Chapter 3 • Affected Environment and Environmental Consequences

Introduction

This chapter provides information concerning the existing environment of the Kachina Village Forest Health Project area and potential consequences to that environment. It also presents the scientific and analytical basis for the comparison of alternatives presented in Chapter 2. Each resource potentially affected by the Proposed Action or alternatives is described in terms of its current condition and uses. These resource descriptions also include descriptions of and reasons for the spatial and temporal boundaries of cumulative effects analyses. Existing baseline, or benchmark, conditions and possible thresholds are also indicated.

Following each resource description is a discussion of the potential effects (environmental consequences) to the resource associated with the implementation of each alternative. All effects—including direct, indirect, and cumulative effects—are disclosed. Effects are quantified, where possible, and qualitative discussions are included. The means by which potential adverse effects will be reduced or mitigated are described in Chapter 2.

The discussions of resources and potential effects take advantage of existing information included in the Forest Plan's EIS, EIS's from other projects, project-specific resource reports and related information, and other sources as indicated. Where applicable, such information is briefly summarized and referenced to minimize duplication. The planning record for the Kachina Village Forest Health Project includes all project-specific information, including resource reports, the watershed analysis, and other results of field investigations. The record also contains information resulting from public involvement efforts. The planning record is located at the Peaks Ranger District office in Flagstaff, Arizona, and is available for review during regular business hours.

Assumptions for this Analysis

Throughout this chapter the reference to "wildfire" equals a high intensity crown fire. There are many kinds of wildfire depending on weather and fuel conditions. Low intensity crown fires are normally suppressed and do not contribute extensively to the future condition of the project area. These effects sections describe the effects of high intensity wildfire that could change future conditions of the area.

Projects identified in the cumulative effects analysis are different depending on the resource discussed. Table 6 on the following page describes projects that were considered in this document by one or more of the resource specialists. Long past projects are not listed as they contributed to forest conditions described under the affected environment sections.

The Flagstaff/Lake Mary Ecosystem Analysis (FLEA) is not listed as a cumulative project because this project does not propose any on-the-ground activities. The FLEA project proposes to amend the Forest Plan. The Kachina Village FHP contains site-specific actions that meet current Forest Plan direction.

Analyzing Effects

Environmental consequences are the effects of implementing an alternative on the physical, biological, social, and economic environment. The Council on Environmental Quality (CEQ) regulations implementing the National Environmental Policy Act (NEPA) includes a number of specific categories to use for the analysis of environmental consequences. Several are applicable to the analysis of the proposed project and alternatives and form the basis of much of the analysis that follows. They are explained briefly here.

Direct, Indirect, and Cumulative Effects

Direct environmental effects are those occurring at the same time and place as the initial cause or action. Indirect effects are those that occur later in time or are spatially removed from the activity, but would be considerable in the foreseeable future. Cumulative effects result from incremental effects of actions, when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor, but collectively major, actions taking place over a period of time.

Unavoidable Adverse Effects

Implementation of any action alternative that would cause some adverse environmental effects that cannot be effectively mitigated or avoided. Unavoidable adverse effects often result from managing the land for one resource at the expense of the use or condition of other resources. Many adverse effects can be reduced, mitigated, or avoided by limiting the extent or duration of effects. The interdisciplinary procedure used to identify specific practices was designed to eliminate or lessen adverse consequences. The application of Forest Plan standards

Table 6. Projects Considered in Cumulative Effects Analysis

Name	Timing	Activities	Area
Pumphouse Multiproduct Timber Sale	Past	Thinning, pile burning, broadcast burning	1,359 acres adjacent to Kachina Village FHP.
ADOT Tree Removal along	Ongoing	Removal of most trees within a 30-foot area or the right-of-way fence	Both sides of Highway 89A through Kachina Village FHP.
Griffiths Spring Parking and Interpretitive Trail	Ongoing	Parking area, toilet and trail.	Griffiths Spring, 1 mile of trail and 1/4 acre parking
Airport Fuels Reduction Project (broadcast burning only)	Forseeable Future	Broadcast burning	1,000 acres northeast of Kachina Village FHP (approximately 200 acres within Kachina Village FHP boundary)
I-17 Wireless Communication Tower at James Canyon	Forseeable Future	Construct tower	1/4 acre
Fort Tuthill to Kachina Village Trail	Forseeable Future	Nonmotorized trail	3 miles
Oak Creek Canyon Fuels Reduction Project	Forseeable Future	Thinning, pile burning; broadcast burning, brush crushing.	Interior of Oak Creek Canyon outside of wilderness boundaries.
State Section 26 (1/2)	Ongoing	Thinning, pile burning	320 acres
Development of Previously Undeveloped Private Land	Ongoing; currently being developed.	Residential development	Section 24 (640 acres)
Maintenance activities on National Forest Roads, Facilities and Trails	Ongoing	Grading, culverts, painting, and signing.	In and around the Kachina FHP.
Illegal Firewood Cutting	Ongoing; low levels	Large diameter green trees cut.	In and around the Kachina FHP.
Recreation Activities	Ongoing	Hiking, biking, horseback riding, ATV, rock climbing, picnicking, camping, etc.	In and around the Kachina FHP.

and guidelines, Best Management Practices, project-specific mitigation measures, and monitoring are all intended to further limit the extent, severity, and duration of potential effects. Such measures are discussed throughout this chapter and are discussed in Chapter 2. Regardless of the use of these measures, some adverse effects will occur. The purpose of this chapter is to fully disclose these effects.

Short-term Use and Long-term Productivity

Short-term uses and their effects are those that occur annually or within the first few years of project implementation. Long-term productivity refers to the capability of the land and resources to continue producing goods and services long after the project has been implemented. Under the Multiple-Use Sustained-Yield Act and the National Forest Management Act, all renewable resources are to be

managed in such a way that they are available for future generations. Harvesting and use of standing timber is an example of short-term use of a renewable resource. This long-term productivity is maintained through the application of the resource protection measures described in Chapter 2, in particular those applying to soil and water resources. These are also discussed throughout this chapter, particularly in terms of wildlife habitat, TE&S habitat, development of old-growth, wildfire potential, and overall forest health goals.

Irreversible and Irretrievable Commitments

There are no irreversible or irretrievable commitments associated with this project. Irreversible commitments are decisions affecting non-renewable resources such as soils, wetlands, unroaded areas, and cultural resources. Such commitments are considered irreversible because the resource has deteriorated to the point that renewal can occur only over a long period of time or at a great expense, or because the resource has been destroyed or removed.

Available Information

There is less than complete knowledge about many of the relationships and conditions of wildlife, fish, forests, jobs, and communities. The ecology, inventory, and management of a large forest area are a complex and developing science. The biology of wildlife species prompts questions about population dynamics and habitat relationships. The interaction of resource supply, the economy, and communities is the subject matter of an inexact science. However, the basic data and central relationships are sufficiently well established in the respective sciences for the deciding official to make a reasoned choice between the alternatives and to adequately assess and disclose the possible adverse environmental consequences. New or improved information would be very unlikely to reverse or nullify these understood relationships.

Plans of Other Agencies

The Kachina Village Project does not conflict with objectives of other Federal, state, and local land use plans, policies and controls for the area. The Council for Environmental Quality regulations implementing NEPA require a determination of possible conflicts between the Proposed Action and the objectives of Federal, state, and local land use plans, policies, and controls for the area.

Aesthetics

In addition to inventory revisions directed by the Forest Plan, the Forest Service is required to begin using the Scenery Management System (SMS) to replace concepts and terminology of the Visual Management System (VMS). In lieu of a forest-wide revision, following is an assessment of the project area using SMS terminology and concepts. Many of the SMS concepts are borrowed from the VMS so the inventory and analysis updates are similar. The major difference between the two systems relevant to this analysis is the addition of a more complete discussion of "landscape character" with the SMS. An expanded discussion of landscape character suitable for an SMS analysis is included in the following section. Inventory and analysis required for implementing the SMS is scheduled to coincide with the next Forest Plan revision (scheduled to begin 2006).

Affected Environment Landscape Character and Scenic Integrity

The Landscape Character Description, as defined in "Landscape Aesthetics - A handbook for Scenery Management" (USDA Handbook 701) describes the positive scenic and cultural elements inherent to the landscape that collectively form the base for comparison of alternative management scenarios. Landscape management that tends to preserve or enhance the inherent positive scenic elements will maintain or increase the scenic integrity of the landscape and will help achieve landscape character goals. Landscape management that eliminates or obscures positive scenic elements or that introduces elements that are visibly alien to the characteristic landscape will degrade scenic integrity and thwart achievement of landscape character goals.

Appendix F contains definitions and explanation of landscape character, including a history of this landscape.

Overall, the landscape within the analysis area appears slightly altered but with the natural appearing landscape dominating. This equates to a moderate to high level of scenic integrity. Alterations to the natural appearing landscape within the project boundary (including private lands) includes the presence of roads and trails, power lines, residential developments, including the Kachina and Forest Highlands subdivisions, and a cell tower. Except for roads and trails, most of these structures are on private land. This assessment will not include any further analysis of private lands within

the project area. Over the past several years increased recreation use of areas adjacent to Kachina and Forest Highlands subdivisions, along portions of FR 237, and in the Mexican Pocket area, have resulted in increasing visible evidence of human activity such as fire rings, compacted bare ground, litter, and additional unauthorized roads and ATV tracks. All of these additional elements in the landscape detract from its natural appearance and degrade the scenic integrity of the area, resulting in a "low" scenic integrity rating that equates to a "Modification" Visual Quality Objective (VQO)[6] at best for the specific areas affected. These more heavily impacted areas, though most visible because of proximity to major roads and access sites, make up a small percentage of the project area.

In contrast, most of the project area located away from the residential areas and high use forest areas have high scenic integrity that equates to the prescribed Retention[7] and Partial Retention[8] VQO's defined in the Forest Plan. Past management has altered the vegetative pattern from the more desirable open pine stands with more big trees to the present less desirable condition with more dense stands of smaller trees. Although the resulting landscape looks unaltered and natural to the casual observer and meets the original VQO's set forth in the Forest Plan, the existing scenic condition falls far short of the potential scenic values inherent in the historic ponderosa pine forest with its open parks dominated by large yellow-barked trees.

The canyons that occur in the area (James and Kelly Canyons and Pumphouse Wash) are mostly not accessible to motorized vehicles and bicycles and are often difficult for pedestrians to negotiate. The canyon vegetation is more diverse and not as fire dependent as the ponderosa pine forests which occur on top of the plateaus between the canyons. The resulting appearance of the canyons is generally primitive with little evidence of human activity and influence, and with vegetation that probably looks very similar to what it has looked like since people first arrived in the area. The existing scenic condition of the area canyons probably comes close to meeting the full potential for scenic quality inherent to such canyon settings within the Flagstaff Character Type. This equates to the prescribed Retention Visual Quality Objective in the current Forest Plan.

Landscape Character Goals

A landscape character goal is an objective for the overall scenic character of the landscape. There is no present direction in the Forest Plan defining any landscape character goals for the Coconino NF. There is language in the Plan directing that, forest-wide, changes to any VQO will be limited to plus or minus 15 percent. The intent of this direction was to maintain the natural appearing landscape character that existed at the time the Plan was developed (mid 1980's). In lieu of a designated landscape character goal defined in the Forest Plan, this analysis will assess the affect of the alternative actions on what we can reasonably discern to be people's preferences for landscape character based on existing research and professional experience.

Scenic Integrity Goals

Visual Quality Objectives defined in the Forest Plan for the area include:

- **Retention** along the Interstate 17 and Highway 89A road corridors within the foreground viewing position (up to 1/2 mile distance), which allows for no visible evidence of management activity or human alteration;
- **Modification**[9] in areas unseen from roads and trails, which allows for visible alterations to the natural appearing landscape that blend with the natural appearing landscape; and
- **Partial retention** for the westernmost extent of the plateau between James and Kelly Canyons, which allows for alterations to the natural appearing landscape which are subordinate to the landscape character.

The Forest Plan calls for an update of the initial VQO inventory at the time of project analysis. An updated inventory has been completed and the

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[6] Visual Quality Objectives (VQO's) are desired levels of visual quality based on the physical and sociological characteristics of an area. VQO's refer to the degree of acceptable alterations of the characteristic landscape.

[7] Retention is a degree of alteration in which management activities, in general, are not evident to the casual forest visitor.

[8] Partial Retention is a degree of alteration in which management activities, in general, may be evident but must remain subordinate to the characteristic landscape.

[9] Modification is a degree of alteration in which management activities may dominate the characteristic landscape but must, at the same time, use naturally established form, line, color, and texture. It should appear as a natural occurrence when viewed in the middleground or background.

result is: 1) Retention VQO areas would remain the same; 2) Partial Retention areas would remain the same; and 3) Modification areas would change to Partial Retention. By selecting one of the action alternatives, the decision maker adopts the new VQO inventory.

Impacts to visual quality objectives from the alternatives are assessed based on the updated inventory.

All "action" alternatives (all alternatives except the "No Action" alternative, Alternative B) would change the landscape character of the area by thinning out the forest. Research and observation both suggest that a forest with fewer trees than now exists across much of the Colorado plateau will generally be more aesthetically pleasing to most people (Brown and Daniel, 1984).

Direct Effects of Alternative A

Alternative A will result in a landscape that will experience disruptions of existing scenic integrity beginning with thinning activities and persisting until thinning slash and other evidence of thinning activity is sufficiently reduced. Some Partial Retention VQO areas will shift to Modification during this short-term period of time. In areas where thinning slash is aggressively removed or burned, as is typically done along some sections of highway or major road corridor, scenic integrity will generally be reduced for 1 to 3 years following tree cutting. In areas with less aggressive slash treatment, which includes the majority of the project area, evidence of thinning activities will likely persist for 3 to 5 years decreasing considerably as prescribed burns reduce the presence of "red" slash and stumps. Prescribed burning and natural processes will most likely reduce the slash throughout the area so that most forest visitors do not notice it 5 years after the thinning (PRD 152).

The west side of the I-17 corridor would receive thinning of smaller diameter trees consistent with the forest beyond the right-of-way. The result would be a relatively consistent appearing landscape character on both sides of the right-of-way fence that would be more pleasing in appearance to most people than Alternative B (No Action).

Broadcast burning will result in disruption of the scenic integrity immediately following the burn and until vegetation re-sprouts in the area (usually 1 to 3 months). Some blackened bark may remain on the base of trees. Partial Retention VQO's may shift to Modification during this short-term time period. The visual affect is for only a portion of the Kachina Village Project area at one time, because different burn blocks[10] will be treated on different years. The amount of seen area will depend on the major roads or trails adjacent to the burn block.

Visual access into the forest landscape will be greatly increased immediately following treatment revealing more landform and vegetative features in the landscape. It will result in a more diverse vegetative mosaic that will generally be less dense and more transparent and, therefore, more interesting to the typical person viewing it than the present scenic condition.

Recreation activities described in Alternative A and common to all of the action alternatives will reduce the visible impacts of heavy recreation use along FR 237 and some of the other road sections identified in the recreation report (PRD 137b). This improvement occurs immediately after activities occur. The fence at Kelly Seep will surround a very small area and affect only that site.

Direct Effects of Alternative B

There are no direct effects to scenic integrity from the "no action" alternative.

Direct Effects of Alternative C

The direct effects of Alternative C are similar to Alternative A (Proposed Action) but with several more trees per acre less than 16 inches removed. The result will be a slightly more transparent and open forest than the Proposed Action, as seen from the perspective of someone viewing it from ground level. This occurs immediately after thinning treatments.

The direct effects of recreation management activities, broadcast burning, and the I-17 corridor are the same as Alternative A (PRD 137b).

Direct Effects of Alternative D

The direct effects of Alternative D are similar to those described for Alternative A (Proposed Action). The direct effect on scenic integrity would be the

[10] Burn blocks is an informal term used to describe areas of land, usually roughly 100-500 acres in size that are burned in a given year or single entry. Roads, utility lines, or fire line usually bound burn blocks.

same as Alternative A except that there would be a small number (estimated to be about 2,000 trees in this category total across roughly 4,500 treated acres, or 1 tree per 2.25 acres) of black-barked trees larger than 18 inches left standing with this alternative that would be cut in Alternative A. Consequently, there would be slightly more smaller diameter trees cut to meet fire reduction basal area objectives resulting in slightly more "transparency" to the forest setting, as seen from ground level. There would also be one additional large "recruit" tree for every 2.25 acres that would "soon" be a large yellow-barked tree (normally within 40 to 60 years for a typical 18 inch tree on a good site) (PRD 129 and 152).

The direct effects of recreation management activities, broadcast burning and the I-17 corridor are the same as Alternative A.

Direct Effects of Alternative E

This alternative would result in more stems per acre remaining after treatment than Alternative A. Many stands with larger trees predominant would not be thinned at all. As a result, there will be less disruption of the existing scenic condition and less slash to dispose of (except for within the "Intensive Zone") throughout the treated stands (PRD 149). This alternative would meet standards for the prescribed Partial Retention VQO (moderate scenic integrity) in all treatment areas except the "Intensive Zone", where it would only meet standards for a Modification VQO (low scenic integrity) due to the contrast with adjacent stands and due to the geometric shape of the "Intensive Zone". This affect occurs immediately after thinning treatment.

The direct effects of recreation management activities, broadcast burning and the I-17 corridor are the same as Alternative A.

Indirect Effects of Alternative A

Alternative A will help the area attain its long-term scenic potential by increasing the viability of older trees, increasing the growth rate of smaller trees, and by creating and maintaining a more diverse and more interesting vegetative pattern mosaic across the affected landscape. The ability of the landscape to reach the maximum inherent scenic potential that existed historically will be enhanced with this alternative. The presence of grassy openings, created by this alternative will add to the scenic quality.

A long-term effect of recreation management activities and broadcast burning is to also help the area attain its long-term scenic potential.

The risk of a running crown fire is lowest in Alternative A (PRD 154).

Indirect Effects of Alternative B

The No Action Alternative results in a vegetative pattern that tends to decrease the viability of larger, older trees and to favor conditions that result in dense stands of smaller diameter trees. Crowding by smaller trees for moisture and nutrients will tend to accelerate mortality in the larger trees, as well as to put them at risk of mortality by wildfire. The long-term result will likely be a decrease in the number and extent of large "yellow pine" across the landscape. The ability of the landscape to reach the maximum inherent scenic potential that existed historically will be compromised with this alternative compared to Alternative A.

Continuation of existing recreation dispersed camping and social trail use will continue creating pockets of landscape with compacted bare soil, fire rings and redundant roads and trails. In these places scenic integrity will trend downward over time.

The potential for large fires occurring within the Kachina area, though reduced considerably from the existing condition, would be higher for this alternative than for the action alternatives (A, C, and D). A large crown fire could either add interest to the landscape or decrease its scenic value depending on the configuration and extent of the burned area. However, the other risk is that an especially large, hot crown fire could reduce the mosaic to a simple burned landscape, reducing the mosaic effect and producing a much less complex and much less appealing landscape pattern.

The risk of a running crown fire is greater in Alternative B than any of the action alternatives.

Indirect Effects of Alternative C

The indirect effects of Alternative C are similar to Alternative A, except that this alternative will result in a large number of possible "recruitment" trees for the next generation of yellow-barked dominant trees, but will tend to more severely thin out the smallest trees in a stand. Lack of sufficient thinning within stands presently dominated by trees 16 inches and larger will slow the growth of the trees and, therefore, slow the rate of "recruitment" in the stands to a small degree.

Forest canopies would tend to remain closed where larger trees are now predominant which will tend to reduce ground cover production on some sites. The resulting diversity of forest settings, from closed canopy stands of large and mid-sized trees, to both open stands and dense stands of smaller trees, interspersed with the prescribed openings and dense groups, would be an interesting vegetative composition resulting in generally good visual access into the forest. It is a small number of trees that would be retained under Alternative C and cut under Alternative A (estimated at about 7,000 trees or about 1.5 trees per treated acre). This number results in a relatively minor effect to total landscape character over the long and short term; however, since the 7,000 trees affected are not distributed evenly over the landscape, the effect on some sites could be noticeable.

Long-term effects of recreation management activities and broadcast burning is to also help the area attain its long-term scenic potential.

The risk of a running crown fire is somewhat greater than Alternative A and less than Alternative B.

Indirect Effects of Alternative D

The indirect affects of Alternative D are almost identical to Alternative A. The small number of trees greater than 18-inch diameter that are retained under this alternative are likely to turn yellow within 20 to 60 years and as such represent an investment in future scenic value. There would be a minor acceleration in the number of black-bark "recruits" within this size class to replace aging yellow-bark pine as they die. The small number of trees that would be retained under Alternative D and cut under Alternative A (estimated at about 2,000 trees or about 1 tree per 2.25 treated acres) results in a relatively minor effect to total landscape character over the long and short-term; however, since the 2,000 trees affected are not distributed evenly over the landscape, the effect on some sites could be noticeable.

Long-term effects of recreation management activities and broadcast burning is to also help the area attain its long-term scenic potential.

The risk of a running crown fire is similar to Alternative C.

Indirect Effects of Alternative E

This alternative would lead to improvements to the long-term landscape character, but would result in less change than the other action alternatives mainly due to the reduced growth rate on the remaining trees that could be expected following treatment in comparison to the action alternatives. The ability of the landscape to reach the maximum inherent scenic potential that existed historically will be enhanced with this alternative, but not to the extent of other action alternatives (Alternatives A, C, and D).

This alternative would be more at risk for stand replacement wildfires than Alternatives A, C, and D. The diverse pattern that this thinning regime would produce is more likely to result in a burned area mosaic that would add a high degree of scenic interest to the landscape. However, the other risk is that an especially large, hot crown fire could reduce the mosaic to a simple burned landscape, reducing the mosaic effect and producing a much less complex and much less appealing landscape pattern. The risk of a running crown fire is greater in Alternative E than Alternatives A, C, and D and the risk of such a fire is less than Alternative B.

Conclusion: All of the action alternatives have very similar effects on recreation settings throughout the Kachina area primarily because they would all adopt the same transportation plan which would close out many of the non-system roads and roads that are in excess of those needed for administrative or recreation access. Decreasing road densities in some areas where they exceed the 2 miles per square mile density objective from the Forest Plan will help retain or expand semi-primitive characteristics to counter the expansion of Roaded Natural characteristics over the past 2 decades.

People will tend to prefer the appearance of the landscape resulting from the action alternatives, compared to what will result from Alternative B (No Action), and will tend to use that landscape more as a result.

Cumulative Effects of Alternative A

Areas chosen for cumulative effects analysis are those projects immediately adjacent to the Kachina Village Project. Projects in the distant past have contributed to the existing condition as described in the preceeding affected environment section and in Appendix F. One recently completed project—the

Pumphouse Multiproduct Timber Sale—resulted in some thinning from below. Combined with the Kachina Village Project, there is an enhancement of the ability of the landscape to reach maximum inherent scenic potential that existed historically. The presence of grassy openings created by this Alternative A will add to the scenic quality. Recently, ADOT removed trees extensively along the Highway 89A corridor. At this time, there is little blending of these activities with the forest beyond. The action alternatives will thin up to the right-of-way fence in some locations, enhancing visual quality by blending the roadway edge with the forest. The Airport Fuels Reduction Project on the northern boundary of the Kachina Village Project will receive broadcast burning that will have the same short-term impacts and long-term future conditions and broadcast burning in the Kachina Village Project area.

Alternative A (Proposed Action) will result in landscape patterns that will blend with other local vegetative patterns resulting from these management initiatives and trends to help create a more scenic landscape character for the Flagstaff Character Type in the long term.

Alternative A (Proposed Action) will have a cumulative effect on the view from I-17 and Highway 89A in that thinning smaller diameter trees will help blend ongoing and future ADOT thinning initiatives along the highways.

Cumulative Effects of Alternative B

The visual effects of a high intensity crown fire, as described under indirect affects of Alternative B, would result in a dramatically different landscape than surrounding areas. There would be a sharp contrast at the border of a wildfire area.

Cumulative Effects of Alternative C

There is very little difference between Alternatives A and C.

Cumulative Effects of Alternative D

There is very little difference between Alternatives A and D.

Cumulative Effects of Alternative E

This alternative will not blend with other wildland-urban interface initiatives nor with ADOT right-of-way thinning, as well as the other action alternatives in the areas south of Kelly Canyon where cutting no trees over 9 inches dbh would occur. Cutting only lower diameter trees limits flexibility for creating openings or clumpiness which add scenic quality (PRD 152).

Conclusion: Alternative A (Proposed Action) will generally enhance the scenic quality of the affected landscape considerably more than continued implementation of the No Action Alternative (Alternative B – existing management). The difference in scenic quality between the two alternatives will increase over time as the vegetative pattern favored by the Alternative A management scenario matures. Alternatives C and D are very similar to Alternative A in their effects on both scenic integrity and landscape character. Alternative D is slightly more desirable for landscape character concerns than Alternative A because of the retention of a few more of the largest black-bark pine in the stands, which could be a major factor in a few sites. Alternative C is slightly less desirable than Alternative A for long-term landscape character concerns because, even though more of the larger black-barked trees are retained, some of the existing large tree clusters will not be thinned enough to increase the viability of existing large trees at those sites. Alternative E is the least disruptive of the action alternatives, except for the “intensive zone” adjacent to the Kachina community which is the most visually discordant element proposed for any of the alternatives. Alternative E does the least to enhance long-term landscape character except for Alternative B. Alternative E introduces a large discordant element into the landscape (the “Intensive Zone”) and falls far short of Alternatives D, A, and C in enhancing long-term landscape character.

Air Quality

Affected Environment or General Air Quality

The prevailing winds for this project area are out of the southwest. However, as fronts pass, winds can arrive from any compass direction for a period ranging from a few hours to 2 or 3 days. The area is not prone to inversions, but inversions do occur more between October and December than at other times of the year. Stable atmospheric conditions, when they occur, may last from 12 hours to 6 or 7 days at a time.

The Kachina Village Project area is located within the Verde Airshed and downwind activity occurs within this airshed only. There are no non-attainment areas[11] or Class 1 airsheds[12] within this airshed.

Flagstaff and its surrounding communities lie to the north and northeast (approximately 2 to 6 miles) from the project area. The communities of Kachina Village and Forest Highlands are immediately adjacent to the northern boundary of the project area. Another area, Oak Creek Canyon, is smoke sensitive because it conveys a large number of tourists through regionally popular vistas. Oak Creek Canyon lies to the southwest of the project area (approximately 2 to 10 miles). Two highway corridors border the project area. They are I-17 and Highway 89A. Traffic is constant along both of these highways. There is a high level of recreation activities, especially in the summer months, within portions of the analysis area.

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

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

Each of the action alternatives seeks to reduce the fire hazard while retaining as many nutrients on site as possible. Each of the action alternatives proposes burning the piled thinning slash (4,804 acres), as well as prescribed burning of the forest floor (6,229 acres). Generally, emissions from prescribed fires can be controlled within acceptable limits while emissions from a wildfire tend to exceed air quality standards in both quantity and duration (PRD 153).

Direct Effects of Alternative A

Emissions generated by the alternatives have been estimated and all modeled emissions would meet National and State Ambient Air Quality Standards. Calculations are located in the project record file (PRD 149).

Smoke from prescribed burning will have short-term impacts on local air quality. Effects occur in two forms: 1) pile burning of slash generated from thinning trees, and 2) broadcast burning the forest floor in small blocks.

Direct Effects of Pile Burning for Alternative A

Pile burning is relatively efficient combustion producing far fewer emissions than broadcast burning. Broadcast burning of the forest floor produces considerably more emissions but is more beneficial to the forest environment. Finally, a wildfire burning through the current fuel conditions produces the greatest amount of emission levels and the most destructive effects.

Under Alternative A, thinning slash shall be piled for burning. Based on current conditions we expect the following tons per acre of fuel to be generated by each of the thinning prescriptions (see Table 7). Approximately 20 percent of this slash would be left on the ground to meet Best Management Practices for soil and watershed health. The balance of the slash would be piled and the piles would be burned under conditions meeting air quality standards.

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[11] The EPA has established NAAQ's for specific pollutants emitted in significant quantities throughout the country that may be a danger to public health and welfare. These pollutants are called criteria pollutants. The NAAQ's are designed to protect human health and the public welfare. The Clean Air Act defines public welfare effects to include, but not be limited to, "effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being." If a community or area does not meet or "attain" the standards, it becomes a non-attainment area and must demonstrate to the public and EPA how it will meet standards in the future. This demonstration is done through the State Implementation Plan.

[12] Designation as a Class 1 area allows only very small increments of new pollution above already existing air pollution levels. Examples include Congressionally designated wilderness areas.

Piles can be burned during rain and snowstorms with excellent smoke dispersion and little diurnal[13] smoke flow into the canyons. Proper pile burning consumes a majority of the fuels before atmospheric cooling begins leaving a small volume of fuel to produce smoke for nighttime subsidence flows.

Smoke from pile burning may subside into upper Oak Creek Canyon area. Pile burning immediately adjacent to subdivisions may cause short-term (1 day) smoke impacts to the subdivision. Public notification of burning will take place prior to ignition.

The high levels of recreation activity that occur in the summer months is not likely to be impacted by smoke because burning is not likely to occur during these times. Fire personnel are usually busy with fire suppression activities in the summer. Hunters and other people recreating in the project area in the fall and spring could be impacted by smoke from burning.

Direct Effects of Broadcast Burning for Alternative A

The initial broadcast burning of each block in the Kachina Village Project will generate smoke for as long as 72 hours after ignition. Successive broadcast burns on a given block (initiated to mimic the 3 to 15-year natural burning cycle) will generate far less smoke volume and have virtually no smoke after sunset of ignition day.

Smoke plume trajectories indicate that Kachina Village, Forest Highlands, I-17, Highway 89A and the upper portions of Oak Creek Canyon may be impacted by smoke when burning. Short-term air quality degradation and reduced visibility may be experienced in the smoke plume trajectories. After sunset, cooling atmospheric conditions will carry smoke down drainages like water flows. Under Alternative A, these down canyon flows may reach upper Oak Creek Canyon in the early morning hours. These nighttime flows may carry smoke down Kelly or James Canyon and reduce visibility along portions of I-17 and Highway 89A adjacent to the project area. These portions will be posted with appropriate signs warning motorists of reduced visibility. Ignition of each days block would be completed in the afternoon, thus limiting the smoke generated after atmospheric cooling begins.

The highest levels of recreation use occur in these summer months when broadcast burning is less likely to occur because fire management personnel are usually busy doing fire suppression at that time. Hunters and other people recreating in the project area may be displaced for a short time due to burning activities.

Direct Effects of Alternative C

Alternative C is similar to Alternative A, but does not thin any trees greater than 16-inches dbh. The difference in Alternative C is difficult to model with precision, since relatively few trees larger than 16-inches dbh would be removed under Alternative A and retained under Alternative C. The amount of thinning slash generated and the emissions produced by pile burning are only slightly less than Alternative A (included in Table 7 for Alternative A Direct Effects).

Direct Effects of Alternative D

Alternative D is similar to Alternative A with the addition of no trees greater than 18-inches dbh being thinned. The difference is difficult to model with precision since relatively few trees larger than 18-inches dbh would be removed under Alternative A that would be retained under Alternative D. The amount of thinning slash generated and the emissions produced by pile burning is between Alternatives C and A (included in Table 7 for Alternative A Direct Effects).

Table 7. Slash Generated for Alternative A.

Thinning Prescription	Thin No Larger Than 9-inch dbh	Thin Between 40-120 BA	Thin Between 40-100 BA	No Thinning; Burn Only
Approximate Acres	681	2,342	1,781	1,425
Slash Generated Tons/Acre	8	13	14	None generated

[13] Occurring during the day

Direct Effects of Alternative E

Table 8 displays the average amount of thinning slash generated by each prescription of this alternative. The sum of these acres (including the 1,425 acres that are no cut, burn only) would be broadcast burned and receive recurring maintenance burns.

As in the other action alternatives, approximately 20 percent of this slash would be left on the ground to meet Best Management Practices for soil and watershed health. The balance of the slash would be piled and the piles would be burned under conditions meeting air quality standards.

Broadcast burning could be conducted without violating air quality regulations, although more frequent maintenance burning would be necessary. This causes an increase in the number of individual days that people may experience the short-term smoke impacts described under the other action alternatives.

Indirect Effects of Alternative A

Alternative A has the greatest reduction in crown fire potential and severe fire behavior over time. The reduction in the fuel load and the increased openness of the canopy will allow future broadcast burning under a wider range of weather conditions than the other alternatives. Having a wider range of weather conditions in which to burn increases the ability of burn managers to limit undesirable smoke impacts.

Indirect Effects of Alternative B

As stated in the existing condition section, the current fuel and vegetative conditions would be likely to generate severe fire behavior. The modeling indicated that a wildfire starting as far as 2 miles from the residential areas could exceed 1,000 acres. Modeling also indicated that such a fire would exceed air quality standards (PRD 73).

Alternative B calls for no action. There would be no emissions except from wildfires that occur. Should a wildfire occur, the amount of fuel consumed and the smoke generated would be geometrically greater than that of the action alternatives. The resulting smoke would spread wider and farther than under controlled burning. Nighttime smoke impacts would reach farther and be more severe and could impact the smoke sensitive areas of lower Oak Creek Canyon. Smoke impacts from a wildfire would extend for more days and nights than under the action alternatives.

