grasslands, restoring frequent fire mixed conifer stands, and fencing aspen clones to reestablish aspen stands on the Williams Ranger District. However, at the current rate of implementation, these projects maintain current amounts and are not likely to have a substantive increase in quality or quantity for the habitat elements. The viability of the species would be maintained through the habitat elements that are at a low or moderate viability rating, and the level of habitat treatment occurring within the habitat elements at a high viability rating.

Federally Listed Species and Sensitive Species

The current forest plan would have impacts to threatened, endangered, and sensitive species and critical habitat for the Mexican spotted owl. All species require evaluation of projects to determine effects to the species and for listed species to determine if consultation with USFWS is appropriate. The current land management plan has numerous standards and guidelines that require the evaluation and protection of federally listed and regionally sensitive species.

The California condor is federally endangered. The condor population on the Kaibab NF is further classified as a §10(j) experimental nonessential population under ESA section 10. By definition, a nonessential experimental population is not essential to the continued existence of the species. While the 10(j) rule provides considerable discretion and management flexibility to address potential conflicts with existing human land uses and activities (e.g., hunting) in the reintroduction area, that discretion must not preclude recovery of the species. California condors have rarely been found on the Kaibab NF outside of the §10(j) area. If any condors are found outside of the §10(j) area, they are protected as a federally endangered species. Most of the standards and guidelines for protection of wildlife and forest management are beneficial for the condor. The primary threat to the Arizona population of condors is ingestion of lead ammunition. As noted in Chapter 1, the ability of the forest to affect the use of lead ammunition is outside the scope of this document; therefore, this is not a forest management activity used to determine viability risk from the implementation of the forest plan. (see Cumulative Environmental Consequence section for effect from lead shot). See the ESA section 7(a)(1) discussion above in the Effects Similar for All Alternatives for actions the forest has taken to help reduce the effects of lead ammunition to the condor.

Of the 69 fatalities noted in the current Five Year Review on the condor reintroduction program (USFWS 2012b), a collision (mainly with power lines) is the only threat affected by forest management actions. There are standards and guidelines that limit development of utility corridors. Utility corridor easements would have some impacts on the condors. The current plan contains a guideline that allows recreation use to continue at current levels includes hunting and could be viewed as a negative impact. However, because the forest only provides access for hunting, and does not manage harvest of game animals, there is little influence from forest management. The condor has a moderate viability risk rating for the one habitat element shown for them. This is based on the limited impacts to this habitat element and the forest ranking for the condor. While some individual birds could be impacted by actions on the forest and cumulatively there is a negative effect to the Southwest population from lead shot, the alternative management activities would not adversely affect the viability of the species. It is estimated the amount of grasslands would not change under this alternative; however, it is predicted that the overall condition of grasslands would continue to decline.

Mexican spotted owl (federally threatened) and its designated critical habitat is protected by the standards and guidelines that were included in the 1996 plan amendment (KNF 1988, as amended). The forest recognizes that projects and program activities implemented under the current plan may occur near or within Mexican spotted owl protected activity centers and within critical habitat. While the standards and guidelines provide protection for the owl and maintain their viability on the forest, activities may be permitted, authorized, or funded which may negatively affect individuals or affect designated critical habitat. There are moderate high viability risk for ponderosa pine habitat elements and high viability risk to mixed conifer habitat elements for the Mexican spotted owl. These risks are based on the limited ability of the forest to make progress toward the desired conditions and the increased risk of losing these habitat elements to wildfires by having unnaturally high fuel loads in these stands. Based on VDDT modeling, it is estimated that the amount of mixed conifer available for nesting and roosting would increase in 15 years by approximately 640 acres to 35,760 acres and ponderosa pine/Gambel oak stands would stay the same at approximately 13,294 acres for a total of 49,054 acres (see appendix B for all results by alternative).

Saddle Mountain Wilderness, in North Canyon Creek, contains the only population of Apache trout (federally threatened) on the forest. Alternative A would retain the standard that the maximum size objective for any fire within a 2-mile radius of North Canyon Spring is 5 acres. The intent of the standard is to prevent a high-severity fire in Apache trout habitat, so it would positively affect the trout in that regard. Alternatively, the standard does not allow for low-intensity fire (which could benefit the trout by helping prevent a high-intensity fire), so this limitation could negatively affect the Apache trout because the greatest risk to the species is a high-severity wildfire in the canyon. The resulting sedimentation and potential loss of shaded canopy from such an event could cause a loss of the local population. The forest is currently limited (unable) to use mechanical fuel reduction methods in this area due to wilderness management regulations. Because of this limitation imposed on the fuels reduction program, the overstory canopy would continue to close and the forested areas around the creek could become unnaturally dense. As the forest density increases and moves toward a closed state, there would be an increased risk for high-intensity fires because canopy fuel volumes would increase as stands became increasingly dense. Further, an increase in tree density would also put the forest at greater risk for bark beetle attacks, which could increase the potential for high-severity wildfire due to the increased amount of susceptible fuels (drier vegetation and greater fuel loads). Increased frequency and extent of high-severity wildfires could greatly affect Apache trout habitat by removal of shade trees near the stream and increased sediment in the water. Depending on the severity of the fires, amount of habitat loss, and location of fire within the watershed, there would be a potential to affect the viability of this population.

Sensitive species that depend on ponderosa pine and mixed conifer habitat would be affected by the 1996 plan amendment. The standards and guidelines for the goshawk and Mexican spotted owl would provide for the goshawk, bald eagle, Allen's lappet-browed bat, Kaibab least chipmunk, Kaibab tree squirrel, Merriam's shrew, and Kaibab northern pocket gopher. Table 15 shows that alternative A has a low to moderate viability risk for these habitat elements for the Kaibab squirrel and a moderate high ranking for bald eagle in ponderosa pine. The VDDT model (summarized in table 17) shows the following changes for ponderosa pine and mixed conifer:

- Goshawk ponderosa pine habitat would increase by 10,942 acres for a total of 196,949 acres.
- Bald eagle and Allen's lappet-browed bat ponderosa pine habitat would increase by 4,942 acres for a total of 415,781 acres.
- Kaibab least chipmunk and Kaibab northern pocket gopher mixed conifer with aspen habitat is estimated to stay approximately the same.
- Kaibab tree squirrel overall ponderosa pine habitat would decrease by 1,685 acres for a total of 101,100 acres; optimum habitat would increase by 3,064 acres for a total of 55,146 acres.
- Merriam's shrew ponderosa pine habitat would increase by 82,062 acres for a total of 213,361 acres.

The goshawk, Allen's lappet-browed bat, and Merriam's shrew show moderate to high viability rating only within the frequent fire mixed conifer habitat element (table 15). This habitat element is only one of several different habitat elements these species use. Based on VDDT modeling, the following shows the change in frequent fire habitat conditions in 15 years:

- Goshawk habitat would increase by 3,832 acres for a total of 39,593 acres.

- Allen's lapped-browed bat habitat would decrease by 4,010 acres for a total of 80,463 acres.
- Merriam's shrew habitat would increase by 3,584 acres for a total of 18,190 acres.

The Kaibab least chipmunk and Kaibab northern pocket gopher show moderate high viability rating only within the mesic mixed conifer/spruce fir habitat element (table 15). This habitat element is only one of several different habitat elements these species use. Based on VDDT modeling, the following shows the change in mesic mixed conifer/spruce fir habitat conditions in 15 years:

- Kaibab least chipmunk and Kaibab northern pocket gopher habitat would show an increase of 694 acres for a total of 3,522 acres.

Based on the risk to viability rating and the amount of habitat provided for each of the above species, viability would be maintained for each of these species dependent on conifer habitat under the no action alternative. While individual animals could be impacted by the actions under this alternative, the alternative would not lead toward Federal listing of the above sensitive species.

Sensitive species that depend on riparian or wetland habitat and either constructed or natural waters have several standards and guidelines in the current plan that protect wetland habitat on the forest. These include invasive weed management, riparian habitat protection, and grazing requirements. These requirements would improve the viability of the bald eagle, Kaibab fairy shrimp, northern leopard frog, and long-tailed vole. The bald eagle had a low to moderate viability risk for all habitat elements. The desired condition discussed above in the Effects Similar for All Alternatives section for the water elements would mitigate impacts to Kaibab fairy shrimp, northern leopard frog and long-tailed vole. The amount of habitat is not likely to change from the current condition, but the quality of habitat would be expected to increase. As wetlands and springs are surveyed and monitored, the forest would be able to better assess which areas are no longer in proper functioning condition and improvements can be made. While individual species could be impacted from actions under the no action alternative, it would not lead toward Federal listing for any of these species.

The current plan has very few standards or guidelines that relate directly to features needed by sensitive species that depend on grasslands, meadows, shrublands, desert communities, caves and mines, rocky outcrops, or cliffs and canyons. These species and features are indirectly affected by standards and guidelines for recreational uses and mineral development. Their main protection is the requirements to protect sensitive species which are addressed outside the plan. The species that depend on these habitat elements are the western burrowing owl, peregrine falcon, pale Townsend's big-eared bat, House Rock Valley chisel-toothed kangaroo rat, spotted bat, Allen's lappet-browed bat, long-tailed vole, Navajo Mogollon vole, Kaibab least chipmunk, desert bighorn sheep, dwarf shrew, and Kaibab northern pocket gopher. Table 15 shows that alternative A (no action) has a low to moderate viability risk for these habitat elements for all of these species except House Rock Valley chisel-toothed kangaroo rat and desert bighorn sheep. These two species are discussed above in the Effects Similar for All Alternatives section.

Shrublands, desert communities, caves and mines, and rock outcrops, cliffs and canyon habitat are not expected to change under the current forest plan. The forest has actively been removing pinyon-juniper in grasslands on the Williams Ranger District. On average, the forest is restoring

approximately 2,000 acres a year. Over 15 years, this rate would restore approximately 30,000 acres. While this would improve habitat conditions, it would not increase the amount of the PNVT. Active management activities could affect individual animals, but would not lead toward Federal listing or affect viability of the populations.

Other Federal Law Compliance

There would be no programmatic take under the Bald and Golden Eagle Protection Act. There was one bald eagle nest site on the forest. In 2012, the bald eagles nested and fledged young on the Williams Ranger District. However, in 2013, one of the pair was found dead and no nesting occurred on the forest. The forest will monitor the site for nesting to see if the eagles will return in the future. If nesting occurs, then the Arizona Eagle Watch volunteers and the forest will monitor the nest site and work with the public at the recreation site about the need to avoid the nesting area. Most of the use on the forest is migrating bald eagles that use the forest during the winter with no known established winter roost sites. There are golden eagle nest sites on the forest, but there are no management activities within the plan that adversely affect these nest sites.

Alternative A was implemented before Executive Order 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds was signed January 10, 2001, to promote the conservation of migratory birds. As a result, many of the topics that must be considered pursuant to this order were not incorporated into existing plan direction. However, during the planning stage of any project, under the current plan, project-led planning under NEPA requires a review of effects and development of mitigations to reduce impacts to migratory birds.

Wildlife Species Viability: Effects Common to All Action Alternatives

A fine filter approach was used to develop plan components to improve the viability of species populations on the forest. Appendix H is a crosswalk that shows how desired conditions, objectives, standards, and guidelines were developed to reduce threats and to meet species' specific habitat needs. These fine filter measures were developed in addition to the broader coarse filter plan components that provide for the viability of all species. The high-risk species would be conserved through desired conditions, standards, and guidelines, as well as through forestwide objectives related to forest health and ecosystem restoration. For listed species, this also meets the requirements to develop conservation actions under ESA Section 7(a)(1).

All of the action alternatives address some of the strategies identified by Inkely et al. (2004) for coping with the challenges of climate change through desired conditions, objectives, standards, guidelines, or management approaches. All action alternatives (1) recognize that climate change may affect wildlife; (2) do not rely on historical weather and species data; (3) control invasive species; (4) conduct medium- and long-range planning; and (5) employ monitoring and adaptive management.

Related to climate change is the increasing potential for large-scale disturbance (e.g., widespread drought, uncharacteristic fire, bark beetle epidemics) events which have the potential to affect a number of ecosystems, in particular forest and woodland communities. The action alternatives recognize the increased potential for these events in the future through a post-disturbance response strategy that includes guidelines and objectives to ensure important wildlife habitat is specifically considered and retained during activities such as salvage logging operations. While

there is the potential for some negative effects on wildlife during salvage operations (e.g., incidental crushing, disturbance), those effects would be outweighed by the overall goal of long-term ecosystem recovery. Current knowledge regarding effects of salvage logging on wildlife and associated ecosystems continues to evolve. For all management activities, the forest intends to use the best available science. The forest would consult the scientific literature and or area experts to be sure current thinking is incorporated into project design and implementation. In addition, during salvage operations the forest would mitigate for wildlife threats through specific plan components as mentioned below and appropriate best management practices (BMPs). The guidelines and objectives for large-scale disturbance are in addition to existing law, regulation and policy, and relevant plan components (e.g., desired conditions for the respective vegetation types; guidelines for vegetation management in forested communities; and guidelines for threatened, endangered, and sensitive species etc.).

In addition to federally listed species and Forest Service sensitive species, golden eagle, red-naped sapsucker, and orange-crowned warbler all had a moderate viability rating for all action alternatives (table 15) for some habitat elements. The golden eagle moderate rating was for both montane/subalpine meadows and Colorado Plateau/Great Basin Grasslands. The red-naped sapsucker and orange-crowned warbler rating was for aspen in ponderosa pine and frequent fire mixed conifer habitat element.

Federally Listed Species and Sensitive Species

The action alternatives would have the same impacts to the federally listed and sensitive species except for those species that depend upon ponderosa pine and frequent fire mixed conifer forest. The action alternatives specify the same desired conditions, objectives, and standards for all the other habitat elements. The guideline for presettlement tree retention, the differing amounts of land managed for timber production, and lands recommended for wilderness are the substantive differences between alternative B and alternatives C and D. For some areas, the guidance for alternatives C and D would have the same effect as alternative B. All other plan components are the same for the three action alternatives.

- **Wildlife Desired Condition:** Native wildlife are distributed throughout their potential natural range. Desirable nonnative wildlife are present and in balance with healthy, functioning ecosystems. Habitat is available at the appropriate spatial, temporal, compositional, and structural levels such that it provides adequate opportunity for breeding, feeding, nesting, and carrying out other critical life cycle needs for a variety of vertebrate and invertebrate species. Species with specific habitat needs (e.g., snags, logs, large trees, interlocking canopy, and cavities) are provided for. Grasses, forbs, and shrubs provide forage, cover, and fawning and nesting sites. Interconnected forest and grassland habitats allow for movement of wide ranging species and promote natural predator-prey relationships, particularly for strongly interactive species (e.g., mountain lions). Habitat configuration and availability allow wildlife populations to adjust their movements (e.g., seasonal migration, foraging, etc.) in response to climate change and promotes genetic flow between wildlife populations. Human-wildlife conflicts are minimal. Hunting, fishing and other wildlife-based recreation opportunities exist, but do not compromise species populations or habitat.
- **Threatened, Endangered, and Sensitive Species Desired Condition:** Threatened, endangered, and sensitive species have quality habitat, stable or increasing populations, and are at low risk for extirpation. Goshawk nest areas are multi-aged forests dominated

by large trees with interlocking crowns and are generally denser than the surrounding forest.

- **Guidelines for Threatened, Endangered, and Sensitive Species:** Project activities and special uses occurring within federally listed species habitat should integrate habitat management objectives and species protection measures from approved recovery plans. Project activities and special uses should be designed and implemented to maintain refugia and critical life cycle needs of Forest Service sensitive species. Activities occurring near areas used by bald eagles should follow recommendations identified in the National Bald Eagle Management Guidelines and Arizona Conservation Assessment and Strategy for the Bald Eagle. A minimum of six goshawk nest areas (known and replacement) should be located per territory.

The following desired conditions and guidelines were developed to help mitigate the potential of habitat loss or disturbance to the federally listed and sensitive species from the implementation of management activities. These desired conditions and guidelines were developed to help ensure that habitat components for these species are incorporated into management activities on the forest. For example the livestock grazing guidelines help to ensure that grasses and forbs are available to provide habitat for grassland or understory species. These guidelines are in addition to livestock grazing manual and handbook policy and direction. Operating instructions for livestock grazing permittees are reviewed annually and an adaptive management strategy is used to adjust use with capacity and minimize any adverse effects. Beside the listed or sensitive species that are associated with these habitat types, it also provides habitat for prey species for some listed or sensitive species that forage on grassland or understory species.

- **Recreation and Scenery Desired Conditions:** A wide spectrum of high-quality recreations settings exist. Use levels are compatible with other resource values. Opportunities for off-highway vehicle (OHV) riding and driving for pleasure are available on the designated system of NFS roads and motorized trails.
- **Guidelines for Recreation and Scenery:** Any new motorized trailheads should be located in front-country areas, incorporate or convert existing roads, protect open space, and protect natural and cultural resources. Group uses should be concentrated in front-country areas. Resource impacts should be reduced in front and back-country areas by directing camping to existing dispersed and designated campsites. New campsites are designated only when necessary to further reduce resource damage.
- **Livestock Grazing Desired Condition:** Grasses and forbs provide adequate forage for permitted livestock. Livestock use is consistent with other desired conditions.
- **Guidelines for Livestock Grazing:** Livestock management should favor the development of native cool season grasses and forbs. Annual operating instructions for livestock grazing permittees should ensure livestock numbers are balanced with capacity and address any relevant resource concerns (e.g., forage production, weeds, fawning habitat, soils, etc.). Post-fire grazing should not be authorized until Forest Service range staff confirms range readiness. Livestock use in aspen areas should be authorized at levels that are consistent with the desired conditions for aspen regeneration and establishment. Livestock use in and around wetlands should be evaluated on an allotment specific basis. Mitigation measures such as deferment and fencing (full or partial) should be implemented as needed to minimize potential livestock effects.

- **Forestry and Forest Products Desired Condition:** Wood products (e.g., wood pellets for home and industrial heating, wood molding, pallets, structural lumber, firewood, posts, poles, biomass for electricity) and other products (e.g., Christmas trees, boughs, wildflowers, mushrooms, grasses, seeds, nuts, cones, etc.) are available to businesses and individuals in a manner that is consistent with other desired conditions on a sustainable basis within the capacity of the land.
- **Guidelines for Forestry and Forest Products:** Timber harvest activities should be carried out in a manner consistent with maintaining or making progress toward the desired conditions in this plan. Harvesting systems should be selected based on their ability to meet desired conditions and not on their ability to provide the greatest dollar return. On suitable timber lands, timber harvest activities should only occur when there is reasonable assurance of restocking within 5 years after final regeneration harvest. On suitable timber lands, even-aged stands should have reached or surpassed 95% of the culmination of mean annual increment prior to having a regeneration harvest, unless it is needed to reduce fire hazard within the wildland-urban interface, or would contribute toward achieving the desired uneven aged vegetation conditions over the long term. On lands classified as not suited for timber production, timber harvesting should only be used for making progress toward desired conditions or for salvage, sanitation, public health, or safety.
- **Transportation and Forest Access Desired Conditions:** Forest roads, bridges, and trails provide safe, legal, and reasonable access for recreation opportunities and resource management. Resource impacts from roads and trails are balanced with the benefits of having the road or trail available for use. All designated routes open to wheeled motorized vehicles are shown on a motor vehicle use map (MVUM) that is readily available to the public. The inventoried roadless areas are free from activities that would alter their roadless character.
- **Standard for Transportation and Forest Access:** Motor vehicle use off the designated system of roads, trails, and areas is prohibited, except as identified on the MVUMs and as authorized by law, permits, and orders in connection with resource management and public safety.
- **Guidelines for Transportation and Forest Access:** Motorized uses in semiprimitive nonmotorized areas should be restricted, except for necessary minimal administrative activities, permitted activities, and emergency access needs. Construction of permanent roads or temporary roads in semiprimitive nonmotorized areas should be avoided unless required by a valid permitted activity. If authorized, roads should be constructed and maintained at the lowest maintenance level needed for the intended use. Roads should be decommissioned when no longer needed.
- **Standard for Recreation Special Uses:** Competitive OHV and motorized events are not permitted on the forest.
- **Guideline for Lands Special Uses:** Uses should be combined to the extent possible in light of technical and environmental constraints.
- **Guidelines for Communication and Electronic Sites:** The number of communication and electronic sites should be the minimum that is consistent with appropriate public services that require the use of forest lands. Environmental disturbance should be minimized by co-locating communications and electronic sites.

- **Energy Transmission and Development Desired Conditions:** Energy transmission and development on the forest meets the legal mandates to facilitate the transmission and development of energy resources in a manner that minimizes adverse impacts and does not detract from meeting other desired conditions applicable to the area. Energy transmission lines are not visible (usually underground) across the landscape.
- **Standard for Energy Transmission and Development:** Major utility corridor development is confined to the area identified and mapped in the West-wide Energy Corridor Programmatic EIS.
- **Guidelines for Energy Transmission and Development:** Environmental disturbance should be minimized by co-locating pipelines, power lines, fiber optic lines, and associated infrastructure. Existing energy corridors should be used to their capacity with compatible upgraded power lines, before evaluating new routes. When compatible with protection of heritage resources, the use of below-ground utilities should be optimized in order to avoid potential conflicts with wildlife, scenery, wildfire, and long-term vegetative management.
- **Minerals and Mining Activities Desired Condition:** Minerals and mining activities meet legal mandates to facilitate production of mineral on the forest in a manner that minimizes adverse impacts to surface and groundwater resources, and that do not detract from meeting other desired conditions applicable to the area.
- **Guidelines for Minerals and Mining Activities:** Surface use should be restricted or prohibited in areas with habitat for threatened, endangered, and sensitive plant and animal species, and for heritage resources nominated or posted to the National Register. Use and occupancy should be restricted yearlong in areas supporting populations of threatened, endangered, and sensitive plant species.

The threats to the California condor are the same as discussed in the alternative A section. Most of the standards and guidelines for protecting wildlife and for range management are beneficial for the condor. Utility corridor easements would have some impacts on the condor. There is a small threat to the condor from rock climbing or blasting if it was allowed to occur within nesting or roosting areas. While some individual birds could be impacted by management actions on the forest, the species would continue to be viable. Table 15 shows there is moderate viability risk to the California condor habitat element. The desired condition, guidelines, and standards that provide protection for the condor from utility development and other activities are as follows:

- **Cliffs and Rocky Features Desired Condition:** Cliff ledges provide cover and nesting habitat for wildlife such as American peregrine falcon, California condor, snakes, bats, birds, and small mammals. Rock climbing and related recreational activities do not disrupt the life processes of rare or threatened species or diminish the function of specialized vegetation, such as mosses, lichens, and fleabanes.
- **Guidelines for Cliffs and Rocky Features:** Activities involving heavy machinery or blasting should minimize impacts to habitat associated with rocky features and cliffs. Near known active raptor nest sites, temporary closures, and use restrictions should be implemented for rock climbing and other potentially disruptive activities.
- **Recreation and Scenery desired conditions**: Visitors have access to information that enriches their recreation experiences and contributes to an understanding of their role in public land stewardship. Leave No Trace, Tread Lightly, fire prevention, wildlife

awareness (e.g., lead reduction, Bear Aware, Animal Inn, etc.), and archaeological resource protection principles are promoted and practiced by the visiting public.

- **Lands Special Uses Guideline:** Uses should be combined to the extent possible in light of technical and environmental constraints.
- **Communications and Electronic Sites Guideline:** The number of electronic sites should be the minimum that is consistent with appropriate public services that require the use of forest lands. Environmental disturbance should be minimized by co-locating communications and electronic sites.
- **Energy Transmission and Development Desired Conditions:** Energy transmission and development on the forest meets the legal mandates to facilitate the transmission and development of energy resources in a manner that minimizes adverse impacts and does not detract from meeting other desired conditions applicable to the area. Energy transmission lines are not visible (usually underground) across the landscape.
- **Standard:** Major utility corridor development is confined to the area identified and mapped in the West-wide Energy Corridor Programmatic EIS.
- **Guidelines:** Environmental disturbance should be minimized by colocating pipelines, power lines, fiber optic lines, and associated infrastructure. Existing energy corridors should be used to their capacity with compatible upgraded power lines before evaluating new routes. When compatible with protection of heritage resources, the use of below-ground utilities should be optimized to avoid potential conflicts with wildlife, scenery, wildfire, and long-term vegetative management.

Two Mexican spotted owl habitat elements have the same viability risk for all three action alternatives. Ponderosa pine horizontal heterogeneity has a moderate viability risk rating and mesic mixed conifer/spruce-fir has a moderate high viability risk rating.

Besides the desired conditions discussed above in the Effects Similar to All Alternatives section, the Apache trout would no longer have the standard that the maximum size objective for any fire within a 2-mile radius of North Canyon Spring is 5 acres. This would benefit the trout by allowing for managed fires that could reduce the risk of large-scale wildfires within the watershed. None of the alternatives would increase the amount of habitat available for the trout. Because of the limited habit and the population being in only one small section of the stream, there would be a high viability risk for this species. The proposed forest management would continue to provide for the viability of this species.

Sensitive species that depend on ponderosa pine and mixed conifer habitat elements would be affected by desired conditions and guidelines for ponderosa pine and mixed conifer. The desired conditions and guidelines for these PNVTs would provide for the goshawk, bald eagle, Allen’s lappet-browed bat, Kaibab least chipmunk, Kaibab squirrel, Merriam’s shrew, and Kaibab northern pocket gopher. Table 15 shows that all the action alternatives have a low to moderate viability risk for these habitat elements for the bald eagle, Kaibab least chipmunk, Kaibab squirrel, and Kaibab northern pocket gopher. While individual species could be negatively impacted by some management activities, the populations for these species on the forest would still be viable. Threats to the species include loss of the following habitat components; mature trees, snags, down logs, removal of mistletoe, and oak trees/mast. There are differences in the amount of acreage for these habitat elements due to the differences in the presettlement tree guidelines between alternative B and alternatives C and D, acreage for these habitat elements are shown in the next sections.

However, all other desired conditions, objectives, standards, and guidelines would be the same for all three action alternatives.

The goshawk, Allen's lappet-browed bat, and Merriam's shrew show a high viability rating only within the frequent fire mixed conifer habitat element (table 15). This habitat element is only one of several different habitat elements these species use. For the rest of their habitat elements, there is low to moderate viability risk for all action alternatives. In addition, the following desired conditions, objectives, and guidelines would reduce the threat to species from habitat loss and would provide long-term viability for the species that depend on the following habitat elements (including Mexican spotted owl). For a full description of the vegetation desired condition, see appendix H. This section highlights some of the important wildlife components.

- **Ponderosa Pine Desired Condition:** *Fine Scale*: Crowns of trees within the mid-aged to old groups are interlocking or nearly interlocking and consist of approximately 2 to 40 trees per group. Gambel oak mast (acorns) provides food for wildlife species. Where Gambel oak comprises more than 10 percent of the basal area, it is not uncommon for canopy cover to be greater than 40 percent. Isolated infestations of southwestern dwarf mistletoe may occur, but the degree of severity and amount of mortality varies among the infected trees. Witch's brooms may form on infected trees, providing habitat and food for wildlife and invertebrate species. *Mid-Scale*: Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest (e.g., goshawk post-fledging family areas, nesting/roosting habitat, drainages, and steep north-facing slopes). Snags 18 inches diameter at breast height (d.b.h.) or greater average 1 to 2 snags per acre. Snags and green snags of various sizes and forms are common. Downed logs (greater than 12 inches diameter at mid-point, and greater than 8 feet long) average 3 logs per acre. Coarse woody debris greater than 3 inches in diameter (including downed logs), ranges from 3 to 10 tons per acre. *Landscape Scale*: The ponderosa pine forest is composed predominantly of vigorous trees, but declining trees are present. Snags, green snags, and coarse woody debris occur across the landscape. Where it naturally occurs, Gambel oak is present with all age classes represented. It is reproducing and maintaining or expanding its presence within its natural range. Old growth occurs throughout the landscape, generally in small areas as individual old growth components, or as clumps of old growth. Old growth components include old trees, dead trees (snags), downed wood (coarse woody debris), and structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).
- **Objectives for Ponderosa Pine:** To make progress toward the desired conditions and reduce the potential for active crown fire in ponderosa pine communities at a rate that would maintain the desired conditions over time: (1) mechanically thin 11,000 to 19,000 acres annually, and (2) treat an average of 13,000 to 55,000 acres annually using a combination of prescribed fire and naturally ignited wildfires.
- **Frequent Fire Mixed Conifer Desired Condition:** *Fine Scale*: Dwarf mistletoe infections may be present on ponderosa pine and Douglas-fir, and rarely on other tree species, but the degree of infection severity and rate of mortality vary among infected trees. Witch's brooms may be present with these infestations, providing habitat for wildlife. *Mid-scale*: Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest; these include goshawk post-fledging family areas, Mexican spotted owl nesting/roosting habitat, and north-

facing slopes. The mosaic of tree groups generally comprises an uneven-aged forest with all age classes and structural stages. Where they naturally occur, groups or patches of aspen and all structural stages of oak are present. Snags and green snags, 18 inches d.b.h. or greater average 3 per acre. Downed logs (greater than 12 inches diameter at mid-point and greater than 8 feet long) average 3 per acre within the forested area of mid-scale units. Coarse woody debris, including downed logs, ranges from 5 to 15 tons per acre. *Landscape Scale*: Old growth occurs throughout the landscape, generally in small areas as individual old growth components, or as clumps of old growth. Old growth components include old trees, dead trees (snags), downed wood (coarse woody debris), and structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). The frequent fire mixed conifer forest community is composed predominantly of vigorous trees, but declining trees are present and snags, top killed, lightning- and fire-scarred trees, and coarse woody debris (greater than 3-inch diameter) are well-distributed throughout the landscape. Dwarf-mistletoe is present and infects ponderosa pine and Douglas-fir, but occurs at endemics levels, which allows for the establishment and sustainability of the desired uneven aged forest structure over time.

- **Objectives for Frequent Fire Mixed Conifer:** To reduce the potential for active crown fire and restore frequent fire mixed conifer communities, burn an average of 1,000 to 13,000 acres annually, using prescribed fire and/or naturally ignited wildfires. Mechanically thin 1,200 to 2,100 acres annually.
- **Mesic Mixed Conifer/Spruce-Fir Desired Conditions:** *Fine scale*: Mid-aged and older trees are typically variably spaced with crowns interlocking (grouped and clumped trees) or nearly interlocking. Dwarf mistletoe infections may be present on Douglas-fir or spruce and rarely on other tree species, but the degree of infection severity and amount of mortality vary among infected trees. Witch's brooms may be present with these infestations, providing habitat for wildlife. *Mid-scale*: Forest conditions in some areas contain higher basal area than the general forest; examples include goshawk post-fledgling family areas, Mexican spotted owl nesting/roosting habitat, and north-facing slopes. The number of snags and downed logs (greater than 12-inch diameter at mid-point, greater than 8 feet long) and coarse woody debris (greater than 3-inch diameter) vary by seral stage. Snags 18 inches or greater d.b.h. typically range from 1 to 5 snags per acre, with the lower range associated with early seral stages and the upper range associated with late seral stages. Coarse woody debris varies by seral stage, but ranges from 5 to 20 tons per acre for early seral, 20 to 40 tons per acre in mid seral, and 35 tons per acre in late seral areas. *Landscape scale*: The forest landscape is a functioning ecosystem that contains all components, processes, and conditions that result from endemic levels of disturbances (e.g., insects, diseases, wind, snow, and fire), including snags, downed logs, and old trees. Dwarf mistletoe infestations may be present in stands that are composed of Douglas-fir or spruce and rarely in other tree species. Witch's brooms may be scattered throughout the infestations providing structural diversity in the stand and improved foraging and nesting habitat for wildlife species such as small mammals (e.g., tree squirrels), and raptors (e.g., goshawks, spotted owls).
- **Guidelines for Vegetation Management in All Forested Communities:** Projects in forested communities that change stand structure should generally retain at least historic frequencies of trees by species across broad age and diameter classes at the mid-scale. As such, the largest and oldest trees are usually retained. Project design and treatment

prescriptions should generally not remove: (1) Mature trees with large mistletoe brooms suitable for wildlife nesting, caching, and denning, except where retaining such trees would prevent the desired development of uneven-aged conditions over time; (2) Large snags, partial snags and trees (greater than 18 inches d.b.h) with broken tops, cavities, sloughing bark, lightning scars greater than 4 inches wide, and large stick nests (greater than 18 inches in diameter); and (3) Known bat roost trees. Trees established after 1890 should generally not be retained in areas where biophysical conditions would have supported stable openings over time. Vegetation management should favor the development of native understory species in areas where they have the potential to establish and grow.

- **Objectives Following Large-scale Disturbances:** To reestablish conifer trees in areas with inadequate seed source and reduce the time to achieve the desired forest structure: Plant 300 to 700 acres annually.
- **Large-scale Disturbance Events in Forest and Woodland Communities Desired Conditions:** Recovery and restoration project design should seek to establish a trajectory toward the desired conditions for the affected vegetation type. Where conifer seed sources are lost or poorly distributed due to high severity fire, artificial regeneration (planting, etc.) should be implemented to promote the desired forest structure and accelerate the recovery of habitat conditions for native wildlife species. Some snags and coarse woody debris should be retained to provide for wildlife habitat, soil stabilization, and other resource benefits. Some clumps of large (18 inches d.b.h.) standing dead trees should be retained. Project design should incorporate measures to protect regeneration and reforestation investments.
- **Guidelines for Threatened, Endangered, and Sensitive Species:** A minimum of six nest areas (known and replacement) should be located per territory. Nest areas should be 25 to 30 acres in size. Goshawk territories (post-fledging family areas) of approximately 420 acres in size should be designated surrounding the nest areas. Potentially disturbing project-related activities should be minimized in occupied goshawk nest areas during nesting season of March 1 through September 30. Potentially disturbing project-related activities should be restricted within 300 yards of active raptor nest sites between April 1 and August 15.

Sensitive species that depend on riparian or wetland habitat and either constructed or natural waters have several desired conditions, objectives, and guidelines in the action alternatives that protect wetland habitat on the forest and are designed to reduce threats to the species. These threats include invasive weeds, loss of riparian habitat, and grazing. These desired conditions, objectives, and guidelines would help provide for viability of the bald eagle, northern leopard frog, and long-tailed vole. The bald eagle had a low to moderate viability risk for all habitat elements. In addition, the desired condition discussed above in the Effects Similar for All Alternatives section for the water elements, the following objectives and guidelines also mitigate impacts to northern leopard frog and long-tailed vole.

- **Objective for Wetlands/Cienegas:** Restore native vegetation and natural waterflow patterns on at least 6 acres of wetlands within 5 years of plan approval.
- **Objective for Natural Waters:** Protect and/or restore at least 10 individual springs within 5 years of plan approval.

- **Guidelines for Natural Waters:** Access to natural waters should be restricted to designated trails and points of entry to mediate erosion and prevent trampling and inadvertent introduction of nonnative and undesirable biota and disease. Activities in and around waters should use decontamination procedures to prevent the spread of chytrid fungus. Diversions of water sources that recharge wetlands should be assessed and appropriate actions should be identified to mitigate or minimize effects. Spring source areas should be preferentially protected. Water rights for springs should be secured where there are no existing water rights or claims. The impacts of management activities on springs, streams, and wetlands should be evaluated and minimized.
- **Guidelines for Constructed Waters:** Scholz Lake should not be managed for recreational sport fishing in riparian aquatic areas, current protocols for preventing the spread of chytrid fungus should be followed. If new drinkers are necessary, they should be constructed in areas that reduce ungulate impact to sensitive vegetation or soils such as riparian, aspen, and wet meadow areas.
- **Nonnative Invasive Species Desired Condition:** Invasive species are contained and/or controlled so that they do not disrupt the structure or function of ecosystems.
- **Guidelines for Nonnative Invasive Species:** All ground-disturbing projects should assess the risk of noxious weed invasion and incorporate measures to minimize the potential for the spread of noxious and invasive species. New populations are detected early, monitored, and treated as soon as possible. Treatment approaches should use integrated pest management (IPM) practices to treat noxious and nonnative invasive species. IPM includes manual, biological, mechanical, and herbicide/pesticide treatments. Use of pesticide, herbicide, and biocontrol agents should minimize impacts on non-target flora and fauna.
- **Guidelines for Livestock Grazing:** Livestock use in and around wetlands should be evaluated on an allotment specific basis. Mitigation measures such as deferment and fencing (full or partial) should be implemented as needed to minimize potential livestock effects. The concentrated use of montane meadows for livestock grazing should be minimized when soils are saturated to reduce grassland impacts. When no other options are available, use should be rotated annually.

The amount of riparian or wetland habitat and waters could have a slight increase from the current amount of habitat due to restoration work. The quality of existing habitat should increase as wetlands and springs are surveyed and monitored. The forest would be able to better assess which areas are no longer in proper functioning condition and improvements can be done. The listed desired conditions, objectives, and guidelines should provide long-term viability for the Kaibab fairy shrimp, northern leopard frog and long-tail vole and would not lead toward Federal listing of these species.

Sensitive species that depend on grasslands, meadows, shrublands, desert communities, caves and mines, and rocky outcrops, cliffs and canyons have desired conditions, objectives, standards, and guidelines to help protect these habitat elements or species dependent on them (see appendix H). The species that depend on these habitat elements are the western burrowing owl, peregrine falcon, pale Townsend's big-eared bat, House Rock Valley chisel-toothed kangaroo rat, spotted bat, Allen's lappet-browed bat, long-tailed vole, Navajo Mogollon vole, Kaibab least chipmunk, desert bighorn sheep, dwarf shrew, and Kaibab northern pocket gopher. Table 15 shows that the action alternatives have a low to moderate viability risk for these habitat elements for all of these

species except House Rock Valley chisel-toothed kangaroo rat and desert bighorn sheep. These two species are discussed above in the Effects Similar for All Alternatives section. In addition, the forest will continue to protect bighorn sheep from disease that may result from being in contact with domestic sheep or goats with the following guideline.

- **Livestock Grazing Guideline:** Grazing of domestic sheep and goats should not be authorized on the Tusayan and North Kaibab Ranger Districts due to the proximity of bighorn sheep in Grand Canyon and Kanab Creek to prevent the spread of disease between domestic and wild populations.

Shrublands, desert communities, caves and mines, and rock outcrops, cliffs and canyons habitat are not expected to increase under any of the three action alternatives. The objective for restoring grassland is stated as following: “Reduce tree and shrub density to less than 10 percent on 5,000 to 10,000 acres of historic grasslands annually.” This would restore between 75,000 to 150,000 acres of grasslands and meadows in 15 years. This work would shift the existing vegetation from ponderosa pine or pinyon-juniper stands to grasslands. These areas are within the grassland PNVT for grasslands because they were historically grasslands. It would not change the amount of the PNVT, but would improve the quality of the habitat. Species that depend on grassland habitat elements would maintain their viability for all three action alternatives, and none of the alternatives would lead toward Federal listing of these species.

Other Federal Law Compliance

No programmatic take will be requested under the Bald and Golden Eagle Protection Act for any of the three action alternatives. Migrating bald eagles use the forest during the winter with no known established winter roost sites. There are golden eagle nest sites on the forest, but no management standards or guidelines within the plan that would promote removing these nest sites. In addition, the following guidelines would provide protection for these species.

- **Vegetation Management in All Forested Communities:** Projects in forested communities that change stand structure should generally retain at least historic frequencies of trees by species across broad age and diameter classes at the mid-scale. As such, the largest and oldest trees are usually retained. Project design should manage for replacement structural stages to assure continuous representation of old growth over time. Project design and treatment prescriptions should generally not remove: Large snags, partial snags and trees with broken tops (greater than 18 inches d.b.h), sloughing bark, lightning scars greater than 4 inches wide, and large stick nests (greater than 18 inches diameter).
- **Wildlife Management:** Project activities and special uses should be designed and implemented to maintain refugia and critical life cycle needs of wildlife, particularly for raptors. Project activities and special uses should incorporate recommended measures for golden eagle management such as closures to limit human disturbance in the vicinity of golden eagle nests. Potentially disturbing project-related activities should be restricted within 300 yards of active raptor nest sites between April 1 and August 15.
- **Threatened, Endangered, and Sensitive Species:** Activities occurring near areas used by bald eagles should follow recommendations identified in the National Bald Eagle Management Guidelines and Arizona Conservation Assessment and Strategy for the Bald Eagle.

- **Activities On or Near Cliffs and Rocky Features:** Activities involving heavy machinery or blasting should minimize impacts to habitat associated with rocky features and cliffs. Near known active raptor nest sites, temporary closures, and use restrictions should be implemented for rock climbing and other potentially disruptive activities.
- **Communication and Electronic Sites:** The number of communication and electronic sites should be the minimum that is consistent with appropriate public services that require the use of forest lands. Environmental disturbance should be minimized by co-locating communication and electronic sites.
- **Energy Transmission and Development:** Environmental disturbance should be minimized by co-locating pipelines, power lines, fiber optic lines, and associated infrastructure. Existing energy corridors should be used to their capacity with compatible upgraded power lines, before evaluating new routes. When compatible with protection of heritage resources, the use of below-ground utilities should be optimized to avoid potential conflicts with wildlife, scenery, wildfire, and long-term vegetative management.

Requirements of Executive Order 13186 were followed while developing plan components that provide for migratory birds. During the development of plan components, migratory birds were considered and desired conditions and guidelines were incorporated to help provide for their conservation. The Important Bird Areas Program is a global effort lead by the Audubon Society that focuses on the identification and conservation of areas that are vital to birds and other biodiversity. No important bird areas are identified on the Kaibab NF. During the planning stage of all national forest management decisions, a review of effects and development of mitigations to reduce impacts to migratory birds is required. The following are steps that were taken in compliance with Executive Order 13186 and the MOU with the USFWS:

- Where desired conditions coincide with reference conditions, returning habitats to desired conditions should protect, restore, and conserve habitat of migratory birds.
- The forest worked with the Fish and Wildlife Service, Arizona Game and Fish Department, and non-Federal partners to develop the forest planning species list, which includes migratory birds that are Fish and Wildlife Service Birds of Conservation Concern (2008), on the Arizona Partner in Flight list, and are Arizona Species of Greatest Conservation Concern.
- Numerous desired conditions and guidelines provide for and protect migratory bird habitat (see appendix H).
- The monitoring plan (chapter 5) also addresses some migratory birds; Wildlife and Fish (MIS) by asking the question: “What is the estimated population trend for Grace’s warbler, western bluebird, and ruby-crowned kinglet?” The forest does not just survey for these species within their habitat type. While collecting point data for these species, all bird species located are recorded. For species that have enough detections, population density estimates can be calculated. Species information will vary by location.

Environmental Consequences for Wildlife Species Viability: Alternative B – Preferred Alternative

Alternative B has the fewest number of species and associated habitat elements (27 total) that rate out in a very high (2), high (6), or moderate high (19) viability risk rating (table 15). It would also result in the smallest number of habitat elements that are departed from reference conditions (12 with fair rating and 1 with poor rating). The fair and poor ratings are primarily due to effects

and/or conditions that are outside of the Kaibab NF's control, such as the legal framework and the need to work with other agencies, or the vegetation type is of lower priority for management and the forest is unlikely to receive the additional funding required to improve these habitat types to reference conditions.

Desired conditions are based on the best scientific information available that describes reference conditions for the different vegetation types of ponderosa pine, mixed conifer, and woodlands and savannas. Alternative B is the alternative that would set these vegetation types on a trajectory that would be most likely to achieve reference conditions. Restoring habitat elements to reference conditions or at least toward reference conditions should provide for viable species populations for those species that evolved within these systems.

The following is the presettlement tree retention guideline for ponderosa pine and frequent fire mixed conifer for alternative B: "Project design and treatment prescriptions should generally not remove: large, old ponderosa pine trees with reddish-yellow, wide platy bark, flattened tops, with moderate to full crowns, and large drooping or knarled limbs (e.g., Thomson's age class 4, Dunning's tree class 5 and/or Keen's Tree Class 4, A and B)."

Beside the recommendations for coping with climate change that were discussed in the Effects Similar for All Action Alternatives section, this alternative is better suited to meeting the following: (1) reducing nonclimate stressors on ecosystems; (2) managing for more diverse conditions; (3) maintaining healthy, connected diverse populations; (4) reducing risk of catastrophic fires; and (5) reducing likelihood of catastrophic events affecting populations. Alternative B is better at meeting the above recommendations because it has a greater ability to create desired openings, which should promote greater regeneration of the herbaceous understory. Over time this should increase the likelihood of restoring natural fire regimes and achieving desired vegetation densities.

According to the Nonnative Invasive Species section, alternative B is the most beneficial for preventing and controlling invasive species. Although the preferred alternative proposes the highest amount of vegetation treatments and planned disturbance out of the four alternatives, thereby creating the highest risk of the spread or introduction of invasive species, it also generates the highest potential for long-term native understory enhancement. This, in turn, increases the ability for native species to out-compete invasive species over the long term, decreasing susceptibility to uncharacteristic fire.

In addition for federally listed species and Forest Service sensitive species, the evening grosbeak and olive-side flycatcher both had a moderate viability rating for the frequent fire mixed conifer habitat element under the preferred alternative (table 15). This alternative has the lowest viability risk to these species.

Federally Listed Species and Sensitive Wildlife Species

The Mexican spotted owl has a moderately high viability rating in the frequent fire mixed conifer and a moderate viability rating for the ponderosa pine/Gambel oak, ponderosa pine vertical heterogeneity, and horizontal heterogeneity habitat components in alternative B. Overall for alterative B, in 15 years the Mexican spotted owl habitat ponderosa pine/Gambel oak habitat component would increase by 1,477 acres for a total of 14,771 acres and mixed conifer habitat would decrease by 639 acres for a total of 34,484 acres. However, while the VDDT model shows a decline in mixed conifer habitat, the model likely overstated the amount of habitat loss. Most of

the loss habitat is due to wildfires within closed canopy systems. The rest of the habitat loss is due to individual thinning or logging projects however, this loss would likely not occur due to project-level mitigations employed to meet the recovery plan for the owl. The viability of the species would continue under this alternative.

The goshawk, Allen's lappet-browed bat, and Merriam's shrew have a moderate viability rating for the frequent fire mixed conifer habitat element (table 15).

For all sensitive species within the ponderosa pine and mixed conifer habitat, in 15 years the VDDT modeling (summarized in table 17) shows the following changes in habitat acreage from current conditions:

- Goshawk ponderosa pine habitat would increase by 49,237 acres for a total of 235,244 acres. Frequent fire mixed conifer would increase by 5,350 acres for a total of 35,310 acres. Overall goshawk habitat would increase 54,587 acres for an overall total of 270,554 acres.
- Bald eagle and Allen's lappet-browed bat ponderosa pine habitat would decrease by 6,018 acres for a total of 404,839 acres. Allen's lappet-browed bat frequent fire mixed conifer habitat would decrease by 3,253 acres for a total of 67,517 acres. The total change in habitat for the bat would be a decrease of 9,271 acres for a total of 472,356 acres of habitat.
- Kaibab least chipmunk and Kaibab northern pocket gopher mixed conifer with aspen habitat acreage is estimated to stay the same. Both species would have an increase of 4,279 acres for a total of 7,107 acres of mesic mixed conifer/spruce fir habitat. This would provide for a total of 27,005 acres of conifer habitat for both species.
- Kaibab tree squirrel ponderosa pine habitat would decrease by 1,685 acres for a total of 101,100 acres; optimum habitat would increase by 13,756 acres for a total of 65,868 acres.
- Merriam's shrew ponderosa pine habitat would increase by 142,241 acres for a total of 273,540. Frequent fire mixed conifer would increase by 22,095 acres for a total of 36,701. Overall Merriam's shrew habitat would increase 164,336 acres for a total of 310,241 acres.

Based on the risk to viability rating and the amount of habitat provided for each of the above species, viability would be maintained for each of these species under this alternative. While individual species could be impacted by the actions under this alternative, the alternative would not lead toward Federal listing of the above sensitive species.

Environmental Consequences for Wildlife Species Viability: Alternatives C and D

Alternatives C and D would have similar effects for all the wildlife forest planning species; as a result, they are analyzed together. While the effects to the viability ratings are the same between both alternatives, there is a difference in the amount of habitat affected between alternatives C and D.

While the alternatives are similar in the expected total number of habitat elements departed from reference conditions as in alternative A, they would have more in fair condition and less in poor

condition (13 in fair and 5 in poor). These alternatives have more species rated as very high, high, or moderate high viability risk than alternative B and less than alternative A (table 15).

The presettlement tree retention guideline for alternatives C and D would replace the following guideline in alternative B: “Project design and treatment prescriptions should generally not remove: large, old ponderosa pine trees with reddish-yellow, wide platy bark, flattened tops, with moderate to full crowns, and large drooping or knarled limbs” with “Projects should retain trees with physical characteristics typical of those that were established prior to 1890 (i.e., generally larger than 16 inches in diameter at breast height, with yellowing platy bark).”

The presettlement tree retention guideline would likely be implemented as a diameter cap of a particular size (based on site conditions). Because all coniferous trees above the diameter cap would be retained, treatment would likely be less effective than alternative B for developing the desired conditions for ponderosa pine, frequent fire mixed conifer, and aspen (Williams Ranger District) habitat elements for the following reasons:

- In order to achieve the desired mix of clumps and openings (horizontal heterogeneity) in ponderosa pine and frequent fire mixed conifer stands that have many large trees, it becomes necessary to remove most or all of the smaller trees. This results in more single-storied, even-aged stands and reduces vertical and horizontal heterogeneity.
- Retaining and regenerating aspen would not be as effective if some of the larger, older conifers cannot be removed to reduce shading and competition.
- Restoration treatments of grasslands would be less effective at restoring historic reference conditions in some areas because some trees which may not have been present historically would be retained.
- Restoration treatments of woodlands and savannas would be less effective at restoring historic reference conditions in some areas because some trees which may not have been present historically would be retained, limiting the ability to create openings and movement corridors in those areas.

The combined effect of the above guideline and the increased risk of stand-replacing fires is one which could negatively impact wildlife species through a reduction in foraging, breeding, and nesting habitat. The following species could be negatively impacted by implementing this guideline: Mexican spotted owl, northern goshawk, evening grosbeak, Grace’s warbler, olive-sided flycatcher, Lewis’ woodpecker, McGillivray’s warbler, green-tailed towhee, golden-crowned kinglet, red-naped woodpecker, orange-crowned warbler, Arizona black rattlesnake, Arizona treefrog, Allen’s lappet-browed bat, southwestern myotis, Abert’s squirrel, Kaibab tree squirrel, and Merriam’s shrew. While these species could be negatively affected at the local scale, overall, the other habitat improvements within these vegetation types would still help maintain overall viability for each of these species.

Alternatives C and D are the least effective at controlling and preventing invasive weeds for several reasons. The Vegetation and Fire section notes the potential for increased stand-replacing fire that would occur at later time intervals due to potential guidelines in alternatives C and D. Because invasive species populations are correlated with increased stand-replacing fires (see Nonnative Invasive Plants section), there is the potential for invasive species to increase over time under these alternatives. This also negatively affects the forest’s ability to cope with climate change. Finally, the following species would be directly affected by an increase in invasive

weeds: golden eagle, western burrowing owl, milksnake, Great Basin spadefoot, Gunnison's prairie dog, House Rock Valley chisel-tooth kangaroo rat, and Navajo Mogollon vole. Invasive weeds have the potential to out-compete native plants necessary for foraging, nesting, and burrowing by these species.

Both the evening grosbeak and the olive-sided flycatcher are found in multiple habitat elements that have a low to moderate viability rating. The viability of these species would be maintained through the habitat elements that are at a lower risk and the level of habitat treatment occurring within the habitat element at a high risk of viability.

Federally Listed Species and Sensitive Wildlife Species

The Mexican spotted owl has a moderate high viability risk for ponderosa pine/Gambel oak and vertical heterogeneity habitat elements, and a high viability risk for the frequent fire mixed conifer habitat element. These risks are based on the potential effect of the presettlement tree retention guideline in areas that have an abundance of large trees within stands, limiting the forest's ability to restore those areas. Overall for alterative C, in 15 years the Mexican spotted owl habitat ponderosa pine/ Gambel oak would decrease by 985 acres for a total of 12,309 acres and mixed conifer habitat would decrease by 7,025 acres for a total of 28,098 acres. For alterative D, in 15 years the Mexican spotted owl habitat ponderosa pine/Gambel oak would decrease by 1,477 acres for a total of 11,817 acres and mixed conifer habitat would decrease by 9,579 acres for a total of 25,544 acres. However, while the VDDT model shows a decline in both conifer habitats, the model likely overstated the amount of habitat loss. While most of the remaining habitat loss is due to wildfires, the rest of the habitat loss is due to individual projects that would not likely occur due to project level mitigations used to meet the recovery plan for the owl.

The goshawk, Allen's lappet-browed bat, and Merriam's shrew show moderate to high viability rating only within the frequent fire mixed conifer habitat element (table 15). This habitat element is only one of several different habitat elements these species use.

For all sensitive species within ponderosa pine and mixed conifer habitat, in 15 years the VDDT modeling (summarized in table 17) shows the following changes from current conditions for alterative C:

- Goshawk ponderosa pine habitat would increase by 5,471 acres, for a total of 191,478 acres. Frequent fire mixed conifer would decrease by 3,745 acres, for a total of 26,215. Overall goshawk habitat would increase by 1,726 acres, for a total of 217,693 acres.
- Bald eagle and Allen's lappet-browed bat ponderosa pine habitat would increase by 4,924 acres, for a total of 415,781 acres. The Allen's lappet-browed bat frequent fire mixed conifer habitat would decrease by 4,430 acres, for a total of 66,340 acres of habitat. The total change in habitat for the bat would be an increase of 443 acres for a total of 482,121 acres of habitat.
- Kaibab least chipmunk and Kaibab northern pocket gopher mixed conifer with aspen habitat acreage is estimated to stay the same. For mesic mixed conifer/spruce-fir habitat both species would have an increase of 3,491 acres, for a total of 6,319 acres. This would provide a total of 26,167 acres of conifer habitat for both species.
- Kaibab tree squirrel overall ponderosa pine habitat would decrease by 4,748 acres for a total of 98,037 acres; optimum habitat would increase by 1,532 acres for a total of 53,614 acres.

- Merriam's shrew ponderosa pine habitat would increase by 125,829 acres for a total of 257,128. Frequent fire mixed conifer would increase by 18,029 acres for a total of 32,635. Overall, Merriam's shrew habitat would increase 143,858 acres for a total of 289,763 acres.

For all sensitive species within ponderosa pine and mixed conifer habitat, in 15 years the VDDT modeling shows the following changes from current conditions for alterative D:

- Goshawk ponderosa pine habitat would decrease by 10,941 acres, for a total of 175,066 acres. Frequent fire mixed conifer would decrease by 4,280 acres, for a total of 25,680. Overall, goshawk habitat would decrease by 15,221 acres, for a total of 200,746 acres.
- Bald eagle and Allen's lappet-browed bat ponderosa pine habitat would increase by 4,924 acres, for a total of 415,781 acres. The Allen's lappet-browed bat frequent fire mixed conifer habitat would decrease by 6,570 acres, for a total of 64,200 acres of habitat. The total change in habitat for the bat would be a decrease of 1,646 acres, for a total of 479,981 acres of habitat.
- Kaibab least chipmunk and Kaibab northern pocket gopher mixed conifer with aspen habitat acreage is estimated to stay the same. Both species would have an increase of 3,491 acres, for a total of 6,319 acres of mesic mixed conifer/spruce-fir habitat. This would provide a total of 26,167 acres of conifer habitat for both species.
- Kaibab tree squirrel overall ponderosa pine habitat would decrease by 7,812 acres, for a total of 94,973 acres; optimum habitat would decrease by 3,064 acres, for a total of 49,018 acres
- Merriam's shrew ponderosa pine habitat would increase by 131,299 acres, for a total of 262,598 acres. Frequent fire mixed conifer would increase by 20,062 acres, for a total of 34,668. Overall, Merriam's shrew habitat would increase 151,361 acres, for a total of 297,266 acres.

Based on the risk to viability rating and the amount of habitat provided for each of the above species, viability would be maintained for each of these species under both alternatives. While individual species could be impacted by the actions under both alternatives, neither alternative would lead toward Federal listing of the above sensitive species.

Summary of Comparison of Alternatives – Wildlife

Alternative A has the greatest potential to negatively affect wildlife species because it lacks clear desired conditions and guidelines developed using the best available science. It also does not reflect advances in scientific understanding and changes in social, economic and ecological conditions that have occurred since it was signed and it is the least able to adapt to changing conditions.

Alternative B has the greatest ability for maintaining viable wildlife populations over time. This alternative is the best at setting the vegetation types on a trajectory toward achieving desired conditions. Alternative B best meets the recommendations proposed to help wildlife species adapt to climate change because it includes specific guidance that provides for resilient ecosystems.

The main difference between alternative B and alternatives C and D is the presettlement tree retention guideline. This guideline would affect all vegetation management activities associated

with ponderosa pine, frequent fire mixed conifer, woodlands, and savannas. In areas that currently contain a high number of large trees, this guideline has the potential to inadequately provide for the desired clumps and openings within conifer stands. This guideline could also affect savanna and woodland habitat restoration by retaining a higher density of conifer trees than would naturally occur in these areas. Alternatives C and D are better than alternative A in providing for species viability and promoting the ability to cope with climate change for most species, but not as good as alternative B.

Table 17. Changes in acres of ponderosa pine and mixed conifer habitat by alternative

Species	Change in Habitat Acres by Alternative				
	Current	Alt A	Alt B	Alt C	Alt D
Mexican spotted owl (nesting/roosting habitat)	48,417	49,054	49,255	40,407	37,361
Northern goshawk	215,967	236,542	270,554	217,693	200,746
Bald eagle	410,857	415,781	404,839	415,781	415,781
Allen's lappet-browed bat	481,627	496,244	472,356	482,121	479,981
Kaibab least chipmunk	22,676	23,370	27,005	26,167	26,167
Kaibab northern pocket gopher	22,676	23,370	27,005	26,167	26,167
Kaibab tree squirrel					
All habitat	102,785	101,100	101,100	98,037	94,973
Optimum habitat	52,082	55,146	65,868	53,614	49,018
Merriam's shrew	145,905	231,551	310,241	289,763	297,266

Management Indicator Species

The current planning rule requires that species shall be selected as management indicator species (MIS) to contrast the effects of the planning alternatives on wildlife populations. The regulatory language concerning MIS is found in the provisions of the 1982 NFMA forest planning regulations (several sections).

The Kaibab NF four priority "needs for change" that were identified during the analysis of the management situation (AMS) guided the selection process for MIS. Based on these priority needs for change, complimentary lines of evidence, proposed action, and plan alternatives, the forest identified four MIS species it believes would serve as strong indicators of management (table18). The four species were selected because they have special habitat needs that may be influenced significantly by planned management under the alternatives. The results are summarized below. The full selection process and rationale for selecting these species is outlined in Management Indicator Species Selection for the Kaibab NF Plan Revision (appendix I).

The Kaibab NF current forest-wide population and habitat trend information for pronghorn (KNF 2010a) was used as a foundation to help determine potential effects between the alternatives for that species. To help determine population and habitat trends for the three bird species proposed as MIS, occupancy modeling, an analytical tool which correlates existing presence/absence data with meaningful habitat covariates, was used in conjunction with existing forest-wide density

estimates collected on songbirds since 2005. In the future, the occupancy models will help to show changes of habitat over time with 2010 data used as a baseline. For the three species of songbirds, the models predict occupancy dynamics (e.g., probabilities of detection, occupancy, colonization, and local extinction) by estimating the proportion of area on the forest occupied by each species. Over time this would provide complementary information on both habitat and species trends.

Table 18. Management indicator species used in the evaluation of all alternatives

Species	What They Are an Indicator For	Priority Need for Change	Difference Between Plan Alternatives
Grace's warbler (*Setophaga graciae*)	Clumps of mature ponderosa pine/pine-oak forests, yellow pine, (parklike environments, such as reference condition).	Modify stand structure and density toward reference conditions and restore historic fire regimes.	Stand structure in ponderosa pine.
Western bluebird (*Sialia mexicana)*	Understory development within openings in ponderosa pine stands.	Modify stand structure and density toward reference conditions and restore historic fire regimes.	Openings in ponderosa pine.
Ruby-crowned kinglet *(Regulus calendula*)	Mixed conifer (frequent fire) mature forest, overstory.	Modify stand structure and density toward reference conditions and restore historic fire regimes.	Would show the potential for moving toward reference conditions.
Pronghorn (*Antilocapra americana*)	Grasslands	Restore historic grasslands conditions by reducing shrub and tree encroachment and restoring fire.	Would show the potential for moving toward reference conditions.

Background Information for Management Indicator Species under

Alternative A: Current Plan, Current Management (No Action)

In 1988, the Kaibab NF selected 18 MIS species, all of which are still MIS under the current plan (see table 19). Each species was selected to represent a particular habitat or habitat characteristic found on the forest. As indicators, they were selected to represent all wildlife and rare plant species found or associated with habitat or habitat components thought to indicate forest health and effects of management activities.

Table 19. Current management indicator species for the Kaibab National Forest and the habitat or habitat components they represent

Management Indicator Species	Habitat or Habitat Component
Aquatic macroinvertebrates	Riparian
Cinnamon teal (*Anas cyanoptera*)	Late-seral wetlands
Northern goshawk (*Accipiter gentilis*)	Late-seral ponderosa pine
Pygmy nuthatch (*Sitia pygmaea*)	Late-seral ponderosa pine
Turkey (*Meleagris gallopavo*)	Late-seral ponderosa pine
Mexican spotted owl (*Strix occidentalis lucida*)	Late-seral mixed conifer and spruce-fir
Red squirrel (*Tamiasciurus hudsonicus*)	Late-seral mixed conifer and spruce-fir
Lucy's warbler (*Vermivora luciae*)	Late-seral, low-elevation (below 7,000 ft) riparian
Yellow-breasted chat (*Icteria virens*)	Late-seral, low-elevation (below 7,000 ft) riparian
Lincoln's sparrow (*Melospia lincolnii*)	Late-seral, high-elevation (above 7,000 ft) riparian
Hairy woodpecker (*Picoides villosus*)	Snags in ponderosa pine, mixed conifer, and spruce-fir
Juniper titmouse (*Baeolophus ridgwayi*)	Late-seral pinyon-juniper and snags in pinyon-juniper
Red-naped sapsucker (*Sphyrapicus varius*)	Late-seral aspen and snags in aspen
Elk (*Cervis elaphus*)	Early-seral ponderosa pine, mixed conifer, spruce-fir
Mule deer (*Odocoileus hemionus*)	Early-seral aspen and pinyon-juniper
Pronghorn (*Antilocapra americana*)	Early- and later seral grassland
Tassel-eared squirrel (*Sciurus aberti*)	Early-seral ponderosa pine
Arizona bugbane (*Actea arizonica*)	Forest plan describes habitat where the plant is found

When the MIS were originally selected, the forest plan called for even-aged timber management. As a result, the MIS were selected to represent various seral stages of the vegetation types. The 1996 amendment to the 1988 forest plan added provisions for the northern goshawk and Mexican spotted owl, and called for a shift from even-aged to uneven-aged management. Following the 1996 amendment, the descriptions of seral stage were no longer applicable, reducing the relevance of most of the original MIS.

It is important to note that not all of the species selected in 1988 specifically have value as MIS on the Kaibab NF. Some of the selected MIS do not actually occur on the forest or occur too infrequently to be reliable indicators for the habitats they were selected to represent. Habitats for these species are either limited in frequency or only occur in areas too limited to maintain a population of the species. Some species have proven to be impractical to monitor, and others are poor indicators of management effects on the forest. As a result, the current MIS list has been shown to provide limited utility in supporting adaptive management. The forest-wide assessment for MIS (KNF 2010a) provides the documentation on why certain species on the current list do not make a good MIS. The following is a summary for each of those species.

