Chapter 3. Affected Environment and Environmental Consequences

This chapter summarizes the physical, biological, social, and economic environments of the Warm Fire project area and the effects of implementing each alternative on that environment. It also presents the scientific and analytical basis for comparison of alternatives presented in the alternatives discussion in chapter 2.

The forest recognized there were many needs that resulted from the Warm Fire. Rehabilitation and recovery actions are listed on the "Warm Fire Rehabilitation and Recovery Plan and Status Summary" posted on the forest Web site and include: monitoring of BAER seeding effectiveness and reseeding if indicated; repairs and maintenance to existing rangeland improvements including pasture fences, corrals, and watering ponds will continue as provided under the grazing permit; maintenance of area roads; hazard tree removals along open Forest System roads and trails; and reforestation of previously planted regeneration treated areas to meet stocking guidelines. The Arizona Department of Transportation (ADOT) started removing dead trees within the Highway 67 right-of-way by the fall of 2006. Research projects have been proposed and additional resource specific projects are being considered. The forest does not consider these projects to be connected actions as defined by 40 CFR 1508.25 because they are managed for different values and purposes and not tied to the proposed actions. The cumulative effects of these projects are disclosed in this analysis where appropriate, to fully evaluate the effects on any given resource value.

In addition to considering the cumulative effects of other projects stemming from the Warm Fire, past, present and reasonably foreseeable projects were also considered, where appropriate, by analyzed resource. Table 10 is a listing of the known past, present and reasonably foreseeable projects considered. Cumulative effects were also analyzed for soils and watershed for the Snake Gulch and House Rock Wash 5th code watersheds (see "Soil and Watershed" section)

Table 10. Past, present and reasonably foreseeable activities for the Warm Fire planning analysis

Project Type Implementa-tion Status	Total Acres	Brief Project Description
Multiple Timber and Salvage Sales Past: 1970s-1990s	34,000	Multiple timber sales using varying harvest practices: Mistletoe, Lam's Lake, Jacob Timber, Jack Lily, Buckridge, Old Oak, Three Elks, Warm Spring, and Big Frac timber and salvage sales have shaped the existing vegetation condition in the Warm Fire planning area and are one component of the subsequent need for change. Past harvest left the analysis area deficit in stands dominated with trees >36 inches in diameter. Type of harvest and age since harvest affected the severity of the Warm Fire and residual live trees remaining.
Fire Supression Past/Present	All Acres	Fire Supression Activities: fire management has shaped existing vegetation in the Warm Fire Recovery planning area. Tree densities pre-fire were higher than pre-European management. Species intolerant of fire also increased in abundance (see table 15).
Wildfire and Burned Area Emergency Response Past	All Acres	The wildfire portion of the Warm Fire makes up the project area. BAER activities were completed in 2006-2007. Wildfire occurred on all project area acres. BAER rehabilitation activities followed large fires to address immediate resource needs, these included rehabilitation of fire lines through scarification and seeding of bare areas with nonpersistent grasses to establish ground cover to keep soil in place.

Project Type Implementa-tion Status	Total Acres	Brief Project Description
		The Warm Fire altered the forest by converting mature conifer forest to standing dead with grass/forb structural stage across the landscape as displayed in figures 12 and 13.
Grazing Allotments Past/Reasonably Foreseeable	All Acres	Cattle Grazing on FS Administered Lands: There is one allotment in the Warm Fire analysis area. Grazing removes some of the grass understory in the Warm Fire analysis area. Grazing in the burned area was deferred for 2 years for vegetation and soil protection, and is anticipated to be deferred until 2011 for protection of plantation areas.
Vegetation Management Present	4,000	Dry Park Vegetation Management Project: project is moving the vegetation closer to the forest plan desired conditions.
Jacob Lake Inn Expansion Present	58	Replace some existing facilities within the permitted area and construct new buildings. Some trees are being removed to accommodate the new buildings. Project restricted to existing impact area. Current ongoing expansion and renovation of FS lands.
Hazard Tree Removal Past/Ongoing	2,370	Hazard tree removal along highways and forest system roads and trails in the 2006 Warm Fire project. The decision for the hazard removal project was signed July 19, 2007. ADOT completed scenic byways. FS under contract began 2008.
Fuels Reduction Present	1,800	Lookout and Burnt Saddle will reduce fuel loads and reduce the risk of catastrophic wildfire (approximately 1,600 acres). Lookout ongoing S of Big Springs on NFSR 422 Burnt Saddle in GA 12 ongoing and almost done. Hwy. 67 Fuels Reduction: This project will remove small trees < 9" d.b.h to create a fuel break along Hwy. 67 (approximately 150 acres).
Wildlife Habitat Improvement Present	1,000	Ryan One free firewood cutting area to be followed with burning and planting approximately 1,000 acres of pinyon-juniper to improve forage for wildlife. Project in GA 12 started in 2007 and ongoing for several years.
Reforestation Present	1,600	Plant ponderosa pine and Douglas-fir seedlings within 1,607 acres within the Warm Fire area. Decision signed September 20, 2007; planting activities began in 2008.
Research Studies for Vegetation Response after Fire Present/ Reasonably Foreseeable	~300	Plots established prior to the fire will be revisited to observe the vegetative response after the fire in various locations throughout the burned area. Forest regeneration study to review seedling survival in the Warm Fire area.
Research Studies for Soil/Water Resource Impacts Reasonably Foreseeable	~20	Small areas identified to compare the effects on soils of salvage logging and no management activities. No disturbance anticipated from no treatment.

Project Type Implementation Status	Total Acres	Brief Project Description
Travel Management Reasonably Foreseeable	North Kaibab Ranger District	Roads analysis to designate motorized routes located on the North Kaibab Ranger District.
Future Vegetative Management Reasonably Foreseeable	6,109	Jacob Ryan Vegetative Management Project: project revised to propose moving vegetation closer to the forest plan desired condition for goshawk habitat and goshawk prey species habitat in ponderosa pine cover types in GA 13. Treatments are proposed on approximately 8,300 acres with even-aged and 18,100 acres of uneven-aged management, treatment of approximately 1,100 acres with dwarf mistletoe, and prescribe burn approximately 27,000 acres following mechanical thinning (some treatments overlap). No watershed, meadow restoration, wildlife or WUI involved in project only uneven-aged vegetation management.
Wildlife Habitat Improvement Reasonably Foreseeable	20,000	The West Side Habitat Improvement project would be a combination of seedlings, pinyon-juniper thinning, and cliffrose enhancement to improve mule deer winter range and grassland associated species habitat on the west side of the NKRD (18,000 acres). Fracas Habitat Improvement project would thin 2,000 acres of ponderosa pine for wildlife habitat improvement. This project area was burned during the Warm Fire. It is unknown at this time whether the original plan to conduct wildlife habitat improvement will occur. Cliffrose planting in portions of the area burned in the Warm Fire to improve mule deer winter range and grassland associated species habitat in burned areas. Wildlife and watershed rehabilitation work following Bridger Knoll Fire. Thinning dense pinyon-juniper and seeding.

Table 11. Pre-fire forest management in the Warm Fire suppression boundary*

Decade	Treatment	Acres
1970s	Salvage	188
1980s	Commercial thin	2,138
	Shelterwood	147
	Shelterwood final removal	46
1990s	Commercial thin	531
	Overstory removal cut	183
	Shelterwood	2,814
	Shelterwood final removal	1,038
	Group selection	604
	Improvement cut	48
	Seed tree	21
	Clearcut	44

*There are an additional 488 acres that were treated but information on year was unavailable.

In order to understand the contribution of past actions to the cumulative effects of the proposed action and alternatives, this analysis relies on current environmental conditions as a proxy for the impacts of past actions, of which the known actions recorded in the district databases are listed above. This is because existing conditions reflect the aggregate impact of all prior human actions and natural events that have affected the environment and might contribute to cumulative effects.

This cumulative effects analysis does not attempt to quantify the effects of past human actions by adding up all prior actions on an action-by-action basis. There are several reasons for not taking this approach. First, a catalog and analysis of all past actions would be impractical to compile and unduly costly to obtain. Current conditions have been impacted by innumerable actions over the last century (and beyond), and trying to isolate the individual actions that continue to have residual impacts would be nearly impossible. Second, providing the details of past actions on an individual basis would not be useful to predict the cumulative effects of the proposed action or alternatives. In fact, focusing on individual actions would be less accurate than looking at existing conditions, because there is limited information on the environmental impacts of individual past actions, and one cannot reasonably identify each and every action over the last century that has contributed to current conditions. Additionally, focusing on the impacts of past human actions runs the risk of ignoring the important residual effects of past natural events, which may contribute to cumulative effects just as much as human actions. By looking at current conditions, we are sure to capture all the residual effects of past human actions and natural events, regardless of which particular action or event contributed those effects. Third, public scoping for this project did not identify any public interest or need for detailed information on individual past actions. Finally, the Council on Environmental Quality issued an interpretive memorandum on June 24, 2005, regarding analysis of past actions, which states, “agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions.” For these reasons, the analysis of past actions in this section is based on current environmental conditions (see figure 11).

Climate Change Considerations

Most climate change predictions for the Southwest anticipate a warmer and dryer climate regionally. A warmer and dryer future climate can be expected in the Warm Fire area, and some of these effects are presently being experienced with the drought conditions the region has experienced over the last 10 to 12 years. Drought conditions contributed to the intensity and large size of the Warm Fire. It is unknown if the present drought is temporary or a natural cycle versus a result of long-term climate change; however, tree vegetation responses are similar whatever the case.

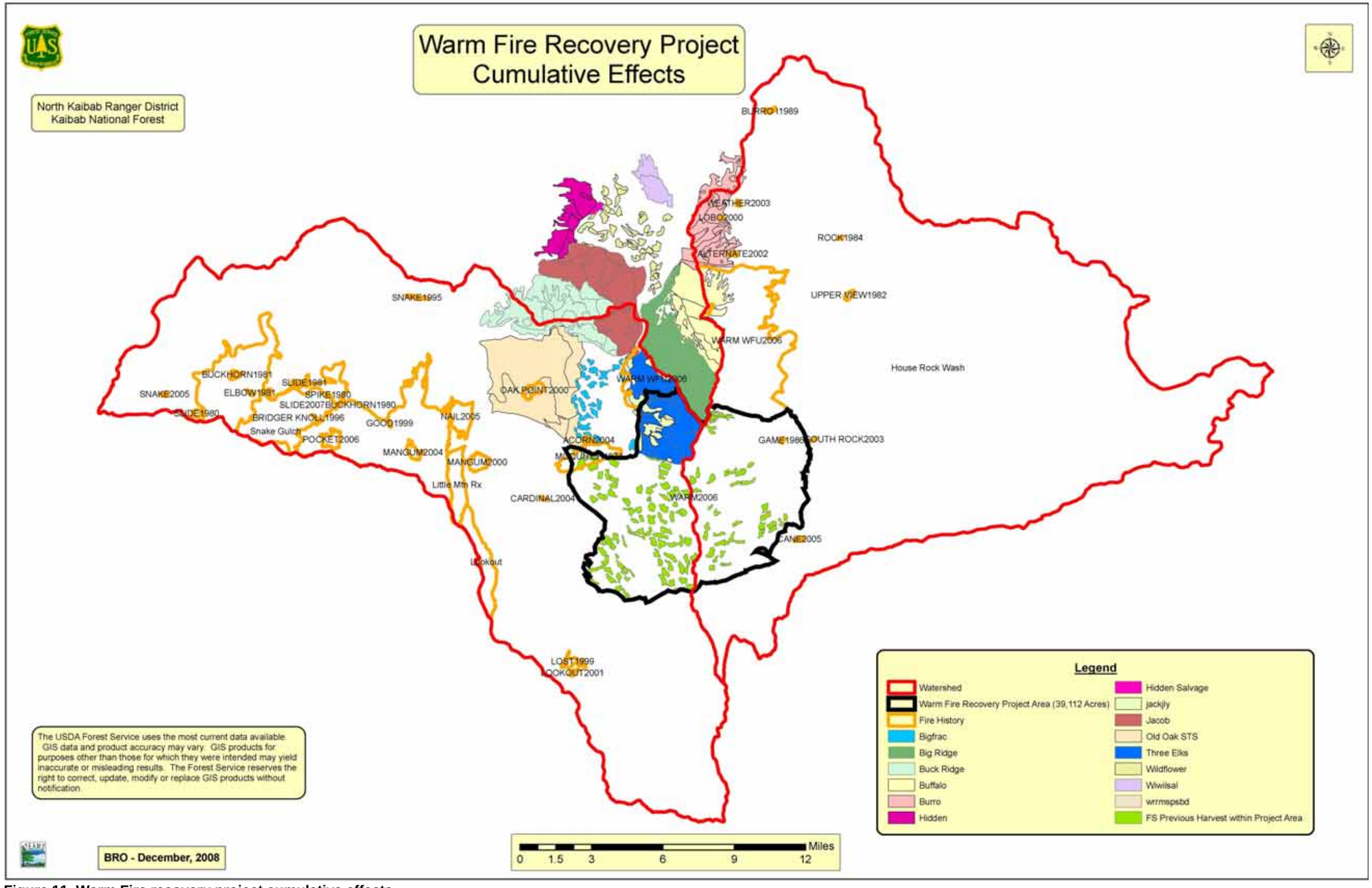

Figure 11. Warm Fire recovery project cumulative effects

Vegetation Resources

Management Direction - Laws, Regulation and Policy

The forest plan made land allocations using management areas, each of which emphasizes a particular desired condition (DC). Forest plan standards and guidelines provide direction for achieving the DC. The project area includes two geographic areas.

The following narratives summarize forest plan direction influencing the forest vegetation activities (salvage timber harvest and tree planting).

Regionally Consistent Standards and Guidelines

These standards and guidelines come from the forest plan (USDA Forest Service 2004a). They apply to the entire forest and regulate management with respect to Mexican spotted owl habitats, northern goshawk habitats, grazing management, and old growth.

Mexican Spotted Owl

Guidelines – Restricted Areas (Mixed Conifer)

- Attempt to mimic natural disturbance patterns by incorporating natural variation, such as irregular tree spacing and various patch sizes into management prescriptions.
- Allow natural gap processes to occur, thus producing horizontal variation in stand structure.
- Retain substantive amounts of key habitat components: snags 18 inches in diameter and larger, down logs over 12 inches midpoint diameter, hardwoods for retention, recruitment and replacement for large hardwoods.

Note: Plan standard and guidelines pertaining to protected activity centers (PACs) were removed from this section since there are no PACs on the North Kaibab Ranger District.

Ecosystem Management in Northern Goshawk Habitat

Standards

- Manage for uneven-age stand conditions for live trees and retain live reserve trees, snags, downed logs, and woody debris levels throughout woodland, ponderosa pine, mixed conifer and spruce-fir cover types. Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape. Sustain a mosaic of vegetation densities (overstory and understory), age classes and species composition across the landscape. Provide food and cover for goshawk prey.

Guidelines – Vegetation Management

- The distribution of VSS, tree density, and tree age are a product of site quality in the ecosystem management area. Use site quality to guide in the distribution of VSS, tree density and tree ages. Use site quality to identify and manage dispersal PFA and nest habitat at 2.0- to 2.5-mile spacing across the landscape.

- Snags are 18 inches or larger d.b.h and 30 feet or larger in height, downed logs are 12 inches in diameter and at least 8 feet long, woody debris is 3 inches or larger on the forest floor.

Management Area Direction

Geographic Area 13: 36,041 acres of National Forest System lands in the project area.

Standards

- Implement resource operations and improvements which contribute to achievement of desired conditions and fulfillment of the Forest Service mission.

Guidelines for Timber Resource Operations and Improvements

- Salvage stands, or parts thereof, that are moderately or severely damaged by dwarf mistletoe, insects, fire, or windthrow using shelterwood or clearcutting with planting methods; restrict ORV use during stand re-establishment.

Geographic Area 16: 3,069 acres of National Forest System lands in the project area.

Management Direction for Timber Resources

- Provide for environmental management of the timber resource with the objective of protecting or enhancing wildlife habitat and watershed values.

Analysis Points

Analysis points are elements of the analysis that are quantified to compare and evaluate the effects of each alternative. The following indicators are used to evaluate how well each contributes toward meeting the desired condition of forest vegetation in the project area.

- Acres occupied by the appropriate native tree species as dictated by site conditions (elevation, aspect, soils, etc.). The measure used to quantify this is cover type.
- Percent of the potentially forested acres that had a prefire mixed conifer, aspen and ponderosa pine cover types within the desired vegetative structural stages (VSS) described in the forest plan (USDA Forest Service 2004a).

Methodology

In order to compare the effects of alternatives on forest development over time, the establishment and growth of naturally occurring seedlings and planted seedlings are tracked into the future. As seedlings are established under the various burn severities and cover types, and because they add to overall stand composition and structure when combined with remaining live trees, stand development over time was modeled into the future to describe changes in cover type and structural stage. Monitoring and evaluation (USDA Forest Service 2008a) confirm these assumptions concerning vegetation recovery and logging effects made in designing this project.

Burn Severity Assumptions

The acreage by mortality class was compiled for each stand within the WFR project area. A stand level overstory mortality rating was then assigned based on the percentage of each mortality class within the stand. The stand level overstory mortality ratings are as follows:

- Low – Less than 30 percent mortality
- Mixed – Greater than or equal to 30 percent and less than 75 percent mortality
- High – Greater than or equal to 75 percent and less than 95 percent mortality
- Very High – Greater than or equal to 95 percent mortality

Mortality for each stand with stand exam data was then simulated in FVS based on these ratings and stand conditions were projected. For stands without data, forest conditions were extrapolated based on similar stands that did have data.

Natural Regeneration Assumptions

Accurate predictions of natural regeneration are difficult to make and must be based on a number of assumptions. Factors that affect natural regeneration are variable and unpredictable. For aspen, the number and condition of clones affects sprouting capability and sprout vigor. For conifers, the availability and abundance of seed in the canopy of fire-killed or injured trees would affect the resulting natural regeneration. Moisture conditions and microsite availability at the time of seed germination affects seedling establishment and growth. Germination percentage of the available seed is variable and affects seedling density. The timing and abundance of seed from future cone crops is variable. For example, Roccaforte et al. (2008) have found no conifer natural regeneration within two study areas within the Warm Fire, and forest monitoring observations (USDA Forest Service 2008a) found very sparse conifer natural regeneration on other fires that have burned on the Kaibab Plateau.

However, reasonable assumptions can be made and are necessary in order to describe stand development over time, and to then compare the effects of each alternative. Table 12 illustrates the assumptions used for natural regeneration.

Table 12. Natural regeneration assumptions

Mortality	Year	Species	Natural Regeneration Trees per Acre	Existing Condition for Conifers/Pre-fire Condition for Aspen
Low	2006	Aspen	150	>30 TPA, >5″ DBH
	2007	Ponderosa Pine	150	>30 TPA, >8″ DBH
	2007	White Fir	150	>30 TPA, >8″ DBH
Mixed	2006	Aspen	250	>10<50 TPA, >5″ DBH
	2006	Aspen	750	>50 TPA >5″ DBH
	2007	Ponderosa Pine	250	>30 TPA, >8″ DBH
	2007	White Fir	50	>15 TPA, >8″ DBH
	2012	Ponderosa Pine	100	>15 TPA, >8″ DBH
	2027	White Fir	50	>15 TPA, >8″ DBH

Mortality	Year	Species	Natural Regeneration Trees per Acre	Existing Condition for Conifers/Pre-fire Condition for Aspen
High	2006	Aspen	350	>10<50 TPA, >5″ DBH
	2006	Aspen	1,000	>50 TPA, >5″ DBH
	2012	Ponderosa Pine	50	>5 TPA, >8″ DBH
Very High	2006	Aspen	250	>10<50 TPA, >5″ DBH
	2006	Aspen	750	>50 TPA, >5″ DBH

The existing (post-fire) condition is used for conifers because conifer natural regeneration depends on a green tree seed source; the prefire condition is used for aspen because the amount of aspen sprouting after disturbance depends on the amount of aspen stocking prior to a disturbance.

Where salvage harvest is planned, natural regeneration is reduced by 20 percent to simulate the effect of equipment impact to natural regeneration that occurred prior to harvest. This is based on the assumption that logging equipment will potentially come in contact with up to 20 percent of a harvest unit, thus could potentially kill any natural regeneration it comes in contact with. This assumption is based on the design features included in the WFR project that are intended to reduce disturbance of recovering vegetation such as restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities, using existing skid trails where available, and limiting the operation of equipment to a single pass (entry and exit) to any area that is not located on a designated skid trail. Aspen clones are anticipated to resprout readily, while conifer regeneration may be slower to respond after damage, especially in areas away from seed sources.

Planting Assumptions

All proposed planting in salvage harvest units will be completed within 5 years after harvest, regardless of proximity to potential natural seed source. Planting stock availability, nursery failures, poor initial seedling survival, unexpected natural regeneration success, unexpected animal damage, and poor soil moisture and salvage harvest delays could extend the time required to accomplish the proposed planting. This is to promote prompt, vigorous recovery of appropriate forest cover.

The intent is to reforest these sites approximating historical stocking levels and species composition. Seedlings will be planted in groups with irregular spacing between each group after salvage operations are completed. The planting pattern will be based on the prefire stand structure with groups being concentrated adjacent to where legacy trees existed before the fire. The number of trees per planting was simulated based on the number of 21-inch trees that existed in the stand prior to the Warm Fire. It was then assumed that planting 6 trees per acre for each 21-inch tree would adequately approximate historical stocking. It was also assumed a minimum of 30 trees per acre would be planted. The range of planting intensity simulated was 30 to 160 trees per acre. We assume a 20 percent mortality rate in these planted seedlings over the first 5 growing seasons. Field examinations will be conducted after salvage operations to determine the required number of seedlings needed and the appropriate mix of species for the final silvicultural prescription.

Outside of harvest units, other areas where the soil inventory indicates a moderate to high potential for planting success are planned for planting, including some areas within the pinyon-

juniper areas. This includes snag corridors that are adjacent to salvage units and other areas that supported forest vegetation types prior to the fire. This analysis provides a coarse scale assessment of the location and acreage of the planned planting areas. Additional sites may also be planted with conifers in the future as needed, based on field reviews of site-specific vegetation recovery, an assessment of progress toward desired forested conditions, and the potential for planting success. It is assumed that any additional planting sites would experience similar cover type and structural stage development as discussed in this analysis.

Projecting tree and stand growth into the future is modeled using the Forest Vegetation Simulator (FVS), calibrated variant for the Southwestern Region. Stand development over time was modeled using existing stand conditions, as provided by site-specific stand exam data collected prior to the fire from 1985 through 2005, and with the natural regeneration and planting assumptions discussed above. Salvage functions are included as well so that estimates of future fuels, snags, and structural stages are based on realistic conditions. Growth projections do not necessarily predict the actual growth that will occur because the model cannot predict all factors that affect stand and tree growth. Model results are used to highlight relative differences, not absolute conditions. No future activities or fires are included in growth simulations, but periodic establishment of natural regeneration is modeled.

The planting levels and patterns respond to anticipated climate change of a warmer and dryer climate. Mimicking the historically less dense tree numbers and the grouped stand structure will create future forest stands that are at stand densities and of a structural arrangement such that they will be resilient under a variety of potential future climates. Lower densities are more likely to survive future drought stress, fire, and insect and disease problems.

Analysis Area for Direct and Indirect Effects

Direct and indirect effects discussions are limited to the Warm Fire Recovery project area. They will focus on the acreage established in appropriate forest cover. Indicators used are cover type and vegetative structural stage (VSS). (See wildlife discussion for old growth and goshawk habitat discussions.)

Cumulative Effects Analysis

A review of past, present and future activities concluded that:

1. Past timber sale activities are included in the forest data that was used in this analysis and, therefore, are included in summaries of effects.
2. Given management constraints and forest plan direction, grazing allotments and their management have no effect directly or indirectly on forest regeneration or structural stage development and, therefore, do not contribute to cumulative effects.
3. The conditions created from past wildfires are included in the stand database, and were considered in analyzing direct, indirect and cumulative effects.
4. Other past activities, present and ongoing activities and foreseeable future activities are not considered to have direct or indirect effects on forest vegetation within the WFR project area, and are not considered in cumulative effects. The proposed salvage areas include removal of dead material within stands of trees killed by the fire. These areas are considered in the grass forb structural stage (VSS 1).

The Warm Fire hazard tree removal (USDA Forest Service 2007a) and the Warm Fire reforestation activities (USDA Forest Service 2007d), planned under separate decisions, included hazard tree removal activities along highways and forest system roads and trails and reforestation within the WFR project area will have a direct effect on the project area and are included in the simulations for analysis of future species composition and vegetative structural stages.

Incomplete Information

Approximately 16 percent of the stands in the project area that supported forested cover types prior to the fire do not have site-specific prefire stand examination inventories. In order to proceed with analysis, a similar neighbor extrapolation process was used to fill information gaps although it was not used to determine specific features on an individual stand basis. Structural stage development over time (after the fire, but including reforestation) was simulated using the FVS stand growth model.

Forest Vegetation Conditions

The following section will discuss forest vegetation within the Warm Fire Recovery (WFR) project area in terms of species composition (cover type) and structure (vegetative structural stage) in the context of historic, pre-fire and post-fire conditions.

Cover Types

Cover types are named for the tree species presently dominant, using canopy cover as the measure of dominance. In the case of mixed conifer, several cover types have been lumped together into a single cover type grouping and codominance is not necessarily implied. The following is a description of the forested cover types that occur within the WFR project area.

Pinyon-Juniper (PJ)

Pinyon and juniper woodlands occur at elevations less than 7,200 feet generally on steep south-facing slopes in the higher elevations and on alluvial bottoms in lower elevations. Pinyon pine and Utah juniper are the dominant tree species with lesser amounts of Rocky Mountain juniper and one seed juniper. Shrub form Gambel oak is regenerating as ground cover on upland landforms, canyon drainages, and on alluvial fans. New Mexico locust is also present. The pinyon-juniper areas are the driest vegetation cover type in the WFR project area. This lack of moisture results in slower growth rates and slower regeneration following disturbance.

Ponderosa Pine (PP)

Ponderosa pine occurs from 7,220 to 8,040 feet and is typically bounded at upper elevations by mixed conifer forest and at lower elevations by grassland, pinyon-juniper forest, or chaparral. Extensive intergrading of species may occur at ecotone boundaries along gradients of slope, elevation, aspect and moisture. Ponderosa pine dominates the overstory with Douglas-fir and white fir often regenerating in the understory on undisturbed sites.

Mixed Conifer (MC)

The dry mixed conifer cover type is found at elevations between 8,000 and 8,700 feet on the Kaibab Plateau between the ponderosa pine and spruce-fir cover types. It is composed of the

white fir, subalpine fir, Douglas-fir and blue spruce cover types. The spruce fir cover type is a mix of Engelmann spruce, ponderosa pine, white fir and blue spruce above 8,700 feet.