Should a wildfire occur, there could be bare soil areas that, when exposed to wind, would continue to produce air pollutants (ash and dust) until precipitation sealed the surface.

Indirect Effects of Alternative C

The difference in Alternative C is difficult to model with precision, since relatively few trees larger than 16-inches dbh would be removed under Alternative A and retained under Alternative C (7,000 trees) (PRD 129). Alternative C is somewhat less effective in preventing a wildfire that would exceed air quality standards. The resulting forest condition would allow prescribed burning under a narrower range of weather conditions than Alternative A.

Indirect Effects of Alternative D

Alternative D may be slightly less effective in reducing crown fire potential and severe fire behavior than Alternative A and slightly more effective in reducing crown fire than Alternative C. The difference is difficult to model with precision, since relatively few trees larger than 18-inches dbh would be removed under Alternative A and retained under Alternative D. The resulting condition would provide a slightly narrower range of weather conditions appropriate for burning than Alternative A and a slightly wider range than Alternative C.

Table 8. Slash Generated for Alternative E.

Thinning Prescription	Thin No Larger Than 9-inch dbh	Thin Between 40-120 BA	Thin Between 40-100 BA	No Thinning; Burn Only
Approximate Acres	2,475	1,889	439	1,425
Slash Generated Tons/Acre	8	13	14	None generated

Indirect Effects of Alternative E

Alternative E has the least reduction in crown fire potential and severe fire behavior, but in most instances it showed improvement over the existing condition (Alternative B). Emissions from the model-generated wildfire in this project area exceeded air quality standards in both quantity and duration.

This alternative results in a higher percentage of closed canopies. Prescribed burning weather conditions would have a considerably narrower range than the other action alternatives making it considerably more difficult to prescribe burn without undesirable smoke impacts. At the same time by retaining more trees per acre, this alternative would tend to accumulate forest floor fuels more quickly than the other action alternatives. This in turn would require more frequent maintenance burning. This increases the number of individual days the airshed is impacted.

Cumulative Effects of Alternative A

There are many prescribed burning projects that have occurred or are planned to occur within the Verde River airshed. However, ADEQ has and will monitor the amount of acres being burned in each airshed on each day. ADEQ does not allow acres burned per day to exceed limits that will lead to excessive air quality degradation. The cumulative effect of this project is to add to the list of requested burn days and increase competition between project areas for those days.

Burning activities on the Kachina Village Project will add to the air quality effects of wood burning stoves, car emissions and other influences from developed private lands. These cumulative effects are short term and so the added effect is not significant.

Projects in the immediate vicinity of the Kachina Village Project include the: Fort Valley Forest Restoration Project; Mars Hill Fuels Reduction Project; Arboretum/Naval Observatory Fuels Reduction Project; Airport Fuels Reduction Project; Lake Mary Fuels Reduction Project; Lake Mary Parcels Fuels Reduction Project; Skunk Fuels Reduction Project; and the proposed Kachina Village Forest Health Project are nearly adjacent to each other. All of these projects progress toward a forest condition with less risk of wildfire. The addition of Alternative A for the Kachina Village Project adds a positive cumulative effect.

Cumulative Effects of Alternative B

There are no direct effects to air quality from this alternative and, therefore, no cumulative effects. This alternative has a higher risk of high intensity wildfire that could cumulatively add to other air quality impacts and cause emissions beyond State and National standards.

Cumulative Effects of Alternative C

The cumulative effects of Alternative C are the same as Alternative A with slightly less reduction in fire risk than Alternative A and slightly more reduction in fire risk than Alternative D.

Cumulative Effects of Alternative D

The cumulative effects of Alternative D are similar to Alternative A with slightly less reduction in fire risk than Alternatives A and C.

Cumulative Effects of Alternative E

Alternative E has a considerably lower probability (than the other action alternatives) of preventing a wildfire that would exceed air quality standards. Alternative E has a greater probability of preventing a wildfire than Alternative B. More frequent broadcast burning would be necessary under this alternative, which has a cumulative effect on implementation of other projects. Requiring more “burn days” from ADEQ to complete the Kachina Village Project leaves fewer “burn days” to complete other fuels reduction burning.

Fire

The objectives related to fire effects, as stated in the Proposed Action’s Purpose and Need, Chapter 1, are to:

- Reduce the potential for a large, stand-replacing fire in the wildland-urban interface;
- Increase the resilience of the area to wildfire;
- Protect wildlife habitat;
- Retain and recruit mature ponderosa pine trees and gambel oak; and
- Set conditions for the reintroduction of fire in the ecosystem.

Each of the action alternatives affects the potential for a large stand-replacing fire to varying degrees. The differences of effects in meeting all of the objectives listed above are largest between Alternative E and the other action alternatives.

Affected Environment

Pumphouse Wash, Kelly Canyon, and James Canyon transect the project. These drainages contain fuel and canopy conditions that can generate severe fire behavior. They also provide slope and wind funneling that increase fire behavior. These drainages are left untreated under each of the action alternatives to provide wildlife habitat and travel corridors. The presence of these drainages and their condition amplify the importance of fuels treatments above and in between these drainages.

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

Flame length is also a reliable indicator of fire intensity and the probability of tree mortality. Hence it can indicate how effectively each action alternative meets the other fire-related objectives identified in the Purpose and Need, Chapter 1.

In the analysis, the Fuel Management Analyst software was used to model wildfire behavior that would probably occur after each of the treatments (PRD 149). Common to each action alternative is a considerable change in treatment across three areas of the proposed project. The first area or zone is within 1 mile of the residential neighborhoods. Within 1 mile of residential, thinning trees up to 9 inches was compared with thinning to an average of 50 basal area left by Alternatives A, C, and D. Alternatives C and D differ from Alternative A only by a 16- and 18-inch diameter restriction, while Alternative E cuts trees 9 inches or less on a large portion of the area within 1 mile of the residential neighborhoods.

The second zone is greater than 1 mile from the neighborhoods yet north of James Canyon. North of James Canyon, thinning to an average basal area of 80 (Alternative E) was compared with thinning to an average basal area of 50 left by Alternatives A, C, and D.

And the third zone is the area south of James Canyon where thinning trees 9 inches or less (Alternative E) was compared with thinning to a 50 basal area (Alternatives A, C, and D).

Direct Effects of Alternative A

Alternative A has the greatest reduction in crown fire potential and severe fire behavior immediately after treatment across all three zones (a fire-related objective). This alternative has the greatest reduction of fire hazard to both the nearby communities and the forest itself. It provides the greatest canopy break (assessed in both percent of opening and distribution of the breaks), the greatest reduction of fire-laddering fuel, and it is the most effective in meeting fire-related objectives.

Within 1 mile of the residential neighborhoods, the flame lengths generated by the model were reduced from 5.7 feet to 3.5 feet and the probability of large tree (12 to 20-inch dbh) mortality was reduced from over 90 percent to less than 20 percent. Farther than 1 mile, yet north of James Canyon, the model indicated this alternative would reduce flame lengths from 7.2 feet to approximately 4 feet and the probability of tree mortality from over 90 percent to less than 16 percent. South of James Canyon the model indicated that this alternative would reduce flame lengths from 7.2 feet to 3.5 feet and tree mortality from over 90 percent to less than 16 percent.

Recreation and road management activities will lessen fire risk in a similar manner for all action alternatives.

There is no effect from riparian rehabilitation activities at Kelly Seep.

Direct Effects of Alternative B

There are no direct effects to fire behavior from the No Action Alternative.

Direct Effects of Alternative C

Alternative C is somewhat less effective in reducing crown fire potential and severe fire behavior across the three zones. The reduction in the fuel load should be as great as Alternative A, although there would be slightly more canopy-closure and a slightly greater number of fire-prone trees.

Direct Effects of Alternative D

Alternative D may be slightly less effective in reducing crown fire potential and severe fire behavior than Alternative A. Under Alternative D, 2,000 fewer trees are thinned than Alternative A (PRD 129). The model is not sensitive enough to discern this small difference between Alternatives A and D. Therefore, the model did not indicate any difference in expected flame length or probability of large tree (12 to 20-inches dbh) mortality between Alternatives A and D.

Alternative D appears to reduce the fire hazard to both the nearby communities and the forest itself as much as Alternative A. Within this project area, it provides only slightly less canopy break and almost as much reduction in fire-laddering fuel as Alternative A.

Direct Effects of Alternative E

Alternative E has the least reduction in crown fire potential and severe fire behavior, but in most instances it showed improvement over the existing condition. Within 1 mile of the residential neighborhoods, the flame lengths generated by the model were not reduced at all (5.7 feet). These flame lengths would make initial attack difficult and ineffective.

This alternative proposes an "intensive zone" treatment for a width of 660 feet where the national forest meets private property. This zone is intended to mitigate the effects of fire resulting from thinning trees only up to 9 inches diameter and having higher canopy closures over the rest of the project area. Initial attack has been quite effective against fires starting in such a fuel break. However, on the Coconino National Forest, a 660-foot-wide fuel break has not proven to be an effective fire stop against fires approaching from beyond such a strip. An illustration is the Slate Fire (1996). An entire strike team of wildland fire engines was unable to even slow down the forward spread of the fire at any of three separate breaks similar to the "intensive zone" treatment.

Jack Cohen's research on wildfire-related structure loss was referenced in comments received in response to the Proposed Action. This research recommended the "intensive zone approach." Cohen's argument that homeowner's could take action to protect their houses is important to those living in the wildland-urban interface. However, Mr. Cohen's research narrowly focuses on "home ignitability" and the combustion of structures. It cannot be extrapolated to address the safety of the adults and children living in a home or working in a community that is threatened by wildfire.

Research showing that an "intensive zone" treatment is effective in protecting structures assumes that emergency response personnel have had enough time to safely remove all the children and adults from harm's way. Consider the time it would take a local law enforcement agency to gather enough personnel to control entrance and exits to a threatened neighborhood. Consider the time and personnel it would take to notify residents and employees door-to-door. Consider the time it would take a parent to gather up each of their children playing out in the woods, over in a friend's backyard, or who have bicycled down to the neighborhood store. Alternative E does not treat enough of the forest to sufficiently reduce the possibility of a severe fire spreading rapidly to nearby communities.

Indirect Effects of Alternative A

By reducing the expected fire intensity more than the other alternatives, Alternative A provides the most resilience to fire (a fire-related objective). The reduction in the fuel load and the increased openness of the canopy will allow prescribed burning under a wider range of weather conditions. This is extremely important because each of the action alternatives requires periodic prescribed burning of the forest floor to maintain the reduction in crown fire potential and severe fire behavior achieved by the initial treatment (a fire-related objective) (PRD 149).

Having a wider range of weather conditions in which to burn increases the number of days a prescribed burn can be executed. The wider range also allows a greater variety of fire effects as well as reducing burn costs and smoke impacts.

Alternative A provides a higher degree of habitat protection (a fire-related objective) by reducing the probability of tree mortality more than the other alternatives (induced by both wild and prescribed fires). By reducing the probability of mortality among large trees (12 to 20 inches dbh) more than the other alternatives, this alternative is also most likely to retain and recruit mature ponderosa pine trees (a fire-related objective).

Indirect Effects of Alternative B

Alternative B calls for no action. As stated in the existing condition section, the current fuel and

vegetative conditions would likely generate severe fire behavior. The modeling indicated considerable torching and spot fires more than half a mile ahead of a running crown fire. The forest condition after a high intensity wildfire would likely not meet management direction in the Forest Plan for a variety of resources.

The modeling indicated an extremely high occurrence of tree mortality (78 to 98 percent) among large trees (12 to 20 inches dbh). Modeling also indicated that a fire starting even as far as 2 miles from the residential areas could burn through Kachina Village, cross a 4-lane highway, and threaten other neighborhoods farther north during one burning period.

Indirect Effects of Alternative C

The difference in Alternative C is difficult to model with precision, since relatively few trees larger than 16-inches dbh would be removed under Alternative A. The model did not indicate any difference in expected flame length or probability of large tree (12 to 20-inches dbh) mortality between Alternative A and C. This alternative would allow prescribed burning under a slightly narrower range of weather conditions than Alternative A.

Alternative C is similar to Alternative A, but does not thin trees greater than 16-inches dbh. Those trees greater than 16 inches targeted for removal under Alternative A and retained under this alternative have some canopy characteristic that worsens the expected fire behavior. This alternative could not remove: large trees (greater than 16 inches dbh) with disease or infection that make the tree more prone to torching; trees greater than 16-inches dbh with genetic flaws that propagate fire-prone regeneration; trees greater than 16-inches dbh that bridged a desired break in the canopy; and trees greater than 16-inches dbh with crown ladders and interlocking crowns. Adequate canopy breaks are necessary to reduce crown fire risk

Indirect Effects of Alternative D

With so few trees greater than 18-inches dbh being removed with Alternative D versus Alternative A, the model was unable to show any difference in fire intensity between the two. Therefore, Alternative D should provide as much resilience to fire. This alternative is effective in meeting the other fire-related objectives as well.

Modeling in these stands indicated the same probability of tree mortality as Alternative A (induced by both wild and prescribed fires). Therefore, Alternative D should provide as high a degree of habitat protection as Alternative A (a fire-related objective). With the same probability of mortality among large trees (12 to 20-inches dbh), this alternative is as likely as Alternative A to retain and recruit mature ponderosa pine trees (a fire-related objective) with a few more mature ponderosa pine possibly killed by fire.

Alternative D would allow prescribed burning under a wide range of weather conditions. Each of the action alternatives requires periodic prescribed burning of the forest floor to maintain the reduction in crown fire potential and severe fire behavior achieved by the initial treatment (a fire-related objective). The wider range also allows a greater variety of fire effects as well as reducing burn costs and smoke impacts

Alternative D is similar to Alternative A, but does not thin trees greater than 18-inches dbh. Those trees greater than 18-inches dbh retained would have some canopy characteristics that worsen expected fire behavior. This alternative could not remove: large trees (greater than 18-inches dbh) with disease or infection that make the tree more prone to torching; trees with genetic flaws that propagate fire-prone regeneration; and trees greater than 18-inches dbh with crown ladders and interlocking crowns. This thinning restriction would also interfere with creating adequate canopy breaks in some locations.

The probability that a mistletoe-infected tree (retained because it is greater than 18-inches dbh) could infect other trees within spore-transport distance is a difference from Alternative A, since a mistletoe-infected stand is much more flammable.[14] The other canopy characteristics do not appear to considerably worsen the expected fire behavior because of the small number of trees greater than 18-inches dbh targeted for removal under Alternative A.

Indirect Effects of Alternative E

Alternative E would fail to meet other fire-related objectives within 1 mile of the residential neighborhoods, since flame lengths and fire intensity generated by the model were not reduced from the existing condition due to the high number of sites

[14] Mistletoe creates dense branches sometimes referred to as “witches broom”.

Table 9. Fuels Management Analysis[1]

Location[2]	Site[3]	Treatment	Effective Canopy Base Ht.	Flame Length Generated by Model	Flame Length That Initiates Crownfire	Fire Type Generated By Model	Probability of Mortality 12" dbh (%)	Probability of Mortality 14" dbh (%)	Probability of Mortality 16" dbh (%)	Probability of Mortality 18" dbh (%)	Probability of Mortality 20" dbh (%)
Within 1 Mile of Residential											
335	15	Existing	8	5.7	5.1	Passive Crown	98	96	95	91	78
		9-inch limit	15	5.7	7.9	Surface	98	96	95	91	78
		50 BA	15	3.5	7.9	Surface	17	12	9	7	5
336	5	Existing	9	5.7	5.6	Passive Crown	97	93	86	31	60
		9-inch limit	15	5.7	7.9	Surface	97	93	86	31	60
		50 BA	35	3.5	14.2	Surface	16	12	9	7	5
North of James Canyon											
344	4	Existing	16	7.2	8.3	Surface	98	96	95	94	92
		80 BA	24	4.1	10.9	Surface	16	12	9	7	5
		50 BA	24	4.4	10.9	Surface	16	12	9	7	5
344	10	Existing	14	7.2	7.5	Surface	98	96	95	94	92
		80 BA	22	4.1	10.3	Surface	21	12	9	7	5
		50 BA	24	3.5	10.9	Surface	16	12	9	7	5
344	19	Existing	18	4.4	9.0	Surface	28	14	10	7	5
		80 BA	27	3.5	11.9	Surface	16	12	9	7	5
		50 BA	30	2.5	12.8	Surface	16	12	9	7	5
South of James Canyon											
354	8	Existing	13	7.2	7.2	Passive Crown	98	96	95	90	84
		9-inch limit	20	7.2	9.6	Surface	98	96	95	90	84
		50 BA	30	3.5	12.8	Surface	16	12	9	7	5
354	10	Existing	8	7.2	5.1	Active Crown	98	96	95	90	84
		9-inch limit	13	7.2	7.2	Pass Crown	98	96	95	90	84
		50 BA	12	3.5	6.8	Surface	16	12	9	7	5

[1] The Fuels Management Analysis for the Kachina Village Forest Health Project was conducted using the Fuels Management Analyst Program (PRD 149). This table displays conclusions for various treatment types. Refer to the map of treatment types in Appendix C to see where the various examples occur under the different alternatives. For example, there are some areas under Alternative E that would result in an average basal area of 50 and some areas where the 9-inch dbh limit example is relevant. To see the various locations of the examples shown in this table, refer to the treatment map located in Appendix C.

[2] The location, previously called compartment, is a grouping of stands.

[3] A site is a stand of trees.

with a 9-inch diameter limit. The probability of large tree (12 to 20 inches dbh) mortality would remain very high at over 90 percent. However, the flame length required to start a crown fire would be increased to 7.9 feet. This would decrease the probability that a wildfire occurring here would become a crown fire. Prescribed burning weather conditions would have a considerably narrower range than the other action alternatives provide.

Farther than 1 mile, yet north of James Canyon, the model indicated Alternative E would reduce flame lengths from 7.2 feet to approximately 4 feet and the probability of tree mortality from 90(+) percent to 16(-) percent for a wildfire originating in this zone. Within this zone, the model indicated the only considerable difference in tree mortality between the action alternatives was among trees less than 12-inches dbh. Alternative E leaves a higher degree of closed canopy (in this middle zone) that could increase tree group torching and spotting.

Only within this middle zone does Alternative E come close to Alternative A in meeting each of the fire-related objectives. Within this middle zone, the reduction in the fuel load and the increased openness of the canopy would allow prescribed burning under as wide a range of weather conditions as Alternative A and probably a wider range than Alternatives C or D.

South of James Canyon, the model indicated that Alternative E would not reduce flame lengths from 7.2 feet nor would it decrease tree mortality from over 90 percent. The model indicated that a fire occurring in this zone after Alternative E was applied would almost certainly produce multiple spot fires in Kelly and James Canyons. Fires in these canyons would, in turn, generate severe fire behavior, spotting over long distances, and threatening several communities to the north. Within this southernmost zone, the probability of tree mortality would remain over 90 percent in all size classes. Prescribed burning weather conditions would have a considerably narrower range within this zone than the other action alternatives. Therefore, Alternative E would fail to meet several of the fire-related objectives within this southern zone.

Cumulative Effects of Alternative A

Wildfires in the wildland-urban interface place particularly high demands on emergency response personnel. Such a fire threatens multiple structures and multiple groups of people in a very short span of time. Firefighting resources must be deployed to protect the people and properties that lie in the fire's path, as well as to extinguish the fire. This complex situation not only leaves fewer firefighters to suppress the wildfire, but also fewer firefighters to respond to unrelated medical emergencies and structure fires that normally occur within urban settings.

Fuel reduction treatments within the wildland-urban interface should reduce expected fire behavior to a level at which a small number of response personnel can quickly and effectively control a wildfire.

Accumulating fuel treatments over a greater area is beneficial, reducing the possibility that a wildfire can get established, and reducing the intensity with which a wildfire can burn. Each of these fuel treatments in the Flagstaff area has the cumulative effect of reducing the total number of acres through which a fire can spread virulently. The cumulative effect of this alternative further reduces the probability that the demand on emergency response personnel will be exceeded.

The following list shows projects from the recent past and present that occur within the Flagstaff wildland-urban interface[15] and in the vicinity of the Kachina Village Project. It includes those listed in the introduction of this chapter, as well as additional projects around Flagstaff and its communities. Other projects, not described in detail here, have occurred farther in the past and contributed to current forest conditions. All acres are approximate.

- Fort Valley Restoration Project (5,000 acres)
- A-1 Ecosystem Management Project (2,500 acres)
- Mars Hill Fuels Reduction Project (500 acres)
- Arboretum/Naval Observatory Fuels Reduction Project (600 acres)
- Airport Fuels Reduction Project (1,000 acres)
- Lake Mary Fuels Reduction Project (1,800 acres)
- Skunk Fuels Reduction Project (500 acres)

[15] The Fire Management Analysis Zone 1U was used to identify these projects in the wildland-urban interface.

- Pumphouse Multiproduct Timber Sale (750 acres)
- Elden Fuels Reduction Project (100 acres)
- Townsend Winona Fuels Reduction Project (300 acres)

One formal proposed action exists for a future fuels reduction project at this time. The Oak Creek Canyon Fuels Reduction Project is a proposal to develop a comprehensive fire management plan to reduce fuels in Oak Creek Canyon. Acres are unknown at this time.

On State Section 26 (1/2 of the section) a pulpwood sale of less than 12-inch diameter trees occurred 5 years ago. Currently slash piles exist on this section. Future planned activities on Section 26 are to re-pile and burn the existing slash piles, conduct pre-commercial thinning, continue to allow livestock grazing, and finish filling in a rock pit. Trees are marked for pre-commercial thinning; however, there are currently no funds to carryout the thinning and pile burning on Section 26 (Paijkos personal communication, 2001).

The above listed projects tend to link fuel treatments that are nearly adjacent to each other. Each of these fuel treatments in the Flagstaff area has the cumulative effect of reducing the total number of acres through which a fire can spread virulently. The Kachina Village Project adds to these effects and further reduces the probability that the demand on emergency response personnel will be exceeded. The reduction in risk of high intensity wildfire cumulatively reduces the deleterious effects of such a fire on the landscape.

Cumulative Effects of Alternative B

The absence of an effective fuel treatment under this alternative would prevent it from accumulating the benefits of reduced fire hazard in conjunction with other fuel treatment projects. The No Action Alternative actually reduces the benefits of other nearby fuels treatment projects by leaving a high fire hazard area, analogous to a hole in the layer of protection around Flagstaff.

Cumulative Effects of Alternative C

The cumulative effects of Alternative C are similar to Alternative A except there is a slightly smaller reduction in the risk of high intensity crown fire as a result of trees retained in this alternative that would have been removed under Alternative A (7,000 trees).

Cumulative Effects of Alternative D

The cumulative effects of Alternative D are similar to Alternative A.

Cumulative Effects of Alternative E

For the reasons stated in the narrative above, Alternative E does not sufficiently reduce the possibility of a severe fire spreading rapidly to nearby communities. The fuel treatments proposed for the northern and southern zones under Alternative E would not accumulate as much fire hazard reduction in conjunction with other fuel treatment projects. This alternative actually reduces the benefits of other nearby fuels treatment projects by leaving a high fire hazard area in the layer of protection around Flagstaff.

Vegetation

Affected Environment

The vegetation on the Kachina Village Forest Health Project is comprised mostly of younger ponderosa pine (blackjacks) of various densities, associated with Arizona fescue (*Festuca arizonica*) and mountain muhly (*Muhlenbergia montana*) in the understory. Existing older ponderosa pine (yellow pine) are scattered throughout as individuals and small groups but are not numerous in most places. There is quite a bit of Gambel oak in the southern part of the project and the steeper slopes of James and Kelly Canyons have a good component of Douglas-fir, especially on the north-facing slopes. Riparian species and conditions exist in the bottom of the canyons. Because of the moderate to heavy canopy cover and density of much of the project area, grasses/forbs and understory shrubs are not in good condition. The underlying parent material is limestone in the northern part of the project area and basalt with areas of sandstone in the rest of the area.

Most of the area, even portions of the steeper canyons, was heavily logged in the railroad-logging era of the late 1800's to the early 1900's. It was not unusual to take every usable tree for railroad ties and mining props, as well as lumber—maybe leaving a few blackjacks as seed trees. The mature yellow pine we have today are very likely those leave trees that were left 80 to 100 years ago. These conditions, in conjunction with heavy grazing from sheep and cattle in the early 1900's, and an unusually heavy ponderosa pine cone crop and optimum moisture

patterns in 1919, resulted in very heavy pine regeneration. The increased density in the 70 to 80-year blackjack pine (approximately 7 to 14 inches in diameter—or poles and mid-aged trees) that we have today is a direct result of that heavy regeneration.

The present age class distribution and density (acres and percent of the total area) of ponderosa pine in the Kachina Village Project area are displayed in Table 10.

There are also 42 acres (0.5 percent of the area) of grass/shrubs and 2,703 acres of private and State Trust Land within the project area. The above data show that 86 percent of the trees (primarily ponderosa pine) are between 5 to 18-inches dbh (poles and mid-aged). Approximately 93 percent of the project area is moderate to heavy in density. These classifications and acres were derived from stands where each stand was inventoried and assigned an age class and density description (Vegetation Structural Stage or VSS). It should be noted that most stands have more than one age class category—the most common occurrence being primarily pole or mid-aged stands in denser groups with less groups or smaller groups and individuals of mature or old-growth included. Also, the arrangement among trees tends to be random or grouped, not homogeneous. The classification for the stand represents the most common age group within that stand.

Much of the project area has small groups of Gambel oak scattered throughout, usually of smaller diameter stems up to about 10-inches dbh. Some of these groups are growing in small openings of their own and growing fine, but many are being crowded and overtopped by larger ponderosa pine which tends to suppress their growth.

Dwarf mistletoe occurs on ponderosa pine throughout the area in patches. While it can be severe in individual patches and cause or contribute to tree mortality, it does not seem to be a serious problem over the entire area. Tree mortality caused by bark beetles due to physiological stress from very dense conditions and competition among trees will continue. Currently, this mortality occurs in individual trees or small pockets scattered throughout the denser stands. To date, mortality caused by bark beetles has not caused serious problems, but it has slightly increased from year to year since we first noticed it about 10 years ago. This mortality adds to the existing fuel loading of the stand and may create small openings within the stand if enough trees are killed. In addition, current dense stand conditions contain the potential for larger scale mortality from bark beetles.

Forest Vegetation Simulator (FVS) is the computer model used to project various stand parameters into the future for a given alternative. The original data came from compartment exam data and reflect stand averages (PRD 113a and 114a). The modeled treatment is somewhat different than what will actually occur on the ground. Stands chosen for on-the-ground treatment are generally overtopped and smaller. Trees are grouped by cutting small corridors or openings between groups, while the larger trees are retained. Smaller diameter trees are retained if they are growing vigorously with good growth characteristics. A larger diameter tree may be cut in place of a smaller one if the larger tree has some flawed growth characteristic, dwarf-mistletoe infection, or has been attacked by bark beetles. Enough trees are cut to leave a desired density to meet certain objectives such as the promotion of better growth and vigor among

Table 10. The Present Age Class Distribution and Density, by Number of Acres and Percent of Project Area, for Ponderosa Pine (*Pinus ponderosa*).

Age Class	Number of Acres	Percent of Project Area
Seedlings/Saplings	385	5
Poles	4,761	62
Mid-aged	1,867	24
Mature	449	6
Old-growth	210	3
Total	7,672	100
Density		
Open canopy 0-39% (Canopy A)	498	6
Medium canopy 40-59% (Canopy B)	3,302	43
Dense canopy 60%+ (Canopy C)	3,872	50
Total	7,672	100

residual trees, reduction of the impact of dwarf-mistletoe, promotion of grass/forb development in the understory, or reduction of the risk of crown fires. These densities can, and often do, vary throughout a stand. This is complex and fairly difficult to model. This particular model is spatially independent, which means that it cannot model the complexities of groups, small openings, or variable spacing between trees. FVS assumes that the trees are spaced homogenously throughout the stand. It is also difficult to model different density objectives within a stand. However, the model can be useful in comparing alternatives and projecting future conditions as long as we remember these limitations and look at trends rather than the veracity of a particular number. The growth rates for given densities are realistic. Table 11 displays certain stand parameters taken from seven selected stands through time. These growth simulations are based on the assumption that stands are treated initially under each alternative. However, no further treatments are conducted because this analysis is measuring the effects of only this entry. Table 11 displays growth for seven selected stands as modeled by the FVS.

Table 11. Growth for Seven Selected Stands. (Growth was modeled by Forest Vegetation Simulator (FVS) for a period of 49 years based on five alternative treatment regimes.)

Year Per Alternative	Trees Per Acre	Basal Area (ft^2)	QMD (inches)	TPA 24+ inches
2000				
Alt. B	228	149	7.2	0.9
Alt. A	115	83	12.7	0.9
Alt. C	114	86	12.8	0.9
Alt. D	115	84	12.7	0.9
Alt. E	143	111	12.7	0.9
2019				
Alt. B	221	176	8.3	1.4
Alt. A	110	107	14.4	2.1
Alt. C	109	110	14.3	2.1
Alt. D	110	108	14.4	2.1
Alt. E	136	135	14.0	1.8
2049				
Alt. B	210	210	9.6	2.7
Alt. A	103	136	16.9	6.6
Alt. C	102	139	16.7	6.8
Alt. D	103	137	16.8	6.7
Alt. E	128	166	16.1	4.4

Our experience from observations at Taylor Woods shows that we can maintain a healthy grass/forb component within a forest stand measuring up to about 60 square feet of basal area. Grasses and forbs decline considerablely underneath the tree canopy from 60 to 80 sq. ft. of basal area, and are barely present in the understory with basal areas above 80 sq. ft. For the Kachina Village Forest Health Project, this means we have a healthy grass/forb component on only about 6 to 7 percent of the entire area as an average. Since we are using stand averages, there may be slightly more than this amount in small openings overall, but not a great deal. This is in stark contrast to historical reference conditions where approximately 85 to 90 percent of the area had a thriving grass/forb community present. Since there are approximately 140 or so species of grasses, forbs, sedges, and shrubs from research conducted by NAU on their Centennial Forest (personal conversation Margaret Moore, NAU) compared to only 3 or 4 tree species, the amount of grass understory has some serious implications for both the amount and composition of native biodiversity.

Even with broadcast burning occurring, some pine seedlings may establish over time. However, the overall percentage of VSS 2 (seedlings and saplings) is not expected to change over time. In order to accurately display the differences between alternatives for the larger diameter material, predicted regeneration after treatment was not considered. This allowed the model to focus on the differences between alternatives of the larger size trees.

Direct Effects of Alternative A

The treatments of Alternative A will shift the average age/diameter class from young-aged forest, 9 to 11.9-inches dbh (62 percent of the analysis area) to mid-aged forest, 12 to 17.9-inches dbh (57 percent of the area) (PRD 131). The computer model shows the average diameter to increase from 7.2 inches in Alternative B (No Action) to 12.7 inches in Alternative A, directly after cut (see Table 11). This is entirely due to mathematical averages as smaller trees are removed and larger trees remain. The

treatments will also reduce overall density from 50 percent of the area in "C" canopy closure to 16 percent of the area in "C" canopy closure. Correspondingly, the "A" canopy closure will increase in acres from 6 percent before the treatment to 32 percent after the thinning (PRD 144).

Reducing the overall density in Alternative A (Proposed Action) has the most effects. This alternative will reduce competition among all tree species, allowing increased growth rates for oak as well as pine and, therefore, more vigorous conditions. Oak tends to be suppressed by pine, so the oak will immediately respond beneficially from removal of pines that overtop them. More vigorous conditions allow individual pine trees to better withstand bark beetle attacks. The more open stands reduce the trees physiological stress. Finally, focusing the thinning on the smaller trees (thinning from below) will dramatically reduce the fuel laddering conditions that contribute to destructive crown fires. The amount of thinning and creation/enhancement of forest openings will break up the heavy canopy closure, and improve understory, also reducing fire risk conditions.

More open conditions allow for more grasses, forbs, and shrubs to grow which can increase the number and amount of biodiversity and be beneficial to many wildlife species. The rehabilitation actions at Kelly Seep also contribute to biodiversity.

There are no direct effects to vegetation from recreation and road management activities as proposed. Short-term effects to ground cover from broadcast burning are described in the soil and water section below.

Direct Effects of Alternative B

There are no direct effects from Alternative B (No Action).

Direct Effects of Alternatives C and D

These two alternatives are the same as Alternative A (we will still treat the same 4,804 acres) except that we will not cut any trees that are 16-inches dbh or greater in Alternative C and 18-inches dbh or greater in Alternative D.

Under Alternative C, approximately 7,000 fewer trees will be cut, compared to Alternative A (Proposed Action) (PRD 139). This restriction will change the VSS class of only three stands, resulting in no difference in VSS classes and very slight differences (1 percent) in crown canopy closures (density). On these three stands there were enough larger trees cut that Alternative C would change the density from an A canopy (less than 40 percent crown canopy closure) to a B canopy (40 to 60 percent crown canopy closure). The amount of difference between Alternative A and Alternative C is small. Also, the VSS categories have a wide range of inclusion. Small differences often do not show up in the VSS categories unless they occur right at the breaking points between categories. Under Alternative D, approximately 2,000 fewer trees will be cut than Alternative A.