- Cinnamon teal – Kaibab NF supports individual birds rather than a population of cinnamon teal on the forest. No ability to reasonably estimate a population trend and associate any changes to management actions.
- Northern goshawk – Difficult to effectively assess population trends. Population fluctuations are typically more closely tied to variable weather conditions and the interrelated response by the species' mammalian prey base. Habitat generalist.
- Mexican spotted owls – Species is not well distributed in the planning area. Limited to seven protected activity centers on the Williams Ranger District. Difficult to assess population trends and relate to habitat changes and assess differences between management alternatives.
- Lucy's warbler – Very limited habitat. Little is known about how habitat changes affect this bird, and it is likely to have individual birds rather than a population of Lucy's warbler on the forest.
- Yellow-breasted chats – Very limited habitat and it is unknown if the species occurs on the forest.
- Lincoln's sparrows – Habitat is limited and there is no resident population.
- Tassel-eared squirrel – Shown as an indicator for early-seral ponderosa pine when in fact this is not the habitat type they use.

Besides the species discussed in the forestwide MIS assessment, elk and mule deer also do not make good MIS. They both use a wide variety of habitats and have many outside factors that affect population trends. It is not possible to tie management activities with forestwide population trends for these two species.

Pronghorn was the only species retained as an MIS from the previous forest plan. Besides being responsive to grassland restoration, the pronghorn is a species that has strong local interest because it is hunted.

Under alternative A, the forest would continue to use the current MIS list. However, for the purposes of analysis and comparison, only the proposed MIS are used to evaluate the alternatives.

Management Indicator Species Current Population and Habitat Trends

For the three bird species, the Wildlife Specialist Report (KNF 2013c) provides detailed information on the species and how the current habitat and population trend was developed.

Grace's Warbler

The main concern for this species across its range is habitat alteration and fragmentation. Present-day ponderosa pine forests differ greatly from pre-settlement forests because of logging, firewood harvest, fire suppression, grazing, and urban development. Size class distributions are now skewed to smaller trees, with a more closed canopy, higher levels of disease, depleted understories, and high susceptibility to crown fires (Stacier and Guzy 2002). On the Kaibab NF, this is seen more on the Williams and Tusayan Ranger Districts than on the North Kaibab Ranger District. Information suggests that pine forests that more closely mimic naturally open parklands with stands of large, mature trees would eventually benefit this species. Previous research suggests that some manipulation of dense, nonvirgin stands may be beneficial. In northern

Arizona, Grace's warbler was most abundant in a silviculturally thinned forest than in unthinned, dense forest. Greater levels of thinning, however, resulted in lower abundance (Stacier and Guzy 2002).

Current Habitat and Population Trend

Grace's warbler is an indicator for ponderosa pine mature clumps within stands. On the forest ponderosa pine covers approximately 515,148 acres. The PNVT for ponderosa pine covers 541,000 acres (KNF 2009 and 2010b). The main difference between cover type and PNVT is that cover type reflects what is currently found on the forest, while PNVT reflects what was on the forest historically, depending on soil type, fire regime, and nature disturbance. Occupancy model results for the Grace's warbler show that 245,417 acres are of high quality and 132,161 acres are of moderate quality, for a total of 377,578 acres within ponderosa pine, based on occupancy potential.

The ponderosa pine forest on the Kaibab NF is highly departed from reference condition (KNF 2010b). The amount and arrangement of forest developmental stages, and increased tree density/canopy cover are the primary characteristics that are departed. Only 19 percent of the PNVT is currently in the reference condition. The reference condition is defined as mature to old forest with various sized patches of young regenerating forest. With the current rate of treatment within ponderosa pine forest, the current habitat trend would be considered stable; however, there would not be progression toward the habitat reference condition.

The forest has conducted bird surveys since 2005. Population trends based on forest monitoring appear to be stable within ponderosa pine habitats. Trends in occupancy for Grace's warbler indicate an initial decrease in occupancy from 2006 to 2007 followed by an increase in subsequent years. As more bird surveys are done, this may help influence the model results (Dickson et al. 2011).

Occupancy modeling results for Grace's warbler indicate basal area and canopy cover to be strong positive predictors of occupancy for that species. Northeastern orientation, while not a "strong" predictor, did appear to negatively affect occupancy and indicated an affinity for more xeric habitat conditions. These results are consistent with other studies that have generally found Grace's warbler in xeric pine or pine-oak dominant habitats with a diversity of tree size classes (Stacier and Guzy 2002).

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

Western Bluebird

Western bluebirds are typically found in open, park-like forests, edge habitats, and burned areas and where moderate amounts of logging have occurred, provided a sufficient number of larger trees and snags remain to provide nest sites and perches. The species does not favor large, open meadows. Clear cutting, snag removal, fire suppression, and any changes in land use that cause open forest and edge habitat to be diminished adversely affect western bluebird populations (Guinan et al. 2008). Restoration of ponderosa pine forests by prescribed thinning of dense stands, followed by controlled burns and reseeding, should benefit this species through increased nest and fledgling success, and decreased predation. Guinan et al. (2008) recommended long-term measures to develop and provide habitat for the western bluebird. Silvicultural practices that retain snags, sufficient numbers of mature trees to ensure adequate snag recruitment for the

future, and smaller saplings and scattered shrubs for cover and foraging perches would provide suitable habitat in managed forests. Habitat restoration treatments include: increasing herbaceous ground cover; reducing ponderosa pine density to less than or equal to 270 stems per hectare (no lower threshold established, but suggested to range from 57 to 150 stems per hectare); and retain Gambel oak trees and snags where present. Recommendations for fire management include: mimicking of natural fire regimens (size, timing, frequency, and severity), including allowing for stand-replacement burns where historic; and consideration of effects of burn geometry (size, heterogeneity in terms of burn severity, and burn-to-edge ratio) in management policies.

In several studies conducted locally in northern Arizona the western bluebird has shown a strong positive response to burning and prescribed thinning in ponderosa pine forest (Wightman and Germaine 2006, Hurteau et al. 2008, Dickson et al. 2009, Chambers and Kalies 2011). Wightman and Germaine (2006) found that blue bird productivity and nest success were significantly affected by tree density (ponderosa pine and Gambel oak) and adequate ground cover (grasses, forbs, and bare ground combined total of at least 20 percent). A resident species, bluebirds can be found forestwide.

Current Habitat and Population Trend

The western bluebird, a ground-foraging species, which depends largely on the understory for capture of invertebrate prey, is an indicator for understory development within openings in mature ponderosa pine. On the forest, ponderosa pine covers approximately 515,148 acres and the PNVT for ponderosa pine covers 541,000 acres (KNF 2009 and 2010b). Occupancy model results for the western bluebird show that 417,111 acres within the ponderosa pine are high quality habitat while 64,315 acres are of moderate habitat quality, for a total of 481,426 acres with potential occupancy.

Vegetation models created for the forest plan revision process suggest that the ponderosa pine forest on the Kaibab NF is highly departed from reference condition. Under current management, these forests would remain highly departed from reference conditions. The amount and arrangement of developmental stages and increased tree density/canopy cover are the primary characteristics that are departed. While the forest is out of reference condition, the current rate of treatment within ponderosa pine should keep the habitat condition stable; however, it would not move the habitat toward reference condition.

Population trends based on forestwide monitoring for this species appear stable. Western bluebird occupancy was positively associated with both basal area and those locations with canopy cover less than 30 percent. This is consistent with the species preference for more open, park like, forested settings. Occupancy models for the forest show the presence of ponderosa pine habitat as a strong predictor for western bluebird (Dickson et al. 2011). Occupancy was fairly steady throughout the analysis period, with the exception of decline in 2007 and subsequent increase in 2008.

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

Ruby-crowned Kinglet

During the breeding season, ruby-crowned kinglets typically forage and nest in dense foliage high in the conifer forest treetops. In Arizona, they reach their highest densities in mixed conifer forests. Breeding ruby-crowned kinglets are most abundant and widespread on the Kaibab Plateau and in the White Mountains. They are also found regularly in the San Francisco Mountains, and

Sitgreaves and Bill Williams Mountains (Corman and Wise-Gervais 2005). This species breeds in dry, open coniferous and mixed forests at high elevations.

While this species is not a mixed conifer obligate (Swanson et al. 2008), it does appear to be strongly associated with this habitat type. Predicting the effects of future forest management action on this species would require information at fine scales as management actions are more likely to impact existing forest structure for the species at that level.

Current Habitat and Population Trend

The ruby-crowned kinglet is an indicator for mature overstory in frequent fire mixed conifer. On the forest, there is approximately 39,130 acres of mixed conifer cover type and the PNVT for mixed conifer covers 127,900 acres (KNF 2009 and 2010b). These numbers also include mesic mixed conifer, which is too difficult to differentiate based on the sampling and modeling methods used for forest planning. However, the majority of the acreage in the mixed conifer PNVT is classified as frequent fire mixed conifer (approximately 107,000; KNF 2008a) and for this analysis, the whole PNVT is treated as frequent fire mixed conifer. This is consistent with analyses in the Vegetation and Fire section. The occupancy modeling results for the ruby-crowned kinglet show that 17,112 acres within mixed conifer are of high quality habitat while 2,997 acres are moderate quality, totaling 29,103 acres of potential habitat occupied.

The majority of the mixed conifer cover type and PNVT occurs at high elevations on the North Kaibab Ranger District with a small amount (approximately 14,200 acres) on the Williams Ranger District. This PNVT is younger and denser than during the reference period. About 5 percent of the area exists in a mature uneven-aged state and only 23 percent of the area is composed of uneven-aged groups. Recent management has focused on moving toward reference conditions. The prescriptions have primarily thinned small trees around or under older trees. In some cases, group selection cuts have removed patches of large trees to promote regeneration within larger uneven-aged areas. Wildland fires within this PNVT are currently suppressed (KNF 2009 and 2010b). While the forest is out of reference condition, the current rate of treatment within the mixed conifer stands should keep the current habitat trend stable; however, it would not move the habitat toward reference conditions over a large portion of the forest.

The forest has collected data on the ruby-crowned kinglet since 2005. Trends based on forest monitoring from 2005 to 2009 suggest this species appears to be increasing at this time. Occupancy model results suggest that variation in vegetation type is the strongest predictor of ruby-crowned kinglet occupancy, with the species strongly associated with the mixed-conifer habitat type. However, occupancy trends were not presented for the ruby-crowned kinglet due to a sharp change in detectability from 2006 to 2007 and insufficient sample sizes (Dickson et al. 2011).

In summary, the current forestwide habitat trend for the ruby-crowned kinglet is stable. While forest monitoring data seem to imply an increasing population trend, the occupancy modeling could not confirm this at this time. To be conservative, the forestwide population trend is considered stable.

Pronghorn

Pronghorn is the only current MIS retained for the revised plan. In the current plan, pronghorn are an indicator of early- and late-seral grasslands. For this analysis, they are an indicator of

grasslands. The 2010 forestwide MIS assessment (KNF 2010a) provided information about pronghorn on the forest and is incorporated by reference in this report.

Causes of decline in pronghorn herds across Arizona are numerous, but generally consistent. Paramount to the persistence of any wildlife species is presence of quality habitat. Continued urban sprawl and associated highway construction has fragmented and damaged quality pronghorn habitat (the latter continues to cause direct mortality via collision with vehicles). Grasslands historically dependent upon regular fire return intervals have been reduced in size by invasion of juniper and shrub species resulting from decades of fire suppression. Past livestock grazing and historic fencing practices have reduced habitat quality and created barriers that pronghorn cannot maneuver. Finally, persistent drought and predation has impacted pronghorn populations to varying degrees statewide. The combination of these factors has led to a reduction in habitat availability and quality, a substantial decline in fawn recruitment, and a correlated increase in efficiency of pronghorn predators (AGFD 2011a).

Current Habitat and Population Trend

During forest plan revision, the grassland PNVT included all grasslands including montane/subalpine grassland. Part of this habitat type is not suitable for pronghorn and is not considered as part of the habitat trend for this analysis. Within the PNVTs, there are approximately 112,250 acres of grassland habitat for the pronghorn. Not all of these acres provide habitat for the pronghorn at this time. Currently, forestwide pronghorn habitat appears to be stable (KNF 2010a).

In 2010, the Arizona Game and Fish Department began a new process for determining population trends for Game Management Units (GMU) 7, 8, and 9 (see table 20). Trends are determined using population models. The inputs for the models are harvest, male-female ratios, and young-female ratios, estimated mean mortality rates, and estimated starting populations. The best model is estimated by changing mortality rates of the starting population so that the predicted male-female ratios from the models for each year match those that are based on surveys (McCall 2011).

Table 20. Trends in pronghorn populations based on Arizona Game and Fish Department data (2012)

Game Management Unit	3-Year	10-Year
7	Stable	Stable
8	Decreasing	Decreasing
9	Increasing	Increasing

Besides the above-listed GMUs, pronghorn are also found in GMU 10 and 12A. All of these game units have a portion of the unit on the forest. Pronghorn numbers on GMU 12A appear to have an increasing trend (KNF 2010a) and, overall, GMU 10 appears to be decreasing. However, the Kaibab NF has about 25 to 35 square miles of good quality pronghorn habitat located on the southeast corner of GMU 10. Pronghorn inhabiting this area frequently exhibit the highest level of fawn survival in the unit as a whole (AGFD 2011a). All of the units have a hunting season for pronghorn, even those with a decreasing trend. When looking at the overall forest contribution to the pronghorn population trend, the forestwide population trend appears to be stable at this time.

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

Comparison of Alternatives

Management Indicator Species in Ponderosa Pine and Frequent Fire Mixed Conifer

Environmental Consequences for Management Indicator Species – Alternative A (No Action)

Under the no action alternative, no changes would be made to the current Kaibab NF Land and Resource Management Plan, and current management practices would continue at current rates. The following excerpt is from the Vegetation and Fire section:

> "Currently, the forest treats around 2,100 acres a year in ponderosa pine with mechanical treatments to alter or restore stand structure, and around 200 acres per year in frequent fire mixed conifer. The current plan was signed in 1988, before the 1995 Federal Wildland Fire Policy was enacted, and no objectives for acres burned by beneficial fire exist in the current plan. Currently fire managers are burning about 8,500 acres per year with prescribed fire, and manage wildfires to achieve multiple objectives on around 11,700 acres per year. This equates to just over 20,000 acres per year that receive beneficial fire disturbance. Due to the restriction of having managed fire with mixed conifer stands, most of the fire acreage occurs outside of the frequent fire mixed conifer habitat." While these treatments would improve habitat quality for Grace's warbler, western bluebird, and ruby-crowned kinglet, there would not be an increase in the amount of ponderosa pine or frequent fire mixed conifer within the PNVTs.
>
> "In the mixed conifer vegetation types, suppression action must be taken on all wildfires in accordance with the terms and conditions associated with the wildland fire use amendment to the plan in 2000. For the North Kaibab Ranger District, frequent fire mixed conifer stands are at a high risk of moving most or all of this vegetation type to an uncharacteristic open state, with minimal natural regeneration, as the result of one or several high-severity wildfire incidents. This has been demonstrated by wildfires that have occurred during the past 15 years. The current plan restrictions also encumber cross-boundary fire management of wildfires burning on the Kaibab Plateau between Grand Canyon National Park and the forest that could otherwise be used to reduce the risk of stand-replacing fires. Objectives for wildfires must change from resource benefit to protection when fires cross the fence from the park onto the forest; conversely wildfires initiated on the forest that could benefit park lands must be suppressed and so they do not cross onto the Park."

The forestwide assessment for MIS (KNF 2010a) shows that the current level of forest treatments is maintaining a stable forestwide habitat trend for both ponderosa pine and frequent fire mixed conifer habitats. This trend is not expected to change over time.

With the forestwide habitat trend staying the same for the ponderosa pine and mixed conifer habitat, it is likely that the forestwide population trends for Grace's warbler, western bluebird, and

ruby-crowned kinglet would not change and all three population trends would remain stable. However, this alternative has the highest potential for uncharacteristic wildfires and insect outbreaks. If these would occur within the next 15 years, population trends for the three species would experience a downward trend.

Description of Action Alternatives

Under all three action alternatives, the highest priority need for change is to modify forest stand structure and density toward reference conditions and restore historic fire regime. Since the desired conditions are based on the reference condition for ponderosa pine and frequent fire mixed conifer, projects which move the forest toward this condition would be beneficial to Grace's warbler, western bluebird, and ruby-crown kinglet. The main difference between the alternatives is how long it would take and how well they would meet the desired conditions.

Objectives under all alternatives would be similar for ponderosa pine and frequent fire mixed confer. In ponderosa pine, the forest proposes to "Mechanically thin 11,000 to 19,000 acres annually using a combination of group selection cuts with matrix thinning and all-size free thinning. Treat an average of 13,000 to 55,000 acres annually using a combination of prescribed fire and naturally ignited wildfires." Within frequent fire mixed conifer, the forest would "Burn an average of 1,000 to 13,000 acres annually using prescribed fire and/or naturally ignited wildfires. Mechanically thin 1,200 to 2,100 acres annually in frequent fire mixed conifer."

Proposed guidelines for vegetation management in all forested communities include:

- Projects in forested communities that change stand structure should generally retain at least historic frequencies of trees by species across broad age and diameter classes at the mid-scale. As such, the largest and oldest trees are usually retained.
- Project design should manage for replacement structural stages to assure continuous representation of old growth over time.
- Project design and treatment prescriptions should generally not remove:
  - Large, old ponderosa pine trees with reddish-yellow, wide platy bark, flattened tops, with moderate to full crowns, and large drooping or knarled limbs (alternative B only).
  - Mature trees with large mistletoe brooms suitable for wildlife nesting, caching, and denning, except where retaining such trees would prevent the desired development of uneven-aged conditions over time.
  - Large snags, partial snags and trees (greater than 18 inches d.b.h.) with broken tops, sloughing bark, lightning scars (greater than 4 inches wide), and large stick nests (greater than 18 inches in diameter).
  - Gambel oak greater than 8 inches diameter at root collar (d.r.c.).
  - Known bat roost trees.
- The location and layout of vegetation management activities should effectively disconnect large expanses of continuous predicted active crown fire.
- Vegetation management prescriptions should provide for sufficient canopy breaks to limit crown fire spread between groups, allow for the redevelopment and maintenance of a robust understory, and mimic the spatial arrangement of the reference conditions.

- Vegetation management activities in mixed conifer forests should incorporate experimental design features and monitoring to accelerate learning and adaptive management.
- Trees established after 1890 should generally not be retained in areas where biophysical conditions would have supported stable openings over time.
- Vegetation management activities should meet or exceed goals for scenic beauty (scenic integrity objectives) by creating natural patterns, structure, and composition of trees, shrubs, grasses, and other plants.
- Vegetation management should favor the development of native understory species in areas where they have the potential to establish and grow.
- Even-aged silvicultural practices may be used as a strategy for achieving the desired conditions over the long term, such as bringing dwarf mistletoe infection levels to within a sustainable range, or old tree retention.
- Seed and plants used for revegetation should originate from the same PNVT and general ecoregion (i.e., Southern Colorado Plateau) as the project area.
- Heavy equipment and log decks should not be staged in montane meadows.

Alternatives C and D would replace the management guideline in both ponderosa pine and frequent fire mixed conifer “Large, old ponderosa pine trees with reddish-yellow, wide platy bark, flattened tops, with moderate to full crowns, and large drooping or knarled limbs” for presettlement trees with the following guideline: “Projects should retain trees with physical characteristics typical of those that were established prior to 1890 (i.e., generally larger than 16 inches in diameter at breast height, with yellowing platy bark, and full crowns).”

Environmental Consequences for Management Indicator Species: Alternative B

Over a 15-year period, the alternative would treat between 360,000 and 541,000 acres of ponderosa pine and between 33,000 and 127,900 acres of frequent fire mixed conifer. These areas were historically either ponderosa pine or frequent fire mixed conifer in the past and are already shown as part of the PNVTs for these vegetation types, so it would not change the amount of the PNVTs, but would improve the quality of the habitat.

Based on the VDDT modeling done for the Vegetation and Fire section of this chapter, alternative B would result in more area in the mid-scale desired condition than the other alternatives. It is also the best for creating clumps and openings desired within the ponderosa pine and frequent fire mixed conifer vegetation types. The vegetation analysis also showed that the preferred alternative is the best at creating interspersions and relative understory diversity for both vegetation types. The preferred alternative also has the lowest temporal departure from the mid-scale desired conditions.

The Vegetation and Fire section shows that the preferred alternative maintains the highest percentage of open states and fine-scale interspersions for both ponderosa pine and frequent fire mixed conifer. It has the lowest risk for stand-replacing fires at all time marks (10, 15, 50, and 250 years). Overall, this alternative would likely not increase the amount of ponderosa pine or mixed conifer stands, but would improve the quality of the habitat to meet the needs of species that evolved in these systems.

In summary, the preferred alternative would be the best at moving the ponderosa pine and frequent fire mixed conifer vegetation types toward reference conditions over time. This would change the forestwide habitat trend for both ponderosa pine and frequent fire mixed conifer to an increasing trend under alternative B.

Since it is believed that Grace's warbler populations have been affected by the loss of ponderosa pine habitat (Stacier and Guzy 2002), it is reasonable to expect that if the habitat is restored, populations at the local level would increase. This would likely change the forest wide population trend from stable to increasing for alternative B.

Based on studies that show an increase in local populations of western bluebirds following habitat improvement (Guinan et al. 2008), it is expected that if the habitat is restored, populations at the local level would increase. This would change the forestwide population trend for western bluebird from stable to increasing for alternative B.

Heterogeneity within the mixed conifer stands is a strong predictor for ruby-crowned kinglet, so it is likely that an increase in the habitat trend would result in the preferred alternative having a change in forestwide population trend from stable to increasing over time.

Environmental Consequences for Management Indicator Species: Alternatives C and D

Over a 15-year period, the alternatives would treat between 360,000 and 541,000 acres of ponderosa pine and between 33,000 and 127,900 acres of frequent fire mixed conifer. These areas were historically either ponderosa pine or frequent fire mixed conifer in the past and are already shown as part of the PNVTs for these vegetation types, so it would not change the amount of the PNVTs, but would improve the quality of the habitat. The main difference between the three action alternatives is how much ponderosa pine or frequent fire mixed conifer quality would be improved to provide habitat for the MIS species under each alternative.

Alternatives C or D would result in less of the forest being in the desired condition. This is because some areas have contiguous areas of presettlement trees. In these areas, there would be a need to remove most or all of the smaller trees to achieve the desired openness or result in denser conditions than desired. This would result in more even-aged single-storied stands. Group selection cutting with matrix thinning (preferred alternative) is more effective at creating multistoried, uneven-aged states than treatments that retain most of the larger trees. With a presettlement tree retention guideline, it would likely take longer to achieve an uneven-aged multistoried state. Alternatives C and D would result in forest conditions that are denser, more contiguous, and susceptible to stand-replacing fire (see Vegetation and Fire section of this chapter).

The presettlement tree retention guideline in alternatives C and D would only restrict treatments where there are currently many contiguous presettlement trees. In areas where larger, older trees are underrepresented or within the range of historic variation, all of the action alternatives would likely result in similar progress toward the desired conditions as the preferred alternative. This would change the forestwide habitat trend for ponderosa pine and frequent fire mixed conifer to an increasing trend for alternatives C and D, although alternative B would likely also provide for more acres of suitable habitat over time.

While the habitat trend would change from stable to increasing, it is not clear how the presettlement tree retention guideline in alternatives C and D would affect the forestwide population trend for Grace's warbler and western bluebird. It is not known if there would be enough habitat improvement for the forestwide population trends for Grace's warbler and western bluebird to change from stable to increasing. The forestwide population trend for both species for these alternatives is expected to be between stable to increasing in the long term. The higher likelihood for stand-replacing fire associated with these alternatives has the potential to decrease forestwide population trends for both species.

Variation within the mixed conifer stands is a strong predictor for ruby-crowned kinglet, so it is possible that alternatives C and D would not substantially change forestwide population trends for the ruby-crowned kinglet. The population trend for this species is expected to be stable to increasing. It is possible that stand homogeneity created as a result of the presettlement tree retention guideline in alternatives C and D would lead to a decreased population trend for ruby-crowned kinglet over time.

Management Indicator Species in Grasslands

Environmental Consequences for Management Indicator Species: Alternative A

One of the priority needs for change is to restore historic grasslands by reducing tree encroachment and meadows. State and transition models developed during the forest plan revision process suggest that all grasslands on the Kaibab NF are trending away from historic reference conditions. The trend away for Great Basin grasslands and semidesert grasslands was found to be low to moderate, while the trend for montane grasslands was high. Conifer encroachment is expected to continue to negatively affect montane grasslands, while pinyon-juniper encroachment is expected to reduce Great Basin and semidesert grasslands (KNF 2009). On average, the forest is restoring approximately 2,000 acres a year. Over 15 years, this would restore approximately 30,000 acres. While this would improve habitat conditions, it would not increase the amount of the PNVT.

Alternative A has no specific plan direction for the removal of encroaching conifers from grasslands, nor are there any plan objectives. The Williams and Tusayan Ranger Districts have implemented some grassland restoration projects, subject to available funding. It is not expected that the current rate of implementation is enough to change trends shown in the models. The vegetation models show that the forestwide habitat trend for pronghorn would change from stable to decreasing under alternative A.

Pronghorn need open grasslands with good forage availability to provide for fawning habitat and health of the adults. If the current forestwide habitat trend changes from stable to decreasing, this would result in the loss of these important habitat components on the forest. Based on these facts, the forestwide population trend for pronghorn would change from stable to decreasing under alternative A.

Environmental Consequences for Management Indicator Species: Action Alternatives B, C, and D

Under all three action alternatives, the priority need for change is to restore historic grasslands by reducing tree encroachment and meadows. Desired conditions, objectives, and guidelines are the same for all three action alternatives.

Objectives for restoring grasslands under all alternatives include:

- Reduce tree and shrub density to less than 10 percent on 5,000 to 10,000 acres of historic grasslands annually.
- Modify fences and/or install crossings to facilitate pronghorn movement on 50 miles of fence within 10 years of plan approval.

Proposed guidelines that affect pronghorn include:

- **Restoring Grasslands:** Pronghorn fence crossings should be installed along known movement corridors.
- **Livestock Grazing:** Livestock management should favor the development of native cool season grasses and forbs. New construction and reconstruction of fences should have a barbless bottom wire and be at least 18 inches high. Annual operating instructions for livestock grazing permittees should ensure livestock numbers are balanced with capacity and address any relevant resource concerns (e.g., forage production, weeds, fawning habitat, soils, etc.) and make adjustments as appropriate.

The Kaibab NF works closely with the Arizona Game and Fish Department to meet the needs of pronghorn antelope. The forestwide guideline above meets current recommendations for all wildlife species (AGFD 2011b). However, where needed, in areas that pronghorn are known to use, the bottom wire may be higher (e.g., 20 inches) and goat bars may be installed to facilitate pronghorn passage.

All three alternatives would restore between 75,000 and 150,000 acres of grasslands in 15 years. Some of this acreage would change the current land designation of ponderosa pine or pinyon-juniper stands to grasslands. These areas were historically grasslands in the past and are already shown as part of the PNVT for grasslands, so it would not change the amount of the PNVT but would improve the quality of the habitat.

All action alternatives have a tree retention guideline. The guideline would apply to all vegetation management activities including removing encroaching conifers from grasslands. In some areas, this could reduce the effectiveness of grassland restoration work.

In alternative B, the guideline for large tree retention would generally retain only the largest and oldest trees that provide for quality raptor perches. Alternatives C and D would add the management guideline that projects should retain trees with physical characteristics typical of those trees established prior to 1890. For some projects, this guideline may be implemented as a diameter cap, which could result in all trees over a certain size being retained. The effectiveness of treatments is likely to be reduced in grasslands that would have a higher number of trees over a certain size. Overall, the amount of grassland restoration treatment is not expected to be vastly different between the action alternatives (see Vegetation and Fire section).

It is expected that an increased focus on grassland treatments would change the forestwide habitat trend for pronghorn for all three action alternatives from stable to increasing in the future. The resulting improvement of habitat should help local populations of pronghorn on the forest. However, since pronghorn are also affected by drought and predators, the habitat improvement alone might not be enough to change the forestwide trend, but it should at least help maintain the local populations. The forestwide population trend for all three alternatives is expected to be stable to increasing in the long term.

Cumulative Environmental Consequences for Wildlife

Cumulative effects from implementation of the Kaibab NF LMP include potential effects of forest management on the wildlife resource, plus potential effects from land management on adjacent lands of other ownership (i.e., private, State, tribal, other Federal agencies, county, etc.). In general, cumulative effects include impacts from past activities and potential future activities, such as agricultural use, forestry, fire, human development, and recreation. Past activities/actions are only considered if their contribution to the existing condition is still ongoing.

To compare the effects of Kaibab NF proposed management to the surrounding landscape, cumulative effects are evaluated considering the management actions of other entities of a similar planning scope within a relevant spatial and temporal context. The analysis area for wildlife includes the Kaibab NF, and relevant portions of Arizona Game and Fish Region II and Bird Conservation Regions 16 (Southern Rockies/Colorado Plateau) and 34 (Sierra Madre Occidental). This encompasses the three counties immediately adjacent to and/or surrounding the Kaibab NF (Coconino, Yavapai, and Mohave Counties) and is of a spatial extent that should account for effects on wide ranging species such as big game and migratory birds: animals that can travel across numerous land jurisdictions. The analysis area encompasses similar habitat types as identified in the proposed action area and reflects similar ecological settings which wildlife species referenced in this report could or would use. These effects were evaluated for the life of the forest plan, approximately 10 to 15 years.

Departures from reference conditions exist in all vegetation types on the forest, and most continue to trend further from reference conditions. This trend is also common on adjacent lands. Forests have become denser, and conifers are invading grasslands. The landscape has become more fragmented as a result of activities that include urban development, ranching, and fire suppression. As a result, there has likely been a net loss of intact, potential habitat and an increased risk to viability for wildlife on adjacent lands; this trend is expected to continue in the future. As a result, the Kaibab NF will play an increasing role in the conservation of these habitats and associated wildlife species on NFS lands.

The action alternatives strive to create and maintain natural communities and habitats in the amounts, arrangements, and conditions capable of supporting viable populations of existing native and desired nonnative plants, aquatic, and wildlife species within the planning area, while contributing to broader landscape scale initiatives where appropriate. As such, wildlife and fish are distributed throughout their natural potential range. The adaptive management process should also help to inform and realize these conditions on the ground.

Wildlife Habitat Restoration

Under the action alternatives, prescribed fires and mechanical thinning would continue across the forest (and adjacent lands) in the coming years to reduce accumulated fuels that can cause uncharacteristic wildfire. Cumulatively, these actions are expected to improve habitat while decreasing the overall long-term viability risk to wildlife species that evolved with fire-adapted ecosystems.

Under the action alternatives, wildfires could be managed more consistently with Grand Canyon National Park by allowing them to move across forest-park boundaries to achieve similar restoration objectives. This continuity would improve overall resiliency of the mixed conifer type on the plateau and should benefit numerous wildlife species. Barriers to such cross-boundary management do not exist outside of current plan restrictions because an interagency fire management organization composed of both Park Service and Forest Service personnel is responsible for all fire management on the Kaibab Plateau.

These goals and strategies are consistent with and complementary to strategies identified in Arizona's Comprehensive Wildlife Conservation Strategy: 2005–2015, as well as the State Wildlife Action Plan (AGFD 2012). These plans both emphasize sustainability, a return to historic (reference) conditions, and are based on the principles of best science, best management practices, and an adaptive management process that includes measurable goals, objectives, strategies, and approaches.

The Arizona Partners in Flight Bird Conservation Plan (Latta et al. 1999) and the Intermountain West Joint Venture Agreement, which provide overall statewide direction for managing migratory land birds, shorebirds, and waterfowl in Bird Conservation Regions 16 and 34, emphasize protection of key habitats for birds and outline goals and objectives for inventory and monitoring, research, information and education, management, and issues involving neotropical migratory bird species. Federal recovery plans for the California condor (USFWS 1996) and the Mexican spotted owl (USFWS 2012a) further guide activities for those species.

Mechanical thinning and fire can affect wildlife habitat in various ways. Projects are mitigated on a site-specific basis to reduce negative effects that might result from habitat modification. Collectively, projects can affect foraging, nesting, hiding and thermal cover, and potentially daily movements on a short-term basis, but most wildlife species would benefit over the long term. Much of the forest and woodland across northern Arizona has become denser than under historic (presettlement conditions) because of decreased wildfire frequency (Swetnam et al. 1999, Covington and Moore 1994, Covington 2003). Forest restoration activities identified in the preferred alternative are likely to move habitat structure and composition back to conditions more consistent with conditions that occurred during the recent evolutionary past for wildlife species on the Kaibab NF and adjacent lands.

Because wildlife species are subject to movement (frequently over great distances), efforts on adjacent lands are important considerations in this process. Continuity is important and projects which span land management jurisdictions will likely be most effective in providing adequate habitat distribution for wildlife over time, further minimizing viability risk. This requires collaboration among various organizations and stakeholder groups.

Similar forest planning efforts are underway on two neighboring forests, the Coconino National Forest and the Apache-Sitgreaves National Forests. Both are also revising their land management

plans concurrently with the Kaibab NF, based upon the same regional vegetative desired conditions, standards, and guidelines, and similar objectives for ponderosa pine and mixed conifer. The cumulative restoration activities from the action alternatives from these plans could have a pronounced effect on modifying stand structure to be less susceptible to stand-replacing fire in these vegetation types, while promoting resiliency with regard to climate change. Collectively, the net result of these revised LMPs should be positive and beneficial for wildlife species by ensuring the persistence of these habitats into the future and by providing continuity of suitable habitats. This should decrease the overall risk to species viability.

Another large-scale planning effort in the analysis area focused on improving resiliency in fire-adapted ecosystems is the 4FRI. If implemented, the 4FRI could treat up to 55,000 acres annually across the Kaibab NF and adjacent NFS lands. The cumulative effect of this process could have widespread beneficial outcomes in restoration across the forest including decreased susceptibility to large disturbances (e.g., uncharacteristic wildfire and insect outbreaks) and increased water yields from winter snowfall through the creation of interspaces. The scale of this project is such that these changes could have a meaningful impact on wildlife habitat by improving adaptability of ponderosa pine type to a changing climate and providing for it well into the future.

Additionally, the General Land Management plan for the Grand Canyon National Park (United States Department of the Interior National Park Service 1995) and the Approved Resource Management Plan for the Arizona Strip (United States Department of the Interior, Bureau of Land Management 2008) which manages public lands in the northern portions of Coconino and Mohave Counties, Arizona, north and west of the Colorado River, focus on desired conditions and monitoring and adaptive management with mutually common goals of promoting native vegetative communities and ecological processes. These goals should help to provide healthy habitat for wildlife and sustainable, resilient ecosystems over the greater landscape.

Wildlife, Development and Connectivity

Some wildlife species are especially at risk with regard to development. For example: birds, bats, and wide ranging species can be affected by transmission lines, turbines, roads, and other activities associated with renewable energy endeavors. These types of activities, which occur on lands of different ownerships and jurisdictions, are anticipated to increase in the future. The Fish and Wildlife Service has issued interim guidelines for site specific development of wind energy facilities that may affect wildlife (USFWS 2011). On the Kaibab NF, proposals for development are dealt with on a case-by-case basis through special uses and the permitting process. In general, no new development is being encouraged on the forest. To that end, the Kaibab NF management strategy includes working closely with the Arizona Game and Fish Department, the county, Arizona Department of Transportation, and other entities to help preserve open spaces and connectedness of wildlife habitat. Much of the land surrounding the forest consists of a checkerboard of State and private land inholdings. Existing collaborations between the Arizona Game and Fish Department and Coconino County generally encourage the protection of open lands and the preservation of the land's natural character within local and regional contexts. Cumulatively, these strategies should decrease the potential for future land fragmentation, while improving the overall integrity of the landscape. This should also provide for more resilience with regard to climate change for those wildlife species that may need to adjust migration routes, foraging corridors, or breeding grounds.

Riparian systems have decreased in size over the past 100 years, largely a result of human development. There has been a 90 percent reduction of this habitat type in Arizona compared to historic (reference) conditions. On the Kaibab NF, this vegetation community is located only within the Kanab Creek Wilderness. Historically, annual flooding was a major disturbance needed to maintain the historic vegetation levels necessary for many wildlife species, which utilize this habitat type. This community is currently departed from historic conditions due to upstream diversions, impoundments, and tamarisk invasion. This watershed is not wholly contained within the forest and the Kaibab NF has little control over upstream water management. For this reason, it will be difficult for the forest to fully restore this habitat to reference conditions. Water resource management activities, including maintaining perennial water quality, quantity, and timing of flows contribute a very important role in overall ecological function and sustainability of these watersheds. Most of these activities are regulated outside the boundary of the forest. Although the Kaibab NF manages what it can in terms of riparian health, cumulatively when combined with management activities of other jurisdictions, these actions would not likely be sufficient to maintain the ecological integrity of riparian habitat over time. For this reason, it will be difficult for the forest to fully restore this habitat to reference conditions. As a result, riparian-dependent species such as the western red bat and the Arizona toad, which could use this habitat, would not realize their full potential. Detailed information on natural flooding regimes and water use can be found in the Soils and Watershed Specialist Report (KNF 2013e).

Wildlife and Recreation

A wide ranging species that could be negatively affected by the use of lead for hunting is the California condor, a federally listed species which primarily occurs within and along the south rim of the Grand Canyon, the Kaibab Plateau on the north side of Grand Canyon, Marble Canyon, the Vermillion Cliffs, and parts of southern Utah (Southwest Condor Review Team 2007). The Peregrine Fund has extensive radio-tracking data, which documents heavy use of the Kaibab Plateau (North Kaibab Ranger District) for travel and forage (Peregrine Fund 2010). While condors are common a few miles to the north along the South Rim of the Grand Canyon, birds have rarely been observed on the southern portion of the forest. The condor's primary use of the forest is for dispersal habitat and foraging; condors are opportunistic scavengers that feed primarily on large dead mammals such as deer, elk, bighorn sheep, and domestic livestock.

The proposed action and alternatives would not affect the amount or distribution of carrion. The biggest threat to the condor is lead poisoning (USFWS 2012b). The Arizona Game and Fish Department regulates hunting in the State and actively encourages the use of non-lead ammunition. This voluntary lead reduction program and related hunter education campaign includes free distribution of non-lead ammunition to hunters in the condor range and thus far has been very successful with an 80 to 90 percent participation rate. The Department is optimistic that this trend will continue. Although voluntary lead reduction efforts have significantly reduced the amount of lead available to condors in Arizona, the condor reintroduction program has yet to observe a corresponding reduction in condor lead exposure rates (USFWS 2012b). Although 80 to 90 percent of hunters in much of the Arizona portion of condor range have participated in the voluntary program since 2007, hunter participation rates in southern Utah's lead reduction program are significantly lower. Condor foraging in southern Utah has increased considerably since 2004. Additionally, foraging in Utah during the fall hunting season has risen consistently since 2005. This shift in condor movement provides a likely explanation for why lead exposure levels have remained essentially static throughout this reporting period rather than declining (USFWS 2012b). The Kaibab NF will continue to support this program focused on heavy

advocacy, hunter education, and readily available non-lead ammunition. The net result of these collaborations should be positive for the condor.

The third 5-year review (USFWS 2012b) notes that lead poisoning is affecting the southwest population from becoming a reproductively self-sustaining population. While it was expected that deaths from lead and other sources of mortality would occur when the condors were released, it was noted these deaths would be compensated for by both natural and captive reproduction (USFWS 1996). To date, this compensation has come primarily from captive reproduction. Any change to the hunting regulations in the experimental population area in Arizona or Utah would require action by the states (USFWS 2012b). Cumulatively, this is having a negative effect on the Southwest condor population.

In summary, the cumulative effect of these planning efforts, when combined with the preferred alternative, is expected to be a beneficial one for wildlife by providing for better coordination across the landscape and perpetuating the habitat conditions necessary to ensure species viability into the future. Alternatives C and D would have similar effects, however, in some areas in ponderosa pine, frequent fire mixed conifer, and woodlands and savannas, there would be less benefit than in alternative B. Alternative A (no action) would not contribute to a cumulative benefit for wildlife species.

Botanical Resources

This analysis evaluates and discloses the potential environmental consequences on the botanical resources that may result from the adoption of a revised land management plan. It examines four different alternatives in detail for revising the 1988 Kaibab NF Land and Resource Management Plan. This is a summary of the information provided in the Botany Specialist Report (KNF 2013d), which documents the potential effects on forest planning plant species, including threatened, endangered, candidate, and sensitive (TECS) plant species and other rare and/or endemic plant species. It provides brief summaries of the ecology and distribution of the TECS and other plant species and addresses the concerns and mitigation for potential treatment effects on such species. The findings of impacts for the selected alternative have been addressed in the biological assessment, which has been prepared for the final EIS.

Habitat elements described in this analysis are the habitat components or features that are required to support plant species. Many of the current conditions, risks, and trends of the habitat elements are the same as their associated PNVT, which were analyzed in the Kaibab NF Ecological Sustainability Report (KNF 2008a) and the Vegetation section of this chapter and are not repeated here.

Description of Affected Environment (Existing Condition) – Botanical Resources

All PNVTs analyzed in the terrestrial vegetation report (KNF 2008a) were departed from reference conditions, suggesting that the associated species' habitat needs were not being met, and therefore, not sustainable given current management practices. Plant habitat elements associated with fine-scale habitat features not captured by coarse PNVT descriptions include: rocky outcrops, cliffs and canyon; and basalts and other soil types. Current conditions of the habitat elements that provide the affected environment particularly related to the forest plan analysis plant species are described below.

In the pinyon-juniper woodlands and ponderosa pine forest, severe wildfire effects represent a significant threat, particularly when combined with secondary threats of uncharacteristic insect or drought-related die-off and invasive plants (KNF 2009). There are 29 forest planning plant species that reside in pinyon-juniper woodlands; important species currently being affected by these changes and threats to the PNVT are paradine plains cactus, disturbed rabbitbrush, cliff milkvetch, Kaibab beardtongue, and western flameflower. There are 25 forest planning plant species associated with the ponderosa pine forest, notable ones include: Rusby milkvetch, hairy clematis, Kaibab beardtongue, and eastern flameflower.

The mixed conifer forests are highly departed from reference condition. Dieback and decline of aspen across northern Arizona began in June of 1999, when over 100,000 acres of aspen were affected by a severe frost event (Fairweather et al. 2008). Tree mortality was even heavier from the 2002–2003 drought period. Secondary agents included cytospora canker, bronze poplar borer, other canker fungi, and insects. Once trees started to decline, they did not improve with the weather, but kept declining until they died. Arizona bugbane, Colorado blue columbine, Rusby milkvetch, and mountain whitlow-grass occur in the mesic mixed conifer with aspen vegetation type.

Current tree density and canopy cover are substantially greater than during the reference period in the spruce-fir PNVT (KNF 2008a). However, on Bill Williams Mountain within the Arizona Bugbane Botanical Area, large old Douglas-fir trees are dying (Phillips and Johnson, pers. obs.). Douglas-fir beetles are the main culprit for Douglas-fir deaths. They initially attack those trees most severely infected by dwarf mistletoe, and then move into the uninfected or lightly infected trees. There is typically an association with root disease (*Armillaria*) infection and Douglas-fir beetle attacks as well (Fairweather et al. 2006).

The primary threats to the sagebrush shrublands are lack of characteristic fire disturbance, limited nutrient cycling, and closed-canopy shrub states resulting from juniper encroachment. These interrelated threats create large areas susceptible to stand-replacing fire events. Further departure from reference conditions are predicted under the current management and disturbances. Bison herbivory may pose a secondary threat on the North Kaibab Ranger District. Fires occurring under current conditions may lead to negative outcomes for native species composition. Increased invasive plant cover after wildfire is considered a moderate risk (KNF 2009). Paradine plains cactus is a very rare plant that occurs in this vegetation type on the North Kaibab Ranger District and is managed under a conservation agreement with the USFWS. Both agencies are currently working to update this agreement.

The primary threats to montane/subalpine meadows are the lack of characteristic fire disturbance and limited nutrient cycling. Under the current disturbance regime and current rate of management, further departures are expected. Excessive ungulate pressure may also play a substantial role in some areas (KNF 2009). The subalpine/montane meadows on the North Kaibab Ranger District are linear, and as a result, are at a higher risk of loss because trees encroach from the edges and the openings close more quickly. Kaibab Indian paintbrush, Kaibab bladderpod, and Mt. Dellenbaugh sandwort are three Forest Service sensitive plant species in the subalpine grasslands of the North Kaibab Ranger District.

The Colorado Plateau/Great Basin grasslands show some degree of departure. This grassland type is greatly departed off-forest. The primary threat is the lack of characteristic fire disturbance and limited nutrient cycling. Conifers are also encroaching. Excessive ungulate pressure may also

play a substantial role in some areas (KNF 2009). Disturbed rabbitbrush is an important forest planning plant species that is currently being affected by these changes.

Semidesert grasslands are much less abundant than they were historically, which reduces the amount of available habitat for grassland-associated species. Bigelow's onion grows in this vegetation type.

The desert communities occupy a proportionally small area of the forest, but provide habitat for a number of unique and endemic plant species not found in other areas of the forest. The primary threats to the desert communities are the invasion of exotic plant species such as cheatgrass, and closed shrub states becoming more common. These threats increase the risk of uncharacteristic fire disturbance. This could further reduce native plant diversity and structure, increasing invasive plant cover and erosion. The U.S. Fish and Wildlife Service proposed rare cactus, Fickeisen plains cactus, as well as Utah agave and Utah century plant grow in the desert communities.

Bebb's willow and pond lily are two rare plant species on the Kaibab NF in wetland/cienegas PNVT. The primary threats are the lack of characteristic fire disturbance, limited nutrient cycling, and reduced water input (KNF 2009). Tree encroachment and high tree density in adjacent vegetation types may lower the water table and reduce water flow in this system. Fire disturbance under current conditions may lead toward invasive plants. Drought is a secondary threat.

The following is the key to the forest rankings in table 21:

Forest Rank: F? (Information insufficient to develop rank)
F1 (Extremely rare on the forest)
F2 (Very rare on the forest)
F3 (Rare and uncommon on the forest)
F4 (Widespread abundant on the forest)
F5 (Demonstrably secure on the forest)
FP (Potential habitat on forest but species not known to occur)
FO (Off forest)

Vegetation Types: CWRF: Cottonwood-Willow Riparian Forest; DC: Desert Communities; GBG: Great Basin Grassland; MCA: Mixed Conifer with Aspen; MSM: Montane Subalpine Meadows; PJW: Pinyon-juniper Woodland; PPF: Ponderosa Pine Forest; SbS: Sagebrush Shrubland; SdG: Semidesert Grassland; SFF: Spruce-fir Forest; W/C: Wetland/Cienega; W: Water.

Table 21. Forest planning plant species list, forest ranks, and associated vegetation types

Scientific Name	Common Name	Forest Rank	Vegetation Types
Actaea arizonica	Arizona bugbane	F1	MCA
Agave utahensis var. *kaibabensis*	Utah century plant	F1	PJW
Agave utahensis var. *utahensis*	Utah agave	F2	DC
Allium bigelovii [a]	Bigelow's onion	FO	DC, SdG
Aquilegia caerulea var. *pinetorum*	Columbine	F1	MCA, SFF
Arenaria aberrans	Mt. Dellenbaugh sandwort	F1	MSM
Asclepias hallii	Hall's milkweed	F1	PJW, PPF
Asclepias quinquedentata	Slimpod milkweed	F1	PPF
Astragalus amphioxys var. *modestus*	Aladin's slippers	FO	PJW, SbS
Astragalus ampullarius	Gumbo milkvetch	FP	DC, PJW
Astragalus cremnophylax var. hevronii	Hevron's milkvetch	FP	DC
Astragalus cremnophylax var. *myriorraphis*	Cliff milkvetch	F1	PJW
Astragalus episcopus var. *lancearius*	Lancer milkvetch	F1	PJW, SbS
Astragalus humistratus var. *tenerrimus*	Groundcover milkvetch	F3	PPF, SFF
Astragalus lentiginosus var. *oropedii*	Freckled milkvetch	FP	PJW, PPF
Astragalus lentiginosus var. *vitreus*	Freckled milkvetch	F?	PJW, SbS, GBG
Astragalus pinonis var. *atwoodii*	A milkvetch	F1	PJW
Astragalus rusbyi	Rusby's milkvetch	F1	MCA, PPF
Astragalus subcinereus	Silver milkvetch	F2	PJW, SbS, PPF
Astragalus titanophilus	Limestone milkvetch	FP	GBG
Astragalus troglodytus	Creeping milkvetch	F1	PJW, SbS, PPF
Botrychium echo	Reflected moonwort	FO	MSM
Camissonia gouldii	Diamond Valley suncup	FO	PJW
Carex oreocharis	A sedge	F1	MSM
Castilleja kaibabensis	Kaibab Indian-paintbrush	F1	MSM
Chrysothamnus molestus	Disturbed (Tusayan) rabbitbrush	F2	GBG, PJW
Cirsium rothrockii	Rose-color thistle	FP	PPF
Clematis hirsutissima var. *hirsutissima*[b]	Hairy clematis	F1	PPF
Cleome lutea var. jonesii	Jones' spider-flower	FO	CWRF, PJW
Cordylanthus wrightii ssp. *kaibabensis*	Wright's bird's-beak	F1	PJW, PPF, SbS
Cryptantha abata	Dent-nut cat's-eye	FO	PJW, PPF
Cystopteris utahensis	Utah bladder fern	F?	PJW, PPF
Draba asprella var. *asprella*	Rough whitlow-grass	FO	PPF

Scientific Name	Common Name	Forest Rank	Vegetation Types
Draba asprella var. *kaibabensis*	Rough whitlow-grass	F1	PJW, PPF
Draba asprella var. *stelligera*	Rough whitlow-grass	FO	PPF
Draba rectifructa	Mountain whitlow-grass	F1	MCA
Erigeron saxatilis	Cliff fleabane	F1	PPF
Eriogonum corymbosum var. *glutinosum* [c]	Wild buckwheat	FO	PJW, PPF
Eriogonum darrovii	Darrow's wild buckwheat	F1	GBG
Eriogonum pulchrum (= Eriogonum ericifolium var. *pulchrum)*	Yavapai wild buckwheat	FO	PJW, PPF
Eriogonum jonesii	Jones' wild buckwheat	F?	PJW
Eriogonum mortonianum	Morton wild buckwheat	FP	SbS
Eriogonum thompsoniae var. *atwoodii*	Atwood's wild buckwheat	FP	SbS
Escobaria vivipara var. *kaibabensis* [d]	Spinystar	F5	PJW
Gaillardia parryi	Parry's blanket-flower	F1	PJW
Hedeoma diffusa	Flagstaff pennyroyal	F1	PPF
Helianthus arizonensis	Arizona sunflower	FP	PJW
Heuchera novomexicana	New Mexico alum-root	FP	PJW
Ivesia arizonica [e]	Arizona whitefeather	FO	PJW, PPF
Ivesia arizonica var. *arizonica*	Arizona whitefeather	F?	PJW, PPF
Lepidium montanum var. *glabrum*	Mountain pepperweed	FO	DC, PJW
Lesquerella arizonica	Arizona bladderpod	F2	PJW, PPF
Lesquerella kaibabensis	Kaibab bladderpod	F1	MSM
Lotus mearnsii var. mearnsii	Mearns lotus	F?	DC, SdG
Macromeria viridiflora var. *viridiflora*[f]	Giant-trumpets	F4	PPF
Mertensia macdougalii	Macdougal's bluebells	F1	MWR, PPF
Moneses uniflora	Wood nymph	FO	MCA, PPF, SSF
Myosurus nitidus	Western mouse-tail	F1	PJW, PPF
Nuphar lutea	Pond lily	F1	W
Pediocactus paradinei	Paradine Plains cactus	F1	PJW, SbS
Pediocactus peeblesianus var. fickeiseniae	Fickeisen Plains cactus	F1	GBG, DC
Pediomelum mephiticum	Skunk-top scurfpea	FO	DC, PJW, SdG
Penstemon caespitosus var. *desertipicti*	Mat penstemon	F2	PJW
Penstemon laevis	Southwestern beardtongue	F1	PJW, PPF
Penstemon nudiflorus	Flagstaff beardtongue	F1	PJW, PPF
Penstemon pseudoputus	Kaibab beardtongue	F2	PPF, MSM
Penstemon rydbergii[g]	Rydberg's penstemon	F4	MSM

Scientific Name	Common Name	Forest Rank	Vegetation Types
Perityle congesta	Compacted rock daisy	F1	PJW, PPF
Perityle gracilis	Grass-like rockdaisy	F?	PJW
Phacelia serrata	Serrate phacelia	FP	PJW, PPF
Phemeranthus validulus (=Talinum validulum)	Western flameflower	F2	PJW, PPF
Phlox amabilis	Arizona phlox	F1	PJW, PPF
Potentilla crinita var. *lemmonii*	Bearded cinquefoil	F2	PPF
Ranunculus oreogenes	Oregon buttercup	F1	PPF
Rosa stellata ssp. *abyssa*	Grand Canyon rose	F1	PJW, SbS
Salix bebbiana	Bebb's willow	F1	W/C
Shepherdia rotundifolia	Roundleaf buffaloberry	F1	PJW
Sporobolus interruptus	Black dropseed	F?	MSM, PPF
Stachys rothrockii	Rothrock's hedge-nettle	F?	PJW, PPF
Thelypodiopsis ambigua var. *ambigua*	Long Valley tumblemustard	FO	DC, PJW
Thelypteris puberula	Showy maidenfern	FO	CWRF
Triteleia lemmoniae	Oak Creek triteleia	F?	PPF

[a] Forest Service sensitive species that do not occur on the Kaibab NF (FO or FP) are not carried forward for viability analysis.

[b] Variety *arizonica* has been combined with the typical variety, *hirsutissima*. Not considered in this analysis.

[c] Recent investigation revealed this taxon is more widespread and common than previously determined. No locations are documented for the Kaibab NF.

[d] *Escobaria vivipara* var. *kaibabensis* is now included in *Coryphantha vivipara*, "the most widespread, abundant and variable member of the genus…." (Morin 1997, Flora North America, pp. 235-236). Not considered further in this analysis.

[e] Not considered further because the variety on the forest is var. *arizonica* (included in table).

[f] Recent investigation revealed this taxon is more widespread and common than previously determined. NatureServe ranking G4?T3?. Not considered further in this analysis.

[g] Recent investigation revealed this taxa is more widespread and common than previously determined. NatureServe ranking G4T5. Not considered futher in this analysis.

Critical Habitat for Listed Plant Species

The forest has no designated critical habitat for plants at this time. However, the July 8, 2013 Federal Register has the proposed listing and designation of critical habitat for Fickeisen plains cactus (*Pediocactus peeblesian var. fickeiseniae*). There is one CHU proposed for the Fickeisen plains cactus that is located on the North Kaibab Ranger District. The CHU 4 (South Canyon) is entirely located on the forest and contains 272 acres within the unit. The unit contains at least 62 individuals scattered among six areas along the rim of South Canyon Point.

Environmental Consequences to Plant Species Viability

The plant species viability assessment focuses on information relevant to the Kaibab NF. This evaluation used the Species Viability Process (described previously in this chapter under the Species Viability Analysis section) to identify species for which there are substantive risks to

maintenance of viable populations, and to ensure consideration of appropriate habitat management strategies to reduce those risks to acceptable levels where feasible.

From the 81 plant species used as Forest Planning species, 53 species had a rating of F?-F3 (table 21) and will be carried forward in this viability analysis. This list includes one Federal listed species and 14 Regional Forester Sensitive Species known to occur on the Kaibab NF. Consequences unique to each alternative and the differences among the action alternatives for the forest planning plant species are compared in table 22. Ratings of risk to viability for each species/habitat relationship by alternative are also presented in the table.

The following is a key to variables used in table 22 (see appendix H for a more detailed description of the rating codes):

Status: F (Federally listed or proposed as threatened or endangered)
S (Regional forester's sensitive species list)
O (Locally rare and other)

F Rank: F? (Information insufficient to develop rank)
F1 (Extremely rare on the forest)
F2 (Very rare on the forest)
F3 (Rare and uncommon on the forest)

Viability Risk: VH (Very High)
H (High)
MH (Moderately High)
M (Moderate)
L (Low)

As table 22 shows, the one listed species, 14 regional forester sensitive species, and 36 other forest plan analysis plant species were found to have at least one element ranked as a high rating risk category.

Table 22. Risk to plant species viability for each species/habitat relation by forest plan revision alternative

Scientific Name	Common Name	Status	F Rank	Habitat Element/Feature	Viability Risk by Alternative			
					A	B	C	D
Actaea arizonica	Arizona bugbane	S	F1	Aspen within mesic mixed conifers	H	H	H	H
				Canyons	MH	MH	MH	MH
Agave utahensis var. *kaibabensis*	Utah century plant	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Desert Communities	VH	VH	VH	VH
				Cliffs and ledges	MH	MH	MH	MH
Agave utahensis var. *utahensis*	Utah agave	O	F2	Pinyon-juniper woodland	M	M	M	M
				Desert communities	H	H	H	H
				Cliffs and ledges	M	M	M	M

Scientific Name	Common Name	Status	F Rank	Habitat Element/Feature	Viability Risk by Alternative			
					A	B	C	D
Aquilegia caerulea var. *pinetorum*	Columbine	O	F1	Aspen with mesic mixed conifer and spruce	H	H	H	H
				Seeps	H	H	H	H
Arenaria aberrans	Mt. Dellenbaugh sandwort	S	F1	Montaine subalpine grassland	H	H	H	H
				Limestone Soils	MH	MH	MH	MH
Asclepias hallii	Hall's milkweed	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
Asclepias quinquedentata	Slimpod milkweek	O	F?	Ponderosa pine	H	MH	H	H
Astragalus cremnophylax var. *myriorraphis*	Cliff milkvetch	S	F1	Pinyon-juniper woodland	MH	MH	MH	MH
Astragalus episcopus var. *lancearius*	Lancer milkvetch	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Sagebrush shrubland	MH	MH	MH	MH
Astragalus humistratus var. *tenerrimus*	Groundcover milkvetch	O	F3	Ponderosa pine	M	L	M	M
				Spruce/fir forest	M	M	M	M
Astragalus lentiginosus var. *vitreus*	Freckled milkvetch	O	F?	Pinyon-juniper woodland	MH	MH	MH	MH
				Sagebrush shrubland	MH	MH	MH	MH
				Great Basin grassland	H	MH	MH	MH
Astragalus pinonis var. *atwoodii*	A milkvetch	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
Astragalus rusbyi	Rusby's milkvetch	S	F1	Aspen within mesic mixed conifers	H	H	H	H
				Ponderosa pine	H	MH	H	H
Astragalus subcinereus	Silver milkvetch	O	F2	Pinyon-juniper woodland	M	M	M	M
				Sagebrush shrubland	M	M	M	M
Astragalus troglodytus	Creeping milkvetch	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Sagebrush shrubland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
Carex oreocharis	A sedge	O	F1	Montaine subalpine Grassland	H	MH	MH	MH
Castilleja kaibabensis	Kaibab Indian-paintbrush	S	F1	Montaine subalpine Grassland	H	MH	MH	MH

Scientific Name	Common Name	Status	F Rank	Habitat Element/Feature	Viability Risk by Alternative			
					A	B	C	D
Chrysothamnus molestus	Disturbed (Tusayan) rabbitbrush	S	F2	Great Basin grassland	MH	M	M	M
				Pinyon-juniper woodland	M	M	M	M
				Calcareous soils	M	M	M	M
Clematis hirsutissima var. *hirsutissima*	Hairy clematis	S	F1	Ponderosa pine	H	MH	H	H
				Dolomitic limestone soils	MH	MH	MH	MH
Cordylanthus wrightii ssp. *kaibabensis*	Wright's bird's-beak	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
				Sagebrush shrubland	MH	MH	MH	MH
Cystopteris utahensis	Utah bladder fern	O	F?	Pinyon-juniper woodland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
				Wet ground	H	H	H	H
				Cliffs and ledges	MH	MH	MH	MH
Draba asprella var. *kaibabensis*	Rough whitlow-grass	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
				Cliffs and ledges	MH	MH	MH	MH
Draba rectifructa	Mountain whitlow-grass	O	F1	Aspen within mesic mixed vonifers	H	H	H	H
Erigeron saxatilis	Cliff fleabane	S	F1	Ponderosa pine	H	MH	H	H
				Cliffs and ledges	MH	MH	MH	MH
Eriogonum darrovii	Darrow's wild buckwheat	O	F1	Great Basin grassland	H	MH	MH	MH
Eriogonum jonesii	Jones' wild buckwheat	O	F?	Pinyon-juniper woodland	MH	MH	MH	MH
Gaillardia parryi	Parry's blanket-flower	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
Hedeoma diffusa	Flagstaff pennyroyal	S	F1	Ponderosa pine	H	MH	H	H
				Rocky dolomitic cliffs and ledges	MH	MH	MH	MH
				Limestone	MH	MH	MH	MH
Ivesia arizonica var. *arizonica*	Arizona whitefeather	O	F?	Pinyon-juniper eoodland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
				Rocky limestone	MH	MH	MH	MH
Lesquerella arizonica	Arizona bladderpod	O	F2	Pinyon-juniper woodland	M	M	M	M
				Ponderosa pine	MH	M	MH	MH

Scientific Name	Common Name	Status	F Rank	Habitat Element/Feature	Viability Risk by Alternative			
					A	B	C	D
Lesquerella kaibabensis	Kaibab bladderpod	S	F1	Montane subalpine grassland	H	MH	MH	MH
				Rocky slopes	MH	MH	MH	MH
Lotus mearnsii var. *mearnsii*	Mearns lotus	O	F?	Semidesert grassland	H	H	H	H
Mertensia macdougalii	Macdougal's bluebells	O	F1	Montaine willow riparian forest	H	MH	MH	MH
				Ponderosa pine	H	MH	H	H
Myosurus nitidus	Western mousetail	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
				Seasonally wet ground	H	H	H	H
Nuphar lutea	Pond lily	O	F1	Water	H	H	H	H
Pediocactus paradinei	Paradine Plains cactus	S	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Sagebrush shrubland	MH	MH	MH	MH
				Limestone	MH	MH	MH	MH
Pediocactus peeblesianus var. *fickeiseniae*	Fickeisen Plains cactus	F	F1	Desert communities	VH	VH	VH	VH
				Limestone	MH	MH	MH	MH
Penstemon caespitosus var. *desertipicti*	Mat penstemon	O	F2	Pinyon-juniper woodland	M	M	M	M
Penstemon laevis	Southwestern beardtongue	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
Penstemon nudiflorus	Flagstaff beardtongue	S	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
				Basalt soils	MH	MH	MH	MH
Penstemon pseudoputus	Kaibab beardtongue	O	F2	Ponderosa pine	MH	M	MH	MH
				Montaine subalpine grassland	MH	M	M	M
Perityle congesta	Compacted rock daisy	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
				Limestone	MH	MH	MH	MH
				Cliffs and ledges	MH	MH	MH	MH
Perityle gracilis	Grass-like rockdaisy	O	F?	Pinyon-juniper woodland	MH	MH	MH	MH

Scientific Name	Common Name	Status	F Rank	Habitat Element/Feature	Viability Risk by Alternative			
					A	B	C	D
Phemeranthus validulus =Talinum validulum	Western flame-flower	O	F2	Pinyon-juniper woodland	M	M	M	M
				Ponderosa pine	MH	M	MH	MH
				Seasonally wet	MH	MH	MH	MH
				Limestone soils	M	M	M	M
Phlox amabilis	Arizona phlox	S	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
				Limestone soils	MH	MH	MH	MH
Potentilla crinita var. *lemmonii*	Bearded cinquefoil	O	F2	Ponderosa pine	MH	M	MH	MH
Ranunculus oreogenes	Oregon buttercup	O	F1	Ponderosa pine	H	MH	H	H
Rosa stellata ssp. *abyssa*	Grand Canyon rose	S	F1	Pinyon-juniper woodland	MH	MH	MH	MH
				Sagebrush shrubland	MH	MH	MH	MH
				Limestone	MH	MH	MH	MH
				Cliffs and ledges	MH	MH	MH	MH
Salix bebbiana	Bebb's willow	O	F1	Wetland/Cienega	VH	VH	VH	VH
Shepherdia rotundifolia	Roundleaf buffaloberry	O	F1	Pinyon-juniper woodland	MH	MH	MH	MH
Sporobolus interruptus	Black dropseed	O	F1	Montane subalpine grassland	H	MH	MH	MH
				Ponderosa pine	H	MH	H	H
Stachys rothrockii	Rothrock's hedge-nettle	O	F?	Pinyon-juniper woodland	MH	MH	MH	MH
				Ponderosa pine	H	MH	H	H
				Sandstone	MH	MH	MH	MH
Triteleia lemmoniae	Oak Creek Triteleia	O	F?	Ponderosa pine	H	MH	H	H
				Wet soils	H	H	H	H

Table 23 shows that alternative B would provide habitat improvement for 34 habitat relationships, almost three times as many as would alternatives C and D. No alternative would provide optimal protection and management for all occurrences to habitat relationships that were ranked as VH, H and MH. However, all the other species except one which is affected by external factors, would have habitat abundance and distribution maintained. No species would suffer a decline in habitat abundance and distribution resulting from management under any of the alternatives. Alternative A would not provide improvement of habitat, but habitat abundance and distribution would be maintained.