Aspen (QA)

Quaking aspen is considered a relatively short lived, shade intolerant, disturbance dependent species, which is perpetuated on sites where fire, disease, avalanche, or other stand-replacing events are active (Bartos 2001). Aspen occurs as an early seral species in both the ponderosa pine and mixed conifer cover types and is considered an important successional community in these types. Where aspen occurs as the dominant overstory species, it exists as dense colonial stands interspersed with young and mature ponderosa pine and minor amounts of blue spruce, Douglas-fir and white fir. Dense aspen stands occupy the transition zones between upland conifer forests and meadows.

Vegetative Structural Stage Coding

Vegetative structural stage (VSS) portrays forest successional pathways, which includes the canopy cover and canopy layer. VSS is based on the tree size class with the highest square foot of basal area. Basal area includes all species. Table 13 describes the VSS coding. (See wildlife discussion for old growth and goshawk habitat discussions.)

Table 13. VSS descriptions

VSS	Successional Stage (d.b.h. in inches)	Canopy Cover	Stories
1	Grass-forb/shrub (Nonstocked, 0 to 1″)	Less than 10% tree canopy	N/A
2	Seedling/sapling (1″ to 5″)	A – Open (10-39%) B – Moderately Closed (40-59%) C – Closed (60%+)	N/A
3	Young forest (5″ to 12″)	A – Open (10-39%) B – Moderately Closed (40-59%) C – Closed (60%+)	SS – Single Story MS – Multiple Storied
4	Mid-aged forest (12″ to 18″)	A – Open (10-39%) B – Moderately Closed (40-59%) C – Closed (60%+)	SS – Single Story MS – Multiple Storied
5	Mature forest (18″ to 24″)	A – Open (10-39%) B – Moderately Closed (40-59%) C – Closed (60%+)	SS – Single Story MS – Multiple Storied
6	Old-growth (24″+)	A – Open (10-39%) B – Moderately Closed (40-59%) C – Closed (60%+)	SS – Single Story MS – Multiple Storied

For example: 4BMS is a mid-aged, multiple storied stand with between 40 and 59 percent canopy cover.

Analysis Area

The analysis area for forest vegetation includes all National Forest System lands contained within the part of the Warm Fire perimeter that was managed under a wildfire suppression strategy. This analysis area includes approximately 39,112 acres of National Forest System lands.

Affected environment is defined as that portion of the Warm Fire project area that could potentially be affected by the alternatives under consideration (CEQ 1992). For forest vegetation, the affected environment was defined using two activities from the proposed action: salvage timber harvest and tree planting. Table 14 summarizes the Warm Fire affected environment for forest vegetation.

Table 14. Forest vegetation acres for the Warm Fire analysis area

Warm Fire Project Area	Acres
Total NFS lands within the Warm Fire project area	39,112
Minus nonforested and nonvegetated lands	-1,340
Total forested or potentially forested lands within the Warm Fire project area	37,772
Salvage	
Minus forest land in inventoried roadless area	-5,726
Minus forest land with low and mixed low mortality	-12,005
Forest land considered for salvage	20,041
Minus forest land not selected for salvage harvest (e.g., due to steep slopes or lack of salvage material)	-10,927
Forest land included in the salvage proposed action (alternative 2)	9,114
Minus proposed action located on severe hazard soils or not strategic to fuels reduction.	-3,358
Forest land included in alternative 3	5,756
Forest land included in the salvage proposed action (alternative 2)	9,114
Minus proposed action located in designated MSO habitat or inoperable due to MSO designation	-3,573
Forest land included in alternative 4	5,541
Reforestation	
Minus forest land with low and mixed low mortality	-12,005
Forest land considered for reforestation	25,767
Minus forest land predicted to have adequate aspen natural regeneration	-4,800
Minus forest land with a low probability of regeneration success	-10,989
Forest land included in the planting proposed action	9,978

Historic Conditions

Historic refers to forest conditions prior to European settlement influence on ecological processes that shaped those conditions. Frequent low-intensity fire is the primary natural disturbance process that has been excluded since presettlement times due to fire suppression activities.

Fire Regimes

A fire regime is a description of the role fire plays in an ecosystem, based on characteristics of the disturbance, the dominant or potential vegetation being described, or the fire severity as it affects dominant vegetation (Agee 1993). Fire regimes are based on fire occurrence and behavior prior to European settlement and described with characteristics of frequency, seasonality, intensity, duration and size.

The three major cover types within the WFR project area are supported by varying fire regimes based on their geographic location, edaphic factors, and climatic factors. Fire regimes in the project area range from high frequency, low intensity in ponderosa pine, to mixed severity in the mixed conifer and pinyon-juniper. Generally, in low severity fire regimes, most trees survive a disturbance, while in high severity fire regimes, most trees are killed. A wildland fire disturbance that produces both low and high severity effects is called a mixed severity fire regime (Fulé et al. 2003a).

Historic Fire Regimes by Vegetation Type

Refer to the "Fire Risk and Fuels" section of this chapter for a full description of historic fire regimes by cover type.

Pre-Warm Fire Forest Vegetation Conditions

Changes to Fire Regimes after European Settlement

Prior to 1880, forest lands in the Grand Canyon area underwent repeated burns by large fires characterized by low severities and high fire frequencies, with fire sizes prior to European settlement reaching at least hundreds of hectares (Fulé et al. 2003a, 2003b). An abrupt disruption of the historic fire regime began with the arrival of Mormon settlers in the 1850s. Extensive livestock grazing commenced by the 1880s and in 1887 there were 200,000 sheep and 20,000 cows documented on the Kaibab Plateau. Large deer herds were blamed for overgrazing in the 1920s, 1930s and 1950s. Fire suppression started in the early 20th century (White and VanKat 1993). Most of the rim country experienced fire exclusion after 1879 with modern fire-free intervals about 5.5 times longer than historic at the two sites that Fulé et al. (2003b) studied.

Prefire Pinyon-Juniper (PJ) Composition and Structure

Woodland cover and stand densities have increased throughout the West over the last century. The increasing range of the pinyon-juniper woodlands has been attributed to a variety of factors, including grazing, lack of fire, and favorable climatic conditions.

Present day, dense pinyon-juniper stands are known to experience crown fires when high winds and low relative humidity occurs (Brown et al. 2000).

Prefire Ponderosa Pine (PP) Composition and Structure

Fire exclusion since the late 1800s has resulted in loss of the key ecosystem disturbance process from ponderosa pine forests. The rapid onset of fire suppression and domestic livestock grazing brought an abrupt cessation to this surface fire regime (Savage and Mast 2005). The results may be seen in denser forests, reduced understory species composition and plant cover, and higher accumulation of litter and duff on the forest floor (Gildar and Fulé 2004). Gildar and Fulé (2004) also found, when measuring burned and unburned sites in ponderosa pine forests in the Grand Canyon National Park, that tree density, forest floor vegetation, and coarse woody debris were significantly higher at the site that had not burned for at least 120 years.

Low intensity and frequent surface fires have been replaced with high intensity and infrequent crown fires. Areas that have not burned yet have a higher density of trees, especially of the smaller size class and younger age class (Allen et al. 2002; Covington and Moore 1994a; Dahms and Geils 1997).

Prefire Mixed Conifer (MC) Composition and Structure

The elimination of fire disturbance has resulted in more homogenous mixed conifer forests, with greater numbers of smaller, fire susceptible trees (Fulé et al. 2003a, 2004; Smith and Schussman 2006; White and VanKat 1993). The increase in young, fire intolerant trees such as spruce and fir now means greater vertical and horizontal fuel continuity when combined with dead fuel loading. This change in the fuel profile to an increase in ladder and crown fuels provides for a change in the historic fire regime from high frequency/mixed severity to infrequent/high severity.

In a study in south central Utah on the Paunsaugunt Plateau, Jenkins et al. 1998, state that the altered stand composition in favor of white fir and Douglas-fir observed since European influence could not have occurred with frequent, low-intensity fire. The reduction in surface fire is noted as altering community type structure and reducing the area occupied by aspen and ponderosa pine. They note the change in vegetation composition and structure has brought about a change in fuel loading and subsequently changed from a timber-grass understory fuel model to a closed timber-litter or timber-litter and understory fuel model.

Most of the mixed conifer type within the Warm Fire area was likely open ponderosa pine or dry mixed conifer habitat before human influences changed forest structure and composition. Moist, mixed conifer forests were largely limited to the highest elevations on the Kaibab Plateau (currently mapped as spruce-fir forest) and steep, north-facing slopes, creating pockets and stringers of mesic habitat within drier forest (Lang and Stewart 1910). In terms of fire ecology, dry mixed conifer functions similar to ponderosa pine habitat (Fulé et al. 2003a). A century of excluding frequent fire return intervals has allowed mesic, fire-intolerant species to migrate to lower altitudes (Fulé et al. 2003a; Cocke et al. 2005).

Prefire Aspen (QA) Composition and Structure

There is widespread concern over aspen decline in the West (Romme et al. 2001, Sheppard et al. 2001). Several factors have been hypothesized as causal agents in the decline of aspen, including fire exclusion.

Aspen stands are becoming denser and dominated by conifer species (Fulé et al. 2003a; Cocke et al. 2005). Without fire, the ability for aspen to regenerate is reduced, leading to further declines of aspen forests. The larger, relatively homogeneous stands of aspen that can develop on the North Kaibab Ranger District are unique for the Kaibab National Forest and of high value to an array of wildlife species.

Warm Fire Vegetation Conditions – Comparison Between Historic and Prefire

A generalized comparison of species composition and VSS between historic and prefire conditions illustrates how excluding fire as a disturbance process has affected forest composition and structure. Table 15 displays these concepts.

Affected Environment

Post-Warm Fire Vegetation Condition

Fire Effects to Vegetation

Refer to the "Fire Risk and Fuels" section of this chapter for a complete description of fuel conditions and vegetation mortality. Table 16 displays the percent of each cover type in each mortality class.

Species Composition – Cover Type

An assessment of post-fire (current) cover types indicates that 50 percent of the potentially forested acres (potentially forested acres are those that had a forested cover type prior to the Warm Fire) in the WFR project area are in a completely non-stocked condition with an additional 18 percent considered non-stocked but with a 1 to 9 percent tree canopy cover. Of the remaining 32 percent, approximately 27 percent are in the ponderosa pine cover type, 3 percent aspen, 2 percent mixed conifer and less than 1 percent pinyon-juniper. Figure 12 displays the acres and percent of potentially forested acres by cover type. (See wildlife discussions for old growth and northern goshawk habitat discussions.)

Table 15. Comparison of historic and prefire vegetation conditions

Cover Type (CT)	Historic Fire Regime	Species Composition		Major Vegetative Structural Stages		
		Historic	Prefire	Historic VSS	Prefire	
					VSS	Percent of CT
PJ	High Frequency, Fire Maintained, Open Grassland Savannas; Mixed Surface and Crown Fires in Denser Stands.	GRASS pinyon juniper	grass PINYON JUNIPER	1 3ASS 4ASS 5ASS	4AMS 4BMS 5CMS	24% 29% 24%
PP	High Frequency/Low Intensity	PP df wf qa	PP DF WF qa	5AMS 6AMS	3AMS 3CMS 4BMS 4CMS 5BMS 5CMS 6CMS	8% 9% 12% 15% 9% 12% 8%
MC	Mixed – Small Infrequent High Intensity with Widespread More Frequent/Low Intensity	PP DF wf bs QA	pp DF WF bs qa	5AMS 6AMS 1 2B 3BSS 4BSS	3BMS 4BMS 4CMS 5BMS	10% 28% 12% 10%
QA	Determined by Adjacent Forest – For the WFR Project Area It Is the PP or MC Fire Regime	pp DF WF BS QA	pp DF WF BS QA	3CSS 4CSS 5BMS	3CMS 4BMS 4CMS 4CSS 6CMS	15% 14% 28% 6% 6%

Historic species composition and VSS are inferred from descriptions in the literature cited. Species Composition – Capital letters indicate dominance or co-dominance; Lower case letters indicate present but subordinate. Prefire VSS data derived from Warm Fire Recovery database.

Table 16. Percent of cover type within each mortality class

Cover Type	Mortality Class			
	Low	Mixed-Low	Mixed-High	High
Pinyon-Juniper	3%	4%	12%	81%
Ponderosa Pine	23%	18%	12%	47%
Mixed Conifer	8%	7%	7%	78%
Aspen	15%	18%	15%	52%

Source – Warm Fire Assessment

Forest Structure - Vegetative Structural Stages

Approximately 67 percent of the potentially forested acres (potentially forested acres are those that had a forested cover type prior to the Warm Fire) are in the grass/forb shrub successional stage, which means they have less than 10 percent tree canopy cover. The remaining 32 percent of the forested acres within the WFR project have 10 percent or greater tree canopy cover (see figure 12). The approximate percent in each successional stage is: less than 1 percent in the seedling/sapling stage; 6 percent in the young forest stage; 9 percent in the mid-aged forest stage; 8 percent in the mature forest stage; 9 percent in the old-growth stage (see figure 13). Thirteen percent of the stands have 10 to 39 percent canopy cover with 19 percent having 40 percent or greater canopy cover while 27 percent are multistoried and 5 percent are single storied.

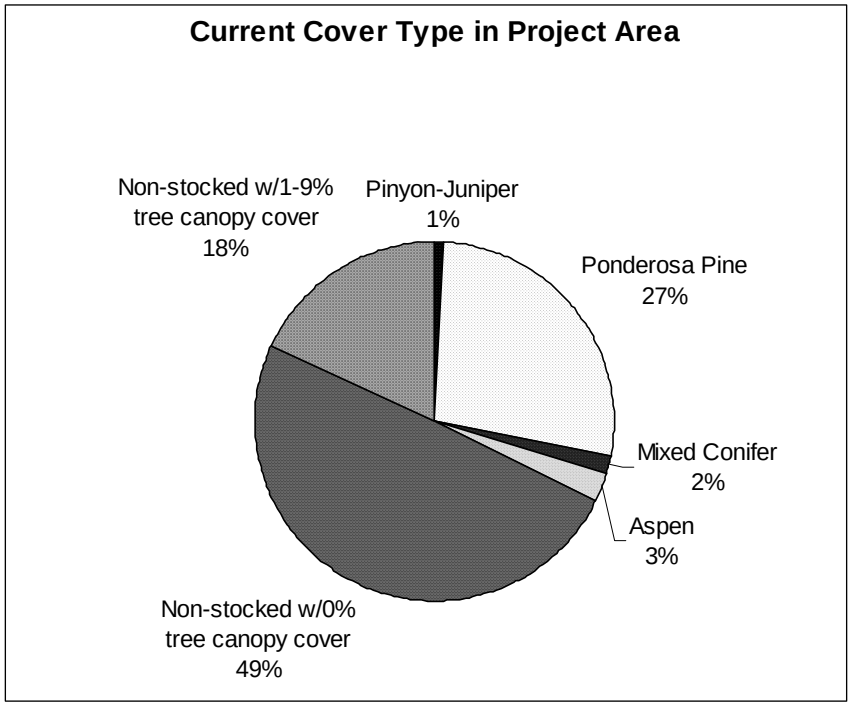

Figure 12. Current acres of cover type and percent of potentially forested acres

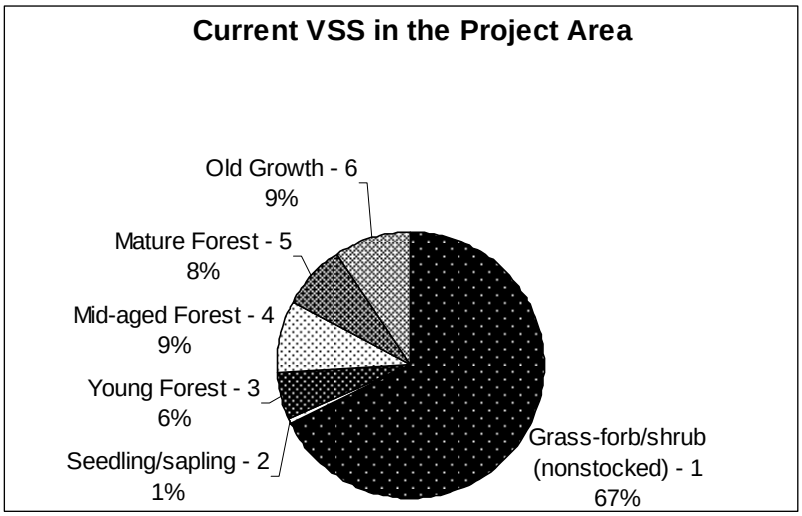

Figure 13. Current acres and percent of potentially forested acres for each VSS successional stage in the WFR project area

Table 17. Current acres and percent of potentially forested acres for each VSS category in the WFR project area

VSS	Acres	Percent of Potentially Forested Acres
1	25,580	67%
2A	191	<1%
2B	54	<1%
2C	0	0%
3AMS	608	2%
3BMS	600	2%
3CMS	548	1%
3ASS	237	<1%
3BSS	48	<1%
3CSS	146	<1%
4AMS	579	2%
4BMS	1,199	3%
4CMS	655	2%
4ASS	710	2%
4BSS	39	<1%
4CSS	33	<1%
5AMS	994	3%
5BMS	1,152	3%

VSS	Acres	Percent of Potentially Forested Acres
5CMS	512	1%
5ASS	261	<1%
5BSS	31	<1%
5CSS	16	<1%
6AMS	1,320	3%
6BMS	1,197	3%
6CMS	797	2%
6ASS	264	<1%
6BSS	1	0%
6CSS	0	0%

Potentially forested acres are those that had a forested cover type prior to the Warm Fire.

Environmental Consequences

Vegetation Response to Fire Common to All Alternatives for Untreated Areas

The post-fire vegetative response and composition depends on several factors including fire severity, prefire vegetation, and species adaptations to fire (Brown et al. 2003). The following is a discussion of how fire affects the major tree species and potential successional pathways for each of the cover types within the WFR project area.

Pinyon-Juniper

Pinyon pine and juniper trees are easily killed by fire. Both species have low fire resistance from seedling to maturity based on bark thickness and inability to regenerate easily after disturbance (Brown et al. 2000). A possible pathway of re-establishment from a post-crown fire pinyon-juniper stand to pinyon-juniper woodland may take up to 300 years and would potentially progress through the following successional stages (Brown et al. 2000):

1. Skeleton forest/bare ground
2. Annual stage
3. Perennial grass/forb stage
4. Shrub stage
5. Shrub open tree
6. Climax woodland

Pinyon-juniper stands in the Warm Fire area experienced mostly high intensity fire behavior and subsequent high severity effects, resulting in high levels of overstory mortality. Much of this prefire cover type of pinyon-juniper is now at the skeleton forest/bare ground stage, and will progress to the next stage based on the available grass/forb seed source and presence of sprouting shrub species such as Gambel oak. In pinyon-juniper areas experiencing less than high severity effects, the climax woodland stage still exists or the stands have been moved back to the shrub open tree stage. Some stands typed as pinyon-juniper at the higher elevations, are proposed for

conifer planting where ponderosa pine or mixed conifers were components of the stands prior to the fire, and where seed sources are currently lacking.

Ponderosa Pine

Savage and Mast (2005) studied multiple ponderosa pine sites that had experienced stand-replacing crown fire in the late 20th century.

Although the effects of large, stand-replacing wildfires are variable, several fires have led to long-term changes from forested systems. They identified three general pathways of vegetation response following fire. Pathways of vegetation response are:

- Ponderosa pine—crown fire to dense ponderosa pine regeneration
- Ponderosa pine—crown fire to shrub fields, Gambel oak, manzanita
- Ponderosa pine—crown fire to grass

They suggest that these alternative states after crown fire could be perpetuated by a fire regime favoring these compositions and structures, self-perpetuating themselves through stand-replacement disturbances.

They also state post-crown fire forests of high density ponderosa pine seedlings may be just as vulnerable to stand-replacing fires as those already considered at high risk (Savage and Mast 2005).

In the low and mixed-low fire severity sites on the Warm Fire in ponderosa pine sites, ponderosa pine seedlings were evident on the forest floor by August and September 2006. The ability of ponderosa pine to regenerate these sites and more severely burned sites will depend on surviving seed trees, competition from sprouting species, such as oak and aspen, as well as moisture conditions necessary to the seedlings survival.

Aspen

Quaking aspen (*Populus tremuloides*) is very competitive on burned sites. It often dominates a site after fire even where it was barely noticeable as a component of the prefire vegetation. Aspen has adapted to fire in many ways, including easy top-kill by fire so root systems can send up a profusion of sprouts, and rapidly growing sprouts that extract the needed water, nutrients and photosynthate from the post-fire extant root system (USDA Forest Service 2006a).

Aspen root suckering is affected by depth and diameter of parent roots. A study in Utah by Schier and Campbell found that over 90 percent of aspen sprouts following fire came from within 4.7 inches of the soil surface. On a Utah burn site, high severity fires appeared to increase the depth at which sprouts originated (USDA Forest Service 2006a). Moderate severity fire does not damage aspen roots. Severe fire may damage or kill shallow aspen roots, but deep roots are not damaged by fire and maintain the capacity to sprout (USDA Forest Service 2006a). Severe fire may result in fewer sprouts than moderate severity fires; however, since aspen is self-thinning, post-fire sprouting densities between moderate and severe fires achieve similar numbers several years after the fire (USDA Forest Service 2006a). Aspen is clearly evident and even abundant in the mixed-low, mixed-high, and high fire severity sites on the Warm Fire.

Douglas-fir

From seedling to pole-sized, Douglas-fir (*Pseudotsuga menziesii*) has a low branching habit and thin bark make it very susceptible to fire damage. Crown scorch can kill Douglas-fir. The low branching habit encourages damage to the crown, which can outweigh the insulative nature of the bark. However, as they mature, the bark thickens and survival of moderately severe fires is possible (USDA Forest Service 2006a).

The ability of Douglas-fir to re-establish following the Warm Fire will depend on a viable seed source and desirable growing conditions. Douglas-fir seed germinates and establishes best on bare mineral soils, conditions provided by fire disturbance. Douglas-fir seedlings need partial shade while they are very young, but once established, require full sunlight (USDA Forest Service 2006a). Regeneration success of Douglas-fir on the Warm Fire will depend on available and surviving seed trees, good seed crops, and accessible bare mineral seedbeds.

White Fir

White fir (*Abies concolor* var. *concolor*) is highly susceptible to fire damage as a young tree due to its thin bark, resin blisters on the bole, and drooping lower branches. As a result, young trees are easily killed by even low intensity surface fires. As trees mature, the bark thickens and the older trees develop some degree of fire tolerance. Following fire, white fir re-establishes via wind-dispersed seed (USDA Forest Service 2006a). White fir is an aggressive shade-tolerant tree that is able to reproduce successfully in the understory of ponderosa pine, Douglas-fir, and aspen stands.

Direct/Indirect Effects

Alternative 1 – No Action

Under the no action alternative, current management plans would continue in the project area. No timber salvage, tree planting, or fuels management activities as described in this document would be applied to accomplish project goals. Natural regeneration would occur as discussed above in the “Vegetation Response to Fire” section. Road maintenance and repair, trail maintenance and repair, BAER monitoring, evaluating previous plantation regeneration efforts, repairing range improvements, and hazard tree removal would continue. This alternative would allow the area to recover without management actions.

Cover Types

Cover types displayed in figures 14 and 17 are as follows: PJ = pinyon-juniper; PP = ponderosa pine; MC = mixed conifer; QA = quaking aspen; NS = non-stocked with 0 percent tree canopy closure; NS_S = non-stocked, with 1 to 9 percent tree canopy closure.

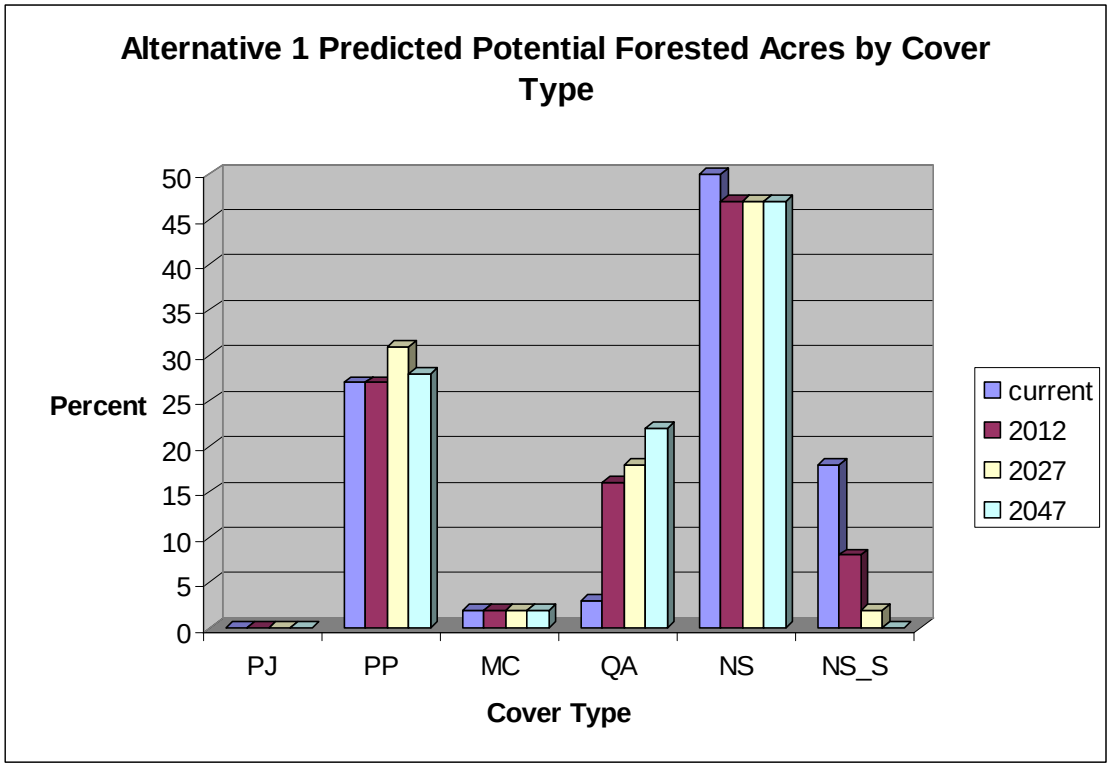

Figure 14. Alternative 1 predicted percent of potentially forested acres by cover type (5, 20, and 40 years from current) (Potentially forested acres are those that had a forested cover type prior to the Warm Fire)

Under alternative 1, the PJ and MC cover types would remain stable over the next 40 years at less than 1 percent and 2 percent of the potentially forested acres respectively. These are areas that burned at a lower severity and experienced lower mortality of the overstory trees.