One of the project objectives is to manage for 10 percent of the area in small openings. To accomplish this, there is a need to enlarge some existing small openings. The intent is to remove smaller diameter trees whenever possible, but it may be necessary to cut an occasional larger tree and limiting trees cut to less than 16 inches or 18 inches may hinder this effort. This is especially evident for Alternative C where the estimated percent of openings drops from 10 percent in Alternative A to 5 percent in Alternative C.

Also, both bark beetles and dwarf mistletoe are present in the project area and have caused mortality in larger sized ponderosa pine individually and in small groups. There is more flexibility to treat the occasional outbreak of bark beetle or mistletoe if trees 16 or 18 inches or over can be removed as needed for this purpose. Under Alternatives C and D there is less flexibility to accomplish bark beetle and mistletoe treatment.

Direct Effects of Alternative E

Treatments in Alternative E will result in average diameters greater than Alternative B, but not as much as Alternative A over 50 years (9.6-inches dbh for Alternative B; 16.1-inches dbh for Alternative E; and 16.9-inches dbh for Alternative A). The computer model shows the average diameter to increase from 7.2 inches in Alternative B to 12.7 inches in Alternative E (as well as Alternative A) immediately after treatment. This is entirely due to mathematical averages as smaller trees are removed and larger trees are retained. The alternative treatments will immediately shift the average age/diameter class from young forest, 5 to 11.9-inches dbh (62 percent of the existing structure) to mid-aged forest, 12 to 17.9-inches dbh (44 percent of the area after treatment). Likewise, treatments will reduce density from 50 percent (Alternative B) to 31 percent in Alternative E for the "C" canopy closure, but not as

much as the 16 percent for Alternative A. Because the cuts in Alternative E are not as heavy as the cuts in Alternative A, the effects lie between Alternative B and Alternative A, and the resulting benefits of increased tree growth and vigor are about half of Alternative A (PRD 130).

Alternative E accomplishes only about half of the oak release that would occur in Alternatives A, C and D. Grass/forb establishment will be helped about twofold (the "A" crown canopy closure increases from 6 percent to 12 percent), but not as much as for Alternative A (the "A" crown canopy closure increases from 6 percent to 32 percent, or fivefold). Therefore, native biodiversity in the grasses/forbs and shrubs will benefit about twice as much as Alternative B but not quite half as much as with Alternative A. Limiting tree removal to 9 inches and less on certain stands will hinder the creation of 10 percent of the area in openings.

Indirect Effects of Alternative A

The computer model suggests that Alternative A will achieve twice the growth at half the mortality over Alternative B (No Action) over time. Also, we will have over twice the number of large-sized trees (24+/- inches dbh) after 50 years than Alternative B. The reduction of competition and stress and promotion of vigorous growing conditions within the stands greatly reduces the risk of serious bark beetle mortality.

Alternative A would reduce the pole-size age class by more than 35 percent and the dense canopy closure by more than 34 percent. Therefore, stand susceptibility would be reduced compared with Alternative B (No Action).

Pine regeneration will result from the created openings and broadcast burns, but plans to conduct broadcast burns over time will kill most of the pine seedlings, maintaining a primarily 2-aged older stand structure.

Indirect Effects of Alternative B

Pine trees will continue to grow at slow rates, averaging about 0.3 to 0.4-inches diameter growth per decade.

Current stand structures are characterized by a high degree of fuel laddering, with smaller, overtopped trees and a large amount of closed and continuous canopy closure (over 93 percent of the project area has either very dense or moderately dense canopy closure). This will continue and even increase over time, contributing to undesirable fire risk conditions.

The indirect effects of having so much of an area in high density stand conditions has some major implications from a forest health aspect due to potential mortality from bark beetles. Several species of bark beetles affect ponderosa pine on the Coconino National Forest, with the most important being the western pine beetle and pine engraver beetles (*Ips* spp.). These agents are among the most important mortality agents affecting ponderosa pine. Outbreaks of the western pine beetle are mostly associated with relatively dense, mature pine forests and are often precipitated by drought. Pine engraver beetles prefer to breed in fresh pine debris, but under certain conditions will attack living trees, typically smaller diameter trees or tops of larger trees. The western pine beetle targets dense stands also. Historically, frequent fire regimes in the ponderosa pine forests may have limited bark beetle populations by maintaining stands in an open condition. In the absence of fire or other stand disturbance, susceptibility to bark beetles will increase over time, especially if drought conditions continue.

Analysis of existing conditions (Alternative B) consisted of using current stand variables to develop hazard ratings of bark beetles attacking ponderosa pine. The hazard rating system was previously adapted by Jill L. Wilson, former entomologist with the Arizona Zone Entomology and Pathology Office, from the rating system developed by Munsen and Anhold (Chojnacky et al., 2000). The rating method requires stand measurements of basal area, average ponderosa pine diameter at breast height (dbh), and the proportion of ponderosa pine in the canopy. Although this hazard rating system was originally developed for mountain pine beetle, it has been transferred to other Dendroctonus bark beetles attacking ponderosa pine.

Based on the current stand data, all compartments have composite stand values in the moderate to high hazard categories. Of the 43 stands analyzed, 30 are in the high hazard category, 13 in the moderate category, and none in the low category. Furthermore, all compartments had at least 50 percent of stands in the high category. Therefore, it can be concluded that much of the analysis area is moderately to highly susceptible to bark beetle attack. (See Table 12) (PRD 132d)

The amount of tree mortality varies considerably during bark beetle infestations. Sometimes only a few groups of trees are attacked and killed, but in other situations literally thousands of pine trees can be killed. Within severely impacted areas, *Ips* populations in central Arizona have killed up to 176 trees per acre and nearly all tree size classes were affected (Parker, 1991). Roundheaded pine beetle outbreaks in New Mexico and Arizona have resulted in basal area reductions ranging from 25 to more than 50 percent (Negrón et al., 2000). Mortality caused by the western pine beetle typically has been limited to small pockets of ponderosa pine within the recent history of Arizona, but has the potential to cause extensive mortality (DeMars and Roettgering, 1982).

Factors that influence the amount of mortality are not well understood, but factors contributing to more severe outbreaks include extensive stands of susceptible hosts, extended periods of drought or other favorable climatic conditions, and consecutive years of creating slash within adjacent areas.

Indirect Effects of Alternatives C and D

Differences between Alternatives C and D and Alternative A are not measurable in terms of improved growth, number of trees 24 inches in diameter or greater, and a reduced mortality over time. Long-term effects on the reduction of susceptibility to bark beetle infestation are the same for Alternatives C and D as for Alternative A.

Indirect Effects of Alternative E

Growth rates and individual tree vigor is greater than Alternative B, but only about half as much as Alternative A. In regards to bark beetle susceptibility, there are slight differences between the effects of Alternative E and Alternatives A, C, and D. More acreage would be retained in the pole-size age class and there would be less acreage in the mid-aged to mature age classes in Alternative E compared with the other action alternatives. Crown canopy density distribution under Alternative E retains 85 percent of the area in B and C canopy densities, where Alternatives A and D maintain 60 percent and Alternative C, 61 percent. There would be a considerable reduction in both the pole-size age class and the dense canopy compared with Alternative B. Therefore, Alternative E also would reduce stand susceptibility to bark beetle attack compared with Alternative B.

Cumulative Effects of Alternative A

The projects discussed here are immediately adjacent to the Kachina Village Project area. This is because a tree removed from one location only affects the trees immediately surrounding it. The effects of reducing tree densities and, thereby, increasing tree vigor are additive to the lessening of the possiblility of large scale mortality from fire, insects or disease across the larger landscape. This effect occurs in areas surrounding the project area, unlike fire effects which look at the wildland-urban interface.

Many past projects and management activities have shaped the current conditions as described in the affected environment part of this section. The majority of acreage in the Kachina project and adjacent areas (Swinging Timber Sale around Mountainaire, Newman Timber Sale directly to the east of the Kachina Project area, and the Woody area to the west) support high densities of ponderosa pine, usually in excess of 120 basal area. The Swinging and Newman Sales were treated about 10 to 12 years ago with a relatively light cut. While

Table 12. Composite Stand Hazard Rating Value.

Location (Compartment Number)	Ponderosa Pine Percent	Average DBH (inches)	Stand Basal Area (ft^2/ac)	Composite Stand Values	Hazard Rating
335	3	2.5	3	8.5	High
336	3	2.25	2.25	7.5	Moderate
344	3	2	2.55	7.55	Moderate
345	3	2	2.8	7.8	Moderate
354	3	2.17	2.33	7.5	Moderate
368	3	2.4	2.6	8.0	High
Total	3	2.22	2.59	7.8	Moderate

helping reduce overall density somewhat, there are still extensive areas of high density pine stands present. The Woody area to the west has not been treated for at least 20 years.

Recent past projects adjacent to the Kachina Village Project area are the Pumphouse Multiproduct Timber Sale and tree removal within the easement fences of Highway 89A. The northern part of the project area was recently logged in the Pumphouse Timber Sale in 1998/99. This sale harvested selected trees 5-inches dbh and greater, and was a relatively light cut, thinning from below. Some of the units had precommercial thinning (cutting selected trees between 1 and 5-inches dbh) associated with them. A total (both pre-commercial and commercial thinning) of 1,359 acres were treated under the Pumphouse Timber Sale.

The Kachina Village Project adds to the above mentioned projects to lessen the possibility of landscape scale mortality from insects and disease. The effect of reduced crown closures and subsequent increase in herbaceous vegetation is additive to the same effect in the above mentioned projects. This increase is fairly slight for all areas. The faster increase in diameter growth over time due to thinning will add to a similar effect in the above mentioned projects, and offset the lack of large trees in untreated areas.

Cumulative Effects of Alternative B

The potential for bark beetle outbreaks is additive to the same potential in dense stands that occur within portions of the surrounding landscape.

Cumulative Effects of Alternatives C and D

Cumulative effects are similar to Alternative A.

Cumulative Effects of Alternative E

Alternative E will help in reducing bark beetle susceptibility over a larger area, but not as much as Alternative A (Proposed Action). The stand densities and canopy closures will grow back more quickly than other action alternatives and, in conjunction with adjoining areas, will still present a relatively dense pine structure and closed canopy conditions across a large area if no other actions are taken. Few openings will be created, so there is little increase in herbaceous vegetation.

Soil and Water Quality

Affected Environment

The Kachina Fuels Reduction Project is located in the Oak Creek 5th code watershed acres. The project area is also located in two 6th code watersheds: Fry Canyon (618 project acres) and Pumphouse Wash (7,097 project acres). Major drainages within the area include Fry Canyon, Pumphouse Wash, James Canyon, and Kelly Canyon. All of these drainages are ancillary to Oak Creek. Elevations range from approximately 6,800 feet in the northern portion of the project area to approximately 6,300 feet in the far western portion of the project area.

The majority of runoff occurs during the fall and winter months (October to April). Snowmelt from late February to mid-May produces most of the runoff. Occasional winter frontal storms also produce runoff from heavy or prolonged rain events. Very little runoff occurs during the months of mid-May to October.

Fourteen terrestrial ecosystem survey map units exist within the project area. Each unit describes an area with similar slope, vegetation, climate, and physical soil properties. The survey contains predictions and limitations of soil and vegetation behavior for selected land uses. It also highlights hazards or capabilities inherent in the soil and the impact of selected uses on the environment. For example, erosion hazard is predicted based on relative susceptibility of the soil to erosion when vegetation and litter are removed. A slight rating indicates that all vegetative ground cover (vegetation basal area and litter) could be removed from the site and resulting soil loss will not exceed tolerance soil loss rates. A moderate rating indicates that predicted rates of soil loss would result in a reduction of site productivity if left unchecked. Reasonable mitigation measures can be applied to reduce or eliminate soil loss. A severe rating indicates that predicted rates of soil loss have a high probability of reducing site productivity (USDA Forest Service 1992). Following is a brief description of the map units located within the project.

- Map Unit 53: Landform - Valley Plains (63 acres). This component is unsuited for timber production but is well suited to forage production. Soil condition is impaired, resulting from historic livestock grazing and current elk grazing.

- Map Unit 55: Landform - Valley Plains (16 acres). This component is unsuited for timber production but is well suited to forage production. Soil condition is unsatisfactory, resulting from historic livestock grazing and current elk grazing.
- Map Unit 60: Landform - Valley Plains (59 acres). This component occurs in the lower portion of Fry Canyon and is the riparian flood plain.
- Map Unit 471: Landform - Sandstone/ Limestone Escarpments (65 acres). Steep slopes and surface rock fragments limit most management activities. Soil condition is inherently unstable and erosion hazard is severe.
- Map Unit 536: Landform - Elevated Plain (198 acres). This component has a moderate erosion hazard. Maintenance of vegetative ground cover is essential to prevent sheet and rill erosion. Natural regeneration and re-vegetation potentials are high.
- Map Unit 546: Landform - Elevated Plain (1,290 acres). This component has a slight erosion hazard. Natural regeneration and re-vegetation potentials are high. Potential productivity is higher than expected due to higher than normal precipitation.
- Map Unit 550: Landform - Elevated Plain (241 acres). This component has a moderate erosion hazard. Maintenance of vegetative ground cover is essential to prevent sheet and rill erosion.
- Map Unit 555: Landform - Escarpments (1,261 acres). Due to its northern aspect and cooler, moister conditions, this component supports a mixed conifer climax community. This component has a moderate erosion hazard. Maintenance of vegetative ground cover is essential to prevent sheet and rill erosion.
- Map Unit 570: Landform - Elevated Plain (816 acres). This component has a slight erosion hazard and is well suited to timber productivity.
- Map Unit 575: Landform - Escarpment (7 acres). This component has a severe erosion hazard. Maintenance of vegetative ground cover is essential to prevent sheet and rill erosion.
- Map Unit 578: Landform - Elevated Plain (196 acres). This component has a slight erosion hazard. Upon removal of overstory, juniper and oak may offer considerable plant competition.
- Map Unit 582: Landform - Elevated Plain (2,887 acres). This component has a slight erosion hazard. Natural regeneration and re-vegetation potentials are high.
- Map Unit 584: Landform - Hills-Scarp Slopes of Plains (683 acres). This component has a moderate to severe erosion hazard depending on slope. Maintenance of vegetative ground cover is essential to prevent sheet and rill erosion.
- Map Unit 585: Landform - Elevated Plains (353 acres). Shallow soils and surface rock fragments limit most management activities.

Forest roads affect site productivity in the roadbed and log landing area by removing and displacing topsoil, altering soil properties (compaction), changing microclimate, and accelerating erosion. Forest roads take land out of production by removing trees and displacing soil or removing soil during building and maintaining. Currently, approximately 36 miles of classified forest road and 37 miles of private road exist within the project area. At an average width of 20 feet, the road network covers an estimated 177 acres, or 1.7 percent of the 10,417-acre project area. Unproductive national forest land due to roads is 87 acres, or 1.1 percent of forest land within the area. Most of these roads will require some degree of maintenance for project activities. This total is low enough as to not affect overall watershed health. Site-specific instances of erosion occur in some places of the road system (PRD 137c).

Compacted forest road surfaces tend to intercept precipitation from rainfall and runoff from adjacent areas, concentrating flow and essentially increasing drainage efficiency and runoff quantity. Depending on the landscape position of forest roads, surface erosion from road surfaces and ditches may have the effect of introducing above background sediment input to streams. Roads adjacent to, or frequently crossing stream channels, have a higher likelihood of introducing sediment to stream channels than those located on ridgetops or mid-slopes. At least in the Northwest, it is believed that most of the sediment from timber harvest activities is related to roads and road building. With the exception of the canyons, the Kachina Village Forest Health Project

area is relatively flat and not prone to mass soil failure, as is documented in the Northwest. The basalt soils in the project area are fairly resistant to erosion and produce little sediment from the road system, even though many of the roads are poorly maintained. There are very few road crossings of perennial streams in the Kachina Village Project and few crossings of ephemeral streams.

The Kachina Village Forest Health Project area occurs within the Oak Creek 5th code watershed. This watershed is ultimately tributary to the Verde River. The watershed is further broken down into the Fry Canyon and Pumphouse 6th code watersheds. Table 13 is a summary of the number of total acres within the Oak Creek 5th code and Fry and Pumphouse 6th code and the percent of the analysis area within the watersheds.

Table 13. Total Acres within the Oak Creek 5th Code, Fry and Pumphouse 6th Code, and the Percent of the Analysis Area within the watersheds.

Watershed (acres)	Kachina (acres)	Percent of Analysis Area Within Watershed
Oak Creek 5th Code Watershed, 298,097 acres	10,416	3.5
Fry Canyon 6th Code Watershed, 19,453 acres	617	3.2
Pumphouse 6th code Watershed, 31,641 acres	9,799	31

Table 14. Summary of the Water Quality Status of Stream Courses Affected by the Kachina Village Project Area.

Waterbody Name Location Reach or Lake Number	Designated Uses	Use Support	Assessment Comments
Oak Creek 15060202-020	A&Wc, FC, FBC, Agl, Agl[1]	Full	Turbidity based on 2 samples in 1993

[1] ADEQ = Arizona Department of Environmental Quality, AGFD = Arizona Game and Fish Department, A&Wc = Aquatic and Wildlife (cold water fish), A&Ww = Aquatic and Wildlife (warm water fish), FBC = Full Body Contact, FC = Fish Consumption, Agl = Agriculture Irrigation, AgL = Agriculture Livestock Watering, DWC = Domestic Water Source.

The Department of Environmental Quality water quality assessment report referred to as the "1998 305(b) Report" is a description of the status of water quality in Arizona. The report was prepared to fulfill triennial reporting requirements contained in the Clean Water Act. Table 14 is a summary of the water quality status of stream courses affected by this project area from this report.

Explanation of Best Management Practices and Guidance Practices

The Non-point Source Intergovernmental Agreement signed by the Forest Service (Region 3) and the Arizona Department of Environmental Quality states that the Forest Service will endeavor to minimize and mitigate all potential non-point source pollution activities. As agreed upon by the State of Arizona and the Forest Service, the most practical and effective means of controlling potential non-point pollutants from forests and rangelands is through the development of preventative or mitigating land management practices, generally referred to as Best Management Practices (BMP's), or in the case of Arizona's process, Guidance Practices (GP's). The purpose of this agreement is to meet objectives defined by the United States Congress in the Federal Water Pollution Control Act (as amended in 1987). These objectives are to restore and maintain the chemical, physical, and biological integrity of Arizona's waters by complying with water quality standards identified for designated uses in down-stream perennial waters.

BMP's or GP's were developed for the project area and will apply to all treatment alternatives. These BMP's/GP's are designed to protect soil and water quality (PRD 137e).

Direct Effects of Alternative A

In Alternative A, 19 thinning acres (0.4 percent) occur on soils with severe erosion hazard, 883 thinning acres (18 percent) occur on soils with moderate erosion hazard, and 3,900 acres (81 percent) occur on soils with slight erosion hazard (PRD 137c).

The most important direct effect on soil condition will be from mechanical activities (machine piling, feller-buncher, skidder). Ground cover will be disturbed through mechanical actions. Some compaction from skidding equipment will occur in all treatment areas where machines are used (roughly 4,721 mechanical treatment acres). No skidding compaction or ground cover disturbance will occur where hand thinning is done (roughly 81 hand treatment acres). Skid trails will tend to cause compaction and, in some cases, the channeling of water. The expected duration of effects is less than 10 years. This is estimated to occur in less than 10 percent of the areas that are mechanically treated. Some onsite soil loss will occur on soils with moderate erosion hazard where machines are used (799 acres). Soil loss effects on moderately erosive soils are small in relation to the surrounding landscape and do not contribute to negative soil and water effects overall. Undesirable effects from the proposed activities can be mitigated through the implementation of BMP's. Recommended BMP's are described in PRD 137e. There will be only minor impacts to onsite soil quality and productivity.

Alternative A proposes to manage dispersed recreation along FR 237. Currently, there are substantial areas of bare, compacted soil due to unmanaged camping sites and the social roads associated with the sites. Designating sites for camping will help limit soil disturbance and protect the riparian area in Pumphouse Wash. Some of the compacted areas will be rehabilitated by scarification and seeding. The proposed management changes in the Mexican Pocket area will allow for rehabilitation of roads and camping sites in the mountain meadow adjacent to Highway 89A. Trail management proposals should provide for better maintenance and definition of the trail system. All the recreation management activities reverse deleterious effects from the current condition.

Table 15. Thinning Treatment Acres for Alternative A

Map Unit	OG[1]	Thin 40-100 BA 25 Percent Defer	Thin 40 to 120 BA	Thin 9-inch or less Owl	Thin 9-inch or Less By Hand	GH[2]	WL[3]	Total	Erosion Hazard
53	2	3	12	0	1	0	0	17	Slight
55	0	0	5	0	12	0	0	17	Slight
60	0	0	0	0	0	0	0	0	Slight
471	0	4	15	0	0	0	0	19	Severe
536	0	0	69	0	0	0	0	69	Moderate
546	96	433	67	228	0	103	10	937	Slight
550	2	0	66	0	42	0	0	110	Moderate
555	8	111	35	99	0	9	63	325	Moderate
570	0	0	662	0	26	0	0	688	Slight
575	0	0	0	0	0	0	0	0	Severe
578	0	165	0	30	0	0	0	195	Slight
582	218	723	816	36	0	0	70	1863	Slight
584	42	108	173	56	0	0	0	379	Moderate
585	51	109	6	6	0	11	0	183	Slight
Total	419	1,656	1,926	455	81	123	143	4,802	

[1] Improving Old Tree Longevity and Gambel Oak Habitat (Variable thinning around old trees and Gambel oak)

[2] Dense Canopy Retention for Improving Forest Resiliency of Goshawk Habitat (Variable thinning to average of 80 BA with openings created)

[3] Wildlife Movement Corridor

Broadcast burning will have the effect of reducing litter accumulations and, most likely, promoting herbaceous vegetation. Short-term reductions in ground cover will result where litter is totally consumed. Litter and/or vegetation cover bare soil in 1 to 2 years on this forest (Lindenmuth 1960; Davis and others 1968; Sackett and others 1993). Total consumption of ground cover will be patchy and will not adversely affect overall ground cover. Low severity fires burning only surface fuels do not considerably heat the soil surface. Soil temperatures do not rise substantially where repeated cool-burning fires are used to reduce fuel buildup (Debano et al. 1998).

Pile burning thinning slash may cause small patches of soil heating to the point where soil characteristics are changed. These patches are small in relation to the project area.

Alternative A intends to rehabilitate 17.65 miles of existing roadway by closing, scarifying, and re-vegetating, approximately 56 percent of the Forest Service roads in the project area (PRD 137c). These areas will not likely return to full productivity for many years, but will become stable after only a few years. The area of rehabilitated roadway amounts to 43 acres. This reduction in amount of roadway improves on the current condition and lessens site-specific erosion related to roads.

Under Alternative A, an additional 5.75 miles of road will be re-opened for temporary haul roads (PRD 137c). Temporary roads are defined as roads associated with a timber harvest contract, not intended to be a part of the forest development transportation system, and not necessary for resource management (FSM 77-5.7/27/94). Roughly 90 percent of these temporary roads have been constructed, used, and rehabilitated through previous harvest entries. Some new construction will be required to relocate or substitute for undesirable existing temporary road locations. Temporary roads have fewer adverse effects than permanent roads, as they will be decommissioned shortly after use. These previously used roads are stable in terms of soil movement but are relatively unproductive compared to undisturbed forest land. These additional roads amount to 14 acres of unproductive forestland. The temporary addition of these acres does not affect overall watershed health. Onsite soil quality effects from temporary roads are minimal and BMP's will mitigate onsite effects.

Roads also contribute to the invasion of exotic (non-native) plant species dispersed by wind, water, vehicles, and other human activities, as the disturbed areas serve as an avenue for establishment of exotic species into a new landscape. Invasion by exotic species may have unwanted biological and ecological effects if those species are able to displace natives or disrupt the structure and function of an ecosystem. The overall roadway reduction will lessen potential spread of invasive and noxious weeds via roads on the project area. Temporary roads will cause a short-term increase in the potential spread of invasive and noxious weeds. Mitigation measures will be applied to limit spread of invasive and noxious weeds.

The current road system is fairly well designed so as to reduce road-related surface erosion at the scale of individual road segments. The open road network described under Alternative A incorporated key factors such as road location, particularly layout relative to stream systems, road drainage, surfacing, and cut slope and fill slope treatments. Surfacing materials reduce the yield of fine sediment from road surfaces. Drainage structures will be maintained in all roads as appropriate to assigned maintenance levels. Proper drainage will reduce the off-site transport of sediment.

There are no direct effects to soil and water quality from the fence and structure removal at Kelly Seep.

Direct Effects of Alternative B

There are no direct effects to soil quality from the No Action Alternative.

The No Action Alternative does not produce new roads and, therefore, results in no change.

Direct Effects of Alternative C

The direct effects for Alternative C are similar to Alternative A.

Direct Effects of Alternative D

The direct effects for Alternative D are similar to Alternative A.

Direct Effects of Alternative E

Alternative E will require 2.5 miles of temporary road, or 6 acres of unproductive forest land (PRD 137c). This is roughly half the number of miles of temporary road required under Alternatives A, C and D. Because soil effects are minimal due to BMP's, the difference between the alternatives is not extensive. (See Table 16.)

Table 16. Comparison of the Miles or Equivalent Acres of Temporary Road, Road Maintenance, and Rehabilitated Roads for Each Alternative.

Alternative	Temporary Road Miles	Temporary Road Acres	Road Maintenance Miles	Road Maintenance Acres	Rehabilitated Miles	Rehabilitated Acres
A, C and D	5.75	14	36	87	17.65	43
B	0	0	0	0	0	0
E	2.5	6	36	87	17.65	43

In Alternative E, treatment acres and erosion hazard are the same as the other alternatives. The difference in this alternative is that only 2,330 acres will be mechanically treated (a little over half of the other alternatives). Consequently, we can expect approximately half of the impacts to soil quality and productivity described for Alternative A to occur. Some compaction from skidding equipment will occur in all treatment areas where machines are used (roughly 1,890 mechanical treatment acres). No skidding compaction or ground cover disturbance will occur where hand thinning is done (roughly 2,326 hand treatment acres). Some onsite soil loss will occur on soils with moderate erosion hazard (405 acres). Because the mitigation measures described in the soil and water mitigation section will be followed, there will be only minor impacts to onsite soil quality and productivity from any of the action alternatives. The effects from Alternative E will be slightly less due to limited equipment use south of Kelly Canyon.

Table 17. Thinning treatment acres for Alternative E[1].

Map Unit	Intensive[2]	Thin 60 to 120 BA	Thin 9-inch dbh Tree and Less by Hand	Thin by Hand; No Roads	Total	Erosion Hazard
53	6	3	0	5	14	Slight
55	4	0	0	13	17	Slight
60	0	0	0	0	0	Slight
471	0	15	4	0	19	Severe
536	20	15	0	34	69	Moderate
546	12	264	661	1	938	Slight
550	45	18	0	48	111	Moderate
555	0	113	210	2	325	Moderate
570	273	200	0	215	688	Slight
575	0	0	0	0	0	Severe
578	0	0	196	0	196	Slight
582	48	1,056	721	0	1,825	Slight
584	32	162	164	21	379	Moderate
585	0	44	153	24	221	Slight
Total	440	1,890	2113	363	4,803	

[1] The old tree longevity, wildlife movement corridor and dense canopy retention for goshawk are not shown in this table because they are the same as under Alternative A.

[2] Intensive Zone Thinning – Adjacent to Private Land (variable thinning 40 to 50 BA).

Indirect Effects of Alternative A

The combination of thinning to open the stand and burning will likely result in the promotion of herbaceous vegetation over litter as the major component of ground cover. Protection against erosion occurs the same whether the forest floor is covered with needlecast and woody material or herbaceous ground cover. So there is no difference between the alternatives from a soil and water quality perspective related to the number of openings. The benefit of herbaceous ground cover is nutrient cycling into the soil that maintains and enhances future herbaceous growth.

Stand canopy conditions and fuel loading will be reduced so that the potential effects of intense wildfire are reduced. The effects of wildfire are discussed in more detail under Alternative A.

Some negative potential off-site[16] effects associated with the Kachina Village Forest Health Project include sedimentation from ground-disturbing activities and potential short-term increases in runoff from disturbed surfaces. Adequate buffers have been developed on all major drainages in the area. Only a small portion of anticipated soil loss will travel off-site and enter ephemeral stream channels. Most of this sediment will remain in storage rather than move downstream into Oak Creek.

There are no indirect effects to soil and water from rehabilitation activities at Kelly Seep.

Indirect Effects of Alternative B

Alternative B will perpetuate stand conditions that are conducive to the occurrence of intense wildfire. On- and off-site impacts on hydrologic function resulting from severe fire include:

- Precipitation flowing on the surface of the soil rather than infiltrating it;
- Excessive erosion during precipitation events;
- Rapid stream flow response from precipitation; and
- A reduction in base flow between storms.

As forest canopy and protective organic matter is consumed by severe fire, interception is reduced and soil erosion is increased.

Changes in forest canopy cover can affect snow accumulation and melt patterns by creating large openings. Consequently, the timing, quantity, and quality of runoff from severely burned watersheds are altered. Changes in soil and watershed conditions become more considerable as fire size and intensity increase.

Wildfire can have major effects on vegetation, ground cover, and soil properties, resulting in reduced infiltration and increased overland flow. Intense wildfire can reduce soil surface resistance to erosion, resulting in accelerated soil erosion particularly because of heavy summer precipitation. Peak discharges are likely to increase because of wildfire, and water quality is likely to decrease due to increased sediment loads.

The degree to which soil is heated depends on a variety of factors, including soil moisture, fuel loading, fuel moisture, fuel distribution, soil texture, and others. The peak temperature and duration of heating greatly influences subsurface soil temperature. The amount of change in soil properties is largely dependent on the amount of energy radiated downward into the underlying duff and mineral soil. The amount of heat radiated downward increases as fire severity increases. If a wildfire burns hot, then negative impacts to soil could occur from soil heating. Soil heating may cause changes in soil properties, such as reduction of structure and porosity and changes in soil color. Burning reduces soil organic matter and soil plant and litter cover. In most cases, soil erosion by wind and water is increased. The severity and duration of accelerated erosion depends on slope, soil texture, recovery of plant material, severity and extent of burning, and post-fire precipitation timing and intensity. The duration of the fire effects on soil structure depend on the severity of the fire and rate of recovery. The duration may last from 1 year to many decades (Wells et al. 1979).

High degrees of soil heating can destroy soil structure, thus affecting soil pore size distribution and overall porosity. This reduces infiltration rates and increases overland flow. Soil water repellency is increased as organic matter is heated. The more severe the fire, the deeper the water repellant layer, unless heating is so intense that surface organic matter is destroyed.

Alternative B will produce no dispersed camping management, trail management, or road management. Deleterious trends will continue in the site-specific locations that are currently receiving heavy dispersed camping use. The current level of landscape dedicated to roadways (and not vegetation) will continue.

Indirect Effects of Alternative C

The indirect effects of Alternative C are similar to Alternative A.

Indirect Effects of Alternative D

The indirect effects of Alternative D are similar to Alternative A.

[16] Off-site means an effect that occurs downstream from the treatment area.

Indirect Effects of Alternative E

Stand canopy conditions and fuel loading are reduced but not as much as in Alternatives A, C, and D. Risk of fire is higher than Alternatives A, C, and D in the areas south of Kelly Canyon. The combined thinning and burning will promote herbaceous vegetation over litter more than B but less than A, C, and D. Off-site effects are less than A, C, and D because potential for short-term runoff from disturbed areas is less because of fewer acres with mechanical treatment. Under Alternatives A, C, and D only a small portion of anticipated soil loss will travel off-site and enter ephemeral stream channels. Most of this sediment will remain in storage rather than move downstream into Oak Creek. Therefore, the difference between Alternative E and the other action alternatives is negligible.

Cumulative Effects of Alternatives A, C, and D

An appropriate area to consider cumulative effects is the Pumphouse 6th code watershed. The few acres associated with the Fry Canyon watershed are located at the bottom of the canyon at the confluence with Pumphouse Wash. Pumphouse Wash is a tributary to Oak Creek and is, therefore, subject to the same stringent water quality standards as Oak Creek.

Actions considered for this section are those activities that occurred in the Pumphouse 6th code watershed in the past 10 years. Activities are described at the beginning of this chapter. Impacts from activities that occurred more than 10 years ago are unlikely to be evident today.

The cumulative effects of land-disturbing activities can be seen on site or downstream of the activity. Onsite effects include changes to soil characteristics, vegetation, and nutrient cycling.

There are no grazing effects associated with the Kachina Village Project and, therefore, no cumulative effect added to grazing activities on existing allotments within the watershed.

The minor effects to soil quality of machinery use in thinned stands can be considered cumulative with similar activities in the Pumphouse Multiproduct Timber Sale (approximately 776 acres) and the State Trust Land Section 26 (1/2) where a pulpwood sale of less than 12-inch diameter trees occurred 5 years ago. Currently slash piles exist on this section of state land. Future planned activities on Section 26 are to re-pile and burn the existing slash piles, and conduct pre-commercial thinning. The effects to soil and water quality from Alternative A are minor and do not add cumulatively to surrounding projects in a way that causes a negative overall effect.