Table 24 summarizes species with a high rating and their associated status by each planning alternative. The species status highlights the relative role of other provisions included in law and

policy that result in additional consideration for at-risk species during planning. Only the highest rating for each species for each alternative is shown.

Table 23. Number of plant species/habitat relationships rated as very high, high, and moderately high risk to viability for each category of management effect by forest plan revision alternative

Management Effect/Risk	Alternatives			
	A	B	C	D
1. Provide Optimal Protection and Management for All Habitat Occurrences				
Very High	0	0	0	0
High	0	0	0	0
Moderately High	0	0	0	0
Total	0	0	0	0
2. Improve Habitat Abundance and Distribution Through Restoration				
Very High	0	1	1	1
High	0	5	5	5
Moderately High	0	28	7	7
Total	0	34	13	13
3. Maintain Habitat Abundance and Distribution				
Very High	3	2	2	2
High	49	15	36	36
Moderately High	48	42	46	46
Total	100	59	84	84
4. Reduce Habitat Abundance and Distribution as a Result of External Factors				
Very High	0	0	0	0
High	1	1	1	1
Moderately High	0	0	0	0
Total	1	1	1	1
5. Decline in Habitat Abundance and Distribution as a Result of Management				
Very High	0	0	0	0
High	0	0	0	0
Moderately High	0	0	0	0
Total	0	0	0	0
Total for All Management Effect Categories				
Very High	3	3	3	3
High	50	21	42	42
Moderately High	48	70	53	53
Total	101	94	98	98

Table 24. Number of plant species rated as very high, high, and moderately high risk to viability for each category of species status, by forest plan revision alternative

Management Effect/Risk	Alternatives			
	A	B	C	D
Federal Listed Species				
Very High	1	1	1	1
High	0	0	0	0
Moderately High	0	0	0	0
Total	1	1	1	1
Regional Forester's Sensitive Species				
Very High	0	0	0	0
High	10	2	5	5
Moderately High	4	13	9	9
Total	14	15	14	14
Rare and Endemic Species				
Very High	2	2	2	2
High	24	8	22	22
Moderately High	10	20	10	10
Total	36	30	34	34
Total for All Management Effect Categories				
Very High	3	3	3	3
High	33	10	27	27
Moderately High	14	33	19	19
Total	50	46	49	49

There are 50 forest plan analysis plant species that have at least one habitat element with one of the three high rankings to viability risk. The other three forest plan analysis plant species had risk ratings of low to moderate and are not shown in the table. Forest plan analysis species have lower risk ratings under alternative B, than under action alternatives C and D and no action alternative A.

Environmental Consequences for Botanical Resources Common to All Alternatives

Planning for, and evaluation of, plant species viability for forest plan revision has focused primarily on providing desired abundance and distribution of habitat elements, in compliance with NFMA regulations. Risks to species viability can be much further reduced by additional provisions present in existing law, regulation and policy. These include specific consideration of effects to federally listed threatened and endangered species, those proposed for such listing, and regional forester's sensitive species. These effects are disclosed in biological assessments and

evaluations conducted as part of all national forest management decisions. These assessments and evaluations identify where additional protective measures are warranted to provide for continued existence of the species on national forest land. Projects that may affect federally listed or proposed species must be coordinated with the USFWS.

In support of these requirements, these species are often the focus of inventory and monitoring efforts. Additional species-based provisions included in all forest plan revision alternatives supplement existing law and policy. Many of the high risk species will be conserved through rare community requirements included in this forest plan, as well as through forestwide objectives related to forest health and community restoration. All alternatives would continue to manage the Arizona Bugbane and Paradine Plains Cactus Botanical Areas to prevent further listing of that species.

Five habitat elements emerged as having a high likelihood of being a limiting factor for all alternatives. These include desert communities, Gambel oak shrublands, wetland/cienega, riparian forest, and cottonwood-willow riparian forest. All of these habitat elements naturally occur on less than 1 percent of the landscape across the Kaibab NF. It is not the forest intent to make these naturally rare habitat features more common than they were historically. For most of the species listed in table 22, their habitat elements may be common on the Kaibab NF, but the species are naturally limited in abundance or distribution due to micro-habitat needs. For these species, it is not the intent of the forest to increase their populations outside of areas they would naturally occur.

There would be continued treatment of noxious and/or nonnative invasive plants under all alternatives. Recreation, livestock grazing, special uses, mining and minerals development, and energy development would continue to occur under all alternatives. These actions would follow manual and handbook policy and direction. Livestock grazing under all alternatives would provide for continued availability of forage for domestic livestock. Operating instructions for livestock grazing permittees are reviewed annually. Because an adaptive management strategy is used to adjust use with capacity and minimize any adverse effects, the consequences associated with continued grazing use is minimal (see Grazing Section of this chapter).

In addition to following existing law, regulation, and policy as mentioned above, projects would implement (BMPs) (FSM2530.2) and other mitigation measures designed to protect soils and watershed resources. BMPs and soil and water conservation practices (SWCPs) (FSH 2509.22 R3, FS-990a) have been designed to mitigate ground disturbance from forest mechanical treatments and these practices would help to mitigate any potentially negative impacts and would provide for viability of botanical resources affected by large-scale disturbance. See the Soils and Watershed section for additional information.

The Grand Canyon Game Preserve, which occurs on portions of the North Kaibab Ranger District, was established by presidential proclamation. No mining or minerals development is allowed in that area as a result of this designation. This would afford some protection from threats associated with mining activity for those species which occur in that area, including Fickeisen plains cactus and Paradine Plains cactus.

There are also limited threats to the Fickeisen plains cactus from livestock or bison grazing. The South Canyon population is located in an area where this is no authorized livestock grazing and there is no evidence of bison grazing within this area.

Environmental Consequences for Botanical Resources for Alternative A – Current Plan, Current Management (No Action)

Alternative A has the greatest number of species with risk to viability from each category of management effect (50 total) that rate out in a very high (3), high (33), or moderate high (14) viability risk rating (table 24).

If alternative A is selected, there would be no change in management actions on the Kaibab NF. The current forest plan was approved in 1988, and has been amended several times. Many of the rare plant species that were identified in the plan in 1988 are no longer considered rare, due to new information that has been gained from floristic surveys or project-specific surveys. The current Region 3 Sensitive Species List (USDA Forest Service 2013) is used for surveys and input to projects. Information on other rare plant species, such as the analysis species used in the current planning process, would not be gathered under alternative A.

Alternative A would continue to address uses and resources separately without recognition of interrelationships. Management direction would be lacking when guidance is needed to deal with more complex situations such as those arising after uncharacteristic wildfires. Several rare plants occur in areas that have been affected by wildfires, such as the Warm Fire. In the current forest plan, desired conditions are missing for land management areas and are either missing or inadequate at guiding projects in many of the forest's vegetation types and special areas. The current plan does not integrate desired disturbance processes and is typically written in terms of standards and guidelines, rather than desirable conditions to move toward.

The current plan does not acknowledge or attempt to address climate change. It fails to emphasize the restoration of natural ecological processes and ecosystems that will be resilient to such change. Related to climate change is an increased likelihood for large-scale disturbance events (e.g., bark beetle outbreaks, widespread uncharacteristic fire, and drought). The current plan offers little direction for management activities and botanical resources associated with large-scale disturbance, but would continue to provide for plant species viability in the ways mentioned in the Environmental Consequences Common to All Action Alternatives section.

Under alternative A, objectives would continue to be focused on outputs, rather than progress toward desired conditions. The priority needs for change have been identified as: modifying stand structure and density toward reference conditions and restoring historic fire regimes; protecting and regenerating aspen; protecting natural waters; and restoring grasslands and meadows. These priorities are important for ensuring viability of many rare plant species and would not be met under alternative A. Many rare plant species occur in vegetation types that lack characteristic fire disturbance. Aspen regeneration is a concern for species associated with the mesic mixed conifer vegetation type. The current forest plan offers little guidance for managing springs and ephemeral wetlands, which are rare and ecologically important resources. Actions to protect natural waters are relatively inexpensive and easy to accomplish, provide important benefits, and have a high concordance with social and economic needs.

Standards and guidelines under alternative A would not support attaining desired conditions or accomplishing objectives. The standards and guidelines are often very prescriptive about how to accomplish a project instead of focusing on the project outcome and read as more of a "one size

fits all approach," leaving little management flexibility with regard to variation among site-specific conditions and limited ability to respond to emerging threats such as climate change. The standards and guidelines under alternative A provide minimal guidance for mineral exploration and development, a potential threat to Fickeisen Plains cactus, (Federally endangered species), as well as other rare plant taxa (e.g., Utah century plant, Utah agave, and Grand Canyon rose).

In alternative A, standards and guidelines are based on outdated science and information about rare plant species. Much has been learned over the past 23 years and methods of communication via computers and internet have made much more information (such as plant locations and habitat data through SEINet) readily available for use. Retention of current standards and guidelines under alternative A might result in conflicts with direction currently in Forest Service handbooks and manuals, and strategies for conserving plant species such as Arizona bugbane and Paradine Plains cactus.

Monitoring under alternative A focuses on outputs, rather than effectiveness and progress toward desired conditions.

The current plan has very few standards or guidelines that relate directly to features needed by sensitive species that depend on grasslands, meadows, shrublands, desert communities, caves and mines, rocky outcrops, or cliffs and canyons. These species and features are indirectly affected by standards and guidelines for recreational uses and mineral development. Their main protection is the requirements to protect sensitive species which are addressed outside the plan. Recreation, livestock grazing, special uses, mining and minerals development, and energy development would continue to occur under alternative A. In addition, alternative A does not have the guidelines (present for alternatives B, C and D) that "project design should incorporate measures to protect and provide for rare and narrow endemic species where they are likely to occur."

The current plan would continue to address invasive species through a forestwide standard that "incorporates measures to control invasive species into project planning, implementation and monitoring." In addition, a guideline which incorporates "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 NF s within Coconino, Gila, Mohave, and Yavapai Counties, Arizona" (USDA Forest Service 2005) would further help to mitigate the threat posed by invasive plants.

Environmental Consequences for Botanical Resources Common to Action Alternatives B, C, and D

The organization of the proposed plan and alternatives is better integrated across resource areas than the current forest plan (alternative A). Since monitoring is needed that supports adaptive management, focusing on outcomes and progress toward desired conditions rather than outputs, this aspect of the action alternatives is a particularly positive benefit for the forest plan analysis plant species. Specifically, the monitoring plan addresses botanical resources through the following questions:

- Natural waters: In treated/protected areas, are water flow patterns and vegetation intact?
- Threatened and Endangered species: What is the population trend of *Pediocactus peeblesianus* var. *fickeisenii*?

- Pediocactus Conservation Area: Were the monitoring requirements met as identified in the Pediocactus conservation agreement?
- Arizona Bugbane Botanical Area: Were the monitoring requirements met as identified in the Arizona bugbane conservation agreement?
- Nonnative Invasive Species: What is the areal extent of priority nonnative invasive plants on the Kaibab NF?

The action alternatives articulate clear desired conditions for habitats and refugia for narrow endemics or species with restricted distributions and/or declining populations, including desired conditions that locations and conditions of rare and narrow endemic species are known, and habitat and refugia are present for narrow endemics or species with restricted distributions and/or declining populations. There is also a guideline: “Project design should incorporate protective measures to provide for rare and narrow endemic species where they are likely to occur.” These desired conditions and guideline provide more direction under all the action alternatives for the 33 rare and endemic plant species being carried forward as forest planning species than does the current plan (no action alternative A) and will help to insure the viability of these species. Existing management areas such as the Arizona Bugbane Botanical Area and the proposed Pediocactus Conservation Area, as well as the conservation agreements for Paradine plains cactus and Arizona bugbane, provide for management and guidance for these rare endemic plants.

Bill Williams Mountain has been identified as a Management Area because it contains multiple resources and uses of high natural, cultural, and economic value. The establishment of the Bill Williams Mountain LMA would provide guidance over a wider area surrounding the Arizona Bugbane Botanical Area by establishing desired conditions that provide quality habitat for Arizona bugbane, guidelines that restrict commercial plant collection, and restrictions on the existing term permit for the Elk Ridge Ski Area.

Desired conditions also specify that threatened, endangered, and sensitive species have quality habitat, stable or increasing populations, and are at low risk for extirpation. Project activities and special uses would be designed and implemented to maintain refugia and critical life cycle needs of Forest Service sensitive species. Guidelines reinforce desired conditions by stating that project activities and special uses occurring within federally listed species habitat should integrate habitat management objectives and species protection measures from approved recovery plans.

Modifying stand structure and density toward reference conditions and restoration of historic fire regimes would enhance habitats of rare plant species. There are 29 forest plan analysis plant species that reside in the pinyon-juniper woodlands, and 25 forest plan analysis plant taxa grow in the ponderosa pine forest.

Desired conditions for the pinyon-juniper woodlands that provide for composition, structure and function of the vegetative conditions resilient to the frequency, extent, and severity of disturbances would be important to plant species such as Paradine Plains cactus, disturbed rabbitbrush, cliff milkvetch, Kaibab beardtongue, and western flameflower, species are currently affected by changes and threats to the pinyon-juniper woodlands. Even the rare Paradine Plains cactus is able to withstand moderate fire.

Studies of several forest planning species of the ponderosa pine forest, Rusby milkvetch (Springer et al., in press), Flagstaff pennyroyal (Phillips et al. 1992), and hairy clematis (Maschinski et al.

1997) have shown that these species respond favorably to treatments that open the ponderosa pine forests and restore more natural fire return intervals.

Field observations of other rare plant species such as Flagstaff beardtongue indicate positive responses to fire. Under the group selection matrix thinning, multi-storied, uneven-aged states are created more effectively (see Vegetation, Fuels and Fire section of this chapter). Since these states are more like the desired condition for the ponderosa pine PNVT, the habitats of many of the rare and endemic plant species that evolved under more open forests with frequent low-intensity ground fires would be enhanced under this alternative.

All the alternatives have emphasizes for aspen regeneration to insure long-term healthy aspen populations and to provide local habitat diversity and scenery. This would be particularly favorable in the long term to several plant species: Arizona bugbane, columbine, Rusby milkvetch, and mountain whitlow-grass. On the Williams Ranger District, where the Arizona Bugbane Botanical Area occurs on Bill Williams Mountain, there has been very little successful regeneration of aspen. Aspen trees die after severe frost events weaken them, leaving them susceptible to infestations of secondary agents including cytospora canker, bronze poplar borer, and other canker fungi and insects (Fairweather 2006, personal communication). However, some negative short-term impacts could result during project implementation such as trampling and crushing associated with implementation of fencing and conifer reduction projects.

Kaibab Indian paintbrush, Kaibab bladderpod, and Mt. Dellenbaugh sandwort are three Forest Service sensitive plant species in the subalpine meadows of the North Kaibab Ranger District. The preferred alternative's priority need for change aimed at restoring historic meadows by reducing tree encroachment and restoring fire could be beneficial to forest plan analysis plant species in this vegetation type. The subalpine meadows are likely to be affected by climate change since they are a relict vegetation type from cooler wetter Pleistocene Ice Ages. Improving the extent and quality of the habitat to allow native species to occur in natural patterns of abundance, composition and distribution, with maintenance and improvement of water infiltration, nutrient cycling, and soil productivity, would be beneficial to these species. The management approach of diffusing grazing pressure from elk and livestock will enhance the rare endemic plant species in these vegetation communities as well. The guideline, "Heavy equipment and log decks should not be staged in montane meadows," will protect the habitat of the above species as well as Tusayan flameflower, a forest plan analysis species that is present in montane meadows, but difficult to locate during much of the year due to its small stature and cryptic nature.

Uncharacteristic fire is also a threat to the habitat of Arizona bugbane in the botanical area due to very little successful regeneration of the aspen and dying off of large old-growth conifers. Aspen trees die off after severe frost events weaken them. This is followed by infestations of secondary infectious agents including cytospora canker, bronze poplar borer, and other canker fungi and insects (Fairweather 2006, personal communication). An objective for the Bill Williams Mountain LMA is to implement a fuels reduction project within 5 years of plan approval. Arizona bugbane has shown resilience to moderate fire and responds favorably to the resulting increase in nitrogen, bare soil, and opening of the forest canopy for regeneration (Phillips and Crisp 2010).

The establishment of the Pediocactus Conservation Area would aid in the management of Paradine Plains cactus by providing plan direction for the area encompassing this rare cactus. Paradine Plains cactus is managed under a conservation assessment and strategy developed by the

Forest Service, Bureau of Land Management, and U.S. Fish and Wildlife Service (USDA et al. 1997). Paradine Plains cactus is very small, occurs in colonies and withdraws underground during dry conditions, making it extremely difficult to locate during much of the year. Evaluating potential ground-disturbing activities in the Pediocactus Conservation Area and implementing protective measures as needed would help protect the species. Restricting motorized access would reduce impacts from vehicles and the associated uses of the area by people (campsites, social trails, etc.) on the plants and habitat. Cheatgrass is an on-going threat to the Paradine Plains cactus and its habitat because this nonnative annual grass changes the fire return interval to more frequent than would occur under natural conditions. High-severity fires are lethal to Paradine Plains cactus, as the Warm Fire has shown. Treating invasive nonnative plants would reduce direct competition with invasive plants and reduce the potential of the indirect effects of fire mortality and alteration of plant species and the cactus' colonizing soil mycorrhizae, which are essential for the health of the plants. Since plant collection is a serious threat to Paradine Plains cactus, de-emphasizing the species in forest literature would be helpful.

Recreation, livestock grazing, special uses, mining and minerals development, and energy development would continue to occur under all alternatives. However, the action alternatives (B, C, and D) have the guideline that project design should incorporate protective measures to provide for protection of rare and narrow endemic plant species where they are likely to occur, and that "project activities and special uses should be designed and implemented to maintain refugia and critical life cycle needs of Forest Service Sensitive Species." These guidelines would help maintain species viability from Kaibab NF management activities.

Guidelines for minerals and mining also specify that surface use should be restricted or prohibited in areas with habitat for threatened, endangered, and sensitive plant and animal species and use and occupancy should be restricted yearlong in areas supporting populations of threatened, endangered, and sensitive plant species. In addition, guidelines for cliffs and rocky features specify that "where recreation activities have the potential to trample known populations of narrow and endemic plant species, signs should be posted educating the public to stay on designated trails and avoid impacts," and "talus slopes should be surveyed for endemic species prior to authorizing quarrying, rock hounding, or construction activities that may alter them." These guidelines would benefit species such as Grand Canyon rose, cliff fleabane, and numerous other rare and narrow endemic species. This specificity is lacking under the current plan (alternative A).

The expected relative significance of the implementation of the action alternatives plan decisions within the context of the greater landscape would be a slight increase in available forage with minimal consequences to other resources (see Livestock Grazing section of this chapter). Thus, some rare and endemic plants, such as disturbed rabbitbrush and the subalpine meadow species that incur grazing pressures would benefit under the action alternatives.

Uncharacteristic wildfire and the associated threat of competition from nonnative invasive species, is a threat to some species, especially those in desert communities. Under the action alternatives, guidelines under Wildland Fire Management help to mitigate this threat: "Actively growing wildfires in the Desert Community vegetation type in Kanab Creek Wilderness should be suppressed," and a forestwide guideline to "Evaluate the risk of cheatgrass invasion. When there is a moderate to high risk of cheatgrass invasion, mitigation measures should be developed. If adequate treatments are not available, or if they are cost-prohibitive, objectives to minimize the burned area should be developed." These guidelines provide stronger and more specific plan

direction emphasizing wildfire and cheatgrass invasion than the current plan (alternative A) and would benefit numerous species including Fickeisen plains cactus.

Under the action alternatives, there is more explicit plan direction to address invasive species, than under alternative A. There is an objective to treat 2,000 to 3,000 invaded acres annually. Forestwide guidelines further specify that all ground-disturbing projects should assess the risk of noxious weed invasion and incorporate measures to minimize the potential for the spread of noxious and invasive species. New populations should be detected early, monitored, and treated as soon as possible, and treatment approaches should use integrated pest management (IPM) practices to treat noxious and nonnative invasive species. IPM includes manual, biological, mechanical, and herbicide/pesticide treatments.

Under the action alternatives, there is more explicit plan direction to address the bison herd on the North Kaibab Ranger District. Guidelines specify that the bison herd should be managed so it is concentrated within the House Rock Wildlife Management Area, and that active management should be used to minimize impacts from bison to sensitive resources, particularly outside the House Rock Wildlife Management Area. Management of the bison herd under these guidelines will reduce potential damage to sensitive plant species and habitats caused by the bison, and decrease the spread of nonnative invasive species.

The action alternatives acknowledge and better address climate change than the current plan (alternative A) by providing for resilient ecosystems that will be better able to withstand large-scale disturbance events such as drought and uncharacteristic fire. These disturbances have the ability to affect numerous ecosystems and plant habitat. Some forest management activities that would respond to such events like salvage logging could have negative direct (e.g., incidental crushing and trampling of plants) as well as indirect effects on plants (e.g., impacts to soil hydrologic function, soil stability, and nutrient cycling, as well as an increase in nonnative invasive plant competitors) resulting from ground disturbance through mechanical harvest and restoration treatments

During management activities that respond to large-scale disturbance events, the forest would mitigate threats for listed, sensitive and rare and narrow endemic plant species through the specific plan components that follow below, and also through appropriate BMPs and SWCPs as mentioned in the Environmental Consequences Common to All Alternatives section. Alternatives B, C, and D include a forestwide strategy with specific guidelines and objectives to address management activities and large-scale disturbances in forest and woodland communities. Specific guidelines that would provide for plant viability include: Recovery and restoration project design should seek to establish a trajectory toward the desired conditions for the affected vegetation type; erosion control measures should be implemented to protect significant resource values and infrastructure such as stream channels, roads, structures, and archaeological or historic sites; practices that restore nutrient cycling and stabilize soils (revegetation, mulching, lop and scatter, etc.) should be implemented; some snags and coarse woody debris should be retained to provide for wildlife habitat, soil stabilization, and other resource benefits; and project design should incorporate measures to protect regeneration and reforestation investments.

The guidelines for large-scale disturbance are in addition to existing law, regulation and policy and relevant plan direction (e.g., desired conditions for the respective vegetation types, guidelines for vegetation management in forested communities, guidelines for rare and narrow endemics, guidelines and objectives for nonnative invasive species etc.).

Wetlands, including perennial waters and ephemeral waters have desired conditions to support healthy native plant species with an objective to restore native vegetation and natural water flow patterns on at least six acres of wetlands within five years of plan approval. Similarly, natural waters which include perennial and ephemeral springs have desired conditions to maintain self-sustaining plant species that occur in natural patterns of abundance and distribution, unwanted nonnative species do not exert a detectable impact on aquatic and wetland ecosystems, hydrophytes and emergent vegetation exist in patterns of natural abundance in wetlands and springs in levels that reflect climatic conditions, and overhanging vegetation and floating plants such as water lilies exist where they naturally occur. Objectives for natural waters include the protection and restoration of at least 10 individual springs within five years of plan approval. These plan components would support plants that used these habitats including Bebb's willow, pond lily, columbine, and western flameflower.

Finally, a management approach under all the action alternatives is to provide species-specific information and management recommendations in a Kaibab NF endemic plant species guidebook that will be maintained as a living document, updated with new information and locations as they become available. This guidebook will provide in one document a substantial amount of information on the species and its population biology, ecology, habitats, locations, and threats and effects of management actions. It will also provide management actions and opportunities which will be useful for project planning and implementation for all resource specialists.

Environmental Consequences for Botanical Resources: Alternative B – Preferred Alternative

Alternative B has the lowest number of species with risk to viability from each category of management effect (46 total) that rate out in a very high (3), high (10), or moderate high (33) viability risk rating (table 24). Alternative B is the preferred alternative.

Desired conditions are based on the best scientific information available that describes reference conditions for the different vegetation types of ponderosa pine, mixed conifer, and woodlands and savannas. Alternative B is the alternative that would set these vegetation types on a trajectory that would be most likely to achieve reference conditions. Restoring habitat elements to reference conditions or at least toward reference conditions should provide for viable species populations for those species that evolved within these systems.

Two of the current four Kaibab NF wilderness areas, Kanab Creek Wilderness and Saddle Mountain Wilderness, have proposed wilderness additions under the preferred alternative. Some rare endemic plants are known to occur or to have potential habitat along the rims of Kanab Canyon. Designating these lands as wilderness could afford the rare and endemic plants that occur within those areas additional protection from disturbances. The area of the Cockscomb that is proposed to be added to the Saddle Mountain Wilderness has not had a thorough floristic inventory. This area may have potential habitat for endemic plants. As lands are designated as wilderness, they would become closed to any new mineral leases and new mineral materials pits. As the existing materials pits within the recommended wilderness areas become depleted or are no longer needed, they would be closed. These actions would enhance protection for rare and endemic plant species and reduce the risk of nonnative noxious and/or invasive plant invasions. However, limited ability to access the wilderness areas could result in more difficulties controlling invasive plants that coincide with rare plant habitats in those areas.

According to the Nonnative Invasive Species Specialist Report (KNF 2013b), alternative B is the most beneficial for preventing and controlling invasive species. The preferred alternative proposes the highest amount of vegetation treatments and planned disturbance out of the four alternatives, thereby creating the highest risk of the spread/introduction of invasive species However, it also generates the highest potential for long-term native understory enhancement. This, in turn, increases the ability of native species to out-compete invasive species over the long term, and further decreases susceptibility to uncharacteristic fire.

Rare and sensitive species may be especially vulnerable to climate change under all alternatives because they often need specific habitat components that are not widely available. The North Kaibab subalpine meadows may become vulnerable as elevational vegetation shifts occur (USDA Forest Service 2010). Future plant distributions in general may be governed by several factors including human influences, abilities of plants to disperse, and the presence of suitable habitat components including such factors as suitable soil types and presence of pollinators (McKenney et al. 2007). Large changes in ecosystem structure and species composition of plant communities are expected due to increasing temperatures and altered precipitation cycles (USDA Forest Service 2010). The specific effects of the factors of climate change on local plant communities and forest plan analysis plants growing in them are not known; however, the beneficial effects of alternatives B, C, and D would slightly counteract the larger effects of global climate change by reducing the vulnerability of sensitive plant populations to additional disturbance. Guidance under alternative B does the best job of addressing climate change by managing for ecosystems which will be resilient to change, and allowing for more site-specific management flexibility. This will allow the forest to better cope with, and adapt to, the changing needs of rare plants and their associated habitats.

Environmental Consequences for Botanical Resources: Alternative C

Alternative C and D have more species at risk from management than alternative B (preferred alternative), but less than alternative A (no action alternative) with 49 total that rate out in a very high (3), high (27), or moderate high (19) viability risk rating (table 24).

The North Kaibab Wildlife Habitat Complex is an area on the North Kaibab Ranger District of approximately 265,000 acres proposed under alternative C. This LMA contains the Kaibab Squirrel National Natural Landmark and eight linked ephemeral riparian valleys and canyons. This LMA would include approximately half of the Pediocactus Conservation Area (the portion north of Highway 89 A and west of the East Side Game Road). In this management area, once forest structure is restored, it would primarily be maintained with fire so there would be less area in the vegetative desired condition than under alternative B, and there would be a greater risk of density-dependent uncharacteristic disturbance, such as active crown fire (see Vegetation, Fuels and Fire section of this chapter). This trend away from the desired condition for the ponderosa pine PNVT would be less desirable for many of the rare and endemic plant species that evolved under more open multistoried, uneven-aged forests with frequent low-intensity ground fires. This is reflected in table 22 whereby rare plants in the Ponderosa Pine PNVT show a lower viability risk under alternative B than under alternatives C and D; and in table 23 where the species in the ponderosa pine PNVT under alternative B show moderately high habitat improvement of habitat abundance and distribution through restoration, whereas those species have only habitat abundance and distribution maintained under alternatives C and D. According to the effects of vegetation modeling, the matrix thinning is more effective at creating multistoried, uneven-aged

states than treatments with an imposed diameter cap (alternatives C and D) (see Vegetation, Fuels and Fire section of this chapter).

In addition to the recommended wilderness additions to the Kanab Creek and Saddle Mountain Wildernesses in the preferred alternative (B), alternative C proposes six new wilderness areas: Burro Canyon, Coconino Rim, Big Ridge, Seegmiller, South Canyon Point, and Willis Canyon. This alternative also contains an area (approximately 1,000 acres) contiguous to a potential wilderness addition to the Sycamore Wilderness on the Prescott National Forest's recommended wilderness areas. Flagstaff pennyroyal and cliff fleabane are known within the current boundaries of the Sycamore Wilderness and Flagstaff beardtongue occurs on top of the rims. Expansion of the boundaries on both the Kaibab and the Prescott NF s might include more habitat for these Forest Service sensitive plant species. The wilderness areas proposed for the North Kaibab Ranger District could result in additional protections for Fickeisen plains cactus and perhaps other forest plan analysis plant species such as Utah century plant, and Hevron's milkvetch. However, limiting ways to access the wilderness areas, and ability to use certain equipment, could result in more difficulties controlling invasive plants in rare plant habitats.

Environmental Consequences for Botanical Resources: Alternative D

Alternative D was developed in response to the issue that "the effects associated with regular mechanical disturbance outweighs the benefits. Restoring the natural fire regime to forested landscapes provides greater overall benefit to ecosystems, communities, and economies."

Alternative D is similar to alternative C, except that the guideline "Following restoration, the desired conditions should be maintained by restoring the natural fire regime" would apply to the entire forest and no new management area would be established. This alternative would also include the same proposed wilderness areas and tree retention guideline as alternative C, with the same benefits and risks.

Comparison of Alternatives for Botanical Resources

The preferred alternative, alternative B, would provide habitat improvement for 34 habitat relationships, almost three times as many as would alternatives C and D. Table 24 shows that the species in the ponderosa pine PNVT would exhibit moderately high improvement of habitat abundance and distribution through restoration under alternative B, whereas those species have only maintenance of habitat abundance and distribution under alternatives C and D. Rare plants in the ponderosa pine PNVT show a lower viability risk under alternative B than under alternatives C and D (table 23) because once forest structure is restored under alternatives C and D, it would primarily be maintained with fire, so there would be less area in the vegetative desired condition than under alternative B, and there would be a greater risk of density-dependent uncharacteristic disturbance, such as active crown fire (see Vegetation and Fire section of this chapter). This trend away from the desired condition for the ponderosa pine PNVT would be less desirable for many of the rare and endemic plant species that evolved under more open forests with frequent low-intensity ground fires.

All the other species except one would have habitat abundance and distribution maintained. Alternative A would not provide improvement of habitat, but habitat abundance and distribution would be maintained. In addition to the desired conditions and standards and guidelines

developed for many different resource values, the action alternatives establishes desired conditions for habitats and refugia for narrow endemics or species with restricted distributions and/or declining populations, and establishes a desired condition that locations and conditions of rare and narrow endemic species are known. The guideline that "Project design should incorporate measures to protect and provide for rare and narrow endemic species where they occur," would facilitate attainment of these desired conditions. These desired conditions and guidelines provide more direction for the 33 rare and endemic forest planning species than does the current plan (no action, alternative A). Other provisions included in law and policy result in additional considerations for at-risk species during planning.

Existing management areas such as the Arizona Bugbane Botanical Area and the proposed Pediocactus Conservation Area, as well as the conservation agreements for Paradine Plains cactus and Arizona bugbane, provide for management and guidance for those rare endemic plants. In addition, Bill Williams Mountain (which encompasses the Arizona Bugbane Botanical Area) has been identified as a management area under all action alternatives. The recommendation of Garland Prairie for formal designation as a research natural area under alternative A was never formalized. Since its original recommendation, this vegetation type has become well represented in the national network of field ecological research natural areas, and as a result, there is a low need. This 340-acre area on the Williams Ranger District, which is typical of the high-elevation grassland ecotone dominated by Arizona fescue and mountain muhly, has been excluded from grazing since about 1989. Under alternatives B, C, and D, this area would be maintained as a natural area, but as a management area in the plan and would no longer be recommended for formal designation.

The Endangered Species Act (1973) provides guidance for managing and conserving threatened or endangered species. Management actions adversely affecting these species require consultation and coordination with the Fish and Wildlife Service. There is one plant species protected under the Endangered Species Act on the Kaibab NF, Fickeisen Plains cactus, which is a listed species. The action alternatives would have the same impacts to the federally listed and sensitive species except for those species that depend upon ponderosa pine and frequent fire mixed conifer forest. The guideline for presettlement tree retention, the differing amounts of land managed for timber production, and lands recommended for wilderness are the substantive differences between alternative B and alternatives C and D. The presettlement tree retention guideline under alternatives C and D would affect all vegetation management activities associated with ponderosa pine, frequent fire mixed conifer, woodlands, and savannas. This guideline has the potential in areas that currently contain a high number of large trees to inadequately provide for the desired level of tree groups and openness within conifer stands. This guideline could also affect restoration of savanna and woodland habitat by retaining higher densities of conifer trees than would naturally occur in these areas, putting these systems at greater risk of density-dependent uncharacteristic disturbance, such as active crown fire.

Cumulative Environmental Consequences for Botanical Resources

The cumulative effects area considered in this analysis includes lands managed by National Park Service (Grand Canyon National Park); State of Arizona; BLM; the Coconino and Prescott National Forests; the Navajo, Hualapai, Kaibab Band of Paiutes, and Havasupai Tribes; and private landowners. These areas contain populations and/or habitat for these rare and endemic plant species. The timeframe for this cumulative effects analysis is 50 years—25 years in the past

and 25 years into the future. This timeframe would encompass the lifespan of most of the plants in current populations, provide reference to actions that have affected the habitat such that the current populations exist as they do, and management actions implemented under the preferred or other alternatives within 25 years in the future would show effects at the population level.

The Kaibab NF is located within three counties (Coconino, Mohave, and Yavapai) in Arizona, with the vast majority in Coconino County. Rare and endemic plants occur in the majority of these areas. Private lands within communities do not typically contain these plants because of drastic alteration of habitat. The Navajo, Hualapai, Kaibab Band of Paiutes, and Havasupai Tribal lands have some populations of rare and endemic plants. State lands are typically used for winter grazing of forest permitted livestock. The BLM has both year-round grazing and winter grazing.

There would be no indirect consequences for two of the rare and endemic plant species (Groundcover milkvetch and mat penstemon) addressed in this analysis (i.e., those forest plan analysis plant species with low to moderate risks, and those that occur in areas outside of those being treated under the action alternatives), so there would be no cumulative effects for these species under those alternatives.

The rare and endemic plant species programs for the Kaibab, Coconino, and Prescott NF s have the same general requirements since they are guided by the same relevant laws, regulations, and policies that apply to the management of Federal lands. The restrictions and limitations placed on the rare and endemic plant species would vary among the forests due to the various concerns or needs of the areas resource management. All three forests are in the process of forest plan revision and have worked cooperatively on gathering information assessing and evaluating the botanical resources, including the rare and endemic plant species, and they are revising their plans using the same concepts and processes. The Arizona Strip General Management Plan of 2007 (BLM portion of the plan; BLM 2008) has very similar guiding laws, regulations, and policies as the Forest Service. The Grand Canyon National Park has a general management plan approved in 1995, that provides programmatic guidance for the entire park (NPS 1995), and also a North Rim Development Plan (NPS 2006), and South Rim Visitor Transportation Plan (NPS 2008) that are broad scale in nature. The adjacent lands managed by these agencies contain known or potential habitat for many of the Kaibab NF forest plan analysis plant species. These cited documents provide guidance for these management areas regarding federally listed and candidate and rare and endemic plant species on lands immediately adjacent to the Kaibab NF. Overall, these plans on adjacent lands, combined with the desired conditions and standards and guidelines of the Kaibab and adjacent Coconino and Prescott NF s, provide for maintenance and enhancement of the habitats of the rare and endemic plant species of northern Arizona within the jurisdictions of the land management agencies.

There are several weed management areas that include the Kaibab NF and/or adjacent lands. These are the San Francisco Peaks Weed Management Area that includes the Williams and Tusayan Ranger Districts, the Yavapai Weed Management Area adjacent to the southwest corner of the Williams Ranger District, and the Arizona Strip Weed Management Area adjacent to and including the North Kaibab Ranger District. The general aims of these weed management areas are to facilitate communication among the members, and coordinate and implement weed treatments. Thus, the invasive species that are currently, or likely to become, of concern on the Kaibab NF are recognized over the broader landscape surrounding the forest. Actions taken in coordination throughout these weed management areas would enhance the effectiveness of efforts of the forest to control invasive plants on its own lands. The weed management areas have a

positive effect on the effectiveness of weed prevention and treatments. Because invasive plants can spread rapidly over lands regardless of jurisdiction, the most effective way to prevent infestations is by prevention, early detection, and rapid effective treatment response to small new infestations wherever they occur.

Because this plan provides proactive protections for rare and endemic plant species through desired conditions, objectives, standards, and guidelines, the results of this plan, when added to the ongoing decisions and activities in the greater landscape, are local positive cumulative effects for these species.

The cumulative environmental consequences to rare and endemic plant species addressed in this analysis would have similar effects to present management or have beneficial effects for most of the plant species.

Nonnative Invasive Plants

This section analyzes in detail the potential environmental consequences on the nonnative invasive species populations that may be affected under each of the four alternatives for revising the 1988 Kaibab NF land management plan. This analysis provides information for considering the potential effects of existing known populations to management activities and possible threats of new infestations that could be created by management activities under each of the alternatives. Additional information can be found in the Nonnative Invasive Species Specialist Report (KNF 2013b).

Invasive species can displace native vegetation and aggressively dominant a site. If an infestation is left uncontrolled, the ecosystem function can be altered. Vegetation treatments using mechanical methods can create disturbance that can allow for an increase for invasive species. While some studies indicate that the level of disturbance can be lower than what is found with light to moderate burning, mechanical treatments can result in ground disturbance.

Roads serve as vectors[1] for new infestations. Forest visitors can bring in weed seed from vehicles or recreational equipment. The continual disturbance of vehicles pulling off the roads and road repairs can leave vegetation displaced and create high potential for new infestations that are imported by forest visitors.

Other vectors that can transport seed include livestock, recreation activities, wildlife, wind, and moisture events. Livestock and wildlife can transport seed by tracking mud on their feet or hooves, in hair, or by eating species containing seed that is not fully digested. Some seed is designed to easily be transported by wind. Almost all seed can be distributed by flowing water.

Once nonnative invasive species become established, it usually takes years to eradicate the population. A musk thistle seed can survive and be viable for germination up to 15 years. One healthy musk thistle plant is capable of producing over 100,000 seeds in its life cycle (Beck 1999).

Cheatgrass is a winter annual grass species that germinates in the fall, winter, or spring. Cheatgrass plants produce many seeds, depending on the environment, spacing, and size of the

[1] Mechanisms for spread of nonnative invasive plants.

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 by clothing, animals, and vehicles. Cheatgrass is very successful at maximizing available moisture and nutrients from the upper layer of soil, and is capable of growing in years of drought and in poor soil conditions. Cheatgrass' ability to grow and produce seed before other species, high seed production, and the ability to grow in places other grass species cannot, allows this species to rapidly overtake a site.

A large cheatgrass infestation can alter ecosystem function. Dense, continuous cheatgrass can make fire ignition and spread more likely. In sagebrush-dominated systems, fire return intervals have gone from between 60 and 110 years to less than 5 years under cheatgrass dominance. With every reoccurring fire, cheatgrass can become more dominant and expand its range. With each successive disturbance event, cheatgrass' frequency continues to make it more difficult for native species to work back into the system.

Under the guidance of the Coconino, Kaibab, and Prescott NF s Integrated Treatment of Noxious or Invasive Weeds Environmental Impact Statement (USDA Forest Service 2005), the forest has multiple options to treat invasive species of concern. Identified invasive species are treated in the most efficient manner possible with the goal to contain, control, and eradicate each population. There are guidelines for authorized uses of different treatment methodologies, specific mitigation measures for special areas, and general best management practices.

Any chemical application must occur either by or under the supervision of applicators certified by the Arizona State Department of Agriculture. Federal hazardous material (HAZMAT) standards are to be followed for the storage, transportation, and use of chemicals. Herbicide label specifications provide direction for storage, application, and handling for each specific herbicide type. All biological control efforts are made in cooperation with the USDA Animal and Plant Health Inspection Service.

Currently, the annual program of work focuses on treating known infestations across the forest, prioritizing the species and locations that pose the greatest threats of altering ecosystem function. Surveys are focused in areas that have recently experienced disturbance, are expected to be disturbed, and/or see high visitor use. This allows the forest to detect, control, and eradicate new infestations before they have the opportunity to spread. This has proven to be a successful strategy for eradicating and/or reducing potentially serious invasive species threats.

Description of Affected Environment (Existing Condition)

The Kaibab NF has had an expansion of weeds from a few isolated known populations along roads in the 1990s to about 55,165 acres today. These plants are now widely dispersed across the forest. The forest started to inventory for weeds in 1997, and has conducted surveys each year that are documented in the national database called Natural Resources Information System. Inventories were concentrated at first along major travel corridors, campgrounds, and other areas where disturbances occur. Since 1997, more general surveys have been conducted for projects on grazing allotments, timber sales, and inventories associated with the National Fire Plan for fire rehabilitation purposes and forest health initiatives. Table 25 lists the locations of known populations of nonnative invasive species of concern on the Kaibab NF.

Table 25. Nonnative invasive species of concern on the Kaibab National Forest

Species	Location of Known Populations
Musk thistle (*Carduus nutans*)	Several small populations around the Jacob Lake area and along State Highway 89A.
Spotted knapweed (*Centaurea masculosa*)	Small populations in numerous places along State Highways 67 and 89A and a few isolated occurrences along roads in the Warm Fire.
Scotch thistle (*Onopordum acanthium*)	Five populations on western side of NKRD and along Interstate 40 on the Williams Ranger District, and along Highway 64 on the Tusayan Ranger District.
Diffuse knapweed (*Centaurea diffusa*)	Small populations along Highway 64.
Leafy spurge (*Euphorbia esula*)	Small populations near Big Springs Field Station and Hull Cabin.
Cheatgrass (*Bromus tectorum*)	Numerous populations across the forest, primarily along roads and in fire areas.
Oxeye daisy (*Chrysanthemum leacanthemum*)	Small populations occurring in the Demotte Park area.
Bull thistle (*Cirsuim vulgare*)	Several populations along State Highways 89A and 67 and in the Warm, Pumpkin, and Eagle Rock Fires.
Salt cedar (*Tamarix ramosissima*)	Large populations in Kanab Creek Wilderness.
Dalmatian toadflax (*Linaria genistifolia*)	Multiple small infestations along Highway 64 near Tusayan and inside a few burn areas on the Williams Ranger District.
Yellow starthistle (*Centaurea solstitialis*)	No known populations on the forest, but species can be found on Federal lands in northern Arizona.
Russian thistle (*Salsola kali*)	Multiple infestations forestwide and on adjoining lands in pinyon-juniper and cold desert shrub ecosystems.
Jointed goat grass (*Aegilops cylindrical*)	Few isolated occurrences along roads on the Williams Ranger District.

Many of the larger established weed infestations have occurred due to disturbance created by fires in the last 15 years. Specifically the larger fires with portions that burned with high intensity or severity (Bridger Knoll, Pumpkin, and Warm) and generated high levels of disturbance, displaced vegetation, and altered soil characteristics across thousands of acres.

Recent post-fire vegetation studies in southwestern ponderosa pine forests have shown dramatic increases in total cover of exotic plants in both moderate- and high-severity burn areas (Phillips and Crisp 2001, Crawford et al. unpublished data, Foxx 1996). Once there is a source and vector for invasive species, moderate- to high-intensity fire areas provide the disturbance where invasive species can establish prior to native species recovery. The higher the level of disturbance can be compared to the higher risk of invasive species establishment.

North Kaibab Ranger District

Musk thistle, bull thistle, and spotted knapweed have been identified in the Jacob Lake area along the state highways and a few adjacent forest roads in the Warm Fire area. There is a population of leafy spurge near the Big Springs Field Station. Several populations of Scotch thistle exist on the western side of the district. Treatment in the form of manual hand grubbing or herbicide

application has been ongoing since 2003. Monitoring and removal of located plants is ongoing at each site throughout the annual growing season to ensure newly germinated species are eradicated prior to seed production. Treatment will be ongoing for the foreseeable future. Surveys for new populations in areas with high potential for infestation are ongoing.

Cheatgrass can be found in many locations across the North Kaibab Ranger District. While most of the larger, denser populations are found in pinion-juniper woodlands that have experienced large disturbance events, numerous populations have been found in ponderosa pine ecosystems and even a few isolated findings in the mixed conifer. With its abundance across the entire forest, this species poses the greatest risk of having a negative effect on ecosystem function. Mapping and treatments on cheatgrass began in the pinion-juniper woodlands in 2007, prioritizing highest risk locations for treatment. The intent of this effort is to greatly reduce the large populations of cheatgrass and return the sites infested back to a native vegetation species composition. To date, use of mechanized equipment to apply herbicide and native species seed has had a moderate level of success in reducing the frequency of cheatgrass in treatment locations.

There is a large infestation of salt cedar occurring inside Kanab Creek Wilderness. It is part of a continuous infestation spanning across the entire Kanab Creek drainage system. Mapping of the population began in 2007. Salt cedar beetles migrated to Kanab Creek in 2009, and were first detected on the forest portion of Kanab Creek in 2010. The tamarisk beetles were recorded down the entire length of Kanab Creek in 2011. Monitoring for the effects of the beetle on salt cedar is ongoing.

Tusayan Ranger District

A population of leafy spurge has been detected in the Hull Cabin vicinity and receiving treatment since 2007. Diffuse knapweed, Scotch thistle, and Dalmatian toadflax are known to occur in small populations along State Highway 64. Monitoring and treatment of these populations is ongoing. Cheatgrass has been detected along several forest roads. Some of these roads have been receiving treatment since 2010.

Williams Ranger District

Bull thistle and Dalmatian toadflax have been detected in several areas that recently experienced disturbance by fire. Treatment on each respective population has been ongoing. Scotch thistle can be found along Interstate 40 and has been receiving treatment for several years. Cheatgrass is being detected in several areas including along roads and recent fire areas in the past few years. Treatment for cheatgrass began in 2010.

There are other highly invasive species that occur outside the forest including several thistle and knapweed species that could still be transported in from other areas of the forest and surrounding lands.

For the purposes of this analysis, current known populations of noxious and invasive species were reviewed and incorporated as the affected environment along with discussion of how these species respond to management activities. How these populations could be affected by management activities and the potential for new infestations are analyzed for each alternative. Invasive seed vectors which provide the ability for seed to be moved from one area to another and the level of disturbance generated by each alternative are primary evaluation criteria. The scale of potential activities and the impact to invasive species is also evaluated.

Environmental Consequences for Nonnative Invasive Plants

Effects Common to All Alternatives

Under all alternatives, invasive species would continue to be introduced and spread, and the forest would continue its programmatic survey and treatment of invasive species. Disturbances including wildfire would continue to occur, which provides receptive areas for invasive species to become established.

Environmental Consequences for Nonnative Invasive Plants: Alternative A – Current Plan, Current Management (No Action)

Current conditions would continue to be maintained. The current rate of spread of existing noxious and invasive weeds and the current rate of introduction of new invasive species would continue. With this alternative, there would be no alteration to current restoration and biomass production guidelines. Mechanical vegetation treatments would continue forestwide on areas with a suitable timber base. These projects provide temporary disturbances that can increase the potential for spreading existing invasive populations or introduce new infestations. Restoration of springs and natural waters would continue at the current rate, thus allowing current infestations to spread or allowing new infestations to occur.

The established best management practices that are to be implemented for every ground-disturbing project (USDA Forest Service 2005) have been effective to date in reducing existing populations, allowing for the survey for new infestations in areas expected to receive future treatment, and measures to be taken that can reduce the vectors for invasive species introduction.

While creating temporary disturbances, these projects also provide for long-term benefits that can limit future invasive species infestations. If an area goes untreated, it can be more susceptible to high-intensity wildfires that would greatly alter the ecosystem and create the highest potential for new invasive species infestations.

This alternative would not include any additions to wilderness areas. All current non-wilderness areas would continue to have same current potential for new infestations as well as existing authorized methodologies for treatment and control. This alternative provides for the highest rate of access to the highest portion of acres on the forest by not establishing new wilderness areas or making additions to existing wilderness areas, thus it also creates the highest level of threat of newly introduced invasive species by maintaining the current level of access.

By continuing current management under the existing forest plan, all of the available mechanized options for invasive species survey and treatment would continue. While there is no need to conduct invasive species treatment inside the areas proposed for wilderness in the other alternatives, invasive species treatment by mechanical-based methodologies would remain as an option if an infestation was detected.

Environmental Consequences for Nonnative Invasive Plants: Alternative B – Proposed Plan, Preferred Alternative

The preferred alternative proposes increasing mechanical thinning from an average of 2,000 acres per year to a range of 11,000 acres to 19,000 acres per year in ponderosa pine. Prescribed burning and naturally ignited fires would increase from an average of 20,000 to 55,000 acres a year.

With increased ground disturbance, there would be an increased threat of spreading existing infestations. Without early detection and treatment, invasive species like cheatgrass have the ability to emerge, reproduce, and rapidly invade these areas, out-competing the native understory species. There would also be an increased threat of new species introductions from vehicles and machinery coming into the project area to perform restoration activities.

By reducing the overall overstory density through mechanical thinning and wildland fire, this alternative provides for the greatest potential to enhance understory vegetation in the treated areas of ponderosa pine, mixed conifer, aspen, and grasslands (refer to the Vegetation and Fire section in this chapter). Increasing the frequency of the understory species creates areas that are less susceptible to nonnative species like cheatgrass. The proposed action predicts the least amount of stand-replacing fire in ponderosa pine, and is a close second behind alternative A in the dry mixed conifer (Vegetation and Fire Specialist Report; KNF 2013a). Conditions following high-severity fires provide the highest susceptibility for invasive species introduction and establishment.

By combining best management practices designed to reduce introduction of invasive species; monitoring for species before, during, and post project; and continuing methodologies to control invasive species detected, a healthier ecosystem less prone to invasive species invasion can be achieved.

This alternative proposes additions to the Kanab Creek and Saddle Mountain Wilderness Areas. These proposed wilderness areas currently receive little to no use by mechanized vehicles due to access or terrain. The current rate of spread of existing noxious and invasive weeds and the current rate of introduction of new invasive species would continue in these areas.

Of the wilderness additions, only a few of the additions to Kanab Creek Wilderness are currently known to have an invasive species infestation, which is cheatgrass. The current infestation found in these areas is expected to continue to out-compete native species and spread to other areas. Once added to the Kanab Creek Wilderness, the ability to apply herbicide and native species seed by mechanized equipment would no longer be an option. This would limit cost-effective options for potential future cheatgrass treatment in these areas.

This alternative prioritizes restoration of springs and natural waters, which includes treatment of invasive species. As a result, current infestations are expected to be reduced and additional infestations may be prevented in these areas.

In summary, alternative B proposes the highest amount of vegetation treatments and the most planned disturbance of the four alternatives. This would create the highest risk of invasive species to be spread or introduced. However, alternative B reduces the potential for uncharacteristic high-intensity fire, which reduces the potential for large contiguous areas of unplanned disturbance and susceptibility. Alternative B also increases the potential for long-term native understory enhancement, which increases the ability for native species to out-compete invasive species.

Environmental Consequences for Nonnative Invasive Plants: Alternative C

This alternative would have similar consequences with regard to invasive species as alternative B on the Tusayan and Williams Ranger Districts and the area outside the North Kaibab Habitat Complex on the North Kaibab Ranger District, except that it has a guideline for retaining trees with physical characteristics indicating they were established prior to 1890. The tree retention guideline would likely result in denser than desired conditions and an increase in potential for stand-replacing wildfire.

This alternative would designate an approximately 260,000-acre management area on the North Kaibab Ranger District with a guideline that once desired stand structure was restored (within the limits of the tree retention guideline), the desired conditions would be primarily maintained with wildland fire and natural disturbance.

The potential consequences of this alternative would be increased disturbance and an increased risk of invasive spread and introduction when compared to alternative A and very similar to alternative B for the duration that the North Kaibab Habitat Complex continues mechanical treatments. This alternative would reduce the threat of catastrophic wildfires and provide options to generate healthier forest timber stands and an enhanced understory that would be more competitive with invasive species.

The North Kaibab Wildlife Habitat Complex would initially be managed in a fashion similar to the remaining areas of the forest. The difference being the long-term management implications of each site after restoration and then becomes primarily managed by natural disturbances and prescribed fire. This would then indicate that increases in stand-replacing fire would occur at later time intervals (see Vegetation and Fire section of this chapter). Impacts to invasive species introduction and establishment would initially remain similar to alternative B forestwide, with potential increases over time to invasive species populations on the North Kaibab Ranger District correlating with increased potential for stand-replacing fires.

Environmental Consequences for Nonnative Invasive Plants: Alternative D

Alternative D would have similar effects as alternative C. Mechanical and timber production process could be used to restore stand structure to the extent possible. After each area was restored to the desired condition, the desired conditions would primarily be maintained with natural disturbances and prescribed fire.

Impacts to invasive species introduction and establishment would initially remain similar to alternative B forestwide, with potential increases over time to invasive species correlating with increased stand-replacing fires comparable or greater than alternative C.

Environmental Consequences for Nonnative Invasive Plants Common to Alternatives C and D

Alternatives C and D propose the same additions to existing wilderness areas as alternative B, plus they would recommend six new wilderness areas: Burro Canyon, Coconino Rim, Willis Canyon, Seegmiller, South Canyon Point, and an area adjacent to a potential wilderness area

(PWA) on the Prescott National Forest. None of these proposed wilderness areas contain National Forest System (NFS) roads and they typically receive minimal use by the public, so spread of invasive species by forest visitors is minimal. Recommendation of these additional PWAs would decrease the area of the forest suitable for treatment of nonnative invasive plant populations using motorized or mechanized means by approximately 38,000 acres.

The level of forest visitor use in these PWAs is not expected to increase or decrease because of the creation of wilderness. The incorporation of these areas into wilderness is not likely to increase or decrease the current rate of spread of invasive species. Any potential invasive species would continue to spread through the same non-mechanized vectors as they do currently. The only potential impact would be if invasive species invaded these areas, the forest would be limited to non-mechanized treatments for control.

There are non-mechanized options that can be performed to reduce the further spread of cheatgrass or other potential species, but they can be less effective and more time consuming. Thus, the ability for the forest to effectively control the infestation would be limited.

These alternatives prioritize restoration of springs and natural waters, which includes treatment of invasive species. As a result, current infestations are expected to be reduced and additional infestations may be prevented in these areas.

Cumulative Effects for Nonnative Invasive Plants

There are many sources and vectors that can spread invasive species across the forest as well as to the forest from neighboring lands. The source of invasive species can come from private, State, Native American, or other federally administered lands inside or adjoining the Kaibab NF as well as State- and county-maintained roads that enter or cross the forest. This cumulative effects analysis boundary includes all potential invasive sources that can be found on the land management areas adjoining the Kaibab NF that could likely be spread into the forest within the next 15 years. The cumulative impacts of vectors that can spread invasive species inside the forest are also taken into account.

As invasive species continue to become a growing concern in the Southwest, many of the land management agencies, stakeholder groups, and private landowners have developed management plans to inventory and control invasive species. The following list includes some of the land management organizations that have recognized the need to control invasive species within their management area and have developed and implemented plans for invasive species control:

- Bureau of Land Management, Arizona Strip and Hassayampa Field Offices
- National Park Service, Grand Canyon National Park
- Camp Navajo
- Coconino and Prescott National Forests
- The Navajo Nation
- The Kaibab Band of Paiute Indians
- Coconino County
- Arizona Department of Transportation
- Arizona State Land Department

Other groups working toward addressing invasive species issues include private landowners, coordinated weed management areas, natural resource conservation districts, and environmental and conservation groups. The results of these efforts would reduce the potential for invasive species to be transported to the forest when compared to if no actions toward invasive species management were taken.

While the efforts made by these agencies and groups have been effective, there are still invasive species that can be spread to the forest by multiple vectors. Regardless of the size of an infestation on adjoining lands, there has to be a way for it to be transported for there to be a cumulative impact. The potential vectors that could transport invasive species to and from the forest include:

- Livestock that graze on the Kaibab NF that also spend some portion of the year on private, State, BLM, or other national forest lands.
- Forest visitors and their mode of travel that enter the forest to engage in recreational activities.
- Use of State, county, and forest maintained roads that access or cross the forest.
- Wildlife migrations.
- Wind.
- Water and other gravitational movements down drainages or streams.

The level of potential invasive seed transportation to and from the forest by each of these vectors would remain consistent across all four alternatives. Any potential differences in cumulative effects among the alternatives would be due to potential disturbance generated by management activities. Anticipated large disturbance events and correlating impacts to invasive species establishment would initially remain similar in alternatives B, C, and D while alternative A would maintain the least amount of expected disturbance and the least amount of invasive species establishment. Over time, the threat of high-severity fire increases in alternative C (specific only to the North Kaibab Habitat Complex) and increases forestwide in alternatives D and A. At that point, the respective order from highest to lowest threat of established invasive species that were imported from other areas would be D, A, C, and finally B.

Watersheds and Soils

The Soil and Watershed Specialist Report (KNF 2013e) contains more detailed information, along with maps displaying the analysis area for soils and watersheds for the Kaibab NF and the hierarchy of the watersheds and associated hydrologic unit codes (HUCs).

Description of Affected Environment (Existing Condition)

Watersheds

The analysis area for watershed resources includes all of the 4th-, 5th-, and 6th-level hydrologic units that contain, at least partially, NFS lands. Hydrologic units are subdivisions of watersheds nested from largest to smallest areas and are used to organize hydrologic data. Each basin is identified by a unique HUC, as well as name at each level. HUCs are identifiers as assigned to basin polygons by the U.S. Geological Survey (USGS). A subbasin (HUC8) is a 4th-level

hydrologic unit, a watershed (HUC10) is a 5th-level hydrologic unit, and a subwatershed (HUC12) is a 6th-level hydrologic unit.

The Kaibab NF intersects eight HUC8 subbasins, occupying an average of 15 percent of each, with the minimum being 0.38 percent and the maximum being 28 percent of any single subbasin. The forest comprises more than 10 percent of four of the subbasins. Subbasins represent the broadest level of analysis and extend well beyond forest boundaries.

Historically, subbasin conditions have been satisfactory. Overall, management of surface water resources plays the largest role in maintaining overall ecological function of subbasins where NFS lands occur; however, surface water as perennial streams on the forest is extremely limited with only 1.5 stream miles of perennial waterflow in North Canyon Creek on the North Kaibab Ranger District.

The forest intersects 29 HUC10 watersheds and occupies an average of 33 percent of each of these with the maximum being 93 percent and the minimum being 0.15 percent of any single watershed. Snake Gulch and Sycamore Creek are the dominant watersheds (i.e., have the greatest number of acres) on the Kaibab NF and have some of the largest acreages extending beyond forest boundaries. No watersheds are wholly within the Kaibab NF.

The forest intersects 126 HUC12 subwatersheds. Fifty-two occur on the North Kaibab Ranger District, 25 occur on the Tusayan Ranger District, and 49 occur on the Williams Ranger District. The Kaibab NF occupies an average of 52 percent of each subwatershed that the forest intersects, with several being wholly within the forest and the minimum occupancy of a single watershed by NFS land being less that 0.01 percent. The lands that comprise the HUC12 subwatersheds (hydrologic units generally of the scale 10,000 to 40,000 acres) consist of contiguous units of NFS lands and combinations of forest, other Federal, State, and privately owned lands.

Currently, all vegetative communities and, therefore, soils and watersheds are departed to some degree from desired conditions (and reference conditions) or are trending away. In many cases, increased density of small trees, increased canopy bulk density, increased total canopy cover, loss of understory species diversity, and increased occurrences of invasive species have resulted in changes to soil stability, soil nutrient cycles, and soil hydrologic function (i.e., water holding capacity). Current vegetation conditions within the ponderosa pine and frequent fire mixed conifer vegetation types are contributing to increased risk of uncharacteristic disturbances, such as stand-replacing fire in areas where low-severity, high-frequency fire regimes historically dominated. These two vegetation types cover approximately 40 percent of the Kaibab NF and constitute the second and third largest vegetation communities on the forest, behind pinyon-juniper woodlands.

NFS roads near drainages or with stream crossings contribute to impaired watershed function when roads and ephemeral drainage crossings are used during wet weather or are inadequately maintained due to increased sediment and turbidity. Some watersheds on the forest have high road densities that threaten watershed function by redirecting and channelizing surface waterflow in roadside ditches and other road water diversion structures (i.e., road drainage features). Noxious and invasive weed infestations have also impaired the ecological function of some watersheds by prohibiting the colonization and establishment of native vegetation, altering soil chemical and physical properties including soil hydrologic function.

Management of NFS lands often influences subwatershed conditions and, therefore, water resources conditions at larger scales (i.e., watershed and subbasin). In areas of mixed ownership, reasonable assumptions regarding the management of nonforest lands are based on historic and current management practices and activities on those lands in the future.

See the Soils and Watershed Specialist Report (KNF 2013e) and Kaibab NF Ecological Sustainability Report (KNF 2008a) for additional details of the subbasin, watershed, and subwatershed extent and conditions within the analysis area.