There would be a slight increase in the PP cover type and a minor increase in the QA cover type over the next 40 years. The change in the PP cover type is due to surviving overstory trees and possibly some natural regeneration where seed sources are available which eventually develop greater than 10 percent canopy cover. The increase in the QA cover type is due to natural regeneration (sprouting) where larger aspen clones existed before the fire. Increases in the PP and QA cover types account for the reductions in the NS_S cover type (figure 14).

The remainder of the potentially forested acres in the WFR project area (47 percent) would stay in a non-stocked condition for the 40-year analysis period and possibly for many years after. These areas experienced high mortality during the fire and have little, if any, seed source available and/or very little potential for substantial and contiguous aspen sprouting. Of the potentially forested acres in a non-stocked condition in 2047, 10 percent were in the PJ cover type and 37 percent were in the MC or PP cover types prior to the Warm Fire (figure 15).

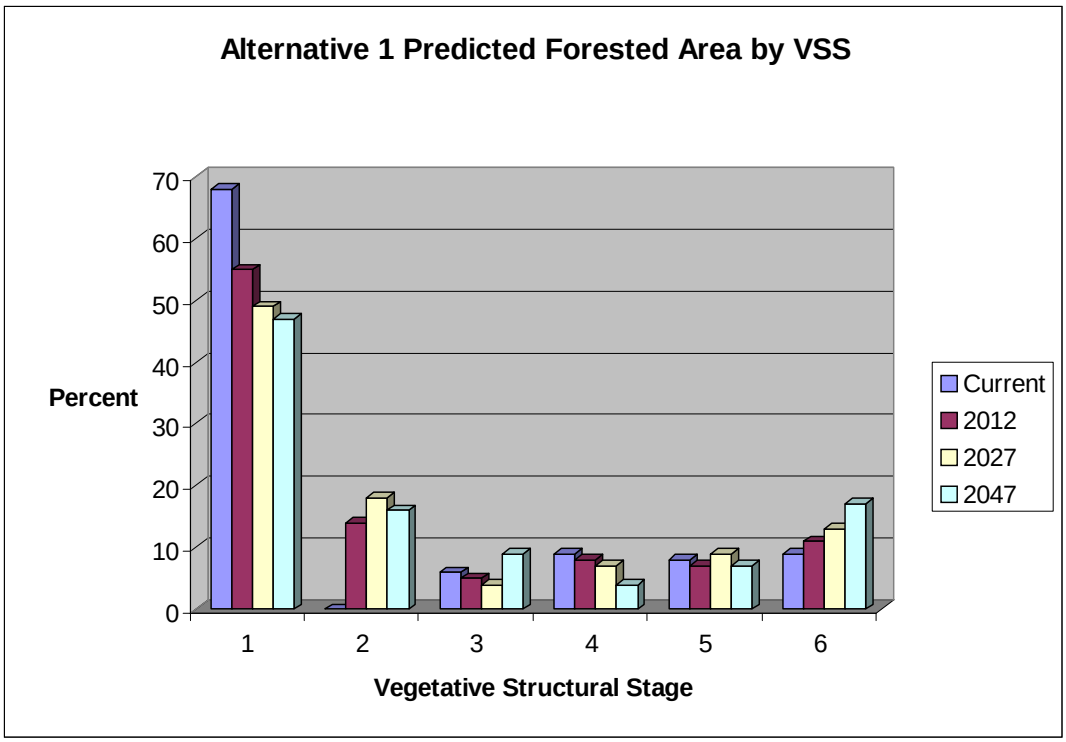

Figure 15. Alternative 1 predicted percent of potentially forested acres by VSS – current and 5, 20, and 40 years out (Potentially forested acres are those that had a forested cover type prior to the Warm Fire)

All of the non-stocked acres that were previously in the PJ cover type and some that were in the MC and PP cover types have experienced a change in site conditions due to burn severity that make regeneration difficult. At a minimum, this alternative does not meet the desired conditions of a forested landscape occupied by the appropriate native tree species as dictated by site conditions (elevation, aspect, soils, etc.) on those acres that previously had MC or PP cover types and have moderate to high potential of regeneration success through planting.

Vegetative Structural Stage

Under the no action alternative, there would be progress from dominance by the early VSS successional stages (1 and 2) trending toward more presence of the later VSS successional stages within the WFR project area (figure 16). Approximately 21 percent of the current VSS 1 acres would advance from the grass-forb/shrub stage to a stocked condition having greater than 10 percent tree canopy cover over the next 40 years. It is estimated by the year 2047, 47 percent of the project area would remain in the grass-forb/shrub stage. The seedling/sapling stage shows a marked increase over the next 40 years due mostly to the development of aspen natural regeneration. By 2047, the percentage in this VSS class would be approximately 16 percent.

The other stages would experience some fluctuations with an overall increase of 5 percent from current in 2047; VSS 3-5, 3 increase 5 percent, 4 decrease 4 percent, 5 decrease 1 percent. The old-growth stage (VSS 6) shows a steady increase over the next 40 years and would be approximately 17 percent of the potentially forested acres by 2047.

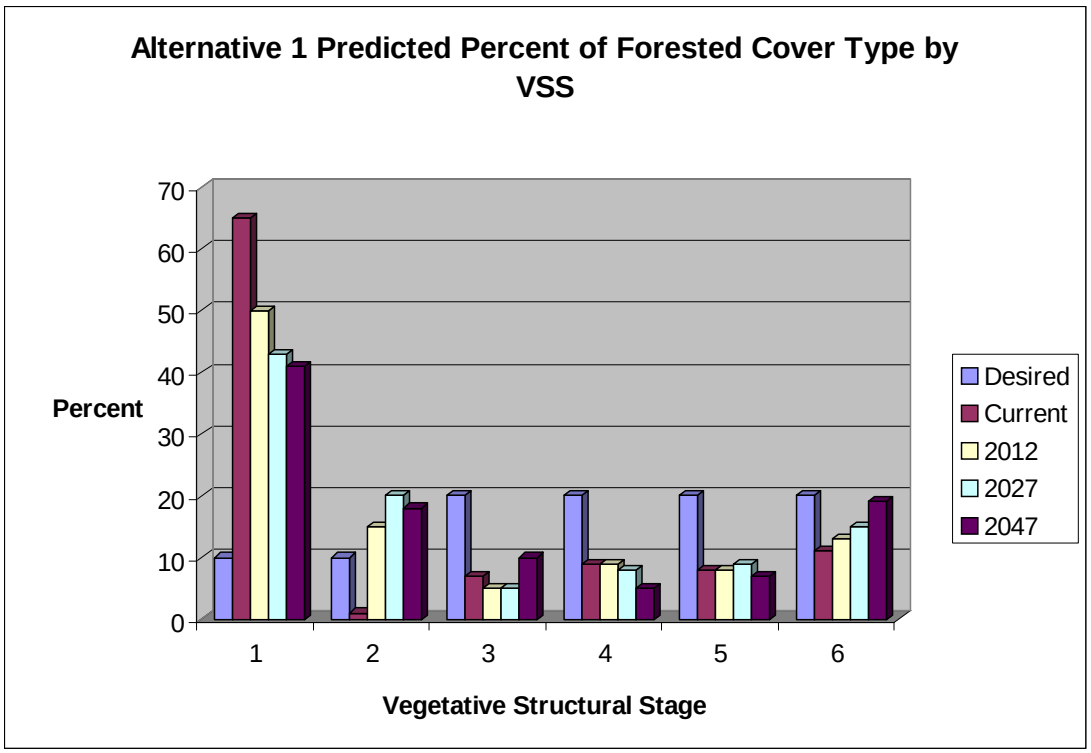

Figure 16. Alternative 1 predicted percent of prefire MC, QA and PP cover type acres by VSS – current and 5, 20, and 40 years out

Under the no action alternative, there would be slight progress toward the VSS successional stage desired condition for the stands that had a prefire MC, QA and PP cover type within the WFR project area (figure 14), but by the end of the 40-year analysis period, it is estimated that VSS 1 would experience a decrease of 24 percent from 65 percent currently to 41 percent in 2047. This represents 31 percent above the desired 10 percent. VSS 2 shows more fluctuation over the next 40 years and would remain approximately 8 percent above desired by 2047. The presence of the four later VSS classes (3 to 6) shows a combined increase of 6 percent over the next 40 years but still falls short of the desired 20 percent in each stage. The old-growth stage (VSS 6) is very close to desired by 2047 at 19 percent.

The Action Alternatives (Alternatives 2, 3 and 4)

Salvage harvest would have no effect on cover type or vegetative structural stage because it is removing non-seed source dead trees within current grass-forb structural stage areas. Harvest equipment will have an effect on aspen natural regeneration, but it is not anticipated the mortality experienced by aspen sprouts would be over 20 percent, which is not enough to have a negative effect on natural regeneration. Planting of conifers and natural regeneration of aspen would have an effect on cover types and structural stages. Both the planting activities and projected natural regeneration are the same in all action alternatives, therefore, direct and indirect effects will be discussed for all the action alternatives together. Although alternatives 3 and 4 include planting without salvage harvesting, reforestation is not anticipated to differ from alternative 2 in the long-term due to lack of seed sources and vegetative competition (e.g., from grasses).

Under the action alternatives (alternatives 2, 3, 4) salvage of fire-killed trees with no green needles, tree planting, and fuels treatments would be implemented to progress toward desired conditions for the WFR project area. Natural regeneration would occur as discussed above in the "Vegetation Response to Fire" section. Current management plans would continue in the project area. Road maintenance and repair, trail maintenance and repair, BAER monitoring, evaluating previous plantation regeneration efforts, repairing range improvements and hazard tree removal would continue.

Table 18. Warm Fire Recovery project action alternative description

Alt.	Description	Salvage Acres	Approx. MMBF Gross Volume Removal	Regeneration Acres	
				Planting	Natural
2	Proposed action	9,114	73.4	9,978	4,800
3	The operation of equipment on soils identified with severe erosion hazard shall be restricted when soil conditions are such that accelerated soil erosion, excessive soil surface displacement, or excessive compaction would occur.	5,756	52.8	9,978	4,800
4	Salvage harvest would not occur in stands designated as Mexican spotted owl habitat.	5,541	42.0	9,978	4,800

Cover Types

Under all of the action alternatives, the PJ and MC cover types would remain stable over the next 40 years at less than 1 percent and 2 percent of the potentially forested acres respectively. These are areas that burned at a lower severity and experienced lower mortality of the overstory trees.

There would be a 9 percent increase in PP cover type and a 5 percent increase in QA cover type over the next 40 years. The change in the PP cover type is due to surviving overstory trees and possibly some natural regeneration where seed sources are available which eventually develop greater than 10 percent canopy cover. The change in the PP cover type is also a result of the seedling growth in the planted stands. Once established, ponderosa pine overstory will provide microsites favoring establishment of mixed conifer species. Planting of mixed conifer and ponderosa pine will ensure the resiliency of the habitat by establishing a trajectory back to coniferous forest. The increase in the QA cover type is due to natural regeneration (sprouting) where larger aspen clones existed before the fire. Increases in the PP and QA cover types account for reductions in the NS_S cover type (figure 17).

The 19 percent remaining in the NS_S cover type in 2047 are planted stands that have not developed 10 percent or greater canopy cover. These stands would not be considered stocked at that time due to the lower planting intensity (planted with fewer trees) but would eventually develop 10 percent or greater canopy cover. They would be considered stocked with a PP cover type at that time.

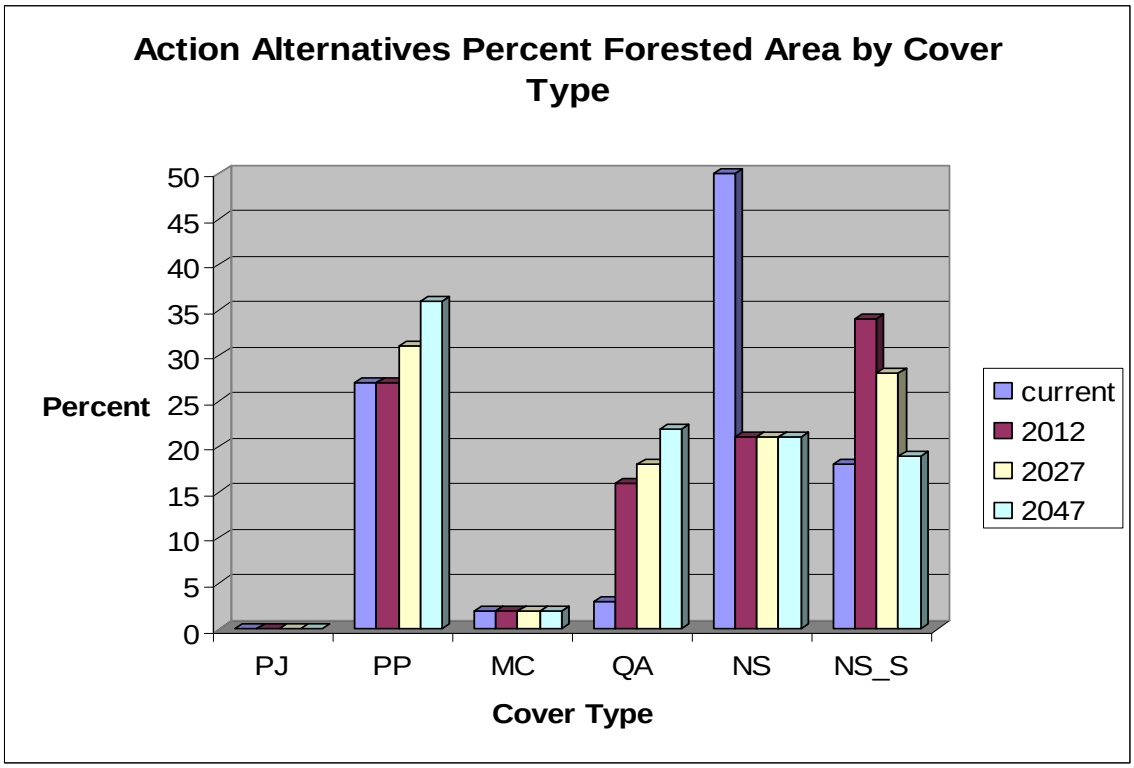

Figure 17. Predicted percent of potentially forested acres by cover type—5, 20 and 40 years from current—action alternatives

The reduction from current in the NS cover type is due to the planted acres shifting to the NS_S cover type. The remainder of potentially forested acres in the WFR project area (21 percent) would stay in a non-stocked condition for the 40-year analysis period and possibly for many years after. These are areas that experienced high mortality during the fire and have little, if any, seed source available and/or very little potential for substantial and contiguous aspen sprouting. Of the potentially forested acres in a non-stocked condition in 2047, 10 percent were in the PJ cover type and 11 percent were in the MC, QA or PP cover types prior to the Warm Fire. All of the non-stocked acres previously in the MC, PJ, or PP cover types experienced a change in site conditions due to burn severity that make regeneration difficult. All action alternatives would meet the desired conditions of a forested landscape occupied by the appropriate native tree species as dictated by site conditions (elevation, aspect, soils, etc.) (figure 17).

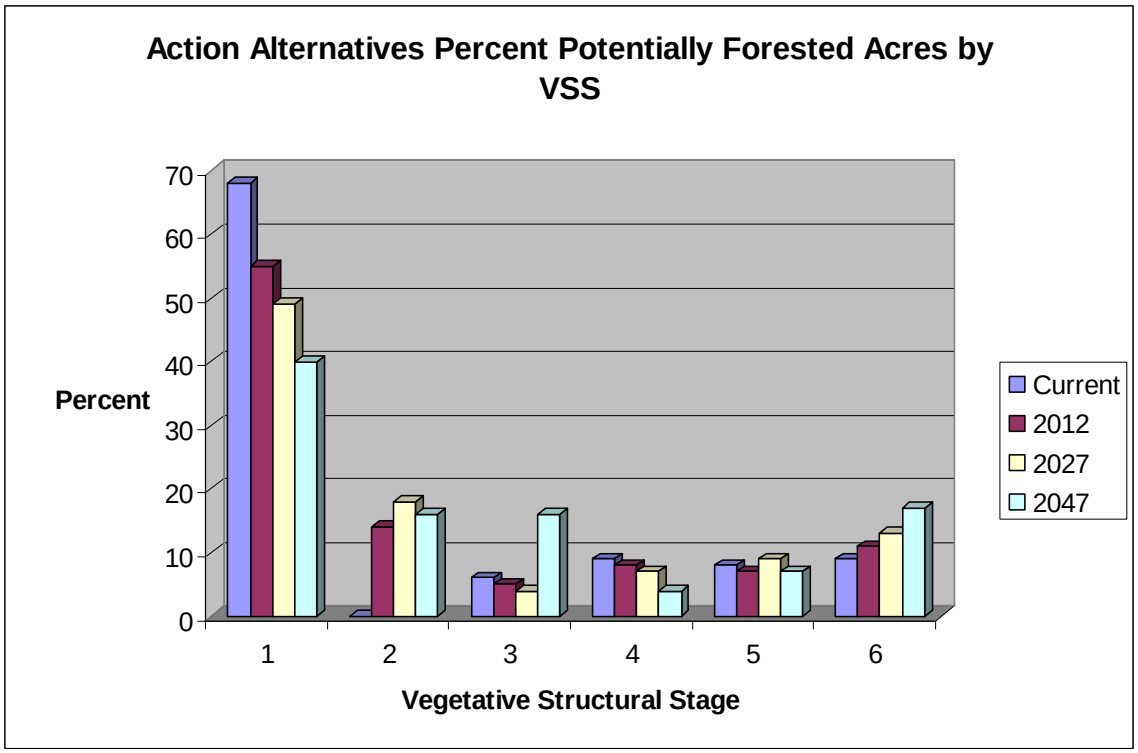

Figure 18. Predicted percent of potentially-forested acres by VSS - 5, 20 and 40 years from current – action alternatives

Vegetative Structural Stages

Under the action alternatives, there would be progress from dominance by the early VSS successional stages (1 and 2) trending toward more presence of the later VSS successional stages within the WFR project area (figure 18). Approximately 28 percent of the current VSS 1 acres would advance from the grass-forb/shrub stage to a stocked condition having greater than 10 percent tree canopy cover over the next 40 years. It is estimated that by the year 2047, 40 percent of the project area would remain in the grass-forb/shrub stage. The seedling/sapling and young forest stages show a marked increase over the next 40 years due mostly to the development of aspen natural regeneration and planted stands. By 2047, the combined percentage in these VSS classes would be approximately 32 percent. The VSS 4, 5 and 6 stages would experience some fluctuations with an overall increase of 2 percent from current in 2047.

The old-growth stage (VSS 6) shows a steady increase over the next 40 years and would be approximately 17 percent of the potentially forested acres by 2047.

Under the three action alternatives, there would be fair progress toward the VSS successional stage desired condition for the stands that had a prefire MC, QA and PP cover type within the WFR project area (figure 19). By the end of the 40-year analysis period, it is estimated that VSS 1 (grass/forb shrub non-stocked) would decrease by 32 percent; from 65 percent currently to 33 percent in 2047. This represents 23 percent above the desired 10 percent. VSS 2 (seedling/sapling) shows more fluctuation over the next 40 years and would remain approximately 8 percent above desired by 2047. The presence of the four later VSS classes (3–

young forest, 4–mid-aged forest, 5–mature forest, and 6–old growth) shows a combined increase of 14 percent over the next 40 years but still falls short of the desired 20 percent in each stage. The young forest (VSS3) and old-growth stages (VSS6) are very close to desired by 2047 with 18 percent and 19 percent respectively.

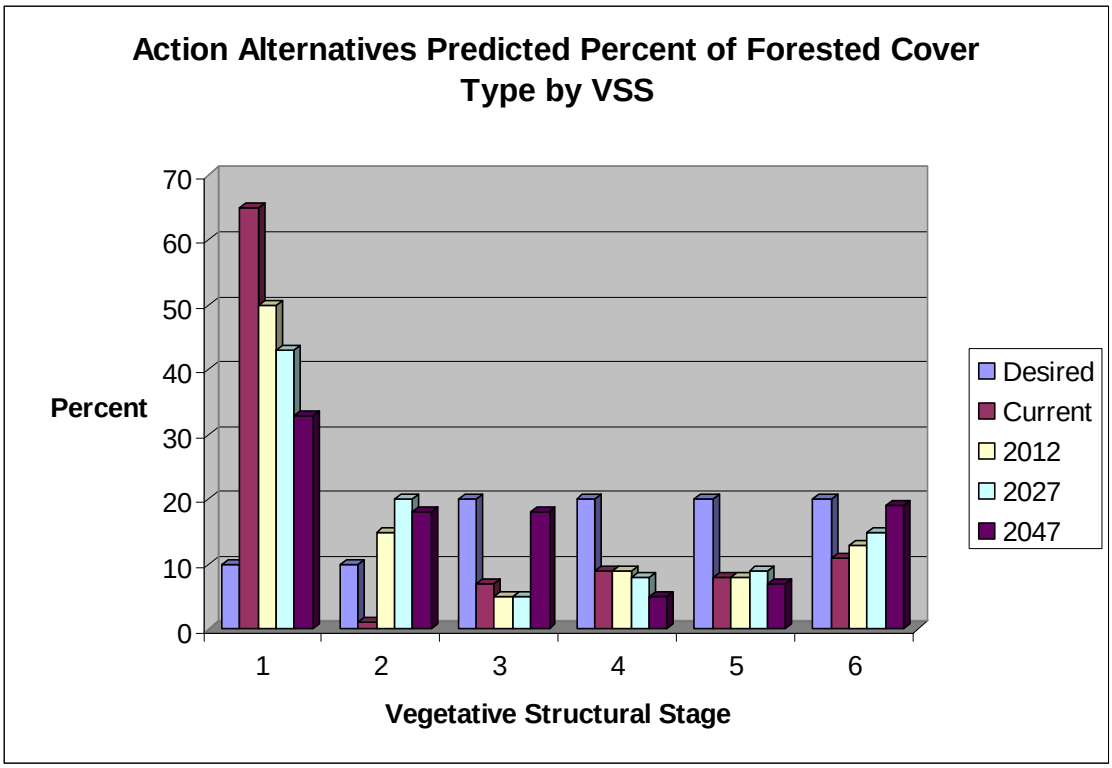

Figure 19. Predicted percent of prefire MC, QA and PP cover type acres by VSS—current and 5, 20 and 40 years from current—action alternatives

Cumulative Effects

The cumulative effects assessment area for the vegetation resource is the Warm Fire Recovery project area and approximately 150 feet outside that boundary where seed sources can potentially provide seed for natural regeneration within the project area. Effects outside this area do not notably influence vegetative structural stage or cover type within the area. The timeframe considered is approximately 10 years in the future, at which time the majority of post-fire activities would be completed and the vegetation response to the fire would stabilize.

A review of past, present and future activities concluded that:

1. Past timber sale activities are included in the forest's data that was used in this analysis and, therefore, included in summaries of effects.
2. Grazing allotments and their management have no effect directly or indirectly on forest regeneration or structural stage development, given management constraints and forest plan direction (excluding livestock grazing for at least two growing seasons) and, therefore, have no cumulative effect.

3. The condition of past wildfire sites are included in the stand database and were considered in analyzing direct, indirect and cumulative effects.
4. Other past, present and ongoing activities, foreseeable future activities, are not considered to have direct or indirect effects on forest vegetation since they occur outside the areas that may be affected by project activities and are not considered in cumulative effects.
5. Other foreseeable activities, as listed, except the Warm Fire hazard tree removal (planned for the winter of 2007/2008 under a separate decision) and the Warm Fire reforestation activities (planned for the spring of 2008 under a separate decision), have no direct or indirect effect on forest vegetation and are not considered to contribute to cumulative effects on vegetation.

The reforestation activities and hazard tree removal activities along highways and forest system roads and trails within the WFR project area will have a direct effect on the project area and are included in the simulations for analysis of future species composition and vegetative structural stages.

Cumulative Effects: Alternative 1 – No Action

In the short term, there would be little change in cover type or VSS from the current condition under alternative 1. Tree planting in the spring of 2008 (planned for under a separate decision), conifer natural regeneration, aspen sprouting, and stand development within stands that have a green component post-fire account for those changes.

Future livestock grazing could have an effect on planted conifers, natural regeneration, and aspen sprouts, but post-fire limitations on livestock grazing within the WFR project area are in effect until sufficient vegetation recovery has occurred. Therefore, no cumulative effects are anticipated.

Hazard tree removal activities along highways and forest system roads and trails within the WFR project area (933 acres) would have no effect on structural stage. However, they may result in up to 20 percent mortality of conifer natural regeneration and aspen sprouting resulting in a minor negative effect. The hazard tree removal environmental assessment reported no significant cumulative effects from this action.

The 1,607 acres of planting in the spring of 2008 (planned for under a separate decision) will have a positive effect by moving those areas planted from a non-stocked to a stocked condition.

Cumulative Effects: Action Alternatives (Alternatives 2, 3 and 4)

In the short term, there would be some change in cover type or VSS from the current condition under alternatives 2, 3, and 4. Tree planting in the spring of 2008 (planned for under a separate decision), conifer natural regeneration, aspen sprouting, and stand development within stands that have a green component post-fire account for those changes.

Future livestock grazing could have an effect on planted conifers, natural regeneration, and aspen sprouts; however, project design features specifically intended to control livestock grazing within the WFR project area will be in effect until sufficient vegetation recovery has occurred are included in alternatives 2, 3 and 4. Therefore, no cumulative effects are anticipated.

Hazard tree removal activities along highways and forest system roads and trails within the WFR project area (933 acres) will have no effect on structural stage. However, they may result in up to 20 percent mortality of conifer natural regeneration and aspen sprouting resulting in a minor negative effect. The hazard tree removal environmental assessment reported no significant cumulative effects from this action.

Tree planting (1,607 acres) expected in 2008-2009 (planned for under a separate decision), and additional tree planting expected to occur over the following 5 years (9,978 acres) under alternatives 2, 3 and 4 would have a positive effect by moving those areas planted from a non-stocked to a stocked condition. Planting under these alternatives may take upwards of 10 years to accomplish due to narrow planting windows.

Salvage harvest operations planned under alternative 2 (9,114 acres), alternative 3 (5,756 acres), and alternative 4 (5,541 acres) are not expected to have cumulative effects on structural stage development; however, they may result in up to 20 percent mortality of conifer natural regeneration and aspen sprouting resulting in a minor negative effect.