Recreational use in the Pumphouse watershed is moderate to high. Recreation uses will probably increase in the future. Individuals and groups use the area. Activities include hiking, horseback riding, bicycling, jeep driving, off-highway vehicle driving, dispersed camping, and camping in developed campgrounds. In some places throughout the watershed, recreation use causes one or more of the following effects: loss of vegetative ground cover, soil compaction, localized erosion, increased runoff and biological pollution. The effects to soil quality of recreation management activities are positive and do not combine with activities in other areas in a way that causes a negative cumulative effect. The effects to soil quality of recreation management activities under Alternative A are positive and will serve to offset, to some extent, the negative impacts in the remainder of the Pumphouse watershed. It is difficult to speculate where campers displaced from areas in the Kachina Village Project will go. There may be increased dispersed camping and subsequent impacts on the west side of Highway 89A along FR 545. Some campers may continue into Flagstaff. Because the campers in this area do not travel very far off of paved roads, it may be that many of them seek out other paved road forest access that lies outside of the Pumphouse 6th code watershed.

The effects of broadcast burning are negative for the short-term, or 1-2 years until herbaceous ground cover or needlecast is re-established. After this, the effect of broadcast burning on soil quality is beneficial. Other broadcast burning projects occurring in the Pumphouse 6th code watershed include a portion of the Airport Project (of the 1,000 acres in this project, approximately 200 are in the Pumphouse 6th code watershed). The timing of these burns is regulated through the ADEQ permitting process for air quality. Therefore, the number of acres burned at one time in the watershed is not enough to cause a cumulative negative effect.

Under Alternative A, only a small portion of anticipated soil loss will travel off-site and enter ephemeral stream channels. Most of this sediment will remain in storage rather than move downstream into Oak Creek. Therefore, there is very little added effect to off-site effects when combined with other activities in the Pumphouse 6th code watershed.

Alternative A reduces the overall amount of landscape taken up by roadway and, therefore, has a beneficial effect when added to other areas in the watershed. This same beneficial trend is occurring on other areas within the Pumphouse 6th code watershed. The objective for managing the road system on the Coconino National Forest within these watersheds is to limit overall road densities to 2 miles per square mile. With the exception of private land development few, if any, new roads need to be constructed for activities proposed in the Pumphouse watershed. Some roads have been closed or obliterated recently and additional closures and obliterations are expected in the future. Existing open National Forest System roads will be maintained at levels suited to their uses and locations. As timber sales continue to decline, so will the periodic road maintenance associated with sales. Funding appropriated for maintenance of forest system roads is also declining. Some funds have and will be invested in road closures, obliteration, and drainage maintenance.

Alternative A creates 5.75 miles of temporary road. One other project used temporary roads within the Pumphouse 6th code watershed: the Pumphouse Multiproduct Sale had an estimated 2 miles of temporary road. The Airport Fuels Reduction Project does not have temporary roads. When added together, these projects do cause a significant cumulative effect related to temporary roads.

In conclusion, it appears that the Proposed Action will not pose a significant cumulative effect in association with other activities in the watershed. Assuming soil and water mitigation measures are employed, the harvest burning treatments proposed in Alternative A would have little incremental cumulative effect when considered with the effects of past and future projects. These treatments will have little direct or indirect effect on soil condition and water quality. Treatments in Alternative A are designed to reduce the likelihood of landscape level wildfire and the watershed disturbing effects associated with such a fire. Improvements in road and recreation management would improve soil condition in the long-term and consequently have a positive effect on soil condition and, perhaps, downstream water quality.

Cumulative Effects of Alternative B

Alternative B (No Action) with wildfire could result in the greatest impact to soil condition and water quality and, therefore, the greatest cumulative effect. A severe crown fire would result in large increases in soil movement and runoff for at least a few years.

Cumulative Effects of Alternative E

The cumulative effects for Alternative E are similar to Alternative A, except that canopy closures will be somewhat higher south of Kelly Canyon and risk of catastrophic wildfire in that area will be greater than Alternatives A, C, and D and less than Alternative B.

Alternative E creates 2.5 miles of temporary road, which is a smaller addition to the effects to temporary roads in other areas within the Pumphouse 6th code watershed.

Alternative E has less potential off-site effects because fewer acres receive mechanical treatment. The addition of off-site effects to other projects in the 6th code watershed is less than Alternative A.

Recreation Setting and Opportunity

Affected Environment

The project area provides many year-round recreation opportunities because of its close proximity to Flagstaff and Oak Creek Canyon, and because of its diverse landscape of pine forest and canyon country. Local residents of Kachina Village, Forest Highlands, and Pine Del use the areas north of Kelly Canyon, east of Pumphouse Wash, in the Griffiths Spring area, and Kelly pit on a daily basis for walking, hiking, mountain biking, OHV riding, rock climbing, exercising pets, wildlife viewing, target practice, firewood gathering, and winter recreation activities. A considerable amount of use by non-local recreationists occurs along Highway 89A, including camping, hiking, driving for pleasure, and viewing wildlife and scenery.

Recreation setting characteristics and recreation opportunities for the affected area have evolved over the last century from primitive settings with only rare evidence of human presence to a mostly natural appearing area with moderate evidence of human activity, mostly roads. Primary access from outside the project area is from I-17 and Highway 89A via FR's 237, 631, 253 and the non-numbered road into Mexican Pocket. Additional primitive roads have developed over time as people have passed over the natural ground in vehicles with enough frequency

for a road to develop. Recreation setting objectives defined in the Forest Plan for the area include Roaded Natural[17] for areas adjacent to primary roads; and Semi-Primitive Motorized[18] for areas accessible only by primitive roads.

Several popular areas provide dispersed camping opportunities in the ponderosa pine forest and in campsites with scenic views of the canyons. Most camps are located along main Forest Service roads, via a single 2-track road. Popular camping sites are along FR's 237 and 535, Kelly Canyon exit, Mexican Pocket, and Sterling Canyon (PRD 137d). Over the last several years, dispersed camping in this area has progressed from nice scenic campsites overlooking Oak Creek Canyon to unsightly campsites with no ground vegetation, chopped up green trees, multiple fire rings, litter, toilet paper, and scattered human waste. As the current dispersed campsites are occupied—especially during weekends and holidays—new user-created, 2-track roads are created with new campsites established every year.

This project area has seen an increase in camping use over the last several years. The greatest increase in use and resource impacts is along the Highway 89A corridor that encompasses 1/2 mile on either side of the highway. As a result of the limited number of camping sites in Oak Creek Canyon, recreationists have found Highway 89A north of Oak Creek Vista a good place to camp. As a result of this increased use, the Forest Service has seen an increase in human-caused fires and resource damage in this area. This area receives the highest use during weekends and holidays, where it isn't uncommon to see groups of 50 or more people camping along FR 237 and in Sterling Canyon.

There are approximately 544 dispersed campsites in the project area that have been inventoried, identified with GPS coordinates, and placed in our GIS system (PRD 137b). An additional 100 dispersed campsites have not been inventoried. Primary season of use for these areas is the summer months from May through September with some fall use during hunting season. It is estimated that during a busy summer weekend many of the sites are in use. The exact number of people using these campsites has not been calculated.

There are two non-motorized Forest Service system trails in the project area: Griffiths Spring (1-mile long interpretive loop trail) and at Oak Creek Vista (a short .2-mile paved trail).

The other trails in the area are user-created (non-motorized and motorized) from area residents who live in Kachina Village, Forest Highlands, and Pine Del and access the forest on a daily basis. Residents access the forest from their backyards, from two main access points off Toho Trail Road, and near the water treatment plant in Kachina Village. The area west of Kachina Village along Pumphouse Wash is closed to motorized vehicles. The old roads that have been closed to motorized use in Pumphouse are now used on a daily basis for hiking and jogging, and are not part of an official Forest Service trail system.

In addition to the numerous user-created trails near the residential areas, users also like to explore the canyons. There are three main canyons in the project area: Pumphouse Wash, Kelly Canyon, and James Canyon. These canyons are popular for canyoneering, hiking, photography, wildlife viewing, and rock climbing.

Direct Effects of Alternatives A, C, D, and E

The effects described in the "Aesthetics" section earlier in this chapter will result in more esthetically pleasing recreation settings throughout the project area. These alternatives are identical in how they treat system and non-system roads in the area, and in how they differ from the existing condition. These alternatives will not affect the total area of vehicular access but will decrease road densities in some of the more heavily roaded areas; thereby increasing opportunities for solitude and ability to get away from the sights and sounds of other people that contribute to the overall "primitiveness" of forest settings. In general, some arterial and secondary roads will remain open, allowing access to most areas that are now accessible by vehicle. The Mexican Pocket area will be closed to vehicles. There will be more administrative presence in the form of signing and patrols to enforce restrictions, which will tend to create a less primitive setting.

[17] RN - easy vehicle access, sight and sound of other people common, moderate to low opportunity for solitude and "challenge and risk," moderate scenic integrity.

[18] SPM - primitive roads, sights/sounds of others uncommon, moderate/high opportunities for solitude and "challenge and risk," high scenic integrity.

All action alternatives would provide opportunities for dispersed camping in designated dispersed campsites. Campfires would be allowed only in designated dispersed campsites and would substantially reduce the probability of escaped campfires. Campsites in designated areas would allow contact that is more frequent with Forest Service personnel and improve compliance. This alternative may restrict recreational pursuits and may cause a loss of perceived freedom by reducing campsite locations. The number of traditionally used dispersed campsites will be reduced for management purposes. It is estimated that camping opportunities along the Highway 89A corridor will be reduced by at least half over time. The total amount of people this will affect is not calculated. A likely result will be competition for the designated dispersed campsites and the possibility for the creation of new dispersed sites outside of the closure area. This alternative, while environmentally beneficial, has the potential for social conflicts.

The trail and trailhead improvements proposed are the same for all action alternatives and would directly affect and improve recreational resources and values. The access and safety of users would be improved and the trail system would be maintained on a scheduled basis. Additionally, the measures would provide protection to the local environment from resource damage. The action alternatives would add approximately 9 miles of new trail to the Forest Service trail system.

The designated trail systems south of Kachina Village, south of Griffith Springs, and in the Mexican Pocket area will be located using existing user-created trails and roads where appropriate. Based on site-specific analysis, the trails would be located through non-sensitive areas and/or in areas previously disturbed. The trails would be constructed, maintained, and signed to Forest Service standards for safety and to minimize soil, water, wildlife, cultural, and vegetation impacts. It is estimated that over half of the new trail will be on existing closed roads or social trails thus limiting new construction.

The construction of a trailhead would directly impact the soil through grading and construction activities. The trailheads would be graveled, thereby converting the soils onsite into an impermeable surface capable of withstanding concentrated visitor use. The trailheads would be clearly delineated to deter users from dispersed parking to prevent trampling and damage to sensitive plant communities.

All action alternatives contain thinning and burning, therefore affecting the view from trails and temporarily affecting the quality of some recreation activities. Stands may be noticeably less dense and slash piles, skid trails, or log landings may be visible for a short time during the activity and after it ceases. There could be short-term disruptions for recreationists while the work is being completed. These disruptions would include noise, traffic, and rehabilitation activities on the trails. These disruptions would be minor and short term.

Timber cutting activities could potentially affect trail and trailhead locations. Alternatives will incorporate mitigation measures requiring the purchaser to obtain approval from the Forest Service for log landing, skid trail locations, or slash piles.

There are no effects to recreation from the riparian rehabilitation project at Kelly Seep.

Direct Effects of Alternative B

The No Action Alternative will have no direct effect on existing recreation settings or opportunities within the project area.

Indirect Effects of Alternatives A, C, D, and E

Recreation settings will become more esthetically pleasing (see “Aesthetics” earlier in this chapter) with these alternatives than with the No Action Alternative. This will likely increase recreation use compared with use resulting from the No Action Alternative, although total use is likely to remain low in the SPM areas (areas accessed via primitive roads) with any alternative.

An indirect effect of the action alternatives would be the possible temporary displacement of recreationists while the activities are completed. Recreationists using facilities both within and outside the project area that are not affected by this alternative could notice more use, which could negatively affect their recreation experience. This type of displacement could occur during harvest, rehabilitation, and broadcast burning. However, the effect would be minor, as all of the activities would be scheduled over a number of years.

The proposed trail plan and trailheads for Alternatives A, C, D, and E will benefit the long-term recreational trail resource in the project area. The combined actions would provide substantial improvements to a heavily-used social trail network,

prevent further resource damage due to an unmanaged trail system, and rehabilitate areas damaged by overuse.

Indirect Effects of Alternative B

Recreation settings in the project area will either retain existing landscape character trends, or will assume characteristics of fire-altered landscapes if wildfires occur. Over time, as the scenic quality of recreation settings across the project area decreases (see aesthetics section) and differences in vegetative pattern become more apparent, other local areas receiving different management are likely to become more attractive to many people. Opportunities for solitude and escape from the sights and sounds of other people will continue to diminish as non-regulated recreation use continues to increase. Volunteer or user-created roads will increase and will cause additional visual impacts. The extent of the area meeting Roaded Natural ROS setting will continue to expand at the expense of the more primitive Semi-Primitive areas.

Dispersed camping under Alternative B (No Action) would allow camping to continue as it is today and provides the greatest amount of freedom because there would be fewer restrictions where people could choose to camp. It is expected that in the future more dispersed camping areas would become established and result in greater resource and sanitation problems. The potential for escaped campfires from campers as well as partygoers would likely increase as the population grows around Flagstaff and tourism increases. Perceived threats to private property would likely increase as would complaints concerning activities associated with dispersed camping.

Alternative B (No Action) would have the greatest potential for a large, catastrophic fire that could substantially damage recreation resources and user experience in the project area. An indirect effect of a No Action Alternative would be a continuation of the trend toward increasing forest fuels and fire risk. Alternative B would also essentially leave the user-created trail system as it is today with the potential for the user-created trails to grow as residents and visitors attempt to avoid crowded areas. Adverse effects include soil erosion, habitat fragmentation, and the spread of noxious and invasive weeds. This area is heavily used for recreation, and users could be displaced to other areas which would put additional pressure on other nearby areas and facilities.

Cumulative Effects of Alternatives A, C, D, and E

The actions considered in this discussion are those that have occurred in the recent past (10 years). Management activities that occurred prior to this time helped create the current condition described under the affected environment section. The people that recreate in the Kachina Village area are primarily: 1) adjacent landowners; 2) weekend campers or day-use recreationists coming up from Oak Creek Canyon; and 3) local residents enjoying primarily daytime activities such as climbing and mountain biking. Since people can range far and wide in search of recreation interests, it is difficult to choose an area for considering cumulative effects. For this discussion, actions to consider are those that occur in areas immediately within or adjacent to the project area. These are:

- Griffiths Spring parking area and trail development.
- Ongoing use of the Oak Creek Vista Overlook.
- Ongoing use of the Fort Tuthill Campground and Day Use Picnic Areas.
- Ongoing dispersed recreation on lands surrounding the Kachina Village Project.
- The Fort Tuthill to Kachina Village Trail (in the planning stages).
- Ongoing social trail use adjacent to communities such as Pine Del, Mountain Dell, and Mountainaire.

The continuation and enhancement of Semi-Primitive Motorized recreation settings will add to the presence of that setting in the surrounding landscape. Surrounding areas are also likely to maintain and enhance some Semi-Primitive settings. The exact amount is unknown.

The positive effects of changing to designated dispersed camping along the Highway 89A corridor will offset deleterious effects of heavy dispersed camping in adjacent areas.

Although it is difficult to estimate where displaced campers may go, we estimate that major forest roads outside of the Kachina Village area may see increased use. In addition, more people may travel to Flagstaff and use the Fort Tuthill or private campgrounds. Displaced campers will not affect Oak Creek Canyon because strict camping rules are in

place for that area. Displaced campers may add to current camping impacts in adjacent areas causing a slight increase in resource impacts.

A new Forest Service trail proposed will add to existing trail opportunities at Griffiths Spring and Fort Tuthill. The Fort Tuthill to Kachina Village Trail will add a link between communities and to the Flagstaff Urban Trail System. No other trails are currently planned in the remainder of adjacent areas.

Better design and signing of Forest Service trails will offset deleterious trends of poorly located user-created trails in surrounding areas.

Cumulative Effects of Alternative B

Roaded Natural settings may increase over time and Semi-Primitive settings may decrease. This would offset other areas where Semi-Primitive settings are likely to increase due to road and vegetation management.

Continuation of resource impacts due to high levels of dispersed camping will add to deleterious trends in adjacent areas.

Continuation of resource impacts due to poorly located social trails will add to similar effects in adjacent areas.

Cumulative effects for Alternative B (No Action) resulting in a wildfire would be visible throughout the area. The trails and general areas that were once used for recreational activities would be less attractive, thus affecting the setting and user's experience. The area would be closed until it was safe to re-enter and all rehabilitation work was completed. Should high intensity crown fire occur, many recreation activities might be displaced to the surrounding landscape, adding impacts to surrounding lands and increasing competition and possibly conflict between users.

Wildlife Habitat - General

Coconino Forest Plan Direction

The Forest Plan standards and guidelines for managing wildlife habitat were developed to meet the needs of MIS, threatened, endangered and sensitive species on the Coconino National Forest. The Kachina Village Forest Health Project (FHP) meets standards and guidelines in the Forest Plan and meets all monitoring requirements. Habitat quality index modeling was conducted for MIS species. Threatened and endangered species were addressed through consultation with the USFWS. Sensitive species are managed in accordance to existing management plans for priority species.

Not all desired conditions in the Forest Plan can be achieved with a single action. Often many actions are necessary over time that progress toward desired conditions as outlined by standards or guidelines. Since the Forest Plan is a permissive document, if an action progresses toward, but does not preclude nor deviate from Forest Plan direction, then the action meets the intent of the Forest Plan. An example of this is vegetative structural stage (VSS) distribution described in the northern goshawk section of the Forest Plan. The amount and distribution of thinning activities planned is focused on reducing fire hazard by removing trees that facilitate the movement of fire from ground level up into the crowns. The forest canopy would be broken up with some small openings that will result in some increase in herbaceous vegetation and pine tree seedlings. This project will also facilitate the growth of larger trees, thus progressing toward that component of goshawk habitat. At this time, treatments are not designed to facilitate the establishment of pine seedlings (regeneration). Although these thinning actions make progress toward the desired VSS distribution that the goshawk guidelines indicate, this entry will not focus on increasing VSS 2 (pine seedlings and saplings). Future thinning[19] entries could maintain openings, begin regeneration treatments, and maintain the forest structure with low fire hazard.

Species viability analysis as required in NFMA is appropriately addressed at the Forest Plan level. The Forest Plan requires monitoring for all MIS through habitat capability modeling. As specified in the Forest Plan, some species require field surveys to determine population numbers, which the Arizona Game and Fish Department collects. Monitoring for threatened, endangered, and sensitive (TE&S) species is planned to address those species on a priority basis. The USDI Fish and Wildlife Service assists in tracking populations of threatened and endangered species.

[19] Future actions will occur based on future NEPA decisions.

Vegetative Structural Stages and Canopy Cover

Vegetative structural stage (VSS) data, an important component in describing habitat, was used to analyze the effects for the northern goshawk, MIS species, and old-growth. VSS data is provided below for three time periods: immediately following treatment, and years 20 and 50 following proposed treatments. Each table and graph illustrates VSS class and canopy closure for all action alternatives and No Action for the three time periods. VSS data was collected for the project area prior to planning. VSS post-treatment data modeling was calculated with the aid of Forest Vegetation Simulator modeling (PRD 130).

Table 18. Percent Vegetative Structural Stage (VSS) Immediately Following Treatment for Each Alternative.

Percent VSS	VSS 1	VSS 2	VSS 3	VSS 4	VSS 5	VSS 6
Existing Conditions (Alt. B - No Action)	0.5	5	61.5	24	6	3
Alternatives A and D	5.5	3.5	26	52	10	3
Alternative C	3	3.5	26	54.5	10	3
Alternative E	1	4	40	43.5	8.5	3
Desired from Forest Plan	10	10	20	20	20	20

VSS Immediately Following Treatment and Under No Action

Alternatives A and D would exhibit VSS distribution that would more closely approximate desired conditions than the other alternatives, including the No Action Alternative. Alternative C closely approximates Alternatives A and D. To account for the creation of grassy openings, 10 percent of 3,891 acres (as described in the Proposed Action) were included in VSS 1 class for Alternatives A and D; 5 percent of 3891 acres for Alternative C; and 10 percent of 439 acres from the intensive treatment zone for Alternative E. Based on the professional opinion of Forest Service specialists, creation of grassy openings would be difficult to achieve in many of the treated stands for Alternative C, and it would be very difficult to create any grassy openings under Alternative E. This estimation for grassy openings included here is for VSS class comparison in relation to northern goshawk guidelines and is for representative purposes. (See Table 18) (PRD 123 and 151)

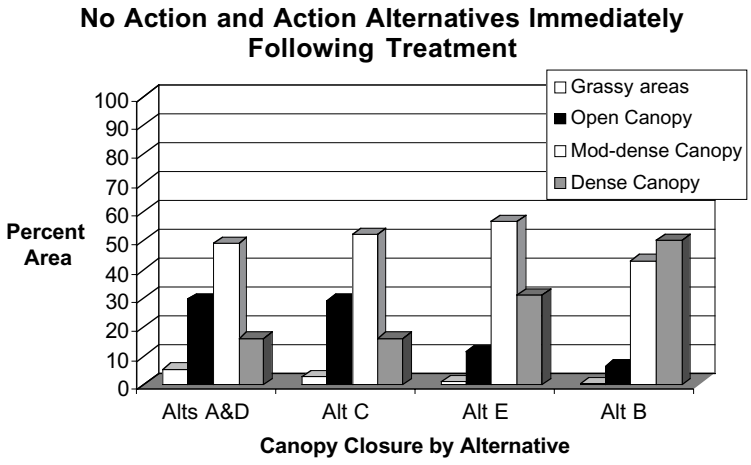

Figure 23. Canopy Closure Immediately Following Treatment for Each Alternative.

Canopy Closure Immediately Following Treatment and Under No Action

Canopy closure is defined as open (<40 percent canopy cover), moderately dense (40 to 60 percent canopy cover), and dense (>60 percent canopy cover). To account for the creation of grassy openings, 10 percent of 3,891 acres were included in VSS 1 class for Alternatives A and D, 5 percent of 3,891 acres for Alternative C; and 10 percent of 439 acres from the intensive treatment zone for Alternative E.

Under the action alternatives, the overall canopy of the forest would change from one that is dense to one that is moderately dense. Canopy closure for Alternatives A and D would be the same, and Alternative C would be very similar to Alternatives A and D. Alternatives A, C, and D would reduce dense canopies in the project area more than Alternative E. There would be no change under Alternative B. Alternatives B and E would have the effect of allowing the potential of a large wildfire to remain high (see fire effects analysis section). Alternatives A and D would decrease wildfire potential, specifically potential for a crown fire, the greatest due to the greater reduction of dense canopies and the creation of more open, grassy areas. Similarly Alternative C would decrease wildfire potential, although slightly less than Alternatives A and D due to the lesser amount of grassy openings created.

VSS 20 Years Post-treatment and Under No Action

The 20-year post-treatment would be similar in VSS composition for all action alternatives. Each action alternative shows VSS 3 meeting the desired condition, an overabundance of VSS 4, and a shortage in the remaining VSS classes. Primarily there would be a gain of sites in the VSS 4 class, and decreases in the VSS 3 class under all action alternatives. There would also be a slight decrease in VSS 2. VSS 6 and VSS 5 would be unchanged as compared to initial time. Even with broadcast burning occurring, some pine seedlings will likely establish within openings over time. Seedlings may be patchy depending on the schedule and intensity of broadcast burning. VSS 1 was, therefore, held constant from immediate post-treatment condition for this analysis. Alternative B (No Action) would continue to show an overabundance in the VSS 3 and VSS 4 classes with some trees shifting into the VSS 4 class. There would be a slight decrease in the VSS 2 class. The remaining VSS classes under Alternative B would be unchanged and continue to show shortages. (See Table 19) (PRD 151)

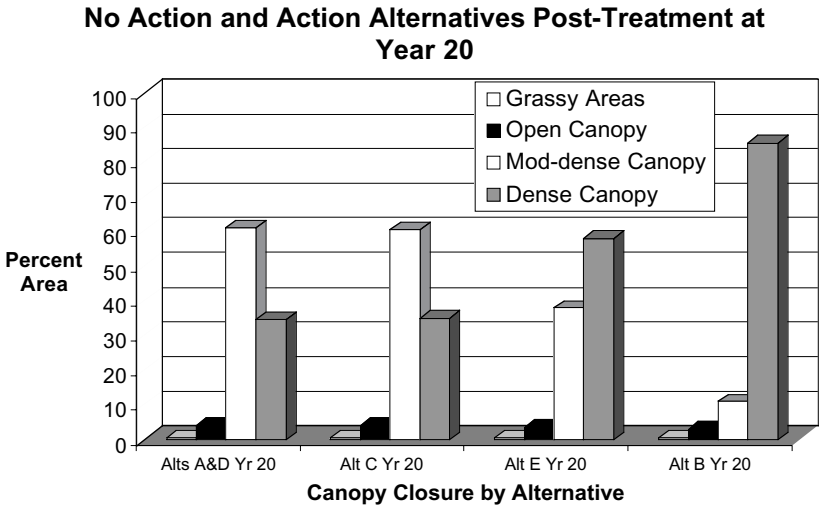

Figure 24. Canopy Closure at Year 20 for Each Alternative.

Canopy Closure Year 20

Analysis of canopy closure at 20 years post-treatment shows that the forest under Alternatives A, C, and D would be relatively the same in canopy closure with most of the forest being composed of moderately dense canopy (approximately 61 percent). Under Alternative E, the forest would be composed of approximately 58 percent dense canopy. Under Alternative B, approximately 80 percent of the forest would be mostly composed of dense canopies. The potential for a large wildfire event would remain high under Alternatives B and E. (See Figure 24.)

VSS 50 Years Post-treatment and Under No Action

Alternatives A, C, and D would be similar in VSS composition 50 years post-treatment. There would be an overabundance in VSS 4 class and a small excess in the VSS 5 class compared to desired conditions. All other VSS classes would show shortages, with no sites falling into the VSS 2 class. Without further treatment after initially treating stands, in 50 years there would be decreases in the VSS 2 and VSS 3 classes. VSS 4 showed an increase at 20 years but in 50 years, VSS 4 would decrease to be only slightly less than at the time of initial treatment. There would be an increase in VSS 5 class that would exceed the desired condition. VSS 6, old-growth designation, would show a minor increase. VSS 1 was held constant from immediate post-treatment condition in the analysis.

Table 19. Percent Vegetative Structural Stage (VSS) at Year 20 for Each Alternative.

Percent VSS	VSS 1	VSS 2	VSS 3	VSS 4	VSS 5	VSS 6
Alt. B (No Action) from existing conditions	0.5	3	53	34.5	6	3
Alternatives A and D (post treatment)	5.5	3	20	58.5	10	3
Alternative C (post treatment)	3	3	20	61	10	3
Alternative E (post treatment)	1	3	20.5	64.5	8	3
Desired from Forest Plan	10	10	20	20	20	20

Alternative E, 50 years post-treatment, would show an overabundance in VSS 4 and shortages in the remaining classes. VSS 2 and 3 would decrease, with no sites in VSS 2. Number of sites in VSS 4 and 5 would increase. VSS 6 would remain unchanged. VSS 1 was held constant to immediate post-treatment condition in the analysis.

Alternative B (No Action), would continue to show overabundances in the VSS 3 and VSS 4 classes with some trees shifting into the VSS 4 class. VSS 2 would decrease to zero. The remaining VSS classes under Alternative B would be unchanged and continue to show shortages. (See Table 20.)

Table 20. Percent Vegetative Structural Stage (VSS) at Year 50 for Each Alternative.

Percent VSS	VSS 1	VSS 2	VSS 3	VSS 4	VSS 5	VSS 6
Alt. B (No Action) from existing conditions	0.5	0	33	57.5	6	3
Alternatives A and D (post treatment)	5.5	0	12	49	29	4.5
Alternative C (post treatment)	3	0	12	51.5	29	4.5
Alternative E (post treatment)	1	0	12.5	71.5	12	3
Desired from Forest Plan	10	10	20	20	20	20

Canopy Closure Year 50

After 50 years post-treatment and under no action, and with no further treatments in the project area, analysis of canopy closure shows that the forest under all alternatives would be relatively the same. Barring any wildfire events, approximately 91 to 94 percent of the forest would be composed of dense canopies. There would be no or very little open areas. (See Figure 25.)

Forest Fragmentation

Affected Environment

Forest fragmentation is described as a patch of forest within a sea of non-forested land, often surrounded by urban development or rural farms (Gladen 1999). The forest in the project area is currently dominated by VSS 3 class (62 percent), trees 5 to 11.9 inches in diameter. Most of the project area (50 percent) has canopy closure greater than 60 percent (C canopy) followed by a substantial amount of B canopy (40 to 60 percent closure; 43 percent of the area). The forest is contiguous across the project area with a few openings (0.5 percent) distributed throughout the area. The forest is not fragmented (PRD 123 and 151).

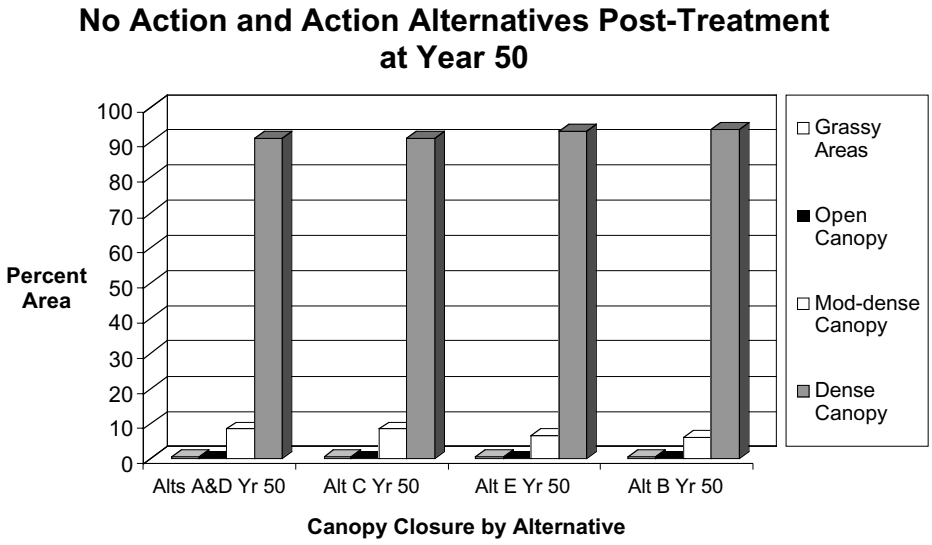

Figure 25. Canopy Closure at Year 50 for Each Alternative.

Direct Effects of Alternatives A, C, D, and E

Alternatives A and D would modify most of the sites into the VSS 4 class project-wide (52 percent) due to the removal of trees mostly smaller than 12 inches in diameter. Canopy closure would become predominantly B canopy (49 percent of the area). Some openings would be created (approximately an estimated 400 acres), increasing openings to 5.5 percent of the area. There would be some patches of trees, but overall the patchiness is with the openings.

Overall there would be a relatively contiguous forest canopy with variability in the level of canopy closure. The forest would not become fragmented.

Alternative C would be similar to Alternatives A and D. VSS 4 class would dominate post-treatment (54.5 percent). Canopy closure would also be dominated by B canopy (52 percent). Some openings would be created, approximately 200 acres estimated, increasing openings to 3 percent of the area. There would be some patches of trees, but overall the patchiness is with the openings. Overall there would be a relatively contiguous forest canopy with variability in the level of canopy closure. The forest would not become fragmented.

Alternative E would modify the overall VSS class distribution into one almost equally dominated by VSS 3 (40 percent) and VSS 4 (43.5 percent). Canopy closure would become predominately a B canopy (56.5 percent) with the retention of a substantial amount of C canopy (31 percent). There would be a slight increase in the amount of openings (approximately an estimated 44 acres) to 1 percent of the area. The forest canopy would remain contiguous across the project area, with some variability in the level of canopy closure north of Kelly Canyon. The forest would not become fragmented.

There would be no change under Alternative B (No Action). There is no additional forest fragmentation.

Indirect Effects of Alternatives A, B, C, D and E

There are no indirect effects to species because there is no forest fragmentation effect.

Cumulative Effects of Alternatives A, B, C, D and E

The forest would not become fragmented under any of the alternatives. Therefore, there is no added effect to forest fragmentation in the surrounding landscape. There is no cumulative effect regarding forest fragmentation.

Effects of Snag and Log Creation

This section describes the effects of the action to create snags and logs under Alternatives A and D. The Forest Plan does not provide standards and guidelines for creating log and snag structures. The Forest Plan does provide standards and guidelines for desired densities of snags and logs on the landscape. The Forest Plan states that within 10K blocks, at least 50 percent of the forested land meet the following criteria for snags: "At a minimum, snags are maintained at an average of 200 snags per 100 acres." Snag species will represent the tree species composition of the stand.