Soils

Soils within the Kaibab NF include a wide variety of taxonomic classifications, reflecting the influences of factors such as parent material, climate, topography, and organisms over time. As a result, soil characteristics range from shallow, weakly developed, rocky soils on plateaus, mesas, cliffs, escarpments, and ridges to deeper, more productive soils on alluvial fans, plains, and in valley bottoms. In general, soils on the forest are fine textured and contain a wide range of rock fragment sizes within soil profiles and at the surface. The dominant parent materials consist of sedimentary rocks, including sandstone, carbonates (primarily limestone and dolomite), mudstone, shale, gypsum and igneous rocks, including granite, basalt, and basalt cinders.

The most productive soils on the Kaibab NF occur within the wetland/cienega and montane/subalpine PNVTs followed by the Great Basin/Colorado Plateau grasslands. Soils of these PNVTs have high organic matter content and moisture-holding capacity and are, therefore, capable of supporting the greatest amount of vegetation production. Currently, surface organic matter (litter) and grass and forb productivity are moderate on some grassland terrestrial ecosystem units (TEUs) offering some opportunity to improve soil productivity, particularly where trees have encroached and shaded grasses and forbs, resulting in replacement of understory vegetation with forest litter (i.e., needles, twigs, and branches). By definition, these vegetation types should have no more than 9 percent tree cover. Encroaching trees in some areas have reduced vegetative ground cover and increased forest litter (i.e., duff). Woody material on the surface can also intercept moisture, reducing available moisture to grasses and forbs.

Desert communities and semidesert grassland PNVTs have considerably lower soil productivity. These soils have lower organic matter content due to less vegetative ground cover that would otherwise provide organic matter inputs. These PNVTs cannot be expected to produce high amounts of forage.

Pinyon-juniper woodlands currently have low to moderate soil productivity, but there is potential to improve soil productivity on these PNVTs. Areas where tree canopy cover exceeds 40 percent exhibit sparse understories with increased bare ground, resulting in impaired soil condition and increased risk of sheet erosion. These PNVTs present excellent opportunities for mechanical thinning while crushing or lopping and scattering woody debris to increase surface organic matter and improve forage. On any given site, the potential living plant biomass that can be supported by the soils and climatic regime is finite. The large percentage of soil areas in the pinyon juniper community being in the unsatisfactory condition is due to complete occupancy of the site by pinyon and juniper trees. This dominance results in a paucity of herbaceous plants on the soil surface and a very high percentage of bare soil exposure. These bare soils experience very high erosion rates, primarily during monsoonal rain events that are typically intense and have the force to move soil particles. The resulting high erosion rates are the reason why these areas are classified in an unsatisfactory condition.

Ponderosa pine, mixed conifer and spruce-fir PNVTs generally have moderate soil productivity with moderate to high levels of soil organic matter. Excessive amounts of duff built up and dispersed evenly across the soil may carry wildfire across entire stands and may contribute to stand-replacing fires, posing a risk to watershed condition in terms of degraded soil and hydrologic function. Forage productivity is generally low to moderate. Similar to pinyon-juniper woodlands, as ponderosa pine forest canopy cover increases, there is a corresponding decrease in understory productivity and subsequently, forage productivity decreases (personal observations and USDA Forest Service 1989). Under improved conditions of the PNVT, these soils can be expected to produce greater amounts of forage than under current conditions in many areas where forest thinning has not been conducted to decrease stand and overstory density.

Overstocked pinyon-juniper woodlands, ponderosa pine, and frequent fire ponderosa forests have decreased herbaceous productivity due to tree competition for soil nutrients and moisture and reduced light interception at the forest floor. As canopies are treated (thinned or burned) or with insect and disease outbreaks, herbaceous understory and forage production increases (Abella and Covington 2004, Korb and Springer 2003).

Aspen stands that are in a state of decline exhibit reduced leaf fall that leads to a decrease in soil organic matter accumulation and eventually a decline in the thickness of the mollic soil horizon (Cryer and Murray 1992). As a result, nutrients are leached from upper soil horizons leading to decreased soil water-holding capacity and reduced base saturation. The result is a gradual increase in soil acidity, which provides an environment conducive to conifer encroachment into aspen stands. These processes, along with browsing of aspen by ungulates, are occurring throughout much of the Williams Ranger District. As a result, some of these aspen stands are trending toward late-successional, conifer-dominated vegetation communities.

Impaired or unsatisfactory soils occur where invasive and noxious weeds have displaced native vegetation or altered vegetative communities. Invasive and noxious plant species have the potential to change chemical and physical properties of soils by altering nutrient cycles and plant-water relations. Some invasive plants are allelopathic, meaning they release chemicals into the soil that inhibit the growth of other plants. The resulting reduction in native vegetative cover causes a corresponding increase in soil erosion from unprotected soil surfaces as a result of soil particle detachment by rainsplash and entrainment in surface runoff.

Impaired and unsatisfactory soils are also found in areas where uncharacteristic wildfire has altered soil physical, chemical and hydrologic properties through loss of protective vegetative cover and organic matter, reduced water infiltration, changes to soil color, and loss of available nutrients.

Climate Change

Based on current climate models, some of the climate change factors that may influence soil condition are: (1) more extreme natural ecological process events, including wildfires, intense rain, flash foods, and wind events, and (2) changes in climate may affect the vigor and productivity of forage plants and, thus, overall soil conditions.

It is possible that higher temperatures and decreased precipitation modeled for the next century would decrease understory vegetative production. There is a need to reduce vulnerability by maintaining and restoring resilient, native ecosystems.

Environmental Consequences for Watersheds and Soils

Environmental Consequences for Watersheds and Soils Common to All Alternatives

Mechanical harvest and restoration treatments may impact soil hydrologic function, soil stability, and nutrient cycling through soil displacement, rutting, compaction, and puddling and removal of vegetative ground cover. Soil compaction decreases soil water infiltration and, therefore, nutrient inflows. The amount of soil compaction depends on harvest methods, amount of slash retained on site, operator technique, and soil conditions and properties (Page-Dumroese et al. 2010).

Project-level implementation would include BMPs (FSM2530.2) and other mitigation measures designed to protect soils and watershed resources. BMPs and SWCPs (FSH 2509.22 R3, FS-990a) have been proven effective in mitigating ground disturbance from forest mechanical treatments as well as intercepting sediment in runoff (Fleishman and Jagow 1996, Fleishman 2005).

Under all alternatives, prescribed fire is allowed to burn under conditions and prescriptions that should not result in large areas of high burn severity that would be detrimental to soil physical, chemical, or biological properties resulting in loss of soil productivity. Prescribed fires and wildfires managed for resource benefit may have negative isolated areas of high severity or places where fires smolder for prolonged durations that can result in negative effects to soil physical, chemical, and biological properties. Soil structure is the most important soil physical characteristic that affects soil hydrologic function and soil stability since the organic matter component, which improves aggregate stability, porosity, and water infiltration rates, can be lost at relatively low fire temperatures. The loss of soil structure increases the bulk density of the soil and reduces porosity, thereby making the soil more vulnerable to post-fire erosion.

Soil biological processes are also affected by fire. Soil microorganism response to fire depends on numerous factors, including fire severity, site characteristics, preburn vegetation community composition, and preburn soil microorganism populations and species diversity. However, some generalizations can be made. First, most studies have shown strong resilience of microbial communities to fire. Recolonization to preburn levels is common, with the amount of time required for recovery generally varying in proportion to fire intensity and duration. Second, the effect of fire is greatest at the forest floor (litter and duff). Fires that do not entirely consume the forest floor and soil humus are recommended (Neary et al. 2005).

Recent and ongoing planning under the Travel Management Rule identifies an open road system and closes the forest to most cross-country travel. As a result, the road system is the same for all plan alternatives. The road system results in a net loss of soil productivity within the road corridor, including cut and fill slopes. Roads are the dominant source of erosion and sediment in forests (Swank and Crossley 1988, MacDonald and Coe 2008). Some road locations are in areas that are more sensitive than others, such as along ephemeral drainages, or in areas of inherently unstable soils. However, with implementation of the Travel Management Rule across the forest, unauthorized cross-country travel would be eliminated and many roads that have resulted in degradation of soil productivity and water quality would be closed. Some motorized cross-country travel would continue for permitted uses.

New permanent road construction is generally not required for mechanical thinning operations, but the reopening of maintenance level 1 roads (i.e., those roads placed in storage, or closed between intermittent uses) increases the amount of open roads and, potentially, the amount of soil erosion that occurs during project implementation. Temporary road use results in removal of vegetation along the road corridor, exposes mineral soil, and results in soil compaction within the travelway. Typically, there is increased erosion from roads during the first two years following road construction or reopening (MacDonald and Coe 2008; Megahan 1974). Slope failures and mass movement of soils may occur as a result of road construction. New roads or reopening closed roads may also provide an environment conducive to the invasion and establishment of invasive plant species. New temporary roads would be closed, obliterated, and revegetated following use. Road design, avoidance of problem soils, appropriate design criteria, implementation of BMPs for road construction and maintenance, and road closures would be implemented to minimize adverse impacts to soils.

Grazing does not typically result in detrimental effects when sufficient herbaceous material protects the soils during periods of intense summer rainfall, or during spring snowmelt, as is common in most areas grazed by domestic livestock under current grazing management, which is low to moderate. Grazing does have the potential to result in localized impacts to soil condition through hoof compaction, and indirectly from the removal of protective vegetative cover and subsequently, effective ground cover. The effects to soil condition include reduced soil hydrologic function of highly compacted areas where cattle congregate and trail, and reduced soil stability from loss of ground cover wherever overutilization of available forage occurs.

Since current composition and density of biological soil crusts[2] have not be inventoried, we can only infer trends based on current and projected management impacts that have been shown in research to alter populations of biological crusts. Of most importance is the role crusts play in maintaining productivity of the semidesert and Great Basin grasslands and woodland ecosystems. Some mosses and other crust-forming organisms are found in wetter environments, but are less important to overall soil productivity. It is estimated that improved cattle management on the forest that is currently being implemented would benefit biological crusts. Reduction in grazing pressure due to estimated increases in forage production would also benefit soil biological crusts.

Following large-scale disturbances such as wildfire, insect infestations, disease outbreaks, and wind storms, decisions may be made under all alternatives to recover economic value of trees killed by such events, and to reduce hazardous fuels created. Salvage logging provides a means to offset other recovery efforts following large scale disturbances such as soil stabilization, reforestation, and forest infrastructure repair and maintenance, but also has the potential to increase soil erosion rates, effect soil nutrient cycling processes, increase soil compaction and displacement, and increase the risk of spread of weeds. Post-disturbance salvage logging has been and continues to be a controversial activity on NFS lands. Arguments for and against post-disturbance salvage logging are well documented in the literature with regard to the effects to soils and water resources. Several white papers, opinion papers, and refereed journal articles exist that reflect opposing viewpoints and the current state of knowledge of the subject (e.g., Beschta et al. 1995, McIver and Starr 2001, Ice and Adams 2004, Brown et al. 2003, Peterson et al. 2009, Collins et al. 2011).

[2] Biological soil crusts are formed by living organisms and their byproducts, creating a crust of soil particles bound together by organic materials. The primary living organisms of biological soil crusts include cyanobacteria, green and brown algae, mosses, lichens, liverworts, fungi, and bacteria.

While there is a potential for adverse direct and indirect effects to soils and watershed resources from salvage logging, most adverse effects can be minimized or mitigated through proper implementation of BMPs and SWCPs. Management considerations for decreasing adverse impacts to soils and watershed resources from salvage logging following large-scale disturbance include those recommended by Lindenmayer and Noss (2006) and should also include, but are not limited to, the following:

- Minimizing the number and length of roads necessary to complete activities.
- Installing necessary roads on stable, well-drained soils away from waterbodies.
- Minimizing the number of stream crossings necessary to complete activities.
- Avoid sensitive soils and sites.
- Considering harvest systems that produce the least soil disturbance in completing activities. These systems can include: logging on frozen-ground or snow-packed conditions, forwarding, full suspension cable yarding, helicopter yarding, partial suspension cable yarding, and ground-based skidding under dry conditions.
- Stabilizing disturbed areas upon completion of activities, including seeding with native species where warranted.
- Maintaining adequate residual woody debris to protect soil surfaces from erosion, provide shade and moisture to plants and organisms, and restore nutrient cycles.
- Buffering sensitive sites such as stream channels, waterbodies, and springs.

Environmental Consequences for Watersheds and Soils: Alternative A – Current Plan, Current Management (No Action)

Under alternative A, the Kaibab NF would continue vegetation management practices at approximately the current rate. Mechanical vegetation treatments that have the potential to improve long-term soils and watershed conditions in the ponderosa pine vegetation type would continue to occur on approximately 2,100 acres annually, which is only enough to maintain a static condition and would not make progress toward desired conditions. Alternative A would also continue mechanical vegetation treatments in the frequent fire mixed conifer vegetation type at a rate of approximately 200 acres annually (approximately 5 to 10 percent of the acreage proposed under the action alternatives). With only 200 acres in the frequent fire mixed conifer vegetation type receiving mechanical prescribed thinning treatments annually, it is unlikely that alternative A would achieve desired conditions for soils and watersheds. Trends indicate that fuel loading would continue to increase in both living biomass and woody detritus. At the current rate of mechanical prescribed thinning on the forest, it is unlikely that alternative A would achieve desired open, uneven-aged conditions and associated understory response in the ponderosa pine and frequent fire mixed conifer vegetation types as effectively as the action alternatives since the objectives for the action alternatives exceed the current rates under the current plan.

Under current management, prescribed burning is not achieving desired conditions for soils and watershed resources as acres treated with low-intensity prescribed fire are not sufficient to reduce the risk of uncharacteristic wildfire at the landscape scale. Currently, fire managers are burning about 8,500 acres per year with prescribed fire and manage wildfires to achieve multiple objectives on around 11,700 acres per year, totaling just over 20,000 acres per year that receive beneficial fire disturbance (KNF 2013a).

Under alternative A, there are no desired conditions specified for the grassland or aspen vegetation types and no objectives in the plan to reduce encroaching conifers from grasslands or aspen stands. Since there are no clearly defined desired conditions for vegetation types, it is unlikely that landscape-scale desired conditions would be achieved in grasslands and aspen vegetation types.

The use of roads and the need for reopening maintenance level 1 roads is estimated to be lowest under this alternative because fewer acres are being treated using mechanical methods and prescribed fire. This would have the lowest short-term soil effects related to road usage. The action alternatives would likely require greater road use and need for temporary road access to implement prescribed thinning and fire treatments. Maintenance level 1 roads, as defined in FSH 7509.58, 10, 12.3, refers to intermittent service roads during the time they 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. 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.

Under current grazing management, alternative A has the lowest potential for improving rangeland resources and associated vegetative cover, since current management is resulting in fewer acres restored than proposed under the action alternatives. Vegetative cover protects soils by holding them in place.

Alternative A, current management, is not sufficient to effect a change in trend and increase resilience to changing climate. Under current management, forest restoration projects are occurring at a rate slower than proposed under all the action alternatives. As a result, large landscapes are at increased risk of climate-related disturbances.

Current management is not achieving resilience to climate change since forest restoration projects are occurring at a rate slower than proposed under all action alternatives.

Environmental Consequences for Watersheds and Soils Common to Action Alternatives B, C, and D

Under the action alternatives, there are objectives that propose mechanical prescribed thinning on approximately 11,000 to 19,000 acres annually in the ponderosa pine vegetation type and 1,200 to 2,100 acres annually in frequent fire mixed conifer. Initially, mechanical forest prescribed thinning treatments would increase the risk of soil compaction, rutting, puddling, accelerated erosion, potential sediment delivery to surface waters, and establishment of invasive and noxious weeds through the use of heavy machinery. However, long-term improvement in herbaceous understory vegetation and forest structure and function would occur as a result of these alternatives since treated areas are expected to recover rapidly (i.e., 1 to 3 years) following mechanical vegetation treatments and implementation of BMPs and SWCPs would minimize and

mitigate potential adverse effects. The resulting increase in effective ground cover (i.e., herbaceous vegetation and litter) would improve soil stability, nutrient status, and water-holding capacity. Storm water runoff velocities would decrease as a result of improved surface roughness with vegetative ground cover providing a filter against sediment transport to waterways.

Approximately14,000 to 68,000 acres of wildland fire would occur annually in the ponderosa pine and frequent fire mixed conifer vegetation types under the action alternatives. This would include both prescribed fire and wildfire that would improve ecological function of soils, increase understory vegetation production and diversity, and decrease the risk of uncharacteristic wildfire that can adversely affect soils and watershed conditions. All action alternatives include objectives to reduce encroaching conifers in grassland vegetation types. The amount of treatment to protect and regenerate aspen is not expected to be different among the action alternatives, if funding is available. Native vegetation would reestablish in these areas soon after a treatment is completed (i.e., 1 to 3 years). Soil stability and productivity within exclosures would improve over time through elimination of impacts to aspen regeneration by wildlife and domestic livestock (i.e., browsing and trampling). Additional benefits include reduced susceptibility of sites to invasion by noxious weeds. These increases in native plant cover would reduce the amount of open, disturbed sites susceptible to weed invasion. Where aspen recruitment occurs in the absence of wildlife and domestic livestock impacts, soil ecological processes common in aspen vegetation communities would return over time, contributing to sustainable aspen populations.

Treatments to reduce tree encroachment in grasslands would result in minor soil compaction and removal of native vegetation where tree removal is practiced. Soil compaction and removal of vegetative ground cover has the potential to cause accelerated erosion and degradation of surface water quality. These conditions typically occur for short periods following treatment (i.e., 1 to 3 years). Implementation of BMPs and appropriate design features and mitigation measures would minimize these adverse effects.

Recreational uses that may impact soils include camping, hiking, mountain biking, and horseback riding. All of these activities may result in erosion and compaction. Across the forest, recreational use is relatively low, and as a result, associated impacts tend to be localized and occur on a small percentage of the planning area. Implementing site-specific BMPs and SWCPs for recreation projects minimizes adverse impacts to soils and water quality. The impacts from recreation could occur under all of the alternatives. No recreation development is proposed under any alternative. Terms and conditions of special use permits would require site-specific BMPs to provide for maintenance of soil productivity under all alternatives. Therefore, there are no anticipated effects to soil condition from permitted special use activities.

Restoring and maintaining resilience in forest, woodland, chaparral, grassland, shrublands, and riparian ecosystems are part of the basic elements of forestwide desired conditions, objectives, and management approaches provided for in alternatives B, C, and D. Restoring and maintaining resilience would likely improve the potential for ecosystems to retain or return to desired conditions after being influenced by climate change related impacts and variability. Management practices (e.g., selection cutting for age class diversity and structure, and restoring native grasslands) that sustain healthy plant and animal communities, and provide adequate nutrients, soil productivity, and hydrologic function promote resilience and reduce the potential for uncharacteristic disturbance. See the Vegetation and Fire section of this chapter for additional information on vegetation and fire.

Under the action alternatives, there are more explicit plan directions to address the bison herd on the North Kaibab Ranger District. Guidelines specify that the bison herd should be managed so it is concentrated within the House Rock Wildlife Management Area, and that active management should be used to minimize impacts from bison to sensitive resources, particularly outside the House Rock Wildlife Management Area. Management of the bison herd under these guidelines will reduce potential damage to sensitive soil and water resources caused by the bison, and decrease the spread of nonnative invasive species.

Environmental Consequences for Watersheds and Soils: Alternative B – Preferred Alternative

Within the capacity of the Kaibab NF, the proposed action would most effectively achieve long-term desired conditions for soil and watershed resources in ponderosa pine and frequent fire mixed conifer vegetation communities by modifying stand structure and density toward reference conditions and restoring historic fire regimes, thus improving the ecological function and sustainability of soils and watersheds in these vegetation types. While the preferred alternative has a large/old tree retention guideline, it would not retain all presettlement trees where doing so would prevent the achievement of desired stand densities and associated openings.

Mechanical harvest and restoration treatments under alternative B would have similar impacts as described under current management (alternative A). However, alternative B proposes the most mechanical harvest treatments of all alternatives and, thus, the greatest risk of short-term soil and watershed damage from mechanical treatments. Most of these impacts would be minimized and mitigated with implementation of BMPs and SWCPs.

Effects from road use would be similar to alternative A. However, alternative B proposes the greatest amount of timber harvest/mechanical restoration treatments and suitable timber base of all alternatives. For this reason, use of roads and the additional use of maintenance level 1 roads are estimated to be highest under alternative B. Maintenance level 1 roads generally recover (i.e., stabilize and revegetation) following use and implementation of BMPs and SWCPs.

Prescribed fires and wildfires managed for resource benefit would have the same effects to soils and watershed resources as outlined under alternative A. However, alternative B proposes more fire for ecosystem objectives than under current management (alternative A). It is possible that restoration activities may result in short-term localized adverse effects to soils and watershed resources including removal of vegetative cover, rutting, compaction, and erosion. These adverse effects could occur on any soils and associated PNVTs where prescribed thinning and fire treatments are implemented on the forest. However, they would generally be short-lived and mitigated through implementation of BMPs and SWCPs. The outcome would be an overall benefit of ecological restoration of the natural range of variability of fire-adapted ecosystems.

Since alternative B proposes the largest acreage for forest mechanical and fire restoration treatments in ponderosa pine and frequent fire mixed conifer, understory production and corresponding vegetative and effective ground cover is expected to exhibit the largest improvement under alternative B.

Alternative B would result in the greatest amount of area in the desired condition for the vegetation types (see Vegetation and Fire section of this chapter). Alternative B would result in the greatest amount of acreage in the desired condition for the soils and their associated PNVTs (see Vegetation and Fire section of this chapter). This would provide for adequate nutrients, soil

productivity, and hydrologic function to promote ecosystem resilience to changing climate and reduce the potential for uncharacteristic disturbance that can have severe effects to soils and watershed resources.

Environmental Consequences for Watersheds and Soils: Alternative C

While alternative C would be expected to modify forested ecosystems toward desired conditions, retention of all presettlement trees could prevent sufficient reduction of stand density in some areas to effectively reduce the risk of uncharacteristic wildfire. High-severity fires can have profound negative effects to soil properties including: (a) decreased soil productivity through loss of available nutrients; (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; and (d) increased soil temperatures that inhibit plant reestablishment. Removal of some presettlement trees under some circumstances would achieve desired conditions through removal of diseased trees, interlocking crowns, and other conditions conducive to uncharacteristic wildfire.

Objectives under all action alternatives would be to treat with fire an average of 13,000 to 55,000 acres annually in ponderosa pine, and an average of 1,000 to 13,000 acres annually in frequent fire mixed conifer using a combination of prescribed fire and naturally ignited wildfires.

Desirable fire effects would be similar to alternative B. However, with the presettlement tree retention guideline, it is possible that prescribed fires would burn with greater intensity because stands would include more areas with crown closure and higher overall stand densities than would likely occur under alternative B.

Effects to soils and watershed resources due to increased road use would be similar to those under alternative A. However, alternative C would require more maintenance level 1 and temporary roads than under current management (alternative A) to conduct mechanical forest restoration treatments. Lower road use levels are anticipated under this alternative than under alternative B because fewer trees would be removed due to the presettlement tree retention guideline and mechanical treatment could only be conducted to achieve desired conditions in the North Kaibab Wildlife Habitat Complex (i.e., approximately 260,000 acres), which would reduce the need for road use for future mechanical treatments within the management area.

Alternative C proposes the same number of acres of mechanical and wildland fire restoration treatments as alternative B. However, since mechanical treatments in the management area would only be conducted to restore stand structure, it is uncertain if future natural disturbances and acres that can be treated by prescribed fires would be sufficient to maintain the ecological function of ponderosa pine and frequent fire mixed conifer vegetation types following mechanical treatments within the management area. Where wildland fires do not occur, fuel loading would increase over time, leaving the management area at higher risk of uncharacteristic wildfire. For this reason, alternative C does not provide the ecosystem resilience necessary to mitigate changing climate as well as alternative B.

Environmental Consequences for Watersheds and Soils: Alternative D

Alternative D is similar to alternative C with the exception that the guideline for restoring conditions to the desired conditions, and thereafter, would be maintained with fire and natural disturbance would apply to the entire forest. Impacts to soils and watershed resources from mechanical prescribed thinning would be similar to those described under alternative A with acreages approximately equal to alternatives B and C. The presettlement tree retention guideline would result in slightly less soil disturbance than alternative B, since fewer large trees would be removed and transported to landings. However, treatments under alternative D are not likely to fully restore the ecological integrity of the ponderosa pine and frequent fire mixed conifer vegetation types in areas where there are a lot of presettlement trees. Where the desired openness is not achieved, there would be an increased risk of large-scale, uncharacteristic, stand-replacing wildfire and subsequent adverse effects to soils and watersheds. This risk may be increased in a hotter or drier climate.

Effects to soils and watershed resources due to increased road use would be similar to those under alternative A. However, alternative D would require more maintenance level 1 and temporary roads than under current management (alternative A) to conduct mechanical forest restoration treatments, but lower road use levels than alternatives B or C.

Grazing impacts to soils and watersheds under alternative D would be similar to alternatives B and C. The presettlement tree retention guideline may decrease the effectiveness of forest restoration treatments since the remaining presettlement trees would contribute to shading of the forest floor. By limiting the amount of sunlight reaching the forest floor, biological soil activity is decreased due to cooler soil temperatures. As a result, microbial decomposition rates are reduced, resulting in lower nutrient availability to understory plants. Additionally, grasses and forbs require sunlight to maintain adequate ground cover to protect soil surfaces from erosion by wind and water.

Comparison of Alternatives for Soils and Watersheds

Table 26 summarizes the projected trends in soil and watershed condition based on estimates of vegetative ground cover, soil organic matter content, and potential soil loss. Each PNVT was examined to determine whether soil and watershed conditions would generally trend toward, away, or remain static with implementation of the objectives of each alternative.

Table 26. Estimated trends in soil condition for each vegetation type by alternative

Vegetation Type (PNVT)	Current Departure From DC†	Alt. A	Alt. B	Alt. C	Alt. D
Ponderosa pine forest	Moderate	Stable	Toward. Greatly improved soil vegetative ground cover; increased organic matter content; improved nutrient cycling; improved soil moisture; reduced erosion hazard; greatest reduction of risk from uncharacteristic wildfire disturbance.	Toward. Slightly improved vegetative ground cover and organic matter content; improved nutrient cycling; slightly improved soil moisture; moderate reduction in erosion risk and protection from uncharacteristic wildfire.	Toward. Slightly improved vegetative ground cover and organic matter content; improved nutrient cycling; slightly improved soil moisture; moderate reduction in erosion risk and protection from uncharacteristic wildfire.
Frequent fire mixed conifer forest	Low	Stable	Toward. Reduced surface fuel loads and increased vegetative ground cover; improved nutrient cycling; improved soil moisture; decreased erosion risk.	Toward. Reduced surface fuel loads and increased vegetative ground cover; improved nutrient cycling; improved soil moisture; decreased erosion risk. Slightly less reduction in risk of uncharacteristic wildfire than alternative B.	Toward. Reduced surface fuel loads and increased vegetative ground cover; improved nutrient cycling; improved soil moisture; decreased erosion risk. Slightly less reduction in risk of uncharacteristic wildfire than alternative B.
Great Basin/ Colorado Plateau grassland and steppe	None	Away	Stable	Stable	Stable
Montane/ subalpine grassland	Low	Away	Toward. Removal of encroached trees improves vegetative ground cover, soil nutrient cycling, soil organic matter and moisture content, and reduces erosion risk.	Toward. Removal of encroached trees improves vegetative ground cover, soil nutrient cycling, soil organic matter and moisture content, and reduces erosion risk. Presettlement tree retention guidelines limit the effectiveness of this alternative at achieving DC.	Toward. Removal of encroached trees improves vegetative ground cover, soil nutrient cycling, soil organic matter and moisture content, and reduces erosion risk. Presettlement tree retention guidelines limit the effectiveness of this alternative at achieving DC.
Pinyon-juniper woodland	High	Away	Stable	Stable	Stable

Vegetation Type (PNVT)	Current Departure From DC†	Alt. A	Alt. B	Alt. C	Alt. D
Wetland/ cienega	Low	Away	Toward. Prescribed thinning and fire use would decrease water uptake by trees and shrubs resulting in a potential increase in surface runoff and groundwater recharge. Native emergent vegetation would increase.	Toward. Prescribed thinning and fire use would decrease water uptake by trees and shrubs resulting in a potential increase in surface runoff and groundwater recharge. Native emergent vegetation would increase. Presettlement tree retention guidelines limit the effectiveness of this alternative at achieving DC.	Toward. Prescribed thinning and fire use would decrease water uptake by trees and shrubs resulting in a potential increase in surface runoff and groundwater recharge. Native emergent vegetation would increase. Presettlement tree retention guidelines limit the effectiveness of this alternative at achieving DC.

†Current departure estimates (KNF 2008b)

Under alternative A, desired conditions for soils and watersheds in ponderosa pine and frequent fire mixed conifer vegetation types would not be achieved as effectively as under the action alternatives.

Alternative B proposes the most mechanical harvest treatments and, thus, the most risk from soil compaction and ground cover removal, followed by alternatives C and D. However, implementation of BMPs and SWCPs as previously discussed would minimize and mitigate potential adverse effects to soils and watershed conditions.

The majority of treatments in both ponderosa pine and frequent fire mixed conifer under action alternatives B, C, and D, would occur on level to moderately steep landscapes. Site-specific BMPs and SWCPs would be prescribed to reduce impacts of mechanized equipment in all treatment areas. Soil disturbance monitoring (Page-Dumroese et al. 2009a and 2009b) would provide the necessary feedback for adaptive management to protect soil productivity.

Use of prescribed fire provides resource managers the opportunity to control the severity of the fire and to avoid creating large areas that burn at high severity. Each alternative proposes the use of prescribed fire for fuel reduction and ecosystem restoration on the same acreage. However, alternative D prescribes the most fire for ecosystem restoration, followed by B, C, and then A. Fire treatments range from low-severity broadcast burning for ground fuel reduction, to isolated torching (less than 10 acres) that creates and maintains heterogeneity and desired openings.

In aspen, the effectiveness of treatments is likely to be somewhat higher for the proposed action or alternative A than for alternative C or D due to differences in the presettlement tree retention guidelines.

The road system (miles, management level, and location) is the same for all alternatives; however, road use is estimated to be higher under alternative B followed by C and D because alternative B would have the greatest level of timber harvest/mechanical restoration treatments

and suitable timber base of all alternatives. Since alternatives C and D would include removal of land from the suitable timber base, these alternatives would have the lowest impact to soils and watershed condition from roads over time.

Cumulative Environmental Consequences for Soils and Watersheds

The cumulative effects analysis area for soils and watersheds includes all of the 4th- (HUC8), 5th- (HUC10), and 6th-level (HUC12) hydrologic units that contain, at least partially, Kaibab lands.

Almost all of the watersheds associated with the forest have private inholdings and areas outside of the forest boundary. Many of the impacts discussed above occur on lands of other ownership, such as unpaved roads, grazing, mining, forest management, and fuel treatments that may result in reduced watershed conditions.

The Coconino and Prescott National Forests are currently revising their forest plans. These forests share boundaries with the Kaibab NF and implement similar management practices. Forest management and planning efforts are closely aligned with the Kaibab NF through cooperation and coordination throughout the forest plan revision process.

The BLM, Arizona Strip shares a boundary with the North Kaibab Ranger District. The Arizona Strip Proposed Plan/Final EIS was completed in 2007. Land management practices on BLM lands are implemented in a manner similar to Forest Service lands under NEPA requirements. Coordination between the Kaibab NF and BLM, Arizona Strip is ongoing where resource management issues overlap Kaibab NF and BLM managed lands.

Grand Canyon National Park has shared boundaries with the Tusayan and North Kaibab Ranger Districts. The Grand Canyon National Park General Management Plan was completed in 1995 in accordance with NEPA. The Kaibab NF coordinates with the park on natural resource management projects and planning efforts as needed.

Coconino and Yavapai Counties have implemented management plans that provide frameworks for managing land use, the natural environment, and conservation of natural resources. As populations in these counties continue to grow, increased pressure on NFS lands can be expected. Planning on the forest would, therefore, require considering the impacts that population growth in these counties and expansion of the wildland-urban interface toward the forest ownership has on implementing forest management practices.

Potential cumulative environmental consequences from other landowners and jurisdictions, when added to the environmental consequences of the action alternatives, include:

- Adverse impacts to soils and watershed condition caused by road construction and maintenance;
- Adverse impacts to soils and watershed condition as a result of grazing of domestic livestock;
- Adverse impacts to soils and watersheds caused by minerals and mining activities;
- Beneficial effects of low-intensity wildland fire including nutrient cycling and fuel load reduction; and

- Beneficial effects of reduced overstory and corresponding increase in vegetative understory abundance and diversity.

The potential cumulative environmental consequences of the action alternatives when combined with the past, present, and foreseeable effects of activities on lands within the watershed boundaries is a mix of beneficial and adverse effects, with most of the adverse effects being short term and the beneficial effects being long term. The overall effects of the action alternatives are beneficial, as well as the overall effects of other land management agencies in the cumulative effects analysis area. Therefore, when combined, the net cumulative effect on soil and watershed resources is positive.

Water Resources

Affected Environment for Natural Waters

Natural waters are highly productive ecosystems in otherwise low productivity arid landscapes. Wildlife is more concentrated around open water sources than across the general landscape, and obligate aquatic and semiaquatic species depend on these limited and dispersed water sources. Springs are frequently more stable ecologically than surrounding upland ecosystems in arid regions, and may offer biological refugia for some species, particularly narrowly endemic species. Contemporary uses include potable local and urban water supplies and agricultural uses such as livestock watering. In addition, springs provide traditional cultural and recreational opportunities. Detailed information on water resources can be found in the Soils, Watershed and Water Resources Specialist Report (KNF 2013e).

Perennial Streams

The only known historic perennial streams on the Kaibab NF are North Canyon Creek and Kanab Creek. The perennial reach of North Canyon Creek is located in the Upper North Canyon Wash subwatershed (HUC12) of the North Canyon Wash watershed. The creek runs approximately 1.5 miles before becoming subsurface flow. Current riparian conditions are thought to be near historic conditions with a wide variety of riparian species present. However, the stream contributes only 2 percent of the perennial stream miles in this watershed, while the forest area makes up almost 25 percent of the watershed.

The Forest Service, in cooperation with the Arizona Game and Fish Department, recently completed repair and replacement of log drop and other fish habitat structures in North Canyon Creek. This project has helped protect a genetically important population of Apache trout by rehabilitating pools that provide winter habitat and refugia in times of stream dewatering from limited precipitation. The project was completed in the lower to middle portion of North Canyon Creek below North Canyon Spring in Saddle Mountain Wilderness. This stream channel is currently classified in good condition. It is in the Saddle Mountain Wilderness and is not diverted for human uses.

Kanab Creek is also a perennial stream within the forest, but with current upstream water use and diversion, the perennial flow within the Kaibab NF boundary has been reduced substantially. Flooding disturbance and flow, which are critical ecological processes, are also greatly reduced. The base flow of Kanab Creek now originates primarily from springs that issue from canyon walls within the Kanab Creek Wilderness. High-intensity, short-duration monsoon thunderstorms also contribute to the base flow of Kanab Creek during the monsoon season. These storms can

cause localized flash flooding along the Kanab Creek drainage, but with upstream water capture and diversion, this process is now less pronounced.

Natural Lakes

On the Kaibab NF, most of the lakes exhibit ephemeral characteristics and do not hold water throughout most years, but they often retain sufficient water into the growing season to function as lacustrine and palustrine wetlands. Most of the lakes that exhibit perennial characteristics on the forest are modified. Perennial lakes include Cataract Lake (37 acres), Coleman Lake (80 acres), Kaibab Lake (70 acres), Dogtown Reservoir (94 acres), Steel Dam Reservoir (5 acres), Stone Dam Reservoir (14 acres), and White Horse Lake (42 acres).

There are 12 natural lakes on the Williams Ranger District. All of these lakes are ephemeral and are more appropriately characterized as ephemeral wetland ecosystems. These include Allen Lake, Coleman Lake, Davenport Lake, Dry Lake, Duck Lake, Faye Lake, Holden Lake, Mineral Lake, Moritz Lake, Three Mile Lake, Raymond Lake, and Smoot Lake.

There are 28 known natural lakes on the North Kaibab Ranger District. Most are relatively undisturbed by human impacts other than fencing. They include Bear Lake, Crane Lake, Deer Lake, Dog Lake, East Lake, Fracas Lake, Franks Lake, Glen Lakes, Indian Lake, Lookout Lake, Oquer Lake, VT Lake, and Wall Lake. Fracas Lake and Wall Lake are spring fed. Franks Lake is a designated geologic-botanic area in the current plan.

All of these lakes provide unique riparian plant communities and a diversity of habitats for fish (stocked, no native fishery) and wildlife. In the past, domestic livestock would congregate and trample or consume riparian and wetland vegetation and defecate and urinate directly in the waterbodies, compromising the ecological integrity of these important habitat features. The North Kaibab Ranger District, with cooperation and assistance from other organizations (Grand Canyon Trust and Arizona Deer Association), has fenced all but two of these lakes to exclude livestock. Two unfenced lakes occur at the district boundary and are shared with other ownership. Access to these lakes by livestock is discouraged.

Springs

Arizona has the second highest density of known springs in the United States, with the Mogollon Rim and the North Kaibab having among the highest densities of springs in Arizona (Larry Stevens, personal communication). According to the National Hydrography Dataset layer, there are 709 springs in all the Kaibab NF connected HUC8 subbasins. The forest contains 167 known springs or about 23 percent of the total. Ninety-two of these springs occur on the North Kaibab Ranger District, 74 occur on the Williams Ranger District, and 1 has been identified on the Tusayan Ranger District.

The historic extent and flow of springs are generally unknown, but are presumed to be approximately equal to the current extent and flow. No springs on the Kaibab NF flow more than 0.2 mile. The extent and flow of springs fluctuate largely as a factor of precipitation. Human impacts (i.e., livestock grazing, water capture and diversion, and recreation) have adversely affected many springs on the forest. Many of the springs are developed, which probably occurred after the Homestead Act of 1862. These developments remove water from the site and reduce riparian vegetation extent. Several springs have been documented to be at risk or have nonfunctional riparian areas due to ungulate grazing, lack of spring infrastructure maintenance,

and recreational activity. Springs can exhibit reduced flows caused by transpirational effect of increasingly dense forest vegetation encroaching on these areas, but this has not been conclusively documented on the Kaibab NF. In addition, springs located adjacent to wells may exhibit reduced flows caused by groundwater pumping, or draw down.

Wetlands/Cienegas

The number and extent of historic wetlands on the Kaibab NF is largely unknown; however, the number and extent of wetlands is estimated from information found in the U.S. Fish and Wildlife Service National Wetlands Inventory. The National Wetlands Inventory data include stock tanks as areas identified as wetlands. Generally, wetlands are areas where soil saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface (Cowardin et al. 1979). This is not the case for most stock tanks on the forest.

The National Wetlands Inventory identifies four primary wetland types on the Kaibab NF. These include freshwater emergent wetlands, freshwater forested/shrub wetlands, riverine wetlands, and lakes. There are approximately 295 acres of freshwater emergent wetlands, 1 acre of freshwater forested/shrub wetlands, 5 acres of riverine wetlands, and 690 acres of lakes on the forest.

Affected Environment for Developed Waters

Numerous lakes on the Kaibab NF have either been constructed in drainages or wet meadows or were natural lakes that have been substantially altered (impounded or excavated) to increase the water-holding capacity. Most of these lakes dry substantially during the summer before the monsoon. Several of the lakes are artificial impoundments with constructed dams and are the source of recreational opportunities for forest visitors. Constructed lakes that exhibit perennial characteristics on the forest are summarized in table 27.

Table 27. Perennial constructed lakes of the Kaibab National Forest and associated acreages

Lake Name	Acreage
Cataract Lake	37
Coleman Lake	80
JD Dam	28.
Kaibab Lake	71
Dogtown Reservoir	94
Steel Dam Reservoir	5
Scholz Lake	63
Stone Dam Reservoir	14
White Horse Lake	42

There are three large reservoirs (500 acre-feet or larger) on the Williams Ranger District. These include West Cataract Creek, Dogtown Reservoir, and Kaibab Lake. Dogtown Reservoir is the largest with a maximum water storage capacity of 1,390 acre-feet. Kaibab Lake has a maximum water storage capacity of approximately 967 acre-feet, and West Cataract Creek has a water storage capacity of approximately 860 acre-feet. The most common uses of these reservoirs are

public water supply for the city of Williams, recreation, and fire protection. Three other reservoirs that that have watersheds originating on the Kaibab NF, but are not on the forest, include City Reservoir, Gonzales Lake, and Santa Fe Reservoir.

There are 492 reservoirs and stock tank claims within the 126 subwatersheds (HUC12) on the Kaibab NF, and 3,281 in the 4th-code watersheds according to the Arizona Department of Water Resources. This represents 15 percent of the total number of structures in the analysis area subbasins (HUC8). Most of the reservoirs and stock tanks were built between 1930 and 1980. These impoundments have reduced flow volume and duration of some ephemeral and intermittent stream channels on the forest. However, a reduction in riparian vegetation has not been observed due to the historically short duration that water is present in these stream channels. The reservoirs and stock tanks have increased perennial water on the forest for domestic livestock and wildlife, as well as increased riparian vegetation surrounding them.

Surface Water Quality

Improvements to the Nation's waters over the past three decades are largely due to the control of traditional point sources of water pollution. However, a large number of waterbodies remain impaired and the goal of eliminating pollutant discharge and attaining fishable and swimmable waters is still unrealized. Nonpoint sources of pollution such as agriculture, construction, forestry, and mining are responsible for much of the Nation's remaining water quality impairment.

On the Kaibab NF, the most common nonpoint source pollution is sediment generated from roads in close proximity to drainages, from residual effects of past, and in some cases, current livestock grazing, and from short-term impacts of ground-disturbing activities such as timber harvest and high-severity fire. In the 1980s, before widespread use of best management practices for protecting soils and watersheds, timber harvesting was widespread and was also a nonpoint source of pollution in the form of sediment delivery offsite and into adjacent stream courses. Currently, the Kaibab NF implements and monitors site-specific BMPs for all activities with the potential to pollute Arizona's waters.

Surface water quality has generally been satisfactory on the Kaibab NF except during drought conditions and extreme flood events, or immediately following high-severity wildfires. There are currently no streams or waterbodies on the forest classified as not meeting Environmental Protection Agency (EPA) water quality standards for their designated uses. White Horse Lake is the only lake or wetland on the forest that has been classified as impaired (category 5) for the designated uses under EPA water quality standards. In 1998, the lake was placed on the EPA 303(d) list for exceeding the turbidly standard for Aquatic and Coldwater Fisheries designated use. From 1997 to 2000, the lake exceeded standards for dissolved oxygen, pH, and turbidity. In 2002, the lake exceeded the standard for dissolved oxygen. The Arizona Department of Environmental Quality classified the lake as Category 5 (for high pH, fish kills in 1994, ammonia and turbidity exceedances). In 2006, Arizona Department of Environmental Quality placed White Horse Lake into an improved class, category 2, Attaining Some Uses. The lake was delisted in 2008 and is currently meeting EPA water quality standards. White Horse Lake is a popular recreation reservoir, and there is potential for future exceedances of water quality standards.

Water Yield and Water Rights

It is estimated that overall water yield on the Kaibab NF is static to slightly upward in nonforested areas to slightly downward in forested areas over the last 20 years, based on analysis of streamflow water yield and the following conditions:

- Streamflow is directly dependent on annual precipitation, including snowpack. Historically, periods of lower or higher annual precipitation has occurred and is expected to continue to occur.
- Greater tree and shrub basal area and canopy cover have been recorded over the last 20 years, which probably results in increased evapotranspiration and decreased runoff, water yield, and groundwater recharge.
- Drought conditions have prevailed in most years since about 1999, and have probably contributed to decreased precipitation, runoff, water yield, and groundwater recharge. Climatic (drought) and vegetative conditions on the Lower Colorado River watersheds are similar to the Verde River watersheds and, therefore, the water yield trend is estimated to be similar (static to slightly downward).
- Nonforested areas have less vegetative ground cover than forested areas (pinyon-juniper and conifers) and, in many areas, have less vegetative ground cover than under the potential plant community as identified in the Kaibab NF Terrestrial Ecosystem Survey. In addition, many of these areas have had disturbance resulting in compacted soil surfaces. Decreased vegetative ground cover and compacted soils can result in greater water runoff rates and amounts than would occur under more natural conditions.

Past studies indicate vegetative treatments only result in short-term water yield increase (1 to 3 years). However, it is estimated that forestwide, current water yield (supply) is similar to or slightly less than in the early 1980s, due to recent climatic drought conditions and greater evapotranspiration caused by increased tree basal areas, resulting in increased water consumption.

Periodic flooding is a natural disturbance that is necessary for maintaining stream channels and many riparian plant species. Occasionally, high flows can cause damage to road infrastructure and other manmade structures. Flooding is more common after large wildfires, where protective vegetative cover is removed and soil structure is altered. In severely burned watersheds, studies show peak flows (the highest flow rate measured after a storm event) can be slightly to thousands of times higher than the prefire flow rate (Neary et al. 2005, Ffolliott and Neary 2003). Damaging flow events can also occur from high-intensity summer rainstorms, or when rainfall occurs over a melting snowpack.

The current trend of use of surface water by the Kaibab NF is static. The forest's consumptive use is expected to remain static into the future, as surface water in Arizona is considered to be fully appropriated. Water right adjudications will dictate the amount and ownership of surface waters within the forest. According to Arizona Department of Water Resources Statement of Claim Filings for water rights, there are 492 stock tank claims located on the forest and 3,281 stock tank claims located in all affected 4th-HUC watersheds. These claims include several watershed level reserved water rights claims allowing use of stock water for firefighting and watering of roads during maintenance.

City of Williams Municipal Watershed

The Williams Municipal watershed is approximately 26,060 acres in size with approximately 75 percent (19,566 acres) being NFS land and 25 percent (6,494 acres) being privately owned.

Table 28 lists the eight subwatersheds (HUC12) and their associated acreages that occur within the Williams Municipal Watershed. Two of these HUC12 subwatersheds, Cataract Creek Headwaters and Dogtown Wash, encompass more than 96 percent of the total municipal watershed area.

Citizens of Williams, Arizona, depend on this 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 primary 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 (about 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 29 provides a list of reservoirs in the Williams Municipal Watershed and their approximate water storage capacities and percentages of total available surface water supply. Water from these reservoirs originates from snowmelt and summer precipitation.

Table 28. Subwatershed (HUC12) names, acreages, and associated percentages of each that comprise the Williams Municipal watershed

Subwatershed Name	HUC12 Number	Acres	Percent of Williams Municipal Watershed
Cataract Creek Headwaters	150100040502	14,616	56.1
Dogtown Wash	150100040501	10,627	40.8
Upper Red Lake Wash	150100040503	681	2.6
Johnson Creek	150602010302	70	<0.3
Upper Hell Canyon	150602020204	25	<0.3
Upper Cataract Creek	150100040504	23	<0.3
Big Spring Canyon	150602020307	9	<0.3
Pitman Valley-Scholz Lake	150602020305	3	<0.3

Table 29. Reservoirs, associated water storage capacities, and percentages of total municipal surface water in the Williams Municipal watershed

Reservoir Name	Water Storage Capacity (Million Gal.)	Water Storage Capacity (Acre-feet)	Percent of Total Water Storage Capacity
Dogtown	360	1,105	40.2
Kaibab Lake	300	921	33.4
Cataract	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

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 nonpotable, raw water used for filter backwash, sediment removal, and chemical feed, which amounts to approximately 4 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.

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 2-year drought results in significant stress on the city of Williams surface water supply. This occurred in 1996 to 1997, and again in 1999 to 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).

Some regional water stakeholders, including the Havasupai Tribe, have expressed concern regarding impacts of the city of Williams well development program on springs in the Grand Canyon area. The city of Williams and Havasupai Tribe have entered into an agreement regarding regional groundwater 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 effect 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 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 developing 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).

Climate Change

Climate change predictions for the Southwest include:

- Higher temperatures and increased drought occurrences (IPCC 2007, Sprigg et al. 2000);
- More extreme natural ecological process events, including wildfires, intense rain, flash foods, and wind events (Swetnam and Bentacourt 1997);
- Greater vulnerability to invasive species, including insects, plants, fungi, and vertebrates (Joyce et al. 2001);
- Long-term shifts in vegetation patterns (Westerling et al. 2006; Millar et al. 2007);
- Potential decreases in surface and groundwater due to reduced precipitation (USDA Forest Service 2008b); and
- Increased evapotranspirational losses and earlier snowpack melt, which may affect available water for forest use (Guido 2008, State of New Mexico 2005).

Changes in the distribution of water resources, including the timing of precipitation, water storage and availability, watershed management, and human water needs, would undoubtedly present some of the most important challenges in relation to climate change and management of NFS lands in the Southwest. Terrestrial and aquatic ecosystems and human socioeconomic conditions require water. Two possible climate change scenarios are discussed: wetter/warmer and drier/warmer.

Under a wetter climate scenario, the potential for flooding is likely to increase through earlier and more rapid melting of the snowpack, with more intense precipitation. Even if total precipitation increases substantially, snowpack would likely decrease due to higher overall temperatures. However, it is possible that increased precipitation would improve water supplies, reduce demand, and ease some of the competition among competing uses (Joyce et al. 2001, Smith et al. 2001).

In contrast, a drier climate would be likely to decrease water supplies and increase demand for such uses as agriculture, recreation, aquatic habitat, and power generation, thus increasing competition for a decreasing supply (Joyce et al. 2001). These trends would increase pressures on the already limited water supplies in the Southwest, increase energy demand, alter fire regimes and ecosystems, create risks for human health, and affect agriculture in the region (Swetnam and Betancourt 1997, Sprigg et al. 2000).

The potential for future droughts becoming more severe due to changing climate is a significant concern, especially since the Southwest currently leads the Nation in population growth. The most likely future for the Southwest is a substantially drier one. The Southwest should, therefore, be prepared for droughts that could potentially result from multiple causes. The combined effects

of natural climate variability and human-induced climate change could result in a challenging combination of water shortages for the region (Karl et al. 2009).

Development in the Southwest has primarily depended upon technology to deliver water resources. Most snowpack and many upland reservoirs are on national forests (Smith et al. 2001, State of New Mexico 2005). Some studies predict water shortages and lack of storage capacity to meet seasonally changing river flow, and transfers of water from agriculture to urban uses, as critical climate-related impacts to water availability (Barnett et al. 2008).

Agriculture remains the greatest water user in the Southwest. However, there has been a decrease in the amount of water used by agriculture, as Arizona's and New Mexico's rapidly increasing populations demand more water for municipal and other uses, and irrigation technologies improve. This has been an ongoing trend and could affect future agricultural uses.

Flash flooding, particularly following extended drought, may increase the number and severity of floods; and accelerate rates of soil erosion. The timing and extent of storm-related precipitation will play a key role in determining the degree to which people and the environment are affected (Swetnam and Betancourt 1997, Swetnam et al. 1999, Lenart 2007). In the Southwest, intense debate will likely continue over water allocation. When combined with a highly variable climate changes occurring at the landscape scale, there is an increased likelihood for conflict over water resources (Lenart 2007). In light of these possibilities, there is a need to reduce vulnerability by maintaining and restoring resilient native ecosystems.

Environmental Consequences for Water Resources

Environmental Consequences Common to All Alternatives

Under all alternatives, mechanical prescribed thinning, burning, grazing, and recreational activities are expected to occur.

Mechanical harvest and restoration treatments can impact soil hydrologic function and soil stability through soil displacement, rutting, compaction, puddling, and removal of vegetative ground cover. These impacts can have short-term effects on water quality and water yield. If large contiguous areas receive mechanical forest restoration treatments, increased erosion and sedimentation could degrade surface water quality from water that flows from treatment areas. Ground cover is often disturbed during mechanical treatments (including the removal of vegetation) and may, therefore, result in some exposure of mineral soil, leaving it at risk of raindrop impact and transport to stream and surface waterbodies. However, BMPs and SWCPs called for by existing Forest Service Handbook direction (FSH 2509.22 R3) have proven effective in mitigating ground disturbance and minimizing adverse impacts to soils and surface water quality.

Potential impacts from timber harvest and forest restoration operations and prescribed fire include the contamination of water or wetlands from chemical substances such as gasoline, oil, or hydraulic fluid that is leaked from forestry equipment. There are also potential effects from chemicals used for treating nonnative invasive plants associated with timber harvest activities.

Prescribed fires and wildfires managed for resource benefit may impact water yield through removal of vegetative ground cover over large areas. Low-intensity fire has also been shown to affect surface water quality through increased transport of sediment and ash in storm water runoff. Adverse effects to water quality are generally short term, lasting between 1 and 3 years. After 3 years, vegetative ground cover not only reestablishes, but improves substantially and serves as a filter to retain sediments and ash on upland locations.

Surface water quality in springs, wetlands, cienegas, stock ponds, and lakes may be adversely affected where adjacent areas are burned. These effects are expected to be short term (i.e., 1 to 3 years). Burning treatments have the potential to increase spring discharge when areas above spring heads are burned. This is due to decreased water uptake by plants, resulting in increased water infiltration into the soil.

While forest restoration treatments are not proposed for the purpose of increasing water yield, it is expected to do so for short time periods (i.e., 1 to 3 years) following treatments. This is due to decreased interception and evapotranspiration by trees. The resulting increase in soil moisture and runoff is expected to increase short-term water yield and groundwater recharge in treated areas. Increased groundwater recharge could result in increased flow from springs and possible reinitiation of flow from springs that have had no observed discharge for many years. However, there is no certainty whether spring flow would be significantly different from pretreatment levels following the use of fire.

Treatments to reduce tree encroachment in grasslands would result in minor soil compaction, removal of native vegetation, and short-term degradation of surface water quality where tree removal is practiced. Implementation of BMPs and SWCPs would minimize these adverse effects. Long-term improvement in soil stability and productivity would occur as grasses and forbs reestablish in areas where tree canopy cover is reduced. Soil carbon storage and nutrient cycling would return to historic levels through improved fine root turnover, organic matter accumulation, and increased soil water-holding capacity.

The proposed road system is the same for all alternatives. Roads are the dominant source of erosion and sediment in forests (Swank and Crossley1988, MacDonald and Coe 2008). As noted in the Watersheds and Soils section, some road locations are in areas that are more sensitive than others, such as along riparian areas, or in areas of inherently unstable soils. There are a large number of nonsystem roads (estimated to be hundreds of miles, Travel Management Rule Specialist’s Report) that are contributing to loss of soil productivity as well.

New road construction is generally not needed for mechanical prescribed thinning operations, however, the reopening of maintenance level 1 roads (i.e., those roads placed in storage or closed between intermittent uses) increases the amount of open roads and, potentially, the amount of soil erosion that occurs during project implementation. Temporary road use results in removal of vegetation along the road corridor, exposes mineral soil, and results in soil compaction within the travelway. Typically, there is increased erosion from roads during the first two years following road construction or reopening (MacDonald and Coe 2008, Megahan 1974).

New temporary roads would be closed, obliterated, and revegetated following use. Road design, avoidance of problem soils, appropriate design criteria, implementation of BMPs for road construction and maintenance, and road closures would be implemented to minimize adverse impacts to soils.

Roads located directly above the heads of springs have, in some cases, been shown to adversely affect spring water quality and habitat conditions through introduction of sediment from road cutbanks and fill slopes. Roads adjacent to wetlands and riparian areas have also been shown to have detrimental effects on water quality in these ecosystems. Implementation of BMPs and SWCPs would minimize adverse effects to water quality in these areas during project implementation.

Recreational uses shown to impact water quality include camping, hiking, mountain biking, and horseback riding. All of these activities may result in soil erosion and compaction and water quality impacts. Implementing site-specific BMPs and SWCPs for recreation projects would minimize adverse impacts to soils and watersheds.

Environmental Consequences for Water Resources: Alternative A – Current Plan, Current Management (No Action)

The current plan (alternative A) has no desired conditions for water resources such as natural lakes, wetlands, and springs and offers little guidance for managing these rare and ecologically important resources. The location and condition of natural lakes on the forest are generally well known. However, knowledge gaps exist with regard to the number, location, and ecological condition of wetlands, springs, and cienegas on the forest. Protection and restoration of these important natural waters has, therefore, been minimal and current management is not likely to achieve desired condition for these resources.

The current plan (alternative A) has no desired conditions for the vegetation types and no objectives in the plan to reduce encroaching conifers from grasslands or aspen stands. There are no clearly defined desired conditions for vegetation types, so it is unlikely that landscape-scale desired conditions for water resources—particularly wetlands, cienegas, springs, and other natural surface waters—would be achieved.

Under alternative A, the Kaibab NF would continue vegetation treatments at near the current rate, which is approximately 2,100 acres annually in the ponderosa pine forest PNVTs and 200 acres in the frequent fire mixed conifer PNVT. Where mechanical vegetation treatments occur and open the canopy, there is potential to improve vegetative ground cover in the ponderosa pine vegetation type, and improve water yield and water quality. At the current rate of treatment, mechanical prescribed thinning has not contributed to a measurable increase in the flow of ephemeral and intermittent watercourses or increased spring flow. Acreages for wetlands and cienegas have remained static throughout the current planning period. It is unlikely that alternative A would achieve desired conditions for water yield and water quality in ponderosa pine and frequent fire mixed conifer PNVTs.

The current trend in water yield is estimated to be static or slightly reduced over time as a result of increased stand density. Current rates of prescribed burning are not achieving desired conditions for water quality and water quantity, as acres treated are not sufficient to remove understory fuels, increase herbaceous vegetative cover, and increase the amount of precipitation that reaches soil surfaces and is retained as snowpack.

The road system (miles, management level, and location) is the same for all alternatives; however, use of roads and the need for additional level 1 roads is estimated to be lowest under alternative A because fewer acres are being treated each year with mechanical methods and

prescribed fire. This alternative would, therefore, have the lowest impact to short-term water quality than the proposed action alternatives. However, there would be a greater risk of uncharacteristic high-intensity wildfire, which has the potential to result in significant effects to waters where there is a nexus.

Because the current plan had no objectives for fencing wetlands or springs, domestic livestock and wildlife ungulates would continue to adversely affect springs that are not fenced to exclude livestock through trampling of vegetation and browsing. Defecation and urination in and around natural waters would continue to adversely affect water quality in these areas.

While the current plan addresses specific management direction for Bill Williams Mountain including protection of electronic infrastructure on the mountain, managing visual quality, managing the Bill Williams Ski Area, and the ecological significance of Arizona bugbane, it does not adequately address the high risk potential for high-severity wildfire, flooding, and debris flows that would be expected to adversely affect the Williams and surrounding homesites. The water supply for the city of Williams would be at risk and soil erosion would adversely affect surface water quality in drainages and impoundments.

At the current rate of forest restoration activities on the Kaibab NF, alternative A provides the least resilience to climate change for the ponderosa pine and frequent fire mixed conifer than the proposed action alternatives.

Environmental Consequences for Water Resources Common to Action Alternatives B, C, and D

The action alternatives provide desired conditions and include objectives and strategies for managing and restoring wetlands, springs, and cienegas, and protecting other natural waters. It further recognizes that actions to protect natural waters are relatively inexpensive and easily implemented, provide important values, and have a high concordance with social and economic needs. The action alternatives call for the protection of 10 springs over a 5-year timeframe.

The action alternatives address the need for improved cooperation and coordination with partners and stakeholders (i.e., Museum of Northern Arizona, Grand Canyon Wildlands Council, The Nature Conservancy, Grand Canyon Trust, National Park Service, Arizona Game and Fish Department, and U.S. Fish and Wildlife Service) to develop a GIS layer of northern Arizona springs and seeps and collaborate with stakeholders to gain support for spring restoration.

The management approach would include evaluating and minimizing the impacts of normal forest management activities on springs, streams, and wetlands; reducing or eliminating the impacts of nonnative species in aquatic, wetland, and riparian habitats, where practicable, and secure water rights for springs where there are no existing water rights or claims.

Under the action alternatives, there are objectives that propose mechanical thinning in the ponderosa pine vegetation type on approximately 11,000 to 19,000 acres annually and 1,200 to 2,100 acres annually in the frequent fire mixed conifer vegetation type over the plan period. Initially, mechanical thinning treatments would increase the risk of adverse effects to water quality through accelerated erosion and potential sediment delivery to surface waters. However, long-term improvement in plant-water-soil relationships are expected as herbaceous understory vegetation and forest structure and function improves following mechanical vegetation

treatments. Additionally, mitigation measures would be implemented to minimize adverse effects to soils and water quality.

Approximately14,000 to 68,000 acres of beneficial wildland fire would occur annually in the ponderosa pine and frequent fire mixed conifer vegetation types. This would include both prescribed fire and wildfire, which has the potential to increase short-term water yield in treated areas.

Prescribed fires and wildfires managed for resource benefit would have the same effects to water quality and water yield as described above for all alternatives. However, the action alternatives propose more fire for ecosystem restoration than current management (alternative A). It is possible that in the interest of restoring ecosystem function and resilience, short-term localized adverse effects to water quality would occur. These effects would generally be short-lived and minimized and mitigated by implementing BMPs and SWCPs. The outcome would be a long-term benefit to water quality and water yield.

Treatments to reduce tree encroachment in grasslands would result in minor soil compaction, removal of native vegetation, and short-term degradation of surface water quality where tree removal is practiced. Implementation of BMPs and SWCPs would minimize these adverse effects. Long-term improvement in soil stability and productivity would occur as grasses and forbs reestablish in areas where tree canopy cover is reduced. Soil carbon storage and nutrient cycling would return to historic levels through improved fine root turnover, organic matter accumulation, and increased soil water-holding capacity.

The action alternatives identify Bill Williams Mountain as a management area since it contains multiple resources of high natural, cultural, and economic value. The action alternatives also recognize the importance of the Bill Williams Mountain watersheds as a source of municipal water for the city of Williams and its importance to the Havasupai Tribe since it constitutes the headwaters of Cataract Creek. It further recognizes the significance of the mountain as a sacred site by American Indian tribes and its eligibility as a traditional cultural property. Finally, the action alternatives address the current risk of high-severity wildfire to Bill Williams Mountain because of its steep slopes, dense vegetation, and excessive fuel loads. Guidelines for managing Bill Williams Mountain include restricting the size of the Elk Ridge Ski Area to the existing established permit area, maintaining high-use roads to prevent erosion and protect watersheds, eliminating commercial plant collecting, and protecting the Arizona bugbane. The action alternatives would, therefore, guide Bill Williams Mountain toward the desired conditions more effectively than the current plan.

Under the action alternatives, there is more explicit plan direction to address the bison herd on the North Kaibab Ranger District. Guidelines specify that the bison herd should be managed so it is concentrated within the House Rock Wildlife Management Area, and that active management should be used to minimize impacts from bison to sensitive resources, particularly outside the House Rock Wildlife Management Area. Management of the bison herd under these guidelines will reduce potential damage to sensitive soil and water resources caused by the bison, and decrease the spread of nonnative invasive species.

Environmental Consequences for Water Resources: Alternative B – Preferred Alternative

The proposed action provides the greatest opportunity to achieve long-term desired conditions for water quality and water yield in ponderosa pine and dry mixed conifer vegetation types by guiding stand structure and density toward reference conditions and restoring historic fire regimes, thus guiding the plant-water-soil relationships toward improved ecological function.

Mechanical thinning restoration treatments under alternative B would have similar impacts to water quality and quantity as described under current management (alternative A). Adverse effects would include changes to soil hydrologic function, which could increase water yield in treated areas and removal of vegetative ground cover, which would adversely affect short-term water quality. Alternative B proposes the most mechanical harvest treatments and, thus, results in the highest short-term risk to water quality. With implementation of BMPs and SWCPs during forest restoration prescribed thinning operations, adverse impacts to water quality would be minimized. Long-term adverse effects to water quality caused by implementing alternative B are not anticipated.