Post-fire Management Actions Discussion

The increasing frequency and extent of fires in the Western United States has raised concerns over post-fire management actions (Roccaforte et al. 2008; Shatford et al. 2007). Of particular concern within the WFR project is the reality that uncharacteristic stand-replacement fires in dry forests can produce uncharacteristic levels of post-fire fuels, including standing dead and down trees. Removing portions of that particular biological legacy may be appropriate as part of an intelligent ecological restoration program, and not simply as salvage (Franklin and Agee 2003). This concept was considered in the design of the management actions for the WFR project as demonstrated by the desired condition statements for vegetation and fuels and in the comparison of the current condition to the desired condition that follows in this report.

While it is important to consider the concepts presented in the many papers and studies related to the benefits and consequences of post fire management actions, many of these studies are from the Pacific Northwest within the Biscuit Fire or similar areas. For example, there are two studies of interest regarding the natural regeneration of conifer vegetation after wildfire. The Shatford et al. (2007) study considered the return of forest vegetation after disturbance and the need for planting. The Donato et al. (2006) study addressed the initial effects of salvage logging on natural regeneration.

Two things that were considered in the Shatford paper as it relates to the WFR project are:

1. The study occurred in the Klamath/Siskiyou which are generally brush habitat types and have a strong brush response after fire compared to the Kaibab Plateau which is generally grass/forb habitat types and has a strong grass/forb response after fire. These are two totally different plant communities, and managers should exercise caution in extrapolating the results of this study to other forest types.
2. In the abstract of the paper in reference to natural regeneration it states that “managers must face the challenge of long regeneration periods.” In the purpose and need for the WFR project, it is stated that the Kaibab National Forest is not willing to tolerate long regeneration periods in areas that have a low potential for natural regeneration, and where there is a reasonable potential of planting success. The abstract then goes on to state

> "managers must be able to accommodate high levels of variation across the landscape of a fire." It is recognized that there is going to be high levels of variation across the landscape after the Warm Fire due to aspen sprouting, variable and sometimes heavy natural regeneration adjacent to existing seed sources, variable planting densities, and survival in areas identified for planting, and slow (in some cases centuries) recolonization of conifers in harsher areas with no seed sources.

In reference to the Donato et al. (2006) study, it is recognized that salvage logging after a fire can have a negative affect on natural regeneration. While it is difficult to make precise estimates of the extent of natural regeneration after a wildfire (see natural regeneration assumptions in the "Methodology" section of this report), the WFR project was designed to decrease the risk of salvage operations disturbing natural regeneration by salvaging only in areas that have a low probability of natural regeneration (i.e. salvage operations would occur within high and mixed-high fire mortality areas of the project area), limiting the salvage to fire-killed trees without green needles, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities, using existing skid trails where available, and limiting the operation of equipment to a single pass (entry and exit) to any area that is not located on a designated skid trail.

Scientific studies of the resulting vegetative conditions after a stand-replacing wildfire relevant to the ponderosa pine forests of Arizona and the Kaibab Plateau were considered during the analysis. For example Savage and Mast (2005) studied multiple ponderosa pine sites within the southwestern U.S. that had experienced stand-replacing crown fire in the late 20th century. Although the effects of large, stand-replacing wildfires are variable, several fires have led to long term changes from forested systems. One of the potential vegetation pathways they determined was long term, self perpetuating grass or shrub fields with little or no conifer presence. Indications at this time is that conifer natural regeneration within the high severity burn areas within the WFR project is nonexistent (Roccaforte et al. 2008) and that these areas that do not have substantial aspen sprouting are on a pathway to long term, self perpetuating grass and brush fields. The reforestation project design is an effort to re-establish conifer presence and interrupt the vegetation pathway that has resulted from a stand-replacing crown fire.

A monitoring review of post fire recovery within southwestern ponderosa pine ecosystems has become available since the release of the Warm Fire DEIS. The Kaibab National Forest (USDA Forest Service 2008a) documented recent field observations of four ponderosa pine forest areas within or near the forest that experienced stand-replacing fire sometime in the last 4 decades of the 20th century. Three of the areas were partially or completely salvage logged and planted. This paper evaluates the success of these areas in maintaining soil productivity and progress toward attainment of long-term desired conditions in terms of reforestation, growth rates, understory vegetation response, presence of coarse woody debris and snags, and an evaluation of the time to recovery to desired forest structure. The findings in this paper confirm the assumptions concerning vegetation recovery and logging effects that were made in designing the WFR project.

Another post-Warm Fire DEIS paper was by Monsanto and Agee (2008). They concluded that reducing excessive coarse woody debris loads early in the post-wildfire period could reduce lethal soil temperature zones by nearly half compared to unsalvaged areas. Given the WFR project is in a fire dependent ecosystem, the ecological effects of salvage operations bring long-term

advantages to soil health, reducing root damage to recovering forests, and making stands more resistant to future fires (Monsanto and Agee 2008).

Evaluation of Alternatives for Forest Plan Consistency

National Forest Management Act Consistency Finding

The National Forest Management Act (NFMA) states "…it is the policy of the Congress that all forested lands in the National Forest System be maintained in appropriate forest cover with species of trees, degree of stocking, rate of growth, and conditions of stand designed to secure the maximum benefits of multiple use sustained yield management in accordance with land management plans."

The no action alternative (alternative 1) does not meet or move toward meeting NFMA direction for maintaining appropriate forest cover nor, in the long run, meet the "sustained yield management" direction under NFMA. Under alternatives 2, 3 and 4, reforestation (tree planting) is included and would be consistent with NFMA requirements to maintain forested lands in appropriate forest cover and with related forest plan goals, objectives, standards and guidelines.

Forest Plan as Amended

Implementation specifications for the tree planting activity would help move the area toward meeting forest plan desired conditions for appropriate forest cover.

Alternatives 2, 3 and 4 are consistent with forest plan standards and the regionally consistent standards and guidelines as described in the "Management Direction" section at the beginning of this "Vegetation Resources" section.

Irreversible Commitments

There are no anticipated long-term irreversible commitments of the forest vegetation.

Irretrievable Commitments

There are irretrievable commitments of the growth of forest vegetation for about 5 years because of the new landings that are built to facilitate the salvage operation. They are to be rehabilitated after use, but there will be a lag in reforestation and growth on skid trails since the sites are impacted more heavily than the surrounding forest land.

Soil and Water Resources

Regulatory Framework

Kaibab National Forest Plan

Goals

- Maintain soil productivity and watershed condition. Rehabilitate non-productive lands on a planned basis to eliminate unsatisfactory watershed condition by 2020. Maintain a high quality sustained water yield for forest users and others. Identify and protect wetlands and flood plains.

Standards and Guidelines

- Retain woody debris larger than 12 inches in diameter. Leave 5 downed logs and 10-15 tons of woody debris per acre (including the downed logs).
- Allow no timber harvest except for fire risk abatement in mixed conifer and pine-oak forests on slopes greater than 40 percent where timber harvest has not occurred in the last 20 years.

Best Management Practices

Objectives

- Determine changes in soil quality.
- Advise managers when adjustments are needed in land management practices to protect or improve soil quality.
- Determine status and trend of watershed condition through the evaluation of soil condition.

Soil Quality Standards

Soil quality standards are thresholds that indicate soil impairment. The phrase "soil condition objectives," as used throughout this supplement, is equivalent to "soil quality standards."

Soil Condition Evaluation

Soil condition is an evaluation of soil quality based on an interpretation of factors which affect three primary soil functions. The primary soil functions evaluated are: soil hydrology, soil stability and nutrient cycling. It is important to realize that these functions are interrelated.

- **Soil Hydrology:** This function is assessed by evaluating or observing changes in surface structure, surface pore space, consistence, bulk density, infiltration or penetration resistance using appropriate methods. Increases in bulk density or decreases in porosity results in reduced water infiltration, permeability and plant available moisture.
- **Soil Stability:** Erosion is the detachment, transport, and deposition of soil particles by water, wind or gravity. Vascular plants, soil biotic crusts, and litter cover are the greatest deterrent to surface soil erosion. Visual evidence of surface erosion may include rills, gullies, pedestalling, soil deposition, erosion pavement, or loss of the surface "A" horizon. Erosion models are also used to predict onsite soil loss.
- **Nutrient Cycling:** This function is assessed by evaluating the vegetative community composition, litter, coarse woody material, root distribution and soil biotic crusts. These indicators are directly related to soil organic matter, which is essential in sustaining long-term soil productivity. Soil organic matter provides a carbon and energy source for soil microbes and provides nutrients needed for plant growth. Soil organic matter also provides nutrient storage and capacity for cation and anion exchange.

Soil Condition Categories

Ecological land units are assigned a soil condition category which is an indication of the status of soil functions. Soil condition categories reflect soil disturbances resulting from both planned and

unplanned events. Current management activities provide opportunities to maintain or improve soil functions that are critical in sustaining soil productivity.

Following is a brief description of each soil condition category:

- **Satisfactory:** Indicators signify that soil function is being sustained and soil is functioning properly and normally. The ability of soil to maintain resource values and sustain outputs is high.
- **Impaired:** Indicators signify a reduction of soil function. The ability of soil to function properly has been reduced and/or there exists an increased vulnerability to degradation. An impaired category should signal land managers that there is a need to further investigate the ecosystem to determine causes and degrees of decline in soil functions. Changes in management practices or other preventative actions may be appropriate.
- **Unsatisfactory:** Indicators signify that loss of soil function has occurred. Degradation of vital soil functions results in the inability of soil to maintain resource values, sustain outputs, and recover from impacts. Soils rated in the unsatisfactory category are candidates for improved management practices or restoration designed to recover soil functions.

Clean Water Act

The objective of the act is to restore and maintain the chemical, physical and biological integrity of the Nation's waters (Section 101(a)). It also regulates discharge of dredged or fill material into navigable waters (waters of the U.S.) (Section 404). The Forest Service abides by the Clean Water Act through implementation of best management practices (BMPs) otherwise known as soil and water conservation practices within the Forest Service. The "Soil and Water Conservation Practices Handbook" (FSH 2509.22)(USDA Forest Service 1990a) was developed in concert between the USDA Forest Service, Southwestern Region and both Departments of Environmental Quality from Arizona and New Mexico. It is a formalized agreement with the specific purpose to respond to the objectives defined by Congress in the Federal Water Pollution Control Act, as amended. The main objective of this law is to restore and maintain the chemical, physical, and biological integrity of the Nation's water.

National Forest Management Act 1976

The objectives of this act ensure that forest planning and management activities provide for the conservation and sustained yield of soil (site productivity) and water resources.

Executive Order 11990, 1977; Wetlands Management

E.O. 11990 requires Federal agencies to follow avoidance, mitigation, and preservation procedures with public input before proposing new construction in wetlands. To comply with Executive Order 11990, the Federal agency would coordinate with the ACOE, under Section 404 of the Clean Water Act, and mitigate for impacts to wetland habitats.

Executive Order 11998, 1977; Flood Plain Management

E.O. 11998 requires all Federal agencies to take actions to reduce the risk of flood loss, restore and preserve the natural and beneficial values in flood plains, and minimize the impacts of floods on human safety, health, and welfare.

Intergovernmental Agreement between the State of Arizona and U.S. Department of Agriculture Forest Service Southwestern Region (USDA Forest Service 2008c)

To respond to the objectives defined by Congress in the Federal Water Pollution Control Act, as amended (1987). This objective is to restore and maintain the chemical, physical and biological integrity of the Nation's waters in Arizona by attaining the goal of water quality which provides for the protection and propagation of fish and wildlife, and provides for safe recreation in and on the waters of the State of Arizona;

To respond to the goals and policies of the State of Arizona as defined in the Arizona Environmental Quality Act (EQA) of 1986; and

To identify the responsibilities and activities to be performed by each agency in carrying out the State Water Quality Management Plan (208) and Non-point Source Management Plan (319) as related to activities on National Forest System (NFS) lands. The understanding between the State of Arizona and the Forest Service responds to the objectives of the Clean Water Act by providing for the cooperation on water quality issues and the use of agreed upon best management practices (BMPs) to protect water quality and quantity on Forest Service lands. The list of BMPs intended for use on this project is incorporated into the project design features in chapter 2.

Analysis Methods

The analysis for this project is a compilation of data and information from field notes, geographic information systems (GIS) analysis of spatial data, soil data from the "Kaibab National Forest Terrestrial Ecosystem Survey" (TES) (USDA Forest Service 1991), and sediment delivery modeling using the Forest Service interface for the Water Erosion Prediction Project (FSWEPP) computer model.

The soil quality standards for Region 3 (USDA Forest Service 1999) are largely qualitative. Most of the measures are based on visual observations of surface soil characteristics. Soil quality standards divide the soil resource into three functional areas: soil hydrology, soil stability, and nutrient cycling. Impacts to soils are measured by the departure from natural conditions as compared to the current or impacted condition. The soil hydrology indicator for change is the expected change in compaction to the soil resource. The soil stability indicator uses soil displacement, rilling, rutting, puddling indicators as measures of change. In addition, this analysis also utilized erosion estimate (tons per acre) outputs from the FSWEPP modeling as an additional measure for change. Nutrient cycling is measured by the availability of organic material at the soil surface. This analysis utilizes the number of acres that fine woody fuels and CWD are added to the soil surface.

Source areas for watershed impacts were identified in the field and located on maps spatially using GIS. Relative impacts to watershed condition through erosion and sediment delivery were then estimated for both the no action (current condition) and the action alternatives using the

FSWEPP model. The results of these analyses were then used to show a comparison between the no action and proposed action alternatives.

The Watershed Erosion Prediction Project (WEPP: Disturbed) (WEPP: Road) models were used for analysis of post-fire harvest and road use erosion predictions (Elliot 1999, 2004). WEPP is designed to assist as a tool to evaluate erosion and sediment delivery potential from forest roads, harvest activities, prescribed fires, and wildfires, using input values for forest conditions developed by scientists at the Rocky Mountain Research Station (Elliot 1999). WEPP was used to estimate maximum sediment delivery distances and used average hill slope and road slope conditions, and a 30-year climate record period. Estimates of erosion and sedimentation are not considered absolute values, but rather are estimates only for the purpose of comparing alternatives.

Actual erosion and sediment delivery rates would be expected to be lower than the WEPP model output figures reflect. This is because the WEPP model does not account for the mitigation measures to control erosion and sedimentation that the Forest Service would implement. Forest Service soil and water conservation practices (also known as best management practices or BMPs) have been found to greatly reduce impacts to water quality and soil resources (Seyedbagheri 1996). In particular, the model does not account for the improvements in road and trail drainage and design features to reduce erosion and sedimentation from the transportation system.

Roads proposed to be used for the project are all classified Forest System roads and were stratified by proximity to stream channels and road use by project alternative. Those road segments proposed for haul routes that are within high severity burn areas, have relatively moderate to steep grades, and are located close to stream channels received a higher risk rating than those farther away from the stream or located outside of high burn severity areas.

Assumptions

The proposed action and all other action alternatives incorporate project design features as well as Forest Service soil and water conservation practices (USDA Forest Service 1999) that are designed to protect and restore watershed resources. All of these measures included in the action alternatives have evolved through extensive research and development (Burroughs and King 1989) and have been monitored and modified over several decades, with the express purpose of improving measures and making them more effective. Federal and State site evaluations of BMP control measures (Ice 2004; Rashin 1994; Seyedbagheri 1996; USDA Forest Service 2004) have found the practices to be effective in protecting soil productivity and water quality (adhering to National Forest Management Act and Clean Water Act requirements) and have “certified” for Forest Service application as the Agency’s means to protect water quality (State of Arizona, USDA Forest Service MOU 2008).

All of the proposed treatment units were either burned at high or moderate-high burn severities. Duff, litter, and surface vegetation were all consumed leaving an ash covered mineral soil surface. The current condition for the majority of the affected soil map units is either classed as impaired or unsatisfactory—generally due to the lack of ground cover and organic material for nutrient cycling. A study in New Mexico found that heavy disturbances from mechanized timber harvest activities removed vegetative ground cover exposing bare soil. This had the greatest influence on runoff and sedimentation from erosion. Steep slopes with exposed mineral soil exhibited the

greatest increases in runoff and sedimentation. However, light to moderate disturbances in which vegetative ground cover was disturbed, but not displaced did not significantly increase soil erosion and runoff over undisturbed control areas even on steep slopes. Surface disturbance following thinning was similar between slopes, but steep slopes (slopes >30 percent) were potentially susceptible to severe disturbance in which vegetative ground cover is removed resulting in exposed bare soil (Cram et al. 2007). It is, therefore, assumed that by keeping ground-based equipment to gentle slopes and on existing skid trails where available (to reduce added soil disturbance), the net effect of the project activities will be positive due to the addition of CWD to soil map units which are in need of ground cover and organic material.

It is also assumed that new skid trail development (and additional skid trail compaction) would be minimal. Current road and trail density over the project area is approximately 6.9 miles per square mile. Therefore, there should be sufficient access to burned stands such that new disturbance to soils would be minimized. None of the roads proposed for use in the project area are non-system roads. The few situations that may call for a new skid trail would require that soils be protected through the restriction of equipment passes, and the new skid trail (as with all other skid trails) would be treated for drainage soon after treatment activities have been completed. All heavily used skid trails would be decompacted with methods such as disking to alleviate any reduction in infiltration capacity.

The FSWEPP modeling was based on two modeled erosion units—the lower used as the stream management zone and the upper for the alternative activity. Model runs were based on 500 to 1,000 foot average slope lengths between activity units and intermittent stream channels. Soils were modeled as clay loam and loam on slopes ranging from 0 to 15 percent and 15 to 45 percent. Ground cover was adjusted to reflect current conditions.

The following analyses rely on the fact that the project design features and soil and water conservation practice measures would be fully implemented.

Affected Environment

History and Prefire Condition

Soil

Soils in the project area are dominated by loam and clay loam soil textures. Most of the organic matter in this soil is concentrated near the surface in the upper soil layers. Percentages of rock fragments within the soil profile tend to be moderately high. Infiltration rates are also high, mostly due to the high rock fragment content.

Soils were originally mapped with the terrestrial ecosystem survey (TES) (Brewer et al. 1991) (figure 20) by grouping areas similar in slope, climate regime, and vegetation. The TES indicates that slope, ground cover, and precipitation regime are the primary factors influencing erosion hazard within the project area.

Soil Map Units 293, 294, 623, 624 comprise the majority of the affected soil units (approximately 79 percent of the project area). These four map units represent most of the pine and mixed conifer stands within the proposed treatment areas.

Units 293 and 294 are generally located within pine/oak vegetation type stands and are mapped as slight for erosion hazard. Soil Map Units 293 and 294 are basically differentiated by their slope

classes (0 to 15 percent slopes for Unit 293, and 15 to 40 percent slopes for Unit 294). The main management concerns for these units are soil compaction when soils are wet, and mixing of the subsurface clayey soils with the surface horizon soils which will reduce local site productivity.

Soil Map Units 623 and 624 are located within mixed conifer stands and represent the upper elevation and higher precipitation areas for the project area. Soil Map Units 623 and 624 are basically differentiated by their slope classes (0 to 15 percent slopes for Unit 623, and 15 to 40 percent slopes for Unit 624). These units are rated as severe for erosion hazard due to the higher precipitation, slope, and inherent physical soil properties. Management concerns for these soil units include accelerated erosion when ground cover is removed on slopes over 8 percent.

Soil loss (erosion) and compaction are the primary causes for impacts to long-term soil productivity. Erosion processes are most affected by the presence or absence of ground cover (vegetation and litter). The TES describes the ground cover percentages that are the minimum (tolerance in table 21) to maintain long-term soil productivity. Map Units 293 and 623 both have relatively high ground cover loss tolerances, whereas units 294 and 624 have less tolerance for ground cover loss. Compaction results from roading and harvesting activities and is correlated with soil texture, antecedent soil moisture, and intensity of soil impacts.

Erosion Hazard

Soil erosion hazard rating (EHR) is the relative susceptibility to erosion upon removal of all vegetation and litter. Erosion hazard mapping (see figure 21) was completed by first classifying soils into three slope classes. These areas of slope classes are further classed into subsets of soil map units by vegetation types and climate regimes. Management concerns for these soil units include accelerated erosion when ground cover is removed on slopes over 8 percent.

Soil loss (erosion) and compaction are the primary causes for impacts to long-term soil productivity. Erosion processes are most affected by the presence or absence of ground cover (vegetation and litter). The TES describes the ground cover percentages that are the minimum to maintain long-term soil productivity displayed in table 21. Map Units 293 and 623 both have relatively high ground cover loss tolerances, whereas units 294 and 624 have less tolerance for ground cover loss. Compaction results from roading and harvesting activities and is correlated with soil texture, antecedent soil moisture, and intensity of soil impacts. Table 19 displays the erosion hazard ratings for all soil map units found within the project area. Approximately 74 percent of the acres in the 39,110-acre project area are mapped as moderate or severe erosion hazard potential. The combination of local slopes, inherent physical soil properties, and climate regime are the dominant drivers for the following soil map unit ratings.

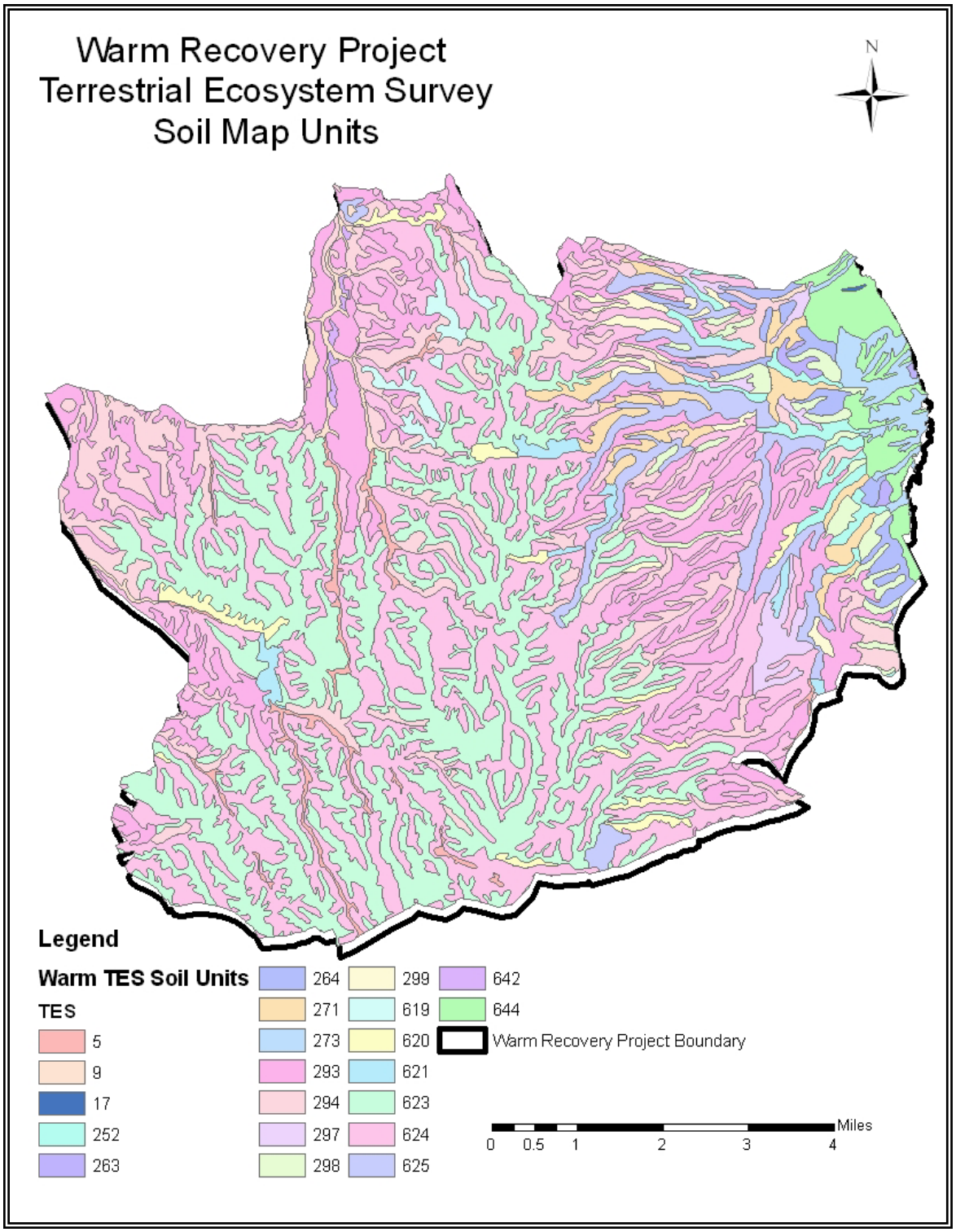

Figure 20. TES mapped soil units in the project area

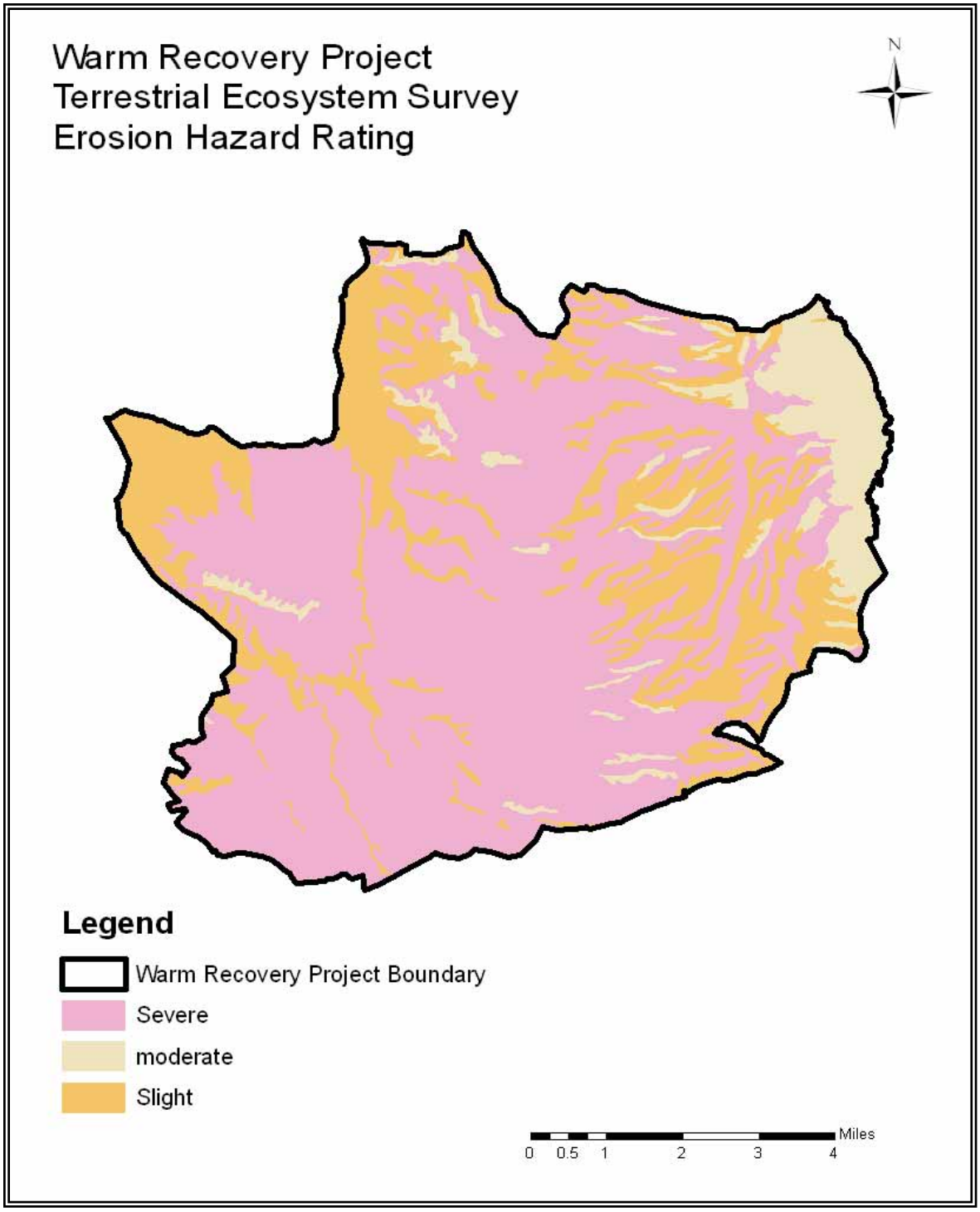

Figure 21. Soil erosion hazard within the Warm Fire Recovery project area

Table 19. Terrestrial Ecosystem Survey map unit acres, EHR, and percent of project area

Map Unit Symbol	Erosion Hazard Rating	Acres	Percent of Project Area
5	Slight	513	1
9	Slight	229	1
17	Slight	7	0
252	Severe	556	1
263	Moderate	94	0
264	Moderate	523	1
271	Severe	781	2
273	Moderate	564	1
293	Slight	5,272	13
294	Slight	3,517	9
297	Slight	424	1
298	Moderate	724	2
299	Severe	306	1
619	Moderate	285	1
620	Moderate	527	1
621	Severe	302	1
623	Severe	9,450	24
624	Severe	12,658	32
625	Severe	1,473	4
642	Slight	61	0
644	Moderate	844	2
	Total Acres	**39,110**	

These soil map units were analyzed using the Universal Soil Loss Equation (USLE) to predict erosion rates due to sheet and rill erosion. Erosion rates were developed for four different conditions and then finally classed as having a slight, moderate, or severe erosion hazard rating based on their susceptibility to exceed the threshold erosion rate. Soil map unit areas that occur on moderate to steep slopes and naturally have low ground cover percentages are often classed as moderate to severe erosion hazard. Likewise, management activities and other disturbance events (wildfires for example) which reduce ground cover can also place soils into a moderate or severe erosion hazard rating. Management activities are not prohibited on soil map units that are classed as severe for erosion hazard. This rating implies that forest managers must provide for extra or special mitigation measures that will ensure that project activities will not move activity area soils below their threshold values.