Under Alternatives A and D, snags will be created from some of the 16 inch and/or 18-inch black-barked trees. The creation of snags and logs will be guided by biological and watershed needs. Black-barked trees that are snags don't stand as long as snags created from old, yellow pine trees. The creation of snags from black-barked ponderosa pine has not been studied and the results of this activity are uncertain. The value of black-barked logs is unknown. Therefore, the Forest Service is approaching this application conservatively. The creation of snags and logs will be accomplished on the ground during layout; therefore, the actual number of snags and logs created is undeterminable at present.

Affected Environment

The mean number of snags per acre currently in ponderosa pine forests within the project area is 0.4, with standard deviation of 0.7 and range of 0 to 3.9 snags per acre. The mean number of logs per acre is 2, with standard deviation of 2 and range of 0-9.6 logs per acre. These averages are below the standards for both snags and logs, but more so for snags (PRD 128a and 151).

An analysis was completed October 2001 (PRD 120) to determine which sites have the conditions to allow for snag and log recruitment. Sites analyzed are located south of Kelly Canyon where wildlife use is higher. Conditions that allow for snag and log recruitment are based on two fundamental questions: 1) is there a need for snags and logs within a site, and 2) are there 16-inch or larger, black-barked trees within the site that could be converted to snags and/or logs. Analysis indicates that 28 sites in the area analyzed might be suitable for snag and log recruitment.

Losses of snags and logs from prescribed burning does occur and is estimated to be 20 percent loss of snags and 50 percent loss of logs (Randall-Parker and Miller 1999), although many will be protected using appropriate ignition and piling techniques, and lining of most snags. Randall-Parker and Miller (1999) also found that snags would continue to fall and provide new logs on the forest floor at a rate of 2 logs per 25 acres per year.

Direct Effects of Alternatives A, C, D, and E

Under Alternative A, snag and log recruitment would contribute to meeting the standards and guidelines, although the average number of snags and logs post-implementation might still be below standards. Additionally, with the retention of yellow pine trees and recruitment old-growth stands, some trees would in time naturally convert to snags, and the natural conversion of snags to logs would contribute to additional numbers of snags and logs on forests. Any created snags and logs will be monitored for use by wildlife species.

Alternative C would not include the component of creating snags and logs. There is little value of smaller (<16-inch diameter) snags and logs, therefore, efforts to create such smaller snags and logs is not feasible.

Alternative D would create snags and logs only from the 16 to 17.9-inch diameter class, thus fewer snags and logs would be created compared to Alternative A. This may not be a considerable difference. Any created snags and logs will be monitored for use by wildlife species.

Alternative E also will not include the component of creating snags and logs due to the 16-inch and 9-inch diameter limits outside the intensive treatment zone next to private property. There is little value of smaller (<16-inch diameter) snags and logs, therefore, efforts to create such smaller snags and logs is not feasible. There will be no snags or logs created within the “Intensive Zone”.

There will be no snag or log creation under Alternative B (No Action).

Indirect Effects of Alternatives A, B, C, D, and E

Snags created under Alternatives A and D would hopefully benefit cavity-nesting species, burrowing species and species that use snags as perches. Logs created under these alternatives would hopefully benefit small mammals, burrowing species and species that prey on small mammals.

There would be no indirect effects under Alternative C.

The high fire hazard potential would persist under Alternative B project-wide and under Alternative E south of Kelly Canyon. In the advent of a large wildfire, existing snags and logs would be lost. Wildfire would create snags by killing live trees, and these snags would eventually fall and become logs. Only snags and logs near edges of forested areas would be useful to wildlife because other necessary habitat components that support wildlife species would be lost in a large wildfire.

Cumulative Effects of Alternatives A, B, C, D and E.

Past silvicultural practices targeted the harvest of large diameter trees. This created the limited number large, old trees currently across the landscape, which in turn has limited the number of snags and logs that currently exist across the landscape. It was the large, old trees that naturally developed into snags, and the snags eventually became logs.

The broadcast burn effects on snags and logs are additive to similar effects in broadcast burning that have or will occur in the Pumphouse Multiproduct Timber Sale area, the Airport Fuels Reduction broadcast burn, and the Oak Creek Canyon Fuels Reduction Project. Burning occurs over time in these areas and does not impact large acreages at any one time. As in the Kachina Village FHP, large old trees will continue to replace snags slowly over time. Since efforts to retain snags through lining and burning techniques occur on all of the above-mentioned projects, the cumulative effect is not considerable.

Old-Growth

Affected Environment

The Forest Plan standards and guidelines for old-growth are that a minimum of 20 percent of ecosystem management areas be allocated to old-growth (page 70-1). In the Kachina Village FHP area there are 48 sites designated as existing or developing old-growth. There are 877 acres currently designated as existing old-growth, 11.4 percent of national forest lands. An additional 1,401 acres are designated as developing old-growth, 18.1 percent of national forest lands. Both groups total 2,268 acres of sites[20] managed for old-growth or 29.3 percent of the project area (Figure 26; PRD 128a).

Existing old-growth is defined as sites that currently display existing old-growth characteristics such as large, old-growth trees, abundance of snags and

[20] A site is a stand of trees usually of similar vegetation type and topography.

dead and down material. These sites meet or closely meet the old-growth definition of the Forest Plan. Existing old-growth sites were selected based on information obtained from field site reviews and surveys, databases from RMRIS and ArcView, and aerial photograph examinations. Most sites included under existing old-growth are those located in canyons, Mexican spotted owl PAC's (protected activity centers), the northern goshawk PFA (post-fledging family area), and the wildlife movement corridor.

Developing old-growth are those sites selected based on existing large yellow-pine trees (greater than 16-inches dbh) or large tree (greater than 18-inches dbh) densities which had higher numbers of these tree types compared to other sites within the project area. Black-barked trees greater than 18-inches dbh have the potential to develop into future old-growth trees sooner than smaller sized trees, and areas with large numbers of trees 18-inches dbh develop sooner into future old-growth stands than other areas that do not have large numbers of such trees.

Sites designated for old-growth management were selected to provide for a variety of wildlife species including Mexican spotted owl, northern goshawk, black bear, turkey, and brown creeper. Functions and interactions within old-growth areas, reproductive areas, feeding habitat, dispersal habitat, and prey species habitat are provided for.

Allocations of old-growth sites identified in the Kachina Village FHP EIS have been entered into the stand database and GIS layers at the project level. These allocations will be adjusted and official upon final decision for the Kachina Village FHP and entered into the forest level GIS layers.

Of the total acres of existing and developing old-growth in the project area, some are deferred from treatment. Old-growth mixed conifer habitat, 135 acres, has been deferred from treatment across all action alternatives. This existing old-growth habitat is found within a Mexican spotted owl PAC. In addition, 976 acres of ponderosa pine and pine-oak habitat are deferred from treatment across all action alternatives, consisting of 359 acres of existing old-growth and 617 acres of developing old-growth.

Direct Effects of Alternatives A, C and D

Alternatives A, C, and D would thin from below 1,157 acres of developing and existing old-growth; 373 acres of existing old-growth; and 784 acres of developing old-growth, consisting of ponderosa pine and pine-oak habitat (PRD 128a). Thinning from below will improve the health and growth of the old-growth tree component and long-term health of the stand.

In existing old-growth sites, the thinning from below methods would include:

Thinning from below to a basal area of 40 to 100 ft.^{2} per acre South of Kelly Canyon (37 acres) and Mexican Pocket (46 acres) treatment areas:

- Thinning from below around old trees in the Thinning from Below – Improving Old Tree Longevity and Gambel Oak Habitat (92 acres) treatment areas;
- Thinning from below in the Wildlife Movement Corridor (98 acres) treatment areas; and
- Thinning from below trees no greater than 9 inches in diameter in the Thinning from Below – Mexican Spotted Owl Protected Activity Centers (100 acres) treatment sites.

Thinning from below in developing old-growth sites includes:

- South of Kelly Canyon (324 acres) treatment areas;
- Mexican Pocket (67 acres) treatment areas;
- Improving Old Tree Longevity and Gambel Oak Habitat (176 acres) treatment areas;
- Dense Canopy Retention for Improving Forest Resiliency of Goshawk Habitat (82 acres) treatment area; and
- Mexican Spotted Owl Protected Activity Centers (135 acres) treatment sites.

All existing old-growth trees would be maintained across all action alternatives. There are some 18-inch, black-barked trees that would be removed under Alternative A, but the removal of those trees would not affect old-growth designation of sites. (See Figure 26.)

There would be various densities in the forest landscape with the different thinning prescriptions. This is desirable for wildlife and would help diversify species across the project area. Some species such as brown creeper and northern goshawk would benefit from denser ponderosa pine old-growth habitat, and other species such as flammulated owl would benefit from open, park-like ponderosa pine old-growth.

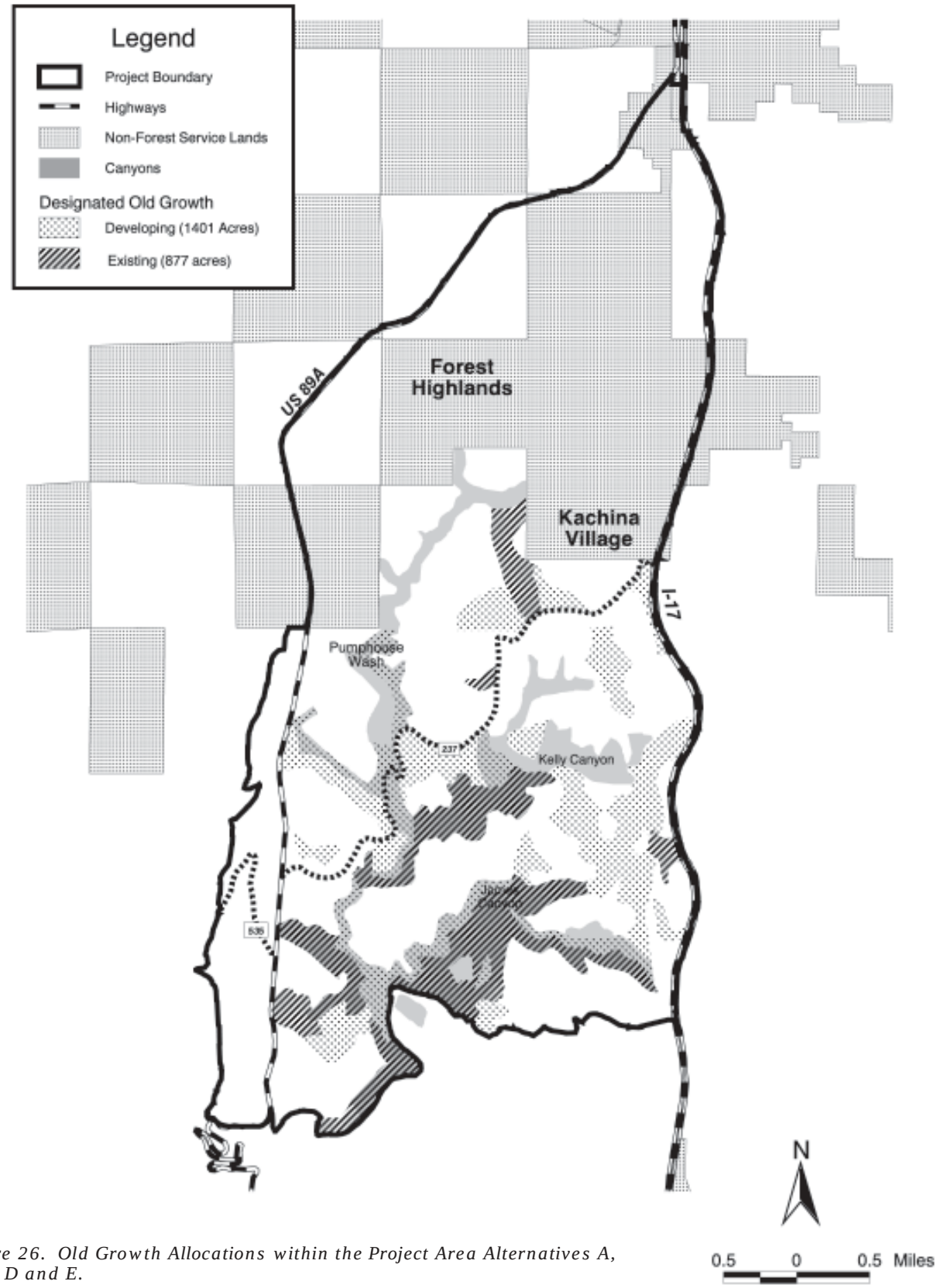

Figure 26. Old Growth Allocations within the Project Area Alternatives A, B, C, D and E.

Direct Effects of Alternative E

Under Alternative E 1,157 acres of developing and existing old-growth would be thinned from below: 373 acres of existing old-growth and 784 acres of developing old-growth, consisting of ponderosa pine and pine-oak habitat (PRD 128a). The thinning that would occur will help improve the health and growth of the old-growth tree component and long-term health of stands, although not to the extent as the other action alternatives. Under Alternative E there is a 9-inch diameter limit on 737 acres of existing (184 acres) and developing (553 acres) old-growth stands. Trees on these sites would have slower growth rates, and the canopy would be denser compared to other action alternatives. Old-growth trees on these sites would be more susceptible to mortality due to competition, insect infestation and diseases.

Thinning from below treatments in old-growth sites under Alternative E include:

- Intensive thinning to 50 basal area in a zone extending 660 feet out from private property boundaries (43 acres);
- Variable thinning to 60 to 120 basal area with a 16-inch diameter limit north of Kelly Canyon outside the private property intensive zone (377 acres);
- Thinning with a 9-inch diameter limit in north of Kelly Canyon where there are no roads (28 acres); and
- South of Kelly Canyon with a 9-inch diameter limit (709 acres).

Under Alternative E, three sites designated as old-growth, existing or developing, fall into the 660-foot wildland-urban interface zone, which is the zone of intensive treatment. These are sites 336/11 (existing old-growth), 336/12 (developing old-growth) and 345/1 (developing old-growth). Removal of trees within this "Intensive Zone" would not change the designation of these sites as old-growth. In the intensive treatment zone, more of the smaller diameter size trees would be removed, leaving the larger trees. Under Alternative E, the post-treatment designation of old-growth sites inside and outside the 660-foot wildland-urban interface zone would not differ from all other alternatives.

North of Kelly Canyon for Alternative E, effects would be the same as Alternative C where no trees greater than 16-inches diameter are cut. South of Kelly Canyon has a 9-inch diameter limit for this alternative, and old-growth stands south of Kelly Canyon would remain dense. Wildlife species distributions would differ from other action alternatives due to the dual forest structure pattern under this alternative. North of Kelly Canyon would favor species that require more open old-growth stands such as flammulated owl. Stands south of Kelly Canyon would favor species that benefit from denser old-growth stands such as brown creeper.

The high fire hazard potential would persist under Alternative E for old-growth stands south of Kelly Canyon. In the event of a large wildfire, old-growth sites would be compromised and trees would be lost, thus affecting form and function of old-growth.

Indirect Effects of Alternatives A, C, and D

Modeling was completed for all action alternatives comparing several thinning from below scenarios and tree size in 50 years (PRD 130). In 50 years, tree growth rate is greatest with the thinning to 50 basal area scenario, followed by the thinning to 80 basal area. The thinning with a 9-inch diameter limit showed slightly greater growth in trees compared to the no thin scenario, yet these two scenarios are similar to each other with both showing the slowest growth rates at 50 years with no other thinning activities.

There is relatively no difference between Alternative A (Proposed Action), C (16-inch diameter limit), and D (18-inch diameter limit) in regard to future old-growth recruitment. Alternatives A, C, and D would show the greatest recruitment for old-growth of trees into the VSS 5 and 6 classes in 50 years (PRD 151). These alternatives would thin out trees and reduce dense canopies compared to Alternatives B and E, therefore reducing the risk of loosing old-growth trees due to biological stresses or a crown wildfire event. Alternatives A, C, and D would promote development of old-growth habitat (see VSS tables above). Thinning improves health and vigor of trees and improves the likelihood of stands reaching old-growth condition; trees would grow larger more quickly. In 50 years post-treatment under Alternatives A, C, and D, there would be an increase of approximately 190 percent in the VSS 5 class and a 50 percent increase in the VSS 6 class.

Indirect Effects of Alternative E

Under Alternative E trees would have smaller diameters, on average, compared to trees under the other action alternatives, and trees would have slower growth rates. With limited treatment in sites where trees less than 9-inches diameter are cut, old-growth recruitment areas would decline in health and vigor, and some may never reach old-growth condition due to dense stand conditions.

Dense stand conditions increase susceptibility to insect infestation and diseases, and increase risk from crown wildfire. The high fire hazard potential would persist under Alternative E for old-growth stands south of Kelly Canyon. In the event of a large wildfire, old-growth sites would be compromised and trees would be lost, thus affecting form and function of old-growth. In 50 years post-treatment, there would be little recruitment to old-growth condition with an increase of 41 percent in the VSS 5 class and no recruitment into the VSS 6 class.

Indirect Effects of Alternative B

Under Alternative B (No Action), there would be no immediate change to old-growth trees or old-growth stands. Under Alternative B the dense nature of the forest would persist, thus trees are susceptible to higher mortality rates due to competition, insect infestations and diseases, and the forest is at risk of a large wildfire event. Modeling shows that old-growth habitats primarily within Mexican spotted owl PAC's 040214, 040509, and 040539 and the wildlife movement corridor are at most risk from a wildfire (PRD 73).

Under Alternative B, old-growth tree mortality would occur at a greater rate than in thinned stands due to biological stresses such as competition, insect infestation and diseases (PRD 130; see document 112 in the project record for the Fort Valley Ecosystem Restoration Project). Without treatment, many old-growth recruitment areas would decline in health and vigor, and some may never reach old-growth condition due to current dense stand conditions that increase susceptibility to insect infestation and diseases, and increase risk from crown wildfire. This alternative would show greater tree mortality rates. If a wildfire event occurred, the result would be loss of old-growth trees and old-growth blocks, as 95 percent of developing and existing old-growth sites have expected fire behavior rated as high to extreme (PRD 73). In 50 years there would be no recruitment into the VSS 5 and 6 classes.

Cumulative Effects of Alternatives A, C and D

Past silvicultural practices targeted the harvesting of large trees and suppression of fires. This in effect created conditions we have today: small sized trees comprising the vast majority of the landscape (VSS 3), and a paucity of large, old trees that would be recruitment old-growth and the old-growth component (VSS 5 and 6).

Old-growth analysis in the long term was addressed at multiple scales during the analysis phase. Old-growth allocations to the west (Crater Sinks 10K and Woody Ridge 10K), south (Ritter 10K), and east (Newman 10K) were considered. North of the project area, City of Flagstaff, did not offer flow and connectivity of old-growth. Old-growth allocations in the Kachina Village FHP area tie to those associated with Fry Canyon (Crater Sinks 10K), Woody Ridge (Crater Sinks 10K), the Wilson Seep drainage system that connects to Pumphouse Wash (Ritter 10K), the Mortgage Spring drainage system that connects to James Canyon (Ritter 10K), and James Canyon and its tributaries east of I-17 (Newman 10K) (Figure 27).

In the Kachina Village FHP, existing old-growth trees are maintained and add to the presence of existing old-growth trees in the surrounding landscape. Developing old-growth areas are enhanced, and will add to the overall amount of old-growth on the landscape when combined with the project areas described above. The amount of national forest land managed for old-growth is 29.3 percent, exceeding the Forest Plan guideline of a minimum of 20 percent.

Cumulative Effects of Alternative E

Old-growth will develop more slowly than under Alternatives A, C, and D and, therefore, the addition of old-growth with old-growth in the surrounding landscape occurs more slowly. Potential loss from wildfire is higher than Alternatives A, C, and D and lower than B. Loss of old-growth from high intensity crown fire would subtract from the total amount of old-growth in the surrounding landscape. The designation of old-growth areas is the same as Alternatives A, C, and D.

Cumulative Effects of Alternative B

There would be less old-growth over time as some trees are unable to develop into old-growth due to dense stand conditions. Tree mortality will be higher. These factors combine to provide less old-

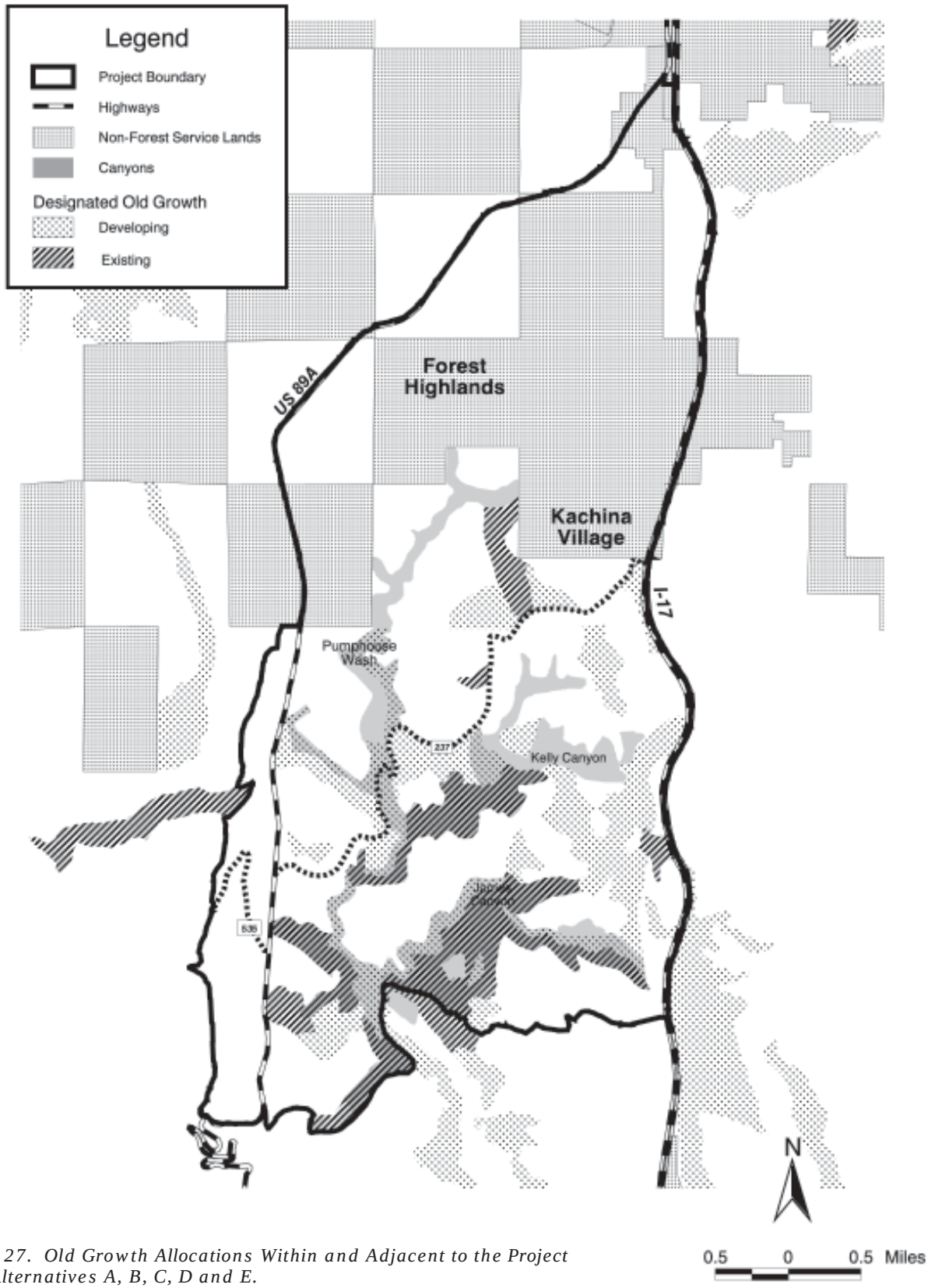

Figure 27. Old Growth Allocations Within and Adjacent to the Project Area Alternatives A, B, C, D and E.

growth trees to add to the surrounding landscape. The designation of old-growth areas is the same as Alternatives A, C, D, and E. The potential for loss of old-growth to high intensity crown fire is high in this alternative; this would subtract from the total amount of old-growth in the surrounding landscape. (See Figure 27.)

Threatened, Endangered, and Sensitive Species

A narrative for the project area of the evaluation of the threatened, endangered and sensitive species that occur on the Mormon Lake Ranger District is located in the project record (PRD 123 and 124). Four species are evaluated in the biological assessment and evaluation (BA&E) regarding the preferred alternative for the project, as these species occur or there is suitable habitat in the project area and there are possible affects. These species are American peregrine falcon, northern goshawk, Flagstaff beardtongue, and Flagstaff pennyroyal.

Consultation with the USDI Fish and Wildlife Service (USFWS) regarding threatened and endangered species in the project area has already occurred under the Wildland-Urban Interface Batch-Programmatic Environmental Assessment and Evaluation for several projects in the Southwestern Region (USDA Forest Service 2001a) (PRD 137a and 138). A biological opinion was issued by the USFWS in April 2001 (USDI Fish and Wildlife Service 2001). Eight species found within or near the project area, currently or historically, were included in the analyses. The USFWS made determinations for species potentially affected by activities within the Kachina Village FHP area. They are shown in Table 21.

Black-footed ferret and jaguar occurred historically in the project area according to the USFWS. Currently there are no black-footed ferrets or suitable habitat within the Kachina Village FHP area. The jaguar is extirpated from the area. Gila trout occurred historically in Oak Creek, downstream from the project area.

There are no bald eagle nesting areas or known winter roost areas in the project area; however, there is one bald eagle potential winter roost area. There are two Mexican spotted owl PAC's that occur within the project area and two that extend into the project area. Critical habitat for the loach minnow, razorback sucker, and spikedace occurs in Oak Creek and the Verde River downstream from the Kachina Village FHP, with the watershed of these streams in the project area. These five species are discussed below.

Sensitive Species Analyzed

- Navajo Mountain Mexican vole, *Microtus mexicanus navaho*
- American peregrine falcon, *Falco peregrinus anatum*
- Northern goshawk, *Accipiter gentilis*
- Flagstaff beardtongue, *Penstemon nudiflorus*
- Flagstaff pennyroyal, *Hedeoma diffusum*

Table 21. Threatened, Endangered or Sensitive Species Potentially Affected by Activities

Species	Determination
Black-footed ferret, *Mustela nigripes*	No effect; no critical habitat
Jaguar, *Panthera onca arizonensis*	No effect; no critical habitat
Bald eagle, *Haliaeetus leucocephalus*	May affect, not likely to adversely affect; no critical habitat
Mexican spotted owl, *Strix occidentalis lucida*	May adversely affect; no critical habitat
Gila trout, *Onchorhynchus gilae gilae*	No effect; no critical habitat
Loach minnow, *Tiaroga cobitis*	No effect to the species; critical habitat call is may affect, not likely to adversely affect
Razorback sucker, *Xyrauchen taxanus*	May affect, not likely to adversely affect; critical habitat call is may affect, not likely to adversely affect
Spikedace, *Meda fulgida*	May affect, not likely to adversely affect; critical habitat call is may affect, not likely to adversely affect

- Spotted skipperling, *Piruna polingii*
- Mountain silverspot butterfly, *Speyeria nokomis nitocris*
- Blue-black silverspot butterfly, *Speyeria nokomis nokomis*

Bald Eagle, *Haliaeetus leucocephalus* (Threatened)

Affected Environment

There is one bald eagle potential winter roost site approximately 34 acres in size south of Kelly Canyon. Wintering bald eagles occur in the project area, primarily along Interstate 17, which is the eastern boundary of the project area. Bald eagles feed on road-killed animals along the highway. They forage on animal carcasses forest-wide, and prey on waterfowl and fish at lakes and tanks that support these prey species. At night, small groups (usually 2 to 12) or individual eagles roost in groups of large trees in protected locations such as drainages and hillsides. Roost sites are ponderosa pine groups of large trees (average size of 28.3 inches in diameter and 93 feet tall), 5 to 40 acres in size (old-growth groups 5 to 10 trees per acre), on slopes of 10 to 35 percent, with a canopy closure of 50 to 80 percent, and are near food sources (Dargan 1991).

Consultation with the USFWS has already occurred (USDA Forest Service 2001a) and the determination in the biological opinion for the bald eagle in the Kachina Village FHP and region-wide was “may affect, not likely to adversely affect” (USDI Fish and Wildlife Service 2001). Mitigation measures for known roosting areas will be followed (see Chapter 2, “Project-Specific Mitigation”).

Direct Effects of Alternatives A, B, C, D, and E

Under all action alternatives, proposed mechanical treatments and broadcast burning may cause visual or auditory disturbance to foraging bald eagles. This disturbance would be localized, of short duration and low intensity, and may affect individual birds but would not affect the overall distribution or reproduction of the species.

Under all alternatives, recreation would continue along Forest Road (FR) 631 in the vicinity of the potential winter roost site. FR 631 would remain open for approximately 2 miles, and recreation activities are expected to continue at current levels along this stretch of road under all alternatives. The greatest impact currently occurs along the first mile of FR 631 and the potential winter roost site is located along this stretch. Impacts to individual birds may occur from recreation activities between October 15 and April 15 because this site is in close proximity to the Kelly Canyon interchange on I-17 and this area of the forest may be accessible at times during the winter months, however, throughout much of the winter the area would be inaccessible due to snowpacked roads.

Recreation activities would continue in other areas within the project boundary. Under all action alternatives, recreation activities would be regulated and the number of impact areas would be reduced, therefore providing a benefit to bald eagle. Under Alternative B, recreation activities would continue at current levels. Recreation activities in the project area would not considerably affect the overall distribution, reproduction or winter roosting of the bald eagle as recreation activities are reduced during winter months when bald eagles are present.

There are no direct effects to bald eagles from Alternative B (No Action).

Indirect Effects of Alternatives A, B, C, D, and E

Indirect effects to the bald eagle include affects to eagle habitat, eagle prey species, or prey species habitat. There are no anticipated adverse effects to prey species or prey species habitat.

The main effects are more likely to occur when project treatments modify the number of trees in a group of suitable roost trees, as eagles prefer to roost in large trees within close proximity to other large trees.

Thinning would improve old tree longevity in the potential winter roost site and any other unknown winter roost sites by reducing competition for light, moisture, and nutrients and reducing the risk of insect infestation and disease. Under Alternative A there would be recruitment of trees into developing and existing old-growth stands, which may be used as future winter roost sites for bald eagles.

Although treatment prescriptions call for retaining large trees, Alternative A may thin approximately 2.8 black-barked, 18-inch diameter trees per acre from site 345/34, of which approximately the southern and southwestern 12 acres is part of the potential winter roost site. Some black-barked, 18-inch diameter trees would be removed from the northeastern portion of the potential winter roost site. This may reduce the quality of roosting potential for

this portion—35 percent of the potential winter roost site—by possibly reducing canopy closure to less than or equal to 45 percent in the 12-acre portion. The remaining 22 acres of the potential winter roost site would not be affected. Site 345/34 is designated as existing old-growth, and the designation would not be affected by the removal of less than or equal to 2.8 black-barked, 18-inch diameter trees. (See Chapter 2, "Wildlife and Sensitive Species Habitat Protection" for mitigation measures regarding the bald eagle.)

Under Alternatives C and D, canopy closure would remain within the limits of the preferred 50 to 80 percent. There would be no adverse indirect effects to the potential bald eagle roost site or any other unknown roost sites. Under Alternatives C and D there would be recruitment of trees into developing and existing old-growth stands, which may be used as future winter roost sites for bald eagles.

Under Alternative E all trees 9 inches in diameter and larger would be retained in roughly the southern half of the project area. The potential winter roost site would not be adversely affected under Alternative E from thinning activities. However, under Alternative E tree density would remain high and the adverse effects to trees from competition coupled with the continued risk of insect infestation and disease would persist. Under Alternative E there would be very little or no recruitment of trees into developing or existing old-growth, thus there would be relatively no benefit to wintering bald eagles. Additionally, the high fire hazard potential south of Kelly Canyon would persist. In the event of a large wildfire, the potential winter roost site and old-growth sites may be destroyed.

Under Alternative B (No Action), there are no treatment effects. However due to the continued high tree density, adverse effects to trees from competition coupled with the continued risk of insect infestation and disease would persist. Alternative B would not promote recruitment of trees into developing or existing old-growth, thus there would be no benefit to wintering bald eagles. Additionally under Alternative B, there is high fire hazard potential in the project area. In the event of a large wildfire, the potential winter roost site, any other unknown roosts, and old-growth sites may be destroyed.

Proposed treatments under all action alternatives would not affect the numbers, distribution or reproduction of the bald eagle, but may at times disturb foraging birds on a short-term basis. Recreation activities under all alternatives would not adversely affect the bald eagle.

Cumulative Effects of Alternatives A, B, C, D, and E

Historical silvicultural practices of removing large sized trees and suppression of fires on national forest and state lands created a forest of existing conditions composed primarily of dense canopy stands of 5 to 12-inch diameter trees. This condition is not beneficial to wintering bald eagles. However, recent past silvicultural practices have created more suitable habitat for the bald eagle by leaving large trees and thinning from below, which enhances tree growth and vigor.

Under the action alternatives, there is no effect to the numbers, distribution or reproduction of the bald eagle so there is no added effect. Recreation management activities and recreation have little affect on wintering bald eagles so there is little added affect. Short-term disturbance to foraging or roosting bald eagles during thinning and broadcast burning activities may cause eagles to forage and roost in nearby areas for the duration of the activity.