Effects of roads to water quality and water yield under alternative B would be similar to those outlined under alternative A. However, alternative B has the greatest amount of timber harvest/mechanical restoration treatments and suitable timber base of all the alternatives. For this reason, use of roads and the additional amount of maintenance level 1 roads are estimated to be highest under alternative B. These roads generally recover (i.e., stabilize and revegetation) following use and implementation of BMPs and SWCPs.

The increased understory vegetative cover following forest restoration treatments, including removal of trees encroaching on grasslands would contribute to improved water quality since herbaceous vegetation would serve to capture sediment and improve soil quality (i.e., aggregate stability and porosity, and carbon sequestration), contributing to improved water infiltration rates.

Alternative B proposes the greatest number of acres for vegetation management (e.g., select cutting for age class diversity and structure, and reclaiming and restoring native grasslands) that would sustain healthy plant and animal communities, and provide adequate nutrients, soil productivity, and hydrologic function. These conditions promote resilience and reduce opportunities for uncharacteristic disturbance and damage to ecosystem functions.

Environmental Consequences for Water Resources - Alternative C

This alternative is similar to the proposed action except it contains the previously described management area called the North Kaibab Wildlife Habitat Complex. This management area would be approximately 260,000 acres in size, and includes the national natural landmark for the Kaibab squirrel and several linked ephemeral drainages. This alternative would contain a guideline for retaining presettlement trees. Mechanical treatments, including timber harvesting, could be conducted within the management area to initially restore stand structure to a point where natural disturbance processes could be used without uncharacteristic results, and within the limitations of the tree retention guidelines. Thereafter, the desired conditions would be maintained primarily with natural disturbances and prescribed fire. Such treatments would not likely fully restore the ecological integrity of the management area. Where natural disturbances do not occur, fuel loading would recur through natural forest ingrowth and tree encroachment into openings.

Forest ingrowth creates “ladder fuels” that allow ground fires to ascend and spread quickly as crown fires.

Mechanical thinning objectives would be similar to alternative B (i.e., to mechanically thin 11,000 to 19,000 acres in ponderosa pine annually, and 1,200 to 2,100 acres annually in frequent fire mixed conifer acres over the plan period). The number of acres treated per year would decrease over time, as treated acres are removed from the suitable timber base in the North Kaibab Wildlife Habitat Complex.

Wildland fire objectives of 30,000 to 60,000 acres of wildland fire disturbance in ponderosa pine and frequent fire mixed conifer with desirable fire effects would be the same as in alternative B.

Under alternative C, potential water yield would not be expected to increase as much as under alternative B due to the presettlement tree retention requirements. Leaving more trees would result in higher evapotranspiration rates than areas where more trees are removed.

Impacts to water quality and water yield from mechanical prescribed thinning would be similar to those described under alternative A with acreages treated being approximately equal to alternative B. The presettlement tree retention guideline would result in slightly less soil disturbance than alternative B since fewer trees would be removed and transported to landings. However, the presettlement tree retention guideline would result in greater long-term transpirational water loss than under alternative B. In addition, the resulting higher stand densities would intercept more precipitation, preventing it from reaching soil surfaces where it could be utilized by herbaceous understory plants or contribute to increased water yield. Overall, a slightly lower water yield increase would be expected under alternative C than alternative B.

With the presettlement tree retention guideline required under this alternative, it is possible that prescribed fires would burn with greater intensity because stands would have greater crown closure and stand densities than under alternative B. Higher burn intensities have the potential to adversely affect surface water quality through sediment and ash transport to surface waters in stormwater runoff.

Lower road use levels are anticipated under alternative C than under alternative B, because fewer trees would be removed due to the presettlement tree retention guideline and because mechanical treatment would only be used initially to restore conditions, to the extent possible, in the North Kaibab Wildlife Habitat Complex. With lower tree harvest levels, there would be a corresponding reduction in truck traffic necessary to transport harvested products from the forest to forest product converting facilities. Upon completion of prescribed thinning treatments to restore forest conditions, there would no longer be log truck traffic on NFS roads within the North Kaibab Wildlife Habitat Complex.

Grazing impacts under alternative C would be similar to alternative B. However, the presettlement tree retention guidelines would decrease the effectiveness of forest restoration treatments at increasing vegetative ground cover since retention of all presettlement trees would limit understory response to mechanical thinning treatments.

Forest structure would be more open with improved understory abundance and species diversity and improved nutrient cycling following prescribed fire. Grassland restoration would include removal of encroaching conifers, which would improve understory abundance and species

diversity. Removal of encroaching conifers in grasslands could increase short-term water yield in these areas.

Environmental Consequences for Water Resources - Alternative D

Alternative D is similar to alternative C with the exception that no lands would be managed for timber production. Once restored to the desired stand structure, conditions would be maintained through fire and natural disturbance.

Impacts to water quality and quantity from mechanical thinning would be similar to those described under alternative A, with acreages treated being approximately equal to alternatives B and C. The presettlement tree retention guideline would result in slightly lower potential water yield increase under alternative D than alternative B. Where natural disturbances do not occur, conditions in ponderosa pine and frequent fire mixed conifer vegetation types would be similar to those in the management area under alternative C. These conditions would be conducive to higher burn intensities and large-scale uncharacteristic stand-replacing wildfire. Higher burn intensities would cause adverse impacts to water quality through increased sediment and ash transport to surface waterbodies in stormwater flow.

Since mechanical treatments to conduct forest restoration would only occur initially, short-term adverse impacts to water quality from forest operations would be lower than alternative B.

Effects of roads on soils and watershed resources would be similar to those outlined under alternative A. However, alternative D would require more use of existing maintenance level 1 and temporary roads than under current management (alternative A) to conduct mechanical forest restoration treatments (i.e., transportation of harvested trees and machinery). While the road system would be the same, lower use levels would be anticipated under this alternative than under alternative B.

Since lower road use is anticipated under alternative D, short-term adverse effects to water quality are expected to be lower than for alternatives B and C. Lower road use under alternative D would also mean less compacted soils than under alternative B, resulting in increased water infiltration on road surfaces.

Grazing impacts under alternative D would be similar to alternatives B and C. The presettlement tree retention guideline would decrease the effectiveness of forest restoration treatments at improving understory herbaceous vegetation response because retention of all presettlement trees would limit light interception at the forest floor. This alternative would also result in a lower predicted water yield than under alternative B.

Grassland restoration would include removal of encroaching conifers, which would further improve understory abundance and species diversity. Removal of encroaching conifers in grasslands could increase short-term water yield in these areas.

Since mechanical treatments under alternative D could only be conducted initially across the Kaibab NF to restore stand structure, there is uncertainty as to whether future natural disturbances would be sufficient to maintain the ecological function and natural range of variability within ponderosa pine and frequent fire mixed conifer vegetation types following mechanical treatments. Where natural disturbances do not occur, fuel loading could increase over time, leaving

ponderosa pine and frequent fire mixed conifer at risk of uncharacteristic wildfire. For this reason, alternative D would not provide the level of protection and improvement of water quality and water yield offered by alternative B.

Comparison of Alternatives for Water Resources

Under alternative A, desired conditions for water quality and water yield in ponderosa pine and frequent fire mixed conifer vegetation types would not be achieved as effectively as under the action alternatives. Alternative B has the highest potential to achieve long-term desired conditions for water yield and water quality in the ponderosa pine and frequent fire mixed conifer vegetation types. However, short-term risks to water quality are also highest under alternative B. Alternatives C and D would guide water yield and water quality in ponderosa pine and frequent fire mixed conifer vegetation types toward desired conditions, but it is uncertain whether restoration objectives would be fully achieved, leaving these vegetation types at greater potential risk of high-intensity wildfire than under alternative B.

Alternative B proposes the most mechanical harvest treatments and, thus, poses the most risk to short-term water quality impacts from soil disturbance and ground cover removal, followed by alternatives C and D. However, with implementation of BMPS and SWCPs during forest restoration, alternative B provides the greatest opportunity to achieve long-term desired conditions for water quality and water quantity. Soil disturbance monitoring (Page-Dumroese et al. 2009) would provide the necessary feedback for adaptive management to protect soil productivity.

Alternatives B and D have the highest potential to adversely affect water quality through use of prescribed fire, followed by alternative A then C. Alternatives B and D also have the highest potential to increase water yield followed by alternative C then A.

The road system (miles, management level, and location) is the same for all alternatives, however, use of roads and the additional amount of level 1 roads are estimated to be higher under alternative B followed by C and D since alternative B has the greatest percentage of timber harvest/mechanical restoration treatments and suitable timber base of all alternatives. Since alternatives C and D would include removal of land from the suitable timber base, these alternatives would have the lowest impact to water quality from roads.

Recreational uses shown to impact water quality include camping, hiking, mountain biking, and horseback riding. All of these activities may result in soil erosion with sediment transported to streams and waterbodies. These impacts from recreation could occur under all of the alternatives. Recreation use and demand is estimated to increase proportionately for all alternatives with the increase in population growth.

For a pasture to be available for grazing, it not only has to have sufficient available forage, but adequate water availability as well. Some allotments or pastures rely on developed springs, but many utilize stock tanks to capture snowmelt and monsoon rainfall for use by livestock. During recent droughts, many stock tanks on the Kaibab NF have dried up, making some pastures unusable for cattle even though forage may have been available. Stock tanks on the forest have altered the free-flowing character of many of the forest waters. Most impoundments are found in ephemeral drainages. Many of these impoundments provide for sediment capture; however, maintaining them often releases or creates sediment as well. Stock tanks provide a well-

distributed perennial source of water in many areas for domestic livestock and wildlife in an otherwise dry environment.

Restoring and maintaining resilience in forest, woodland, chaparral, grassland, shrublands, steppe, and riparian ecosystems are part of the basic elements of forestwide desired conditions and objectives provided for in alternatives B, C, and D. Restoring and maintaining resilience would likely improve the potential for ecosystems to retain or return to desired conditions after being influenced by climate change-related impacts and variability. Management practices (e.g., forest restoration treatments) that sustain healthy plant and animal communities and provide adequate nutrients, soil productivity, and hydrologic function promote resilience and reduce opportunities for disturbance and damage. See the Vegetation Specialist's Report for further discussion of ecological condition trends.

Cumulative Environmental Consequences for Water Resources

The cumulative effects analysis area is the 4th-, 5th- and 6th-level HUCs that intersect Kaibab NF lands. Almost all of these watersheds have private inholdings and lands administered by other agencies. Many of the activities and related impacts discussed above occur on lands of other ownership—such as unpaved roads, grazing, mining, forest management, and fuel treatments—that may result in impacts to water quality and water yield.

The Coconino and Prescott National Forests are currently revising their forest plans. These forests share boundaries with the Kaibab NF and implement similar management practices. These revised plans would likely include restoration and protection objectives and guidelines for natural waters similar to those of the Kaibab NF since forest management has been similar across these forests historically. Future forest management and planning efforts on the Coconino and Prescott National Forests are expected to align with the Kaibab NF through similar desired conditions, objectives, and guidelines that direct project-specific planning, and through cooperation and coordination throughout the forest plan revision process and future forest project implementation.

The BLM Arizona Strip shares a boundary with the North Kaibab Ranger District. The Arizona Strip Proposed Plan/Final EIS was completed in 2007. Land management practices on BLM lands are implemented in a manner similar to NFS lands under NEPA requirements. Coordination between the Kaibab NF and BLM Arizona Strip is ongoing where resource management issues overlap Kaibab NF and BLM-managed lands.

Grand Canyon National Park shares boundaries with the Tusayan and North Kaibab Ranger Districts of the Kaibab NF. The Grand Canyon National Park General Management Plan was completed in 1995. The Kaibab NF coordinates with the park on natural resource management projects and planning efforts as needed.

Camp Navajo adjoins the Kaibab NF at the eastern boundary of the Williams Ranger District. The primary purpose of Camp Navajo is to support the military missions of the Arizona Army National Guard. In July 2009, Camp Navajo revised their integrated natural resource management plan (INRMP). The INRMP is designed to support and accommodate accomplishment of the military missions while providing for natural resources stewardship and management. Specific goals identified by the revised INRMP are found on page 1-2. These goals are consistent with Kaibab NF desired conditions for water resources.

Coconino and Yavapai Counties have implemented management plans that provide frameworks for managing land use and the natural environment and for conserving natural resources. As populations in these counties continue to grow, increased pressure on NFS lands can be expected.

Potential cumulative environmental consequences from other landowners, when added to the environmental consequences of the action alternatives, include:

- Adverse impacts to natural waters on other ownerships caused by road construction and maintenance;
- Adverse impacts to natural streamflows by construction of impoundments and other infrastructure designed to capture surface runoff or transport spring water to offsite areas;
- Adverse impacts to natural waters (i.e., drawdown) caused by groundwater pumping;
- Beneficial effects of low-intensity wildland fire that reduces the risk of stand-replacing wildfires; and
- Beneficial effects of reduced overstory and corresponding increase in vegetative ground cover.

Protection and restoration of natural waters on the Kaibab NF under the action alternatives would benefit natural and constructed waters on adjacent lands where there are stream courses that connect forest waters to other lands. Additionally, the action alternatives call for increased prescribed thinning and burning from current levels. Increased mechanical prescribed thinning treatments would increase the risk of adverse effects to water quality through accelerated erosion and potential sediment delivery to surface waters in the short term. However, long-term improvement in plant-water-soil relationships is expected as herbaceous understory vegetation and forest structure and function improve following mechanical vegetation treatments.

The potential cumulative environmental consequences of the action alternatives, when combined with the past, present, and foreseeable effects of activities on lands within the watershed boundaries, include both beneficial and adverse effects, with most of the adverse effects being short term and the beneficial effects being long term. Overall effects of the action alternatives are beneficial, as well as the overall effects of other land management agencies in the cumulative effects analysis area. Therefore, when combined, the net cumulative effect would be positive.

Air Quality

Description of Affected Environment (Existing Condition) – Air Quality

The information in this section comes from the Air Quality Specialist Report (KNF 2012a), which evaluates and discloses the potential environmental consequences on air quality that may result with the adoption of a revised land management plan.

The Clean Air Act establishes National Ambient Air Quality Standards (NAAQS) for six principal pollutants that pose health hazards: carbon monoxide (CO), lead, nitrogen dioxide, particulate matter less than 10 microns in size (PM_{10}), particulate matter less than 2.5 microns in size ($PM_{2.5}$), ozone, and sulfur dioxide. The major pollutant of concern in smoke from wildland fire, including prescribed burns and wildfires, is fine particulate matter (Ottmar 2001). Particles larger than 10 microns in size tend to settle out of the air; smaller particles remain airborne and can cause respiratory problems. Studies indicate that 90 percent of smoke particles emitted during

wildland fires are PM_{10}, and about 90 percent of PM_{10} is $PM_{2.5}$ (Ward and Hardy 1991). Human health studies on the effects of particulate matter indicate that $PM_{2.5}$ is largely responsible for health effects (Core and Peterson 2001). Because of its small size, $PM_{2.5}$ has an especially long residence time in the atmosphere and penetrates deeply into the lungs (Ottmar 2001).

The same particulate matter that poses health risks is also largely responsible for these impairments to visibility. To protect high scenic value of our nation's national parks and wildernesses, Congress designated all wilderness areas over 5,000 acres and all national parks over 6,000 acres as mandatory Federal Class I areas in 1977, subject to the visibility protection requirements in the Clean Air Act. The Class I areas most likely to be impacted by activities on the Kaibab NF are the Grand Canyon National Park and Sycamore Canyon Wilderness.

Problem or nuisance smoke is defined by the EPA as the amount of smoke in the ambient air that interferes with a right or privilege common to members of the public, including the use or enjoyment of public or private resources. While no laws or regulations govern nuisance smoke, it effectively limits opportunities of land managers to use fire. Public outcry regarding nuisance smoke often occurs long before smoke exposures reach levels that violate NAAQS (Achtemeier et al. 2001).

Coconino County enjoys good air quality. For the past 10 years, 70 percent or more days were rated in the good category by the EPA Air Quality Index. Good is the best rating, where air pollution poses little risk to human health. Less than 1 percent of days per year rated in the unhealthy for sensitive groups category, and no days were rated unhealthy, very unhealthy, or hazardous (US EPA 2010).

Few pollution sources such as large metropolitan areas, industry, or power plants exist in northern Arizona, contributing to its reputation for clean air. On rare occasions, pollution from distant large population centers in California affects the air quality in the area. Huge dust storms that occur during the summer monsoons in the Phoenix valley can produce large amounts of fugitive dust that have also been known to affect air quality in northern Arizona, but these events are generally limited to a few days a year. Ozone levels are increasing and trending up in northern Arizona. Natural background ozone concentrations are naturally high in the West; transport from industry and large urban areas in California and other nonlocal sources also contributes significantly (Koo et al. 2010, Tong and Mauzerall 2008). Under current regulations, ozone levels in northern Arizona are largely outside of the regulatory control of the State of Arizona. Spikes seen in ozone levels do not correlate with fire activity, although, under certain weather conditions, smoke from fires has the potential to create ozone. It is not known how much ozone is created from wildland fire, or what prescriptive criteria could deter ozone creation.

The forest management activity with the potential to exceed air quality health standards, impair visibility in Class I airsheds, and generate nuisance smoke is prescribed burning. Road dust has not been demonstrated to be a measurable contributor on a regional level to visibility in the 16 Class I areas located on the Colorado Plateau (ADEQ 2003).

During the comment period for the proposed land management plan and draft environmental impact statement, a comment was received expressing concern that accumulated radionuclides would be released from prescribed fires and wildfires. In Northern Arizona there are several types of radioactive elements. Most of these are naturally occurring, such as Radon, Potassium, and Thorium. Northern Arizona also has deposits of uranium, which can and has been used for

commercial purposes. In addition, Northern Arizona, like much of the world, also has traces of man-made radioactive material, primarily from weapons testing conducted in the mid-20th century. These radioactive elements include cesium and strontium. These man-made forms of radiation tend to be non-volatile.

Radioactive elements are often found in plants and soils, although the concentration levels are very low. This is a type of background radiation that is always present. Our bodies are able to withstand this amount of radiation.

When a fire burns through an area, these radioactive particles may become re-suspended and drift into the air and spread, much like any other fire emission. The levels of radioactive material that could be released in a prescribed fire or other fire, based on studies that have been conducted on other fires, are very low and below thresholds which produce a health risk. A study that included Lockett Meadow on the neighboring Coconino National Forest found levels of radioactive materials in the soil were no different than background levels, and would provide no added human health risk (Ketterer et al. 2004, Graham 2012).

The Kaibab NF has burned an average of 8,500 acres per year since 2000. No notice of violation of the NAAQS has ever been issued to the Kaibab NF.

Wildfires, though they are not planned forest management activities, also contribute to air quality impacts. If naturally ignited by lightning, the forest may use wildfires to achieve resource objectives if current and expected fire behavior is desirable. Among the many factors fire managers and line officers must carefully weigh when deciding whether to suppress a wildfire, or manage it to perform its natural role in the ecosystem, is whether the potential benefits of the wildfire outweigh the smoke impacts to the airshed, affected communities, and rural residents.

The 10-year running average occurrence for wildfires is around 200 fires per year. Most are contained and controlled at 0.1 acre in size. The average number of acres per year treated by wildfires for resource objectives since 2003 is 11,700. For wildfires where suppression action is taken, 0.5 percent to 2 percent escapes initial attack efforts. This small percentage of escaped wildfires results in an average of over 5,000 acres per year burned by high-severity wildfires.

Baseline visibility conditions have been established for the Grand Canyon National Park and Sycamore Canyon Wilderness, which are the two Class I areas potentially affected by activities and wildfires on the Kaibab NF. The Forest Service will continue to adhere to requirements in the Arizona State Implementation Plan to meet natural condition visibility goals (table 30, Fitch and Truman 2007).

Table 30. Baseline and 2064 air quality goals in 2003 Arizona State Implementation Plan (SIP) for Natural Conditions (Fitch and Truman 2007). Deciview (dv) is a measure of visibility.

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

Winds from the southwest are predominant throughout the Southwest. As a result, during daytime hours, fire activity on the Kaibab NF is most likely to affect smoke-sensitive receptors to the north and east of fire locations. Nighttime settling of residual smoke from fires, however, generates far more concerns and complaints of nuisance smoke.

The Williams Ranger District has the largest number of smoke-sensitive receptors they need to consider during fire management activities, where nuisance smoke can be an issue. Receptors include the cities of Flagstaff and Williams, and the community of Parks, and multiple smaller housing developments scattered across the district. The most sensitive smoke receptor in the State of Arizona is the Verde Valley, which is easily impacted with nuisance smoke from the cumulative burning on the southern part of the Williams Ranger District, the western side of the Coconino National Forest, and the eastern side of the Prescott National Forest, as diurnal drainage of smoke from fires settles into this valley. Considerable coordination between forests happens when burns and wildfires that can affect the Verde Valley take place, facilitated by the interagency Smoke Management Group housed at Arizona Department of Environmental Quality. Multiple smoke monitors in the Verde Valley track emissions concentrations, as well as cameras that capture images of visibility conditions. Spikes are found in particulate matter concentrations as smoke from fire activity on the surrounding forests settles into the valley at night, although levels have not, as yet, exceeded NAAQS thresholds. Many complaints of nuisance smoke in the Sedona area are primarily concerned with the reduced quality of highly valued scenic views of the Red Rocks. Visibility in the Class I area of Sycamore Canyon Wilderness can also be affected by smoke from fires in the southeast portion of the district.

The predominant smoke-sensitive receptors on the Tusayan Ranger District are the town of Tusayan, Grand Canyon Airport, and developed areas in the Grand Canyon National Park. Smoke that may affect the visibility and scenic values of the park is always a concern.

The North Kaibab Ranger District has relatively few smoke-sensitive receptors, which are small and widely scattered. Few complaints on nuisance smoke are ever received. On the southwest side of the district, smoke from fires may settle into the Grand Canyon overnight and reduce visibility until inversion layers lift the following day.

Description of Alternatives

Alternative A – No Action Alternative

Under this alternative, no changes would be made to the current Kaibab NF land management plan, and management practices would continue at current rates. No objectives for acres burned by beneficial fire exist, though fire managers are currently burning about 8,500 acres per year with prescribed fire and manage wildfires to achieve resource objectives on around 11,700 acres per year. This equates to just over 20,000 acres per year that receive low to moderate fire entry. The forest currently thins about 2,100 acres per year in ponderosa pine and frequent fire mixed conifer to modify or restore stand structure.

Action Alternatives B, C, and D

The action alternatives include the following desired conditions for air quality:

- Air quality meets or surpasses State and Federal ambient air quality standards.

- Management activities on the Kaibab National Forest do not adversely impact Class I airshed visibility as established in the Clean Air Act.

Two guidelines apply to the action alternatives:

- Project design for prescribed burns, and strategies for managing wildfires, should incorporate as many emission-reduction techniques as feasible, subject to land management objectives and economic, technical, and safety criteria.
- Decision documents, which define the objectives and document line officer approval of the strategies chosen for wildfires, should identify smoke-sensitive receptors and include objectives and courses of action to minimize and mitigate impacts to those receptors as feasible.

The action alternatives all include the following objectives:

- Burn 13,000 to 55,000 acres in ponderosa pine and 1,000 to 13,000 acres in frequent fire mixed conifer annually, using a combination of prescribed fire and naturally ignited wildfires.
- Mechanically thin 11,000 to 19,000 acres in ponderosa pine and 1,200 to 2,100 acres in frequent fire mixed conifer to modify stand structure toward desired conditions.

Alternative C

Alternative C differs from alternative B in that it contains a new management area called the North Kaibab Wildlife Habitat Complex. This management area would be approximately 260,000 acres in size and would not be managed for timber or biomass production. Stand structure would be modified as nearly as possible toward desired conditions using a combination of mechanical thinning treatments, prescribed fires, and wildfires with beneficial fire effects. After that, no further mechanical treatments would take place, so fewer and fewer acres would be mechanically thinned over time. Maintenance of the vegetative desired conditions would be largely with wildland fire.

Alternative D

This alternative also contains the same objectives as in alternative B. It differs in that forestwide, no lands would be managed for timber or biomass production. Mechanical treatments would be used to move stand structure as nearly as possible to desired conditions; after that, no further mechanical treatments would take place, so fewer and fewer acres would be mechanically thinned over time. Again, maintenance of desired conditions would be largely with wildland fire.

Environmental Consequences for Air Quality

Air quality is not expected to be a primary driver in the selection of one alternative over another.

Transient impacts to air quality from fire are present in all alternatives. Most of the forest is occupied by fire-adapted vegetation types, and smoke from fires, regardless of ignition source or fire effects, is inevitable.

All alternatives are expected to achieve the desired conditions for air quality:

- Air quality meets or surpasses State and Federal ambient air quality standards.

- Management activities on the Kaibab National Forest do not adversely impact Class I airshed visibility as established in the Clean Air Act.

These desired conditions pertain specifically to the management activity of prescribed burning. No other management activities on the forest have been found to impair air quality.

The number of acres burned with prescribed fire is expected to be the same under all alternatives due to legal, climatological, social, and logistical limits. The reasons for this are fully explored in the assumptions section of the Air Quality Specialist Report (KNF 2012a).

The desired conditions focus on adherence to State and Federal regulations. The Smoke Management Group, housed at Arizona Department of Environmental Quality, greatly facilitates the forest's ability to adhere to the Arizona State Implementation Plan and Federal and State regulations. This also is true under all alternatives.

Again, because desired conditions are expected to be met under all alternatives, air quality is not expected to be a primary driver in selecting one alternative over another.

Some comparison between alternatives can be made by looking at the indirect effects of management activities that reduce the likelihood of high-severity fires. High-severity active crown fires produce large quantities of emissions that are often heavily concentrated. The alternative that best alters stand structure to promote characteristic surface fire over active crown fire would have the least negative environmental consequences to air quality.

Mechanical treatments to restore stand structure have indirect beneficial effects on air quality because they alter future fire behavior. Stands with open states, with 30 percent canopy cover or less, are more likely to exhibit surface fire behavior, even under hot, dry, windy weather conditions. The crown bulk density is lower, and gaps and interspaces in the canopy inhibit the spread of active crown fire from group to group (Friederici 2005, Rothermel 1991, Scott and Reinhardt 2001). Some passive crown fire (individual tree torching and isolated group torching) occurs in open states, even under low or moderate fire weather conditions, but is not sustained from group to group as active crown fire across the landscape.

Less biomass is consumed by a fire during a surface fire because primarily only litter and debris on the forest floor are consumed rather than the canopies of the trees. The amount of mechanical treatment, modeled for each alternative in the Vegetation Dynamics Development Tool (VDDT), influences the attainment of open states, promoting surface fire over active crown fire and, thus, fewer emissions from wildfires.

Alternatives are compared using outputs from the VDDT of summation of the percentage of ponderosa pine and frequent fire (dry) mixed conifer in open states with 30 percent crown cover or less. For further information on the VDDT analysis, refer to the Vegetation and Fire section of this chapter. Tables 31 and 32 display the percentage of area in open states for ponderosa pine and frequent fire mixed conifer, for each alternative, and at current and four future time marks. The highest attainment of open states at each time mark is shaded.

Table 31. Percentage of the ponderosa pine vegetation community in open states with 30 percent crown cover or less

Alternative	Time Mark – Years				
	0	10	15	50	250
A	36	46	48	59	67
B		**64**	**68**	**76**	**78**
C		42	46	68	70
D		44	47	75	71

Table 32. Percentage of frequent fire mixed conifer vegetation community in open states with 30 percent crown cover or less

Alternative	Time Mark – Years				
	0	10	15	50	250
A	33	28	30	34	43
B		43	**47**	**52**	**59**
C		41	44	46	50
D		**44**	**47**	47	53

Environmental Consequences for Air Quality: Alternative A – No Action, Current Plan

In ponderosa pine, alternative A has 11 to 20 percent less area in open states than the preferred alternative. This is because of the lower rate of mechanical thinning treatments which would create more open stand structure.

In frequent fire mixed conifer, alternative A has a markedly lower percent of area in open states than all other alternatives and, thus, the greatest susceptibility to high-severity, elevated-emission production fires.

Environmental Consequences for Air Quality: Alternative B – Preferred Alternative

The preferred alternative would have the least susceptibility to uncharacteristic, high emission producing fire over time inferred from greater attainment of open states in both ponderosa pine and frequent fire mixed conifer.

The proposed mechanical treatments in the preferred alternative would set stand structure on a trajectory toward desired conditions more quickly than in other alternatives. The combination of mechanical thinning and regular wildland fire under low and moderate conditions would increase the percentage of the ponderosa pine and mixed conifer communities in open states promoting surface fire behavior over active crown fire.

Environmental Consequences for Air Quality: Alternatives C and D

Once restored within the limits of the presettlement tree guideline, mechanical treatments in alternatives C and D would decrease over time, because mechanical thinning would only be used initially to restore the desired structure. A detailed discussion of the potential effects of the presettlement tree retention guideline of alternatives C and D compared to the tree retention guideline in the proposed action is found in the Vegetation and Fire section of this chapter.

In ponderosa pine, alternatives C and D have about 20 percent less area in open states than in the preferred alternative. This indicates a higher potential for high emission producing high-severity fire. At the 50- and 250-year time marks, alternatives C and D exhibit an increasing area in open states even though the amount of mechanical thinning treatment is decreasing. This is due to continued entry with wildfire.

At the 250-year time mark, it should be noted that there is an elevated percentage of area in an unnatural open state that is the result of high-severity fire. These areas take a long time to regenerate and attain desired conditions as they are large, seed sources at the edges are distant, and because the large old trees that are part of the desired condition take a hundred years or more to grow. The preferred alternative has the least area in uncharacteristic open states at all time marks.

In frequent fire mixed conifer, alternatives C and D have a similar amount of area in open states as alternative B at the 10- and 15-year time marks. This is because, at these time marks, a comparable amount of mechanical treatments to achieve more open states is occurring in all three alternatives. This indicates a comparable potential for high-emission-producing, high-severity wildfires among all three alternatives at these time marks. By the 50- and 250-year time marks, alternatives C and D have 5 to 9 percent less area in open states than the preferred alternative, as mechanical treatments continue to decrease, so the potential for high-emission-producing fires becomes somewhat higher than under the preferred alternative.

Comparison of Alternatives for Air Quality

In ponderosa pine, VDDT modeling for alternative B indicates the least susceptibility to high-severity wildfires with elevated emissions over time inferred from greater attainment of open states at all time marks. Alternatives A, C, and D are fairly comparable to each other at all but the 50-year time mark, when alternative A has 9 percent less open states than alternative C, and 16 percent less area than alternative D.

In frequent fire mixed conifer, alternative A has a markedly lower percent of area in open states than alternatives B, C, and D and, thus, the greatest susceptibility to high-severity, elevated-emission-production fires with 7 to 18 percent less area in open states than all other alternatives at all time marks. Alternatives B, C, and D are fairly comparable. However, alternative B has somewhat more area in open states than alternative C at all time marks, and equal or more than alternative D at three of four time marks, so alternative B is the least susceptible to high-severity wildfires with elevated emissions.

Overall, in both ponderosa pine and frequent fire mixed conifer, alternative B results in the highest percentage of open states at all but two time marks, and the least susceptible to high-severity fires with elevated emission production.

Cumulative Environmental Consequences on Air Quality

Northern Arizona enjoys good air quality. Few pollution sources such as large metropolitan areas, industry, or power plants exist, contributing to its reputation for clean air. The forest management activity with the air quality potential to exceed health standards, impair visibility in Class I airsheds, and generate nuisance smoke is prescribed burning.

Examining cumulative effects from smoke on air quality differs from the evaluation of cumulative effects for many other resources due to the transient nature of air quality impacts from smoke. Cumulative effects are not the total emissions produced in a day or a year, but rather the concentration of all fire emissions in a given airshed at a given time. For NAAQS, these concentrations have a varying time-weighted period depending on the pollutant. For PM_{10} and $PM_{2.5}$, they are measured as a 24-hour average and as an annual arithmetic mean.

Cumulative effects from prescribed burns and from wildfires that are not being actively suppressed on Federal, State, and tribal lands are largely mitigated through implementation of the Enhanced Smoke Management Program, in the Arizona State Implementation Plan, by the interagency Smoke Management Group. The personnel in the group are funded largely by the Federal agencies, which demonstrates the initiative of the agencies to, in some degree, self-regulate emissions produced from prescribed burns across Federal and State boundaries.

The Smoke Management Group assists land managers in mitigating cumulative effects of smoke from prescribed burns across the State, and assists the forest in not exceeding NAAQS or visibility thresholds through coordinating, reporting, evaluating, and scheduling activities within and between agencies when potential emissions would likely exceed desired conditions.

While emissions from wildfires are not regulated, Federal, State, and tribal land managers understand their responsibility to balance the ecological benefits of wildfires with the social impacts of the smoke they produce. The Smoke Management Group also assists land managers in this area by limiting prescribed burn approvals during periods when wildfires are already impacting an airshed. The group makes recommendations on the timing—or assists in the coordination between units—of tactical operations such as burn outs that would produce large amounts of emissions, so that they are completed, when possible, under the most favorable ventilation conditions, or spread out over several burning periods to reduce total emissions when ventilation is not as good, or through other emission reduction techniques.

Through the services of the Smoke Management Group, cumulative effects from wildland fire that are within the control of Federal and State land managers are managed to keep air quality across the State of Arizona within desired conditions, including not exceeding NAAQS, protecting visibility in Class I areas, and promoting general public support of prescribed burn and wildfire management programs. The coordination of the Enhanced Smoke Management Program across Arizona thus manages for no significant cumulative environmental smoke effects in the State of Arizona.

Recreation

The Kaibab NF offers visitors a wide variety of opportunities for motorized and nonmotorized recreation activities in settings that range from primitive and unconfined to urban and highly developed. Picnicking, camping, viewing wildlife, hunting, fishing, driving for pleasure, all-

terrain vehicle riding, snowmobiling, and backpacking occur in front country and back-country areas of the forest. The front country is composed of outdoor areas that are easily accessible by vehicle and mostly visited by day users. Developed campgrounds are included in the front country arena. Front country locations tend to be more crowded and attract a wider range of visitors than back country. Back-country areas emphasize isolation, remoteness, lack of development, and more difficult access. Four designated wilderness areas on the Kaibab NF provide outstanding back-country opportunities. Recreation is enhanced by the scenic beauty of the area which includes dramatic forest, mountain, and high desert landscapes.

Proximity to the Phoenix and Flagstaff metropolitan areas, several Colorado River communities, and Grand Canyon National Park has made the Kaibab NF an important recreation destination in Arizona. Furthermore, many local residents have a long-term connection with the forest for day-use recreation, annual gatherings, holiday celebrations, and hunting camps. High visitation occurs on summer weekends and holidays as people from nearby urban areas seek the higher elevation pine forests of the forest for relief from desert heat. More information can be found in the recreation specialist report (KNF 2012b).

Description of Affected Environment (Existing Condition) – Recreation

Recreation Settings

Visitors to the Kaibab NF desire a variety of recreation options, ranging from undeveloped, remote opportunities to more development and easier access. The forest's goal is to provide an appropriate mix of recreation settings for a variety of motorized and nonmotorized uses. To facilitate achievement of this goal, the Forest Service uses the recreation opportunity spectrum (ROS), a nationally recognized classification system that describes six different recreation settings (primitive, semiprimitive nonmotorized, semiprimitive motorized, roaded natural, rural, and urban) and the associated opportunities and experiences (USDA Forest Service 1982). Factors that determine the ROS class for an area include access, remoteness (including distance from roads and settlements), degree of naturalness (level of human modification to the landscape), facilities and site management, social encounters (number of encounters with other people within a typical day), visitor impacts, and visitor management (degree of visitor controls). Recreation facilities are constructed to an appropriate development level based on ROS. National policy has identified the ROS framework as the common foundation for recreation and wilderness resource input into land and resource management plans. ROS provides a framework for defining the types of motorized and nonmotorized outdoor recreation opportunities the public might desire and identifies that portion of the spectrum a given national forest might be able to provide and/or sustain.

The ROS is typically used to set management direction to reflect "desired" recreation conditions in land and resource management plans. However, the 1988 Kaibab NF forest plan did not comprehensively map forestwide ROS classes. In 2000, recreation managers located on the Tusayan and Williams Ranger Districts contracted with Northern Arizona University (NAU) to complete forest visitor use surveys, the results of which, combined with other recreation planning efforts, led to amendment 6 of the 1988 forest plan on October 21, 2004, to include an updated programmatic ROS and Scenery Management System classifications and standards (KNF 2004a).

To assist with managing and maintaining desired ROS classes, the South Zone Districts developed the "Kaibab National Forest Recreation Opportunity Spectrum and Scenery

Management System Guidebook (KNF 2004b). Forest plan direction under Amendment 6 directs the South Zone to follow the guidebook for project analysis and implementation. Some exceptions for meeting desired ROS classes were given in the amended direction especially for meeting forest health, grassland restoration, and fuels treatment desired conditions. In 2006, the North Kaibab Ranger District began a similar planning effort, which was deferred in anticipation that it would be addressed in this plan revision.

Two wilderness areas are located entirely within the Kaibab NF and two are co-located on the Coconino and Prescott NFs. These and other wilderness areas are congressionally mandated to provide outstanding opportunities for solitude and primitive and unconfined recreation. Consequently, all motorized recreational uses are excluded. The Kaibab NF also emphasizes nonmotorized recreation opportunities in the semiprimitive nonmotorized ROS classes.

The Kaibab NF also contains scenic and historical trails. Approximately 90 miles of the Arizona National Scenic Trail traverses the Tusayan and North Kaibab Ranger Districts. This primitive, nonmotorized trail highlights the State's diverse ecosystems, scenery, and history. The Beale Wagon and Overland trails highlight early European settler history in the area, and the Bill Williams Mountain Complex National Recreation Trails provides a variety of hiking opportunities.

Table 33. Current plan desired recreation opportunity spectrum (ROS) acres by ranger district (2004 amendment)

Desired ROS Class	Tusayan and Williams	North Kaibab
Non-wilderness		
Urban	641	0
Rural	52,570	0
Roaded Natural	282,462	328,853
Roaded Modified	62,351	587
Semiprimitive Motorized	248,132	171,829
Semiprimitive Nonmotorized	42,390	48,097
Wilderness		
Semiprimitive Nonmotorized	11,721	61,350
Primitive	2,813	44,302

Developed recreation includes a variety of distinctly defined sites and/or areas where facilities such as campgrounds, picnic areas, interpretive sites, information centers, and snow play areas have been developed for concentrated public use and enjoyment. Privately developed facilities are approved by the Forest Service and permitted under special use authorizations. Developed recreation sites are generally in a rural or roaded natural ROS setting. Roads, parking lots, picnic tables, toilets, drinking water, ski lifts, boat ramps, fishing piers, and buildings such as lodges and cabins may be present at developed sites and areas.

Dispersed Recreation

Dispersed recreation occurs on areas that are not developed for concentrated or intensive public use, including roads, trails, and general forest and water areas not treated as developed sites. Popular dispersed recreation activities include driving for pleasure, nature/wildlife viewing, hiking, camping, hunting and fishing, and off-highway vehicle (OHV) riding. People who enjoy dispersed activities often avoid developed sites because they prefer less human disturbance and onsite control.

Many people camp along roadsides and use these areas for staging additional activities such as walking, biking, hunting, riding horses, bicycling, and off-road vehicle use. The highest concentrations of dispersed use sites are found on the Tusayan and Williams Ranger Districts. Much of this use occurs in shaded flat areas where few natural or constructed barriers block access to the general forest area. Some of these concentrated use areas have experienced crowding during peak seasons, health and safety concerns (e.g., littering and human waste), and resource degradation (e.g., vegetation removal, trampling, soil erosion, wildlife disturbance, etc.). Inventory and monitoring of concentrated dispersed use areas has been limited, so detailed, comprehensive information regarding their location and related uses throughout the forest does not exist.

Much dispersed recreation use occurs on trails located throughout the forest. The Forest Service uses a database application called INFRA to house information on national resources, such as buildings, trails, roads, wilderness areas, and water systems. According to information entered into the INFRA trails database, there are 506 miles of trails on the forest, with 96 miles in wilderness and 410 in nonwilderness. Managed use is a mode of travel that is actively managed and appropriate on a trail, based on its design and management. A trail or trail segment may have more than one managed use and numerous uses may be allowed.

Motor Vehicle Use

The Forest Service Travel Management Rule, published in 2005, requires each national forest or ranger district to provide for a system of NFS roads, trails, and areas designated for motor vehicle use. It acknowledges motorized recreation as an appropriate use of NFS lands under proper management and provides a definition for OHVs. Implementation of the rule restricts motorized cross-country travel.

A requirement of the Travel Management Rule is publication of a motor vehicle use map (MVUM) (36 CFR 212.56) that identifies motorized route/area designations. Once the map is published, motor vehicle use inconsistent with designations is prohibited (36 CFR 261.13).

The Kaibab NF is utilizing a district-by-district approach to implement the Travel Management Rule. For each district, an environmental assessment has been prepared to document the purpose and need for action and the direct, indirect, and cumulative environmental effects of the proposed action and various alternatives to the proposed action. For all districts, a final MVUM identifying which routes/areas are available for motorized vehicle use on the Kaibab NF will be or has been published. Decisions for all three districts have recently been signed. The final decisions for the Williams and Tusayan Ranger District amended the current forest plan to prohibit motorized travel off of designated routes except as identified on the MVUM. The MVUM for the North Kaibab Ranger District has recently been issued. Each decision and resultant MVUM would also provide direction for motorized vehicle use in the revised forest plan.

Current Trends in Recreation Use

As the population in Arizona grows, it is inevitable that competition for existing resources, including land and water, will become a more critical issue. An increase in development to accommodate incoming residents and visitors would undoubtedly conflict with demand for more and varied outdoor recreation opportunities. It is also likely that access to existing recreation resources could be compromised by growth, as less private land is being opened up to recreation uses (Cordell et al. 2004). Finally, the number of people using existing outdoor recreation resources is likely to increase, while at the same time tax support for outdoor recreation areas may decrease, which could result in the degradation of natural and cultural resources and a lack of available capital to maintain and manage these sites (Cordell et al. 2004). The resolution of such conflicts has important long-term implications for the future of tourism and quality of life in Arizona.

On the Kaibab NF, historic participation in various recreation activities is a good indicator of the types of recreation opportunities and settings recreation visitors demand (table 34). In 2000, the top five recreation activities were viewing wildlife and natural features, camping, general relaxation, and hiking or walking. In 2005, the top five recreation activities were viewing natural features, hiking or walking, viewing wildlife, driving for pleasure, and relaxing. In 2010, the top five activities were viewing wildlife and natural features, hiking or walking, driving for pleasure, and relaxing.

Projected Recreation Use

As part of the requirement for the analysis of the management situation, a comprehensive evaluation report (CER) was prepared in April of 2009 to evaluate the needs for change in light of how management under the current Kaibab NF forest plan is affecting current conditions and trends related to sustainability (KNF 2009).

Table 34. Visitor activity results from national visitor use monitoring on the Kaibab National Forest

Activity	Percent Participation		
	2000	2005	2010
Viewing natural features (scenery, flowers, etc.)	64	54.7	55.4
Viewing wildlife, birds, fish, etc.	60	44.8	45.5
Relaxing, hanging out, escaping noise and heat, etc.	47	36.7	35.6
Hiking or walking	44	47.2	53.2
Developed camping	26	13.7	16.8
Picnicking	26	12.4	14.6
Driving for pleasure	23	44.2	49.4
Nature center activities	19	18.9	17.6
Resort use	17	8.9	19.4
Hunting – all types	14	4.9	0.9
Horseback riding	12	2.4	1.8
Gathering natural forest products	12	1.7	5.8
Primitive camping	11	13.2	9.2
OHV use (4-wheelers, dirt bikes, etc.)	7	3.4	4.7
Fishing – all types	5	3.6	16.3
Nature study	4	10.9	9.9
Other nonmotorized activities	4	8.3	0
Backpacking	1	2.8	4.8
Bicycling, including mountain bikes	1	6.4	4.2
Downhill skiing or snow boarding	1	1.6	0.5
Visiting historic and prehistoric sites	0	21.5	17.4
Cross-country skiing, snowshoeing	0	0.1	0.0
Snowmobiling	0	0	0.2
Motorized/nonmotorized water travel (jet boats, ski sleds, canoe, kayak, raft, etc,)	0/0	0.3/0.2	0.7/2.3

Methodology and Analysis

Probable management activities related to alternatives A, B, C, and D were used to evaluate or predict long- and/or short-term effects on recreation settings. These activities were evaluated in relation to their effects on recreation settings, opportunities, and/or experiences.

This analysis used the running averages of acres of ponderosa pine and frequent fire (dry) mixed conifer treated by wildland fire, acres mechanically treated (thinned), and acres identified for potential wilderness areas from the objectives for each alternative as fixed numbers per year in order to make broad comparisons between alternatives.

Assumptions

Recreation is not expected to be a primary driver in selecting one alternative over another, because predicted impacts between alternatives with regard to recreation are not dramatically different. The reasons large differences do not exist include:

- All alternatives are expected to achieve the desired conditions for recreation in the proposed plan.
- All projects implemented on the forest will require a site specific assessment of their potential impacts to recreation resources and verification of the need for mitigation to meet or exceed desired ROS classes.
- All alternatives provide for an appropriate array of motorized and nonmotorized recreational opportunities.
- None of the alternatives prohibit future site specific recreation project planning.

Environmental Consequences for Recreation

Environmental Consequences for Recreation: Alternative A – Current Plan, Current Management (No Action)

Management under the current forest plan does not have comprehensive adopted ROS classes for the North Kaibab Ranger District. Amendment 6 of the 1988 forest plan incorporated new direction for recreation and adopted ROS classes on the Williams and Tusayan Ranger Districts only. Therefore, under alternative A, no new direction or adopted ROS classes for the North Kaibab Ranger District are included. Recreation management for the forest would maintain its present course with guidance provided by amendment 6 for the Tusayan and Williams Ranger Districts. ROS classes could be mapped and adopted for the North Kaibab Ranger District through an additional amendment. No new acres of wilderness are proposed under the current plan, and 400,943 acres are designated as suitable timberlands.

Environmental Consequences for Recreation Common to All Action Alternatives

Land management activities directed by the LMP have the potential to impact recreation opportunities, settings, and/or experiences under all action alternatives (B, C, and D). Recreation resources are affected when management activities alter the recreation setting, experience, and/or related opportunities. These effects can be both short and long term. With the exception of differences in proposed wilderness and effects associated with differences in prescribed thinning/prescribed burning, implementation of the action alternatives would likely have similar impacts on recreation.

Alternatives B, C, and D would include desired ROS classes for the North Kaibab Ranger District and subsequently improve the management of recreation by developing a consistent forestwide approach. Decisions related to recreation settings and related physical and social components would be consistent with ROS classes. Under alternatives B, C, and D, the revised plan would adopt desired ROS classes for the entire forest and include guidance for the entire forest to follow the ROS/Scenery Management System (SMS) Guidebook for project analysis and implementation.

Direction in the form of desired conditions, guidelines, and standards for recreation is contained primarily in the Recreation and Scenery section of the revised plan.

Forest acreage is represented by ROS classes ranging from primitive to urban. An overlay consisting of the desired/adopted ROS classes is shown on a map in the proposed plan. For all alternatives, all ROS classes were developed in conjunction with the 2003 National ROS Mapping protocol. Table 35 displays the acres of ROS class prescribed under each plan alternative.

Table 35. Acres of desired recreation opportunity spectrum (ROS) classes by alternative

ROS Class	Alt. A*	Alts. B, C, and D
Nonwilderness		
Urban	641	641
Rural	52,570	52,570
Roaded Natural	282,462	611,045
Roaded Modified	62,351	62,938
Semiprimitive Motorized	248,132	419,961
Semiprimitive Nonmotorized	42,390	93,758
Wilderness		
Semiprimitive Nonmotorized	11,721	11,721
Primitive	2,813	105,434

*Alt. A does not include acres of ROS classes for the North Kaibab Ranger District because ROS acres for the district were not mapped.

The alternatives utilize ROS and the SMS as integrated, complimentary management systems (see the Scenery section of this chapter for detailed information regarding SMS). Integrated management of recreation and scenery via the ROS/SMS Guidebook helps provide effective and coordinated direction including adequate mapping and standards and guidelines to ensure management activities achieve desired ROS conditions.

Management areas that emphasize recreation in their desired conditions include wilderness, Kaibab Plateau-North Rim Parkway (Arizona State Scenic Road and National Forest Scenic Byway), the Arizona National Scenic Trail, Overland and Beale National Historic Trails, I-40 Parks Nature Trail, Bill Williams Mountain Complex National Recreation Trails, and developed recreation sites. Aspen has also been identified as having high recreational value. Desired conditions for aspen include an emphasis on providing opportunities for scenic enjoyment, recreation, and cultural/spiritual experiences.

All projects implemented on the forest will require a site-specific assessment of their potential impacts to recreation resources, experiences, and settings. Projects affecting National Scenic, Historic and Recreation trail corridors will be planned, project effects evaluated, and mitigation measures developed to preserve the nature and purposes of these trails. This will include an inventory of qualities, values, resources and associated settings (as defined in the National Trails System Act and in order to comply with Executive Order 13195). The ROS/SMS Guidebook

provides management guidance to help ensure ROS classes are sustained and mitigation is consistent across the forest. The prescribed ROS classes for the forest would serve as a guide for the design and implementation of management activities when formally adopted into the revised forest plan. Each alternative would sustain the same range of ROS settings and provide an appropriate array of motorized and nonmotorized recreation opportunities. Where an existing or current ROS class is the same as an adopted or desired ROS class, management activities would not change or diminish the setting. This is primarily the case with primitive and semiprimitive motorized and nonmotorized settings that are contained in designated or recommended wilderness or in areas with little to no scheduled management activities.

The Recreation Facility Analysis process is an important administrative tool that enables the Forest Service to continue offering quality developed recreational experiences on national forests and grasslands. None of the alternatives would change previous decisions made in the 2007 Kaibab Recreation Facility Analysis planning process, nor would any of the alternatives prevent subsequent planning efforts related to the Recreation Facility Analysis process or other national policy requirements related to developed recreation. Any new developed recreation facilities would be subject to site-specific project planning and analysis, and the development level of new projects would be consistent with ROS designations.

None of the alternatives focus on dispersed recreation in front country and back-country areas on the forest. However, none of the alternatives would prevent or preclude subsequent site specific planning for dispersed recreation, which could result in future opportunities as well as closures, prohibitions, and/or restrictions to some uses and/or areas.

Virtually every acre of the Kaibab NF provides opportunities for recreation. As a result, almost every management activity associated with the action alternatives, as well as a wide array of disturbance events, has the potential to affect recreation opportunities and experiences. The most obvious and significant management activities affecting the quality of recreation are mechanical and fuel treatments used for managing vegetation for timber production and/or wildlife objectives. Activities such as prescribed burning, mechanical thinning, and herbicide treatments can cause changes to recreation settings and/or disturb recreationists. These activities can have physically obtrusive effects in the short term, but often provide for positive visual elements, such as structural and species diversity, larger trees, and healthier vegetation that enhance recreation in the future.

Mechanical thinning activities typically impact access (i.e., road construction or reconstruction) and scenic quality of the treated area. Roads that are constructed or reconstructed to accommodate mechanical treatments can have both positive and negative effects on the recreation experience. Negative effects may include increased noise and nuisance dust levels, altered landscapes (i.e., the presence of slash piles, denuded ground, and tree stumps), additional traffic, temporary closure of recreation facilities or trails, disrupted travel routes due to road closures, conflicts, and potential safety hazards associated with logging trucks on roads. Positive effects can include improved access to an area for recreation activities such as pleasure driving, gathering forest products, hunting, fishing, and roadside dispersed camping. Mechanical treatments can positively impact those seeking a more developed, roaded recreational experience associated with improved access. Additionally, it can improve habitat for some species and enhance wildlife-related recreation opportunities.

Prescribed fire could result in short-term impairment of scenery (through burned landscapes), air quality (through increased smoke), and other aspects of recreation experiences through increased traffic, temporary closure of recreation facilities, trails or roads, and potential safety hazards associated with fire equipment on roads and creation of hazardous conditions. The extent of these effects may, however, be less than those of a wildland fire because prescribed fire is typically of a lower intensity and shorter duration.

Environmental Consequences for Recreation: Alternative B – Preferred Alternative

The preferred alternative (alternative B) is aimed at addressing four primary needs for change: (1) modifying stand structure and density of forested ecosystems toward reference conditions; (2) protecting and regenerating aspen; (3) protecting natural waters; and (4) restoring grasslands by reducing tree encroachment in grasslands and meadows. This alternative also calls for providing a balanced range of recreation opportunities within limits of the administrative and resource capacity. Activities associated with working toward achieving these needs for change have the potential to affect recreation in both short and long timeframes. Mechanical treatments and prescribed burning may temporarily displace recreationists and impact recreation opportunities and experiences in the short term, but in the long run would likely enhance the recreation environment by reducing the risk of uncharacteristic wildland fire and improving scenery, habitat, and watershed function. Alternative B recommends the designation of 6,394 acres of wilderness through additions to the Kanab Creek, Saddle Mountain, and Sycamore Canyon wildernesses, as well as a small area adjacent to Grand Canyon National Park. Under alternative B, management of recreation would be guided by comprehensive adopted ROS classes for all three ranger districts on the Kaibab NF.

Environmental Consequences for Recreation: Alternatives C and D

Alternatives C and D address the same primary needs for change as alternative B, call for providing a balanced range of recreation opportunities within limits of the administrative and resource capacity, and call for management of recreation opportunities to be guided through the adoption of comprehensive ROS classes for the forest's three ranger districts. These alternatives differ from alternative B in that in addition to the recommended wilderness in the proposed action, they would recommend five areas (Burro Canyon, Coconino Rim, Seegmiller, South Canyon Point, Sycamore Canyon Addition, and Willis Canyon) totaling approximately 37,900 acres for wilderness designation. Alternative C calls for the retention of trees greater than 120 years of age and designation of a 260,000-acre North Kaibab Wildlife Habitat Complex Management Area and its removal from the suitable timber base, wherein desired conditions would be maintained by restoring the natural fire regime following restoration to desired conditions. Alternative D also calls for the retention of trees greater than 120 years of age, but does not designate the new management area; it removes the entire forest from the suitable timber base and applies the guideline that following restoration, desired conditions would be maintained by restoring the natural fire regime to the entire forest. This could provide for greater wildlife viewing opportunities and reduced visitor displacement over time.

Comparison of Alternatives for Recreation

Alternative A has the most land in the suitable timber base and, consequently, would have the greatest potential to negatively affect recreation opportunities and experiences through timber

harvest activities. Alternatives B and C have less land in the suitable timber base than alternative A. Alternative D would have the least management activity disturbance to recreation because all lands are removed from the suitable timber base. Under all alternatives, the desired ROS settings would be sustained, but alternatives B, C, and D would propose the adoption of comprehensive ROS classes for the entire Kaibab NF to bring them in line with national standards. As long as vegetative enhancements set a trajectory toward desired conditions, mechanical treatments that improve both vegetation and wildlife habitat should be acceptable short-term deviations from ROS classes in any of the alternatives.

Alternatives B, C, and D recommend varying acreages for wilderness designation. Alternative B proposes additions to existing wilderness totaling 6,394 acres. Alternatives C and D recommend designation of six other wilderness areas in addition to those proposed in alternative B. As a result, opportunities for primitive, unconfined recreation consistent with wilderness designation would increase slightly with alternative B, and more considerably with alternatives C and D. Motorized and nonmotorized recreation opportunities would neither increase nor decrease under any of the alternatives as a result of the proposed wilderness areas, as these areas have consistently been managed for nonmotorized uses.

Trampled and reduced vegetation, manure, and interaction with livestock have the potential to affect recreation experiences, particularly for people unaccustomed to recreating in an environment with livestock. Because no differences exist among the alternatives in the number of allotments open to grazing, no change from current conditions in grazing impacts on recreation is anticipated. Adaptive management and site specific project planning would address any needed changes to management.

Maintenance, construction, reconstruction, and decommissioning of roads and trails can affect recreation opportunities and experiences. Road construction and reconstruction are usually associated with timber harvest, forest health projects, facility development, utility corridors, telecommunication sites, and mineral and energy development. Road construction and reconstruction can create changes in the factors (access, remoteness, degree of naturalness, site management, and social encounters) that determine the ROS class for an area. Decommissioning roads can lead to a shift from the more developed, modified settings to the less developed. Under all alternatives, roads would be constructed, maintained and/or decommissioned according to the ROS classifications formally adopted in the revised forest plan.

Utility developments such as cell towers, windmills, solar grids, pipeline corridors, power lines, and access routes can result in short-term impacts to recreation through construction, vegetative clearing, and other ground-disturbing activities. Long-term effects from operations and maintenance of permanent structures are usually greatest when they occur in primitive, semiprimitive, and roaded natural areas with a high scenic component and little or no previous existing development. In such cases, recreationists who prefer less developed settings and more natural-appearing environments may experience substantially modified environments with moderate to high evidence of the sights and sounds of humans within the immediate area of the utility development. All plan alternatives would emphasize restricting utility development to designated corridors and sites. Subsequently, utility development effects on recreation would be similar for all alternatives.

Under all alternatives, there is potential to place undeveloped private land in public ownership through land exchange or purchase, thereby providing additional opportunities for recreation.

There is also potential for lands purchased or exchanged into private ownership to decrease the amount of public land available for recreation on the forest. These potential beneficial and adverse effects to recreation exist equally under all alternatives.

Under all alternatives, integration, collaboration, and active engagement with communities are essential components of creating long-term sustainable recreation programs. The importance of community stewardship and partnerships would grow increasingly important over the life of the plan, requiring agencies at all levels to share resources and increase collaborative efforts regarding sustainable resource management.

Existing levels of outdoor recreation funding are inadequate to meet the recreation needs of Arizona's residents and visitors. Funding is limited or not available for construction and renovation of facilities, operations and maintenance, planning and monitoring, and staffing programs. Budget stresses are presenting challenges to local, State, and Federal governments as they attempt to continue providing recreation for a growing and changing population. Securing adequate funding to maintain, construct, and/or reconstruct recreation facilities and trails to meet the needs of a growing population will be a challenge under all alternatives.

Cumulative Environmental Consequences for Recreation

The analysis area for cumulative effects includes the Kaibab NF and adjacent lands in northern Arizona including the Coconino and Prescott National Forests, Grand Canyon National Park, several local national monuments, Arizona State Parks, Bureau of Land Management lands in northern Arizona and southern Utah, and Coconino County and local parks. These public lands provide a wide range of recreation opportunities in addition to the Kaibab NF. However, differences in agency missions often result in different types of recreation experiences. National Park Service tends to more tightly manage visitor activities. They provide highly developed and managed visitor facilities in front country locations, and often offer permitted back-country opportunities. The BLM and other national forests provide opportunities similar to the Kaibab NF. Arizona State Parks typically emphasize particular land features such as a lake, and offer related recreation opportunities such as boating, fishing, swimming, and camping. Local and county park facilities are typically oriented toward day users (some offer camping) and more urban recreation opportunities such as volleyball and basketball. Kaibab NF management emphasizes dispersed recreation and provides many opportunities for related activities. Adjacent national forests receive more recreation visitation than the Kaibab NF, and have employed additional recreation management actions or have installed additional developed facilities to prevent damage to natural and cultural resources. Provision of the less developed, dispersed recreation activities is the niche filled by the Kaibab NF.

Within the planning period (the next 10 to 15 years), human population growth—as well as growth and demand for a variety of recreation settings, experiences, and opportunities—is expected to increase. Arizona's human population has been growing at a far greater rate than the national average, which is likely to continue throughout the life of this plan. A growing human population places increasing demands on recreation that could result in more human concentration and use at existing recreation areas, increased human-human conflicts, increased density of watercraft and off-highway vehicles, and reduced quality of recreation settings. The increasing use of OHVs may result in increased conflict among motorized and nonmotorized user groups throughout the cumulative effects analysis area. As use increases, compliance with

regulations could become a greater challenge as recreational participants increase and often compete for limited space and resources. Especially vulnerable are semiprimitive and primitive settings, which emphasize solitude, challenge, risk, unmodified natural environments, and minimal encounters and/or signs of other users.

As Arizona's population increases, the demand for recreational opportunities and open space will grow. However, the land and resources required to provide these opportunities are finite. Land management agencies will continue to provide a variety of recreation opportunities, but are not likely to be able to meet all demand for every activity desired. In the context of recreation-related decisions in and around the forest, the preferred plan alternative provides for long-term, continued opportunities for dispersed recreation in a landscape where these opportunities are becoming more valuable due to increased demand and limited opportunities for these experiences in the greater landscape.

Scenery

One of the primary attractions of the Kaibab NF is its scenery. Scenic resources vary by location and are greatly influenced by existing natural features such as vegetation, water bodies, landforms and geology. Ecological systems contain three ever-changing and interrelated dimensions: physical, biological, and social. All three relate to the aesthetics of ecosystems. Land and resource planning, along with the resulting administrative actions on the land, determine how ecosystems and their aesthetics are evaluated and managed. Additional information can be found in the Scenery Resource Specialist Report (KNF 2012c).

Description of Affected Environment (Existing Condition) – Scenery

Visitors to the Kaibab NF have identified scenery as one of the forest's greatest attractions. National Visitor Use Monitoring conducted in 2000, 2005, and again in 2010 identified "viewing scenery" as one of the top primary activities visitors engaged in during their visits to the forest (USDA Forest Service 2000, 2005, and 2010). Benefits derived from scenic settings include identity, self-image of communities, and enhanced quality of life. Sightseeing, driving for pleasure, and outdoor photography are among the Nation's leading recreational activities, and projected demand for these activities along with high quality scenery are expected to grow. The high scenic quality of the Kaibab NF can be partially attributed to the 1996 amendment to the Kaibab NF forest plan, which called for uneven-aged timber harvest that emphasized scattered groups of trees and retention of large, old trees that are especially desirable to visitors of the forest. The Arizona National Scenic Trail traverses the Kaibab NF. This trail was designated for the opportunities it provides for primitive, nonmotorized recreation in outstanding scenic settings.

In response to growing agency and public concern for visual resources, the Forest Service developed a Visual Management System (VMS) in 1974 to integrate aesthetic considerations into large-scale resource management decisions (USDA Forest Service 1974). VMS included objective criteria, such as viewing distance and the degree of visual change to the landscape for estimating the effects of management activities. VMS included mapping of visual quality objectives (VQOs) at the forest level. However, VMS used somewhat subjective definitions of what constituted an aesthetic landscape and relied on professional judgment to quantify effects.

In 1996, the new SMS was released (USDA Forest Service 1995). SMS updates VMS and provides a nationally standardized approach for analyzing, planning, and implementing stages of ecosystem management. SMS integrates increased understanding of ecosystem processes and cultural landscapes in identifying the effects of various management practices on scenic resources. The SMS provides guidelines that are used to inventory the landscape and classify the effects of management activities.

In 2004, the Kaibab NF used the SMS to establish new programmatic direction for scenery management on all Federal land within the Tusayan and Williams Ranger Districts (South Zone) (KNF 2004b). Analysis in the environmental assessment included establishing measurable scenic integrity objectives (SIOs) for each portion of the landscape.

A companion guidebook, the Kaibab National Forest Recreation Opportunity Spectrum and Scenery Management Guidebook, was created as part of the 2004 planning effort (KNF 2004b). Forest plan direction included in amendment 6 of the 1988 forest plan instructs the forest to use the guidebook as a primary source for scenery and recreation management. Direction contained in the guidebook includes goals, strategies, standards, and guidelines.