Ground Cover – Organic Matter and Coarse Woody Debris

Most of the organic matter in the soil is concentrated near the surface in the upper soil layers. A variety of microbiota and invertebrates play an active role in the conversion of litter, leaves, and other organic debris into humus. Microorganisms including bacteria and fungi are the primary decomposers of organic matter in soil (DeBano et al. 1998).

Forest ecosystems have evolved with a continual flux of small and large woody material. Woody material is an important component in maintaining long-term soil productivity and is critical in the development and function of forest ecosystems.

Soil, wood, humus, and the upper layers of mineral soil that are rich in organic matter are the primary substrates for development of ectomycorrhizae, a type of fungus associated with tree roots. Ectomycorrhizae absorb moisture and nutrients from the soil and translocate them to their host plants, making ectomycorrhizae essential for the development of forest ecosystems. Therefore, their presence and abundance is assumed to be a good indicator of a healthy functioning forest soil (Graham et al. 1994). Other important soil fungi are associated with herbaceous plants, litter and duff, and soil organic matter. Both aboveground and below ground nutrients are lessened by the removal of vegetation, organic matter and coarse woody debris. This loss of vegetation and reduction in coarse woody debris, which resulted in a loss of site productivity, characterizes the moderate and high burn severity areas.

Using ectomycorrihizae as a bioindicator of healthy, productive forest soils, Graham et al. (1994) developed conservative recommendations for leaving coarse woody debris after timber harvesting to ensure enough organic matter was left to maintain long-term forest productivity. For example, in ponderosa pine/fescue and Gambel oak habitat types in Arizona, they recommended 5 to 13 tons per acre. Brown et al. (2003) further describes CWD needs for forests recovering from wildfire within the context of managing downed woody fuels hazard. The authors indicate that for dry ponderosa pine forests, a range of 5 to 20 tons per acre of CWD and 5 tons per acre of fine fuels are within suggested management limits for wildfire resistance to control and soil productivity. They also found that the upper limit of the recommended range or higher seems appropriate for stands recovering from high severity wildfire where much of the partially decomposed coarse woody debris and other forest floor organic matter was consumed.

Climate

Weather station data collected at nearby Jacob Lake, Arizona, indicate that mean annual precipitation is approximately 21 inches a year. Most of that precipitation falls as rain during the months of March, July, and August. Mean annual snowfall is approximately 105 inches. Continuous snow cover normally occurs between October 15 and April 15 (WRC 2007).

Water

Watersheds

The Warm Fire Recovery project area is located within the Marble Canyon portion of the Colorado River (15010001) and Kanab Creek (15010003) 4th code watersheds. The affected 5th code watersheds are House Rock Wash (1501000101—a subwatershed of Marble Canyon) and Snake Gulch (1501000307—a subwatershed of Kanab Creek) (see figure 22).

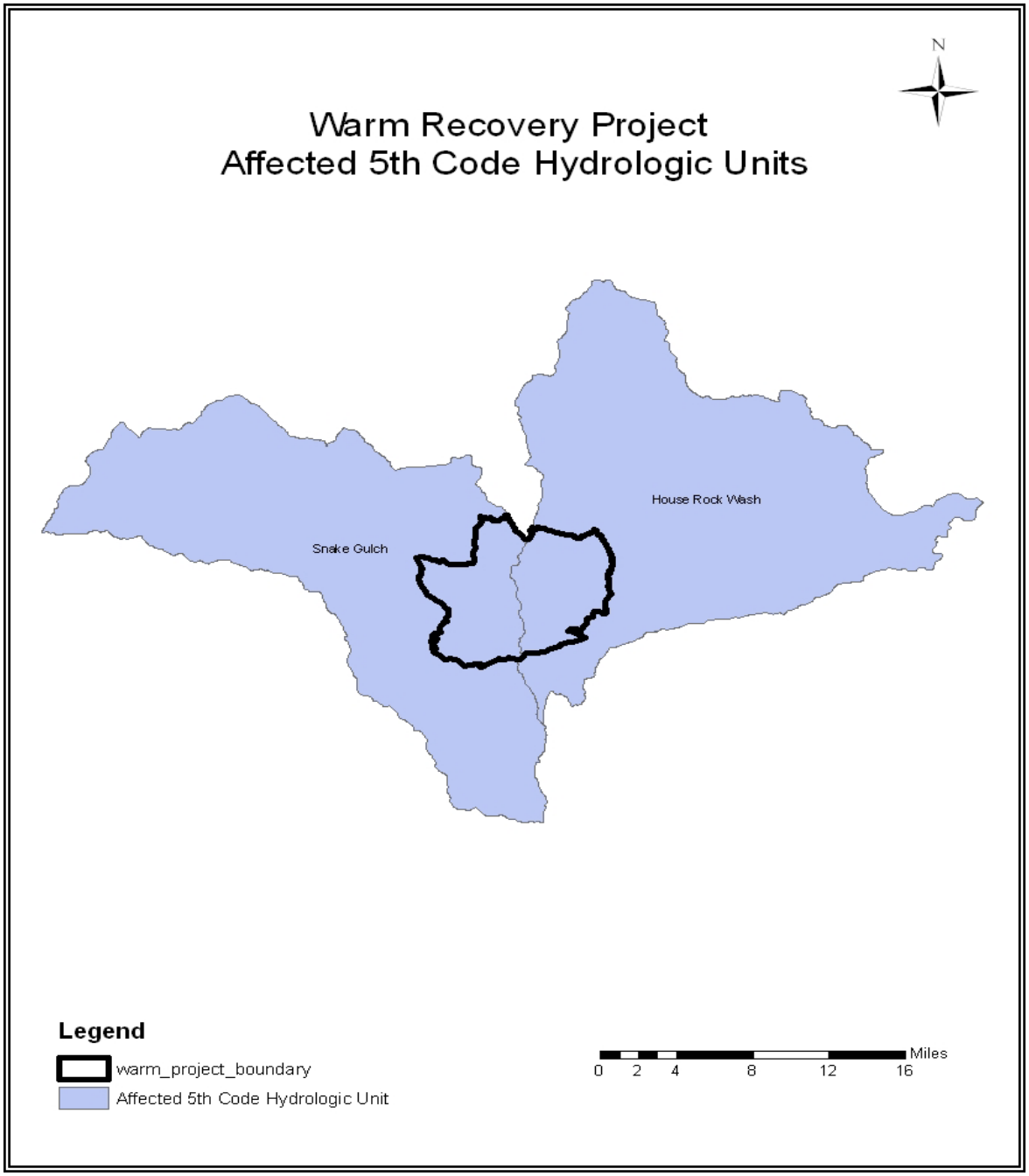

Figure 22. Location of 5th code hydrologic units affected by the Warm Fire

The total acreage of each watershed within the project area is shown in table 20. The Kanab Creek watershed extends into Utah. Acreage presented for the Kanab Creek watershed is for that portion of the watershed which occurs in Arizona.

Table 20. 5th Code hydrologic units affected by the Warm Fire, acres burned and percent total watershed acres burned

Watershed Area	House Rock Wash (1501000101)	Snake Gulch (1501000307)
Total Watershed Acres	192,974	179,372
Watershed Acres Burned	18,505	20,596
Percent Watershed Burned	9.6%	8.7%

Stream, Lakes, Wetlands, and Other Water Bodies

There are approximately 97 miles of mapped stream channel within the project area (see figure 22) classified as intermittent or ephemeral according to the National Hydrographic Dataset. There are no perennial streams in the project area. The larger drainages within the project area include the east and west forks of Warm Springs Canyon, Moquich Canyon, South Fork of Castle Canyon, Snipe Hollow, Franks Canyon, and tributaries to South Fork Rock Canyon. There are no known wetlands or flood plains within the project area.

Ephemeral and intermittent stream channels in the project area have developed under regimes of sporadic flows following intense rainfall events or spring runoff. Eroded soil and organic materials following these events can be mobilized from the hillslopes to be deposited into the upper headwater streams. In-channel flows during these events are quite flashy and can be laden with accumulated stream deposits. But, under normal unburned watershed conditions, local soil porosity, ground cover, in-channel vegetation, and organic debris are usually sufficient to retard substantial downstream transport. Sediments and organic materials are often only mobilized and redeposited relatively short distances downstream. Over time, these channels develop rounded swale forms with no definable bed or bank.

Intense, low frequency floods and fires occasionally are able to overwhelm the inherent infiltration capacity and sediment trapping ability of the affected watersheds. In these cases, runoff is generated either through an extreme abundance of rainfall or a lack of ground cover and hillslope roughness.

Stream channel function and form usually changes in response to these events through the scouring and downstream transport of deposited stream sediments and instream organic materials. Channels temporarily can take on more of a gully form as a result of the post-fire scouring flows. But over time as the watersheds revegetate, the channels will eventually refill to swale forms with sediments and organic materials eroded at normal background erosion rates.

There are also several small lakes and intermittent or ephemeral ponds, also known as “tanks.” Most of the lakes are small, averaging an acre or less. The natural tanks are usually associated with sinkhole formation within the underlying limestone formation. The tanks often hold water after spring snowmelt or heavy summer precipitation events and slowly loose water to evaporation and infiltration.

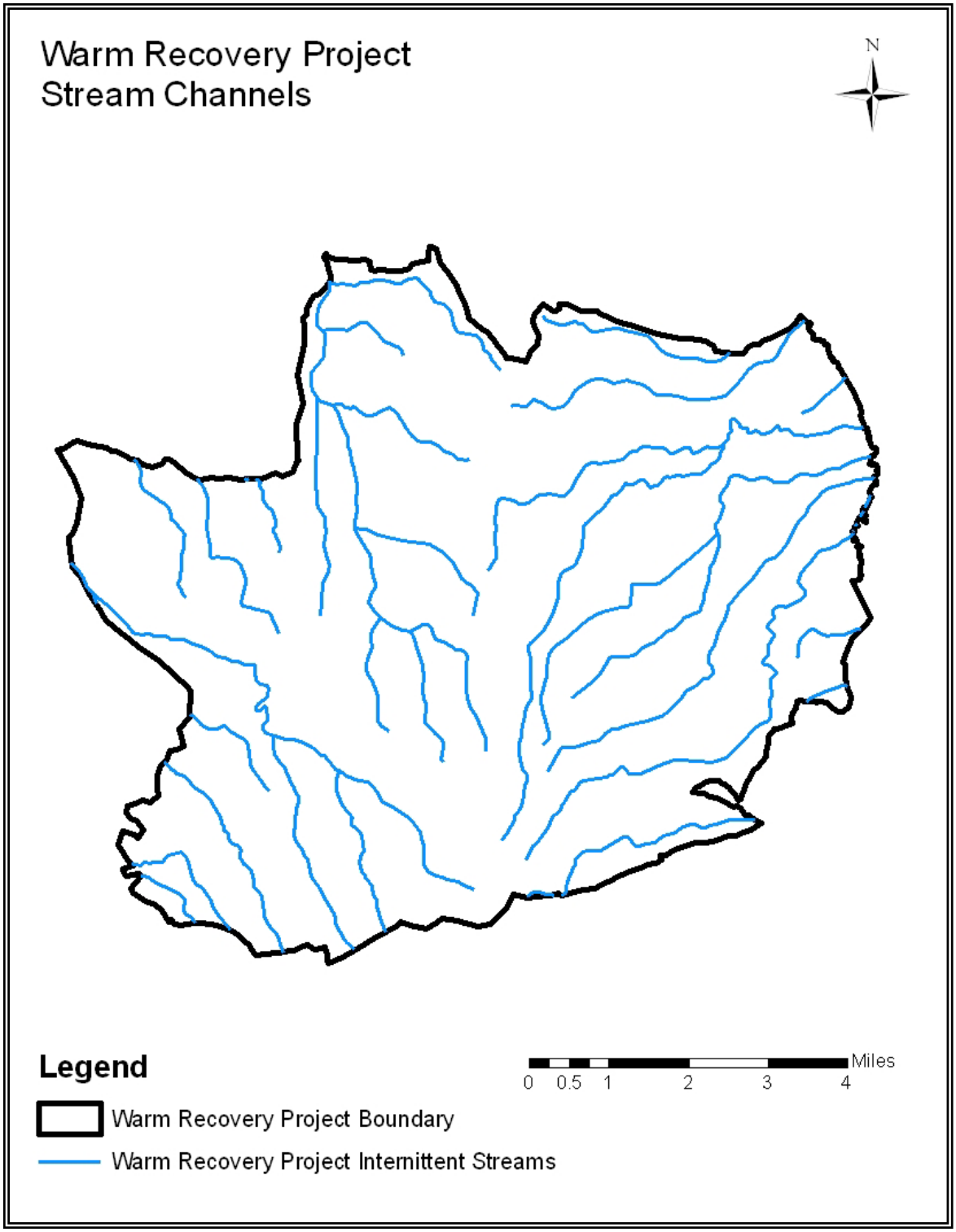

Figure 23. Stream channels affected by the Warm Fire

Post-Warm Fire - Current Condition

Soil Condition Evaluation

Burned Area Emergency Response (BAER)

Burned Area Emergency Response surveys and composite burn index (CBI) field sampling was conducted after the Warm Fire was contained. Results from both surveys indicated that most of the green vegetation, duff, litter, fine fuels, and coarse woody debris were consumed in the moderate, high-moderate, and high burn severity areas. In nearly all of these areas, ash and surface rock fragments were all that was left above the mineral soil surface. Some of the larger (12 inches and greater) pieces of coarse woody debris remained, but in general even these bigger fuels were consumed or at least deeply charred.

Soil Hydrology

Field surveys completed during June 2007 indicate that much of the surface ash layer was transported offsite during the heavy monsoon rains during the summer and fall of 2006. Measured rainfall intensities at Jacob Lake approached .33 inch per hour during those rainfall events and field evidence in the fire area indicates that precipitation intensities were equal to or greater than those at Jacob Lake. Erosion on the gentler slopes (0 to 20 percent) was not evident except for movement of localized ash deposits (Brewer, personal communication). Steeper slopes (greater than 20 percent) (middle and lower third of the hillslope) did show signs of surface wash and shallow rilling. These were the most likely source areas for the flood flows resulting from last summer and fall's monsoon rains.

Immediately after the fire, the BAER report identified approximately 34 percent of the area experiencing some degree of water repellency (USDA Forest Service 2006b). Generally, widespread strong water repellency was found on sites where dense vegetative cover burned intensely, while weakened, discontinuous layers formed where sparse vegetative cover was only partially consumed. Random point tests for hydrophobic soils did not find any water repellant areas during field surveys in June 2007. Infiltration capacities overall appear to be on a recovery phase back toward prefire conditions. However, soil surface organic material and soil surface roughness is still greatly reduced from prefire conditions. The lack of surface litter and duff layers diminishes the watersheds abilities to attenuate peak flows. This will be reflected in flashy runoff and channel flow responses to high intensity, short duration rainfall events.

Surveys of proposed treatment units indicate that aside from the wildfire effects, the majority of the long impacts from past activities are derived from old skid trails, roads, and old landings. The current forest GIS road layer indicates that current road densities are approximately 6.7 miles per square mile. Many of those roads are actually old skid trails that were located with global positioning devices, but are not actually a part of the forest transportation system. There are also an unknown number of skid trails that are not identified within the forest GIS road layer, but exist within the project area.

Soil disturbance surveys indicate that the current existing percentage of landings and skid trails is approximately 8 to 12 percent of the proposed activity area. As noted above, most of these skid trails still show compaction and are not exhibiting substantial recovery. Roads, old skid trails and old landings were often found to have lingering compaction of a magnitude which inhibits woody vegetation growth and infiltration. This was identified by compacted massive and platy upper-A horizon soil layers, lack of vegetation on old skid trail and road areas, and suppressed conifer stems. Loams and clay loams are moderately susceptible to compaction from ground-based

logging operations (Powers 2002). The field evidence indicates that most of the existing arterial (collector) skid trails received sufficient intensity of use to have created lasting compaction on these sites.

Soil Stability

Erosion is a natural, continual process. Several of the soil map units within the project area are rated as being inherently susceptible to erosion (see erosion hazard discussion above). However, in the moderate and high severity burn areas, erosive forces at the soil surface were intensified when fire consumed the protective vegetation cover and litter accumulations and other decomposed organic matter on the soil surface, exposing bare mineral soil. Additionally, soil erodibility was exacerbated due to the volatilization of the soil organic material and the destruction of soil aggregates (DeBano et al. 1998).

Post-fire soil loss rates were higher on hydrophobic soils than on non-hydrophobic soils. The reduced infiltration on hydrophobic soils and consequent accelerated overland flows combined to create conditions that contributed to dislodging and transporting soil particles. Water repellency is usually confined to severely burned areas that had high levels of litter and plant cover.

Forest Service Watershed Erosion Prediction Project modeling conducted during the Burned Area Emergency Response analysis indicated that erosion rates after the fire would be approximately 18 tons per acre for the first year following the fire and would slowly return to natural background erosion rates within 3 years. Natural background erosion rates under forested stands are negligible due to the abundance of duff, litter, and coarse woody debris (CWD).

The flashy nature of runoff from the fire area should decrease as ground cover is re-established with the regrowth of vegetation and increased litter and deadfall from fire-killed trees. Similar high severity burns in dry ponderosa stands (Robichaud and Brown 1999) and visits to nearby recent wildfire areas (the Bridger Fire) (USDA Forest Service 2008a) indicate that ground cover recovery will occur within approximately 3 to 5 years.

Seeding of ridgetops through the Burned Area Emergency Response program, along with natural post-fire regeneration of other native grasses, forbs, and shrub species has already improved ground cover greatly according to survey transects conducted during the summer following the fire (June 2007). The surveys found a substantial increase in vegetative regrowth of seeded grasses, native grasses, forbs, brush, and aspen (see figure 24). Grasses seeded from the aerial seeding conducted for the Burned Area Emergency Response were the primary cover encountered—these areas were generally along ridgetops and gentle slopes. Seeds washed into drainage bottoms have also sprouted and are beginning to stabilize transported sediment deposits. There was no evidence of conifer regeneration; however, it may have been too soon to encounter any new seedlings at the time of the survey.

Soil map units on moderately steep slopes (15 to 40 percent) were not meeting ground cover tolerance standards as of June 2007. Erosion generated from late summer thunderstorm events in 2006 was evident in this slope range. Sheet wash, rilling, and sediment delivery has occurred on Soil Map Units 294 and 624. Continued regeneration and development of annual and perennial vegetation (grasses, forbs, etc.) during the 2008 growing season has increased the level of ground cover and that trend is expected to continue (Robichaud and Brown1999; USDA Forest Service 2008a).

Figure 24. Revegetation of grasses, forbs, and other species in the Warm Fire area

Table 21. Estimated percent ground cover by map unit, burn severity, and condition class rating within proposed activity units

Map Unit	Burn Severity	Estimated Current Ground Cover (percent)	Estimated Ground Cover at Soil Loss Tolerance (percent)	Soil Condition Class Rating
293	High	30	5	Satisfactory*
	Mod/High	NA	NA	No acreage in this category
294	High	28	51	Unsatisfactory
	Mod/High	NA	NA	No acreage in this category
623	High	39	10	Impaired
	Mod/High	52	10	Satisfactory*
624	High	47	65	Unsatisfactory
	Mod/High	69	65	Satisfactory*

NA - Not Applicable indicates there was no acreage available to calculate percent for that category. *Note: This table was updated to reflect the correct information.

Table 21 shows the four map units that comprise 96 percent of the soils potentially affected by project activities. Estimated ground cover numbers that are at or below ground cover tolerance numbers indicate soil map unit areas that are not meeting soil quality standards. Estimated current ground cover percentages were obtained from ground cover surveys completed in June 2006. Estimated ground cover at soil loss tolerance is taken from the TES. Unsatisfactory ratings indicate that soil quality standards are currently not being met, while impaired indicates that soil

quality standards are being met, but that they are still in a “recovering” condition due to burn severity. Current conditions of the soils show that the high burn severity areas on moderately steep slopes within proposed treatment units are currently below the minimum tolerances for ground cover to meet soil quality standards. Table 21 displays the ground cover percentages identified by the TES as the minimum to maintain long-term soil productivity.

Nutrient Cycling

Fire affects organic matter in two ways. First, moderate and high severity fires kill the biological organisms that decompose organic matter (Neary et al. 2005). Microorganisms including bacteria and fungi—which are the primary decomposers of organic matter in the soil (DeBano et al. 1998)—were affected by the fire.

Secondly, fire dramatically increases the rate of organic matter decomposition during the combustion process. Most of the organic matter in the soil was concentrated near the surface in the upper soil layers and was exposed to intense radiant heat during the fire. Different chemical components found in organic matter are lost when soil temperatures increase during heating. The loss of soil organic matter is closely linked to volatilization of nitrogen (DeBano et al. 1998), which contributes to a loss of site productivity.

Both aboveground and below ground nutrients are reduced by the removal of vegetation, organic matter, and coarse woody debris. This loss of vegetation and reduction in coarse woody debris—which resulted in a loss of site productivity—characterizes the moderate and high burn severity areas. Further, historic impacts of old skid trails, landings, and roads show evidence of the lack of nutrient cycling and support of the expected distribution of vegetation species. Typically, these old disturbance features had enough compaction and soil displacement that there was not much species diversity and only a few suppressed individuals were able to pioneer these sites.

Water Quality and Stream Channels

Water Quality

The Arizona Department of Environmental Quality (ADEQ) issued a report on water quality within the State of Arizona (ADEQ 2004) and found no fire-impaired water bodies within the project area or immediately downstream that do not meet water quality standards. There have been no further reports since the fire, indicating that the State intends to add streams within or adjacent to the fire area to the 303(d) list.

Stream Channels

As noted above, all stream channels in the project area are classified as ephemeral or intermittent. They typically have waterflow in response to long duration storms during fall and winter months, spring snowmelt, or short duration, high intensity rainfall events. Changes to spring snowmelt timing, runoff, and peak flows are expected. Burned watersheds respond to rainfall faster, producing more flash floods (Neary 2003). The timing and peak flow of runoff from spring snowmelt is affected by the reduction in canopy cover and increased solar radiation at the snowpack surface. The increased heating at the snowpack surface reduces the snowpack melt time and can produce larger peak flows.

The current loss of ground cover and slope roughness has created a situation where runoff and sediment delivery to stream channels has increased substantially. The short duration, high intensity rainfall events are particularly prone to deliver sediment to small headwater streams and scour channels of in-channel sediment deposits. Sediment yield analysis conducted during the BAER following the fire estimated that post-fire erosion rates could reach 18 tons per acre with sediment yield rates approaching 2,600 cubic yards per square mile during the first year following the fire, and would decrease to natural background levels over the next 3 years as ground cover increased. Vegetative recovery (ground cover) was expected to occur within 3 years (USDA Forest Service 2006b).

Figure 25. Evidence of post-fire stream incision resulting from increased storm runoff

Stream channels downstream of the burn area potentially could be impacted by pulses of sediment derived from the burn. High intensity, short duration summer thunderstorms are common in and around the fire area and often produce enough rainfall to cause localized severe erosion. These thunderstorm generated erosion events are natural and are even able to produce sediment delivery and transport under unburned forest conditions. Although under the post-fire condition, these rainfall events are able to dislocate and transport more sediment due to the lack of ground cover and other organic material lost during the fire.

Roads often account for a substantial portion of the sediment yield to stream channels within watersheds that are managed. Roads affect geomorphic processes and, thereby, sediment yield by four primary mechanisms: accelerating erosion from the road surface and prism itself by both mass and surface erosion processes; directly affecting channel structure and geometry; altering surface flow paths, leading to diversion or extension of channels onto previously unchannelized

portions of the landscape; and causing interactions among water, sediment, and woody debris at engineered road-stream crossings (Gucinski et al. 2001).