Short-term smoke impacts can be considered cumulatively with similar impacts in the Pumphouse Multiproduct Timber Sale area and the Airport Fuels Reduction Project Broadcast Burn, however, implementation of these burns are not likely to occur simultaneously and do not combine to cause a negative effect.

Mexican Spotted Owl, *Strix occidentalis lucida* (Threatened)

Affected Environment

There are two Mexican spotted owl protected activity centers (PAC's) that occur within the project area (040509 and 040539) and two that extend into the project area (040214 and 040512). There is one PAC adjacent to the southwest boundary of the project area (040215). Mexican spotted owl habitat typically consists of mixed conifer and/or ponderosa pine-Gambel oak vegetation types in steep canyons, on mountainsides and on ridges. In the Kachina Village FHP, owl PAC's are associated with canyons. Outside of PAC's there are 160 acres of steep slope protected, 2,060 acres of restricted habitat and 219 acres of restricted habitat identified as target/threshold within the project area boundary. The breeding season is from March 1 to August 31.

Surveys done to Forest Service Region 3 protocol were conducted within the project boundary and 1/2 mile outside the project boundary in 2000 with positive results (PRD 3). Owls were located in PAC

040215 (single response), 040509 (pair response), 040512 (pair response), and 040539 (single response). No nests were located. No Mexican spotted owls were located in PAC 040214, and none were located outside PAC's.

PAC's were monitored during 2001 with positive results. Owls were located in PAC 040215 (single response), 040509 (pair response), 040512 (single female response) and 040539 (pair response). No nests were located. No Mexican spotted owls were located in PAC 040214.

Within the project boundary, only two Mexican spotted owl PAC's would be treated. PAC 040509 would have 294 acres and PAC 040539 would have 162 acres thinned from below with trees no greater than 9 inches in diameter removed. These acres would also be broadcast burned along with other acreage outside of the canyons. There is no planned broadcast burning within canyons or within 300 feet of the canyon rims.

Consultation with the USFWS has already occurred (USDA Forest Service 2001a) and the determination in the Biological Opinion for the Mexican spotted owl in the Kachina Village FHP was "may adversely affect" (USDI Fish and Wildlife Service 2001). Furthermore, on a region-wide basis it is the biological opinion of the USFWS that "implementation of the Proposed Action, as necessary to reduce the risk of catastrophic wildfire, is not likely to jeopardize the continued existence of the Mexican spotted owl" (USDI Fish and Wildlife Service 2001, page 101).

Direct Effects of Alternatives A, B, C, D, and E

Under all action alternatives there would be no direct effects from thinning from below activities as the canyons, where spotted owls are primarily found, are deferred from treatment.

Under all action alternatives, direct effects to Mexican spotted owl would be from smoke created from broadcast burning. Smoke would tend to settle into the canyons and low-lying areas during nighttime, and could potentially affect spotted owls. Smoke may drift into PAC's from burning that occurs in other portions of the Kachina FHP area. Smoke effects could occur in the spring within the breeding seasons. Smoke effects would be short term. Mexican spotted owls are known to return to PAC's or to areas near PAC's after fires and smoke events have ceased. Short-term impacts from smoke would be reduced by coordination of timing and type of burning with wind direction, topography, time of year, and distance to PAC's. There is no lighting of broadcast fires allowed on acres within PAC's during the breeding season.

There are no direct effects from Alternative B.

Indirect Effects of Alternatives A, B, C, D, and E

Under all action alternatives, there would be minimal effects from thinning and piling in owl habitat as thinning treatments are outside of the canyons away from the activity centers. Treatments in owl habitat will be conducted in compliance with the Recovery Plan (USDI Fish and Wildlife Service 1995) and Forest Plan standards and guidelines. It is estimated there could be up to 20 percent loss of snags and 50 percent loss of downed logs during broadcast burning (Randall-Parker and Miller 1999) although many will be protected using appropriate ignition and piling techniques, and lining of most snags. Microhabitat monitoring will be conducted according to Region 3 Microhabitat Monitoring Protocol. Broadcast burning occurs within a portion of each PAC. Effects to prey species are minimal because snags and logs are maintained in the unburned portion of each PAC.

Under Alternatives A, C, and D the fire hazard potential is reduced. Thinning from below in sites adjacent to owl PAC's, in addition to thinning from below trees no greater than 9-inches diameter in certain sites within owl PAC's, would give added protection to owl habitat from a large wildfire event.

Under Alternative E dense forest conditions would still occur and the high fire hazard potential would persist. Under Alternative B the high fire hazard potential in the project area will persist. A large wildfire event may result in the loss of Mexican spotted owl habitat and possibly individual owls.

Under all action alternatives, road closures and increased management of camping and recreation opportunities would be beneficial to Mexican spotted owl by regulating access and reducing human impacts to owl PAC's and individual owls.

Rehabilitation activities at Kelly Seep will not affect owl habitat.

Cumulative Effects of Alternatives A, B, C, D, and E

The projects in the general area considered for this analysis are those listed in the introduction to this chapter.

Past silvicultural practices targeted the harvesting of large trees and suppression of fires. This, in effect, created conditions we have today that create the high fire hazard potential in the project area.

Under all alternatives there would be no direct effects to Mexican spotted owl PAC's and, therefore, no cumulative effect to other PAC's in the area. Treatments in owl habitat will be conducted in compliance with the Recovery Plan (USDI Fish and Wildlife Service 1995) and Forest Plan standards and guidelines. This results in minimal direct effects and, therefore, no cumulative effect. Broadcast burning occurs within a portion of each PAC. Effects to prey species are minimal because snags and logs are maintained in the unburned portion of each PAC. This effect is additive to similar impacts on the adjacent Airport Fuels Reduction Project (approximately 1,000 acres of broadcast burning). The combined effect is minimal.

Should Mexican spotted owl habitat be lost due to high intensity crown fire, the owl populations in the general area would be affected.

Fishes

Affected Environment

Three threatened and endangered species occur downstream from the Kachina Village FHP area in Oak Creek and Verde River: loach minnow, *Tiaroga cobitis* (threatened), razorback sucker, *Xyrauchen taxanus* (endangered), and spikedace, *Meda fulgida* (threatened). Critical habitat for the loach minnow occurs in Oak Creek and the Verde River over 15 miles downstream from the project. Critical habitat for the razorback sucker occurs in the Verde River 54 miles downstream from the project. Critical habitat for spikedace occurs in Oak Creek and Verde River over 15 miles downstream from the project. Although these fishes do not occur within the project area, the watersheds of Oak Creek and the Verde River do.

Direct Effects of Alternatives A, B, C, D, and E

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

There are no direct effects from Alternative B.

Indirect Effects of Alternatives A, B, C, D, and E

Indirect effects to fishes would be from the possibility of sedimentation during treatments and re-opening of temporary roads in the project area. Under all action alternatives, Best Management Practices would be implemented (See PRD 137c) and any effects would be minimized.

Under Alternatives A, C, and D there would be minimal effects to fish species habitat, with no adverse effects expected. Any sedimentation that may occur from project activities would be short term with expected soil stabilization and the establishment of an herbaceous vegetation understory. Adequate buffers have been developed on all major drainages. Most sediment will remain in storage rather than move downstream into Oak Creek, with a small portion of anticipated soil loss expected to occur and enter ephemeral stream channels (see soil and water effects section). Road closures would reduce sedimentation loads. Alternatives A, C, and D would reduce the risk of a large wildfire the most, thus the potential risk of sedimentation and affects to fishes downstream from such an event would be reduced.

Under Alternative E effects would be less than the other action alternatives due to less mechanical disturbance in the project area. Road closures would reduce sedimentation loads. Alternative E would not reduce the risk of a large wildfire event due to a continuation of a dense forest canopy. Fire hazard potential would remain high, and with the advent of a large wildfire event, soil sedimentation would occur and may adversely affect fishes downstream of the project area.

Under Alternative B (No Action), there would be no change in soil conditions and no new soil disturbances. There would be no road closures under this alternative, which would continue current sedimentation loads into drainages. This continued level of sedimentation from the existing road system and social roads may have negative effects to fish species habitat in the long term compared to all action alternatives. Under this alternative fire hazard potential would remain high, and with the advent of a large wildfire event, soil sedimentation would be great and may adversely affect fishes downstream of the project area.

Cumulative Effects of Alternatives A, B, C, D, and E

There are no direct effects that would cause a cumulative effect when added to other activities in and around the Kachina FHP. There are no adverse indirect effects expected and, therefore, no cumulative effect.

Should high intensity wildfire occur, then downstream effects could cause impacts to fish and fish habitat. The potential for high intensity wildfire is greatest under Alternative B.

Navajo Mountain Mexican Vole, *Microtus mexicanus Navaho* (Sensitive)

Affected Environment

There are no documented populations or sightings of voles in the project area; however, some suitable habitat exists within the area. Voles occupy meadows and riparian areas above the Mogollon Rim associated with ponderosa pine or other coniferous forests. They also occur within the forested areas where tree densities are low. They rely on grasses and other herbaceous vegetation for food and cover. Suitable habitat within the project area is currently 7 percent of the project area.

Direct Effects of Alternatives A, B, C, D, and E

Direct effects would be similar between Alternatives A, C and D for this species. Disturbance during thinning and broadcast burning activities may occur to individual voles; some individuals may be lost. Burning removes cover and food. Such activities would occur across the project area at different times; therefore, activities would be temporally and spatially separated. Effects would be short term. There would be no effects to population viability of the voles.

Under Alternative E, effects would be similar but to a lesser extent compared to the other action alternatives. Disturbance activities would be reduced. Roughly half of the project area would be thinned similarly to Alternative C, the northern part of the project, where short-term disturbance would be the greatest under this alternative. Roughly the southern half would retain a dense canopy structure due to the 9-inch diameter limit, where short-term disturbance would be the least.

Recreation effects under all action alternatives would be reduced due to establishment of designated camping areas, reduction in disbursed camping sites, and closing social trails. Road closures under all action alternatives would be beneficial to this species. Under all action alternatives, construction of new segments of a trail system and temporary roads may impact the Navajo Mountain Mexican vole due to construction activities and loss of habitat. Areas where trail construction would occur are limited within the project area.

Benefits to the vole would be realized under all action alternatives with regulated recreation activities and road closures. Temporary roads will be closed after treatments are completed, and in time voles could use these areas.

There would be no disturbance under Alternative B. Currently 62 percent of the project area is in dense conditions. Dense forest stands provide low quality habitat for the Navajo Mountain Mexican vole. Recreation activities would not change under this alternative, and no road closures would occur. Activities from recreation and road travel at current levels would continue to pose an adverse affect to voles due to soil and vegetation disturbance and soil compaction.

Indirect Effects of Alternatives A, B, C, D, and E

Benefits to voles would occur due to the reduction of the dense forest canopy and increased growth in herbaceous vegetation on the forest floor project-wide for all action alternatives, although Alternative E would have a lesser positive effect compared to the other action alternatives. Alternative E would be less beneficial to the vole due to the continuance of a dense canopy overall. Grassy openings and meadows and open canopy areas would increase by approximately 400 percent under Alternatives A and D, increase by 357 percent under Alternative C, and increase 79 percent under Alternative E. Alternative B will continue to limit habitat for this species.

The high fire hazard potential would persist under Alternatives B and E, and a large wildfire event would have the potential to affect many individuals.

In 20 years post-treatment compared to current existing habitat of 7 percent, grassy openings and meadows and open canopy areas would decrease by approximately 36 percent under Alternatives A, C and D, decrease by 43 percent under Alternative E, and decrease by 50 percent under Alternative B.

In 50 years post-treatment, with no further treatments and compared to current existing habitat of 7 percent, grassy openings and meadows and open canopy areas would decrease by approximately 93 percent under all alternatives.

Cumulative Effects of Alternatives A, B, C, D, and E

Past silvicultural practices targeted the harvesting of large trees and suppression of fires. This in effect created the dense forest condition we have today in

the project area that is unfavorable to Navajo Mountain Mexican vole.

Projects reviewed for this discussion are those listed at the beginning of this chapter.

Direct effects of disturbance during implementation of thinning, broadcast burning and recreation trailhead and trail construction activities are additive to similar disturbances in other projects. The timing of implementation is such that all projects will not occur simultaneously. Adverse cumulative effects are not expected.

The direct effect of improved habitat due to recreation and road management activities adds to similar improvements in the Griffiths Spring area and the Fort Tuthill to Kachina Trail area.

The indirect effects of lower canopy closure and the beneficial increase in understory vegetation adds to the same effects in the Pumphouse Multiproduct Timber Sale area, the Airport Fuels Reduction broadcast burn, thinning on State Section 26, and the Oak Creek Fuels Reduction Project.

Infill of private land has the greatest potential impact to vole habitat. There are no undeveloped parcels of private land in the project area.

American Peregrine Falcon, *Falco peregrinus anatum* (Sensitive)

Affected Environment

Peregrine falcons occur statewide as migrant, transient, and/or wintering individuals. The subspecies *anatum* breeds on selected isolated cliff ledges and is a permanent resident on the Coconino National Forest. The peregrine breeding season is from March 1 to August 31. Peregrine falcons do not typically hunt within forested stands but are aerial predators. Peregrines prey mainly on birds found in wetlands, riparian areas, open areas, canyons, and mountain slopes within a 10 to 20-mile radius from the nest site. Prey items also include bats and mammals. The peregrine falcon was removed from the Federal List of Endangered and Threatened Wildlife in August 1999 (USDI Fish and Wildlife Service 1999) and is now a Forest Service Sensitive species.

There is one known breeding area associated with the project. Falcons are known to occupy this site; nesting status is unknown. There is other potential habitat within the project area.

Direct Effects of Alternatives A, B, C, D, and E

Falcon nesting habitat is located in Pumphouse Wash within 1/4 mile of sites selected for treatment. Under all action alternatives there is potential for disturbance during treatments, therefore, timing restrictions during the breeding season would be implemented to avoid potential negative effects to falcons (see Chapter 2, “Wildlife and Sensitive Species Habitat Protection”).

Under Alternative B (No Action), there would be no direct effects.

Indirect Effects of Alternatives A, B, C, D, and E

Under Alternatives A, C, and D the forest would be opened up and provide better sight distances for hunting, therefore benefiting falcons. Prey species base may shift to species that favor more open habitats than currently exist due to a change in forest structure.

Alternative E would open the forest to a lesser extent compared to other action alternatives. Prey species would continue to be present, with species favoring more dense forests. There would be minimal improvement of sight distances for hunting.

There would be no change to the prey species base under Alternative B, and no change in falcon hunting patterns associated with forest structure. This is not a negative effect.

Under Alternatives B and E high fire hazard potential would persist. With the advent of a large wildfire, falcons may be adversely affected. Smoke from fires would settle into the canyon during nighttime, although this would be short term. Additionally, there would be the possibility that spotting from a wildfire may occur and cause a fire to start in the canyon near falcons. Under this scenario, prey species habitat may be destroyed and individual falcons may be harmed. However, population viability would not be affected because there is only one eyrie in the project area.

Cumulative Effects of Alternatives A, B, C, D, and E

Past silvicultural practices targeted the harvesting of large trees and suppression of fires. This, in effect, created the dense forest condition we have today in the project area. A shift in prey base species that favor dense forest conditions would have occurred. This does not contribute to a cumulative effect to peregrine falcon.

Potential negative direct effects are mitigated with timing restrictions on implementation of activities in the vicinity of nesting habitat; therefore, there is no added effect when considered with other projects in and surrounding the Kachina FHP.

The beneficial indirect effect of increased sight distances for hunting is additive to similar effects where they occur in the Pumphouse Multiproduct Timber Sale and the Oak Creek Canyon Fuels Reduction Project.

Northern Goshawk, *Accipiter gentilis*

Affected Environment

The principle forest types occupied by northern goshawk in the Southwest are ponderosa pine, mixed species, and spruce-fir. The goshawk is a forest habitat generalist that uses a wide variety of forest stages. Three components of a goshawk's nesting home range are identified as nest area, post-fledging family area, and foraging area. It prefers stands of intermediate canopy cover for nesting, while more open areas are used for foraging.

The northern goshawk is opportunistic and a generalist, not relying on one certain prey item or habitat type for foraging. There are over 50 vertebrate species known in the diets of nesting northern goshawks from various locations in North America (Reynolds et al. 1992). Seventeen species are highlighted as selected prey of the northern goshawk (Reynolds et al. 1992). The species most frequently taken by northern goshawk in Arizona and New Mexico are cottontail rabbit, pigeon, golden-mantled ground squirrel, northern flicker, American robin, Abert squirrel, and least chipmunk. It is anticipated that with some places becoming more open and others remaining dense under action alternatives, prey diversity will increase. More open areas will result in increased populations of cottontail rabbit, robins, mourning doves, golden-mantled ground squirrels, and chipmunks.

Only one northern goshawk post-fledging family area (PFA) (040515) is located within the project boundary, and one PFA is adjacent to the northeast edge of the project boundary (040507). The remainder of the project area is foraging habitat for northern goshawk. The project area and 1/2 mile beyond the boundary were surveyed for northern goshawks in year 2000 according to Forest Service Region 3 protocol (PRD 4). No goshawks were found during that survey period.

PFA 040515 was established about 1992 shortly after the publication of "Management Recommendations for the Northern Goshawk in the Southwestern United States" (Reynolds et al. 1992) and prior to the "Record of Decision for Amendment of Forest Plans" (Forest Plan Amendment 11, 1996). The PFA was established based on a number of sightings of goshawks in the general area between 1989 and 1992, and a large unoccupied stick nest was located in 1992. Nest searches conducted in 1992 yielded negative results. Monitoring during the nesting and fledgling period in 1993 likewise yielded negative results. Surveys were conducted in 1991, 1992 and 2000 according to regional protocol with negative results. A revisit to the stick nest in 2001 indicated that the stick nest was no longer in existence and no goshawks were seen or heard within the PFA during this visit. However, there were goshawk sightings within the project boundary during the summer of 2001.

The Forest Plan calls for the establishment of a PFA for known nest sites, old nest sites, areas where historical data indicates goshawks have nested there in the past and where goshawks have been repeatedly sighted over a 2-year or greater time period. Nests were located but confirmed nesting of goshawks has not been documented for PFA 040515, nor have goshawks been sighted for at least 2 consecutive years in the same area. Even in view of these facts, there is a lack of information for years 1994 through 1999. Year 2000 was a drought year and year 2001 indicated nesting of goshawks on the forest was limited, proving to hinder verification of nesting in this PFA. Therefore, we have decided to continue analysis of this PFA.

PFA 040515 overlaps Mexican spotted owl PAC 040539, and the spotted owl standards and guidelines will take precedence over the northern goshawk standards and guidelines in overlapping sites. Conformance with the Mexican spotted owl standards and guidelines and the northern goshawk standards and guidelines will not adversely affect other threatened, endangered, or sensitive species, and does not conflict with other established recovery plans or conservation agreements.

The Forest Plan standards and guidelines state that the general desired distribution across vegetative structural stage (VSS) classes, within and outside PFA's, is 10 percent, 10 percent, 20 percent, 20 percent, 20 percent and 20 percent for VSS 1 through 6 consecutively. Northern goshawk use of grassy openings is well documented in the Manage-

ment Recommendations in the Southwestern U.S. for the Northern Goshawk (Reynolds et al. 1992). Desired canopy cover in ponderosa pine habitat outside PFA's, per Forest Plan standards and guidelines, is 40+ percent on average for VSS 4 through VSS 6 classes. Desired canopy cover in ponderosa pine habitat within PFA's is, on average, 50+ percent (2/3) and 60+ percent (1/3) for VSS 4 class and 50+ percent for VSS 5 and 6 classes. Stands preferred for nesting habitat are in VSS 5B through 6 classes (Reynolds et al. 1992). An "A" canopy is <40 percent cover, "B" is 40 to 60 percent cover and "C" is >60 percent cover. There are somewhat different standards for mixed conifer habitat, however mixed conifer habitat is deferred from treatment within the project area and will not be analyzed herein. The Forest Plan standards and guidelines for canopy cover and the northern goshawk apply to VSS 4, 5, and 6 classes only.

Proposed treatments within the PFA, 614 acres in size, would occur in 5 of the 13 sites. Approximately 304 acres would be treated within the PFA. Only one of the VSS 4 sites would be treated. There are no VSS 5 or 6 sites within the PFA. Sites with nesting stands are deferred from treatment. Human activities in or near nest stands will be limited during the breeding season, March 1 through September 30, so that goshawk reproductive success is not negatively affected.

Direct Effects of Alternatives A, B, C, D, and E

Under all action alternatives, smoke effects from broadcast burning may disturb individual birds, although this would be short term and would not adversely affect goshawks. Timing of broadcast burning may reduce any smoke impacts.

It is estimated there may be up to 20 percent loss of snags and 50 percent loss of downed logs during broadcast burning (Randall-Parker and Miller 1999) although many will be protected using appropriate ignition and piling techniques, and lining of most snags. In addition, a small number of snags may be created from experimental efforts to create snags under Alternatives A and D (PRD 120).

There are no direct effects under Alternative B, No Action.

Indirect Effects of Alternatives A, B, C, D, and E

Reduction of snags and logs would have a negative impact on numbers of prey items, thus prey availability, for northern goshawk. The impact of this effect is expected to lessen in the short term as snags fall and become logs. The number of snags would continue to be in short supply, due to a current shortage of snags. Number of snags is expected to increase in the future as other trees grow, age, and die.

Vegetative Structural Stage (VSS)

Outside the PFA Alternatives A and D would alter the VSS class distribution, changing the forest project area from one dominated by VSS 3 more toward the desired condition, although still lacking the desired condition (Table 22). Because the majority of the forest within the project boundary is within the VSS 3 class, modifications to current sites would cause the sites to fall primarily into the VSS 4 class. Some openings (VSS 1) would be created. Some stands would be converted into the VSS 5 class. Post-treatment effects would be an overabundance of VSS 3 and VSS 4, and a shortage in the remaining VSS classes. The post-treatment lack of sites in the VSS 5 and 6 classes is due to a current lack of sites in these classes. However, over time trees in the VSS 4 class would grow and shift into the VSS 5 class, and later age into the VSS 6 class (see Tables 19 and 20, depicting VSS in 20 years and in 50 years).

Under Alternatives A and D, the PFA would remain dominated by VSS 3 class (Table 23). Treatments would modify some of the sites from VSS 3 class to VSS 4 class. Some openings (VSS 1) would also be created. Post-treatment effects would be an overabundance of VSS 2 through 4, and shortages of VSS 1, VSS 5, and VSS 6 classes within the northern goshawk PFA. The shortages of VSS 1, 5, and 6 classes are due to current conditions lacking such sites.

Alternative C would be very similar to Alternatives A and D, with the only difference that fewer grassy openings (VSS 1) would be created. The effects analysis is the same as under Alternatives A and D.

Under Alternatives A, C, and D forest conditions conducive to goshawk nesting would be improved, although there would continue to be a lack of appropriate nesting stands. Improvement would be short term and long term due to increasing number of tree stands shifting into the VSS 5 and 6 classes. Northern goshawks are expected to continue to forage in the project area. Thinning would increase vigor and growth of remaining trees. Understory herbaceous vegetation would be enhanced from a

more open forest canopy, as sunlight and moisture would be more available. Understory herbaceous vegetation would also be enhanced from broadcast burning as a result of nutrient cycling. These last effects benefit prey species that inhabit more open areas, thus benefit goshawks. Prey species that inhabit denser forests would still be available to northern goshawk. The increase in prey species diversity is very beneficial to northern goshawk; for example, when environmental conditions oscillate, different species of prey will be more abundant, always offering a food resource to northern goshawk. Under Alternatives A, C, and D there would be a reduction in fire hazard potential, thus a reduction in the risk of habitat loss. Treatments would aid the development of recruitment PFA's.

Alternative E would alter the VSS class distribution outside the PFA from a forest dominated by VSS 3 to one dominated more by VSS 4 (Table 22). There would be no change within the goshawk PFA (Table 23). Because the majority of the forest outside the PFA is within the VSS 3 class, modifications to current sites would cause the sites to fall primarily into the VSS 4 class. A few stands would be converted into the VSS 5 class, and very few openings

Table 22. Existing VSS Class Percentages of Total Project Area Acreage, Anticipated Post-treatment VSS for All Action Alternatives, and General Desired VSS Condition outside the PFA.

GENERAL (Does not include PFA)										
	Existing Conditions Alternative B		**Alternatives A and D**		**Alternative C**		**Alternative E**		**Recommended Standards**	
VSS*	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
1	42	0.6	401	5.5	221	3	86	1	710	10
2	267	4	166	2.5	166	2	166	2	710	10
3	4,412	62	1,711	24	1,711	24	2,756	39	1,420	20
4	1,720	24	3,854	54	4,033	57	3,218	45	1,420	20
5	449	6.4	758	11	759	11	662	9	1,420	20
6	210	3	210	3	210	3	210	3	1,420	20

* VSS classes 1=unstocked opening, 2=<5 inches diameter at breast height (dbh) (4.5 feet); 3=5 to 11.9 inches dbh; 4=12 to 17.9 inches dbh; 5=18+ inches dbh; and 6=old-growth.

Table 23. Existing VSS Class Percentages of Total Project Area Acreage, Anticipated Post-treatment VSS for All Action Alternatives, and General Desired VSS Condition within the PFA.

PFA										
	Existing Conditions Alternative B		**Alternatives A and D**		**Alternative C**		**Alternative E**		**Recommended Standards**	
VSS*	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
1	0	0	30	5	15	3	0	0	61.4	10
2	118	19	118	19	118	19	118	19	61.4	10
3	349	57	278	45	287	47	349	57	122.8	20
4	147	24	188	31	193	31	147	24	122.8	20
5	0	0	0	0	0	0	0	0	122.8	20
6	0	0	0	0	0	0	0	0	122.8	20

* VSS classes 1=unstocked opening, 2=<5 inches diameter at breast height (dbh) (4.5 feet); 3=5 to 11.9 inches dbh; 4=12 to 17.9 inches dbh; 5=18+ inches dbh; and 6=old-growth.

would be created. Post-treatment effects would be an overabundance of VSS 3 and VSS 4, and a shortage in the remaining VSS classes. The post-treatment lack of sites in the VSS 5 and 6 classes is due to a current lack of sites in these classes. Over time a few stands in the VSS 3 and 4 classes would grow and shift into the VSS 4 and 5 classes, respectively, and none would age into the VSS 6 class (see Tables 19 and 20 depicting VSS in 20 years and in 50 years and within PFA in Table 25).

Under Alternative E there would be no improvement in the condition of the PFA. Alternative E treatments would improve habitat conditions conducive for goshawk nesting north of Kelly Canyon outside the urban-interface zone and outside the PFA due to an increase in the VSS 5 class, although there would continue to be a lack of appropriate nesting stands. Little improvement toward nesting habitat would occur south of Kelly Canyon. Northern goshawks are expected to continue to forage in the project area, with prey species diversity increasing north of Kelly Canyon. Thinning would increase vigor and growth of remaining trees, and understory herbaceous vegetation would be enhanced, although not to the extent as the other action alternatives. There would not be a reduction in the high fire hazard potential under Alternative E.

Under all action alternatives, all yellow pine trees will be deferred from treatment and retained across the project area. Yellow pines are important for goshawk nest areas. Thinning from below of smaller trees around yellow pines would occur to improve tree longevity. Under Alternative E thinning around yellow pines may be less than that of the other action alternatives due to a 9-inch diameter limit for many sites. Sites would also be managed in efforts to retain snags, logs and woody debris, which is habitat for prey species.

Under Alternative B, the dense forest canopy would persist and the forest structure would continue to be dominated by VSS 3 class. Over time a few stands would shift into the VSS 4 class (see Tables 19 and 20 depicting VSS in 20 years and in 50 years). There would continue to be a severe lack of nesting stands (VSS 5 and 6 classes). There would be no improvement in habitat conditions for northern goshawk. However, goshawks are expected to continue to forage in the project area.

Under Alternatives B and E, the high fire hazard potential would persist and devastation of goshawk habitat may occur in the event of a large wildfire.

Table 24. Canopy Cover Distribution Outside of the Northern Goshawk PFA.

GENERAL (Does not include PFA)									
	Existing Conditions Alternative B		**Alternatives A and D**		**Alternative C**		**Alternative E**		**Recommended Standards for Ponderosa Pine**
VSS*	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	
4A	170	10	557	42	560	39	318	21	VSS 4 average canopy cover 40+ percent
4B	941	55	737	55	839	58	845	56	
4C	609	35	38	3	38	3	355	23	
Sum	1,720		1,332		1,437		1,518		
5A	185	41	227	33	222	33	235	37	VSS 5 average canopy cover 40+ percent
5B	185	41	387	56	381	56	315	50	
5C	79	18	79	11	79	11	79	13	
Sum	449		693		682		629		
6A	0		0		0	0	0	0	VSS 6 average canopy cover 40+ percent
6B	210	100	210	100	210	100	210	100	
6C	0		0		0	0	0	0	
Sum	210		210		210		210		

* VSS classes: 4=12 to 17.9 inches dbh; 5=18+ inches dbh; and 6=old-growth. A=<40 percent canopy cover, B=40 to 60 percent canopy cover, C=>60 percent canopy cover.

Table 25. Canopy Cover Distribution Within the Northern Goshawk PFA.

	Existing Conditions Alternative B		Alternatives A and D		Alternative C		Alternative E		Recommended Standards for Ponderosa Pine
VSS*	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	
4A	0	0	0	0	0	0	0	0	VSS 4 average canopy cover 60+ percent (1/3) and 50+ percent (2/3)
4B	108	74	100	72	104	73	108	74	
4C	39	26	39	28	39	27	39	26	
Sum	147		139		143		147		
5A	0		0		0		0		VSS 5 average canopy cover 50+ percent
5B	0		0		0		0		
5C	0		0		0		0		
Sum	0		0		0		0		
6A	0		0		0		0		VSS 6 average canopy cover 50+ percent
6B	0		0		0		0		
6C	0		0		0		0		
Sum	0		0		0		0		

* VSS classes: 4=12 to 17.9 inches dbh; 5=18+ inches dbh; and 6=old-growth. A=<40 percent canopy cover, B=40 to 60 percent canopy cover, C=>60 percent canopy cover.

Table 26. Sites within the Northern Goshawk PFA Showing Future Conditions in 20 Years and 50 Years Post-treatment for All Action Alternatives compared to Alternative B, No Action, Kachina Village Forest Health Project, Coconino National Forest, Arizona. Treated stands are shaded.

		Alternative B			Alternatives A & D		Alternative C		Alternative E	
Location	**Site**	**Current**	**20 Yrs.**	**50 Yrs.**	**20 Yrs.**	**50 Yrs.**	**20 Yrs.**	**50 Yrs.**	**20 Yrs.**	**50 Yrs.**
345	12	3C	3C	4C	4B	4C	4B	4C	4B	4C
345	13	3C	3C	3C	4B	5C	4B	5C	4C	4C
345	16	4B	4B	4C	4B	4C	4B	4C	4B	4C
345	17	2C	2C	3C	2C	3C	2C	3C	2C	3C
345	20	3C	3C	3C	4C	4C	4C	4C	4C	4C
345	21	3B	3C	3C	4B	4C	4B	4C	3C	3C
345	22	2C	2C	3C	2C	3C	2C	3C	2C	3C
345	25	3B	3C	3C	3C	3C	3C	3C	3C	3C
345	40	3C	3C	3C	3C	3C	3C	3C	3C	3C
345	41	3B	3B	3C	3B	3C	3B	3C	3B	3C
354	2	4C	4C	4C	4C	4C	4C	4C	4C	4C
354	3	3C	3C	3C	3C	3C	3C	3C	3C	3C
354	35	4B	4C	4C	4B	5C	4B	5C	4C	4C

Canopy Cover Associated with VSS Class

Canopy cover standards would be met under all alternatives outside the PFA (Table 24). Post-treatment canopy cover distribution for VSS 4 within the PFA would show a slight shortage for the 60+ percent class (C canopy cover); the desired condition is 33 percent. This result is attributed to current conditions. There are no sites that are in the VSS 5 and VSS 6 classes within the PFA, therefore, there is an acute lack of optimal nesting stands within the PFA.

In the long term under Alternatives A, C and D, a few sites within the PFA would grow and age into stands that would provide favorable nest stand conditions (Table 25). Alternatives B and E would have slower tree growth and would not offer optimal nest stands (VSS 5B-6) in the future, although Alternative E would show some improvement in tree growth over Alternative B.

Roads and Recreation in Northern Goshawk PFA

Recreation activities within the PFA may hinder goshawk reproduction. Currently there are roads and social trails that allow access to or traverse nesting areas within the PFA. Disturbance in nesting areas during the breeding season may cause goshawks to abandon the nest and possibly abandon future use of the nesting area. Under all action alternatives, social trails through nesting areas would be closed, thus benefiting northern goshawks. Road closures would also benefit northern goshawk by reducing disturbance. Under Alternative B, No Action, closure of social trails and some roads would not occur allowing continued access to nesting stands. Therefore, recreational activities would continue to hinder nesting use of affected stands and may adversely affect northern goshawk.

Cumulative Effects of Alternatives A, B, C, D, and E

Historical silvicultural practices of removing large sized trees and suppression of fires created a forest of existing conditions seen today.