The environmental assessment for amendment 6 of the forest plan includes constituent information, the significance of scenic quality and aesthetic experience to people including expectations, desires, and preferences, acceptable levels of quality, behaviors, and values. Constituent information provides the foundation for understanding and identifying valued landscape attributes, landscape character, scenic integrity, and concern levels. The environmental assessment and subsequent guidebook identified the combination of physical, biological, and cultural images (landscape character) that gives the Kaibab NF its unique visual and cultural identity and helps to define “sense of place.”

Landscape character and scenic integrity are the key components used to inventory and describe existing conditions for scenery. Scenic integrity is the state of naturalness or a measure of the degree to which a landscape is visually perceived to be “complete.” The highest scenic integrity ratings are given to those landscapes with little or no deviation from the landscape character constituents value for its aesthetic quality. Landscape character provides a frame of reference from which scenic attractiveness and scenic integrity can be determined. Landscape character types and specific scenic integrity setting descriptions are contained in the “Kaibab National Forest Recreation Opportunity Spectrum and Scenery Management Guidebook.”

Scenery was not addressed as a priority need for change in the proposed plan; however, all topics in the plan indirectly relate to scenery. Restoration of vegetation structure and improvement of forest health improves scenery, especially in the long term. Aspen is recognized as having high scenic quality and, therefore, the need to protect and regenerate aspen improves and enhances scenery. Likewise, water features increase the scenic attractiveness of the forest and measures to protect seeps, springs, ephemeral wetlands, and North Canyon Creek improve and enhance scenery. Restoration of grasslands and meadows also has a positive outcome for scenery.

Though not identified in the comprehensive evaluation report (CER; KNF 2009) as a priority need for change, the Kaibab NF places a high level of concern on managing the landscape’s scenic quality. There is public concern over the visibility of forest management activities and the impact of those activities on scenery, local residents, adjacent communities, landowners, and the user public, particularly recreationists.

The key indicator used in this analysis to determine how the alternatives affect scenery is the area allocated to scenic integrity objectives (SIOs) adopted for each alternative, and the level at which various management activities are evident or meet an acceptable threshold of dominance. The term "scenic integrity objective" refers to the degree of acceptable visual alteration of the landscape and is defined as a desired level of scenic excellence based on physical and sociological characteristics of an area. Typically, more stringent or very high SIOs are incorporated to protect the most highly visible and frequently seen areas that have the greatest variety in vegetation and other naturally occurring features. SIOs are rooted in the SMS. The SIOs applicable to the Kaibab NF revised forest plan are:

- ***Very High*:** Characteristic landscape is intact, with only minute deviations.
- ***High:*** Characteristic landscape appears intact. Deviations may be present, but should repeat form, line, color, texture, and pattern common to the landscape character so completely and at such a scale that they are not evident.
- ***Moderate:*** Landscape appears slightly altered. Noticeable deviations are visually subordinate to the landscape character.
- ***Low:*** Landscape appears moderately altered. Deviations may be dominant, but are shaped to borrow from the natural landform and other visual dominance elements (line, form, texture, color), and are subordinate to the characteristic landscape when viewed as a background.

Probable management activities related to the alternatives were used to evaluate or predict long- and/or short-term effects on scenery. Activities were evaluated in relation to their ability to meet or exceed forestwide desired SIOs established in the revised forest plan.

This analysis used the running averages of acres of ponderosa pine and frequent fire (dry) mixed conifer treated by wildland fire, acres mechanically treated (thinned), and acres for potential wilderness areas from the objectives for each alternative as a fixed number per year in order to make broad comparisons between alternatives.

Environmental Consequences for Scenery

Land management activities directed by the plan have the potential to impact the scenic condition in both the long and short term. Scenic resources are affected when management activities alter the natural appearance of the landscape. Scenery is not expected to be a primary driver in selecting one alternative over another, as predicted, impacts between action alternatives are not dramatically different. This is because all action alternatives are expected to achieve the desired conditions for scenery, and all projects implemented on the forest will require a site specific assessment of their potential impacts to scenic resources that verifies the need for mitigation in order to meet or exceed SIOs.

The proposed forest plan provides the following guidelines with regard to activities affecting scenery:

- In areas with high SIOs, only minimal alterations from landscape character goals described in the desired conditions should be allowed.
- In areas with moderate SIOs, only slight alterations should be allowed, which ensure that deviations remain visually subordinate to the landscape character.

- In areas with low SIOs, only moderate alterations should be allowed.[3]

Further discussion of how the scenery guidelines would be applied is specified in the ROS/SMS Guidebook. The guidebook was developed to help meet the desired conditions that emphasize healthy, sustainable forests. At the completion of all site specific projects, the entire project area landscape should meet the mapped SIO. Management activities within very high and high SIO areas maintain the scenic integrity of these corridors and would not be apparent from the travelway.

In the revised plan, all forest travelways on the Kaibab NF (e.g., roads, trails, high-use routes, important sites, etc.) were evaluated and all major and secondary corridors were assigned various levels of concern. Foreground views are generally the most sensitive to viewers from concern level 1 and 2 roads, trails, and sites. Foreground is described as 0 to 0.25 mile from the observer based on the standards for a flat landscape and limited distant views on the plateau; middle ground is 0.25 to 3 miles; and background is 3 or more miles. These distance zones have been defined for consistency with the SMS national standard, resulting in a much larger middle ground and a smaller background than the 1988 forest plan. High SIOs assigned to the foreground of the travel corridors of most concern indicate those areas of scenic importance to the visitors' experience.

The revised plan also uses SMS and the ROS as integrated, complimentary management systems (see the Recreation section of this chapter for detailed information regarding ROS). Integrated management of scenery and recreation via the ROS/SMS Guidebook helps provide effective and coordinated direction including adequate mapping standards and guidelines to ensure management activities achieve desired conditions (SIOs).

Additional guidance for monitoring and development of mitigation measures is provided in the ROS/SMS Guidebook. Monitoring is intended to assist managers in tracking changes in scenic classes and scenic integrity over time. Progress toward desired conditions is tracked and additional measures are identified when needed to ensure that implementation of project level management activities achieves or sustains the desired conditions established in the revised plan and by amendment.

The Kaibab NF's conversion from VMS in the 1988 plan to SMS in the revised plan is consistent with a shift to more far-sighted ecosystem management benefits and principles. Activities such as prescribed burning, large-scale vegetation management activities, and herbicide treatments are examples of management activities that illustrate the benefits of a longer-term scenery management philosophy. These activities have visually obtrusive effects in the short term (typically out of step with adopted SIOs), yet they provide for more positive visual elements such as variety, larger trees, and healthier vegetation in the relatively near future.

[3] Descriptions of the terms "minimal," "slight," and "moderate" can be found in Agricultural Handbook Number 701, "Landscape Aesthetics: A Handbook for Scenery Management." In general, "minimal" means deviations are not evident because they closely follow the form, line, color, texture, and pattern common to the landscape character; "slight" means that noticeable deviations are subordinate to the landscape character being viewed; and "moderate" means deviations may begin to dominate the landscape, but borrow from the characteristics of the valued landscape character.

Management of adopted SIOs in the action alternatives would provide consistent direction for scenery. These adopted SIOs indicate the desired or acceptable level of human-induced alteration to the natural landscape character. The very high SIO allocation is assigned to primitive and semiprimitive nonmotorized settings, which include designated wilderness.

Table 36 displays the acres of SIOs prescribed for each alternative. A “very low” SIO is not included as a scenery objective in the revised plan. All acreage is consistent with the SMS model of scenic classes. Acreage is lower in alternative A (current plan) because the SMS has not yet been adopted on the North Kaibab Ranger District.

Table 36. Acres allocated to scenic integrity objective by alternative

SIO	Alternative A	Alternatives B, C, and D
Very High	17,603	123,920
High	221,764	415,160
Moderate	460,846	815,760
Low	15,684	16,245

Environmental Consequences for Scenery

Environmental Consequences for Scenery Common to All Alternatives

All projects implemented on the Kaibab NF would require a site specific assessment of their potential impacts on scenic resources. If mitigation is needed, the ROS/SMS Guidebook would provide management guidance to ensure SIOs are met and mitigation is consistent across the forest. The prescribed SIOs for the forest would guide the design and implementation of management activities when formally adopted into the revised forest plan.

If implemented, each alternative would have the potential to maintain, alter, or enhance the visual character of the forest’s landscapes to varying degrees. Where an existing or current SIO is the same as an adopted or desired SIO, management activities would not change or diminish the SIO. This is primarily the case in areas with high and very high SIOs, which are in designated or recommended wilderness or in areas, such as semiprimitive nonmotorized settings, where little to no management activities would occur.

Activities such as motorized use, vegetation management, fire management, livestock grazing, minerals exploration and extraction, recreation, and the construction and maintenance of utility corridors can change the character of natural landscapes. The specific effects of these activities on scenic resources are dependent on time and intensity. Effects to scenery are typically greatest in the first 5 years following activities.

Mechanical thinning treatments would occur under all alternatives to meet vegetation and wildlife management objectives. Thinning often improves scenic quality, particularly where there are opportunities to enhance scenic views, regenerate aspen stands, and grow bigger trees, especially ponderosa pine. Well-designed treatments can provide for a landscape consistent with the public’s expectation for high quality scenery by increasing the variety of vegetative species and/or reducing stand homogeneity (stands with uniform spacing and tree size). In general, short-term change to the existing scenic integrity resulting from mechanical treatments is more acceptable

where existing disturbance is already apparent in the natural landscape. In areas where little evident change in natural scenery has previously occurred, disturbance may be less acceptable to the public. These areas are typically associated with visually sensitive viewsheds assigned more stringent SIOs.

There is potential to temporarily impact the existing landscape from annual mechanical treatment activities under all alternatives. Mechanical treatments that target aspen regeneration, as well as other vegetative conditions, could change the short-term character of the landscape in some local areas. Short-term effects to the scenic landscape include unnatural appearing slash piles, stumps, denuded vegetation, bare soil, and scarring. Project design and/or mitigation under all alternatives would consider scenic resources so that vegetation would appear natural, particularly in the long term. In many instances, variety, texture, and color are actually enhanced along with the primary goal of improving wildlife and/or vegetative conditions. SMS incorporates this type of human-caused effect to achieve the more farsighted desired SIOs.

Environmental Consequences for Scenery: Alternative A, No Action

Under alternative A, scenery management for the forest would maintain its present course with guidance provided by amendment 6 for the Tusayan and Williams Ranger Districts. The current forest plan does not have adopted SIOs for the North Kaibab Ranger District. Therefore, under the current plan (alternative A), no new direction or adopted SIOs for the North Kaibab would occur. SIOs could be adopted for the North Kaibab Ranger District with a separate analysis and forest plan amendment. Alternative A proposes no new wilderness areas and retains the greatest amount of land that would be managed for timber production.

Environmental Consequences for Scenery: Alternatives B, C, and D – Action Alternatives

Desired conditions and guidelines for scenery are similar across alternatives B, C, and D. These alternatives would incorporate SIOs for the North Kaibab Ranger District and subsequently increase the importance of high-quality scenery as a component of the recreation experience and setting. Under these alternatives, the revised plan would adopt SIOs for the entire forest and include guidance for the entire forest to follow the ROS/SMS Guidebook for project analysis and implementation. Decisions related to scenery would be consistent with the SMS. Differences among alternatives regarding proposed wilderness areas and acreages of suitable timber, and the retention of old trees (discussed in more detail in the Recreation section) have the greatest potential to impact scenery resources.

Comparison of Alternatives for Scenery

In the long run, all action alternatives would likely meet or exceed established SIOs. Alternatives B and C would have the greatest potential to modify stand structure and regenerate aspen and, consequently, would have the most management activity disturbance to scenery. Alternative D would have the least management activity disturbance to scenery. As long as vegetative enhancements set the forest on a trajectory toward desired conditions, mechanical treatments that improve both vegetation and wildlife habitat should be acceptable short-term deviations from SIOs.

For all nonwilderness and roadless areas, prescribed fire would be utilized under all action alternatives to benefit certain wildlife and plants, improve scenery, assist in nutrient cycling, and reduce the threat of large, high-severity wildfires in the future. Under all action alternatives, the use of prescribed fire (outside of wilderness) has the potential to improve scenic integrity especially in regard to reducing uncharacteristic wildland fire and improving vegetative health and structure.

Annual prescribed fire management activities have the potential to temporarily impact scenery. Alternatives B, C, and D apply prescribed fire to the same acreage. Alternative A currently treats the smallest area, which has the least potential to affect SIOs through management activities, but has the lowest potential for meeting the desired conditions over the long term. Prescribed fire may temporarily reduce desired SIOs, but in the long term, SIOs are expected to be met or exceeded in prescribed fire treatment areas.

Secondary or indirect effects resulting from some methods used to fight wildfire have the potential for long-term visual impacts. Fuel breaks bladed with heavy equipment often leave enduring scars on the landscape. In wilderness and roadless areas, fire suppression techniques are more restricted than in nonwilderness and roadless areas. The more restrictive methods reduce permanent scarring such as that created by heavy equipment. Therefore, it is anticipated that potential negative secondary effects associated with wildfire suppression and recovery activities would be inversely proportional to the amount of wilderness or inventoried roadless area in each alternative. Alternatives B, C, and D include additional recommended wilderness. None of the alternatives would change the distribution or amount of SIOs.

Livestock grazing would continue under all alternatives. Although seasonal use of bedding areas, heavy utilization of forage, and structural improvements such as fences and livestock watering tanks may be evident in the landscape and could detract from the natural appearance if not properly located, the potential for change to the existing scenery as a result of continued livestock grazing is minimal. If adaptive management is applied successfully, the effects from livestock grazing are anticipated to be acceptable for all alternatives.

Soil erosion, whether caused by increased snow/water flows or development activities such as road construction, timber harvest, or mining, may result in a change in scenic conditions due to soil displacement and the disturbance or removal of vegetation. Soil erosion does occur naturally and, as with wildfire, would be transparent relative to meeting SIOs. Under all alternatives, any development or proposal for increased water yield would use BMPs to protect the soil resource and reduce the potential change to scenic quality.

A reduction in air quality may affect the ability to view an area or to see clearly; however, unless the air quality deteriorates to the point that vegetation dies at visually apparent levels, changes in air quality would have no lasting direct effect on scenery. Effects would be similar for each alternative, but the potential for uncharacteristic smoke emission producing fires is greater under alternative A because of limited treatments that would reduce the risk of uncharacteristic wildland fire.

Although the construction of roads could create new opportunities for viewing scenery and the closure of roads could decrease viewing opportunities, the primary effects to the scenic resource of changes in roads relate to potential change to the existing landscape. Roads typically affect form, line, color, and texture negatively. Often the most apparent impacts are landscape scarring

and unnatural linear features in background views. In middle ground, cut and fill slopes also affect form, color, and texture. Signage, gates, barriers, and other traffic control devices are typically most evident in the foreground. Highly and/or fully developed motorized trails exhibit similar effects on scenery as roads. Vehicle access needed for vegetation management activities under alternative B would allow for the most construction and reconstruction of roads and, thus, have the greatest potential for scenic impact. Alternatives A and D have the lowest potential for the construction and reconstruction of roads because fewer trees would be removed. Electronic sites and/or structures are, by their very nature, in juxtaposition to the visual elements that define or ground one within the national forest landscape. If placed insensitively, this form of development can conspicuously advertise human-caused change, resulting in a marked degradation of the scenic quality of the natural landscape. It is probable under all alternatives that existing scenic quality could be altered by the placement of new utilities or the replacement and improvement of existing utilities. Under all alternatives, emphasis would be placed on restricting utility development to designated corridors and sites. Subsequently, any effects would be largely independent of any given alternative.

Under all alternatives, mineral or energy exploration and subsequent development have the potential to affect scenic resources. Although most of the areas with the potential for mineral development have been withdrawn, valid existing mining claims may still be developed where valid existing rights can be proven. Although efforts would be made to reduce the scenic effects of mining activity, the nature of mineral development is such that SIOs are often difficult to meet when mining takes place. In some cases, SIOs might not be met over the short term, although long-term mitigation would be achieved through effective site location, application of BMPs, and adherence to rehabilitation plans. Under alternatives C and D, the potential for scenic change resulting from mining activities would be the least of any alternative, as additional wilderness would be withdrawn from new mineral entry (contingent upon congressional designation). However, mining and associated development could still occur on valid, existing claims. Alternative A recommends no additional wilderness acreage and would have the greatest potential for change to the existing landscape or scenery from impacts associated with mineral development.

There is potential to place undeveloped private land in public ownership through land exchange or purchase, which would likely best protect scenic quality for the long term. There is also potential for lands purchased or exchanged into private ownership to be developed to the detriment of scenic quality. These potential beneficial and adverse effects exist equally under all alternatives.

Cumulative Environmental Consequences for Scenery

The Kaibab NF is adjacent to a number of developing communities and large towns. Viewsheds containing portions of the forest affect the quality of life for many people living in the local area. Private lands near the forest are generally more valuable when they possess a scenic view of NFS lands. As a result, property values may increase or decrease depending upon the quality of adjacent scenery.

Lands managed by other government agencies at the county, State, and Federal levels have the potential to affect the scenic viewing experience of visitors to the Kaibab NF. Differences in agency missions and management of scenic resources could result in inconsistencies between

agencies, with the potential to negatively alter the appearance of lands adjacent to the forest. Other agencies' management activities that do not result in a natural landscape can affect the experience of forest users who are viewing scenery.

Urbanization of lands adjacent to the forest also affects the experience of those viewing the scenery. In some areas, housing developments are defining the edge of the forest boundary. When a limited number of structures are designed to blend into the landscape, the effect is minimal; however, if the structures or associated developments are not blended into the landscape or are large in scale, they can have a negative impact.

As stated earlier, tourism is often based on visitors seeking high quality scenic settings. The Kaibab NF provides a highly scenic backdrop for many adjacent communities. Any activities detrimental to the scenic landscape, whether on NFS, private, or other public lands, may negatively affect the quality of many people's experience.

Wilderness

The Wilderness Act of 1964 defined a wilderness as an area of undeveloped Federal land designated by Congress that has the following characteristics:

- It is affected primarily by the forces of nature, where people are visitors who do not remain;
- It may contain ecological, geological, or other features of scientific, educational, scenic, or historic value;
- It possesses outstanding opportunities for solitude or a primitive and unconfined type of recreation; and
- It is an area large enough so that continued use would not change its unspoiled natural condition.

As a part of the plan revision process, the Kaibab NF performed an evaluation of all areas within the forest not yet designated as wilderness that satisfy the definition of wilderness found in the Wilderness Act of 1964. This analysis determined the wilderness capability of these areas, their availability for wilderness designation, and the need for additional wilderness in the planning area. For additional information on this evaluation, see appendix E, Wilderness Area Evaluation Summary, and the Potential Wilderness Evaluation Report (KNF 2013f).

Affected Environment (Existing Condition)

The Kaibab NF manages and/or co-manages four wilderness areas: Kanab Creek Wilderness (68,474 acres), Saddle Mountain Wilderness (41,115 acres), Kendrick Mountain Wilderness (6,660 acres), and Sycamore Canyon Wilderness (58,408 acres). There are 61,505 acres of Kanab Creek Wilderness located on the North Kaibab Ranger District of the Kaibab NF ; the remaining 6,969 acres are administered by the Bureau of Land Management. Roughly two-thirds of Kendrick Mountain Wilderness lies within the Kaibab NF. The other portion is within the Coconino National Forest, but the entire wilderness area is managed under the Kaibab NF forest plan. Sycamore Canyon Wilderness is located within three different national forests—the Coconino, Kaibab, and the Prescott—but management direction for the Sycamore Canyon Wilderness is located in the Coconino forest plan. Saddle Mountain Wilderness is the only wilderness that is entirely located in and managed by the Kaibab NF.

The Kanab Creek Wilderness contains the Forest's only segment of river eligible for classification as "Wild and Scenic." The eligibility of this segment is discussed further in the "Kaibab National Forest Wild and Scenic River Assessment," which is located in the project record.

All activity, including maintenance of trails and dispersed campsites, is to be nonmotorized and nonmechanized in designated wilderness. Activities such as hiking, hunting, fishing, camping, horseback riding, and cross-country skiing are allowed. Motorized and mechanized equipment and vehicles including bicycles are prohibited in designated wilderness, as are commercial enterprises except for outfitters and guides under permit.

Management activities in designated wilderness on the Kaibab NF have focused primarily on minimal trail construction and maintenance that meet wilderness standards, interpretation and education, law enforcement, and boundary marking and maintenance. Allowed management activities include search and rescue, research (with restrictions), fire control, and access to existing inholdings and private rights. Timber harvest, road construction, creation or maintenance of wildlife and viewpoint openings by motorized methods, and maintenance of trails with motorized equipment such as chain saws are examples of prohibited activities in wilderness.

The demand for wilderness goes beyond recreation. Other values include long-term environmental monitoring, scenic backdrops for tourism, watershed protection, and maintenance of biological diversity. Many people who do not regularly visit primitive, roadless, or designated wilderness areas still value protection of such areas to maintain the opportunity for visits in the future (option value). People also gain benefits simply from knowing that natural areas exist (existence values) and that their protection today sustains them for future generations (bequest value). The option, existence, and bequest values, when combined are known as passive use values (Loomis 2000).

Several studies have shown the importance and value people place on these passive use benefits of wilderness (Cordell et al. 1999). These values or needs are reflected in the National Survey on Recreation and the Environment finding that roughly 70 percent of those surveyed agreed or strongly agreed to the question, "How do you feel about designating more Federal lands in your state as wilderness?" Over 96 percent agreed or strongly agreed with the statement, "I enjoy knowing that future generations will be able to visit and experience wilderness areas."

Wilderness designation, with its associated benefits and limitations, engenders passionate debate in the American public. On the Kaibab NF, the public has been divided on this subject. While some desire more wilderness, others do not want the restrictions that come with a wilderness designation.

Recommended Wilderness Areas Common to the Action Alternatives

The following contains a brief description of the potential wilderness areas (PWAs) common to the action alternatives (see table 37). Full descriptions can be found in the Potential Wilderness Area Evaluation Report (KNF 2013f), which is available on the Kaibab NF Web site.

Kanab Creek Additions

The Kanab Creek Additions include eight small areas (4,710 acres) adjacent to Kanab Creek Wilderness. These areas would extend the wilderness boundary to the rim, making it more

recognizable and manageable. The primary recreational uses of the Kanab Creek Wilderness include horseback riding, hiking, backpacking, hunting, photography, watching birds and other wildlife, and dispersed camping. Multiple trails provide access to and traverse the wilderness. Most visitors use trailheads originating on the east side of the wilderness, since road access on the west side is poor. Trail systems are minimally maintained and conditions vary from year to year. Spring and fall are the optimal seasons of the year for using the area. Summer visitation is lower as temperatures can exceed 110 degrees Fahrenheit.

Current recreational uses within the Kanab Creek Addition are similar to those within Kanab Creek Wilderness. The current ROS classification for most of this PWA is semiprimitive nonmotorized (SPNM).

Saddle Mountain Addition

The Saddle Mountain Wilderness addition is 1,296 acres and is commonly referred to as the "Cocks Comb." It is located on the eastern side of Saddle Mountain Wilderness. Primary recreational uses of the Saddle Mountain Wilderness include horseback riding, hiking, backpacking, photography, watching birds and other wildlife, and dispersed camping.

Trailheads accessing the wilderness originate at the top of the Kaibab Plateau and at its base in House Rock Valley. Saddle Mountain Trail parallels the main ridge for approximately 4 miles, where views of Marble Canyon Gorge, Cocks Comb, House Rock Valley, and the Vermilion Cliffs can be observed. The trail also provides access into Grand Canyon National Park. The North and South Canyon Trails, 7 and 4 miles long, respectively, follow canyon bottoms. Portions of both trails, when descending from the top of the Kaibab Plateau into lower elevations, are very steep. This area receives relatively heavy human use, but in winter and early spring, snow often makes access difficult.

The proposed Saddle Mountain addition provides extraordinary views into Marble Canyon and House Rock Valley. The Cocks Comb area contains cliff dwelling structures, rock art, and various archaic and pueblo habitation sites. Current recreational uses within this area are similar to those within Saddle Mountain Wilderness. Although the current ROS classification for this area is semi-primitive motorized, its remote location provides for semiprimitive non-motorized use.

Grassy and Quaking Aspen Canyons (Adjacent to Proposed Wilderness in Grand Canyon National Park)

In 1980, Grand Canyon National Park conducted a wilderness evaluation in which the Park Service proposed approximately 1 million acres of park to be designated as wilderness by Congress. The lower portions of Grassy and Quaking Aspen Canyons in Grand Canyon National Park are proposed for wilderness designation. The administrative boundary between Grand Canyon National Park and the Kaibab NF crosses both steep canyons and is not well marked. Recommendation of the upper portions of Grassy and Quaking Aspen Canyons (232 acres) for wilderness designation would result in all of Grassy and Quaking Aspen Canyons being managed more consistently and with a more identifiable boundary. Although this area is classified as roaded natural, the steepness of these two canyons would allow only nonmotorized use.

Jacks Canyon

Jacks Canyon is 156 acres in size and encompasses the steep (greater than 40 percent slope) portions of Jacks Canyon, which is a tributary to Sycamore Canyon. This PWA was added to all action alternatives after release of the draft Plan and DEIS to correct a mapping error in the initial PWA evaluation. This area was incorrectly included as part of Sycamore Canyon Wilderness in the GIS layers used in the initial evaluation, and was thus excluded from subsequent analysis. When evaluated for capability, availability, and need, this area was found to meet the criteria for inclusion in the action alternatives as a PWA. This area is adjacent to the Sycamore Canyon Wilderness and is characterized by steep canyon walls and limestone outcroppings. This PWA extends the boundary of the Sycamore Canyon Wilderness into a side canyon. The area is currently used for backcountry recreation and hunting, and although most of the PWA is classified as semi-primitive motorized the steepness of the canyon would likely limit mechanized and motorized vehicle use.

Additional Potential Wilderness Areas Recommended in Alternatives C and D

In addition to the recommended wilderness in the proposed action, alternatives C and D would recommend six other areas:

Burro Canyon – Burro Canyon lies within one of the Kaibab NF's inventoried roadless areas (IRA) and is recognized for its values as a large, relatively undisturbed landscape. Burro Canyon is an area totaling 10,735 acres. Current recreational uses of the area are identified in the potential wilderness area (PWA) report as limited dispersed camping. Key attractions include outstanding views of House Rock Valley and the Vermillion Cliffs, but there is no water available. The current ROS classification for the majority of the area is SPNM.

Coconino Rim – Coconino Rim also lies within one of the Kaibab NF's IRAs. It is an area covering 7,750 acres. Current recreational uses of the area are identified in the PWA report as dispersed recreation. A number of user-created "2-track" trails and campsites exist within the area. Key attractions include outstanding views of the Little Colorado River, Painted Desert, and parts of the Grand Canyon from the top of the rim. The Coconino Rim provides topographical relief in a generally flat area. The current ROS classification is SPNM.

Seegmiller – Seegmiller is a 6,168-acre area. Current recreational uses of the area are identified in the PWA report as hunting and limited dispersed recreation. Key attractions include a variety of cultural resources including habitation sites, rock art, prehistoric storage structures, and historic water developments. Much of this area is flat and remote, providing some opportunities for challenging recreation, particularly backpacking and hunting. The ROS is currently classified as semi-primitive motorized.

South Canyon Point – South Canyon Point is a 5,829-acre area. Current recreational uses of the area are identified in the PWA report as activities associated with House Rock Wildlife Management Area. The House Rock Wildlife area has a free-ranging bison herd managed by AGFD. Activities at the ranch include hiking, photo opportunities, wildlife viewing, and sport hunting. The opportunity for solitude or primitive and unconfined recreation is ranked as medium. The ROS for this area is semi-primitive motorized.

Willis Canyon – Willis Canyon is an area totaling 6,418 acres. Current recreational uses of the area are identified in the PWA report as hunting and limited dispersed camping. No key attractions have been identified. Due to its proximity to a nearby highway, the sights and sounds of civilization are likely. The ROS for this area is SPNM.

Sycamore Canyon Addition – The Sycamore Canyon Addition, also known as Government Canyon, is a 988-acre area on the Williams Ranger District that is adjacent to a PWA under consideration by the Prescott National Forest. Current recreational uses of the area are identified in the PWA report as hunting and limited dispersed camping. Although this area ranked "high" for capability and availability in the PWA evaluation process, due to its small size it was only to be recommended by the Kaibab NF for wilderness designation if the adjacent section on the Prescott NF was recommended in the Prescott's revised forest plan. This portion of the Prescott NF was not included in their proposed action, so the Sycamore Canyon Addition is not recommended as a PWA under the Kaibab NF's Alternative B (proposed action).

Table 37. Acres of proposed wilderness areas by alternative

Name of PWA	Alt. A Acres	Alt. B Acres	Alt. C Acres	Alt. D Acres
Kanab Creek Additions	0	4,710	4,710	4,710
Saddle Mountain Addition	0	1,296	1,296	1,296
Grassy and Quaking Aspen Canyon Additions	0	232	232	232
Jacks Canyon	0	156	156	156
Burro Canyon	0	0	10,735	10,735
Coconino Rim	0	0	7,750	7,750
Seegmiller	0	0	6,168	6,168
South Canyon Point	0	0	5,829	5,829
Willis Canyon	0	0	6,418	6,418
Sycamore Canyon Addition	0	0	988	988
Total Acres	**0**	**6,394**	**43,294**	**43,294**

Environmental Consequences

Environmental Consequences of Potential Wilderness Area Designation

For the purposes of determining the effects of the alternatives on the recreation and wilderness resources in this analysis, the PWAs are examined as if they would be managed as wilderness areas.

Alternative A – No Action Alternative, No New Wilderness Recommended

Alternative A represents the current management alternative, with no additional wilderness areas recommended. Alternative A, therefore, offers the least opportunity for expanded wilderness among the alternatives. An additional effect of this alternative is that the desire by a certain segment of the public for more wilderness on the Kaibab NF would not be fulfilled. Alternative A does, however, respond to the segment of the public that desires no additional wilderness and who

prioritize nonwilderness uses and values, such as timber harvesting, road construction, recreation development, and the use of prescribed fire.

Alternative A would not convert any SPNM acres to wilderness. Wilderness is more restrictive than SPNM, as SPNM allows for future recreation development options such as rustic and rudimentary facilities with subtle site modifications. The forest plan also does not establish group size limits for SPNM. Those desiring semiprimitive type recreation with the ability to have rustic facilities and no group size limits would have the most opportunity under this alternative.

Some of the existing wilderness boundaries in Kanab Creek Wilderness would continue to be difficult to identify on the ground.

Alternative B (Proposed Action): Wilderness

Alternative B contains about 6,394 acres of PWAs, all of which received a combined rating of at least high/medium capability and availability in the wilderness evaluation report. The recommended areas include the Kanab Creek Wilderness additions (4,710 acres), Saddle Mountain Wilderness addition (1,296 acres), Quaking Aspen and Grassy Canyon additions (232 acres), and Jacks Canyon (156 acres). For more information on the wilderness evaluation process and identification of the preferred alternative, see appendix E. Table 38 displays the PWAs and acres for alternative B.

Table 38. Alternative B – acres and proposed wilderness areas

Name of PWA	Acres
Kanab Creek Additions	4,710
Saddle Mountain Addition	1,296
Quaking Aspen and Grassy Canyon additions to Grand Canyon National Park Recommended Wilderness	232
Jacks Canyon	156
Total Acres	**6,394**

This alternative would increase the amount of land managed as wilderness on the Kaibab NF and improve boundary recognition of the area managed for wilderness values. Boundaries that follow natural features—such as ridgelines and breaks in slope—help to facilitate on-the-ground location and management. Boundaries that are easy to define and locate, both on a map and on the ground, generally increase the manageability of wilderness as well as other special areas.

Alternative B would provide better management of Kanab Creek Wilderness than alternative A, as the Kanab Creek Wilderness Addition would extend the west side of Kanab Creek Wilderness to conform to the Kaibab NF boundary. The smaller additions contained within the Kanab Creek Wilderness Additions on the east side of Kanab Creek Wilderness would also improve manageability by extending the boundary to well defined canyon rims.

Alternative B would also provide better management of Saddle Mountain Wilderness than alternative A as the Saddle Mountain Wilderness Addition would improve the boundary by placing it along an easily identifiable NFS road. The Grand Canyon National Park Recommended Wilderness Addition also makes the boundary more easily identifiable and more manageable in

alternative B than in alternative A, by moving the boundary from a not well marked administrative boundary to the rim of a prominent canyon.

Alternative B also addresses public concern for more wilderness than alternative A by recommending an additional 6,394 acres to the National Wilderness Preservation System. An additional effect of this alternative is that the desire by some segments of the public for more wilderness on the Kaibab NF would be fulfilled. Alternative B, however, would not provide for as much wilderness as alternatives C and D.

Alternative B converts more acres of SPNM to wilderness than alternative A, but less than alternatives C and D. As mentioned, wilderness is more restrictive than SPNM. Therefore, alternative B provides fewer opportunities for future recreation development options than alternative A, but more than alternatives C and D. Additionally, rustic and rudimentary facilities and subtle site modifications that are allowed in SPNM would not be allowed in the PWAs. Group size limits would also be established in the PWAs subject to the wilderness group size limit established in the forest plan. Consequently, those desiring semiprimitive type recreation with the ability to have rustic facilities and no group size limits may be displaced to other SPNM settings on the forest. This alternative provides more opportunity for displacement than alternative A, but less than alternatives C and D. However, since this alternative adds small areas to existing designated wilderness, displacement to other SPNM areas is not anticipated to be high.

Finally, Alternative B contains a guideline stating “activities in the section of Kanab Creek identified as eligible as wild in the Nationwide Rivers Inventory should improve or maintain its free-flowing condition and outstanding/remarkable values.” This would ensure the continued eligibility of this segment for designation under the Wild and Scenic River system.

Alternatives C and D: Wilderness

Alternatives C and D would recommend the PWAs that were included in alternative B, plus six additional areas (see table 39). Like alternative B, the PWAs that were also proposed in alternatives C and D would improve the manageability of existing wilderness more than alternative A. The effects from adding the Kanab Creek Wilderness Additions, Saddle Mountain Wilderness Addition, and Grand Canyon National Park Recommended Wilderness Addition would be the same as described under alternative B in the previous section.

In addition to the areas identified in alternative B, alternatives C and D would add five areas, each of which is greater than 5,000 acres, and one area approximately 988 acres on the Williams Ranger District that is adjacent to a PWA on the Prescott National Forest. Due to its small size, this area would only be recommended by the Kaibab NF for wilderness designation if the adjacent section on the Prescott National Forest is recommended in the Prescott’s revised forest plan.

Finally, Alternatives C and D contain a guideline stating “activities in the section of Kanab Creek identified as eligible as wild in the Nationwide Rivers Inventory should improve or maintain its free-flowing condition and outstanding/remarkable values.” This would ensure the continued eligibility of this segment for designation under the Wild and Scenic River system.

Table 39. Alternatives C and D – acres and proposed wilderness areas

Name of PWA	Alternatives C and D Acres
Kanab Creek Additions	4,710
Saddle Mountain Addition	1,296
Grand Canyon National Park Recommended Wilderness Addition	232
Jacks Canyon	156
Burro Canyon	10,735
Coconino Rim	7,750
Seegmiller	6,168
South Canyon Point	5,829
Willis Canyon	6,418
Government Canyon	988
Total Acres	**44,126**

Alternatives C and D add more PWAs than alternatives A and B. Consequently, alternatives C and D provide the most opportunities for a primitive and unconfined type of recreation than the other alternatives.

Comparison of Alternatives: Wilderness

Alternatives C and D would provide the highest probability of solitude; alternatives A and B would provide the least in comparison. Additionally, alternatives C and D respond the most to those who desire more wilderness and the least to those who oppose additional wilderness. Alternative B would also fulfill this desire; however, it would be less than alternatives C and D. Alternative A does not fulfill this desire at all.

Alternatives C and D would provide the most opportunity for wilderness experiences through increased acreage recommended for wilderness designation. Because of the increased opportunity for a wilderness experience under these alternatives, the greatest opportunity exists to reduce pressure and potential crowding in existing and proposed wilderness areas. By distributing wilderness use across more wilderness areas, the ability to protect wilderness character and values also increases. Alternative A does not propose any additional wilderness acreage and would do nothing to further disperse wilderness use. Under alternative B, dispersal of wilderness use would likely be negligible because of the nominal increase in wilderness, and because alternative B does not add new stand-alone areas. However, alternative B would provide more opportunities to disperse use than alternative A, but less than alternatives C and D.

Alternatives C and D would convert the most acres to wilderness. As mentioned, wilderness is more restrictive than nonwilderness SPNM. Therefore, alternatives C and D provide fewer opportunities for future recreation development options than alternatives A and B. Additionally, rustic and rudimentary facilities that are allowed in SPNM would not be allowed in the PWAs. Like alternative B, group size limits would also be established in the PWAs subject to the wilderness group size limit established in the forest plan. Consequently, those desiring

semiprimitive type recreation with the ability to have rustic facilities and no group size limits may be displaced to other SPNM settings on the forest. This may cause added pressure and increased potential for crowding in other SPNM areas. Alternatives C and D would result in the most potential for displacement over alternatives A and B.

Management of Potential Wilderness Areas if Recommended as Wilderness

The areas recommended for wilderness in the plan decision would be managed under the Recommended Wilderness Management Area. The focus of this management area would be to manage these areas to protect wilderness characteristics pending legislation and designation, and to provide for existing uses where compatible with protecting wilderness character.

Under alternatives B, C, and D, use of motorized equipment and equipment used for mechanical transport would be prohibited as these uses are inconsistent with the Wilderness Act. The use of motor vehicles, motorboats, bicycles, hang gliders, wagons, carts, portage wheels, and the landing of aircraft including helicopters would not be allowed, except under special circumstances as analyzed and authorized following a minimum tool analysis. Dispersed recreation that includes nonmotorized and nonmechanized activities—such as hiking, backpacking, fishing, hunting, horseback riding, and cross-country skiing—would be allowed under these alternatives.

A primary effect to recreation under alternatives B, C, and D would result from eliminating motorized/mechanized equipment that may have been or may be used in the future for recreation maintenance and construction purposes in the PWAs as the use of chain saws and other motorized/mechanized types of maintenance and construction equipment are also prohibited in designated wilderness. Costs typically increase when more labor intensive equipment is used such as cross-cut saws versus chain saws. Consequently, the cost to maintain recreational use in the PWAs may increase if alternative B, C, or D is selected. Both alternatives C and D would potentially increase more than alternative B as there are more PWAs allocated to these alternatives. It is important to note that recreation maintenance may be needed whether or not there are designated trails or campsites in the PWAs. Maintenance may be needed to reduce impacts caused by human recreational use. This could come in the form of physical closures and/or rehabilitation activities.

Trail directional signing and marking would conform to wilderness sign standards. Under alternatives B, C, and D, existing signs and trail markers would need to be replaced or removed to meet wilderness standards. Wilderness designation may also warrant future public use restrictions by limiting visitor use and distribution including establishment of group size limits to preserve the wilderness character of the area, whereas if not designated, the areas would allow for greater visitor use and group size limits. Currently, there are no restrictions on group size within these areas.

Recreation objectives for wilderness are to provide outstanding opportunities for solitude and a primitive and unconfined type of recreation. Areas proposed as wilderness under alternatives B, C, and D would allow no new facilities for user comfort. Also under the B, C, and D alternatives, group size limits established for existing wilderness areas in the revised forest plan would apply.

Another primary effect of selecting alternative B, C, or D is that no commercial vegetation management activities would be allowed in PWAs to achieve healthy forest conditions or wildlife, recreation, and scenery management objectives identified in the revised forest plan. Vegetation

management activities that include thinning and prescribed fire could occur and the use of mechanized equipment could be used for maintenance purposes if the areas are not designated as wilderness. There would be less opportunity for vegetation management in alternatives C and D than B, as there are more PWAs allocated to these alternatives.

Potential wilderness areas may also have an impact on motorized and mechanized users in nonwilderness areas. As acreages of wilderness increase, acres available in nonwilderness for motorized and mechanized recreation would decrease. However, increases in future demand for recreation opportunities will likely have a greater impact on pressure and crowding on NFS lands than managing the PWAs as recommended wilderness.

Management of Potential Wilderness Areas if Not Recommended as Wilderness

If not recommended for wilderness designation, the forestwide desired conditions for vegetation and back-country recreation would apply to the PWAs. Vegetation management activities that make the areas suitable for timber production, as well as new road construction, are the primary activities that could alter the wilderness character of the areas. The following discussion addresses the effects to PWAs if not recommended as wilderness.

The PWAs would be managed for SPNM back-country recreation. No bicycles or other mechanized recreational use equipment such as off-road motor vehicles and snowmobiles would be allowed. The landing of aircraft such as helicopters could potentially occur. Dispersed recreation that include nonmotorized and nonmechanized activities such as hiking, backpacking, fishing, hunting, horseback riding, and cross-country skiing would be allowed.

The SPNM recreation classification allows for greater recreation use than wilderness designation and provides opportunities for greater alteration of the land to manage and maintain trails, scenery, wildlife, and forest health conditions. Future planning for the areas if not designated as wilderness could result in increased opportunities for rustic development such as small dispersed campsites for hikers, as well as increased trail development opportunities including opportunities for bicycling. Designation of these areas as wilderness would eliminate or restrict future options for these types of recreation activities and improvements.

Although timber harvest and road construction management activities within the PWAs would be unlikely under any of the alternatives due to the fact that they are mostly steep and not part of the suitable timber base, these types of activities would diminish the apparent naturalness of the PWAs and the degree to which the area is without permanent improvements or human habitation, both of which are principal wilderness characteristics. Mechanical disturbances would also diminish opportunities for solitude or primitive and unconfined recreation, another principal characteristic of wilderness. Overall, mechanical disturbances would diminish the area's capability to be managed as wilderness, and new road construction could eliminate an area's potential for wilderness designation all together (see Potential Wilderness Inventory and Evaluation Report, KNF 2013f). The PWAs that would have the greatest impact from mechanical activities are those with high capability rankings, followed by those with medium and then low (see Potential Wilderness Inventory and Evaluation Report for more detail on capability).

Cumulative Environmental Consequences for Wilderness

The cumulative effects discussion of potential wilderness area management areas occurs in the context of the National Wilderness Preservation System and other designated wilderness areas in Arizona.

Alternative A

Only one designated wilderness area lies completely within the Kaibab NF (Saddle Mountain Wilderness). The majority of Kanab Creek Wilderness, about half of Kendrick Mountain Wilderness, and a small fraction of Sycamore Canyon Wilderness also lie within the boundaries of the Kaibab NF.

No new wilderness on the forest could have a spatial displacement effect where people would find other locations for their wilderness experience because the forest has only one wilderness area completely located within the forest boundary. Viewed in the context of Arizona's expansive wilderness public land base, increased pressure on existing wilderness caused by alternative A would likely be negligible. No new wilderness could be viewed as maximizing the region's potential for SPNM recreation opportunities, as well as maintaining options for management that would be precluded by a wilderness designation.

Alternatives B, C, and D

The cumulative effects discussion of potential wilderness areas occurs in the context of public and private lands in Arizona that provides wilderness opportunities. Alternatives B, C, and D all provide opportunities for expanding the wilderness resource on the Kaibab NF and, subsequently, in the State. Outside of the forest, there are approximately 1.5 million acres in the National Wilderness Preservation System in Arizona. An additional 48 PWAs are within 100 air miles of the Kaibab NF boundary including 24 PWAs within BLM-administered lands, 23 PWAs on adjacent national forests (Tonto, Prescott, and Coconino National Forests), and 1 on NPS-administered lands. It is important to note that the above only addresses existing wilderness. The Prescott and Coconino National Forests are also completing a plan revision and may be recommending additional acres for wilderness designation.

Public land in Arizona is abundant, making the State uniquely capable of providing wilderness opportunities throughout the region. The question then becomes whether the region needs more wilderness opportunities, a topic on which the public is divided. While some would argue the current National Wilderness Preservation System land base is sufficient and any additions would detract from other competing uses, others feel wilderness-quality lands are disappearing to urban development and adding potential wilderness now represents the only permanent option for preserving wilderness before it disappears. Alternatives B through D address this regional wilderness resource situation by offering a range of potential wilderness additions.

Heritage Resources

Description of Affected Environment (Existing Condition) – Heritage Resources

The Kaibab NF is rich in historically and culturally significant heritage properties. To date, approximately 30 percent of the forest has been surveyed for heritage resources and over 9,600

archaeological sites have been identified and documented. On the national level, the Kaibab NF ranks second among national forests in the number of documented archaeological sites and third in the Nation in sites eligible for the National Register of Historic Places based on the data from the Forest Service INFRA database. Additional information regarding this section can be found in the Heritage and Tribal Relations Report (KNF 2012d).

These heritage properties are related to a long history of human occupation and use of the forest dating back at least 12,000 years. Such sites include preceramic lithic scatters associated with Archaic hunter-gatherers, pithouse and masonry structures associated with early farmers, historic sites related to Native American and early Anglo-European use of the area, numerous petroglyph and pictograph sites, and traditional cultural properties. To date, 44 historic properties on the Kaibab NF have been listed on the National Register of Historic Places for their historic significance and more than 2,400 additional sites have been determined to be eligible for inclusion in the National Register.

For decades, Kaibab NF archaeologists have monitored samples of archaeological sites before, during, and after project implementation. In rare cases, monitoring has shown isolated unintended impacts to heritage properties as a result of project implementation. However, in general terms project-specific mitigation measures have been largely successful in avoiding impacts to cultural resources. Furthermore, many impacts to heritage properties identified during monitoring are either associated with activities not related to agency actions, such as unmitigated off-road vehicular travel or recreational use, or to historic activities that were implemented prior to the National Historic Preservation Act.

In recent years, most adverse impacts to heritage resources have been caused by high-intensity, stand-replacing wildfire and increased erosion associated with such fires. The majority of archaeological sites on the forest are prehistoric and lack combustible features; these are considered to be nonfire sensitive under low- to moderate-intensity burning. However, all archaeological sites are susceptible to adverse impacts from high-intensity burning, as is well documented after the recent Warm (Reid et al. 2008) and Schultz Fires (Haines and Lyndon 2010).

Environmental Consequences for Heritage Resources

Environmental Consequences for Heritage Resources: Alternative A – Current Plan, Current Management (No Action)

The no action alternative would not alter the existing condition and would have no measurable direct effects on any heritage resources. However, current management does not address specific management issues related to traditional cultural properties (TCPs) included in the alternatives below. Furthermore, under the no action alternative, existing fuel loading and the high risk of a stand-replacing wildfire could have an indirect effect on heritage sites. Historic sites with wooden, glass, and other similar components (fire sensitive sites) would remain at the greatest risk from burning. All sites would remain at risk from increased erosion associated with high-intensity fires.

Environmental Consequences for Heritage Resources: Alternative B – Preferred Alternative

Alternative B would have no measurable direct effects on any heritage resources. However, alternative B includes additional direction related to TCPs, heritage resources, and culturally significant tribal resources that should result in improved management. For example, alternative B designates the Bill Williams Mountain TCP as a management area with specific guidance based partly on cultural concerns. This guidance includes standards and guidelines limiting snow making on Bill Williams Mountain and restricting the footprint of the existing ski area. Tribes have indicated that both ski area expansion and snow making would adversely impact the Bill Williams TCP. Red Butte is similarly designated as a management area due to cultural concerns.

Of the existing alternatives, alternative B would result in the most rapid ecological restoration and reduction of fuels on historic sites, coupled with a comparatively lower risk of high-intensity fire across the landscape. Therefore, alternative B would result in quicker restoration to conditions favorable for cultural resources.

Environmental Consequences for Heritage Resources: Alternatives C and D

Alternatives C and D would have no measurable direct effects on heritage resources. Alternatives C and D are identical to alternative B in regard to additional direction related to TCPs, heritage resources, and culturally significant tribal resources, which should result in improved management. However, increased risks of high-intensity fire (and postfire erosion) associated with these alternatives would correlate with increased risks of unplanned adverse impacts to heritage resources. Therefore, alternatives C and D may result in indirect effects to heritage resources.

Alternatives C and D would recommend an additional 44,126 acres of PWAs on all three districts. Of these PWAs, 7,852 acres have been previously surveyed for cultural resources and 234 heritage properties have been identified. Burro Canyon, Kanab Creek, Houserock Valley, Sycamore Canyon, and the Coconino Rim are predicted to contain moderate to high densities of heritage resource sites based on existing survey data. However, several of these PWAs contain prominent geographic landscape features that are culturally significant to area tribes and may be eligible to the National Register of Historic Places as traditional cultural properties.

If human visitation to PWAs declines as a result of decreased access, decreased visitation may indirectly increase protection of cultural resources. Wilderness designation may also limit some undertakings that otherwise may impact cultural resources. However, no mechanical thinning would be permitted within PWAs. As with alternative C, a “burn only” management strategy is predicted to result in increased high-intensity fire and associated erosion, increasing potentially indirect impacts to cultural resources, particularly in mixed conifer and pinyon-juniper woodlands.

The increased risks of high-intensity fire (and postfire erosion) associated with these alternatives would correlate with increased risks of unplanned adverse impacts to heritage resources. Therefore, alternatives C and D may result in indirect effects to heritage resources.

Comparison of Alternatives

Alternative B may increase the risk of unplanned impacts to cultural resources due to increased mechanical thinning treatments. However, threats to cultural resources from uncharacteristic high-intensity wildfires far outweigh relatively minimal risks of unintended adverse impacts for project implementation. Therefore, increased restoration of the forest to minimize high-intensity wildfire under alternative B would have an overall beneficial effect that far outweighs potential adverse impacts. Higher risks of high-intensity fire associated with alternatives C and D may increase the potential for adverse impacts to cultural resources over time.

Cumulative Environmental Consequences for Heritage Resources

Archaeological Sites

The Kaibab NF manages for “no effect” or “no adverse effect” to cultural resources for all planned management activities. Monitoring data indicate that project activities, such as those related to ecological restoration work, may result in unplanned or inadvertent adverse impacts to cultural resources in rare cases. Such unplanned or inadvertent adverse impacts are addressed and mitigated on a case-by-case basis and are more than offset by the benefits of ecological restoration.

Traditional Cultural Properties and Traditional Use Areas

The Southwestern Region is a cultural landscape with a long history of occupation by numerous tribes. Places of historic traditional and cultural significance to these tribes (TCPs) and traditional resource collection areas (traditional use areas) are located across the landscape. Many of these TCPs and traditional use areas are located on nontribal lands including State, Federal, private, county, and city lands.

Across this cultural landscape, there is a trend toward the degradation of places of traditional cultural importance. Every management decision that adversely impacts these places contributes to the cumulative loss of TCPs and traditional use areas across the region. The proposed plan provides for proactive protection of known TCPs, important resources, and traditional use areas on the forest. Therefore, the proposed plan helps to offset the general loss of TCPs in the region by providing increased protection for local forest resources.

Livestock Grazing

Range management on the Kaibab NF has changed dramatically since the early 1900s. In the early days of the forest, grazing was largely unregulated and the range was typically grazed by cattle, sheep, and horses. During the 1930s, fences began to divide the forest into permitted grazing allotments. The peak of grazing was during World War II when Congress demanded as much protein as possible from national rangelands. Since the 1970s, livestock numbers have steadily declined and rangeland improvements have been put in place to improve livestock distribution. For additional detail and analysis pertaining to this section please see Appendix D, which discusses the grazing suitability and capability analyses conducted as a part of the plan revision process, and the Range Specialist Report (KNF 2013g).

The Kaibab NF has 38 livestock grazing allotments, covering approximately 1,414,000 acres (92 percent) of the forest area. Areas not included in current permits include: Bill Williams Mountain/city of Williams, Kanab Creek, high recreational areas, and various livestock exclosures, primarily around wetland vegetation.

Permitted animal unit months (AUMs) have declined on the forest throughout the years. The following is a breakdown of permitted AUMs in the last 40 years: 1971 - 108,545; 1986 - 86,375; 2002 – 73,541; 2009 – 64,351. Of the 64, 351 AUMs in 2009; 51,416 AUMs permitted in cattle, 12,683 in sheep, and 252 in horses. The forest does not anticipate significant reductions in permitted numbers in the future. Livestock actual use in any given year is typically between 70 and 90 percent of permitted numbers. In drought years these numbers can be significantly lower.

Description of Affected Environment (Existing Condition): Livestock Grazing

The Vegetation and Fire section of this chapter and supporting specialist report provide detailed information on the conditions and trends of the vegetation environment.

Since 1992, all current range allotments on the Kaibab NF have been through a rigorous evaluation and NEPA process. Forage production has been properly matched with permitted livestock numbers. Adaptive management is being used to maintain and improve the rangeland resources.

Livestock grazing occurs throughout the forest on a wide variety of vegetation types from the upper elevation subalpine spruce-fir to lower elevation desert grasslands. Ecological conditions and trend of forage areas have been evaluated annually (utilization and actual use) and extensively (long-term monitoring sites) during the NEPA analysis for each allotment. The majority of long-term monitoring sites show an improvement in condition and trend since the 1950s (district range allotment analysis files). The exception to this is where tree density has increased, which has resulted in a reduction in forage production.

Species composition has changed throughout this time period in a direct response to the amount and timing of moisture. From the 1950s to the early 1990s cool season grasses replaced warm season species with the increase in winter and spring moisture. Since the 1990s, warm season species have increased with a decrease in winter moisture and increase in summer moisture. Ground cover has increased with warm season species, primarily because blue grama is a sod forming species.

Livestock are attracted to areas with high amount of forage and water. Wetlands, springs, and aspen stands on the Forest can be negatively affected by this use. Recent range NEPA analyses have addressed issues in these areas, but the forest will continue to evaluate livestock effects in sensitive portions of the forest.

Description of Alternatives

Alternative A, No Action (Current Plan)

Alternative A continues to use adaptive management to balance livestock numbers with forage capacity.

Action Alternatives B, C, and D

Alternatives B, C, and D also would use adaptive management to balance livestock numbers with forage capacity. In addition, the following desired conditions and guidelines were added to provide more specific direction. The action alternatives also include plan components for restoring fire adaptive ecosystems, restoring grasslands, and providing protection to aspen, wetlands, and springs.

Desired Conditions for Livestock Grazing for Alternatives B, C, and D

- There are opportunities to engage in ranching activities and graze livestock on NFS lands. These activities contribute to the stability and social, economic, and cultural aspects of rural communities.
- Grasses and forbs provide adequate forage for permitted livestock
- Livestock use is consistent with other desired conditions.
- Allotment fencing allows for passage of animals susceptible to movement restrictions such as pronghorn.

Guidelines for Livestock Grazing for Alternatives B, C, and D

- Livestock management should favor the development of native cool season grasses and forbs.
- As grazing permits are waived back to the forest, they should be evaluated for conversion to forage reserves to improve flexibility for restoring fire-adapted ecosystems and in response to other range management needs.
- New construction and reconstruction of fences should have a barbless bottom wire that is at least 18 inches high to facilitate pronghorn movement.
- Annual operating instructions for livestock grazing permittees should ensure livestock numbers are balanced with capacity and address any relevant resource concerns (e.g., forage production, weeds, fawning habitat, soils, etc.).
- Grazing of domestic sheep and goats should not be authorized on the Tusayan and North Kaibab Ranger Districts due to the proximity of bighorn sheep in Grand Canyon and Kanab Creek to prevent the spread of disease between domestic and wild populations.
- Post-fire grazing should not be authorized until Forest Service range staff confirms range readiness.
- Livestock use in aspen areas should be authorized at levels that are consistent with the desired conditions for aspen regeneration and establishment.
- Livestock use in and around wetlands should be evaluated on an allotment specific basis. Mitigation measures such as deferment and fencing (full or partial) should be implemented as needed to minimize potential livestock effects.
- The concentrated use of montane meadows for livestock grazing should be minimized when soils are saturated to reduce grassland impacts. When no other options are available, use should be rotated annually.
- The term permit for the Rain Tank grazing allotment should be first offered to the Havasupai Tribe if one becomes available.

Environmental Consequences for Livestock Grazing

Environmental Consequences Common to All Alternatives

All alternatives would continue to provide for continued availability of forage for domestic livestock and opportunities for ranching lifestyles consistent with the other desired conditions.

Livestock grazing under all alternatives would be managed with adaptive management to match livestock numbers with annual forage production. The Kaibab NF would continue to keep grazing at conservative use levels, which should provide for plant integrity, density, diversity, and regeneration over time, as well as forage availability for all species (livestock and wildlife).

All alternatives would use adaptive management to address climate change, but climate change is specifically addressed in the action alternatives. Climate change is expected to affect forage conditions on the forest. The adaptive management used in allotment management planning allows for adjustments in the number of livestock and season of pasture use so that livestock use matches forage production for every grazing season. The Forest Service has given regional and forest direction of use of rangelands after a drought to ensure health of this forage resource.

The impact of livestock grazing to riparian habitat at wetlands and springs would be analyzed in all new range NEPA projects on the forest. If substantial negative effects cannot be mitigated through grazing management practices (i.e., herding and grazing deferment when the areas are wet), then livestock exclosures may be necessary. These exclosure areas would likely not be available for forage, but are not big enough to reduce stocking rates in a pasture. The use of water by livestock at these exclosures is mitigated with alternative water sources, providing lanes to the water, or piped to a livestock drinker.

The impact of livestock grazing to aspen would be analyzed in all new range NEPA projects on the forest. If it is found that livestock are having a significant effect on a clone, the clone will likely be fenced or adjustments in grazing management will be made, i.e., seasonal deferrals of pastures, reduction in pasture graze periods, or reduction in livestock numbers. These exclosures areas would likely not be available for forage, but are not big enough to reduce stocking rates in a pasture.

Under all alternatives, dispersed recreation, firewood gathering, wildfires, roads, OHV use, and elk grazing can also affect the forage resources. The intensity of these effects varies throughout the forest depending on the intensity of these activities. When conflicts arise from these uses that threaten the long-term condition and trend of forage resources, the forest will look for multiple-use solutions that properly balance these effects.

Environmental Consequences for Livestock Grazing: Alternative A – Current Plan, Current Management (No Action)

Alternative A would maintain the current level of vegetation treatments and fire, which would result in an increase in tree density on the forest, reducing the amount of understory vegetation. This reduction in understory vegetation would reduce the amount of forage available to livestock. Over time, livestock numbers would be reduced until the number of trees decreased.

Environmental Consequences for Livestock Grazing: Action Alternatives B, C, and D

The action alternatives (alternatives B, C, and D) would decrease tree density by mechanical harvest and prescribed burning. This would have a long-term beneficial effect to livestock grazing by increasing the amount of available forage. This increase in forage within existing treed areas increases livestock distribution in pastures, which reduces use on more typical grazing areas like meadows. Improved livestock distribution would improve conditions throughout each pasture.

Prescribed burning and natural fires remove forage available to livestock in the short term until the forage plants can regrow, typically within one year. Grazing management can be affected by this burning and would likely be adjusted by changing pasture rotations, livestock numbers, or livestock season of use on a grazing allotment. Livestock in this situation would need another location to graze.

The action alternatives increase the amount of forage available to livestock over the long term through plan direction of reducing tree densities by harvesting and prescribed burning. Short-term reductions would occur as a result of burning, but this would be offset with the long term increase in forage.

The impact of livestock grazing to riparian habitat would be analyzed in all new range NEPA projects on the forest. This analysis will likely increase the amount of exclosures around wetland and spring riparian areas. These exclosure areas would likely not be available for forage, but are not big enough to reduce stocking rates in a pasture. The use of water by livestock at these exclosures is mitigated with alternative water sources, providing lanes to the water, or piped to a livestock drinker.

Comparison of Alternatives

Alternative B would provide for the biggest increase in forage and best distribution of livestock. The guideline for large tree retention in alternatives C and D somewhat hinders the creation of interspaces and results in a denser canopy, and thus the forest would be less open, resulting is slightly less forage. Alternatives C and D would also result in higher susceptibility to uncharacteristic crown fires, which could result in large areas being unavailable for grazing. Alternative A would result an increase in tree density, increased risk of uncharacteristic wildfire, and reduced forage production over time.

Cumulative Environmental Consequences for Livestock Grazing

The cumulative environmental consequences for a programmatic forest plan also consider lands managed by other entities in the area and describe the relative contribution of the forest plan decision when considering surrounding landscape with other similarly scaled planning efforts and opportunities.

The cumulative effects area for range includes the 6th-code watersheds on the Kaibab NF that contain the grazing allotments (see the Watersheds and Soils section of this chapter). The forest occupies an average of about half of each of the watersheds that the Kaibab NF intersects, with several wholly contained within the forest boundary and the minimum occupancy of a single watershed being less that 0.01 percent. These watersheds are the appropriate scale because the effects from grazing on the forest follow these watersheds. Cattle grazing effects on forest

allotments and other allotments within these watershed areas affect vegetation by reducing plant height, canopy cover, and ground cover.

The timeframe for these combined effects is 10 years in the future because changes in condition and trend in the vegetation depend on the presence of favorable growing conditions after cattle leave the pasture. If growing conditions are favorable, plant height and canopy cover would completely recover within 1 year. If growing conditions are not favorable, plant recovery would occur more slowly (up to 2 to 3 years). Vegetation recovery from the other activities and natural events may take this long, depending on climate.

The cumulative effects area off the forest is primarily private, State of Arizona, BLM, Navajo Tribe, Havasupai Tribe, and NPS. Livestock grazing occurs in the majority of these areas except within Grand Canyon National Park. Private lands within communities are not typically grazed by livestock except for by horses. Private lands outside of communities typically provide forage for smaller livestock operations, but can support larger livestock operators when the private land is in larger blocks. These larger private blocks of lands are typically used for winter grazing for the forest's permitted livestock. State lands are also typically used for winter grazing of the forest's permitted livestock. The BLM has both year-round grazing and winter grazing. Winter grazing is also from forest permitted livestock. Both the Navajo and Havasupai Tribes graze cattle and horses on their lands, which are owned by individual tribal members. There are no indications that livestock use within these areas is going to change much over the next 10 years.

Vegetative treatments, primarily burning and thinning of trees, would occur on these other lands. These types of treatments would increase forage for livestock and improve rangeland conditions in these areas.

Livestock grazing under the action alternatives would provide for continued availability of forage for domestic livestock and opportunities for ranching lifestyles consistent with the other desired conditions in the plan. Because an adaptive management strategy is used to adjust use with capacity and minimize any adverse effects, the cumulative consequences associated with continued grazing use are minimal. The expected relative significance of the implementation of the action alternatives' plan decisions within the context of the greater landscape would be a slight increase in available forage with minimal consequences to other resources and continued opportunities to graze livestock in northern Arizona.

Transportation

Information related to the forest road system was obtained from the Infra Database (I-Web), the database of record for the transportation system and facilities, and from the Kaibab NF Geographic Information System (GIS). GIS is a spatial tool and is linked to the Infra Database. The data includes, but is not limited to, miles of roads, maintenance levels of roads, features of the roads (culverts, grade dips, cattleguards, etc.), road management objectives, maintenance items, and costs. This data reflects the current motorized transportation system and administrative facilities to the best of our available knowledge, how the forests have been managing the motorized transportation system and administrative facilities, and how the public has been using the motorized transportation system. Additional information can be found in the transportation specialist report (KNF 2011a).

Description of Affected Environment (Existing Condition): Transportation

The transportation system within the planning area consists of roads and trails that provide people with access to public lands and to private inholdings. Virtually every activity that takes place within the planning area uses the transportation system, including outdoor recreation, wildfire management, livestock and wildlife management, natural resource development, private inholding access, and electronic communication sites and utility corridor maintenance, as well as the management and monitoring of NFS lands.