Within the Warm Fire Recovery project area there are approximately 413 miles (6.9 miles per square mile) of roads and trails within the project area. Most of those roads are located where they have little or no effect on stream channels because they are either located far enough away from a channel, or they are located on relatively flat topography where the road does not concentrate runoff to an extent that road erosion is a concern. However, there are approximately 19.6 miles of roads that are located on or nearby stream channels. Of these road segments, there are a few that are particularly prone to erosion problems. These are road/stream segments that are on or nearby stream channels and within high burn severity areas (FS Roads 633, 633D, 633E); or they are road segments that have relatively moderate to steep grades and are located in moderate or high burn severity areas (FS Road 429).

Site visits to the fire area (June 12-16, 2007) found that channels in the middle third of the burned watersheds were scouring and gullying on steeper channel segments and re-depositing sediments on lower slope segments (see figure 25). Seeded grasses and other native vegetation are starting to grow in the stream/swale areas, but gullying which was initiated fall 2006 will persist until natural ground cover levels are re-established. BAER seeding efforts were generally successful. Seeded areas are showing signs of revegetation (accounting for approximately 10 to 20 percent of ground cover in seeded areas). Note the sediment deposition and vegetation response within the intermittent channel in figure 25.

Environmental Consequences

Post-Wildfire Salvage Logging Discussion

Post-wildfire salvage logging has been and continues to be a controversial activity on public lands. The arguments for and against post-fire salvage logging are particularly acute in the areas concerning effects to soil and water resources. Several white papers and opinion papers (Beschta et al. 1995; Ice et al. 2004a) reflect the discussion from opposing viewpoints at high levels of the forest management research community. An exhaustive literature review by McIver and Starr (2000) further describes the lack of factual studies concerning the effects of different logging systems on soil and aquatic resources in various ecological regions. Much of the heated debate comes from concerns over logging practices in burned watersheds that are valid in the context of certain regional factors: geologic, biologic, or aquatic; however, these concerns may be greater or less significant or play a smaller role when viewed in the context of another physical or biological region. Thus, the issue of post-wildfire logging is further complicated by the lack of research specific to post-wildfire logging effects at the ecoregion scale.

The absence of ecosystem specific studies on the physical processes of erosion generated by post-fire logging helps to promote this debate and hamper current environmental effects analysis; however, there are several points for effects analysis that many researchers can agree upon:

> The scope and scale of immediate environmental effects of management activities in the post-fire environment depend on several specific features of burned stands, including the intensity of the burn, slope, soil texture and composition, the presence or building of roads, and post-fire weather conditions (McIver and Starr 2000).

While McIver and Starr have identified some of the physical landscape properties that point to problems or concerns with post-fire logging, Beschta et al. (1995) and Karr et al. (2004) have provided a list of activities or situations that should be avoided. A review of these lists within the context of the Warm Fire Recovery project area indicates that there are a few activities of concern for soil and water resources. These activities are:

- Post wildfire logging activities on sensitive soils
- Post wildfire logging on steep slopes
- Logging induced soil disturbance on severely burned soils
- New road building

Internal and external scoping has also forwarded these concerns. Analysis and discussions within the interdisciplinary team process has focused on resolving potential impacts of these activities on the project area. The critical factors identified are to reduce the impact of ground-based equipment on moderate and severely burned soils, avoid new road building, and increase ground cover.

In recognizing these factors, the IDT developed the project in such a way that:

- No new roads would be built. The project will rely on the existing road system.
- Post-wildfire ground-based logging will be restricted to gentle slopes.
- Ground-based activities would be limited to old impact sites (previous skid trails and landings) to the extent feasible.
- Ground cover would be increased overall through project activities. Slash and large woody material would be left in quantities sufficient to meet coarse woody debris recommendations found in Brown et al. (2003) and Graham (1994).

Even though research on the watershed effects of post-fire salvage is limited (McIver and Starr 2001), Ice et al. (2004b) finds that there is little evidence that carefully planned and conducted salvage harvest cannot be conducted without significant impacts (Neary and Hornbeck 1994). For example, the control watershed on the Entiat Burn yielded more post-fire sediment than those that were salvage logged (Helvey 1980). Further, several studies have suggested that needles, fine fuels, and other slash from salvage logging can increase the percent of ground cover and surface roughness, thereby reducing overland flow velocities and surface erosion (Poff 1989; Robichaud 2003). A more recent study of post-fire logging (Chase 2006) concludes that logging slash is less of a factor in reducing sediment delivery due to the lack of ground contact it provides. Chase goes on to say that ground cover resulting from needle fall and revegetation of local plant species does provide for a reduction in sediment production.

Recent site visits to the Bridger Fire (June, 2007) by the IDT hydrologist/soils scientist (Cavan Maloney) and the former Kaibab National Forest soils scientist (Dave Brewer), and monitoring of past burned areas (USDA Forest Service 2008a) found evidence that woody species and ground cover recovery were meeting desired conditions in salvage logged areas. The Bridger Fire burned approximately 10 years ago on the North Kaibab Ranger District and occurred on similar soils and slopes to the Warm Fire. Salvage logging was implemented shortly after the fire, and logging treatments and the implementation of BMPs were comparable to what is proposed for the Warm

Fire area. There are no quantitative studies that were conducted on the Bridger post-fire logging, but these recent site visits indicate that ground cover and surface organic materials can recover within relatively short periods of time (Maloney personal observation) (Brewer, personal communication) (see figure 26).

Most of the post-fire logging studies (literature review, McIver and Starr, 2000) point to the fact that ground-based logging tends to produce more disturbance compared to other logging systems in post-fire logging. However, the results of the Chase (2006) study indicate that "sediment production from salvage logging can be reduced by treatments that minimize percent bare soil and ground disturbance. These include cable logging with full suspension, helicopter logging, or tractor logging with a low density of skid trails. It also is important that any disturbance is oriented perpendicular to the slope in order to minimize concentrated flow pathways that can create rills and increase sediment production."

Figure 26. Vegetation regrowth and coarse woody debris on the Bridger Fire after approximately 10 years

The Bridger Fire salvage example does show that areas with wildfire and logging can regenerate back to conditions that meet soil standards within relatively short periods of time (approximately 10 years) (USDA Forest Service 2008a) as long as skid trails are kept to low densities and are rehabilitated. The Burned Area Emergency Rehabilitation report (USDA Forest Service 2006b) indicated there was a 3-year risk window for accelerated erosion following wildfire within the project area. Chase (2006) shows that post-fire logging may lengthen that window of risk. Looking at the Bridger Fire area, it is not expected that the Warm Fire project area would be at risk to accelerated erosion beyond 5 to 8 years. Ground cover has increased substantially in the

first year since the fire, and overall seeded and natural revegetation of grasses, forbs and shrubs has been robust.

Future fires would expose the soils beneath and directly around coarse woody debris to high heat for extended periods of time, exposing roots to lethal temperatures (Monsanto and Agee 2008). Monsanto and Agee (2008) noted lethal cover ranged up to 24.7 percent on unsalvaged portions of a past fire area, almost twice the lethal cover noted on salvaged portions. Monsanto and Agee (2008) also note "most of the concerns regarding salvage logging have dealt with short-term issues (Beschta et al. 2004). Longer-term ecological effects, such as some of the effects of excessively high levels of coarse woody debris, should be factored into the decisionmaking process. In dry forest types there may be some long-term advantages for managers if excessive coarse woody debris loads are reduced early in the post-wildfire period."

Issues

Issues were identified through internal Agency review and public scoping. The following general areas of concern were identified:

- Long-term soil productivity
- Water quality

The main areas of risk that any action alternative presents to long-term soil productivity and water quality are derived from four areas:

1. Detrimental disturbance to soil resources from soil compaction and surface soil displacement.
2. Loss of CWD recruitment below recommended guidelines (Graham 1994; Brown 2003) for long-term soil productivity.
3. Sediment delivery due to road use and maintenance on road segments that are within or adjacent to streams.
4. Sediment delivery due to yarding activities associated with removing woody material from activity units.

Direct and Indirect Effects

Alternative 1 - No Action

Under the no action alternative, current management plans would continue to guide management of the project area. No timber salvage, reforestation, or fuels management activities as proposed in this project would be implemented to accomplish project goals. Road maintenance and repair, trail maintenance and repair, BAER monitoring and potential reseeding if indicated, evaluating previous plantation regeneration efforts, repair of range improvements, and hazard tree removal would continue. This alternative would allow the area to recover without management actions and addresses issues raised during scoping from comments received regarding lack of scientific information supporting salvage harvesting of burned areas.

The trend of the current condition would continue. On gentle slopes, the burned area would continue to revegetate naturally with grasses, forbs, and other woody species. Ground cover

would increase and would most likely meet minimum TES ground cover tolerances within 3 to 5 years.

Soil Hydrology

Soil hydrology would remain essentially the same as the current condition. Those remaining areas of water repellency that may exist would eventually fade as freeze/thaw, root penetration, and chemical weathering processes occur. Areas of compaction due to past forest treatment and road transportation activities would remain and continue on a slow trajectory for recovery dependent on natural amelioration.

Soil Stability

Soil stability would be in an impaired or unsatisfactory condition for most soil map units due to a lack of ground cover and post-fire accelerated erosion processes. The Burned Area Emergency Response report estimates that this period would last for up to 3 years. As ground cover is established with natural vegetation and litter and deadfall, the soil condition would improve toward the prefire condition. Current soil cover conditions (1½ years post-fire) over forested stands range from 28 to 69 percent. It is expected that ground cover will return to prefire conditions in another 1 to 2 years. Soil condition ratings would remain as shown in table 22.

Current erosion rates under previously forested stands average 3 tons per acre per year for 0 to 15 percent slopes and 10 tons per acre per year for slopes 15 to 40 percent. These decreases in post-fire erosion rates as compared to the immediate post-fire potential erosion rate (18 tons per acre per year) are a reflection of the increase in ground cover due to needles, seeded grasses, and forbs.

Nutrient Cycling

Nutrient cycling on a majority of the soil map units within the project area would be in an impaired or unsatisfactory condition due to the lack of ground cover and available organic materials at the soil surface. Soil organic material was largely removed from most soil map units within the high and moderate/high burn severity areas within the project area.

In the future, accumulations of large dead woody fuel, especially those containing larger diameter decayed pieces, may present a hazard to long-term soil productivity in the event of a future wildfire. Heavy amounts of large diameter fuels can hold smoldering fire on a site for extended periods causing excessive soil heating. Accumulations exceeding 40 tons per acre have the potential to cause long-term soil productivity losses where wildfires re-occur (Brown et al. 2003). Some researchers (Monsanto and Agee 2008) have found that fuel loading as low as 24 tons per acre poses a risk to roots and soils for future wildfire events. The fuels analysis indicates that future fuel loadings from falling snags (within approximately 20 to 40 years) will exceed recommended levels for soil heating in the event a wildfire occurs. Brown et al. (2003) recommends 5 to 20 tons per acre of CWD for dry pine vegetation types. Coarse woody debris plots indicated that 17 percent of the burned stands have in excess of 58 tons per acre. Eighty-three percent of the burned stands had a range of 0.28 to 54.5 tons per acre of CWD.

The effects of the fire on soil hydrology, soil stability, and nutrient cycling would essentially stay on the current slow improvement trend of the post-fire condition. However, exposed soils would be vulnerable to erosion due to the limited ground cover condition.

Alternative 2 (Proposed Action)

Soil Hydrology

Soil compaction is the primary impact that affects soil hydrology. Compaction of the soil reduces soil porosity and inhibits water infiltration. The main causes of compaction to soils from the proposed action would be the use of landings, and the use of ground-based equipment to harvest and yard burned trees from the fire area. These pieces of equipment typically create skid trails where they collect and retrieve the cut trees to be dragged to the landings. Multiple passes on these skid trails can create compaction and reduce infiltration to the extent where long-term soil productivity on those skid trail locations is negatively impacted.

Soil disturbance surveys indicate that the current existing percentage of landings and skid trails is approximately 8 to 12 percent of the proposed activity areas. As noted above, most of these skid trails still show compaction and are not exhibiting substantial recovery. In order to avoid further compaction and displacement of soils, the existing landing and skid trail network would be re-used. All landings would be ripped, and heavily used skid trails would be decompacted utilizing a disk or other shallow soil decompaction equipment to alleviate reductions in infiltration capacity. Therefore, it is not expected that the percentage of compacted areas would increase substantially—not beyond an additional 1 to 2 percent over the current condition. Further, equipment would be limited to slopes less than 20 percent, and skid trail spacing would be a minimum of 100 feet. Allowances would be made for heavy equipment to move over steep pitches (up to 30 percent) for distances no greater than 100 feet.

Those remaining areas of water repellency that may exist would eventually fade as freeze-thaw, root penetration, and chemical weathering processes take place. Alternative 2 has the potential for the most re-compaction of existing skid trails and roads. After use, these landings and skid trails used for the project will have appropriate mitigation measures applied (see BMP 24.24 and 24.25) to hasten infiltration improvement.

Soil Stability

Soil stability would be improved over approximately 9,114 acres due to the addition of slope roughness from the added slash at the soil surface. Slash would enhance ground cover and thereby reduce soil particle detachment by raindrop impact. Enhanced ground cover will come immediately from the direct addition of slash, and over the longer term from the positive response of herbaceous growth to improved microhabitat (shade and moisture) conditions. This improvement comes for most soil map units due to a current condition of reduced ground cover and post-fire accelerated erosion processes. The Burned Area Emergency Response report estimates recovery of soils to minimum soil tolerance levels would take approximately 3 years from the time the fire ended.

FSWEPP modeling indicates that erosion rates from harvest and post-harvest fuel treatment activities (piling and burning) would be approximately 0.3 ton per acre per year for slopes 0 to15 percent and 1 ton per acre per year for slopes 15 to 40 percent. The decrease in erosion as compared to the no action condition is attributable to the increase in soil surface roughness from slash fires and CWD. Soil condition would improve slightly over time. However, soil condition ratings would essentially remain the same because the impaired and unsatisfactory soil condition ratings (table 22) are generally based on steeper slopes which would not be substantially affected by project activities. Modeled sediment delivery to stream channels would be essentially the same as the volumes predicted for the upslope erosion rate.

Soils would be less exposed to future accelerated erosion due to the increased soil surface roughness added by residual logging slash. There would be some attendant soil displacement from the end lining of logs to skid trail areas on treatment units, although overall, the negative effects would be minimized due to the application of project design features and BMPs (see project design features for soils and watershed listed in chapter 2 and Soil and Water Conservation Practices (SWCPs) 24.1, 24.13, 24.16 – 24.18, 24.2, 24.21 – 24.24, 24.26, 24.27, 24.29, 24.3, 25.16, 25.18). The effectiveness of these measures has been proven to control and reduce impacts to soil resources and water quality (Ice 2004; Rashin 1994; Seyedbagheri 1996; USDA Forest Service 2004b).

Nutrient Cycling

Nutrient cycling would be in an improving condition over approximately 9,114 acres due to the addition of small and large woody material. The project would leave at least 15 tons per acre of CWD in the activity units. In addition, up to 5 tons per acre of fine fuels would be left as needles, twigs, small limbs, and other small slash material. The majority of the treatments are proposed for areas where soil organic material was largely removed from most soil map units—within the high and moderate/high burn severity areas within the project area. So the near term addition of CWD and other fine fuels would have a beneficial effect to long-term soil productivity (see project design features detailed in this section: 10-13). The effectiveness of these measures has been proven to control and reduce impacts to soil resources and water quality (Ice 2004; Rashin 1994; Seyedbagheri 1996; USDA Forest Service 2004b).

Alternatives 3

Soil Hydrology

Soil compaction is the primary impact that affects soil hydrology. Compaction of the soil reduces soil porosity and inhibits water infiltration. The main causes of compaction to soils from the proposed action would be the use of landings and ground-based equipment to harvest and yard burned trees from the fire area. These pieces of equipment typically create skid trails where they collect and retrieve the cut trees to be dragged to the landings. Multiple passes on these skid trails can create compaction and reduce infiltration to the extent where long-term soil productivity on those skid trail locations is negatively impacted.

Soil disturbance surveys indicate that the current existing percentage of landings and skid trails is approximately 8 to 12 percent of the proposed activity areas. As noted above, most of these skid trails still show compaction and are not exhibiting substantial recovery. Approximately 86 percent of the treatment units occur on soil map units classified as severe erosion hazard. These units would be winter logged to reduce further impacts to the existing skid trail system. Winter logging greatly reduces soil displacement and re-compaction of existing skid trails (up to 76 percent by some estimates) (Klock 1975).

On all other units, the existing landing and skid trail network would be re-used. All landings would be ripped, and heavily used skid trails would be decompacted utilizing a disk or other shallow soil decompaction equipment to alleviate reductions in infiltration capacity. So it is not expected that the percentage of compacted areas would increase substantially; increases in compacted areas would be less than 1 percent of all activity areas. Again, all equipment would be limited to slopes less than 20 percent, and skid trail spacing on non-winter harvest areas would be

a minimum of 100 feet. Allowances would be made for heavy equipment to move over steep pitches (up to 30 percent) for distances no greater than 100 feet.

Those remaining areas of water repellency that may exist would eventually fade as freeze-thaw, root penetration, and chemical weathering processes take place. Alternative 3 has the potential for the least re-compaction of existing skid trails and unauthorized roads. After use, landings, skid trails and unauthorized roads used for the project will have appropriate mitigation measures applied (see BMP 24.24 and 24.25) to hasten infiltration improvement.

Soil Stability

Soil stability would be improved over approximately 5,756 acres due to the addition of slope roughness from the added slash at the soil surface. Enhanced ground cover will come immediately from the direct addition of slash and over the longer term from the positive response of herbaceous growth to improved microhabitat (shade and moisture) conditions. This improvement comes for most soil map units due to a current condition of reduced ground cover and post-fire accelerated erosion processes. New soil displacement will be minimized due to the over-snow logging on soil map units rated as having a severe erosion hazard. All other treatment areas would require the use of designated existing skid trails, limiting the operation of equipment to slopes 20 percent and less. The Burned Area Report (USDA Forest Service 2006b) estimated recovery of soils to minimum soil tolerance levels would take approximately 3 years from the time the fire ended.

FSWEPP modeling indicates that erosion rates from harvest and post-harvest fuel treatment activities (piling and burning) would be approximately 0.2 ton per acre per year for slopes 0 to 15 percent and 0.7 ton per acre per year for slopes 15 to 40 percent. The decrease in erosion as compared to the no action condition is attributable to the increase in soil surface roughness from slash fires and CWD. Soil condition would improve slightly over time. However, soil condition ratings would essentially remain the same because the impaired and unsatisfactory soil condition ratings (table 22) are generally based on steeper slopes which would not be substantially affected by project activities. Modeled sediment delivery to stream channels would be essentially the same as the volumes predicted for the upslope erosion rate. The difference between the erosion and sediment delivery rates for alternatives 2 and 3 is due to the decrease in ground disturbance on over-snow logging activity units.

Soils would be less exposed to future accelerated erosion due to the increased soil surface roughness added by residual logging slash. There would be some attendant soil displacement from the end lining of logs to skid trail areas on treatment units, but overall the negative effects would be minimized due to the application of project design features and BMPs (see project design features for soils and watershed listed in chapter 2 and SWCPs 24.1, 24.13, 24.16 – 24.18, 24.2, 24.21 – 24.24, 24.26, 24.27, 24.29, 24.3, 25.16, 25.18). The effectiveness of these measures has been proven to control and reduce impacts to soil resources and water quality (Ice 2004; Rashin 1994; Seyedbagheri 1996; USDA Forest Service 2004b).

Nutrient Cycling

Nutrient cycling would be improved over approximately 5,756 acres due to the addition of small and large woody material. The project would leave at least 15 tons per acre of CWD in the activity units. In addition, up to 5 tons per acre of fine fuels would be left as needles, twigs, small limbs, and other small slash material. The majority of the treatments are proposed for areas where

soil organic material was largely removed from most soil map units—within the high and moderate/high burn severity areas within the project area. So the near term addition of CWD and other fine fuels would have a beneficial effect to long-term soil productivity (see project design features detailed in this section: 10-13). The effectiveness of these measures has been proven to control and reduce impacts to soil resources and water quality (Ice 2004; Seyedbagheri 1996; USDA Forest Service 2004b).

Alternative 4 (Action Alternatives)

Soil Hydrology

Soil compaction is the primary impact that affects soil hydrology. Compaction of the soil reduces soil porosity and inhibits water infiltration. The main causes of compaction to soils from the proposed action would be the use of landings and ground-based equipment to harvest and yard burned trees from the fire area. These pieces of equipment typically create skid trails where they collect and retrieve the cut trees to be dragged to the landings. Multiple passes on these skid trails can create compaction and reduce infiltration to the extent where long-term soil productivity on those skid trail locations is negatively impacted.

Soil disturbance surveys indicate that the current existing percentage of landings and skid trails is approximately 8 to 12 percent of the proposed activity areas. As noted above, most of these skid trails still show compaction and are not exhibiting substantial recovery. In order to avoid further compaction and displacement of soils, the existing landing and skid trail network would be re-used. All landings would be ripped, and heavily used skid trails would be decompacted utilizing a disk or other shallow soil decompaction equipment to alleviate reductions in infiltration capacity. So it is not expected that the percentage of compacted areas would increase substantially—not beyond an additional 1 to 2 percent over the current condition. Further, equipment would be limited to slopes less than 20 percent, and skid trail spacing would be a minimum of 100 feet. Allowances would be made for heavy equipment to move over steep pitches (up to 30 percent) for distances no greater than 100 feet.

Those remaining areas of water repellency that may exist would eventually fade as freeze-thaw, root penetration, and chemical weathering processes take place. Alternative 4 has the potential for more re-compaction of existing skid trails and unauthorized roads than alternative 3, but less than alternative 2. After use, these landings, skid trails and unauthorized roads used for the project will have appropriate mitigation measures applied (see BMP 24.24 and 24.25) to hasten infiltration improvement.

Soil Stability

Soil stability would be increased over approximately 5,541 acres due to the addition of slope roughness from the added slash at the soil surface. Slash would enhance ground cover and thereby reduce soil particle detachment by raindrop impact. This improvement comes for most soil map units due to a current condition of reduced ground cover and post-fire accelerated erosion processes. The Burned Area Emergency Rehabilitation report estimates recovery of soils to minimum soil tolerance levels would take approximately 3 years from the time the fire ended.

FSWEPP modeling indicates that erosion rates from harvest and fuels treatment (piling and burning) would be approximately 0.3 ton per acre per year for slopes 0 to 15 percent and 1 ton per acre per year for slopes 15 to 40 percent. The decrease in erosion as compared to the no action condition is attributable to the increase in soil surface roughness from slash fires and CWD. Soil

condition would improve slightly over time. However, soil condition ratings would essentially remain the same because the impaired and unsatisfactory soil condition ratings (table 22) are generally based on steeper slopes which would not be substantially affected by project activities. Modeled sediment delivery to stream channels would be essentially the same as the volumes predicted for the upslope erosion rate.

Effects to soil and water resources for alternatives 2 and 4 are similar at the treatment unit scale. However, alternative 4 would treat less acreage and would, therefore, provide for less of a ground cover increase at the project area scale. The difference in erosion and sedimentation rates between alternatives 3 and 4 is due to the decrease in ground disturbance on over-snow logging activity units (see project design features for soils and watershed listed in chapter 2 and SWCPs 24.1, 24.13, 24.16 – 24.18, 24.2, 24.21 – 24.24, 24.26, 24.27, 24.29, 24.3, 25.16, 25.18). The effectiveness of these measures has been proven to control and reduce impacts to soil resources and water quality (Ice 2004; Rashin 1994; Seyedbagheri 1996; USDA Forest Service 2004b).

Nutrient Cycling

Nutrient cycling would be in an improving condition over all soil map units within treatment areas due to the addition of organic material and ground cover where most soil map units were at or below recommended ground cover tolerance levels. The project would leave at least 15 tons per acre of CWD in the activity units. In addition, up to 5 tons per acre of fine fuels would be left as needles, twigs, small limbs, and other small slash material. The majority of the treatments are proposed for areas where soil organic material was largely removed from most soil map units—within the high and moderate/high burn severity areas within the project area. So the near term addition of CWD and other fine fuels would have a beneficial effect to long-term soil productivity (see project design features detailed in this section: 10-13). The effectiveness of these measures has been proven to control and reduce impacts to soil resources and water quality (Ice 2004; Seyedbagheri 1996; USDA Forest Service 2004b).

Summary of Alternative Effects

The analysis of project effects is based on the relative risk in promoting accelerated soil erosion due to project activities. Ground cover and the organic material it provides to the soil surface is the primary component that gives protection to soils against accelerated erosion. Activities for all action alternatives would generally occur on relatively gentle slopes (slopes less than 20 percent). There would be some minor areas of activity on the steeper slope areas (20 to 30 percent) that will have a greater impact on ground cover and surface erosion. Therefore, slope and the current condition of the soils by the TES slope class are the primary determinants in assigning relative risk by alternative. Table 22 shows the relative risk by alternative and slope class in terms of erosion rates and compares road mileage within stream buffer zones. Alternative 3 has been adjusted to reflect the reduction in soil disturbance due to over-snow logging. Alternative 3 would provide the least risk to soil resources, followed by alternatives 4, then 2. Although alternatives 2 and 4 have the same erosion rates, alternative 2 would occur over more acres.

The relative risk between alternatives assumes that between harvest, fuel treatment, and planting activities, every acre in each proposed treatment unit would be affected. Therefore, the total alternative acreage is assumed to be at risk in each alternative for some level of soil disturbance and potential accelerated erosion. The risk for soil disturbance and accelerated erosion is expected to last until ground cover conditions have recuperated sufficiently to protect the soil surface—approximately within the next 1 to 2 years.

The risk of impacts to water quality and ephemeral/intermittent stream channels from road treatments is relatively low for the proposed action and action alternatives. The transportation system required to conduct salvage operations is in place. Most of those roads are surfaced with materials derived from the local soils and geology. Traffic is light for most of the year with increased use and impacts during the fall hunting season. Erosion from the road template is generally not a problem as most roads are located on relatively gentle slopes. No new roads would be constructed with this project. Some older, existing spur roads would need to be re-opened for salvage activities, then closed following use. Most roads within the project area are not located near active streams; however, there are some road segments that are located on or near stream channels. Roads within stream buffers are the most likely locations for impact to water quality and stream channels. The miles of roads within stream buffers are displayed by alternative in table 22. Again, alternative 3 would provide for the least risk for impacts to stream channels due to road use and maintenance.

Table 22. Comparison of erosion rates and miles of road segments within stream channel buffer zones

Alt.	0 to 15 Percent (tons/acre/yr)	15 to 40 Percent (tons/acre/yr)	Total Miles of Roads Used	Miles of Roads in Stream Channel Buffer Zones
1	3	10	0	(19.6 existing)
2	0.3	1	168	4.2
3	0.2	0.7	130	3.5
4	0.3	1	141	3.8

Note: Alternatives 2 and 4 have the same erosion rates; however, activities would occur over more acres under alternative 2.