The direct short-term effects of smoke disturbance to individual birds adds to similar effects in the Pumphouse Multiproduct Timber Sale area, the Airport Fuels Reduction Project broadcast burn, the Oak Creek Fuels Reduction Project area and State Section 26 burning. However, because ADEQ regulates burning, it is unlikely that these burns would occur simultaneously or even consecutively. In addition, there is enough unburned landscape surrounding these areas that birds can avoid burn areas, returning when smoke subsides.

The decrease in the number of snags and logs and subsequent impact on numbers of prey items adds to a similar effect in the above-mentioned projects where broadcast burning may occur. The cumulative decrease in snags does not result in significant cumulative effect, because other types of prey are available in all areas.

There is a shift toward the desired distribution of VSS classes and canopy cover. Changes in VSS distribution have occurred slightly in the Pumphouse Multiproduct Timber Sale area. The increase in prey species diversity due to an increase in herbaceous understory is additive to similar effects on the projects mentioned above. When combined, there is a positive trend toward Forest Plan desired conditions.

Improvement to nesting habitat forest conditions (Alternatives A, C, and D only) adds to similar improvements of the Pumphouse Multiproduct Timber Sale where nesting habitat is also improved. The closure of social trails in PFA's offsets the effects of social trails in other areas. The decrease in human disturbance from road and trail management activities offsets human disturbance that may occur in the surrounding landscape. The decrease in human disturbance is additive to similar decreases from trail and parking location in the Griffiths Spring area.

No undeveloped parcels of private land remain in the project area.

Cumulative effects are not expected to result in reduction of population viability or a negative trend for listing this species.

Sensitive Native Plant Species

Two sensitive plant species are included in the analysis herein: Flagstaff beardtongue, *Penstemon nudiflorus* and Flagstaff pennyroyal, *Hedeoma diffusum*.

Affected Environment

Flagstaff beardtongue grows in dry pine forests in north-central Arizona from 4,500 to 7,000 feet, flowering from June to August. It occurs on dry slopes with ponderosa pine in mountainous or hilly regions south of the Grand Canyon, in openings and

often along edges of openings and forested areas. It may occur on light, dry neutral soils in eroded or mountainous areas. It has been documented to occur near Anderson Mesa, Lake Mary, Luke Mountain, Mormon Lake, Stoneman Lake, and along Schnebly Hill Road and Oak Creek. Surveys for this plant species were conducted in 2000. Although there were no populations of this penstemon found during survey efforts, suitable habitat exists within the project area (PRD 5).

Flagstaff pennyroyal, a perennial herb, is restricted to scattered limestone and sandstone outcroppings of relatively undisturbed habitats. Habitat for this species consists of rock pavement, cliffs, limestone and sandstone in the ponderosa pine vegetation type, with canopy coverage from 0 percent to 86 percent, and between 4,500 to 7,000 feet elevation. Flagstaff pennyroyal flowers from May through September. The species is found in many areas on the Mormon Lake Ranger District. Surveys were conducted in 2000 and one population of Flagstaff pennyroyal was found within the project area, however, suitable habitat exists throughout most of the project area (PRD 5).

Direct Effects of Alternatives A, B, C, D, and E

Under all action alternatives, disturbance from mechanical activities and broadcast burning may impact individual plants. Alternative E would have a lesser impact due to fewer mechanical activities south of Kelly Canyon. For both species, spring prescribed burning will cause little damage to individual plants if plants are still dormant. Treatment activities would occur across the project area at different times; activities would be temporally and spatially separated. Effects would be short term. Population viability would not be impacted from treatment activities.

There would be no direct effects under Alternative B, No Action.

Indirect Effects of Alternatives A, B, C, D, and E

Under all action alternatives, the creation of grassy openings and reduction in the dense tree canopy in some areas would be beneficial to both species as both species inhabit more open areas or edges. Nutrient cycling from broadcast burning would be beneficial to plants. Any populations of these sensitive species are expected to rebound quickly following broadcast burning, and become larger and more robust with less litter and shade and increased availability of nutrients.

Under Alternative B, distribution of these plant species will be limited due to the dense nature of the forest in the project area. These species thrive in more open habitat conditions than currently exist.

Under Alternatives B and E the high fire hazard potential will persist. With the advent of a large wildfire, plant species would be impacted and populations may be lost due to large expanses of the forest burning at one time and areas would burn hot. Hot fires kill beneficial mycorrhizae in the soil (DeBano 1990, Wright 1996) and volatilize nutrients (Covington and Sackett 1984, 1990; DeBano 1990). Any nutrients that remain in ash may be lost due to erosion. Plants eliminated due to a large, hot-burning wildfire may take years to re-establish. Prescribed fires, which are low intensity fires, typically burn cooler than wildfires (DeBano 1990).

Recreation activities may impact plant species by crushing, trampling and dislodging plants. Impacts occur from hiking and biking due to creation of social trails through habitat and recreational activities such as rock climbing within habitat for these plant species. Off-road driving may crush plants. Under all action alternatives, management of recreation activities by closing social trails and roads would reduce impacts to sensitive plant species. The population of Flagstaff pennyroyal found during survey efforts is located at an access point to James Canyon where a social trail traverses this area. The road leading to this point would also be closed under all action alternatives, thus limiting access to this point and protecting the population. Under Alternative B, individual plants and plant populations of these sensitive species would continue to be at risk from limited favorable habitat and recreation activities.

Cumulative Effects of Alternatives A, B, C, D, and E

Past silvicultural practices targeted the harvesting of large trees and suppression of fires. This, in effect, created the dense forest condition we have today in the project area that is unfavorable to these sensitive plant species that favor more open habitats.

Impacts to individual plants from implementation of thinning, broadcast burning and trail and trailhead construction is additive to similar effects in similar projects in and surrounding the Kachina FHP. However, project design includes avoiding known plant populations where possible, so this cumulative effect is not great. No undeveloped parcels of private land occur in the project area. Flagstaff beard-tongue may have an additional cumulative effect

from reseeding efforts along highways and roadways. Like most penstemons, *P. nudiflorus* hybridizes easily. Seed mixes containing other penstemon species, like *P. strictus*, threaten this species genetically.

Plant response to broadcast burning (larger and more robust) is additive to similar effects that have or may occur in the Pumphouse Multiproduct Timber Sale, the Airport Fuels Reduction Project broadcast burn and the Oak Creek Fuels Reduction Project.

Creation of grassy openings and a decrease in canopy cover is additive to similar effects in Pumphouse Multiproduct Timber Sale, the State Section 26 thinning and the Oak Creek Fuels Reduction Project.

Reduction of impacts from recreation and road management activities add to similar effects in the Griffiths Spring and Fort Tuthill to Kachina Village Trail Projects.

Invertebrates

Affected Environment

Three sensitive species of invertebrates are analyzed herein. They are spotted skipperling (*Piruna polingii*), mountain silverspot butterfly (*Speyeria nokomis nitocris*) and blue-black silverspot butterfly (*Speyeria nokomis nokomis*). These three butterfly species inhabit moist meadows, seeps, springs and streams within ponderosa pine and mixed conifer vegetation types and, in some cases, other habitat types with riparian areas. The two silverspot butterfly species have specific life cycle requirements where they use *Viola* species: adults feed on thistles.

There are no documented populations of these butterfly species within the project area (PRD 6), however, suitable habitat does exist in the canyons and at Lindberg Spring, Griffiths Spring and Kelly Seep. The canyons are deferred from treatment; therefore, those associated riparian areas would be unaffected. A survey for invertebrate species was conducted in the summer of 2000.

A rehabilitation project would be implemented at Kelly Seep under all action alternatives that includes removal of old dilapidated fencing and debris and installing new fencing around Kelly Seep to improve riparian habitat conditions.

Direct Effects of Alternatives A, B, C, D, and E

Under all action alternatives, thinning would occur near the springs and seep. The springs and seep and meadows around them would be protected, however some individuals may be impacted from treatment activities, including rehabilitation efforts at Kelly Seep. These effects would be minimal and short term.

Alternative B (No Action) would not directly impact these species.

Off-road driving across meadows and other recreation activities, such as hiking and biking, may impact habitat and harm eggs, individual adults, or larvae. Butterfly collecting would have a negative effect.

Indirect Effects of Alternatives A, B, C, D, and E

Improvement to Kelly Seep under all action alternatives will be beneficial to these butterfly species. Reducing the canopy closure, checking tree encroachment and removing trees in and at edges of meadows would be beneficial for these species.

Under Alternative B Kelly Seep would not be rehabilitated, thus there would not be any benefits to these species. Favorable habitat would decrease over time as conifers encroach meadows and canopy closure increases.

The high fire hazard potential would persist under Alternatives B and E. A large wildfire event may destroy some habitat and eggs laid by these species, and kill or harm individual adults or larvae, thus adversely impacting these butterfly species.

Cumulative Effects of Alternatives A, B, C, D, and E

The Griffiths Spring Parking and Interpretive Trail affects these species. Other projects do not specifically affect springs, seeps or meadows.

Past silvicultural practices targeted the harvesting of large trees and suppression of fires. This, in effect, created the dense forest condition we have today in the project area. A dense forest canopy hinders growth of vegetation on the forest floor. This, in turn, limits food availability and habitat substrate necessary for the life cycles of these species.

Impacts to individuals during implementation of thinning near springs and seeps, and implementation of the rehabilitation of Kelly Seep adds to similar impacts during the construction of the Griffiths Spring Trail and parking area. Other habitats in the area are not affected, and population viability is maintained.

Improved habitat resulting from rehabilitation of Kelly Seep adds to similar improvements at the Griffiths Spring site.

Improved habitat resulting from rehabilitation of Kelly Seep, reduction of canopy closure, and more and larger openings, offsets the lack of these habitat components in other areas of the landscape, and maintains habitat while there is a loss of habitat from development of private land.

Invasive and Noxious Weeds

The ponderosa pine forest on the Coconino National Forest has been greatly disturbed by logging, livestock grazing, roads, recreation, and the recent expansion of cities, towns and summer homes. Studies of the 1996 wildfires around Flagstaff revealed a nonnative flora of over 30 invasive, noxious plants such as Russian thistle (*Salsola kali),* cheatgrass (*Bromus tectorum*), Dalmatian toadflax (*Linaria dalmatica*), bull thistle *(Cirsium vulgare*) and other species (Crawford et al. 2000; Griffis et al. 2001). Noxious weeds in the project area include cheatgrass, Dalmatian toadflax, bull thistle and diffuse knapweed (*Centaurea diffusum*).

Nonnative plant species often out compete native species and may become established in disturbed areas before native species. Replacement of native plant species with invasive, noxious weeds may impact herbivore populations (reducing the number of individuals) that are prey species for other sensitive wildlife species.

A weed risk assessment is completed for the preferred alternative for this project. Best management practices for weeds and integrated weed management practices are described in the assessment. Many species of noxious weeds are anticipated to be less in 20 years due to the implementation of this project. The intent of this project is to help restore a healthy, functioning ecosystem that will contain a diversity of native species that would check or reduce competition of nonnative and noxious plants. Cheatgrass and Dalmatian toadflax may increase over time. The forest will continue to implement best management practices to contain and control noxious weeds.

Management Indicator Species

The National Forest Management Act of 1982 requires that the effects of each alternative on fish and wildlife be estimated and that "certain vertebrate and/or invertebrate species present in the area be identified and selected as management indicator species" (36 CFR 219.19(a)(1)). Management indicator species were identified and selected for the forest, as noted in the Forest Plan (USDA Forest Service 1996). Management indicator species affected by this project are discussed below and in PRD 150, 151, 155 and 171.

Since the analysis for MIS for the Kachina Village Forest Health Project was completed, an updated forest wide evaluation of MIS was developed. An addendum to the wildlife report is complete and describes a review of the forest wide report (Project Record Document #171). None of the direct, indirect, or cumulative effects change per the July report. Some affected environment information has been updated in this FEIS.

Affected Environment

Forest indicator species predominately occur in mid-aged and mature stands, and do not indicate overall use patterns in the community or those of species of special concern. Passerine[21] bird use is highest in mature and especially old-growth stands. Passerine use by canopy density is evenly distributed with a slight preference for moderate canopies. Vegetative structural stage use by wildlife (Patton 1995, Benoit 1996) is fairly evenly distributed with slightly higher use in mature and old-growth forests and moderate and dense canopy stands. Young stands and open canopies are used the least. Large mammals follow an opposing pattern, with higher use occurring in openings, seedlings, and saplings than in mature or old-growth areas.

Existing human use in the Kachina Village FHP area is high. Road density is high, and there are many miles of social trails. High human use, combined with high road and trail densities, have the potential to impact all of the forest's MIS species and especially raptors, elk, passerine birds, turkey, and the northern goshawk in various ways. Human distur-

[21] A bird of the order passerineformes, examples are sparrows and bluebirds.

bance can cause raptors to abandon nests and move home ranges (Andersen, Rongstad and Mytton 1990, Vincenty 1974). Road use and recreation can cause elk and deer to draw within the woods to more quiet and undisturbed areas, with deer being more vulnerable to disturbance (Edge and Marcum 1991). The greatest impact area is 1/4 to 1/2 mile out from roads (Lyon et al. 1990, J.T. Thomas ed. 1979). Lack of wildlife cover and screening along roads exacerbates disturbance from road use (Gruell et al. 1976). Road use, off-road driving and trail use adversely impact turkeys; home ranges may be shifted and nests abandoned (Bailey and Rinell 1968, Holbrook and Vaughan 1985, Lindezey 1967). Jones and Barsch (1992) found that illegal take of wild turkey was high in northern Arizona, and that high road density is facilitating the illegal take of turkey. Some passerine birds are negatively affected from human presence, and other species are not (Garton et al. 1977, Van der Zande et al. 1984).

The following management indicator species are located within the project boundary and may potentially be affected from the project: Abert squirrel, elk, hairy woodpecker, mule deer, northern goshawk, pygmy nuthatch, and turkey.

Abert Squirrel

The Forest Plan designates the Abert squirrel as a management indicator species for early seral stage ponderosa pine forests. However, Abert squirrels use a variety of age classes and research from several locations has shown strong habitat associations with mature ponderosa pine. Recent research indicates that this species' best habitat is the intermediate to older aged forest (trees 9 - 22 inches dbh), where groups of trees have crowns that are interlocking or in close proximity (Dodd et al. 1998, Elson 1999). Squirrels favor scattered large trees and multi-storied stands mixed with poles. The project area currently exhibits good quality habitat for Abert Squirrel.

According to research conducted by Dodd, et al. (1998), Abert squirrels exhibit better recruitment and fitness in the ponderosa pine forest with tree groups of ≥ 5 interlocking canopy trees per clump, 9 groups per acre, and basal area of 150 sq. ft. per acre. They also recommend maintenance of ≥ 8 trees per acre that are 18+ inches in diameter. They showed that interlocking canopy trees are positively related to squirrel recruitment, and basal area is positively related to squirrel fitness.

Population trend for Abert squirrel on the Coconino National Forest is inconclusive since there is little Forest-specific data. Statewide information indicates a stable trend for hunter harvest of squirrels.

Elk

Elk are indicators of early seral stages of ponderosa pine, mixed conifer, and spruce-fir forests. Overall, elk are considered to be stable statewide (AGFD 2001b) and stable on the Coconino National Forest (USDA Forest Service 2002b). Productivity tends to be high and herds are located in all habitat types. The objective of the Arizona Game and Fish Department is to maintain a stable to gradually declining population over time, with specific objectives for specific areas (AGFD 2001a). Elk are found throughout the project area.

Hairy Woodpecker

This species is an indicator of snags in ponderosa pine, mixed conifer, and spruce-fir forests for suitable nesting and feeding habitat. Hairy woodpeckers are most abundant in mature forests with large old trees suitable for cavity nesting and are also common in medium-aged forests. Hairy woodpeckers prefer forests with dense canopies (Bushman and Therres 1988). They use tree cavities for roosting and winter cover and may excavate new cavities in fall to be used for roosting (Sousa 1987).

This species is experiencing loss of suitable breeding habitat in the form of snags, both range-wide and in Arizona. According to Latta et al. (1999), hairy woodpeckers are uncommon throughout their range yet common in their preferred habitat in Arizona. Data from the Coconino National Forest, as well as statewide data, indicate that hairy woodpecker populations are stable, or slightly increasing, on a long-range scale. Minor population decreases occur on a short-term scale (one to three years), but are generally followed by a recovery (USDA Forest Service 2002).

Mule Deer

This species is an indicator of early seral stages of aspen and pinyon-juniper forests. Early seral stages of ponderosa pine, mixed-conifer, and chaparral habitats are also important for this species. Mule deer typically summer at higher elevations in aspen and ponderosa pine forests and winter in pinyon-juniper woodlands found at lower elevations (Hoffmeister 1986). Mule deer are also found in the ecotone of the ponderosa pine forest and the pinyon-juniper woodland during the summer. Mule deer are browsers and prefer herbaceous, green shoots and fruits of shrubs and trees. This species also feeds on forbs and grasses (Burt and Grossenheider

1976, Hoffmeister 1986). Statewide, the mule deer population is declining (AGFD 2001b). Populations on the Coconino National Forest are considered to be declining (USDA Forest Service 2002).

Mule deer have the narrowest diet range of any North American ungulate. That is to say there is a limited number of plants they can use to their maximum dietary benefit. Deer tend to feed on forbs and browse with grasses in the spring and fall and, therefore, overlap somewhat with the other ungulates in the area. Deer are more cover dependent than elk. Excessive browse utilization has a relatively greater impact on deer compared to other species because it is a primary food item for them. Also, if other species (such as elk or domestic livestock) use browse before them, the larger twigs are not as easy to feed on or digest.

Northern Goshawk

This species is an indicator of late seral stages of ponderosa pine forests. Goshawks are relatively abundant and widespread, and although population trends are difficult to determine, there is no hard evidence of a considerable decline overall, but populations could be declining in some areas (NatureServe 2001). On the Coconino National Forest, northern goshawk territories have been monitored every year since 1989, with an average of 43 territories monitored from 1991 to 2001. The occupancy rate of territories has declined over these last 11 years; however, this does not signify a corresponding trend in population numbers. It is likely that nonbreeding goshawks would not be observed. During the later years of this time period, precipitation amounts have been below average. Climate may very well play an important role in whether or not northern goshawks breed in a given year, and would also influence nesting success of northern goshawks. Although the forest has some information on territory occupancy and reproduction, these data are not designed to detect changes in population trend. Total number of territories has increased and the statewide BBS data indicates a significant increase, but some indicators of occupancy and productivity appear to be declining on the forest, although year-to-year variability is high. At this time, the population status is considered to be inconclusive on the Coconino National Forest. Monitoring and surveys are ongoing on the forest. The northern goshawk is included in the Threatened, Endangered, and Sensitive Species section. Habitat capability modeling for northern goshawk is presented in this section.

Pygmy Nuthatch

Pygmy nuthatches are indicators of late seral stage ponderosa pine forests. The pygmy nuthatch is generally associated with mature ponderosa pine forests, where it prefers open, park-like stands of old, yellow pines. It is also found in dense pine forests, as long as large trees and snags are present. The pygmy nuthatch is also tied to old, large oak trees and cavities. This nuthatch requires dead trees or dead-top trees where it builds nests in cavities. Both in Arizona and North America, moderate threats exist on breeding and wintering grounds. Moderate threats are defined as habitat loss. Forest wide population estimates of pygmy nuthatches were not determined in the early 1980s, but the population trend was thought to be decreasing (USDA Forest Service 1982). Despite concerns about habitat trends for pygmy nuthatches, especially future trends for snag recruitment, data from the Coconino National Forest, as well as statewide data, indicate that pygmy nuthatch populations are stable on a gross, long-range scale. Dramatic population fluctuations occur on a short-term scale (one to three years). Small local populations, such as those in snowmelt drainages, may be temporarily extirpated, indicating a need for a change in management in those areas (USDA Forest Service Closure Orders 2002).

Turkey

Turkey is an indicator of late seral stage ponderosa pine forests, based on roost habitat requirements. Key habitat attributes for turkeys include: availability of roost trees in summer and winter range which consist of groups of large yellow pines; uneven-aged overstory structure; nesting areas; mast from ponderosa pine, pinyon pine, juniper, and oak; riparian areas around springs and seeps; and small openings for seed head and invertebrate production. Mast production is vital to how well turkeys over winter and it is tied to the amount and timing of precipitation. Turkey population trends vary depending on location. In the mid-1990s, the Arizona Game and Fish Department began to utilize information, such as the number of hunters seeing turkeys and the number of turkeys observed per day, gleaned from archery elk questionnaires as a more reliable index of turkey numbers. Data for the forest is available that shows the percentage of hunters seeing turkeys and the number of turkeys observed per day between 1997 and 2001 for GMU (Game Management Unit) 5A, 5B, 6A, 6B, and 7. For the last five years, GMU 7 shows a relatively stable trend, with all other GMUs showing a general

increasing trend for both percent of archery elk hunters seeing turkeys and the number of turkeys seen per day (USDA Forest Service 2002).

Forestwide Habitat Trends for Habitat Types Associated with Affected Management Indicator Species

Ponderosa Pine

Since inception of the 1987 Forest Plan, the age class distribution of ponderosa pine has remained dominated by mid-seral stage stands, with some loss of old-growth and older trees. The net result is a decrease in the distribution and number of old ponderosa pine trees within the pine matrix. Some early seral-stage habitat has been created, mostly by wildfire. Regeneration of ponderosa pine is limited, but is better on limestone soils, which occur primarily on the southern half of the forest. Management indicator species, discussed above, in ponderosa pine habitat are Abert squirrel (early seral stages), elk (early seral stages), pygmy nuthatch (late seral stages), northern goshawk (late seral stages) and turkey (late seral stages).

Ponderosa Pine Snag Component

Overall, snags in the ponderosa pine type on the Forest are being lost faster than they are being replaced, and large snags are lost at a disproportionate rate to small snags, resulting in a downward trend. This trend is greatest on the northern portion of the Forest, where illegal fuelwood cutting greatly affects snag densities. Areas of a stable to slightly increasing trend are located in protected canyons, wilderness, and portions of the southern end of the Forest, but overall densities are below Forest Plan guidelines. Management indicator species, discussed above, for the snag component of ponderosa pine habitat is hairy woodpecker.

Mixed Conifer and Spruce-Fir

The age class distribution of mixed conifer and spruce-fir has changed to some degree during the Forest Plan implementation period, mostly due to wildfire. Since 1989 stand-replacing fires affected approximately 12 percent of mixed conifer and spruce-fir on the Forest. Additional changes to age class distribution of mixed conifer and spruce-fir from tree growth and mortality has been relatively minor; however, a shift in species composition is occurring. Aspen and pine within the mixed conifer are being lost, and the white fir and Douglas fir components are increasing. In the snowmelt drainages along the Mogollon Rim, the big-tooth maple component of mixed conifer is declining as well (Martin 2002). Fir is more susceptible to insect and disease impacts than pine. As pine is replaced by fir, and the older fir component dies, the future trend of mixed conifer will be towards smaller and younger forests. Management indicator species, discussed above, for mixed conifer and spruce-fir is elk (early seral stages).

Mixed Conifer and Spruce-Fir Snag Component

The trend in snags in mixed conifer and spruce-fir is probably increasing due to a number of complex factors, such as wildfire, insect and disease. The tree mortality rate in this type is the highest on the Forest. The longevity of insect and disease killed fir is uncertain, and understanding is lacking regarding the persistence of snags versus recruitment rates. Management indicator species, discussed above, for the snag component of mixed conifer and spruce-fir is hairy woodpecker.

Aspen

Mid- to late-seral stage aspen are declining, due to both natural causes and management actions to regenerate stands. Some early seral stage stands are being created through wildfire and management activities, but recruitment is limited primarily due to grazing by animals. Management activities have not been implemented to a level, or over enough area, to prevent loss of aspen patches in the landscape and provide for adequate aspen recruitment. Management indicator species, discussed above, for aspen is mule deer (early seral stages).

Pinyon-Juniper

Age class distribution of pinyon-juniper woodlands has remained relatively stable. However the vigor of understory components continues to be affected, and erosion remains a concern in dense areas. Some old pinyon trees are being lost due to drought and resulting insect outbreaks. Management indicator species, discussed above, for pinyon-juniper is mule deer (early seral stages).

Habitat Capability Modeling Description

The Habitat Quality Index (HQI) model was used for habitat capability modeling. Modeling was completed for seven management indicator species that would potentially be affected under the project: Abert squirrel, elk, hairy woodpecker, northern goshawk, mule deer, pygmy nuthatch, and turkey.

HQI modeling is based on the value of forage and cover for vegetation type and structure and season of use. Forage includes any habitat that provides food for a species; vegetation for herbivores or prey for predators. Cover includes hiding, thermal, nests, or dens as habitat. The indices from HQI modeling for this project are used for relative comparisons between alternatives.

Action alternatives meet Forest Plan habitat capability desired conditions. Desired limits and acceptable changes regarding wildlife habitat capability are described in the monitoring plan section of the Forest Plan on pages 210 through 216.

Summary of Direct Effects for All Species for Alternatives A, B, C, D, and E

Under all action alternatives, disturbance to species would be reduced with management of recreation activities and road closures. Under all action alternatives, smoke effects from broadcast burning may disturb individual animals, although this would be short term and would not adversely affect any species.

Through time, based on estimated future VSS class distribution (see beginning of wildlife analysis section), Alternatives A, C and D would be more beneficial for late seral species due to greater increases in VSS 5 and 6 over the other alternatives. All alternatives would provide the same limited benefit to early seral species. Habitat would be provided for mid-seral species under all alternatives.

Under Alternative B elk, mule deer, northern goshawk, and turkey would be negatively affected by disturbance from recreation activities and road traffic; animals may move home ranges and may abandon nesting areas.

Indirect Effects for All MIS Species for Alternatives A, B, C, D, and E (Habitat Quality Index)

Under Alternative B, due to no change in current conditions, the high fire hazard potential would persist. Alternative E would present the same high fire hazard potential as Alternative B (refer to Fire Effects section). In the advent of a large wildfire under these two alternatives, forest habitat would be destroyed and population viability of forest-dependent species would be adversely affected. Alternatives A, C and D would reduce the threat of a wildfire event.

Abert squirrel Habitat Quality Index

Under Alternatives A, C, and D, cover would decline and forage would improve compared to existing conditions. The project area would be dominated by high quality forage (68.5 percent) and moderate quality cover (41.5 percent). High quality cover would occur over 24.3 percent of the project area. There are some areas that would not offer any forage value (16 percent) or cover value (16 percent).

Under Alternative E, cover would also decline and forage would also improve, but not to the same degree as under the other action alternatives due to the lesser amount of thinning south of Kelly Canyon. The project area would be dominated by high quality forage (63.5 percent) and moderate quality cover (43.6 percent). High quality cover would occur over 29.3 percent of the project area. There are some areas that would not offer any forage value (17.7 percent) or cover value (17.7 percent).

Under Alternative B, No Action, the project area is dominated by high quality forage (65.2 percent) and high quality cover (45.9 percent). Moderate quality cover occurs over 32 percent of the project area. There are some areas that do not offer any forage value (13.8 percent) or cover value (13.8 percent).

The Forest Plan requires to manage for at least 20 percent of potential habitat capability for Abert squirrel in 10K blocks as determined by the forest habitat capability model (page 125). All alternatives provide greater than 20 percent forage and cover habitat.

Considering cover and forage together, Alternative B offers the highest quality habitat for Abert squirrel.

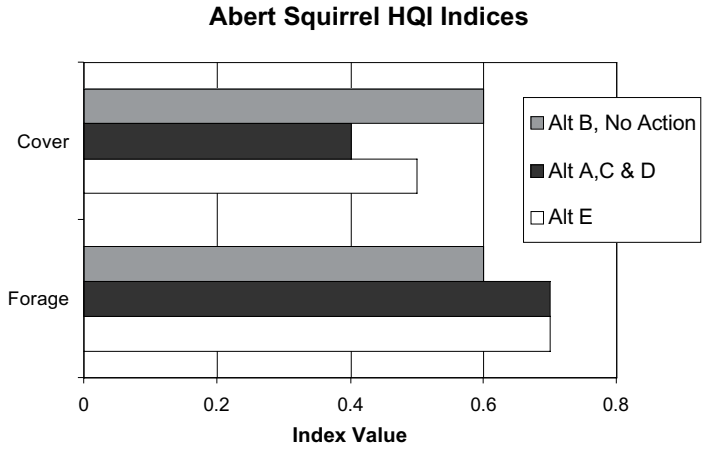

Figure 28. Results of Habitat Capability Modeling for Abert Squirrel.

On the other hand, the action alternatives would not greatly impact Abert squirrel, and would enhance habitat by creating uneven-age stand structure with tree clumping and edge effects. Edge effects are important for feeding opportunities (Dodd et al. 1998); squirrels could visit trees that produce more cones as the trees would be released from competition due to thinning treatments. With the modest estimated change in HQI from existing conditions, the action alternatives may not have a detectable effect on the population trend of Abert squirrel on the Coconino National Forest. The moderate change in forest structure for all action alternatives will not change the forest wide ponderosa pine habitat trend, which is predominately mid-aged. Additional population monitoring may occur as a result of proposed research and monitoring submitted by Arizona Game and Fish Department (see Chapter 2, "Monitoring").

Elk Habitat Quality Index

Under Alternatives A, C, and D, cover would decline and forage would improve compared to existing conditions. The project area would be dominated by moderate quality forage (65.4 percent) and moderate quality cover (51.5 percent). High quality forage (7.4 percent) and high quality cover (16 percent) would occur but would be limited. There are some areas that would not offer any forage value (24.5 percent) or cover value (30.9 percent).

Under Alternative E, cover would also decline but not to the same degree as under the other action alternatives due to the denser condition of the forest in areas where a 9-inch diameter limit is imposed. Forage value would remain the same as under Alternative B, No Action. The project area would be dominated by moderate quality forage (64.9 percent) and moderate quality cover (55.3 percent). High quality forage (2.7 percent) and high quality cover (19.2 percent) would occur but would be limited. There are some areas that would not offer any forage value (28.2 percent) or cover value (23.9 percent).

Under Alternative B (No Action), the project area is dominated by moderate quality (44.7 percent) to low quality forage (16.5 percent). High quality forage is only represented by 2.1 percent of the project area. High quality cover occurs over 44.2 percent of the project area. There are some areas that do not offer any forage value (36.7 percent) or cover value (16.5 percent).

There would be adequate cover under all alternatives. Most foraging opportunities would occur under Alternatives A, C and D. Considering cover and forage together, all action alternatives would improve habitat quality for elk, with Alternatives A, C and D offering higher habitat quality. The creation and/or expansion of openings and broadcast burning will stimulate understory plant growth. This would provide more forage for elk. Thermal and hiding cover will continue to be provided. With the modest estimated change in HQI from existing conditions, the project may not have a detectable effect on the population trend of elk on the Coconino National Forest. Under all action alternatives for the Kachina Village Forest Health Project, the ponderosa pine habitat composition will remain dominated by mid-aged trees, VSS 3 and VSS 4 classes. The moderate change in forest structure under all action alternatives will not change the forest wide ponderosa pine habitat trend. There will be no change in mixed conifer forests within the project area. There is no spruce-fir forest within the project area.

However, elk population numbers are affected by hunting regulations governed by the Arizona Game and Fish Department and the number of elk permits issued. The goal of the Arizona Game and Fish Department is to decrease the number of elk on the forest with specified goals associated with specific Game Management Units (GMU's) (AGFD 2001a). The Kachina Village FHP falls into GMU's 6A, 6B and 7M (this is a metro unit created from parts of 5B, 6A

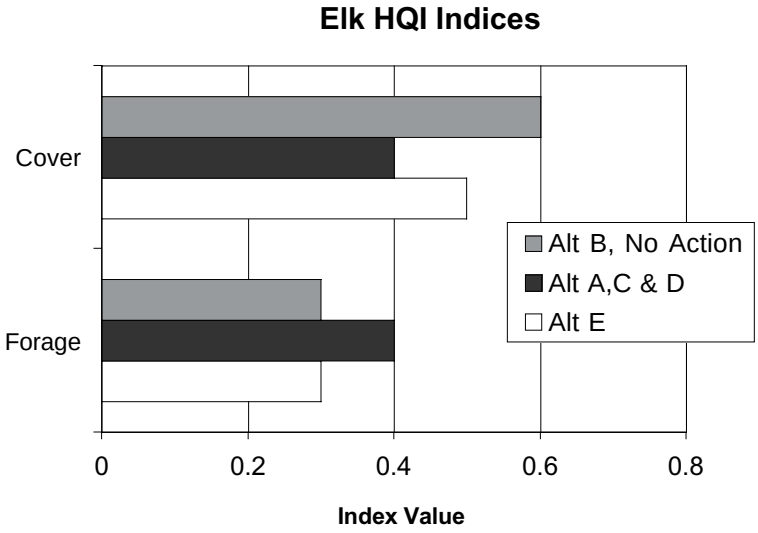

Figure 29. Results of Habitat Capability Modeling for Elk

and 7 in 2001). The goal of Arizona Game and Fish is to stabilize or continue reductions of elk in the project area (AGFD 2001a).

Hairy Woodpecker Habitat Quality Index

Under Alternatives A, C, and D, cover and forage would improve compared to existing conditions. The project area would be dominated by high quality forage (55.2 percent) and high quality cover (59.6 percent). There are some areas that would not offer any forage value (18 percent) or cover value (31.1 percent).