Motorized travel on the forest has evolved over time. Historically, the road system on the Kaibab NF was constructed for commodity access, primarily timber, livestock production, mining, and administration. Some roads were used to access points of interest or areas used for specific activities, such as hunting and camping. While the transportation system continues to provide access for administration of the forest, the majority of use today is for public recreation and vegetation management activities.

The primary forest road system for the forest has already been established. The motorized transportation system is composed of about 480 miles of roads open only to highway-legal vehicles (maintenance level 3 through 5), 4,110 miles of roads open to all motorized vehicles (maintenance level 2), 1,646 miles of roads closed to all motorized vehicles (maintenance level 1), and 323 miles of trails open to motorized vehicles less than 50 inches wide. Three NFS roads are designated as forest highways in the Kaibab NF. The miles of open motorized transportation system include roads with access restricted on a seasonal basis. Roads may be closed during extreme weather conditions for public safety and to minimize resource damage.

Generally, new road construction may occur when access to a particular resource or private inholding is needed. These roads may be permanent, if intended for long-term use, or they may be temporary for a short-term use and then obliterated. Any adjustments to the road network would be made as necessary at the project planning level. Temporary roads have been used for vegetation management activities where permanent roads are not needed for future access.

The Travel Management Rule (November 9, 2005, 36 CFR 212.51) requires that each national forest designate a system of roads, trails, and areas for motor vehicle use by vehicle class and, if appropriate, by time of year. The rule addresses any future proliferation of unauthorized routes by prohibiting cross-country motorized travel, except in designated areas and for designated uses. The designation of specific routes, trails, and areas for motorized vehicle travel is not within the scope of the plan revision process. Motorized vehicle travel has been analyzed in separate environmental assessments for each District. The Kaibab NF continually reviews these analyses in response to feedback provided by the public.

Over the last few decades, funding has not been sufficient to maintain all NFS roads and NFS motorized trails to appropriate standards to meet the road management objective level. Generally, the funding received has been focused on maintaining higher standard roads that serve multiple-access needs. There is currently a backlog of road maintenance referred to as deferred maintenance, tasks that are the cumulative total of all annual maintenance tasks that are not accomplished as needed or scheduled. These maintenance items include, but are not limited to, surfacing, drainage and drainage structures, and closure structures.

Environmental Consequences for Transportation

Environmental Consequences Alternative A – Current Plan, Current Management (No Action)

In alternative A, management of motorized transportation would continue under management area specific goals, objectives, standards, and guidelines in the 1988 forest plan (as amended), which were driven primarily by timber harvesting. There are no specific objectives to identify miles of unauthorized routes to be decommissioned (e.g., recontoured and/or revegetated in riparian areas) and no specific objectives to improve, obliterate/decommission, recontour, or revegetate system roads in riparian areas.

Environmental Consequences for Transportation: Action Alternatives B, C, and D

The action alternatives (B, C, and D) all contain direction for roads and motorized trails that include specific objectives within the planning period to maintain and obliterate roads. All motorized route construction and maintenance would be done in accordance with applicable Forest Service handbooks and manuals, standards and guidelines, BMPs, laws, regulations, and policy. Decommissioning of identified unneeded NFS roads for current or future use would occur by recontouring, ripping, and seeding, as appropriate.

Both mechanical and fire treatments are planned for the action alternatives (B, C, and D). All alternatives would use a mix of mechanical treatment and fire. Mechanical treatments may require more reconstruction (e.g., curve widening, hardened drainage crossings) of roads to accommodate the design needs of the critical vehicle to perform mechanical treatment than fire treatments would require. Mechanical treatment may also require more construction of temporary roads during the treatment period to access the treatment areas than treatment by fire. This may result in mechanical treatment having a higher cost per acre due to motorized access costs. Under alternative C, there would be less need for temporary roads over the long term on the North Kaibab Wilderness Habitat Complex Management Area (approximately 260,000 acres of ponderosa and mixed conifers in the North Kaibab Ranger District), because the desired conditions for vegetation would primarily be maintained with fire. Under alternative D this would be true forestwide.

Cumulative Environmental Consequences for Transportation

The bounds of the cumulative effects analysis are the adjoining national forests, Arizona State Highways that access and traverse the Kaibab NF, counties encompassing the Kaibab NF, and the designated forest highways on the Kaibab NF.

The Four Forest Restoration Initiative (4FRI), a landscape-scale restoration activity to reduce the threat of high-intensity, potentially destructive fires on a significant number of acres on the Apache-Sitgreaves, Coconino, Kaibab, and Tonto NF s, could impact the forest transportation system to access the western side of the Coconino National Forest for treatments and/or removal of biomass. Use of these roads for access to the treatment areas and biomass removal on the west side of the Coconino National Forest would result in increased traffic and a need for more

frequent road maintenance. The increase in traffic and the different types of vehicles could require improvement of the road to accommodate these activities safely.

The Arizona Department of Transportation 2012 – 2016 Tentative Five-Year Transportation Facilities Construction Program in the vicinity of or on the Kaibab NF does not consist of any activities that are expected to increase or decrease the amount of access to the Kaibab NF. Arizona Department of Transportation road improvements could facilitate an increase in forest visitors, as the driving time to the forest from other urban areas decreases as a result of these improvements. This potential increase of forest visitors using the forest motorized transportation system could result in more frequent road maintenance needs.

Forest Lands

The acquisition and disposal of national forest managed lands are designed to consolidate interest and management of the Federal estate to enhance public benefit, and to consolidate the management and ownership of Federal, State, and private lands within the proclaimed forest boundary. The establishment of rights-of-way throughout the forest is needed to create easy accessibility to both public and private lands within the proclaimed boundary of the national forest.

The rules and regulations that govern rights-of way and land acquisition/disposal are dictated by congressional acts or laws and legislation are beyond the discretion of the land management plan. The guidance that is given in the Forest Service manuals and handbooks is based on this legislation and resulting regulations, along with interpretation of the laws by Federal courts.

Management direction is located in FSM 5420 Land Purchases and Donations, FSM 5430 Exchanges, FSM 5460 Right-of-Way Acquisition and FSH 5409.13, FSH 5409.17. The boundary line program management direction is located in FSM 7150. More information on forest lands can be found in the Forest Lands Specialist Report (KNF 2011b).

Description of Affected Environment (Existing Condition): Forest Lands

Currently, 38,200 acres are under private ownership within the Kaibab NF. The majority of these parcels are located on the Williams Ranger District in the vicinity of the communities of Williams, Ash Fork, and Parks. The Tusayan Ranger District has approximately 3,000 acres of private inholdings and the North Kaibab Ranger District has close to 60 acres.

The Williams and Tusayan Ranger Districts contain established communities within their boundaries, including the newly designated town of Tusayan. A number of the larger parcels in these communities are no longer desirable for acquisition by the forest due to the fact that they have been subdivided and developed (mostly for housing). The Tusayan Ranger District has a number of small inholdings scattered across the district. The majority of them are old ranches and homesteads which are undeveloped and still exhibit the characteristics of the surrounding forest.

The North Kaibab Ranger District is almost entirely government-owned but contains two small parcels totaling 39 acres under State ownership, and two parcels under private ownership (19 acres adjacent to Jacob Lake and 38 acres of Kane Ranch in the House Rock Valley of the east edge of the district).

Environmental Consequences for Forest Lands

Environmental Consequences Common to All Alternatives

Under all alternatives, particular tracts or national forest lands are identified for exchange to meet the needs for community expansion in the vicinity of Tusayan, Parks, Ash Fork, and Williams. The tracts of land that are identified for exchange are independent of the alternatives. Other program funding provides for the acquisition of rights-of-way. The continuation of the land ownership boundary line management program is also independent of the alternatives. Under all the alternatives, there would be continued efforts to consolidate land ownership within the forest boundary and establish new rights-of-way, which would benefit both private landowners and Federal land management. The elimination of small isolated inholdings and outholdings within the forest would simplify management activities and treatments of the national forest. The need to acquire rights-of-way for road and trail access is reduced with a consolidated land pattern.

Environmental Consequences for Forest Lands: Alternative A – Current Plan, Current Management (No Action)

Within alternative A (the current forest plan), the lands and realty management sections are redundant from one management area to another, or reiterate direction that comes from the Forest Service manuals and handbooks. The plan identifies specific inholdings for acquisition and tracts of national forest that are suitable for exchange with the goal of land ownership consolidation to improve management efficiency. A number of these properties have been acquired or exchanged, while others have been developed and no longer meet the criteria for lands that are desirable. The need to acquire rights-of-way across State and private property is still a concern. As ownership patterns change within the boundaries of the forest, access to national forest-managed lands will remain an issue.

Environmental Consequences for Forest Lands Common to Action Alternatives B, C, and D

In order to reduce the redundancy between the management areas in the plan and to remove the verbiage from the forest plan that repeats other relevant laws, regulations, and policy, much of the language regarding land consolidation in these alternatives has been changed or dropped. The list of property has changed from the 1988 plan to the 2008 review of ownership. None of the alternatives is expected to have an effect on the Kaibab National Forest lands program.

Cumulative Environmental Consequences for Forest Lands

The geographic area of analysis for cumulative impacts to forest lands is the Kaibab NF and adjacent lands. The forest is located within three counties in Arizona: Coconino, Yavapai, and Mohave. The vast majority of it lies within Coconino County. Only 13.3 percent of Coconino County is privately owned. American Indian reservations (Navajo, Hopi, Kaibab-Paiute, Havasupai, and Hualapai) cover 38.1 percent of the land area. Just over 40 percent of the county is under Federal ownership. The Kaibab NF shares common boundaries with mostly Federal and tribal managed lands.

Less than 2 percent of the forest is contained in Yavapai County, but the majority of this county is owned and managed by Federal and State agencies. The Forest Service maintains 38 percent, the

BLM controls 10.5 percent, and Arizona State Trust Lands manages 25 percent of the county's land area. The remaining 26 percent of Yavapai County is privately owned (Yavapai County 2003).

Approximately 0.5 percent of the forest lies in Mohave County. Most of this land is located within Kanab Creek Wilderness; the rest of the forest within the county is being recommended for wilderness. Due to the small number of Kaibab NF acres in Mohave County, there are no impacts from the forest plan revision in this area.

The lands programs for the Kaibab, Coconino, and Prescott NF s have the same general requirements and the same relevant laws, regulations, and policies that apply to management of Federal lands. The acquisition of inholdings and the exchange of isolated Federal parcels would result in a consolidation of land ownership within national forest managed lands and improve land management objectives and activities. The Arizona Strip General Management Plan of 2007 (BLM portion of the plan; BLM 2008) has very similar guiding laws, regulations, and policies as the Forest Service. The consolidation of Federal lands to improve management activities is also a goal in their management plan.

The Arizona State Land Department has a significant amount of State Trust property adjacent to the forest and has a different mission for its management. It manages State Trust lands and resources to enhance value and optimize economic return for the trust beneficiaries in a manner consistent with sound stewardship, conservation, and business management principles supporting socioeconomic goals for citizens here today and generations to come.

The Navajo Nation and Havasupai Reservation adjoin the Tusayan Ranger District of the forest. The Navajo Nation was established in 1868, and is the largest reservation in the United States. It is located east of the district. The Havasupai Reservation is located northwest of the district. Both of these areas are open to tribal members only and are managed by the local governments of these two Native American nations with oversight by the Bureau of Indian Affairs. The reservations are closed to land ownership by nontribal members and any development is overseen by the tribal government and BIA.

The availability of private lands in and around the forest is very limited, with private land parcels being isolated and widely dispersed outside of the areas around Parks, Williams, Tusayan, and Ash Fork. The consolidation of land available for private ownership in or around these towns would improve access for roads and utilities to the parcels. Future growth and development of adjacent non-Federal lands is expected to result in increased requests for special use authorizations, Educational Land Grant Act and Townsite Act application for schools, fire stations, wastewater facilities, transfer stations, and the like. As Federal land management agencies acquire isolated private inholdings within their legislated boundaries, the efficiency of managing these areas increases due to the presence of fewer right-of-way and other incumbencies across the greater landscape.

Special Uses

More information on special uses can be found in the Special Uses Specialist Report (KNF 2011c).

Description of Affected Environment (Existing Condition)

Special use permits authorize services that support the Forest Service mission and meet the needs of the public. Permits are a partnership between the Forest Service and private businesses and individuals to provide services and facilities. Special uses authorize occupancy and use of NFS lands for appropriate, safe activities that meet demonstrated public needs when consistent with the desired conditions for the specific area. The Kaibab NF has issued over 300 special use permits for a variety of uses, including resorts, research, pipelines, storage yards, a golf course, airport, cell towers, wells, roads, power lines, and wildlife waters.

Permits may be short term, such as for recreation events or noncommercial group uses, or longer term such as resorts and electronic sites. National emphasis on energy development and transmission is expected to grow, as are communications site proposals. As the demand for alternative power sources continues to grow, many companies would likely look to Federal lands as a possible location for wind and solar farms. To determine the need to establish transmission line corridors to connect these new energy generating sources, the existing system was reviewed and evaluated in the West-wide Energy Corridor Programmatic EIS.

The effects of major development projects such as for utilities and transportation systems would be addressed on a site specific basis and mitigated individually following the Forest Service policy regarding special uses. Mitigations are typically accomplished by consolidating new developments along existing routes and corridors, or by construction techniques that disturb less land and improve reclamation success.

Description of Alternatives

Most of the direction for special uses comes from the Forest Service manuals and handbooks and, therefore, applies to all alternatives. The existing law, regulation, and policy governing special uses can be found in the Forest Service Manual, FSM2700, and Forest Service Handbook, FSH2709.11, 2709.12, and 2709.14, which are independent from the forest plan and its alternatives. The special uses program is managed to be consistent with the plan components for other resource areas (e.g., heritage, wildlife, etc.).

Alternative A – Current Plan, Current Management (No Action)

The current forest plan contains redundant direction from one management area to another. Most of the direction in the plan reiterates existing direction from the Forest Service manuals and handbooks. The goals for the program are to administer special uses to best meet public needs and to minimize the number of electronic sites and utility corridors that require the use of forest lands. The management direction for special uses is to provide timely evaluation, administration, and termination of special land use authorizations.

Elements Common to the Action Alternatives

Much of the redundant language has been eliminated between the management areas in the action alternatives. Additionally, the direction found in existing law, regulation, and policy is referenced in the action alternatives, but no longer repeated. All action alternatives would manage special uses consistent with the plan components for other resource areas (e.g., heritage, wildlife, etc.).

The action alternatives contain a guideline that all new communication sites should have a communication site management plan in place prior to the start of operations and must be consistent with the forest land management plan. This would set a specific timeframe for the forest to comply with Forest Service Handbook direction. Also in the action alternatives, the establishment of major utility corridor development is confined to the area identified and mapped in the West-wide Energy Corridor Programmatic EIS, an addition to the forest plan.

Environmental Consequences for Special Uses

Environmental Consequences Common to All Alternatives

Prior to authorization being granted for any special use, proposals are assessed using an interdisciplinary approach to address potential resource conflicts with the proposed project or service. The establishment of energy transmission corridors in the West-Wide Programmatic EIS has defined the width (3,500 feet) and location (center of the existing transmission line easement) for the forest. These corridors are open to both pipeline and transmission line development and would require project/site specific NEPA analysis. The management area for the West-wide Corridor makes it easier for planners, specialists, stakeholders, and the public to find the direction for this area. Additionally, the establishment of a management area allows for further site specific guidance for the area to be developed as needed.

Environmental Consequences for Special Uses for Alternative A – Current Plan, Current Management (No Action)

Under the current plan, there is no direction for the development or implementation of communication site plans on new electronic sites. The lack of a timeframe for completing the site plan could result in incompatible uses being permitted in the same electronic site, such as the mixing of high-power tenants (FM radio station) and low-power tenants (cell phone site) which can result in interference with each other’s operations.

Environmental Consequences for Special Uses Common to Action Alternatives B, C, and D

The action alternatives contain a guideline that all new communication sites should have a site management plan in place prior to the start of operations. This site management plan must be consistent with the forest land management plan. This guideline would improve management efficiency, oversight, and compliance with the current policy. This additional requirement has no effect on the review, reissuance, or permitting of special use projects.

Cumulative Environmental Consequences for Special Uses

The geographic area of analysis for cumulative impacts to special uses is the planning area and lands adjacent to the forest boundary. The forest is located within three counties in Arizona, with the vast majority (97 percent) located in Coconino County. Coconino County is the largest county in Arizona and the second largest in the United States, but it is one of the most sparsely populated. Only 13.3 percent of the county is privately owned. Native American reservations

(Navajo, Hopi, Kaibab-Paiute, Havasupai, and Hualapai) cover 38.1 percent of the land area. Federal and State agencies manage the rest of the county's lands—the Forest Service (28.3 percent), BLM (5 percent), State Land Department (9.5 percent), and National Park Service (6.8 percent) (Coconino County 2003). Just over 40 percent of the county is under Federal ownership. A much smaller portion of the forest (less than 2 percent) is in Yavapai County. The majority of this county is also owned and managed by Federal and State agencies. The remaining 26 percent of Yavapai County is privately owned property (Yavapai County 2003). Although this segment of the forest is small, the West-wide Energy Corridor and State Highway 89 run through it, and Highway 89 is used for access to private lands adjacent to the forest boundary.

The lack of private land has resulted in the need to use public lands as the source or location for public works and utilities. With the exception of applications for transmission lines and distribution facilities that utilize the West-wide Energy Corridor locations, the Forest Service Manual requires that, the forest must consider whether the proposed use can reasonably be accommodated on lands of other ownership. Private lands may provide opportunities for requests such as wind and solar power, small distribution lines, etc., but not for other activities that would require large continuous land bases such as for hunting, tours, and access/utilities for inholdings.

The special use programs for the Kaibab, Coconino, and Prescott NF s have the same general requirements as they are guided by the same laws, regulations, and policies. The management of the special use programs are likely to vary between the forests due to differing concerns or needs of each areas' resource management. The Arizona Strip General Management Plan of 2007 (BLM portion of the plan; BLM 2008) follows similar laws, regulations, and policies as the Forest Service.

Some restrictions to special use authorizations would be required to meet the desired conditions, standards, and guidelines for other resource areas addressed in the action alternatives in the forest plan. The addition of the West-wide Energy Corridor Programmatic EIS to the forest plan has identified the few locations for new major pipelines and transmission lines crossing the Kaibab NF. The cumulative consequences of any of the proposed alternatives for the forest plan would not be significant as they would have little to no effect on the activities and opportunities for these types of uses across the greater landscape. Cumulative impacts to special uses could occur through changes in the designation and development of land resources and the need for access. The presence of threatened, endangered, and sensitive species and historical/archaeological features and concerns may preclude the issuance of some authorizations and place restrictions on others.

Minerals and Mining Activities

Minerals management differs from managing renewable forest resources such as timber, wildlife, or recreational opportunities. First, management of mineral resources on the Kaibab NF is determined in part by the type of mineral ownership (Federal minerals, reserved minerals, outstanding minerals, or any combination thereof). Second, minerals are difficult to locate and inventory. Third, development of mineral resources depends greatly on local, national, and global markets. Finally, mineral resources are not renewable. More information on minerals and mining can be found in the Minerals and Mining Specialist Report (KNF 2012e).

Minerals of economic interest are classified as leasable, locatable, or salable. Coal, oil shale, phosphate, potash, sodium, geothermal resources, and all other minerals that may be acquired

under the Mineral Leasing Act of 1920, as amended, are referred to as leasable minerals. Common varieties of sand, stone, gravel, pumicite, and clay that may be acquired under the Materials Act of 1947 are considered salable minerals or mineral materials. Any minerals that are not salable or leasable, such as gold, silver, copper, tungsten, and uranium, are referred to as locatable minerals. These mineral deposits include most metallic mineral deposits and certain nonmetallic and industrial minerals. Locatable minerals are subject to the Mining Law.

Most of the direction for mining activities is found in existing law, regulation, and policy. As a result, the forest plan provides only minimal direction with regard to minerals. The legal framework that governs minerals (leasable, salable, and locatable) is the result of congressional legislation and court decisions made since the General Mining Law of May 10, 1872. The leasable minerals on NFS lands that are subject to the Mineral Leasing Act of 1920 are under the jurisdiction of the BLM and Secretary of the Interior. An interdepartmental agreement exist that states that all applications to lease Forest Service-managed lands would be referred to the Forest Service for review, recommendations, or consent, and special stipulations to protect the surface and subsurface functions. The Secretary of the Interior has historically followed these recommendations in granting leases on NFS-managed lands. Locatable minerals, and the mining claims upon which they may be located, are restricted to Forest Service lands that are classified as “public domain lands open to mineral entry.” Locatable minerals on acquired lands may fall under the Mineral Leasing Act, but the leasing of these minerals is at the discretion of the forest.

Description of Affected Environment (Existing Condition): Minerals and Mining

The vast majority of Kaibab NF lies within the Colorado Plateau physiographic province. The portion of the Colorado Plateau province that includes the planning area is characterized by predominantly sedimentary rock exposures; a regular, gently dipping surface; and plateaus over 7,000 feet above mean sea level that have been incised in some places to depths over 5,000 feet by the tributaries of the Colorado River. The Colorado Plateau is known generally for unique geological features, including the widespread prevalence and color of exposed sedimentary units, the occurrence of isolated volcanic mountain complexes, and erosional features such as mesas, cliffs, escarpments, and incised stream canyons. While not within the planning area, the Grand Canyon dominates the geological setting and forms the partial geographic boundary for the Tusayan and North Kaibab Ranger Districts; the side tributary canyons to the Grand Canyon form the surface drainage network for the majority of the forest. The Williams Ranger District is dominated by surface features associated with the San Francisco Volcanic Fields, and the edge of the plateau—referred to as the Mogollon Rim—is the southern boundary of the forest.

Currently, there are no active mineral leases and no known coal, oil, or gas reserves on the forest. The geological formations of the area do not favor such deposits within this area of the Colorado Plateau. Locatable minerals on acquired lands may fall under the Mineral Leasing Act, but the leasing of these minerals is at the discretion of the forest and is subject to all standards and guidelines for other resources such as heritage, wildlife, etc.

Salable minerals in the forest consist of sand and gravel deposits, building materials, and cinders. Sand and gravel deposits exist but are relatively isolated within the North Kaibab and Tusayan Ranger Districts and are primarily associated with the Moenkopi Formation and alluvial deposits. On the Williams District, gravel deposits of good quality have formed at the bottom of the southwestern slope of the Mogollon Rim. Building materials (primarily flagstone) are widespread

along this same section of the Rim and are associated with the Coconino Sandstone. Cinder deposits are limited to the Williams District, which is part of the San Francisco Volcanic Field.

The primary economic mineral resource within the area consists of limited locatable mineral deposits, usually associated with breccia pipe formations. All other locatable deposits are associated entirely with stratabound deposits that are small and not commercially viable. The uranium deposits within the northern Arizona breccia pipes are of higher grade than approximately 85 percent of the world's known uranium deposits (International Atomic Energy Agency 2009; World Nuclear Association 2009).

The area of the North Kaibab and Tusayan Ranger Districts which was designated as part of the Grand Canyon Game Preserve is closed to locatable mineral entry and is not available for leasing. The area of was designated as a game preserve in 1906 and was set aside from mineral entry as described in the General Mining Law of May 10, 1872. In 1985, a court decision determined that the area was also closed to leasable minerals activities as this was consistent with the intent of establishing the game preserve.

The Northern Arizona Proposed Withdrawal is outside the scope of this plan. This withdrawal will affect the establishment of new mining claims on public domain lands within the Tusayan and North Kaibab Ranger Districts but will have no effect on the existing valid claims. The withdrawal has closed the districts to the establishment of new mining claims for the next 20 years. The requirements for the new withdrawn area would be the same as other areas on the forest presently withdrawn from mineral entry.

Environmental Consequences for Minerals and Mining Activities

Most of the direction that affects minerals activities is independent of the forest plan and comes from the Forest Service manuals and handbooks. The existing law, regulation, and policy governs minerals on the forest and can be found in the Forest Service Manual, FSM 2800 (Mining Claims FSM 2810, Mineral Leases FSM 2820, Mineral Materials FSM 2850) and Forest Service Handbook, FSH 2809.15 and under Title 36 CFR part 228, subpart A. The minerals program is managed to be consistent with the plan components for other resource areas (e.g., heritage, wildlife, etc.).

Environmental Consequences for Mineral and Mining Activities: Alternative A – Current Plan, Current Management (No Action)

The current goals for minerals management are to administer the mineral laws and regulations to minimize adverse surface resource impacts and support sound energy and mineral exploration and development. The current plan also provides for the timely analysis and processing of locatable and leasable mineral prospecting, exploration, leasing, and development proposals. Lands potentially valuable for uranium and/or oil and gas production are available for exploration and development. Depending on the management area, the surface has special use stipulations and surface occupancy restrictions that are imposed on oil and gas leases and locatable minerals activities.

The removal of common variety minerals (building stone, gravel, cinders) would be permitted in existing sources not encumbered by mining claims. The development of new mineral material

sources would be allowed in accordance with the management direction for other resource concerns such as heritage, wildlife, soil, and water resources. In areas that are visible from the foregrounds of Highways 64, 67, and 89-A, the current plan calls for phasing out common variety minerals pits and rehabilitating extraction sites.

The current forest plan contains redundant direction from one management area to another. Most of the direction in the plan reiterates the Forest Service manuals and handbooks, and this can sometimes result in direction being missed and/or out of date. Under the current plan, acquired lands are available for mining activities and mineral leases because locatable minerals on acquired lands are not addressed in the current forest plan.

Environmental Consequences for Mineral and Mining Activities: Alternative B – Proposed Action, Preferred Alternative

The preferred alternative does not reiterate direction already contained in law, regulation, or policy. Existing direction is incorporated by reference and the proposed plan is organized so that direction is not repeated in each management area where it does not differ from the general forest. Additionally, because the preferred alternative does not reiterate existing law, regulation, and policy, the plan would not become outdated when there are external policy changes.

The proposed plan includes a guideline that limits locatable mineral activities to 50 pounds of samples on acquired lands. This would have little to no effect on mineral opportunities. The mining of locatable minerals on acquired lands where the Forest Service holds the mineral rights is discretionary and is governed by the laws, regulations, and policies that address leasable minerals. This guideline does not apply to lands classified as public domain within the forest boundary. The acres of acquired lands within the forest boundary are generally small tracts and widely dispersed.

The recommended wilderness areas in the preferred alternative would have no effect on establishing new mining claims for locatable minerals because they are all within the Grand Canyon Game Preserve and are not open to mineral entry. If established, these areas would be closed to new claims, but any valid existing claim would not be affected.

For leasable and salable minerals, lands that are identified as potential wilderness in the plan would become closed to new mineral leases and new mineral materials development. As the existing salable materials pits within the recommended wilderness areas become depleted or are no longer needed, they would be closed.

Environmental Consequences for Mineral and Mining Activities: Alternatives C and D

There is no difference in the minerals program between action alternatives with the exception of the establishment of wilderness areas. Alternatives C and D are the same as the preferred alternative except the number of acres available for leases and mineral materials development would be reduced by about 38,000 acres, which would be recommended for wilderness designation and subsequently withdrawn.

Cumulative Environmental Consequences for Mining and Minerals

The geographic area of analysis for cumulative impacts to minerals is the Kaibab NF and adjacent lands. The forest is located within three counties in Arizona: Coconino, Yavapai, and Mohave. The vast majority (97 percent) is located within Coconino County. Only 13.3 percent of Coconino County is privately owned. American Indian reservations (Navajo, Hopi, Kaibab-Paiute, Havasupai, and Hualapai) cover 38.1 percent of the land area. Just over 40 percent of the county is under Federal ownership. The Kaibab NF has common boundaries with Federal and tribal managed lands.

Population growth and development are expected to increase the demand for minerals. Mineral materials to be used in urban and rural areas—such as Tusayan, Parks, Ash Fork or Williams—for construction, decoration, and road projects are in high demand and are expected to increase pressure to develop these resources in the future.

Less than 2 percent of the forest is in Yavapai County. The majority of this county is owned and managed by Federal and State agencies. The portion of the forest in Yavapai County is a major flagstone production area for northern Arizona. The proposed alternatives would have little to no effect on these quarries or mineral production for this area of the forest; therefore, there are no cumulative effects to minerals and mining in Yavapai County.

A much smaller area (approximately 0.5 percent) of the forest lies in Mohave County. Most of this area is located within Kanab Creek Wilderness; the remainder of the forest within the county is being recommended for wilderness. Because these areas are small and mostly already withdrawn, there would be little to no effect on mineral or mining activities for this area of the forest, therefore, there are no cumulative effects to minerals and mining in Mohave County.

Most of the Kaibab NF is located in Coconino County, which also includes portions of the Coconino and Prescott National Forests. These forests are guided by the same laws, regulations, and policies as the Kaibab NF. If any of the areas recommended as wilderness areas are designated as wilderness, they would become closed to new mineral leases and new mineral materials pits and any existing materials pits within the wilderness would be closed once they are depleted or no longer needed..

The Arizona Strip General Management Plan of 2007 (BLM portion of the plan; BLM 2008) has guiding laws, regulations, and policies very similar to the Forest Service and is a potential source for minerals. Grand Canyon National Park has been withdrawn for mineral entry and is closed to mineral leasing and mineral materials.

If the price of uranium continues to climb, it could be expected that the uranium mines on the Tusayan district and the Arizona Strip would be reopened for operation and new ones would be developed. As the mineral withdrawal EIS that encompasses the North Kaibab and Tusayan Ranger Districts and sections of the Arizona Strip adjacent to Grand Canyon National Park moves forward, the results of this study and consequent congressional action would have a greater effect on establishing new mining claims and minerals activities than any of the alternatives in the forest plan.

The alternatives to the forest plan would not affect the availability of locatable minerals on public domain lands on the Kaibab NF nor would they affect lands adjacent to the forest. Alternatives B,

C, and D, which recommend the addition of wilderness areas to the present land base, would reduce the number of acres available for salable mineral materials and the possibility of mineral leases in the future. The restrictions placed on acquired lands for locatable minerals would have no cumulative effect on the environment due to the small number of acres scattered across the forest.

Socioeconomic

For additional information see the Socioeconomic Resource Report (KNF 2013h) and figure 8.

Description of Affected Environment (Existing Condition) – Socioeconomic

The majority of the Kaibab NF lies within Coconino County; however, there are also small areas of the forest in Yavapai and Mohave Counties. Of the 1.6 million acres of the Kaibab NF, 25,622 acres (1.6 percent) are within Yavapai County and 4,646 acres (0.3 percent) are within Mohave County (table 40). Due to the large area and population of these two counties and the small percentage of those counties that contain Kaibab NF lands, they are not included in the socioeconomic effects analysis. The inclusion of these counties could skew and/or mask important consequences of Kaibab NF management. For example, the populations of Mohave and Yavapai Counties would be triple that of Coconino County and yet the number of acres of Kaibab NF land in those counties combined is only 2 percent of the Forest. Little to no economic activity is associated with the Kaibab NF acres within those two counties.

Table 40. Total area, population, and population density for Coconino, Mohave, and Yavapai Counties in 2000

County	Total Area (sq. miles)	Population	Population Density (per sq. mile)
Coconino	18,661	116,320	6.23
Mohave	13,312	155,032	11.64
Yavapai	8,128	167,517	20.6

Source: University of Arizona 2005

Economic, political, demographic, resource, and other considerations have been used in a multitude of ways to define analysis areas. Analysis of natural resource-dependent economic activities is based on IMPLAN[4] data provided by the Forest Service Planning Analysis Group and Inventory and Monitoring Institute in Fort Collins, Colorado. Impact analysis area delineation protocols developed by Management and Engineering Technologies, Inc. /Economic Insights provide a consistent and convenient approach to delineating analysis areas for IMPLAN

[4] IMPLAN (IMpact analysis for PLANing, Minnesota IMPLAN Group, Inc.) is a regional economic impact analysis system that uses county level, input-output data to determine the extent to which these activities (such as livestock grazing) contribute to the local economy. Input-output analysis is an economist's tool that traces linkages among the structural parts of an economy and calculates the employment, income, and output effects resulting from a direct impact on the economy.

analysis.[5] These protocols, as well as input from forest specialists were used to determine which counties to include in our analysis.

Based on labor, income, trade flows, commuting patterns, and expenditures, the analysis area for this project was identified as Coconino County, Arizona, and Kane and Garfield Counties in southern Utah. The two rural counties in southern Utah have traditional, historic, and current social and economic linkages to the North Kaibab Ranger District. A number of day-use recreation visits originate in these counties, and firms and individuals process timber materials (including firewood) from the North Kaibab Ranger District (Eichman and Jaworski 2012, NKRD 2011).

The Grand Canyon and the Colorado River separate the North Kaibab Ranger District from the rest of the Kaibab NF. The communities near the North Kaibab Ranger District identify with and are influenced more by southern Utah than Arizona. The Grand Canyon represents a biophysical, cultural, and socioeconomic divide that is recognized in the analysis. The forest plan revision process addresses the socioeconomic impacts from forest management changes on Coconino County, Arizona, and Kane and Garfield County, Utah. Other than a handful of towns in each county, the analysis area is relatively remote and sparsely populated. Prominent cities and towns within these counties include Flagstaff; Williams, Tusayan/Grand Canyon, and Fredonia in Arizona, and Kanab, Panguitch, and Escalante in Utah).

Prior to estimating potential social and economic effects of alternative forest management actions, it is necessary to describe existing socioeconomic conditions to serve as a baseline. Demographic patterns and trends are used to identify the current and future forest users, to understand how future forest users may be similar to or different from current users, and how growing residential populations may influence forest management. The forest also uses this information to note minority and low income group trends and vulnerabilities. Because management decisions may disproportionately affect some segments of a population more than others, the description and analysis of the social environment takes into consideration the relationship between segments of the population and any differential effects. Changes in population, employment, income levels, business/industry type and activity, and the forest's contribution to the local economy are considered in the analysis.

Population and Demographics

The following section highlights population and demographic trends in the study area. Population is an important consideration in managing natural resources. In particular, population structure (size, composition, density, etc.) and population dynamics (how the structure changes over time) are essential to describing the consequences of forest management and planning on a social environment (Seesholtz et al. 2004).

[5] This method uses Census Bureau's LED OnTheMap accompanied by a set of criteria to address Forest Service needs to delineate labor based economic areas. The criteria guide analysts in the use of LED OnTheMap to delineate economic areas that are: (1) consistent with prior work by other Federal agencies and (2) customized to address unique issues and conditions. The criteria also address, in part, current exclusions in LED employment data.

Population Growth

Population increases may lead to conflicts over land use, travel management, recreation activities, and values. These are conflicts that Forest Service managers attempt to balance when making management decisions. In 2010, the study area was home to 146,718 people. Table 41 displays population data for the study area communities and counties in Arizona and Utah in 1990, 2000, and 2010.

Table 41. Population change in the study area, Arizona and Utah, 1990 to 2010

Location	1990	2000	Percent Growth, 1990-2000	2010	Percent Growth, 2000-2010
Coconino County	**96,591**	**116,318**	**20.4**	**134,421**	**15.6**
Fredonia	1,207	1,036	-14.2	1,314	26.8
Tusayan/Grand Canyon	1,570	2,022	28.8	2,562	26.7
Williams	2,461	2,842	15.5	3,023	6.4
Flagstaff	45,857	52,894	15.3	65,870	24.5
Kane County	**5,169**	**6,046**	**17**	**7,125**	**17.8**
Kanab	3,289	3,564	8.4	4,312	17.3
Garfield County	**3,980**	**4,735**	**19**	**5,172**	**15.1**
Escalante	838	818	-2.4	797	-2.6
Panguitch	1,434	1,623	13.2	1,520	-6.8
Study Area Total	**105,740**	**127,101**	**20.2**	**146,718**	**15.4**
Arizona	3,665,228	5,130,632	40.0	6,392,017	24.6
Utah	1,722,850	2,233,169	8.9	2,763,885	23.8

Source: U.S. Census Bureau, 1990, 2000, and 2010

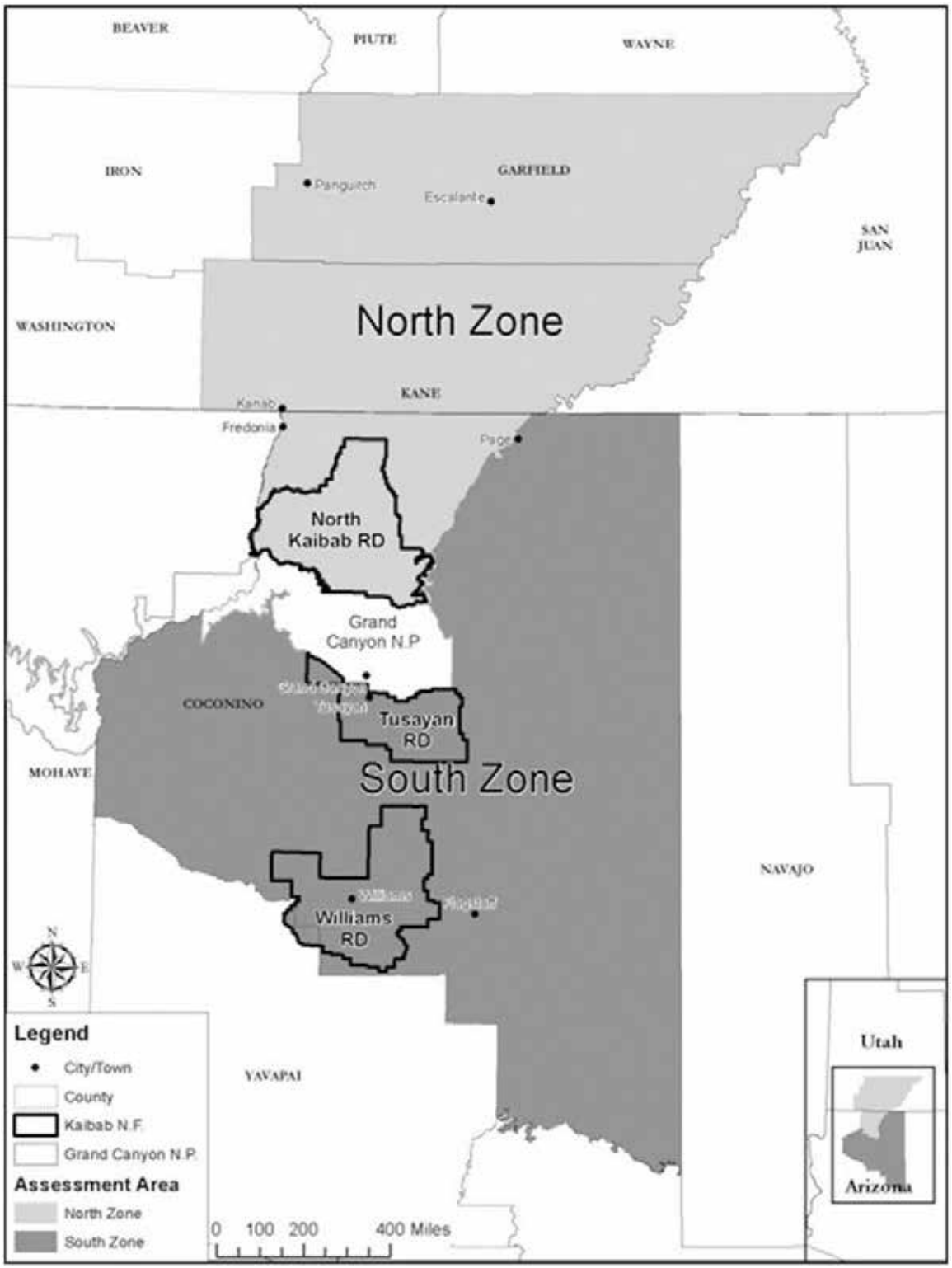


Figure 8. Kaibab National Forest socioeconomic assessment area

Coconino County accounts for 91.6 percent of the total population within the socioeconomic affected environment. These data highlight the importance of separating the effects analysis into the North and South Zones as previously described. Aggregating Coconino County and the small Utah counties could mask substantial changes occurring in the North Zone of the study area.

The socioeconomic impact area population growth rate was significantly less than Arizona and Utah's population growth rate over the last 10 years. The population in all three counties grew at similar rates in the first period, while Garfield County grew at a lower rate than Kane and Coconino Counties in the second period. The communities of Fredonia, Escalante, and Panguich experienced population declines at different times over the past 20 years.

Rapid population growth may signal expanding economic opportunities and/or desirable amenities. Much of Coconino, Garfield, and Kane Counties are occupied by Federal lands. NFS and BLM lands provide natural amenities for area residents. Steady, long-term growth in an area's population is generally an indication of a healthy, prosperous economy. Erratic growth, no growth, or long-term decline usually indicate a struggling economy. From table 41, we can see that these conditions apply to the communities of Fredonia, Escalante, and Panguitch. These conditions exist in the presence of the natural amenities provided by surrounding public lands.

Population Density

Population density can serve as an indicator of a number of socioeconomic factors of interest such as urbanization, ruralness, and availability of open space. More densely populated areas are generally more urban, diverse, and offer better access to infrastructure. In contrast, less densely populated areas provide more open space, which may offer natural amenity values to residents and visitors. Table 42 displays the number of people per square mile for each of the counties of interest.

Table 42. Population density (persons per square mile) for counties in assessment area, 2000 and 2010

Location	2000	2010
Coconino County	6.2	7.2
Arizona	**45.2**	**56.3**
Garfield County	0.9	1.0
Kane County	1.5	1.7
Utah	**27.2**	**33.6**

Source: U.S. Census Bureau 2012a, 2012b

Despite gains in population since 1990, all counties continue to have low population densities. The low population density in these rural counties coincides with a high level of public land ownership. Approximately 42 percent of the land area in Coconino County is publically owned (BLM, Forest Service, and State) and another 38 percent is tribal lands. Only 13.3 percent of Coconino County is private land (University of Arizona 2005). Eighty-eight percent of the land in Garfield and Kane Counties is managed by the Forest Service, BLM, and NPS. About 7.5 percent of all the land in these counties is private (State of Utah 2011).

Age and Gender

Table 43 lists the median age by county for the assessment area. As with other population characteristics, the median age varies substantially between counties. Coconino County is relatively young with the median age between the State and national median. In contrast, Kane and Garfield Counties exceed their State and national median ages. A high median age generally indicates that a relatively large number of retirees reside in the area. An area with a large percentage of retirees will earn more income from investments and transfer payments (e.g., dividends and Social Security), rather than salaries and wages.

Age data may be relevant for forest management decisions. A population's age may affect community values and uses associated with forest lands. For example, older populations are more likely to desire easily accessible recreation opportunities.

Table 43. Median age by county for the assessment area

Location	Median Age
Coconino County	29.0
Arizona	**35.0**
Garfield County	39.4
Kane County	43.6
Utah	**28.8**
United States	**36.8**

Source: U.S. Census Bureau 2009a

Table 44 displays the gender breakdown for the study area counties, State, and Nation. None of the counties markedly deviate from State and national conditions in terms of gender distribution.

Table 44. Gender distribution for the study area, counties, the State, and Nation

Location	Females (percent of total population)	Males (percent of total population)
Coconino County	50.2	49.8
Arizona	**49.9**	**50.1**
Garfield County	48.2	51.8
Kane County	**50.2**	**49.8**
Utah	49.7	50.3
United States	**50.7**	**49.3**

Source: U.S. Census Bureau 2009a

Educational Attainment

Educational attainment—the measure of people with at least a high school diploma or bachelor's degree—is an important indicator of an area's social and economic opportunities.

Table 45 lists the percentage of the adult population with at least a high school diploma and/or bachelor's degree.

Table 45. Educational attainment, percent of persons age 25 and older

Location	High School Graduate	Bachelor's Degree or Higher
Coconino County	86.1	30.1
Arizona	**83.9**	**25.7**
Garfield County	89.1	19.5
Kane County	88.0	17.8
Utah	**90.4**	**28.7**
United States	**84.6**	**27.5**

The vast majority of adult residents in the socioeconomic impact area are high school graduates. Approximately a quarter of area residents have a bachelor's degree or higher. The highest percentage of the adult population with a college degree resides in Coconino County (South Zone). The population of Garfield and Kane Counties is older (table 43) and possesses a lower level of education than that of Coconino County. Opportunities likely exist for working age adults with high levels of education in Coconino County that may not exist in rural Utah counties. A highly educated population is a signal that an area provides economic and cultural opportunities, which attracts additional college educated adults to the area. This process leads to further economic development and job creation (Eichman and Jaworski 2012).

Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (February 11, 1994) required every Federal agency to make achieving environmental justice part of its mission "by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Section 6-606 further indicates that all Federal agency responsibilities articulated in the executive order shall apply equally to American Indians.

Environmental justice is the fair treatment and meaningful involvement of people of all races, cultures, and incomes, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The goal of environmental justice is for Federal agency decision makers to identify impacts that are disproportionately high and adverse with respect to minority and low income populations and identify alternatives that would avoid or mitigate those impacts.

Environmental justice means that, to the greatest extent practicable and permitted by law, all populations are provided the opportunity to comment before decisions are rendered on, are

allowed to share in the benefits of, are not excluded from, and are not affected in a disproportionately high and adverse manner by government programs and activities affecting human health or the environment. Environmental justice is achieved when everyone, regardless of race, culture, or income, enjoys the same degree of protection from environmental and health hazards, and has equal access to the decision making process in order to have a healthy environment in which to live, learn, and work (SWCA 2011).

Minority means a person who is a member of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.

Minority population means any readily identifiable group of minority persons who live in geographic proximity to, and, if circumstances warrant, migrant farm workers and other geographically dispersed/transient persons who will be similarly affected by, U.S. Department of Agriculture (USDA) programs or activities. Minority populations are identified where either: (a) the minority population of the affected area exceeds 50 percent; or, (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

Low income population means any readily identifiable group of low income persons who live in geographic proximity to, and, if circumstances warrant, migrant farm workers and other geographically dispersed/transient persons who will be similarly affected by, USDA programs or activities. Low income populations may be identified using data collected, maintained, and analyzed by an agency or from analytical tools such as the annual statistical poverty thresholds from the Bureau of the Census' Current Population Reports, Series P-60 on Income and Poverty.

Human health and/or environmental effects as used in this departmental regulation include interrelated social and economic effects.

The emphasis of environmental justice is on health effects and/or the benefits of a healthy environment. The Council on Environmental Quality (CEQ) has interpreted health effects with a broad definition: "Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low income communities or Indian Tribes …when those impacts are interrelated to impacts on the natural or physical environment" (CEQ 1997).

Coconino County contains the highest proportion (13.5 percent) of Hispanic/Latino residents in the planning area. However, this is less than half the proportion of this ethnic group present in the State of Arizona (29.6 percent). Coconino County has a high concentration of American Indian residents (27.3 percent), due to the presence of five reservations in the county (table 46).[6]

The Kaibab NF recognizes that the area's American Indian Tribes have cultural ties to and knowledge about the lands now managed by the Forest Service. Many Tribal members regularly visit the forest to gather traditional resources and to visit traditional cultural properties and sacred sites. Due to the level of use of the forest by tribal members and the unique interests of area tribes, the Kaibab NF has conducted extensive tribal consultation and scoping of tribal communities throughout the Forest Plan Revision process. This consultation process reflects a long-standing commitment by the forest to share the stewardship of public lands with area tribes.

[6] Coconino County contains all or part of the Navajo Indian Reservation, Hualapai Indian Reservation, Hopi Indian Reservation, Havasupai Indian Reservation, and Kaibab Paiute Indian Reservation.

The Kaibab NF has included discussions and updates about Plan Revision in regularly scheduled government-to-government consultation meetings with area tribes for the past five years. A detailed listing of tribal consultation meetings as well as a summary of tribal concerns related to Forest Plan Revision is found in the Heritage and Tribal Relations Specialist Report (Heritage and Tribal Relations Report (KNF 2012d).

Table 46. Race and ethnicity in socioeconomic assessment area (population percentage)

Location	White	Hispanic or Latino	American Indian and Alaska Native	Black or African American	Asian	Native Hawaiian and Other Pacific Islander	Other	Two or More
Coconino County	61.7	13.5	27.3	1.2	1.4	0.1	5.2	3.1
Arizona	**73.0**	**29.6**	**4.6**	**4.1**	**2.8**	**0.2**	**11.9**	**3.4**
Garfield County	94.1	4.5	1.6	0.4	1.2	0.2	1.6	0.9
Kane County	95.7	3.7	1.5	0.2	0.4	0.0	0.9	1.3
Utah	**86.1**	**13.0**	**1.2**	**1.1**	**2.0**	**0.9**	**6.0**	**2.7**
United States	**72.4**	**16.3**	**0.9**	**12.6**	**4.8**	**0.2**	**6.2**	**2.9**

Increases in prescribed burns and wildfires managed for resource objectives in all action alternatives (B, C, and D) create the potential for an environmental justice issue related to possible disproportionate effects of increased smoke because:

- Most of the smoke from fire use on the Coconino and Kaibab NF s would carry from the southwest to the northeast and to the Havasupai Reservation and western portions of the Navajo Reservation;
- Many people living in these areas are seniors with health conditions and sensitivity to smoke. The effects of limited communications (they cannot get on a Web site to check out where the Forest is burning, etc.), language barriers, or cultural differences make it difficult to get information to them and receive information in return about smoke impacts; and
- There is a general lack of smoke monitoring data on the reservations.

Therefore, those living on these reservations may be disproportionately impacted by smoke from the various agencies (especially from multiple fires on multiple jurisdictions). Table 47 shows the percentage of residents living in poverty. Coconino County has a significantly higher poverty rate than the other counties and the states of Arizona and Utah. The incidence of poverty in Coconino County is not evenly distributed among racial and ethnic groups. Approximately 50 percent of American Indian residents in Coconino County live in poverty. The high proportion of American Indian residents in the county, therefore, increases the poverty rate relative to other study area counties and the State (Eichman and Jaworski 2012).

Table 47. Percentage of residents living in poverty

Location	Poverty Rate (percentage of population)
Coconino County	17.4
Arizona	14.7
Garfield County	10.8
Kane County	10.6
Utah	10.4
United States	13.5

Based on the minority status and poverty data presented above, Coconino County appears most at risk for environmental justice issues within the planning area. The largest minority group in the county—American Indians—also experiences a very high poverty rate.

Income and Employment

One of the most important measures of overall economic and human well-being in our society is income. Median and per capita incomes are often indicators of the standard of living in an area. High income levels often signal greater job opportunities, highly skilled residents, greater economic resiliency, and well developed infrastructure. Table 48 provides data on per capita income in 2009.

Table 48. Per capita income, 2009

Location	Per Capita Income
Arizona	**$25,203**
Coconino County	$22,238
Flagstaff	$22,598
Williams	$16,852
Fredonia	$15,738
Utah	**$22,684**
Garfield County	$23,772
Escalante	$20,496
Panguich	$17,361
Kane County	$24,515
Kanab	$20,138
United States	**$27,041**

Median Earnings

Per capita income offers an incomplete picture of the economic well-being of an area. Whereas per capita income considers all sources of income (including wage and salary payments, transfer

payments, investment earnings, dividends, and rents), median earnings considers only wage and salary earnings. Table 49 presents data on median earnings for workers.

Table 49. Median earnings for workers, 2009

Location	Median Earnings
Coconino County	$23,391
Arizona	**$28,748**
Garfield County	$25,657
Kane County	$22,405
Utah	**$25,329**
United States	**$29,050**

Non-labor Income

Table 50 displays the role of labor and non-labor income in total personal income for 2000 and 2009. Non-labor income is any income derived from investments, dividends, rents, or transfer payments. In contrast, labor income is salary and wage disbursements from employment. During the past decade, the percentage of total income derived from non-labor sources increased in all considered areas.

Non-labor income is not directly tied to employment; therefore, it can be more resistant to economic downturns. However, as the most recent recession demonstrated, asset markets can be volatile, and non-labor income that depends on investment returns may be unstable.

An increase in non-labor income may reflect changing demographic characteristics. Older populations rely largely on non-labor income, including rents, dividends, and transfer payments (e.g., Social Security). High percentages of non-labor income likely indicate higher concentrations of retirees.

Table 50. Percentage of contribution of labor and non-labor income to total personal income, 2000 and 2009

Location	2000		2009	
	Labor Percent	Nonlabor Percent	Labor Percent	Nonlabor Percent
Coconino County	64	36	62	38
Arizona	68	32	62	38
Garfield County	65	35	60	40
Kane County	60	40	57	43
Utah	73	27	68	32
United States	69	31	64	36

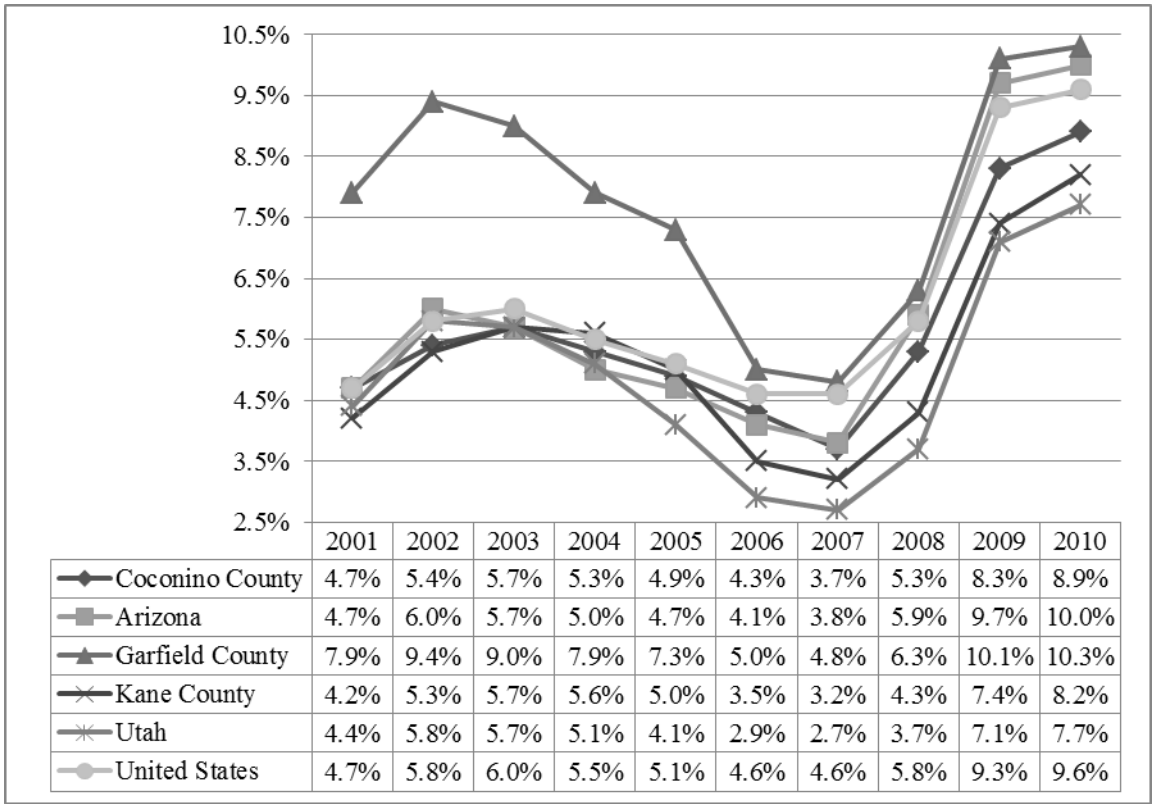
Source: U.S. Bureau of Economic Analysis 2011

Labor income is greater than non-labor income in all counties in the analysis area, accounting for more than half of total personal income. This is consistent with patterns in the Arizona, Utah, and

the Nation. Across all geographies, the share of labor income has decreased as a percent of total personal income. As noted above, areas with a large percentage of retirees are likely to earn more income from investments and transfer payments (e.g., dividends and Social Security), rather than salaries and wages. Increases in non-labor income suggest older age groups are making up a larger portion of the population across the study area, thus non-labor income may be increasingly important.

Unemployment

The unemployment rate provides insight into the correspondence between residents' skills and employment opportunities. The "natural" rate of unemployment is said to be around 5 percent. This is the so-called "natural" rate because this is a level that allows for movement between jobs and industries, but does not signal broad economic distress. Recently, the national unemployment rate has hovered between 9 and 10 percent. Figure 9 provides the annual unemployment rates for the counties, states, and Nation from 2001 to 2010. Garfield County unemployment was consistently higher than the State, Nation, and other study area counties over the period examined.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Coconino County	4.7%	5.4%	5.7%	5.3%	4.9%	4.3%	3.7%	5.3%	8.3%	8.9%
Arizona	4.7%	6.0%	5.7%	5.0%	4.7%	4.1%	3.8%	5.9%	9.7%	10.0%
Garfield County	7.9%	9.4%	9.0%	7.9%	7.3%	5.0%	4.8%	6.3%	10.1%	10.3%
Kane County	4.2%	5.3%	5.7%	5.6%	5.0%	3.5%	3.2%	4.3%	7.4%	8.2%
Utah	4.4%	5.8%	5.7%	5.1%	4.1%	2.9%	2.7%	3.7%	7.1%	7.7%
United States	4.7%	5.8%	6.0%	5.5%	5.1%	4.6%	4.6%	5.8%	9.3%	9.6%

(Source: U.S. Bureau of Labor Statistics 2011)

Figure 9. Annual unemployment rate, 2001 to 2010

Economic Diversity

Economic diversity generally promotes stability and offers greater employment opportunities. Highly specialized economies (i.e., those that depend on very few industries for the bulk of employment and income) are prone to cyclical fluctuations and offer more limited job

opportunities. Determining the degree of specialization in an economy is important for decision makers, particularly when the dominant industry can be affected by changes in policy. For Forest Service decision makers, this is likely to be the case where the forest products industry or the tourism and recreation industries, for instance, are reliant on the local forest(s).

Figure 10 provides a breakdown of employment by industry in the study area. The government, accommodation and food services, and retail trade sectors are the largest employment sectors in the local economy. These industries are consistent with a substantial government presence due to public land management, a large retiree population that consumes health and social services, and amenities that attract tourists who contribute to the accommodation and food services and retail trade sectors.[7]

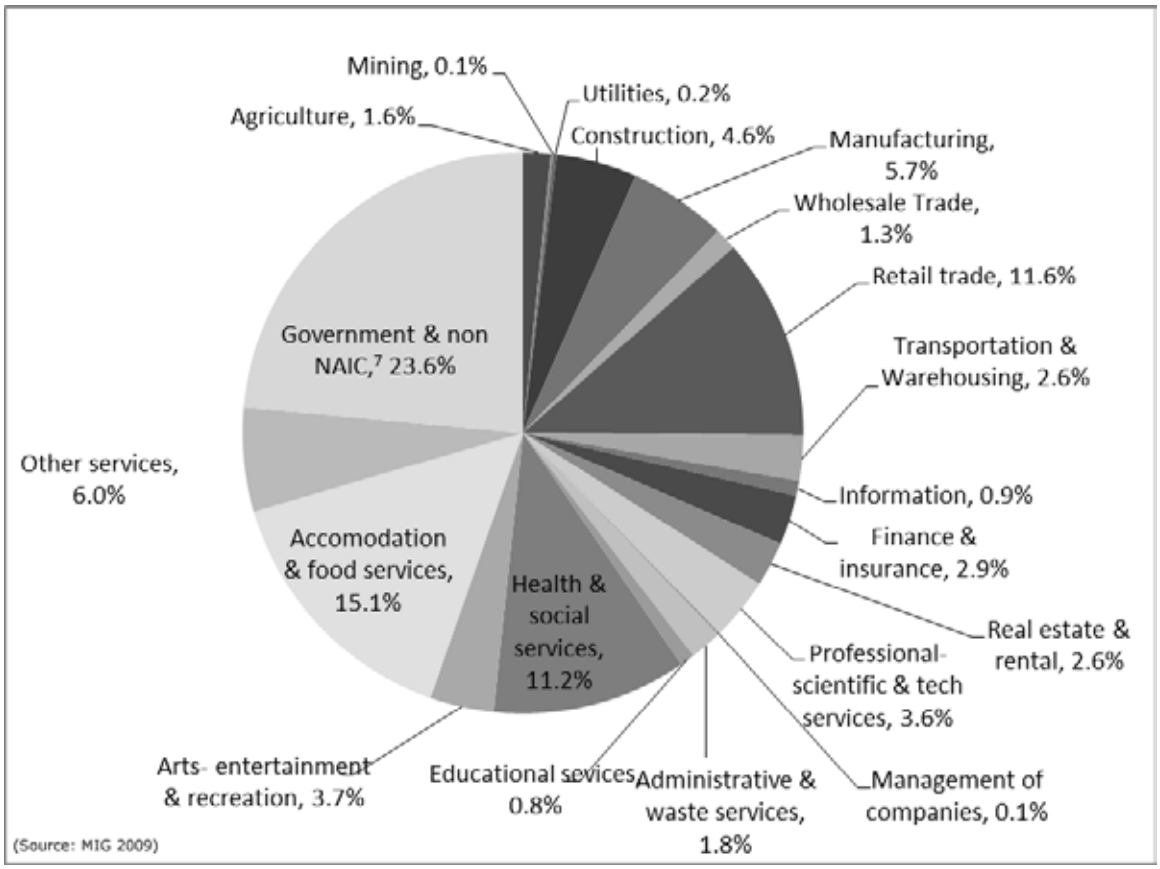


Figure 10. Employment by industry in the planning area

The method applied here uses the ratio of the percent employment in each industry in the region of interest (study area) to an average percent of employment in that industry for a larger reference area (Arizona and Utah). For a given industry, when the percent employment in the analysis region is greater than in the reference area, local employment specialization exists in that industry (USDA Forest Service 1998). Using this criterion applied to 2009 data, the study area can be

[7] The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

characterized as specialized with respect to several industries, particularly Accommodation and food services, arts-entertainment and recreation and government (MIG 2009). Figure 11 provides the employment specialization index for all industries in the study area.

Whereas figure 10 considers the study area in isolation, figure 11 compares industry concentration in the study area to the states of Arizona and Utah as a whole. The numbers on the x-axis of figure 11 show the degree of specialization in the local economy. A score of 1 indicates that the study area and the State are equally specialized in the sector. A score above 1 indicates that the study area is more specialized in the sector than the State. A score below 1 indicates that the study area is less specialized in the sector than the State. As the two figures demonstrate, these two methods of data analysis can suggest quite different results. Agriculture accounts for just 1.6 percent of employment in the study area—a relatively modest figure until it is put in the context of the State. A resident of the study area is more likely to be employed in the agriculture sector compared to residents of Arizona and Utah.

The relatively undiversified economy which presently exists leaves the communities within the planning area precariously dependent on the fairly unstable economic activities of tourism, agriculture, and government expenditures. A more diversified economy would act as a buffer against the economic fluctuations inherent in the basic industries now sustaining these communities.