Cumulative Effects

For the purpose of this analysis, the cumulative effects boundary for hydrologic resources is described as the watershed divide boundaries as delineated by the Snake Gulch and House Rock Wash 5th code watersheds as discussed earlier in this section. The 5th code watersheds are the next scale of watershed area that encompass the project area, yet do not add so much watershed area that any cumulative effects are diluted. All known past, present, and reasonably foreseeable future activities that could contribute to cumulative effects are listed in tables 23 and 24. Those vegetation removal activities that are older than 20 years are assumed to be contributing negligible or no measurable cumulative effect. All known roads and trails are included as they persist over time. The Warm Fire suppression and BAER activities are also included.

Table 23. Past, present, and reasonably foreseeable future treatments and activities for Snake Gulch 5th Code Watershed

Snake Gulch – 179,372 Acres				
Sale	**Method**	**Acres (unless otherwise indicated)**	**Year**	**Percent of Watershed ***
Past Activities				
Vegetation Management				
Mistletoe	Ground based	312	1988-89	<1%%
Jack Lily	Ground based	354	1992	<1%
Warm Spring	Ground based	1,257	1988	<1%
Big Frac	Ground based	1,107	1992	<1%
Past Sales within Project Boundary	Ground based	720	1980s	<1%
Past Sales within Project Boundary	Ground based	710	1990s	<1%
Total		**4,460**		**3%**
Wildfires				
Warm Fire		20,605	2006	11%
Mangum Fire		290	2000	<1%%
Bridger Knoll Fire		19,823	1996	11%
Slide Fire		5,105	2007	3%
Wildfire Suppression Rehabilitation				
Warm Fire Suppression fire line waterbarred		15 miles	2006	
Warm Fire Suppression fire line seeded		15 miles	2006	
Warm Fire Suppression spike camp, safety zones, helispots, drop points rehabilitated			2006	
Slide Fire Suppression fire line waterbarred		11 miles	2007	
Slide Fire Suppression fire line seeded		11 miles	2007	
Burned Area Rehabilitation				
Warm Burn rehab seeding		3,289	2006	2%
Slide Fire Burn rehab seeding (aerial)		850	2007	<1%
Slide Fire Burn rehab seeding (range drill)		900	2008	<1%
Current/Ongoing Activities				
Vegetation Management				
ADOT Hazard Tree Removal		139.5	current	<1%
Highway/Forest Development Roads/Trails		>6.9 miles/sq mi		

Snake Gulch – 179,372 Acres				
Sale	**Method**	**Acres (unless otherwise indicated)**	**Year**	**Percent of Watershed ***
Dispersed Camping				
Hunting				
Burn Rehab Monitoring/Seeding/Rangeland Improvement Repairs				
Grazing				
Central Summer Allotment		178,881		100%
Proposed Activities				
Warm Fire Road Hazard Tree Removal		550		<1%
Jacob Ryan Timber Sale		3,661		2%

*Percent of watershed affected is rounded.

Table 24. Past, present, and reasonably foreseeable future treatments and activities for House Rock Wash 5th Code watershed

House Rock Wash Watershed – 192,974 acres				
Sale	**Method**	**Acres (unless otherwise indicated)**	**Year**	**Percent of Watershed ***
Past Activities				
Vegetation Management				
	Ground Based	2,096	1980s	1%
		4,574	1990s	2.4%
Total		**6,670**		**3.5%**
Wildfires/Fire Rehab/Burned Area Emergency Response				
Warm Fire		18,505		9.6
Warm Fire Additional Activities				
Fire line waterbarred		15 miles		
Fire line seeded		15 miles		
Spike camp, safety zones, helispots, drop points rehabilitated				
Burn rehab seeding		6,745		3.4%
Current/Ongoing Activities				
Vegetation Management				
ADOT Hazard Tree Removal		139.5		<1%
Ryan One		1,000		<1%

House Rock Wash Watershed – 192,974 acres				
Sale	**Method**	**Acres (unless otherwise indicated)**	**Year**	**Percent of Watershed ***
Grazing				
Central Summer Allotment		58,240	Ongoing	30%
Burro		14,137	Ongoing	7%
Ryan		9,184	Ongoing	5%
House Rock		18,211	Ongoing	9%
Kane		12,004	Ongoing	6%
Other Projects				
Highway/Forest Development Roads/Trails		>6.9 Miles/sq mi		
Dispersed Camping				
Hunting				
Proposed Activities				
Jacob Ryan Timber Sale		1,585		1%
Warm Fire Road Hazard Tree Removal		581		<1%

*Percent of watershed affected is rounded.

No Action

The no action alternative would not create cumulative effects because there are no direct or indirect effects from management activities to soil or water resources.

Action Alternatives 2, 3, and 4

The project area within both the Snake Gulch and House Rock Wash watersheds remains in a fairly natural, undeveloped forested condition. The main impact to these watersheds is the near term effects (3 to 5 years) derived from the Warm Wildfire. There are some roads contributing to sedimentation, but overall the portions of these watersheds affected by the proposed project are in a recovering watershed condition due to wildfire effects. Generally, ground cover and woody debris has been lost over the fire area. In the near term (3 to 5 years), accelerated erosion and sedimentation will occur in response to precipitation events.

The fire represents approximately 9.6 and 8.7 percent of House Rock Wash and Snake Gulch watersheds respectively.

Past recreational activities and thinning projects have occurred, but not to the extent or magnitude that it has effected infiltration, runoff, erosion, or nutrient cycling capabilities of the watershed. Past vegetation management activities in Snake Gulch watershed (16 percent of the watershed) do represent a moderate amount of past disturbance activity, but most of those projects are 15 years old or more, and past effects (other than residual skid trails) are ameliorating.

Outside of the Warm Fire suppression boundary there is a history of vegetation management activities within both watersheds. Skid trails and existing road systems are the major legacies of these activities that still have an impact to soil and water resources. The existing road/trail system averages approximately 6.9 miles per square mile throughout both watersheds. Grazing and recreational activities are also ongoing. Overgrazing occurred historically in both watersheds, but AUM numbers have been steadily decreasing since the 1980s to meet range utilization standards. Grazing within the fire area is currently suspended for 2 years from the date of the fire and will be re-initiated using an adaptive management strategy where range conditions can support the use.

As was noted in the direct/indirect effects section, it is expected that there would be a short-term direct or indirect effect due to ground-disturbing activities such as ground-based logging and road maintenance work. That direct or indirect effect is expected to subside and not be measurable within the next 5 to 10 years. In addition, it is expected that the accumulation of cover and organic materials in the form of slash, plus the road restoration associated with the action alternatives, would create a net reduction in the long-term cumulative effect by improving forest soil cover and road drainage systems along stream channels, and rehabilitating existing roads and trails that would not be maintained on the Forest Service system.

The action alternatives associated with the project present a small risk for cumulative watershed effects when considering all past, ongoing, and future activities outside of the project boundaries. As previously described for alternatives 2, 3, and 4, effects from these alternatives would be small; short-term (5 to 10 year) increases in soil erosion and sediment delivery potential, within acceptable limits. The expected long-term reduction in soil erosion rate and sediment delivery compared to the pretreatment existing conditions in the project area would not have any substantial cumulative effect on either of these watersheds, even when combined with effects from the other activities previously mentioned.

Consistency with Regulatory Framework

The action alternatives are consistent with the forest plan and other laws and Executive Orders. All proposed project design features and best management practices would meet or exceed the Kaibab National Forest plan objectives and standards for soil and water quality. The action alternatives have the potential for some localized short-term impacts to soil and water quality, but those impacts should not be of a magnitude and duration to substantially alter or degrade existing soil or water quality conditions. Limiting ground-based skidding to slopes less than 20 percent and using existing roads and trails or over slash mats is designed to reduce detrimental soil disturbance and control runoff and erosion from project activities. Measures to leave sufficient coarse woody debris address nutrient recycling (Brown et al. 2003) and would help maintain soil site productivity, as well as reduce potential erosion.

The Clean Water Act of 1977, National Forest Management Act 1976, Intergovernmental Agreement between the State of Arizona and U.S. Department of Agriculture Forest Service Southwestern Region (USDA Forest Service 2008c) would all be met through the project design features and application of Region 3 FSH 2509.22_20 Best Management Practices for timber and road activities. Further, the project is too far away from any 303(d) listed water body to have any negative effects on a listed stream.

Executive Orders 11990 (Wetlands Management) and 11998 (Floodplain Management) would be met as there are no affected flood plains or wetlands within the project area.

Wildlife and Wildlife Habitat

Introduction

This section summarizes the biological evaluation of impacts from activities proposed for the Warm Fire Recovery project to USDA Forest Service Region 3 sensitive species, and the evaluation of forest management indicator species (MIS) as designated in the Kaibab forest plan. This section also summarizes the biological assessment, which serves as a report to assess potential impacts to wildlife that are federally listed threatened and endangered species. Direction is found in FSM 2672.42.

Applicable requirements and other direction guiding the management and protection of wildlife and habitat may be found in the Endangered Species Act (ESA), National Forest Management Act (NFMA), and USDA Forest Service manuals. The forest plan (USDA Forest Service 2004a) provides forest-wide and site-specific standards and guidelines for maintenance of habitat for wildlife species. The forest plan was developed to be consistent with ESA, NFMA and USDA Forest Service manual direction. Forest plan direction has been incorporated into the project design where appropriate.

Methodology for Analysis

Prefield reviews were conducted to determine which species are known to occur in the area or have suitable habitat present and could potentially occur. Sources reviewed include Arizona Game and Fish Department Heritage Data Management System (AGFD HDMS), Forest occurrence databases (NRIS FAUNA database), and species distribution information. Vegetation analysis is based on stand data in the Timber Stand Management Record System (TSMRS) and post-fire vegetation mortality mapping. More information on the vegetation data is found in the "Vegetation Resources" section of this EIS.

Surveys that have been done in the project area include Mexican spotted owl (MSO) surveys and MSO habitat suitability based on prefire cover types. Goshawk inventory and monitoring has been ongoing since 1991. Observations recorded during all of these surveys have been incorporated. Other sources of information include the forest's MIS analyses (Bratland et al. 2008); landbird surveys (Noble 2006); North Kaibab Species Descriptions (Sanders et al. 2004); Warm Fire Assessment (USDA Forest Service 2007c) and wildlife observations and survey information from the FAUNA database.

The analysis area used for direct and indirect effects is limited to the project area as the effects are localized to the area of fire salvage. The project area is sufficiently large (39,110 acres) to address the mid-level analysis area. The Geographic Area (GA) 13 and 16 scale, and site/stand levels were also evaluated to address the forest plan required three scales of analysis, and cumulative effects. The analysis focuses on changes in vegetation, as this proposal would result in changes to stand structure and tree species composition through salvage and planting. Disturbance associated with project activities may also be an issue and is included in indirect effects. Changes in access (during project implementation) have also been incorporated. The analysis area for determining species population trends is the Kaibab National Forest (KNF). For habitat trends the analysis area is GA 13 and 16.

Timeframes used for the analysis include disturbance effects due to increased traffic, human activity, and equipment use during project activities. Project activities are expected to take

approximately 2 years with no season operating constraints except where nests (goshawk or condor) are found under all alternatives, and areas with severely erosive soils in alternative 3. Changes in vegetation and habitats are also considered during the analysis.

Affected Environment

Existing Condition

Habitat conditions on the North Kaibab Ranger District (NKRD) prior to the Warm Fire included; (1) a large tree component relatively intact compared to the rest of the Southwest. Current conditions (as compared to what was here in 1910) have an excess of trees in every diameter class; (2) the snag prescriptions in the forest plan, combined with "green snags" (i.e., lightning strikes, dead tops, and to a degree, dead limbs) likely maintain snags above historic conditions; and (3) aspen conditions are likely peaking on the NKRD and were projected to start declining in the near future (Noble, personal communication).

The WFR project is the part of the burn that was actively suppressed as a wildfire and contains approximately 39,110 acres. The remainder of the fire which was managed as a wildland fire use (WFU) burn is approximately 19,513 acres with the total fire being 58,623 acres. The WFR is part of GA 13 (274,986 acres) which contains almost all of the coniferous forest within the NKRD and GA 16 (125,408 acres) which contain all of the pinyon-juniper (PJ) on the east side of the NKRD. The ponderosa pine cover type dominated the project area (65 percent), as shown in table 1. Other cover types were represented as well, the amount of grass/forb acres increased greatly after the fire. Table 25 includes the forest cover type in relation to the large scale analysis area of the GA pre- and post-fire.

Table 25. Percent of pre- and post-fire forest cover types within the Warm Fire project area

Cover Type	Pre-fire Acres	Pre-fire Percent of Project Area	Pre-fire Percent of GA 13 Habitat this Represents*	Post-fire Acres	Post-fire Percent of Project Area	Post-fire Percent of GA 13 Habitat this Represents*
Ponderosa pine	25,421	65%	15%	11,902	30%	7%
Mixed conifer	5,619	14%	11%	433	1%	<1%
Pinyon-juniper	3,863	10%	4%**	128	<1%	<1%**
Aspen	2,531	6%	12%	1,085	3%	5%

*Acres for GA 13 (and 16 for PJ): PP=180,735, MC=49,981, PJ=88,145, and AA=21,975

**Pinyon-juniper (PJ) acres within project area are compared to GA 13 and 16 combined since most of the PJ in the project area was in GA 16, which is composed primarily of PJ.

During the Warm Fire, 12,000 acres of ponderosa pine burned as a stand-replacing fire, with 100 percent mortality. Historically, mixed conifer had a mixed fire regime, but in the Warm Fire, 4,300 acres (or 76 percent) of the mixed conifer also burned as a stand-replacing fire with 100 percent mortality. Both of these are outside the historic range of variability. Aspen, which has been declining across the Southwest for years, will benefit and increase in distribution (USDA Forest Service 2007c). Four levels of vegetation mortality were determined within the fire area.

1. **Low Mortality:** light ground char, most trees survived except for pockets of seedlings or saplings; shrubs, forbs and grasses had less than 15 percent mortality, with less than 5 percent mortality in upper canopy.
2. **Mixed-Low Mortality:** Fire effects slightly higher and with more variability than low, characterized by approximately 10 percent mortality of upper canopy and 50 percent subcanopy scorch.
3. **Mixed-High Mortality:** Fire effects less lethal than high and with more variability than high; moderate soil heating, surface litter layer was consumed and duff layer deeply charred. Small woody debris consumed, larger logs remain but are charred. Ground cover is patchy and not continuous. Much of the tree canopy remains, but is scorched, turning the needles brown; characterized by approximately 70 percent mortality in upper canopy.
4. **High Mortality:** High degree of soil heating killed live vegetation; large majority of trees killed with entire tree canopies totally consumed. Foliage, litter and duff were completely consumed, and coarse woody debris was deeply charred or totally consumed; characterized by 100 percent mortality in surface vegetation and upper canopy trees.

Table 26 displays the percent of each cover type in each mortality class in the project area. The percentages indicate that all cover types experienced much higher mortality than would be expected based on historic fire regimes (USDA Forest Service 2007c).

Table 26. Percent of cover type within each mortality class

Cover Type	Low Mortality	Mixed-Low	Mixed-High	High Mortality
Pinyon-juniper	3%	4%	12%	81%
Ponderosa pine	23%	18%	12%	47%
Mixed conifer	8%	7%	7%	78%
Aspen	15%	18%	15%	52%

Cover types that received fire severities at the high and/or mixed high classification were in most cases converted from a stocked stand to an unstocked stand that is now classified as vegetative structural stage (VSS) 1 (grass/forb stage). The primary effect of the Warm Fire on the large scale analysis area was that it moved a large area of GA 13 and 16 further away from the desired mix of VSS classes described in the forest plan (USDA Forest Service 2004a) (table 27). Taking the primary conifer cover types within the project area, ponderosa pine and mixed conifer, VSS 1 went from being absent pre-fire to 61 and 92 percent, respectively. The Warm Fire was so large that there was even a significant decrease where ponderosa pine at the GA 13 level (district wide) was reduced by 8 percent with a corresponding increase in VSS 1.

There are no perennial streams in the project area. Water is limited to intermittent or ephemeral drainages and ponds forming after precipitation events (rain, snowmelt). There are several lakes or ponds, also known as tanks. Most are small, averaging an acre or less. The natural tanks are associated with sinkholes in the underlying limestone formation. The tanks often hold water after spring snowmelt or heavy summer rain events. Some of these have been modified for livestock use (Burger, personal communication).

Table 27. Desired and pre- and post-fire percent for ponderosa pine and mixed conifer

Vegetative Structural Stages (VSS)	Desired Mix of VSS %	Ponderosa Pine		Mixed Conifer	
		Pre-fire Percent	Post-fire Percent	Pre-fire Percent	Post-fire Percent
1 - Grass-forb/shrub (non-stocked)	10	0	61	0	92
2 - Seedling/sapling (1 to 4″ d.b.h)	10	0	0	0	0
3 - Young forest (5 to 11″ d.b.h)	20	23	7	26	4
4 - Mid-aged forest (12 to 17″ d.b.h)	20	34	9	49	4
5 - Mature forest (18 to 23″ d.b.h)	20	26	10	13	0
6 - Mature forest (24″+ d.b.h)	20	17	12	11	0

The existing total road and trail density in the project area is 6.9 miles per square mile. Open road density is 1.6 miles per square mile.

The Kaibab Squirrel National Natural Landmark (KSNNL) was designated by the Department of Interior on the Kaibab Plateau in 1965 and includes areas on both North Kaibab Ranger District (NKRD) and Grand Canyon National Park (GCNP). Part of the project area is in the KSNNL. The project area also lies within the Grand Canyon National Game Preserve, established by Presidential proclamation in 1906.

Migratory flights through this region represent one of the largest raptor migration concentrations known in the Western United States and Canada (HawkWatch International 2007). The forest of the Kaibab Plateau appears to act as a funnel, relative to the surrounding deserts, for migrating raptors. In 2006, surveys found above average passage rates for northern goshawks and peregrine falcons and below average for bald eagles. It is unknown how wildfires and drought are affecting migratory routes (HawkWatch International 2007).

Old Growth (Mature Forests)

The forest plan direction is to allocate no less than 20 percent of each forest ecosystem management area (EMA) to old growth. It further provides direction that in the long term to manage old growth in patterns that provide for a flow of functions and interactions at multiple scales across the landscape through time. Allocations will consist of landscape percentages meeting old-growth condition and not specific acres. Old growth should be evaluated at multiple scales, including one scale above and one scale below the EMA. Analyses should be based on forest type, site capability and disturbance regimes (USDA Forest Service 2004). Even though there are several characteristics of old growth such as snags, down logs, canopy closure, etc., the primary element is the preponderance of mature trees. Some mature trees are smaller than 18 inches diameter at breast height (d.b.h) but most trees that have reached 18 inches d.b.h are considered mature. Therefore, it is acceptable to equate VSS 5/6 (18″+) size class as being functional equivalents of old growth.

EMAs are generally around 10,000 acres. The WFR project area is over 39,000 acres and contains all or parts of 10 EMAs. The total Warm Fire contains two additional EMAs. Therefore, the analysis will be based on the WFR project area as the mid-scale analysis (instead of an EMA) and will use the GA 13 (274,986 acres) which contains all of the conifer forests for the North

Kaibab Ranger District as the scale above and the site (sample point within sites) as being the scale below.

Managing old growth for a flow of functions and interactions across the landscape was one of the primary purposes of the 1996 amendment for all national forests in the Southwestern Region (R3) that adopted the ecosystem approach based on the most current scientific information that developed for the goshawk recommendations (Reynolds et al. 1992) which is not a single species management plan but rather an ecosystem landscape approach. Old growth consists of the accumulation of groups of mature trees at the sub-site level and specific locations change over time due to disturbances, both natural and man made, such as the Warm Fire. This is a basic principle of how old growth functions across the landscape within ecosystem that function with frequent disturbances such as fire, insects, and disease, etc.

Vegetative structural stages (VSS) as determined by similar size groups of trees in an uneven-aged forest are difficult to measure. VSS were determined for each stand (site) exam sample point as described in "Implementation and Interpretation of Management Recommendations for the Northern Goshawk" (USDA Forest Service 2005a). This site scale data was aggregated up to determine pre-fire VSS for the GA 13 large scale analysis area and at the Warm Fire mid-scale analysis area (both wildland fire use and suppression areas). The GA 13 VSS baseline was corrected by reducing the amount of acres lost in the Warm Fire (see table 28).

At the WFR project area level, sites were also classified by VSS in a separate process using the forest vegetative simulator (FVS) model. Both will be displayed separately as the two data sets cannot be compared together.

Mixed conifer (MC) species like white fir or blue spruce do not get as large as ponderosa pine and it is the mixed stands with ponderosa pine that have the larger ponderosa pine to increase averages to achieve the 18 inch plus size needed to qualify as VSS 5 or 6. Therefore, ponderosa pine (PP) was combined with MC to better represent "mixed conifer" as it occurs on the ground. For ponderosa pine other species within the stands such as pinyon-juniper, aspen, and woodland species (oak) were grouped as being "ponderosa pine." Spruce-fir (SF) and PPSF were combined for a SF total. Even though there was a reduction in mature trees (VSS 5/6) there was an even greater loss in the other size classes resulting in an actual increase percentage of old growth for GA 13 for PP and MC (table 28).

Table 28. Old growth (mature trees) within GA 13 and within the Warm Fire

Cover Type[1]	GA 13, VSS 2-6, Acres	GA 13 VSS 5/6, Acres	Percent VSS 5/6, GA 13	High and Mixed-High in Warm Fire, VSS 5/6	High and Mixed-High in Warm Fire, VSS 2-6	Percent VSS 5/6 of Area Lost in Warm Fire	New Adjusted GA 13 Acreage (VSS 5/6)	New Adjusted GA 13 Acreage (VSS2-6)	New Adjusted Percent VSS 5/6, GA 13
MC	36,728	7,077	19	141	5,313	2	6,936	31,415	22
PPMC	21,543	8,984	42	1,675	6,628	19	7,309	14,915	49
Total MC	**58,271**	**16,061**	**28**	**1,816**	**11,941**	**11**	**14,245**	**46,330**	**31**
PP	81,930	44,227	54	1,675	3,890	4	42,552	78,040	55
PPAA	16,058	6,999	44	85	981	1	6,914	15,077	46
PPPJ	2,432	674	28	0	113	0	674	2,319	29
PPWL	19,629	9,946	51	183	1,985	2	9,763	17,644	55
Total PP	**120,049**	**61,846**	**52**	**1,943**	**6,969**	**3**	**59,903**	**113,080**	**53**
PPSF	2,818	806	29	28	726	3	778	2,092	37
SF	18,388	1,143	6	0	66	0	1,143	18,322	6
Total SF	**21,206**	**1,949**	**9**	**28**	**792**	**1**	**1,921**	**20,414**	**9**

[1]MC: mixed conifer, PPMC: ponderosa pine/mixed conifer, PP: ponderosa pine, PPAA: PP/aspen, PPPJ: PP/pinyon-juniper, PPWL: PP/woodland, PPSF: PP/spruce-fir, and SF: spruce-fir.

Old growth data as derived from the use of FVS to model data within the WFR project area is presented in tables 29 and 30. At the project level there were 279 acres of Engelmann spruce and these acres were combined with mixed conifer for this analysis. The data shows that due to the severity of the fire, ponderosa pine (VSS 5/6) went from 43 to 22 percent and mixed conifer went from 24 to 0 percent for an area of approximately 39,110 acres. The desired condition is to have approximately 40 percent for both cover types.

Table 29. Pre- and post-fire acres for VSS 5/6 within the ponderosa pine WFR project area

	Pre-Fire Acres	Post-Fire Acres	Difference in Acres
Ponderosa Pine			
VSS 5	6,467	2,538	-3,929 (61%)
VSS 6	4,109	3,091	-1,018 (25%)
Total	10,567	5,629	-4,938 (47%)
Mixed Conifer			
VSS 5	733	26	-707 (96%)
VSS 6	596	0	-596 (100%)
Total	**1,329**	**26**	**-1,303 (98%)**

Table 30. Percentage of old-growth, ponderosa pine and mixed conifer, pre- and post-fire, WFR project area

VSS	Desired Percent	Pre-Fire Percent	Post-Fire Percent
Ponderosa Pine			
5	20	26	10
6	20	17	12
5/6	40	43	22
Mixed Conifer			
5	20	13	0
6	20	11	0
5/6	40	24	0

It may take 1 to 2 centuries for the structural components of mature forest to return to most of the mixed-high and high mortality burn areas where overstory seed sources are available or where planting occurs. Most of the areas that experienced moderate to high and high severity burns are distant from seed sources, therefore, it is not possible to accurately estimate the time until mature or old-growth habitat recovery occurs if seedlings are not planted. The development of trees and eventual expansion of seed sources is a gradual process that depends on adequate precipitation at appropriate times to ensure seedling survival. For example, pine seedlings that sprouted after the Warm Fire died the following year due to a lack of precipitation. Recent research has called into question whether forests will naturally return in high severity, post-fire landscapes (Savage and Mast 2005). Key habitat components related to both forest structure (i.e. large trees and snags and canopy cover) and understory (i.e. logs and woody debris, wide range of tree and plant species, plant cover) are absent in these mortality areas.

Threatened and Endangered Species

Regulatory Framework

The Endangered Species Act of 1973 declares that all Federal agencies … " utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to section 4 of this Act." The ESA (Section 7 (a)(2)) requires Federal agencies to ensure that any agency actions (any action authorized, funded, or carried out by the agency) are not likely to jeopardize the continued existence of any threatened, endangered, or proposed species. Agencies are further required to develop and carry out conservation programs for these species.

Implementing regulations (36 CFR 219.19) direct the Forest Service to manage habitat to maintain viable populations of existing native and desired nonnative vertebrate species. A viable population is defined as one that has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area, which, in this case is the Kaibab National Forest.

The affected environment and environmental consequences is discussed in detail in the "Warm Fire Recovery Project, Biological Assessment" and this document is the primary reference for the following discussion.

Species List

Endangered and threatened wildlife species for the Kaibab National Forest and their status in the project area is shown in table 31. This list was developed from the "Hazard Tree Removal Environmental Assessment" (USDA Forest Service 2007a) and checked with the U.S. Fish and Wildlife Service list for Coconino County (www.fws.gov/Southwest/es/arizona).