Under Alternative E, cover would also improve but not to the same degree as under the other action alternatives. Forage value would remain the same as existing conditions. The project area would be dominated by high quality forage (51.4 percent) and high quality cover (45.9 percent). There are some areas that would not offer any forage value (20.2 percent) or cover value (42.1 percent).

Under Alternative B (No Action), the project area is dominated by high quality forage (54.1 percent). High quality cover occurs over 30.1 percent of the project area, with low quality cover over 31.7 percent of the project area. There are some areas that do not offer any forage value (15.9 percent) or cover value (38.2 percent).

Considering cover and forage together, Alternatives A, C, and D would offer higher habitat quality. The greatest increase in VSS 5 class would occur under these three alternatives. This class contains large trees which are recruitment trees for snags. With the modest estimated change in HQI from existing conditions, the project may not have a detectable effect on the population trend of hairy woodpecker on the Coconino National Forest. Under all action alternatives for the Kachina Village Forest Health Project, the ponderosa pine habitat composition will remain dominated by mid-aged trees, VSS 3 and VSS 4 classes. The moderate change in forest structure in the project area will not change the forest wide ponderosa pine habitat trend. There will be no change in mixed conifer forests within the project area. There is no spruce-fir forest within the project area. Additional population monitoring may occur as a result of proposed research and monitoring submitted by the Arizona Game and Fish Department and Ecological Research Institute in cooperation with Northern Arizona Audubon Society (see Chapter 2, “Monitoring”).

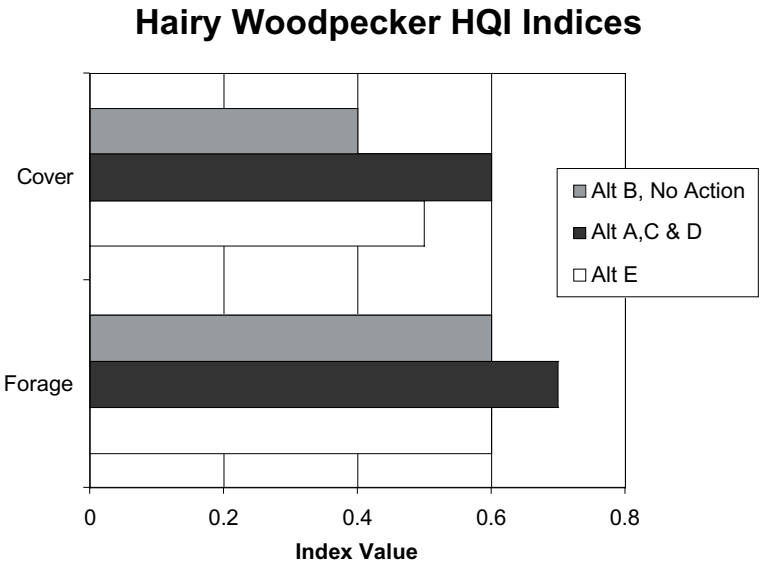

Figure 30. Results of Habitat Capability Modeling for Hairy Woodpecker

Northern Goshawk Habitat Quality Index

Under Alternatives A, C, and D, cover would improve and forage value would remain the same compared to existing conditions. The project area would be dominated by high quality forage (66.7 percent) and high quality cover (37.7 percent). There are some areas that would not offer any forage value (15.3 percent) or cover value (34.4 percent).

Under Alternative E, cover would also improve but not to the same degree as under the other action alternatives. Forage value would decline compared to existing conditions. The project area would be dominated by high quality forage (55.2 percent) and high quality cover (42.1 percent). There are some areas that would not offer any forage value (16.9 percent) or cover value (47 percent).

Under Alternative B (No Action), the project area is dominated by high quality forage (62.3 percent). High quality cover occurs over 27.9 percent of the project area, with low quality cover over 24.6 percent of the project area. There are some areas that do not offer any forage value (10.9 percent) or cover value (45.3 percent).

Considering cover and forage together, Alternatives A, C, and D would offer higher habitat quality. With the modest estimated change in HQI from existing conditions, the project may not have a detectable effect on the population trend of northern goshawk

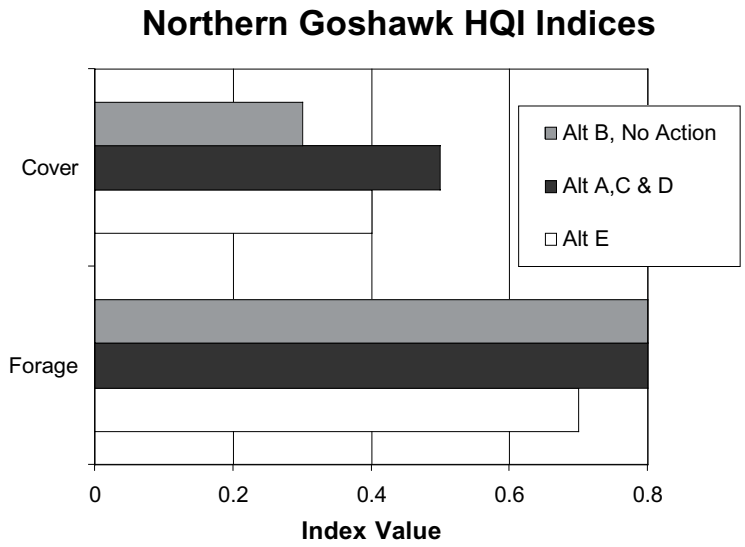

Figure 31. Results of Habitat Capability Modeling for Northern Goshawk.

on the Coconino National Forest. (See Figure 31.) Under all action alternatives for the Kachina Village Forest Health Project, the ponderosa pine habitat composition will remain dominated by mid-aged trees, VSS 3 and VSS 4 classes. The moderate change in forest structure in the project area will not change the forest wide ponderosa pine habitat trend.

Mule Deer Habitat Quality Index

Under Alternatives A, C, and D, cover would decline and forage would improve compared to existing conditions. The project area would be dominated by moderate quality forage (44.1 percent) and high quality cover (40.4 percent). High quality forage would occur over 28.7 percent of the project area. There are some areas that would not offer any forage value (24.5 percent) or cover value (17.6 percent).

Under Alternative E, cover would also decline and forage would also improve but not to the same degree as under the other action alternatives due to the lesser amount of thinning south of Kelly Canyon. The project area would be dominated by moderate quality forage (56.4 percent) and high quality cover (50 percent). High quality forage would be limited and occur over 11.2 percent of the project area. There are some areas that would not offer any forage value (28.2 percent) or cover value (19.1 percent).

Under Alternative B (No Action), the project area is dominated by moderate quality forage (37.2 percent) and high quality cover (68.1 percent). High quality forage is limited and occurs over 9.6 percent of the project area. There are some areas that do not offer any forage value (36.7 percent) or cover value (13.3 percent).

Considering cover and forage together, Alternatives A, C, and D offer higher quality habitat for mule deer. Thinning of stands, creation and/or expansion of openings, and broadcast burning will stimulate understory plant growth. This would provide more forbs and browse for mule deer. Thermal and hiding cover will continue to be provided. With the modest estimated change in HQI from existing conditions, the project may not have a detectable effect on the population trend of mule deer on the Coconino National Forest. Under all action alternatives for the Kachina Village Forest Health Project, the ponderosa pine habitat composition will remain dominated by mid-aged trees, VSS 3 and VSS 4 classes. There are no large stands of aspen within the project area; however, there are small patches of aspen. Although there are no treatments prescribed for aspen, the thinning from below of nearby ponderosa pine and broadcast burning will stimulate growth of aspen. There are no pinyon-juniper woodlands within the project area.

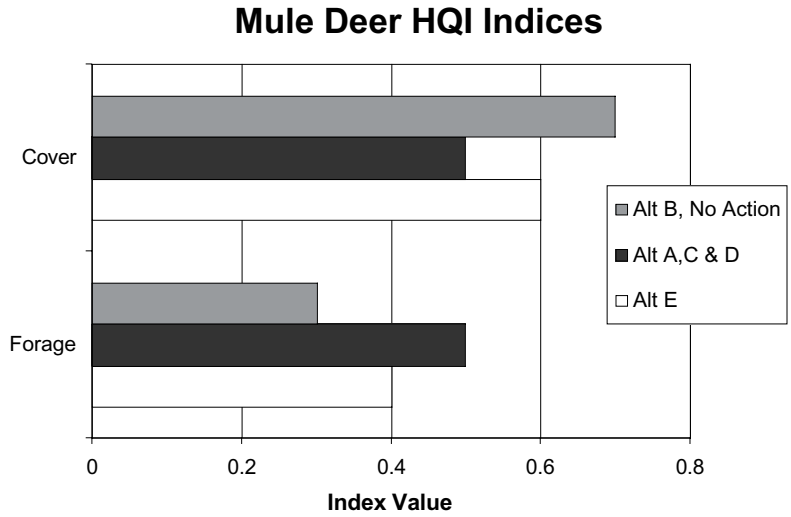

Figure 32. Results of Habitat Capability Modeling for Mule Deer.

Additionally, mule deer is hunted in Arizona and populations are affected by hunting pressures. The goal of the Arizona Game and Fish Department is to increase the number of mule deer (AGFD 2001b). Additional population monitoring may occur as a result of proposed research and monitoring submitted by the Arizona Game and Fish Department (see Chapter 2, "Monitoring").

Pygmy Nuthatch Habitat Quality Index

Under Alternatives A, C, and D, forage and cover values would improve. The project area would be dominated by high quality forage and cover (58.5 percent for both). Low quality forage and cover would occur over 25.7 percent of the project area. There are some areas that would not offer any forage or cover value (15.8 percent for both). There would be no moderate quality forage or cover.

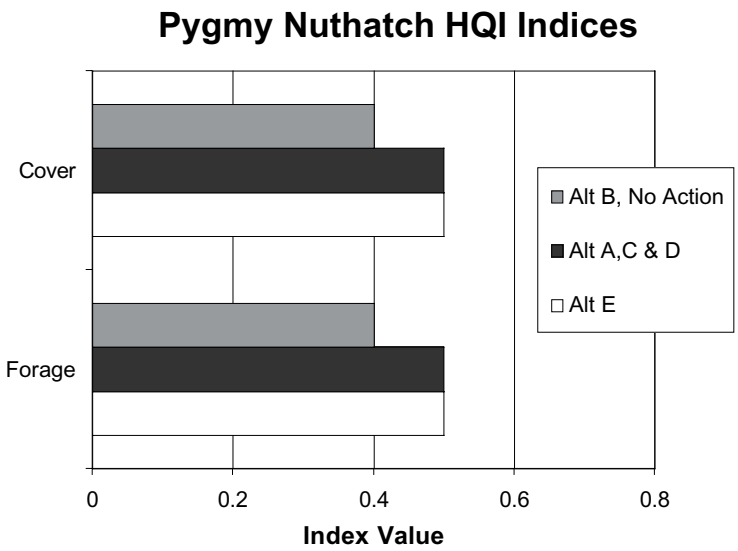

Figure 33. Results of Habitat Capability Modeling for Pygmy Nuthatch

Under Alternative E, forage and cover values would improve the same degree as under the other action alternatives. The project area would be dominated by high quality forage and cover (44.8 percent for both). Low quality forage and cover would occur over 37.7 percent of the project area. There are some areas that would not offer any forage or cover value (17.5 percent for both). There would be no moderate quality forage or cover.

Under Alternative B (No Action), the project area is dominated by low quality forage and cover (57.4 percent for both). High quality forage and cover occur over 28.9 percent of the project area. There are some areas that do not offer any forage or cover value (13.7 percent for both). There is no moderate quality forage or cover.

Considering cover and forage together, Alternatives A, C and D offer higher quality habitat for pygmy nuthatch. These three alternatives would increase the percentage of late seral stages of the forest the most. With the modest estimated change in HQI from existing conditions, the project may not have a detectable effect on the population trend of pygmy nuthatch on the Coconino National Forest. Under all action alternatives for the Kachina Village Forest Health Project, the ponderosa pine habitat composition will remain dominated by mid-aged trees, VSS 3 and VSS 4 classes. The moderate change in forest structure in the project area will not change the forest wide ponderosa pine habitat trend. Additional population monitoring may occur as a result of proposed research and monitoring submitted by the Arizona Game and Fish Department and Ecological Research Institute in cooperation with Northern Arizona Audubon Society (see Chapter 2, "Monitoring").

Turkey Habitat Quality Index

Under Alternatives A, C and D, summer forage and cover and winter cover values would decline compared to existing conditions. Winter forage value would improve. High quality summer forage and summer cover would be limited and occur over 20.2 percent of the project area. Moderate quality summer forage and cover habitat would be dominant and occur over 43.7 percent of the project area. Fifteen percent of the project area would not offer any summer forage or cover. Winter habitat would be dominated by high quality forage (38.2 percent) and moderate quality cover (42.6 percent). Moderate quality winter forage habitat would occur over 37.2 percent of the project area. High quality winter cover would be limited (14.2 percent). There would be some areas that would not offer any winter forage or cover value (16.4 percent for both).

Under Alternative E, summer forage and cover and winter cover values would decline. Winter forage value would improve compared to existing conditions. Moderate quality summer habitat would be dominant and occur over 53 percent of the project area. High quality summer forage and summer cover would be limited and occur over 22.4 percent of the project area. There would be some areas that

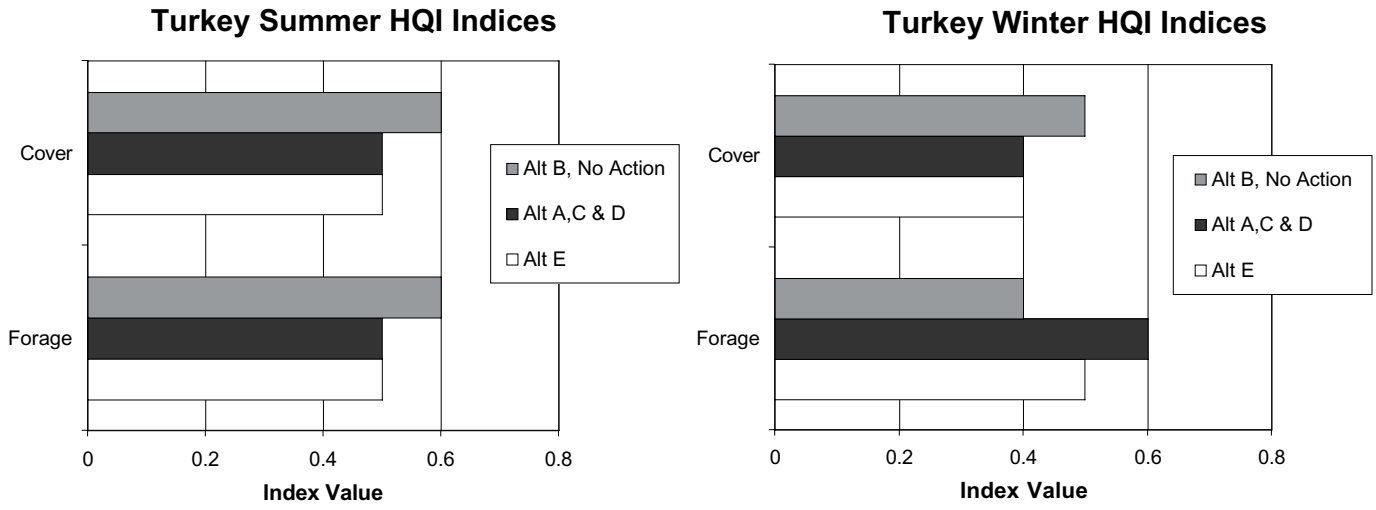

Figure 34. Results of Habitat Capability Modeling for Turkey

would not offer any summer forage or cover value (16.9 percent for both). Winter habitat would be dominated by moderate quality forage (47.5 percent) and moderate quality cover (59 percent). High quality winter forage and winter cover would be limited (23 percent and 14.2 percent, respectively). Some areas would not offer any winter forage or cover value (18 percent for both).

Under Alternative B, No Action, summer forage and cover habitat is dominated by moderate quality habitat (54.6 percent for both). High summer forage and cover habitat covers 27.9 percent of the project area. Some areas do not offer any summer forage or cover value (10.9 percent for both). Winter habitat is dominated by moderate quality forage (42.1 percent) and moderate quality cover (48.6 percent). High quality winter forage is limited (17.5 percent). High quality winter cover occurs over 32.3 percent of the project area. There are some areas that do not offer any winter forage or cover value (12 percent for both).

There is a mix in habitat values across alternatives. The HQI values may not adequately represent conditions for turkey. The other species analyzed herein have year-round habitat, while turkey have distinct summer and winter ranges. Turkeys forage and nest on the ground in openings or at edges and roost in large, old trees. Alternatives A, C and D would offer the most foraging and nesting habitat based on more created openings. Openings would promote greater amounts and vigor of growth of the understory vegetation and offer more edge effect. These three action alternatives would also offer the most roosting habitat due to an increase in VSS 5 class (refer to Tables 18, 19, and 20 at the beginning of the wildlife habitat section). With the modest estimated change in HQI from existing conditions, the project may not have a detectable effect on the population trend of turkey on the Coconino National Forest. Under all action alternatives for the Kachina Village Forest Health Project, the ponderosa pine habitat composition will remain dominated by mid-aged trees, VSS 3 and VSS 4 classes. The moderate change in forest structure in the project area will not change the forest wide ponderosa pine habitat trend. There will be no change in mixed conifer forests within the project area. There are no pinyon-juniper woodlands within the project area.

Additionally, turkey is a game species in Arizona and populations are affected by hunting pressures. The goal of the Arizona Game and Fish Department is to increase the number of turkey (AGFD 2001b). Additional population monitoring may occur as a result of proposed research and monitoring submitted by the Arizona Game and Fish Department and Ecological Research Institute in cooperation with Northern Arizona Audubon Society (see Chapter 2, “Monitoring”).

Cumulative Effects for All MIS Species for Alternatives A, B, C, D, and E

Projects considered for the discussion that follows are those listed in the introduction of this chapter.

Historical silvicultural practices of removing large-sized trees and suppression of fires created a forest

of existing conditions seen today. This current condition is not beneficial to most management indicator species.

In the long term, the development of forests that exhibit a mosaic of habitats creates a positive cumulative effect as treatments in this project and other areas produce a forest structure that would benefit many management indicator species.

The short-term effects of implementation activities associated with thinning, recreation and road management and rehabilitation of Kelly Seep are in addition to similar implementation of the other projects. However, the timing of implementation varies so that most of these projects will not be occurring simultaneously.

The direct short-term effects of smoke disturbance to individuals adds to similar effects in the Pumphouse Multiproduct Timber Sale area, the Airport Fuels Reduction Project broadcast burn, the Oak Creek Fuels Reduction Project area and State Section 26 burning. However, because ADEQ regulates burning, it is unlikely that these burns would occur simultaneously or even consecutively. These effects are short term and would not adversely affect any species.

Table 27. Listing of Priority Migratory Bird Species, by Habitat Type, (Latta et al. 1999) That Are or Have the Potential to be Found within the Kachina Village Forest Health Project Area.

Bird Species	Mixed Conifer	Ponderosa Pine, Pine-Oak	High Elevation Grassland	High Elevation Riparian
Northern goshawk	X	X		
Mexican spotted owl	X	X		
Olive-sided flycatcher	X	X		
Cordilleran flycatcher		X		
Purple martin		X		
Ferruginous hawk			X	
Swainson's hawk			X	
MacGillivray's Warbler				X
Red-faced Warbler				X

Table 28. Special Factors for Mixed Conifer Priority Species (Latta et al. 1999).

Priority Species	Special Factors
Olive-sided Flycatcher	Dietary: flying insects, esp. bees and wasps. Highly territorial on breeding and wintering grounds. High degree of foraging specialization only sallies for insects no gleaning from leaves or ground. Strong site fidelity in both breeding and wintering grounds. Declines may also be related to destruction of wintering habitat (from high site fidelity). Need snags higher than surrounding canopy. Rare cowbird host.

The reduction of human disturbance through recreation and road management activities is additive to similar effects in the Griffiths Spring and Fort Tuthill to Kachina Trail Projects. This reduction in human disturbance offsets other instances of disturbance in other areas. However, this cumulative effect is not great.

The changes in the amount and distribution of cover and forage for management indicator species is additive to similar affects which have or will occur in the Pumphouse Multiproduct Timber Sale, the Oak Creek Fuels Reduction Project and State Section 26. However, for all species there is a modest change in HQI from existing conditions that may not have a detectable effect on population trends, so there is no added effect to population trends from this project.

Migratory Birds

Affected Environment

Following is a listing of priority migratory bird species by habitat type (Latta et al. 1999) that are, or have the potential to be, found within the project area. Northern goshawk and Mexican spotted owl are discussed in the early pages of this document. Mixed conifer habitat is found within the canyons and is deferred from treatment.

Olive-sided flycatcher is associated with forest openings and edges with numerous dead trees and live mature pines. This flycatcher is a rare cowbird host.

Table 29. Special Factors for Ponderosa Pine and Ponderosa Pine-Gambel Oak Priority Species (Latta et al. 1999).

Priority Species	Special Factors
Olive-sided Flycatcher	Same as for mixed conifer.
Cordilleran Flycatcher	Need snags and downed trees for nesting. Rare cowbird host.
Purple Martin	Often prefers habitat near open water. Prefers tall snags adjacent to open areas.

Table 30. Special Factors for High Elevation Grassland Priority Species (Latta et al. 1999).

Priority Species	Special Factors
Ferruginous Hawk	Occur where larger populations of prairie dogs, ground squirrels, rabbits and pocket gophers exist. High sensitivity to human disturbance around nests.
Swainson's Hawk	Eat grasshoppers during migration and on wintering grounds. Have a wider variety of food sources than Ferruginous hawks: i.e., lizards, snakes, birds, ground squirrels, voles, and pocket gophers. Non-breeders hunt communally and eat primarily insects. Not as sensitive to human disturbance as Ferruginous Hawks.

Table 31. Special Factors for High Elevation Riparian Priority Species (Latta et al. 1999).

Priority Species	Special Factors
MacGillivray's Warbler	Obligate understory (dense) nester. Primarily breed in the White Mountains and locally above the Mogollon Rim, in a relatively small geographic area.
Red-faced Warbler	Ground nester.

Cordilleran flycatcher is associated with mid- to late-successional stages with dense canopy closure and drainages that create a cool microclimate. This flycatcher is a rare cowbird host.

Purple martin is associated with open canopy, open mid-story and open understory cover, and high snag density.

Swainson's hawk is uncommon during June, July and during migration and prefers larger openings than found on the project.

Ferruginous hawk is a migrant or uncommon during the winter, using openings much larger than in this project.

MacGillivray's warbler is associated with dense understory and riparian habitat at edges of conifer and deciduous forests. Red-faced warbler is associated with mid-story and dense stands, not necessarily tied to dense understory, and is found mostly in steep canyons. Both species are associated with the canyons in the project area.

Direct Effects of Alternatives A, B, C, D, and E

There would be no direct effects to migratory bird species discussed here.

Indirect Effects of Alternatives A, B, C, D, and E

Under Alternatives A, C and D, effects from thinning and broadcast burning treatments would benefit the olive-sided flycatcher and purple martin due to the creation of openings and the retention of snags and large trees. These three alternatives offer the least amount of dense forest canopy favored by the Cordilleran flycatcher. However, the small number of snags across the project area would limit the distribution of the purple martin. There would be little to no benefit for Swainson's hawk or ferruginous hawk because of the lack of large open lands. Canyons are deferred from treatment; therefore, there would be no affect to MacGillivray's warbler or red-faced warbler.

Alternative E would benefit olive-sided flycatcher and purple martin north of Kelly Canyon due to the creation of some openings. However, the small number of snags across the project area would limit the distribution of the purple martin. This alterna-

tive would retain dense stands south of Kelly Canyon and would favor cordilleran flycatcher. There would be no affect to Swainson's hawk, ferruginous hawk, MacGillivray's warbler or red-faced warbler. Additionally, Alternative E would not reduce the high fire hazard potential south of Kelly Canyon due to the 9-inch diameter limit.

Alternative B would retain dense stands and would favor cordilleran flycatcher. Additionally under Alternative B, the high fire hazard potential would persist. In the advent of a large wildfire, habitat for all species, except Swainson's hawk and ferruginous hawk, would be destroyed.

Cumulative Effects of Alternatives A, B, C, D, and E

Past silvicultural practices targeted the harvesting of large trees and suppression of fires. This, in effect, created the dense forest condition we have today in the project area that favors the cordilleran flycatcher.

Other projects considered are those described in the introduction of this chapter.

There are no direct effects from any of the alternatives and, therefore, no added affect when combined with other projects in and surrounding the Kachina FHP.

The indirect effect of creation of openings and retention of snags (Alternatives A, C and D) adds to similar effects that have or will occur in the Pumphouse Multiproduct Timber Sale, the Oak Creek Fuels Reduction Project and State Section 26.

Cultural Resources

Affected Environment

The Kachina Village Forest Health Project area contains a variety of non-renewable historic and prehistoric archaeological sites that reflect past land uses.

Archaeological evidence indicates that prehistoric use was focused on seasonal hunting, gathering, and food processing activities. Potential water sources in the area, such as precipitation runoff catchments and springs, probably attracted game and supported a diverse vegetative community that, in turn, attracted prehistoric people to the area to exploit these subsistence resources. Known prehistoric sites within the project area consist of limited activity lithic scatters, probably representing temporary camps. These sites probably range from Archaic to Proto-historic in age.

The project area is located at a relatively high elevation and contains several historic archaeological sites, including cabins, homesteads, and a historic cabin.

The project area may have been traditionally used by many Native American tribes, and the area has potential for continued, current use.

Direct Effects of Alternatives A, B, C, D, and E

Potential direct effects to cultural resources as a result of implementation of the alternatives include hand and mechanical thinning; lopping and scattering, piling, and windrowing slash; and pile, broadcast, and maintenance broadcast burning. Specific nonground-disturbing treatments may be allowed within prehistoric and historic archaeological sites that will contribute to the accomplishment of project objectives (reducing fuel loading and the risk of catastrophic wildfire) without affecting major qualities of the sites.

The archaeological clearance for the project documents the archaeological inventory, results of consultations with the tribes, and the determination of no adverse effect in compliance with the National Historic Preservation Act of 1966, as amended. The clearance report contains site-specific protection measures for implementation and monitoring requirements. (PRD 136a)

Consultations with tribes resulted in no specific concerns about the effect of the proposal. Tribal access will not be affected by the proposed project.

There are no direct effects from Alternative B.

Indirect Effects of Alternatives A, B, C, D, and E

Reducing fuel loads using methods that are nonground disturbing on and around archaeological sites is the most effective management tool for reducing the severity of potential wildfire damage and associated indirect effects such as erosion, enhanced visibility, and fire suppression damage to these nonrenewable resources.

Cumulative Effects of Alternatives A, B, C, D, and E

Since there is not an adverse effect to cultural resources because of the project activities, there is no added effect as a result of this project.

Economics

Economic analysis was conducted using techniques and methods developed by Dr. Debra Larson of Northern Arizona University. The analysis focused on the economic question of how 16 inch and greater diameter trees would contribute to total return estimates. Modeling runs were conducted using two product mixes and two logging systems reflecting local markets. Alternative B (No Action) could potentially result in a loss of over 1 billion dollars if Forest Highlands Subdivision were impacted severely by a large catastrophic fire event (Jim Pond, Highlands Fire Department personal communication). The cost to fight such a fire was estimated at 3 million dollars. Long-term impacts to Oak Creek Canyon, wildlife habitat and T&E habitat would be significant. Alternative A without a 16-inch diameter limit would result in a positive 5 to 10 percent change per CCF when compared to Alternative C. The estimated value of the 7,000 trees thinned using Alternative C is approximately $498,000 based on an estimated value per CCF, which is taken from Larson, D. 2000 (in press). However, given the poor tree form expected of the 16-inch diameter trees removed, the grade of these trees may not be realized in the market.

Table 33 shows the estimated present net value of each of the individual projects, and the alternative as a whole.

Direct and Indirect Effects

A brief financial cost analysis utilizing professional experience and knowledge and information and cost analysis for thinning activities provided by Dr. Debra Larson of Northern Arizona University was found to be the best fit, as economics was not identified as a major issue or objective for this project. The cost analysis conducted for thinning allowed us to look at both local logging systems and available markets to predict costs.

Table 32. Comparison of Cost Per Thousand Cubic Feet (CCF), Number of Trees Removed Greater than 16 inches dbh, and Estimated Value for All Action Alternatives.

Economic	Alternative			
Evaluation	A	C	D	E
Number of 16 and greater diameter trees removed	5,000 (16.1 to 17.9) 2,000 (18 +)	0	5,000 (16.1 to 17.9)	0
Estimated Value of 16" and greater diameter trees	$498,000	0	$373,500	0

Table 33. Estimated Present Net Value of Each Project and Alternative

	Alternative			
Project	A	C	D	E
Thinning	+510,090	+238,886	+402,045	670,975
Road Closures, Road Obliteration	10,500	10,500	10,500	10,500
Broadcast Burn	1,245,800	1,245,800	1,245,800	1,245,800
Riparian Restoration	10,000	10,000	10,000	10,000
Snag and Log Creation	50,000	0	25,000	0
Trails and Dispersed	175,000	175,000	175,000	175,00
Total Cost	981,210	1,202,414	1,064,255	2,112,275

None of the alternatives result in a positive net return (PRD 132). Alternative A is the least expensive to implement. Of the action alternatives, Alternative A is the least expensive to implement due to the value of harvesting 16-inch plus trees and the total volume harvested with the 50 basal area cuts resulting in the higher returns. These values do not represent total cost to the taxpayer, because both volunteer labor and private funding may be used to complete some of these projects.

Alternative C has a cutting limit of 16-inches diameter. Trees larger than 16 inches in diameter left uncut by a cap can have an effect on the economics of this project. A report done by Debra Larson summarizes the economic impacts to operators if a 16-inch dbh cutting limit had been imposed over the Fort Valley Research and Demonstration Projects (PRD Fort Valley 309.). She found that in absence of a pulpwood market, that two to three 16-inch dbh plus trees per acre harvested can have a positive economic value.

Economic impacts of thinning trees less than 16 inches (Alternative C) have been transcribed from the Larson report and are included below.

"The cost to conduct a forest thinning program to reduce the risk of catastrophic fire and restore forest ecosystem health is substantial.

Establishing a cap, which prohibits the cutting of 16-inches dbh and greater trees, has a negative effect on the economics of a forest thinning project.

Though the number of 16 to 21.9-inch dbh trees available for cutting in Fort Valley represents only a small percentage of the standing large trees, these trees represent a disproportionately large percent of the total volume to be cut, with profound effects on project economics. Larson's report only referenced the R and D plots, but the same effect applies to the entire Fort Valley project.

Economic effect of the 16-inch cap is related to the health of the Regional wood fiber market. A healthy market could support a restoration program, even with a cap. The current weak, subsistence market, probably cannot support the operators, if a cap is imposed."

Using Larson's calculation of a net loss to the operator of approximately $83 per tree if a 16-inch diameter limit is in place, 16-inch trees represent an approximate value of $498,000 in Alternative A and $373,500 in Alternative D.

The Forest Service has received comments that it failed to consider such indirect impacts as externalized economic costs of logging, such economic value on existing uses and functions of the area including: hiking, camping, mountain biking, horseback riding, cross country skiing, snowmobiling, sight seeing and use of outfitter/guide services, flood control, pest control, carbon sequestering, and many other "ecosystem services." In addition, these comments assert that our economic analysis fails to consider a wide range of costs that will be incurred by the public through loss of these "ecosystem services" and other externalized costs such as increased flooding, increased risk of death, injury, and property damage from logging operations, and increased fire risk.

The Forest Service has not received any comments from recreational users and/or outfitter/guide operators that Alternative A will impact their experience financially. Flood and other watershed questions are addressed in other effects discussion. This analysis considered loss of "ecosystem services," and the other externalized cost mentioned above and found either no impact, or at an inappropriate level of analysis for the Kachina Village Forest Health Project.

Cumulative Effects

The Flagstaff economy is very diverse. The forestry or logging sector makes up only a small percentage of the overall local economy. Jobs created by these activities include the continued development of markets for utilization of products in northern Arizona. New market development across the Southwest is very important in continuing treatments to reduce wildfire potential and improve forest health. This project may result in cumulative benefits to the employment and creation of new markets in the region.

Environmental Justice

The issue of environmental equity and justice in natural resource allocation and decision making is receiving increasing political and social attention. Following President Clinton's Executive Order 12898 (Federal Register, February 1994) all Federal land management agencies have been mandated to address environmental justice in nonwhite and/or low-income populations, with the goal of achieving environmental protection for all communities regardless of their racial and economic composition.

Alternatives A, B, C, D, and E do not result in disproportionate impacts to low-income populations, nor do they impact minority populations. As stated in the economics section above, the overall economy of the Flagstaff area, including its low income and minority populations, is diverse. The Flagstaff economy is strongly tied to the tourism industry, with forest products a very small percentage of the overall economy. Tourists are often traveling to destination points such as Flagstaff, the Grand Canyon, Oak Creek Canyon, or Sedona. Although tourists traveling on I-17 and Highway 89A appreciate the forest view, they would likely still travel to their destinations regardless of changes in that view.