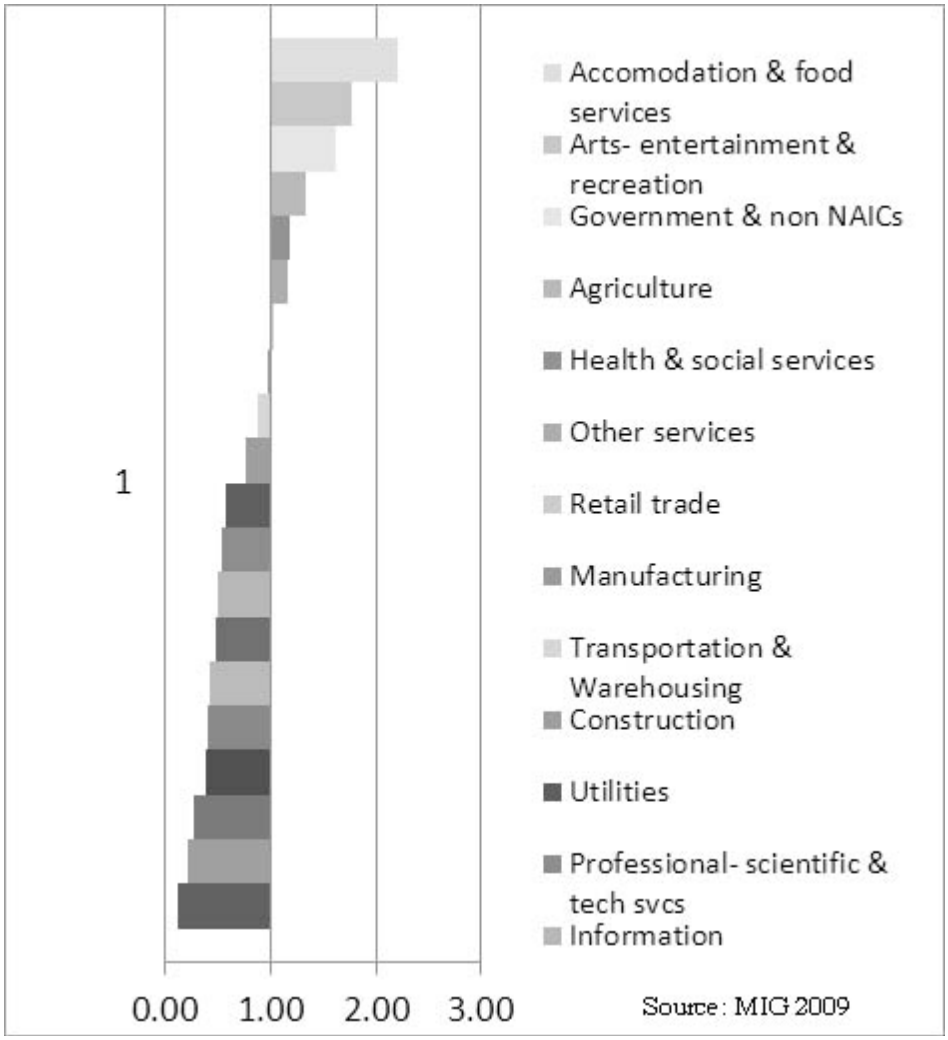


Figure 11. Employment specialization in the study area

Payments to States and Counties

The Forest Service makes payments to states and counties that contain NFS lands. These payments fall into two categories: Payments in Lieu of Taxes (PILT) and Secure Rural Schools and Community Self-Determination Act payments (SRSCS).

Federal agencies do not pay property taxes; therefore, PILT is distributed to counties to compensate for the local services that support activities on Federal lands. These services include law enforcement, road maintenance, and fire departments.

SRSCS payments are intended to improve public schools, maintain infrastructure, improve the health of watersheds and ecosystems, protect communities, and strengthen local economies.

Table 51 lists the PILT and SRSCS payments from the Kaibab NF. The very small amounts paid to Mohave and Yavapai Counties are a reflection of the miniscule percentage of those counties that contain Kaibab NF lands. No payments are made to the southern Utah counties since there are no Kaibab NF lands within those counties.

Table 51. Payments to states and counties from the Kaibab National Forest

Area	SRSCS (FY10)	PILT (FY10)	Total FS Payments
Coconino County	$1,881,601	$505,448	$2,387,049
Mohave County	$11,924	$2,873	$14,797
Yavapai County	$31,018	$8,281	$39,299
Kaibab NF	$1,924,543	$516,602	$2,441,145

Source: USDA Forest Service 2011 and USDI 2010

Environmental Consequences for Socioeconomics

The previous section assessed and described past and current social and economic conditions of the affected environment. The following section will consider the potential consequences of alternative management scenarios on the socioeconomic environment. Sections 219.12(g) and (h) of the 1982 Rule Provisions direct the planning team to estimate and evaluate the significant physical, biological, economic, and social effects of implementing each alternative considered in detail according to NEPA procedures. There are two economic analyses required by the 1982 Rule Provisions—economic impact analysis and financial efficiency analysis.

None of the alternatives, including the proposed plan (alternative B), produce actions or conditions that would result in differences in economic contributions or social impacts for resources other than timber. For example, alternatives B, C, and D would provide for continued availability of forage for domestic livestock and opportunities for ranching lifestyles consistent with the other desired conditions. With the exception of differences in proposed wilderness areas, all action alternatives are expected to have similar impacts on recreation including the same number of acres in each ROS class. The fundamental difference among alternatives concerns the number of acres mechanically thinned and the timber management prescription intensities applied and is, therefore, the focus of the socioeconomic effects analysis.

Economic Impact Analysis

Economic impact analysis estimates the employment and labor income consequences of forest management actions. Economic impacts were modeled using IMPLAN Professional Version 3.0 with 2009 data. Data on use levels under each alternative were collected from the Kaibab NF's resource specialists. In most instances, the precise change is unknown. Therefore, the changes are based on the professional expertise of the resource specialists. The purpose of the economic impact analysis is to compare the relative effects of the alternatives and they should not be viewed as absolute values.

Effects to Socioeconomics Common to All Alternatives

Over the planning period (10 to 15 years), there are no identified differences between all action alternatives (B, C, and D) relative to nontimber resource areas (e.g., range, recreation, fire) that would produce differences in economic effects.

Table 52 below provides employment and labor income estimates for all resource areas except timber. For analytical purposes, it is assumed that these impacts occur only in Coconino County since direct expenditures on management for these resource areas occur only in Coconino County.

Table 52. Employment and labor income by program area, all alternatives

Resource Program Area	Employment (jobs)	Labor Income (thousand $)
Recreation: non-local only†	97	2,599
Wildlife and fish: non-local only†	13	380
Grazing	102	235
Minerals	12	521
Timber	(see table 53)	
Payments to states and counties	66	2,822
Forest Service expenditures*	341	13,476
Total	**631**	**20,033**

† Only non-locals are included as they are bringing "new money" into the economy.
* Includes Forest Service salary and non-salary expenditures (e.g., office equipment)

Table 53 provides information on how the forest contributions to employment and income from the different resource program areas (except timber) are distributed among the various industrial sectors within the impact area. Government is the most significant contributor to the impact area economy accounting for 40 percent of impact area jobs and almost 60 percent of labor income. The lowest paying sectors of the economy are agriculture, mining (cinder pits and flagstone quarry operations), and the entertainment/recreation/accommodation/food services sectors. The highest paying sectors of the economy are wholesale trade, education/health services, and government. These conclusions are based on the percent of area employment compared to the percent of area income.

Table 53. Kaibab National Forest contribution (without timber), employment, and income by major industry

Major Industry	Employment Number of Jobs	Percentage	Labor Income Thousand $	Percentage
Agriculture	97	15.4	60	.3
Mining	12	1.9	126	.6
Construction and utilities	17	2.7	637	3.3
Manufacturing	2	.3	93	.5
Wholesale trade	4	.6	171	.9
Transportation and warehousing	7	1.1	322	1.6
Retail trade	47	7.4	1,315	6.7
Finance, insurance, real estate	24	3.8	388	2.0
Professional, scientific, tech. services	35	5.5	969	4.9
Education, health, and social services	32	5.1	1,643	8.4
Entertainment and recreation services	28	4.4	594	3.0
Accommodation and food services	61	9.7	1,243	6.3
Other services	13	2.1	402	2.0
Government	252	40.0	11,657	59.4
Total Forest Service Management	631		19,620	

Timber-related Economic Effects

As previously described in the affected environment section, the North Kaibab Ranger District is separated from the rest of the Kaibab NF by the Grand Canyon and Colorado River. In the following analysis, estimated impacts on employment and income are presented for that part of Coconino County that lies south of the Grand Canyon/Colorado River and, for that part of Coconino County that lies north of the Grand Canyon/Colorado River combined with Kane and Garfield Counties in Utah. Hereafter, these two areas are referred to as the South Zone and the North Zone.

A significant level of uncertainty exists regarding the development of a sustainable timber harvesting and utilization industry. At present, a small logging sector exists within the South Zone, but there is almost nothing in terms of a wood utilization/processing sector. However, in May of 2012, the Forest Service selected the contractor for the largest stewardship contract in the agency's history. The Four Forest Restoration Initiative (4FRI) is a collaborative effort to restore ecological resilience and function across northern Arizona's ponderosa pine forests, including the South Zone. The 4FRI effort should develop a wood products industry that will in turn strengthen local economies. The 4FRI contract is not applicable to the North Zone. The volume harvested in the North Zone has been small and the local processing facilities can easily handle it. However, implementation of the alternatives analyzed could change that situation. Because of the uncertainty involved, analytical scenarios are developed as a means to examine the impacts on employment and income resulting from differing rates of impact area utilization. In all cases, alternative A represents a continuation of the existing situation.

Table 54 provides the estimated annual forest product volumes available by alternative. These volumes are used to estimate the economic impact and financial efficiency of timber-related activities on the Kaibab NF.

Table 54. Estimated annual forest product volumes by alternative

Forest Product	Alt. A Annual Volumes (CCF)	Alt. B Annual Volumes (CCF)	Alts. C and D Annual Volumes (CCF)
South Zone			
Harvest – Softwood 9+" Sawtimber	12,730	51,665	19,577
Harvest – Softwood 5-9" Pulp	4,023	9,080	6,614
Poles	30	104	104
Posts	315	34	34
Firewood	4,551	15,837	15,837
			North Zone
Harvest – Softwood 9+" Sawtimber	3,956	40,684	13,129
Harvest – Softwood 5-9" Pulp		6,362	4,272
Poles	69	3,502	3,502
Posts	3	30	30
Firewood	3,013	14,998	14,998

Source: Kaibab NF silviculture staff

South Zone

Table 55 presents the estimated impacts to employment and labor income by alternative for the South Zone for three different utilization/processing scenarios. Under these scenarios, 25 percent, 50 percent, and 100 percent of the average annual volume harvested from the South Zone is assumed to be processed within the area.

Table 55. Timber contribution, employment, and income by alternative, South Zone

Scenario	Alt. A	Alt. B	Alts. C and D
Employment (number of jobs)			
25 percent processed within area	148	423	328
50 percent processed within area	192	733	435
100 percent processed within area	275	1,053	546
Income (thousand $)			
25 percent processed within area	5,321	14,558	11,746
50 percent processed within area	6,827	26,553	15,944
100 percent processed within area	10,039	38,870	20,218

North Zone

Table 56 presents the estimated impacts to employment and labor income by alternative for the North Zone for two different utilization/processing scenarios. Under these scenarios, 50 percent, and 100 percent of the average annual volume harvested from the North Zone is assumed to be processed within the area.

Table 56. Timber contribution, employment, and income by alternative, North Zone

Scenario	Alt. A	Alt. B	Alts. C & D
Employment (number of jobs)			
50 percent processed within area	67	553	345
100 percent processed within area	79	632	361
Income (thousand $)			
50 percent processed within area	2,543	21,297	13,571
100 percent processed within area	3,173	25,741	14,492

While estimated employment and income effects are nominally higher in the South Zone, the relative effects, given the size and nature of the population and economy, are significantly more important in the North Zone. In 2009, private nonfarm employment in Garfield County was estimated at 1,122 and 2,156 in Kane County. By contrast, private nonfarm employment in Coconino County was estimated at 44,916 in 2009.

Financial Efficiency Analysis

Financial efficiency is required by the 1982 Rule Provisions. Estimating present net value (PNV) is required by 219.12(g); however, the decision maker is not required by 219.12(j) to select the alternative that maximizes PNV. He or she only needs to identify each alternative's PNV and compare them to the selected alternative. Appendix C provides additional information about the financial analysis, and describes calculation of allowable sale quantity (ASQ) and long-term sustained yield (LTSY).

Efficiency analysis was conducted with QuickSilver[8] Version 6. Data on program revenues were collected from the Final National Forest Statement of Receipts (ASR-13-1). Data on program costs were provided by the Kaibab NF budget staff (1982 rule, 219.12(e)).

Financial efficiency analysis compares forest expenditures and revenues for the expected life (10 to 15 years) of a forest plan. Table 57 presents forest expenditures by program area and alternative. Figures for alternative A are based on average expenditures for fiscal years FY 2006 to FY 2010. Costs are constant for all program areas except timber. Timber-related costs vary by alternative based on different number of acres being thinned, prescription intensity, and variable costs associated with harvest management activities (see spreadsheet Financial Efficiency Analysis 2_26_13 in the project record). The total timber and forest health costs for Alternative B (proposed plan) are higher than those for the other alternatives because Alternative B treats more acres than the other alternatives.

Costs incurred for fire suppression are not included in the expenditures data. These costs are significant but erratic. During the 5-year period, fire suppression expenditures ranged from $1.4 million in 2008 to $6.8 million in 2006. Fire suppression expenditures accounted for 10 to 35 percent of the Kaibab NF's total budget during this 5-year period. When combined with fire preparedness expenditures, wildfire costs consumed between 32 and 49 percent of the total budget. By addressing the number 1 priority need for change and moving toward desired conditions, there would be a fundamental shift from spending funds on fire suppression to hazardous fuels treatment and improving forest health.

Table 57. Kaibab National Forest program expenditures by alternative

Program Area	Alt. A	Alt. B	Alt. C	Alt. D
Timber and forest health	$1,884,454	$6,357,826	$5,148,895	$6,593,254
Range, watershed, and wildlife	$1,752,170	$1,752,170	$1,752,170	$1,752,170
Recreation, Wilderness, and heritage	$1,146,996	$1,146,996	$1,146,996	$1,146,996
Minerals	$300,118	$300,118	$300,118	$300,118
Special uses	$3,019,119	$3,019,119	$3,019,119	$3,019,119
Planning, inventory, and monitoring	$848,483	$848,483	$848,483	$848,483
Fire preparedness	$3,610,747	$3,610,747	$3,610,747	$3,610,747
Hazardous fuels treatment	$1,372,564	$1,372,564	$1,372,564	$1,372,564
Administrative and cooperative work	$2,398,744	$2,398,744	$2,398,744	$2,398,744
Total Expendatures	$16,333,395	$20,806,767	$19,597,836	$21,042,195

Table 58 shows forest revenues by program area. These figures are based on average revenues over the past five fiscal years (FY 2006 to FY 2010) for all program areas except timber. Timber revenues for alternative A are based on the average revenue from annual cut and sold reports for FY 2006 to FY 2010 multiplied by the average annual number of acres currently being mechanically thinned. For alternatives B, C, and D, the revenues change as a function of different

[8] Quick-Silver is a program for economic analysis of long-term, on-the-ground resource management projects. It provides a consistent benefit/cost framework to determine if one management action costs less or has a better payoff than others.

number of acres being thinned, prescription intensity (volume produced), and revenue per CCF[9] harvested (see spreadsheet Financial Efficiency Analysis 2_26_13 in the project record). The total timber and forest health revenues for Alternative B (proposed plan) are higher than those for the other alternatives because Alternative B produces a higher revenue/acre and treats more acres than the other alternatives.

Table 58. Kaibab National Forest program revenues by alternative

Program Area	Alt. A	Alt. B	Alt. C	Alt. D
Timber and forest health	$169,033	$1,025,439	$478,983	$103,785
Range, watershed, and wildlife	$64,125	$64,125	$64,125	$64,125
Recreation, wilderness, and heritage	$76,031	$76,031	$76,031	$76,031
Minerals	$122,908	$122,908	$122,908	$122,908
Special uses	$125,662	$125,662	$125,662	$125,662
Planning, inventory, and monitoring	$0	$0	$0	$0
Fire preparedness	$0	$0	$0	$0
Hazardous fuels treatment	$0	$0	$0	$0
Administrative and cooperative work	$80,585	$80,585	$80,585	$80,585
Total Revenue	**$638,343**	**$1,494,750**	**$948,294**	**$573,096**

Table 59 shows present net value (PNV) by program area and alternative. PNV is the difference between program revenues (benefits) and program expenditures (costs) over a 10-year period, using a 4 percent discount rate. All alternatives result in a negative PNV. Alternative A is the least negative, while alternative D has the highest negative PNV. Alternative B has a higher negative PNV than Alternative C because Alternative B treats fifty-five percent more acres than Alternative C.

[9] CCF equals hundred cubic feet.

Table 59. Kaibab National Forest present net value (PNV) by alternative and program

	Alt. A	Alt. B	Alt. C	Alt. D
Timber and forest health	-$13,913,604	-$43,250,433	-$37,877,169	-$52,635,406
Range, watershed, and wildlife	-$13,691,557	-$13,691,557	-$13,691,557	-$13,691,557
Recreation, wilderness, and heritage	-$8,686,484	-$8,686,484	-$8,686,484	-$8,686,484
Minerals	-$1,437,334	-$1,437,334	-$1,437,334	-$1,437,334
Special uses	-$23,468,528	-$23,468,528	-$23,468,528	-$23,468,528
Planning, inventory, and monitoring	-$6,881,957	-$6,881,957	-$6,881,957	-$6,881,957
Fire preparedness	-$29,286,396	-$29,286,396	-$29,286,396	-$29,286,396
Hazardous fuels treatment	-$11,132,722	-$11,132,722	-$11,132,722	-$11,132,722
Administrative and cooperative work	-$18,802,343	-$18,802,343	-$18,802,343	-$18,802,343
Total PNV	**-$127,300,925**	**-$156,637,754**	**-$151,264,490**	**-$166,022,727**

This analysis is financial, not economic. This means that only quantifiable dollar expenditure and revenue information are included. Not included in the financial analysis are the benefits associated with things such as improvements in the herbaceous understory and wildlife habitat. Also not included are benefits produced and paid for by the 4FRI contractor (South Zone) such as road decommissioning, stream/riparian restoration, and fencing projects to protect aspen. Finally, the expected long-term, multi-million dollar reduction in annual fire suppression costs are not included. Economic considerations would include the system's capacity to produce nonmarket values and ecosystem services valued by society. While it is universally recognized that the forest is to manage for a broad spectrum of ecological, economic, and societal goals, the ability to incorporate ecosystem service values remains elusive.

Social Consequences

At the time the forest reserves were established, the land around what is now the Kaibab NF had already been settled. The communities consisted of Mormon settlers, Spanish explorers, American Indians, cattlemen, and loggers. This history continues to influence the culture today as western rural lifestyles are an important part of local communities.

Due to the small percentage of private land in the area, the Kaibab NF has long been viewed as a community commons. Long-term uses include grazing, timber harvesting, hunting, primitive camping, cutting firewood, and collecting forest products such as medicinal plants. The ecological and social systems within the socioeconomic impact area are tightly linked, and their dependency on one another is increasingly apparent.

A number of social values have been identified with Southwestern Region forests, including: (1) preservation of open space; (2) protection of forest-related amenity values; (3) economic opportunities from both commodity and noncommodity sources; (4) accessible and varied outdoor recreation opportunities; and (5) traditional tribal uses (USDA Forest Service 2008a). The proposed forest plan contains direction that would favorably address these social values.

Alternatives B, C, and D would provide for continued availability of forage for domestic livestock and opportunities for ranching lifestyles consistent with the other desired conditions. All action alternatives are expected to have similar impacts on recreation including the same number of acres in each recreation opportunity spectrum class.

With the exception of the number of acres mechanically thinned and the timber management prescription intensities applied, the only difference between the action alternatives that could produce social consequences is the number of acres proposed for wilderness. There are currently 109,280 acres of existing wilderness. Table 60 displays the number of acres of recommended wilderness by alternative.

Table 60. Kaibab National Forest recommended wilderness acres by alternative

Alternatives	Alt. A	Alt. B	Alts. C and D
Wilderness acres (approximate)	none	6,238 acres	44,126 acres

The Kaibab NF conducted a potential wilderness area (PWA) evaluation (KNF 2013f) as part of the forest planning process in accordance with Forest Service Handbook (FSH 1909.12, Chapter 70) and Southwestern Region direction. The PWA evaluation found that there are an additional 48 existing wilderness areas within 100 air miles of the forest boundary, including 24 existing wilderness areas within BLM-administered lands, 23 existing wilderness areas on adjacent national forests (Tonto, Prescott, and Coconino National Forests), and one on NPS-administered lands. These existing wilderness areas total approximately 1.55 million acres.

Alternatives C and D would be expected to appeal to those members of society who value wilderness status over non-wilderness for the PWAs. Alternative B would be expected to be preferable to those whose value systems reflect a continuation of non-wilderness status.

Increases in prescribed burns and wildfires managed for resource objectives in all action alternatives (B, C, and D) create the potential for an environmental justice issue related to possible disproportionate effects of increased smoke, as most of the smoke would carry from the southwest to the northeast and western portions of the Navajo Reservation.

Alternative A, no action alternative: Fire managers are currently burning about 8,500 acres per year with prescribed fire, and managing wildfires to achieve resource objectives on around 11,700 acres per year. This equates to just over 20,000 acres per year that receive low to moderate fire entry.

Alternatives B, C, and D include the following objectives: Burn 13,000 to 55,000 acres in ponderosa pine, and 1,000 to 13,000 acres in frequent fire mixed conifer annually, using a combination of prescribed fire and naturally ignited wildfires (a total of 14,000 to 68,000 acres per year).

Prescribed burns are conducted in coordination with the Arizona Department of Environmental Quality, so as to occur when conditions are appropriate to minimize impacts to smoke-sensitive receptors downwind. When feasible, management ignitions from wildfires are also conducted when ventilation is favorable for good dispersal. Wind speed, wind direction, mixing layer height, atmospheric temperature profile upward in the atmosphere, and atmospheric stability all impact where and how well smoke would disperse.

During windows of opportunity when fire weather and fire effects are favorable, fire managers on the Kaibab NF strive to treat as many acres with wildland fire as possible each year yet still remain within legal, climatological, logistical, and social limits. Impacts of smoke from wildfires and prescribed burns on the forest, as well as on other Federal and State lands, are cumulative. Therefore, wildland fire activities on other agency lands may further limit the ability to use wildland fire on the forest.

Monitors are available in the Southwestern Region that could be placed in areas of concern during periods of fire activity to measure particulate matter emissions to ensure National Ambient Air Quality Standards are not exceeded.

Short-term Uses and Long-term Productivity

The National Environmental Policy Act (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 Congress, this includes using all practicable means and measures 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 plan was developed to promote ecological integrity and guide management on the Kaibab NF so that it is ecologically sustainable and contributes to social and economic sustainability. The biggest risk to long-term productivity on the forest are the effects associated with uncharacteristic, stand-replacing fire and resulting soil losses (discussed in the Watersheds and Soils section of this chapter), wood production (discussed in the Socioeconomics section of this chapter), and understory or grassland productivity. There are differences in alternatives that would result in more or less modification of stand structure, which correlates to the amount of stand-replacing fire and understory productivity in ponderosa pine and dry mixed conifer systems.

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.

Decisions made in this forest plan would not result in any actual irreversible or irretrievable commitment of resources. The implementation of the desired conditions, standards, and guidelines in the plan would limit the extent and duration of any adverse environmental impacts. For a detailed discussion of types of consequences expected from potential future activities implemented under the plan and alternatives, see the specific topic areas in this chapter.

The proposed plan provides a programmatic framework that guides site specific actions but does not authorize, fund, or carry out any project or activity. Because the land management plan does

not authorize or mandate any site specific project or activity (including ground-disturbing actions), none of the alternatives cause an irreversible or irretrievable commitment of resources.

Chapter 4. Consultation and Coordination

Preparers (Interdisciplinary Team Members)

Ariel Leonard, Forest Planner, Interdisciplinary Team (IDT) Leader

Relevant Experience: Planner for the Forest Service for 10 years. Served as IDT team leader for the forest plan (2008 to present), the Warm Fire Post-fire Assessment, interim IDT leader for travel management, and a variety of project-level NEPA teams. Other related experience includes serving on the Regional NEPA Training Cadre (1900-1), member of the National NEPA Handbook Revision Team, acting forest NEPA coordinator (1 year), 3 years as the Kaibab NF environmental management coordinator (EMS), and 9 years field experience as a biological technician.

Degrees Held: Master's degree in Forestry (policy and silviculture emphasis), Northern Arizona University; B.A., Biology, Antioch College.

Gary B. Snider, Assistant Forest Planner, Socioeconomic Lead

Relevant Experience: Ecological economist with over 30 years of experience in agricultural, regional, forest, rangeland, water resource, and restoration economics. Served on interdisciplinary teams preparing EISs for three forest plans in Colorado, Oregon, and Arizona. Areas of interest include ecological-economic implications of fire hazard reduction treatments under various contracting mechanisms, especially stewardship contracting and devising a methodology for evaluating the ecological-economic success of forest and watershed restoration projects.

Degrees Held: Ph.D., Forest Science, Northern Arizona University (ecological economic approach to analyzing ecological restoration activities (investments in natural capital) and other public lands policies); M.S., Agricultural Economics, University of Arizona (Thesis: Fiscal Impacts of Forest-Rangeland Policies on Local Communities: An empirical study of the Flagstaff, Arizona Trade Area); B.S., Agriculture, University of Arizona.

Bruce J. Higgins, Planning Assistance Contractor, Vegetation Specialist/former IDT Leader

Relevant Experience: Forest planner, Kaibab NF (1994 to 2007); consultant on forest plan revision 2007 to 2013. Experience in leading interdisciplinary teams, technical writing, siliviculture, modeling and GIS analysis. Received a national award with other forest personnel for developing and implementing a management approach to the "Management Recommendations for the Northern Goshawk in the Southwestern United States."

Degree Held: B.S., Forest Management (Recreation emphasis), Oregon State University.

Holly P. Kleindienst, Deputy Fire Staff Officer

Relevant Experience: Wildland firefighter for the U.S. Forest Service since 1986, with experience on hand crews, engines, and helitack. Fifteen years in wildfire and prescribed fire management on the Kaibab NF. Current fire qualifications include Fire Behavior Analyst, Long Term Fire Behavior Analyst, Division Supervisor, and Type 2 Burn Boss.

Degrees Held: M.A., French Literature, Purdue University; B.S., Botany, Miami University; B.A., French, University of Northern Colorado.

Valerie Stein Foster, Wildlife Biologist

Relevant Experience: Biologist with 18 years' experience in the conservation field. Relevant experience includes research and management of threatened and endangered birds, small mammals, invertebrates, herpetofauna, and plants. With the Kaibab NF wildlife program and plan revision team since 2008. Also co-preparer for the DEIS for the revised Coconino National Forest Land and Resource Management Plan.

Degrees Held: M.S., Botany (Ecological emphasis on plant-animal interactions), University of Hawaii at Manoa (Thesis: Habitat Use by the Endangered Hawaiian Honeycreeper (*Pseudonestor xanthophrys*): Effects of Physiognomy and Floristics); B.A., Biology (ecological emphasis) State University of New York at Oswego.

Chirre L. Keckler, Wildlife Biologist

Relevant Experience: Twenty-five years as a wildlife biologist for the Forest Service, with the last 15 years as forest biologist on three different national forests. Served as a member on interdisciplinary teams for EAs on range, timber sales, special use permits, recreational projects, and wildlife projects and on EIS documents for gas field development, forest plan amendments, and Four-Forest Restoration Initiative.

Degree Held: B.S., Wildlife Management, Northwestern State University.

Marcos A. Roybal, Natural Resource Planner

Relevant Experience: Over 5 years' experience in natural resource management and conservation-related fields, with an emphasis on community forestry, water resources, and planning.

Degrees Held: Masters of Water Resources and Masters of Community and Regional Planning, University of New Mexico; B.S., Natural Resource Management, Colorado State University.

John Brown, Special Uses, Lands, and Minerals

Relevant Experience: Over 22 years in managing recreation, lands, minerals and special uses programs for the Forest Service, with 14 years of experience in the Southwestern Region.

Degrees Held: M.S., Forestry, Multi-resource Management, Northern Arizona University; B.S., Recreation/ Resource Management, Emphasis in Natural Sciences (Geology, Biology), Northern Arizona University. A.A., Geology, Glendale Community College.

Jared M. Scott, GIS Specialist

Relevant Experience: Five years of GIS experience in natural resource management. Researched disturbance ecology of subalpine forests in Rocky Mountain National Park, and the taxonomic and parasitic effects of dwarf mistletoe infecting bristlecone pine in Arizona.

Degrees Held: M.S., Forestry, Northern Arizona University; B.A., Geography, University of Colorado, Boulder.

Dustin Burger, Range and Invasive Species Specialist

Relevant Experience: Eight years of rangeland management with direct oversight of livestock grazing permits, invasive species management, and involvement in vegetation management projects.

Degree Held: B.S., Rangeland Ecology and Watershed Management, University of Wyoming.

Christopher "Kit" MacDonald, Soil and Watershed Specialist

Relevant Experience: Seventeen years in natural resources management including soils classification and mapping, soil nutrient management, erosion and sedimentation control, wetland delineation and functional assessment, vegetation management, and burned area emergency stabilization.

Degrees Held: M.S., Forest Science; B.S., Business Administration.

Mike Hannemann, Range, Watershed, and Invasive Species Specialist

Relevant Experience: Over 28 years of range, watershed, and invasive species management with the Forest Service, with over 25 years' experience in northern Arizona.

Degrees Held: Masters in Forestry, Northern Arizona University; B.S., Wildlife Biology, Colorado State University.

Cat Woods, Recreation Specialist

Relevant Experience: Over 20 years' experience specializing in recreation and CDA management and planning. Worked on two other forest plan revisions addressing recreation, wilderness, wild and scenic rivers, and other special areas on the Allegheny National Forest and Tongass National Forest.

Michael Lyndon, Assistant Forest Archaeologist/Forest Tribal Liaison

Relevant Experience: Ten years in cultural resource management for the Forest Service. Five years in tribal relations as the forest lead contact on tribal issues and consultation.

Degrees Held: Masters in Anthropology, Northern Arizona University; B.A., Anthropology, Northern Arizona University.

Barbara Goodrich Phillips, Zone Botanist, Coconino, Kaibab, and Prescott NF s

Relevant Experience: Forty-five years' experience as botanist working on rare plants and noxious/invasive plants throughout Arizona including 15 years at Museum of Northern Arizona, Flagstaff, and 21 years with the Forest Service as zone botanist on the Coconino, Kaibab, and Prescott NF s.

Degrees Held: Ph.D. in Ecology and Evolutionary Biology, Minor in Geosciences, 1976, University of Arizona; M.S. in Botany, University of Arizona, 1973; B.S. in Botany, 1967, Cornell University.

Julie Rowe, Recreation and Wilderness Program Manager

Relevant Experience: Twenty-one years' experience in recreation management and interpretation/environmental education. Special emphasis on outfitter/guide management and recreation capacity analysis. Served as IDT lead/NEPA coordinator for recreation special uses programs on four forests. IDT member for the Coconino Forest Plan Revision and Four Forests Restoration Initiative.

Degree Held: B.A. in Evolutionary Biology, University of California, Santa Cruz.

Consultation and Coordination

Federal, State, and Local Agencies

U.S. Fish and Wildlife Service

Grand Canyon National Park

Arizona Game and Fish Department

Coconino, Prescott, and Apache-Sitgreaves National Forests

Rocky Mountain Research Station

State and Private Forestry, Forest Health Group

Coconino County Board of Supervisors

City of Williams

Tusayan Town Council

Fredonia Town Council

Kana County Commissioners

Tribes

Havasupai Tribe

Hopi Tribe

Hualapai Tribe

Kaibab Band of Paiute Indians

Navajo Nation

Yavapai-Prescott Tribe

Zuni Tribe

Others

Museum of Northern Arizona

Grand Canyon Wildlands Council

Sierra Club-Grand Canyon Chapter

Center for Biological Diversity

Coconino Trail Riders

Friends of Anderson Mesa

Lab of Landscape Ecology and Conservation Biology (Northern Arizona University)

The Nature Conservancy

Grand Canyon Trust

Carol Chambers (NAU Forestry)

Erika Nowak (NAU Biology)

Recreation Aviation Foundation

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Glossary

Adaptive management: A system of management practices based on clearly identified intended outcomes and monitoring to determine if management actions are meeting those outcomes; and, if not, to facilitate management changes that will best ensure that those outcomes are met or reevaluated. Adaptive management stems from the recognition that knowledge about natural systems is sometimes uncertain.

Age class is defined as trees that originated within a relatively distinct range of years. Typically the range of years is considered to fall within 20 percent of the average natural maturity (e.g., if 100 years is required to reach maturity, then there would be five 20-year age classes).

Basal area: Cross-sectional area at breast height (4.5 feet above the ground) of trees measured in square feet. Basal area is a way to measure how much of a site is occupied by trees. The cross-sectional area is determined by calculating the tree's radius from its diameter (diameter/2 = radius) and using the formula for the area of a circle (π x radius2 = cross-sectional area). Basal area per acre is the summation of the cross-sectional area of all trees in an acre or in a smaller plot used to estimate basal area per acre. Diameter at root collar (defined below) is used to calculate the cross-sectional area of multistemmed trees such as juniper and oak.

Browse is either: (1) the part of shrubs, half shrubs, woody vines, and trees available for animal consumption; or (2) to search for or consume browse. Interagency Technical Reference 1734-4 Sampling Vegetation Attributes. 1999 (ITR 1734-4)

Clump refers to a tight cluster of two to five trees of similar age and size originating from a common rooting zone that typically lean away from each other when mature. A clump is relatively isolated from other clumps or trees within a group of trees, but a stand-alone clump of trees can function as a tree group.

Coarse woody debris: Woody material on the ground greater than 3 inches in diameter, including logs.

Collaboration describes people working together to share knowledge and resources to describe and achieve desired conditions for National Forest System lands and for associated social, ecological, and economic systems in a plan area. Collaboration applies throughout land management, encompasses a wide range of external and internal relationships, and entails formal and informal processes.

Connectivity is the arrangement of habitats that allows organisms and ecological processes to move across the landscape; patches of similar habitats are either close together or linked by corridors of appropriate vegetation; the opposite of fragmentation.

Corridor: A linear strip of land identified for the present or future location of transportation or utility rights-of-way within its boundaries.

Critical area is an area which should be treated with special consideration because of inherent site factors, size, location, condition, values, or significant potential conflicts among uses.

Cumulative effects describe the impact on the environment that results from the incremental effect of the proposed action when added to other past, present, and reasonably foreseeable future actions in the resource area, regardless of who undertakes such actions. Cumulative effects can

result from individually minor but collectively significant actions that take place over a period of time.

Deciview (*dv*): A measure of visual air quality. Similar to the decibel scale for sound, the deciview scale is linear with respect to perceived visual changes. A one *dv* change is approximately a 10 percent change in the extinction coefficient, which is a small but usually perceptible scenic change.

Declining refers to the senescent (aging) period in the lifespan of plants that (for trees) includes the presence of large dead and/or dying limbs, snag tops, large, old lightning scars and other characteristics that indicate the later life stages of vegetation.

Designated Areas are areas or features identified and managed to maintain their unique special character or purpose. Some categories of designated areas may be designated only by statute and some categories may be established administratively in the land management planning process or by other administrative processes of the Federal executive branch. Examples of statutorily designated areas are national heritage areas, national recreation areas, national scenic trails, wild and scenic rivers, wilderness areas, and wilderness study areas. Examples of administratively designated areas are experimental forests, research natural areas, scenic byways, botanical areas, and significant caves.

Diameter at breast height (d.b.h.) is the diameter of a tree typically measured at 4.5 feet above ground level.

Diameter at root collar (d.r.c.) is the diameter typically measured at the root collar or at the natural ground line, whichever is higher, outside the bark. For a multistemmed tree, d.r.c. is calculated from the diameter measurements of all qualifying stems (greater than equal to 1.5 inches diameter and at least 1 foot in length).

Dispersed recreation: Outdoor recreation in which visitors are spread over relatively large areas. Where facilities or developments are provided, they are more for access and protection of the environment than for the comfort or convenience of the visitors.

Disturbance is any relatively discrete event in time that disrupts ecosystem, watershed, community, or species population structure and/or function and changes resources, substrate availability, or the physical environment.

Disturbance regime is a description of the characteristic types of disturbance on a given landscape; the frequency, severity, and size distribution of these characteristic disturbance types; and their interactions.

Diversity: The distribution and abundance of different plant and animal communities and species within the area covered by a land and resource management plan.

Ecosystem services are benefits people obtain from ecosystems, including: (1) provisioning services such as clean air and fresh water, energy, fuel, forage, fiber, and minerals; (2) regulating services such as long term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood control; and disease regulation; (3) supporting services such as pollination, seed dispersal, soil formation, and nutrient cycling; and (4) cultural services such as

educational, aesthetic, spiritual and cultural heritage values, recreational experiences, and tourism opportunities.

Endemic: A population that has unique genetic characteristics and likely exists in a very limited geographic area.

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Even-aged forests are composed of one or two distinct age classes of trees.

Even-aged silvicultural practices are the application of a combination of actions that results in the creation of stands in which trees of essentially the same age grow together. Managed even-aged forests are characterized by a distribution of stands of varying ages (and, therefore, tree sizes) throughout the Forest area. The difference in age between trees forming the main canopy level of a stand usually does not exceed 20 percent of the age of the stand at harvest rotation age. Regeneration in a particular stand is obtained during a short period at or near the time that a stand has reached the desired age or size for regeneration and is harvested. Clearcut, shelterwood, or seed tree cutting methods produce even-aged stands.

Federally Recognized Indian Tribe: An Indian or Alaska Native Tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges to exist as an Indian Tribe under the Federally Recognized Indian Tribe List Act of 1994, 25 U.S.C. 479a.

Fire regime refers to the patterns of fire that occur over a long period of time across a landscape vegetation community and its immediate effects on the ecosystem in which it occurs. Five fire regimes are classified based on frequency (average number of years between fires) and severity (amount of replacement of the dominant overstory vegetation) of the fire:

- **Fire regime** I – 0- to 35-year frequency and low (surface fires most common, isolated torching can occur) to mixed severity (less than 75 percent of dominant overstory vegetation replaced);
- **Fire regime II** – 0- to 35-year frequency and high severity (greater than 75 percent of dominant overstory vegetation replaced);
- **Fire regime III** – 35 to 100+ year frequency and mixed severity;
- **Fire regime IV** – 35 to 100+ year frequency and high severity;
- **Fire regime V** – 200+ year frequency and high or mixed severity

Fire suppression: The work of extinguishing a fire or confining fire spread.

Forage is (1) browse and herbage which is available and can provide food for animals or be harvested for feeding; or (2) to search for or consume forage. ITR 1734-4

Foraging areas surround the post-fledgling family areas where goshawks hunt for prey. They are approximately 5,400 acres in size.

Forested land is land at least 10 percent occupied by forest trees of any size or formerly having had such tree cover and not currently developed for non-forest use. Lands developed for non-

forest use include areas for crops, improved pasture, residential, or administrative areas, improved roads of any width, and adjoining road clearing and power line clearing of any width.

Gap refers to the space occurring in a forested area as a result of individual or group tree mortality from small disturbance events or from local site factors such as soil properties that influence vegetation growth patterns.

Goals are concise statements that describe desired conditions to be achieved sometime in the future. They are normally expressed in broad, general terms, and are timeless in that they have no specific date by which they are to be completed. Goal statements form the principal basis from which objectives are developed.

Goods and services: The various outputs, including onsite uses, produced from forest and rangeland resources.

Group refers to a cluster of two or more trees with interlocking or nearly interlocking crowns at maturity surrounded by an opening. Size of tree groups is typically variable depending on forest community and site conditions and can range from fractions of an acre (a two-tree group) to many acres. Trees within groups are typically nonuniformly spaced, some of which may be tightly clumped.

Herbage is the aboveground material of any herbaceous plant. ITR 1734-4 1999

Hydrologic function: The behavioral characteristics of a watershed described in terms of ability to sustain favorable conditions of waterflow. Favorable conditions of waterflow are defined in terms of water quality, quantity, and timing**.**

Hydrologic unit code (HUC): The United States is divided and subdivided into successively smaller hydrologic units which are identified by unique hydrologic unit codes (HUCs). The number of digits in a HUC indicate its relative size; HUCs with more digits are smaller than HUCs with fewer digits.

Interspaces: Open space between tree groups intended to be managed for grass-forb-shrub vegetation over the long term.

Invasive species are species that are not native to the ecosystem being described. For all ecosystems, the desired condition is that invasive species are rarely present or are present at levels that do not negatively influence ecosystem function.

Inventory is the survey of an area or entity for determination of such data as contents, condition, or value, for specific purposes such as planning, evaluation, or management. An inventory activity may include an information needs assessment; planning and scheduling; data collection, classification, mapping, data entry, storage and maintenance; product development; evaluation; and reporting phases.

Key area: A relatively small portion of a range selected because of its location, use, or grazing value as a monitoring point for grazing use. It is assumed that key areas, if properly selected, will reflect the overall acceptability of current grazing management over the range.

Key ecological attributes are attributes for which alteration beyond some critical range/threshold will lead to loss of the resource in a short period of time. Examples include changes in structure, composition, pattern, and process.

Litter is dead, unattached organic material on the soil surface that protects the soil surface from raindrop splash, sheet, and rill erosion and is at least ½-inch thick. Litter is composed of leaves, needles, cones, and woody vegetative debris, including twigs, branches, and trunks.

Long-term sustained-yield timber capacity (LTSY) is the highest uniform wood yield from lands being managed for timber production that may be sustained under a specified management intensity consistent with multiple-use objectives.

Maintain: In reference to an ecological condition: to keep in existence or continuance of the desired ecological condition in terms of its desired composition, structure, and processes. Depending upon the circumstance, ecological conditions may be maintained by active or passive management, or both.

Management area: Land area identified within the planning area that has the same set of applicable plan components. A management area does not have to be spatially contiguous.

Management concern: Issue, problem, or a condition the Forest Service identifies in the planning process which constrains the range of management practices.

Management direction: Statement of multiple use and other goals and objectives, the associated management prescriptions, and standards and guidelines for attaining them.

Management intensity: A management practice or combination of management practices and associated costs designed to obtain different levels of goods and services.

Management practice: Specific activity, measure, course of action, or treatment.

Management prescription: Management practices and intensity selected and scheduled for application on a specific area to attain multiple use and other goals and objectives.

Monitoring: Collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a resource or management objective. A monitoring activity may include an information needs assessment; planning and scheduling; data collection, classification, mapping, data entry, storage and maintenance; product development; evaluation; and reporting phases.

Mosaic: Patterns of patches, corridors, and matrix (forest or non-forest) that form a landscape in its entirety.

Multiple use: The management of all the various renewable surface resources of National Forest System lands so that they are utilized in the combination that best meets the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some lands will be used for less than all of the resources; and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to

the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output.

Native species: An organism that was historically or is present in a particular ecosystem as a result of natural migratory or evolutionary processes and not as a result of an accidental or deliberate introduction into that ecosystem. An organism's presence and evolution (adaptation) in an area are determined by climate, soil, and other biotic and abiotic factors.

Natural variability references past conditions and processes that provide important context and guidance relevant to the environments and habitats in which **native species** evolved. Disturbance-driven spatial and temporal variability is vital to ecological systems. Biologically appropriate disturbances provide for heterogeneous conditions and subsequent diversity, whereas "uncharacteristic disturbance" such as high-intensity fire can have the effect of reducing diversity, increasing homogeneity, and resulting in states that may be permanently altered.

Nest areas (goshawk) are the areas immediately around a nest that northern goshawks use for courtship and breeding activities. Nest areas are approximately 30 acres in size and contain multiple groups of large, old trees with interlocking crowns.

Noxious weed is a legal term applied to plants or plant parts regulated by Federal and State laws. Arizona Administrative Codes R3-4-244, R3-4-245 (Arizona Department of Agriculture 1999) regulate certain invasive species in the state: "A noxious weed is defined as any species of plant that is detrimental or destructive and difficult to control or eradicate and includes plant organisms found injurious to any domesticated, cultivated, native or wild plant." The director of Arizona's noxious weed program uses five biological criteria to describe noxious weeds: (1) exotic, (2) invasive, (3) competitive, (4) persistent, and (5) aggressive.

Nutrient cycling is the circulation or exchange of elements such as nitrogen and carbon between non-living and living portions of the environment.

Objectives are concise, time-specific statements of measurable planned results that respond to pre-established goals. Objectives form the basis for further planning to define the precise steps to be taken and the resources to be used in achieving identified goals.

Old growth in southwestern forested ecosystems is different than the traditional definition based on northwestern infrequent fire forests. Due to large differences among Southwest forest types and natural disturbances, old growth forests vary extensively in tree size, age classes, presence and abundance of structural elements, stability, and presence of understory. Old growth refers to specific habitat components that occur in forests and woodlands—old trees, dead trees (snags), downed wood (coarse woody debris), and structure diversity. These important habitat features may occur in small areas, with only a few components, or over larger areas as stands or forests where old growth is concentrated. In the Southwest, old growth is considered "transitional," given that the location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). Some species, notably certain plants, require "old forest" communities that may or may not have old growth components but have escaped significant disturbance for lengths of time necessary to provide the suitable stability and environment.

Openings are spatial breaks between groups or patches of trees containing grass, forb, shrub, and/or tree seedlings but are largely devoid of big trees with a total tree cover of less than 10 percent.

Patches are areas larger than tree groups in which the vegetation composition and structure are relatively homogeneous. Patches comprise the mid-scale, thus they range in size from 100 to 1,000 acres. Patches and stands are generally synonymous terms, although stands may be much smaller than 100 acres.

Plan or land and resource management plan refers to a document or set of documents that provide management direction for an administrative unit of the National Forest System developed under the requirements of a planning rule.

Planning area is the area of the National Forest System covered by a regional guide or forest plan.

Planning horizon: The overall time period considered in the planning process that spans all activities covered in the analysis or plan and all future conditions and effects of proposed actions which would influence the planning decisions.

Planning period: One decade. The time interval within the planning horizon used to show incremental changes in yields, costs, effects, and benefits.

Potential natural vegetation (PNVT) types comprise the "climax" vegetation that will occupy a site without disturbance or climatic change. PNV is an expression of environmental factors such as topography, soils, and climate across an area.

Post-fledging family areas (goshawk) surround the nest areas. They represent an area of concentrated use by the goshawk family until the time the young no longer depend on adults for food. Post-fledgling family areas are approximately 420 acres in size.

Prescribed fire: A wildland fire originating from a planned ignition to meet specific objectives identified in a written, approved, prescribed fire plan for which NEPA requirements have been met prior to ignition.

Project: An organized effort to achieve an outcome on National Forest System lands identified by location, tasks, outputs, effects, times, and responsibilities for execution.

Public issue: A subject or question of widespread public interest relating to management of National Forest System lands.

Range condition is a subjective expression of the status or health of the vegetation and soil relative to their combined potential to produce a sound and stable biotic community. (USDA Forest Service, Southwestern Region, Record of Decision for Amendment of Forest Plans, Arizona and New Mexico). It is evaluated relative to desired conditions.

Range readiness is the condition when grazing would not permanently damage perennial plants which is determined when plants that would likely be grazed exhibit at least one of the following characteristics: seed heads or flowers, multiple leaves or branches, and/or a root system that does not allow them to be easily pulled from the ground. These characteristics provide evidence of plant vigor, reproductive ability, and recovery.

Ranges of values presented in desired conditions account for natural or desired variation in the composition and structure within a community or resource area. Desired conditions may have a wide range due to spatial variability in soils, elevation, aspect, or social

values. Where desired conditions specify a range, the full spectrum of values within that range is desirable, although the desired distribution may vary depending on the resource. It may also be desirable to manage for desired conditions at the upper or lower end of a range in a particular area, such as lower vegetation density in the wildland-urban interface to achieve the desired fire behavior within proximity of private property and human occupancy; higher densities may be desired in other areas to meet habitat requirements for specific species.

Recreation opportunity spectrum: A framework for defining the types of outdoor recreation opportunities the public might desire, and identifying that portion of the spectrum a given national forest area might be able to provide. The broad classes are:

Primitive (P): Characterized by essentially unmodified natural environment. Interaction between users is very low and evidence of other users is minimal. Essentially free from evidence of human-induced restrictions and controls. Motorized use within the area is generally not permitted. Very high probability of experiencing solitude, closeness to nature, tranquility, self-reliance, and risk.

Semiprimitive Nonmotorized (SPNM): Characterized by a predominantly natural or natural appearing environment. Interaction between users is low, but there is often evidence of other users. The area is managed in such a way that minimum onsite controls and restrictions may be present, but they are subtle. Motorized use is generally not permitted. High probability of experiencing solitude, closeness to nature, tranquility, self-reliance, and risk.

Semiprimitive Motorized (SPM): Characterized by a predominantly natural or natural appearing environment. Concentration of users is low, but there is often evidence of other users. The area is managed in such a way that minimum onsite controls and restrictions may be present, but they are subtle. Motorized use is generally permitted. Moderate probability of experiencing solitude, closeness to nature, tranquility, self-reliance, and risk.

Roaded Natural (RN): Characterized by a predominantly natural appearing environment with moderate evidence of the sights and sounds of other humans. Such evidence usually harmonizes with the natural environment. Interaction between users may be low to moderate, but with evidence of other users prevalent. Resource modification and utilization practices are evident but harmonize with the natural environment. Conventional motorized use is provided for in construction standards and design of facilities. Opportunity to affiliate with other users in developed sites, but with some chance for privacy.

Roaded Modified (RM): Characterized by substantially modified natural environment except for campsite. Roads and management activities may be strongly dominant. There is moderate evidence of other users on roads. Conventional motorized use is provided for in construction standards and design of facilities. Opportunity to get away from others, but with easy access.

Rural (R): Characterized by substantially modified natural environment. Resource modification and utilization practices are to enhance specific recreation activities and to maintain vegetative cover and soil. Sights and sounds of humans are readily evident, and the interaction between users is often moderate to high. A considerable number of facilities are designed for use by a large number of people. Facilities are often provided for special activities. Moderate densities are provided far away from developed sites. Facilities for intensified motorized use and parking are available. Opportunity to observe and affiliate with other users is important, as is convenience of facilities.

Urban (U): Characterized by a substantially urbanized environment, although the background may have natural appearing elements. Resource modification and utilization practices are to enhance specific recreation activities. Vegetative cover is often exotic and manicured. Sights and sounds of humans onsite are predominant. Large numbers of users can be expected, both onsite and in nearby areas. Facilities for highly intensified motor use and parking are available with forms of mass transit often available to carry people throughout the site. Opportunity to observe and affiliate with other users is very important, as is convenience of facilities.

Recreation setting: The social, managerial, and physical attributes of a place that, when combined, provide a distinct set of recreation opportunities. The Forest Service uses the recreation opportunity spectrum to define recreation settings and categorize them into six distinct classes: primitive, semiprimitive nonmotorized, semiprimitive motorized, roaded natural, rural, and urban.

Reference conditions: Environmental conditions that infer ecological sustainability. When available, reference conditions are represented by the *characteristic* range of variation (not the total range of variation) prior to European settlement and under the current climatic period. For many ecosystems, the range of variation also reflects human-caused disturbance and effects prior to settlement. It may also be necessary to refine reference conditions according to contemporary factors (e.g., invasive species) or projected conditions (e.g., climate change). Reference conditions are most useful as an inference of sustainability when they have been quantified by amount, condition, spatial distribution, and temporal variation.

Research natural areas are specially designated areas that represent some of the finest examples of natural ecosystems for the purposes of scientific study and education, and for maintaining biological diversity.

Resilience is the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.

Responsible official is the Forest Service employee who has the authority to select and/or carry out a specific planning action.

Restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on establishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystem sustainability, resilience, and health under current and future conditions.

Risk: A combination of the likelihood that a negative outcome will occur and the severity of the subsequent negative consequences.

Satisfactory range condition is the status or health of the vegetation and soil relative to their combined potential to produce a sound and stable biotic community as evaluated relative to desired conditions; deemed meeting or moving toward those desired conditions. (Adapted from USDA Forest Service, Southwestern Region, “Record of Decision for Amendment of Forest Plans, Arizona and New Mexico.”)

Satisfactory watershed condition is a state where ground cover conditions are effectively maintaining land productivity.

Scale: Desired conditions are described at multiple scales where appropriate. Descriptions at various scales are sometimes necessary to provide adequate detail and guidance for the design of future projects and activities that will help achieve the desired conditions over time. The three scales used in this plan are:

> **Fine scale** is an area 10 acres or less in size at which the distribution of individual trees (single, grouped, or aggregates of **groups**) is described. Fine-scale desired conditions provide the view that can be observed standing in one location on the ground. Fine-scale desired conditions typically contain greater variability, which is desirable for providing heterogeneity at smaller spatial scales.
>
> **Mid-scale** desired conditions are composed of assemblages of fine-scale units and have descriptions that would be averaged across areas of 100- to 1,000-acre units.
>
> **Landscape scale** is an assemblage of 10 or more mid-scale units, typically totaling more than 10,000 acres, composed of variable elevations, slopes, aspects, soils, plant associations, and disturbance processes. Landscape scale desired conditions provide the big picture overview with resolution that would, for example, be observable from an airplane or from a zoomed out Google Earth view. The landscape scale is also appropriate scale for describing less common components that would not necessarily occur on every mid-scale unit within the landscape.

Scenic integrity objectives in the context of the plan are equivalent to “goals” or “desired conditions.” Scenic integrity describes the state of naturalness or a measure of the degree to which a landscape is visually perceived to be “complete.” The highest scenic integrity ratings are given to those landscapes that have little or no deviation from the landscape character valued by constituents for its aesthetic quality. Scenic integrity is the state of naturalness or, conversely, the state of disturbance created by human activities or alteration. Scenic integrity is measured in five levels:

> **Very high (unaltered):** A scenic integrity level that generally provides for ecological change only.
>
> **High (appears unaltered**): Human activities are not visually evident. In high scenic integrity areas, activities may only repeat attributes of form, line, color, and texture found in the existing landscape character.
>
> **Moderate (slightly altered):** Landscapes where the valued landscape character “appears slightly altered.” Noticeable deviations should remain visually subordinate to the landscape character being viewed.
>
> **Low (moderately altered):** Human activities should remain visually subordinate to the attributes of the existing landscape character. Activities may repeat form, line, color, or texture common to these landscape characters, but changes in quality of size, number, intensity, direction, pattern, and so on, should remain visually subordinate to these landscape characters.

Very Low (heavily altered): Human activities of vegetative and landform alterations may dominate the original natural landscape character but should appear as natural occurrences when viewed at background distances.

Snags are standing dead or partially dead trees (snag topped), often missing many or all limbs. They provide essential wildlife habitat for many species and are important for forest ecosystem function.

Soil condition rating: A qualitative rating developed within the Southwestern Region of the Forest Service that provides an overall picture of soil condition vital in sustaining ecosystems. It is based on three soil functions: the ability of soil to resist erosion, infiltrate water, and recycle nutrients. There are four soil condition ratings:

Satisfactory – soil function is being sustained and soil is functioning properly and normally.

Impaired – the ability of the soil to function properly and normally has been reduced or there exists an increased vulnerability to degradation.

Unsatisfactory – degradation of vital soil functions result in the inability of the soil to maintain resource values, sustain outputs or recover from impacts.

Inherently unstable – these soils are eroding faster than they are renewing themselves.

Soil disturbance: When the soil no longer functions because of the loss of surface organic material (affecting nutrient cycling), compaction (affecting regulation and partitioning of water and air flow), and severe burn (affecting nutrient cycling and biology), then soil disturbance has occurred.

Standards: Technical design constraints that must be followed when an action is being taken to make progress toward desired conditions. Standards differ from guidelines in that standards do not allow for any deviation without a plan amendment.

State J: A state in the Vegetation Development Dynamics Tool (VDDT) that is characterized by an open, multistory forest structure with medium to large trees (10- to 20-inch diameter class) and 10 to 30 percent canopy cover.

State K: A state in the Vegetation Development Dynamics Tool (VDDT) that is characterized by an open, multistory forest structure with very large trees (20+ inch diameter class) and 10 to 30 percent canopy cover.

Strongly interactive species is a species whose absence leads to significant changes in some feature of its ecosystem(s). Such changes include structural or compositional modifications, alterations in the import or export of nutrients, loss of resilience to disturbance, and decreases in native species diversity. The type of interactions these species have with their surrounding environment is paramount to the persistence of certain ecosystem features through time. Examples of strong interactions include mutualisms (e.g., pollinators such as butterflies, spore and seed dispersers such as birds), consumers (e.g., large predators such as mountain lions), and ecosystem engineers (e.g., prairie dogs, beavers).

Suitability is the appropriateness of applying certain resource management practices to a particular area of land, as determined by an analysis of the economic and environmental consequences and the alternative uses foregone. A unit of land may be suitable for a variety of individual or combined management practices.

Sustainability: The capability to meet the needs of the present generation without compromising the ability to meet the needs of future generations. “Ecological sustainability” refers to the capability of ecosystems to maintain ecological integrity; “economic sustainability” refers to the capability of society to produce and consume or otherwise benefit from goods and services including contributions to jobs and market and nonmarket benefits; and “social sustainability” refers to the capability of society to support the network of relationships, traditions, culture, and activities that connect people to the land and to one another, and support vibrant communities.

Thinning methods

> **Single tree selection** is used in uneven-aged silvicultural systems in which scattered individual trees of multiple size and/or age classes are removed throughout the stand to achieve desired structural characteristics.
>
> **Group selection** is a method of regenerating uneven-aged stands in which trees are removed, and new age classes are established, in small groups. Small openings provide micro-environments suitable for tolerant regeneration and the larger openings provide conditions suitable for more intolerant regeneration. In the group selection system, the management unit or stand in which regeneration, growth, and yield are regulated consists of a landscape containing an aggregation of groups.
>
> **Sanitation cutting** is the removal of dead, dying, or damaged trees to prevent or interrupt the spread of insects or disease.
>
> **Salvage cutting** is the removal of trees that have been killed or damaged by wildland fire, severe wind, insects or disease, or other natural disturbances.
>
> **Even-aged regeneration** is a cutting method by which a new stand with a single age class is created.
>
> **Matrix thinning** is the thinning of the “matrix” of trees outside of a regeneration area. The matrix is generally thinned from below to some specified density in order to increase stand vigor and resiliency.
>
> **All-size free thinning** is the removal of trees to control stand spacing and favor desired trees, using a combination of thinning criteria without regard to crown position.
>
> **Thinning from below** is the removal of trees from lower canopy positions while retaining the largest and most vigorous trees with the best-developed crowns.

Timber production is the purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use. For purposes of this document, the term timber production does not include production of firewood.

Total maximum daily load (TMDL): A written analysis that determines the maximum amount of a pollutant that surface water can assimilate (the “load”) and still attain water quality standards during all conditions. The TMDL allocates the loading capacity of the surface water to point sources and nonpoint sources identified in the watershed, accounting for natural background levels and seasonal variation, with an allocation set aside as a margin of safety.

Traditional cultural property: A type of historic property under the National Historic Preservation Act defined as "eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community."

Uneven-aged forests: Forests composed of three or more distinct age classes of trees, either intimately mixed or in small groups.

Uneven-aged management is the application of a combination of actions needed to simultaneously maintain continuous high forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes to provide a sustained yield of forest products. Cutting is usually regulated by specifying the number or proportion of trees of particular sizes to retain within each area, thereby maintaining a planned distribution of size classes. Cutting methods that develop and maintain uneven-aged stands are single-tree selection and group selection.

Unsatisfactory range condition is the status or health of the vegetation and soil relative to their combined potential to produce a sound and stable biotic community as evaluated relative to desired conditions deemed not meeting or not moving toward those desired conditions (adapted from USDA Forest Service, Southwestern Region, "Record of Decision for Amendment of Forest Plans, Arizona and New Mexico").

Unsatisfactory watershed condition is a state where effective ground cover conditions are such that impairment of land productivity is occurring.

Vegetation state refers to a combination of the dominant plan canopy cover class and (for forest and woodland) size class and density class within a potential natural vegetation type.

Vegetation Structure includes both the vertical and horizontal dimensions. Horizontal structure may refer to patterns of trees or groups of trees and openings, as well as tree size and tree density. Vertical structure may refer to the layers, appearance, and composition of vegetation between the forest floor and the top of the canopy.

Viable population: A population of a species that continues to persist over the long term with sufficient distribution to be resilient and adaptable to stressors and likely future environments.

Watershed: A region or land area drained by a single stream, river, or drainage network; a drainage basin.

Watershed condition: The state of a watershed based on physical and biogeochemical characteristics and processes.

Wetlands: Areas inundated by surface or ground water with a frequency sufficient to support, and under normal circumstances, do or would support, a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil condition for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds.

Wide ranging species: Species that have large area requirements, using expansive landscapes for breeding, foraging, and movement that are typically beyond the boundaries of any one land

management jurisdiction. Examples include large birds of prey, migratory birds, and nomadic mammals subject to seasonal movements (e.g., winter and summer range for deer, elk, and pronghorn).

Wilderness: Any area of land designated by Congress as part of the National Wilderness Preservation System, as that established in the Wilderness Act of 1964 (16 U.S.C. 1131-1136).

Wildfire: Unplanned ignition of a wildland fire, such as fire caused by lightning, unauthorized or accidental human-caused fires, or an escaped prescribed fire.

Wildland fire: General term describing any non-structure fire that occurs in the wildland. This includes both prescribed fires and wildfires.

Wildland-urban interface: 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.

Witch's broom: Disease or deformity in a woody plant (typically a tree) that results in a dense mass of shoots resembling a broom or bird's nest.

Acronyms

4FRI	Four Forest Restoration Initiative
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
AGFD	Arizona Game and Fish Department
AMS	analysis of the management situation
AOI	annual operating instructions
ASQ	allowable sale quantity
AUM	animal unit month
BA	basal area
BLM	Bureau of Land Management
BMP	best management practice
CCF	hundred cubic feet
CEQ	Council on Environmental Quality
CER	Comprehensive Evaluation Report
CHU	critical habitat unit
CWPP	community wildfire protection plan
d.b.h.	diameter at breast height
DC	desired conditions
DEIS	draft environmental impact statement
d.r.c.	diameter at root collar
EIS	environmental impact statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FACTS	Forest Service Activity Tracking System
FEIS	final environmental impact statement
FIA	Forest Inventory and Analysis
FSH	Forest Service Handbook
FSM	Forest Service Manual
FVS	Forest Vegetation Simulator
GIS	geographic information system
GMU	game management unit
HUC	hydrologic unit code

INRMP	Integrated Natural Resource Management Plan (Camp Navajo)
IPM	integrated pest management
IRA	inventoried roadless area
KNF	Kaibab National Forest
LMA	land management area
LMP	land management plan
LTSY	long-term sustained yield
MIS	management indicator species
MOU	memorandum of understanding
MVUM	motor vehicle use map
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NFS	National Forest System
NKRD	North Kaibab Ranger District
NNL	National Natural Landmark
NPS	National Park Service
OHV	off-highway vehicle
PILT	payments in lieu of taxes
PJ	pinyon-juniper
PNVT	potential natural vegetation type
PWA	potential wilderness area
RNA	research natural area
ROD	record of decision
ROS	recreation opportunity spectrum
SIO	scenic integrity objective
SMS	Scenery Management System
SPNM	semi-primitive non-motorized
SRSCS	Secure Rural Schools and Community Self-Determination Act
SWAP	State Wildlife Action Plan
SWCP	soil and watershed conservation practices
TCP	traditional cultural property
TES	terrestrial ecosystem survey
TEU	terrestrial ecosystem unit

TECS	threatened, endangered, candidate, and sensitive species
TRD	Tusayan Ranger District
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
VDDT	Vegetation Development Dynamics Tool
VMS	Visual Management System
VQO	visual quality objectives
VSS	vegetative structural stage
WRD	Williams Ranger District
WUI	wildland-urban interface

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