Table 31. Threatened and endangered wildlife species

Common Name	Scientific Name	ESA Status	Status on NKRD and in Project Area	Determination of Affect
Southwestern willow flycatcher	*Empidonax traillii extimus*	endangered	Not documented on NKRD or forest, potentially suitable habitat on Kanab Creek (Sanders et al. 2004) but no suitable habitat in project area.	N/A
California condor	*Gymnogyps californicus*	10J, non-essential experimental population	Documented on NKRD and suitable foraging habitat present.	Not likely to jeopardize
Mexican spotted owl	*Strix spotted owl*	threatened	Not documented on NKRD, suitable but unoccupied habitat present.	Not likely to adversely affect either species or critical habitat
Yellow-billed cuckoo	*Coccyzus americanus*	candidate	Not documented on NKRD or forest and no suitable habitat in project area.	N/A
Apache trout	*Oncorhynchus apache*	threatened	Documented on NKRD in North Canyon, but no suitable habitat present in project area.	N/A
Kanab amber snail	*Oxyloma haydeni kanabensis*	endangered	Not documented on NKRD but may be potentially suitable habitat in Kanab Creek (Sanders et al. 2004). No suitable habitat present in project area.	N/A

The project area once provided suitable habitat for two of these species; the California condor and Mexican spotted owl. There is no suitable habitat for the other species, and there would be no effect to those species.

California Condor

Condors almost became extinct due to excessive shooting, lead poisoning and losses from other human-induced causes. The first successful breeding of captive condors began in 1988 and in 1992 birds were released in California. The final rule for establishment of a nonessential, experimental population in northern Arizona was released in 1996 (USDI Fish and Wildlife Service 1996). Beginning in 1996, birds were released on the Vermillion Cliffs in House Rock Valley, just outside the eastern border of the NKRD. Since that time, and through December 2006, 93 condors have been released in northern Arizona. Thirty-three of the released birds have died and 3 were returned to captivity due to behavioral concerns. Losses were due to predation, lead poisoning, bird-human interactions and shootings (Southwest Condor Review Team 2007).

Condors feed on carrion and forage over a wide area; breeding pairs forage most frequently within 70 km of nest and nonbreeders forage more widely (in Sanders et al. 2004). Condors use

the Kaibab Plateau extensively, albeit seasonally. Spring through summer use of the plateau started out low, but has continually increased through time. Condors spend a relatively large amount of time on the North Kaibab during autumn when the deer hunt is in progress. By winter, they cross House Rock Valley and return to the Vermillion Cliffs.

This species nests on the floor of a cliff, cavity, or cave, and in crevices among boulders on steep slopes. Egg laying occurs mainly in February and March, but sometimes through early May. Six nest attempts have occurred on the North Kaibab, although no chicks have been hatched there yet. One location is approximately 3 miles west of the project area where a pair of condors has attempted to nest for the last 3 years. The eggs have been fertile, but died in the later stages of incubation.

Frequent movements over the Kaibab Plateau indicate that they are proficient in finding food on their own, but they are also encountering more exposure to lead bullet fragments and pellets. Lead poisoning is now one of the key risk factors for this population. Four adult condors died of lead toxicity in the winter of 2006/2007.

California condors are opportunistic scavengers, feeding only on carcasses. Typical foraging behavior includes long distance reconnaissance flights, lengthy circling flights over a carcass, and hours of waiting at a roost or on the ground, near a carcass (USDI Fish and Wildlife Service 1996). Condors may use the project area during foraging flights.

Mexican Spotted Owl

Mexican spotted owls (MSO) nest and roost primarily in closed-canopy forests or rocky canyons. Forests used for roosting and nesting often contain mature or old-growth stands with complex structure. These forests are typically uneven-aged, multistoried and have high canopy closure. In this portion of the Colorado Plateau, they roost primarily in rocky canyons. They prey mainly on small mammals, but species composition varies with cover type.

Two primary reasons were cited for listing: alteration of habitat through even-aged management and the threat of this continuing, and the danger of catastrophic wildfire (USDI Fish and Wildlife Service 1995). In 1996, all forest plans in the Southwestern Region of the Forest Service were amended to incorporate MSO habitat management direction. Approximately 7,800 acres (or 20 percent) of all cover types within the project area had received even-aged management treatments since the 1970s prior to the fire (see table 10 at the beginning of chapter 3).

Mexican spotted owls are known to occur in Arizona, New Mexico, southern Utah, portions of Colorado and Mexico. In Arizona, MSOs are known to occur along the Mogollon Rim, San Francisco Peaks, Sky Island Mountains, and within the Grand Canyon. Mexican spotted owls nest within the forests on the KNF on the Williams Ranger District, within the canyons in Grand Canyon National Park (GCNP), and in the canyons in Zion National Park. Even though many acres have been surveyed to protocol, there have been no confirmed breeding records of MSO occurring on the NKRD. The project area may provide habitat for dispersing MSOs. The boundary of Critical Habitat Unit CP-10 (Colorado Plateau Unit 10) extends into the Warm Fire area of the NKRD.

There are unconfirmed reports of Mexican spotted owls on the NKRD from the mid-1980s and early 1990s. No followup surveys of any of the historic reports have ever detected a MSO. Moreover, extensive surveys conducted to protocol from 1992 through 2005 (covering over 80

percent of the mixed conifer on the NKRD) have failed to detect any MSO (Noble, W.; Forest Biologist, East Rim Project Record). In addition, the GCNP has never detected a MSO in the forests on top of the Kaibab Plateau. U.S. Fish and Wildlife Service personnel surveyed selected portions of the NKRD in 2002 targeting areas they felt had the highest potential for resident MSO. None were detected. Given the limited number of historic but unconfirmed sightings on the NKRD, the failure to detect any MSOs on followup surveys to when owl calls were heard, and no detections by any other types of surveys; it seems fair to conclude that there is not a resident population on the NKRD. If MSOs do use the plateau, they are likely transient birds (Noble, W.; Forest Biologist, East Rim Project Record). Accordingly, no protected activity centers (PACs) have been established on the NKRD.

Forest staff conducted a district-wide analysis of MSO restricted habitat based on the MSO Recovery Plan criteria (USDI Fish and Wildlife Service 1995). This analysis determined that the North Kaibab Ranger District contains approximately 61,000 acres of mixed conifer habitat, 3,800 acres of which meets threshold conditions. In order to meet the definition in the recovery plan, an additional 11,450 target stand acres need to be managed to attain the desired thresholds over time. The district then designated the best 25 percent (including acres currently meeting threshold conditions) of mixed conifer based on basal area, stand density index and number of large trees. This best 25 percent is applied to the entire district rather than individual planning areas.

Subsequent work by forest personnel has called into question whether mixed conifer habitat designation on the plateau is ecologically based or a result of historic grazing and subsequent fire suppression. In addition, rather than occurring in landscape-scale blocks as it currently appears, this habitat was likely highly fragmented, based on the interspersion of slope and aspect. Nevertheless, the MSO habitat designations remain as described above to assure that the best nest/roost habitat is retained at both the planning area and landscape levels.

Acres of MSO habitat and acres that were affected in the project area are shown in table 32. About 75 percent of these acres have been surveyed (Sanders 2007). Another 313 acres were not assigned to a mortality class during classification due to cloud cover during photography. The numbers below show acres that include the unclassified 313 acres (ibid*)*.

Although individual spotted owls were not affected by the Warm Fire, 85 percent of the mixed conifer forest was classified as high mortality or mixed-high mortality and most of these areas will not be considered spotted owl habitat for one or more centuries. Within MSO habitat, about 75 percent of the designated MSO habitat is considered to have mixed-high or high mortality (see table 33). These areas had more than 70 percent mortality in the overstory, with all small woody debris consumed and the large woody debris consumed or charred.

Key habitat components and critical habitat primary constituent elements related to both forest structure (i.e., large trees, snags, and canopy cover) and maintenance of prey species, were altered in the mixed-low mortality areas. Portions of the mixed-low mortality areas are expected to provide potentially suitable habitat, as the overstory is more intact (approximately 10 percent mortality) and understory vegetation, duff and woody debris remain over more than 50 percent of these areas. Alteration of habitat components in the low mortality areas was minor and these areas continue to provide potentially suitable habitat.

Table 32. MSO habitat within the project area

Habitat*	Total Acres	High Mortality	Mixed-high Mortality	Mixed-low Mortality	Low Mortality
Threshold habitat (best)	514	378	57	58	21
Target habitat (assigned to threshold but not meeting)	2,531	1,680	240	301	309
Restricted habitat (general)	6,336	4,374	539	658	763
Total	**9,381**	**6,432**	**836**	**1,017**	**1,093**

* Habitat quality is broken into categories based on the MSO Recovery Plan. All acres identified in this table are considered under restricted heading in general, but those stands identified as target or threshold had additional requirements met or to meet, pre-fire. All acres of habitat in this table are considered designated critical habitat per the August 31, 2004 Rule.

Bond et al. (2002) looked at spotted owl survival, site fidelity and reproductive success following fire and suggested that wildfires may have minimal impacts on spotted owl survival rates, site fidelity or reproductive rates over the short term. They suggested that spotted owls may have the ability to withstand immediate, short-term (1 year) effects of fire occurring primarily at low to moderate severities within their territories. While there are no occupied territories in the project area (or on the NKRD), the majority of the designated habitat is in the high or mixed-high mortality classes, as discussed above.

Sensitive Species

Regulatory Framework

The sensitive species analysis in this document meets the requirements for a biological evaluation as outlined in FSM 2672.42. Sensitive species are administratively designated by the Regional Forester (FSM 2670.5) and managed under the authority of the National Forest Management Act. FSM 2670.22 requires the maintenance of viable populations of native and desired nonnative species and to avoid actions that may cause a species to become threatened or endangered. A viable population is defined as one that has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area, which in this case is the Kaibab National Forest.

The 1999 Southwestern Region Sensitive Species list was in place when this project was scoped, issues identified and preliminary analyses completed. The sensitive species list was updated in 2007 and species found on the NKRD are listed in Table 33.

Table 33. Sensitive wildlife species on the NKRD

Common Name	Scientific Name	Status in Analysis Area
Bald eagle	*Haliaeetus leucocephalus*	Migratory use, limited winter use
Northern goshawk	*Accipiter gentilis*	Documented in project area
American peregrine falcon	*Falco peregrinus anatum*	Documented on NKRD. Project area may be used for foraging, no suitable nesting cliffs in the project area.
Grand Canyon rattlesnake	*Crotalus viridus abyssus*	This subspecies range is entirely within the Grand Canyon and related upriver canyons into Glen Canyon

Common Name	Scientific Name	Status in Analysis Area
		(www.reptilesofaz.com). Not documented on NKRD, and would potentially occur only in the extreme southwestern corner of the NKRD. Not in the project area and no further analysis is needed.
Utah Mountain kingsnake	*Lampropeltis pyromelana*	Documented on NKRD and could be present in the project area.
Northern leopard frog	*Rana pipiens*	Only occurs in the House Rock Wildlife Area where ongoing efforts are trying to re-establish a population. Tanks in project area may be unsuitable due to lack of aquatic vegetation and siltation issues. Not in project area and no further analysis is needed.
Desert bighorn sheep	*Ovis canadensis Mexicana*	The project area is outside of the four occupied habitat areas on the Arizona Strip as discussed in "Existing Condition." Species not carried forward into effects analysis.
Spotted bat	*Euderma maculatum*	Habitat consists of high cliff crevices near water sources. This bat is known to forage within the coniferous forest within the NKRD and reproduce in the Grand Canyon.
Allen's lappet-browed bat	*Idionycteris phyllotis*	Habitat consists of woodland and forest, often associated with cliffs and rocky slopes.
Pale Townsend's big-eared bat	*Corynorhinus townsendii pallescens*	Habitat consists of caves and mines in woodland and forest.
Kaibab least chipmunk	*Neotamias minimus consobrinus*	Habitat is the coniferous forest. This species is a generalist and can be found in a variety of habitats within the coniferous forest.
Long-tailed vole	*Microtus longicaudus*	Habitat consists of meadows, sagebrush flats and rocky slopes near or in coniferous forests.
House Rock Valley chisel toothed kangaroo rat	*Dipodomys microps leucotis*	Habitat consists of scattered juniper in sandy areas. Not in project area and no further analysis is needed.
Kaibab squirrel	*Sciurus aberti kaibabensis*	This subspecies is endemic to the Kaibab Plateau. It is considered vulnerable in AZ and rounded globally status is vulnerable as well.
Kaibab northern pocket gopher	*Thomomys talpoides taylori*	Endemic subspecies, relict population, subject to habitat loss due to drought and climate change. Highly restricted distribution, high forest zone subspecies subject to habitat loss and competitive displacement.

Bald Eagle

Bald eagles were recently delisted (USDI Fish and Wildlife Service 2007). This decision was based on a thorough review of the best available information that showed threats to the species eliminated or reduced to the point that the population no longer meets the definition of threatened or endangered under the Endangered Species Act. Their analysis shows 43 breeding pairs in Arizona. The "Post Delisting Monitoring Plan" requires monitoring of the status of bald eagles over a 20-year period with sampling events held once every 5 years. To ensure that appropriate habitat management and conservation will continue on National Forest System lands, the bald eagle has been designated a Regional Forester Sensitive Species in all regions where it was previously a listed species.

Bald eagles occur in Arizona as either breeding populations or winter migrants. Bald eagles primarily breed in central Arizona in close proximity to water. Several hundred wintering eagles arrive in Arizona in the fall, usually late October or early November, and occur in the central and northern part of the state. Wintering eagles generally leave in early to mid-April.

Bald eagles feed on fish, waterfowl, terrestrial vertebrates and carrion. They are often seen perched in trees or snags near water or next to roadways where they feed on road-killed animals. At night, small groups or individual eagles roost in clumps of large trees in protected locations such as drainages and hillsides. Eagles usually roost adjacent to or very near food sources.

Bald eagles are primarily winter visitors to NKRD. There are no known winter roosts on the NKRD; however bald eagles are seen near Big Springs and on deer winter range where they are assumed to be feeding on hunter and winter-killed deer (Sanders et al. 2004).

Northern Goshawk

The northern goshawk will be analyzed at various landscape scales. GA 13 consists of almost the entire conifer forest within the NKRD and will be the largest scale. The Warm Fire is divided into two areas, the WFR project area and the remainder of the wildfire area to the north, which was burned under wildland fire use management and is referenced as wildland fire use (WFU) area.

This subspecies is found in forested regions of North America from Newfoundland to Alaska, south to New Jersey, and to Pennsylvania in the east and northwestern Mexico in the west. The goshawk is a forest habitat generalist that uses a variety of forest types, forest ages, structural conditions and successional stages (Reynolds 2004). It primarily occupies ponderosa pine, mixed species and spruce-fir habitats in the Southwest and prefers mature conifer stands with dense canopies for nesting. A review of numerous studies suggests that availability of nest sites influences nest site occupancy and reproduction, but that forest structural conditions beyond the nest sites have a larger effect on goshawk reproduction and survival by affecting both the abundance and accessibility of their prey (Reynolds et al. 2006).

Goshawk foraging habitat is much more variable than nesting habitat (Reynolds et al. 1992). This is partly because goshawks hunt a wide variety of prey species and different prey species are associated with different habitat characteristics. Important prey species on the Kaibab Plateau include robins, Stellar's jay, hairy woodpecker, northern flicker, red-naped and Williamson's sapsuckers, chipmunks, golden-mantled ground squirrels, cottontail rabbits, black-tailed jackrabbits, Kaibab squirrels and red squirrel (Reynolds et al. 1992; Wiens et al. 2006). Some species use young-aged or open forest, including the rabbits and jackrabbits, ground squirrels, flickers, robins and jays. Mid- to old-aged forest or closed forest support prey species such as sapsuckers and squirrels. The Warm Fire likely had negative effects on most of the goshawk prey species in the high vegetation mortality areas. Prey populations in low and mixed-low mortality areas were probably minimally affected. Some prey species, such as certain woodpecker species, may increase in abundance during the next few years in mixed-high and high severity areas due to increased beetle activity, compared to pre-fire abundances (USDA Forest Service 2007c).

Goshawks typically select forests with open understories for foraging (Reynolds et al. 1992). Fire caused understory thinning occurred in parts of the low and mixed-low vegetation mortality areas and likely had positive effects on goshawk foraging habitat. For this analysis, ponderosa pine and mixed conifer habitat outside of the post-fledging family areas (PFAs) is considered foraging habitat, consistent with forest plan direction.

The goshawk has been petitioned for listing several times, but findings were that listing was not warranted. Braun et al (1996) found no evidence to indicate that northern goshawk populations were declining, threatened or endangered in the Southwest or anywhere in its range, and no evidence of a long-term decline in breeding populations. This review was part of the rationale for not listing goshawks in 2001.

Northern goshawk populations may be affected by forest management treatments that alter the range of environmental conditions beneficial to their reproduction and survival (Reynolds et al. 2006). Forest plans in the Southwestern Region were amended to address management of goshawk habitat. This amendment was based on the 1992 "Management Recommendations for the Northern Goshawk in the Southwestern United States" (Reynolds et al. 1992). The report was reviewed prior to publication by managers and scientists and the final document reconciled their comments. It was reviewed after publication by the Wildlife Society and American Ornithologists Union in 1994. This technical review concluded that "the scope and review of the biology of northern goshawks is excellent and that it encourages forest managers to consider forest ecosystems as assemblages of interacting species of plants and animals." It has withstood other reviews since that time, and is still recognized as the best available science for management of goshawk habitat.

North Kaibab Plateau

The northern goshawk is a common breeding resident on the Kaibab Plateau. The North Kaibab goshawk population is one of the most studied goshawk populations in North America. Research was initiated by the Rocky Mountain Research Station (RMRS), under Richard Reynolds, in 1991 to address poorly understood aspects of goshawk ecology. Goshawk surveys have been conducted by district employees and the RMRS crews using the standard broadcast survey protocols since 1991. Each territory has about 10 to 15 person days per year over the course of 18 years of studies (Reynolds, personal communication). Studies on the North Kaibab Plateau have found extensive temporal and spatial variation in reproduction and a high annual frequency of movements among dispersed alternate nest sites (Reynolds et al. 2005).

Warm Fire (Both WFU and Suppression Areas)

Post-fledging Family Areas (PFAs): One PFA is designated within each territory. PFAs are approximately 600 acres in size, include all nest sites, and include the habitat most likely to be used by fledglings during their early development (Forest Plan, pg. 29). For the North Kaibab Ranger District where there are many years of inventories for goshawks and their nests, the best way to delineate PFAs on the ground is to draw a 600-acre circle around a central point of all known nest sites (Reynolds, personal communication).

There are a total of 28 known goshawk territories and associated PFAs associated with the Warm Fire (table 34). There are 6 territories and associated PFAs within the fire use area, 16 within the WFR project area, and 3 PFAs that overlap the boundary between the 2 areas. Six PFAs had only a small area within the burn area with most of their area being outside and unburned.

Table 34. Acres by severity for each PFA within both the fire use (WFU) area and WFR project area (SUPP)

PFA	WFU/ SUPP	Unburned	Low	Mixed-Low	Mixed-High	High	Unknown (Cloud Cover)	Percent M-H and High	Active Since Burn	Functional
10	WFU	0	14.8	368.3	185.4	11.1		33		Potential
10	SUPP	0	3.3	13.8	2.8	0.4		1		Potential
15	WFU	0	5.9	35.3	18.1	0.4		3		Potential
15	SUPP	0	21.7	152.8	181.7	184.0		61		Potential
16	WFU	0	3.2	85.8	315.9	195.1		85		Potential
30	WFU	0	13.5	158.0	222.4	206.1		71	Yes	Functional
34	WFU	133.4	77.8	200.0	154.0	34.8		31		Potential
71	WFU	578.5					21.5	0		Potential
72	WFU	0	16.7	239.6	261.2	82.5		57		Potential
96	WFU	0	0.2	2.4	16.9	82.0		16		Potential
96	SUPP	0	1.1	4.2	15.1	478.1		82		Non-Functional
123	WFU	85.8	21.8	156	188.4	148.0		56		Potential
9	SUPP	584.6	4.1	0.2	0	0	11.1	0		Potential
13	SUPP	0	26.7	76.3	120.0	371.8	5.2	82	Yes	Functional
28	SUPP	0.1	3.1	31.9	81.2	483.7		94		Non-Functional
37	SUPP	10.3	329.1	135.3	32.4	2.2	90.7	6		Potential
46	SUPP	599.9	0.01	0.006	0	0	0.07	0		Potential
65	SUPP	365.6	6.4	51.6	19.2	3.4	153.8	4		Potential
83	SUPP	27.3	31.5	129.2	93.7	318.3		69	Yes	Functional
84	SUPP	-0.1	0.7	8.8	58.9	516.4	15.3	96		Non-Functional
85	SUPP	0	0	1.8	25.9	572.3		100		Non-Functional
86	SUPP	425.6	107.5	54.3	12.5	0	0.1	2		Potential
93	SUPP	0	0	0	8.6	591.4		100		Non-Functional
94	SUPP	0.1	422	165.6	12.3	0		2		Potential
103	SUPP	596.2	3.3	0.5	0	0		0		Potential
104	SUPP	0	0	0.2	25.9	573.9		100		Non-Functional
108	SUPP	0	313.9	100.5	3.3	0.7	181.6	1	Yes	Functional
125	SUPP	571.9	20	8.1	0	0		0		Potential

Trees within areas with a fire severity classification of mixed-high or high had essentially 100 percent tree mortality and those areas are no longer stocked with trees (see "Vegetation" section above). When these areas compose large blocks, they can no longer function as goshawk breeding habitat. Across the entire burn, 64 percent of the area that was habitat (excludes pinyon-juniper and grassland vegetative types) prior to the burn is no longer stocked with trees (table 35).

Table 35. Acres of burn severity across the WFU and WFR project areas

Area	Low	Mixed-Low	Mixed-High	High	Unknown (Cloud Cover)	Percent Mixed-High and High
WFU	998.1	4,795.3	4,780.5	3,365.5	324.5	58
WFR project	5,785.9	5,005.7	3,431.5	17,616.7	1,958.5	66
Total Fire	**6,784.0**	**9,801.0**	**8,212.0**	**20,982.2**	**2,283.0**	**64**

One PFA within the fire use part of the burn had an active nest in 2007 and 2008 and three additional PFAs in the WFR project area part were active in 2008 (Reynolds, personal communication). Based on the large block of mixed-high and high severity within and around PFAs, and based on nesting occurrence since the fire, it is estimated that all six PFAs within the west half of the WFR project area are no longer functional and may not be functional until large trees again occupy the site. Based on the amount of habitat that remains intact and is associated with active nests, seven additional PFAs may have enough suitable habitat remaining that goshawks may be able to use these areas in the foreseeable future, although most likely at reduced capacity.

Vegetative Structural Stages (VSS): The Kaibab forest plan directs the forest to manage for a particular distribution of vegetation structural stages (VSS) for ponderosa pine, mixed conifer and spruce-fir forests representative of multiaged forest conditions (USDA Forest Service 1996). Post-fire forests will initially develop as even-aged stands in the high mortality areas. Uneven-aged management of these stands will not be possible until trees reach cone bearing age.

The majority of the project area (fire suppression area) is within GA 13 which includes the entire conifer forest of the NKRD. A small portion of the northeastern part of the project area, which primarily consists of the pinyon-juniper vegetative type with some ponderosa pine stringers, is in GA 16. Goshawks utilize the transitional zone between the coniferous forest types and pinyon-juniper but almost all nesting is within GA 13. Using GA 13 as the large scale analysis area, acreage of VSS types at this scale were calculated by taking all known stand exams prior to 2000 and using this as a base to calculate the acres based on the year of the exam, which varied.

Within the project area, or the mid-scale analysis area, there are primarily two cover types that are important to goshawks, ponderosa pine and mixed conifer. There are approximately 278 acres of spruce-fir; however, due to the small amount of acres and that goshawks are not known to use spruce-fir, this cover type within the project area will not be discussed. None of the action alternatives will change the VSS or density classes. The fire was intense; producing extreme changes in whole VSS classes (Table 36). To visually show the drastic changes in VSS classes canopy densities (A, B, and C, with A being open and C closed), and whether site was multiple

storied (MS) or single storied (SS) just VSS classes (each VSS class shown with one color) are displayed in figures 27 and 28.

Approximately 63 percent of the suppression area was stocked with ponderosa pine. Although there was considerable ponderosa pine regeneration in the understory prior to the fire, these areas were stocked with larger trees and the VSS class was based on the larger trees present onsite. The severity of the fire caused 61 percent of the area that contained ponderosa pine to go from fully stocked to VSS 1 class, which either had no trees or no longer had enough trees to be considered stocked (tables 36 and 37 and figure 28).

Approximately 14 percent of the suppression area was stocked with mixed conifer prior to the fire. The mixed conifer consisted of blue spruce, Douglas-fir, white fir, and a smaller component of ponderosa pine. Ninety-two percent of the high density mixed conifer forest went from being fully stocked to having no trees or only a scattering of trees, which was not enough to be considered stocked. All of the larger VSS 5/6 were lost (see figure 27 and table 36). There were no significant changes in the ratio of mixed conifer structural stages in the project area at the GA 13 scale, which had most of the stocking in the VSS 3 and 4 categories. There was essentially no mixed conifer in the fire use area of GA 13.

Table 36. Ponderosa pine VSS classifications (acres) for pre- and post-fire occurrence

VSS	GA13 (Pre-Fire)	Warm Fire Project Area		Difference	GA13 (Post-Fire)
		Pre-Fire	Post-Fire		
Ponderosa Pine					
VSS 1	2,606	88	15,220	15,132	17,738
VSS 2	9,354	23	14	-9	9,345
VSS 3	34,251	5,769	1,741	-4,028	30,223
VSS 4	29,531	8,376	2,230	-6,146	23,385
VSS 5	36,036	6,467	2,538	-3,929	32,107
VSS 6	35,601	4,109	3,091	-1,018	34,583
Mixed Conifer					
VSS 1	299	33	5,193	5,160	5,459
VSS 2	1,520	59	0	-59	1,461
VSS 3	16,553	1,453	203	-1,250	15,303
VSS 4	11,579	2,751	203	-2,548	9,031
VSS 5	4,846	733	26	-707	4,139
VSS 6	46	0	0	0	46

Table 37. Percent of desired and estimated VSS levels at the GA 13 scale and WFR project area level for ponderosa pine and mixed conifer

VSS	Desired Percent	GA13 Pre-fire (percent)	GA13 Post-fire (percent)	WFR Area Pre-Fire (percent)	WFR Area Post-Fire (percent)
Ponderosa Pine					
1	10	2	12	0	61
2	10	6	6	0	0
3	20	23	21	23	7
4	20	20	16	34	9
5	20	24	22	26	10
6	20	24	23	17	12
Mixed Conifer					
1	10	1	1	92	15
2	10	4	1	0	4
3	20	45	26	4	41
4	20	31	49	4	24
5	20	13	13	0	11
6	20	5	11	0	4

Prior to the Warm Fire, across the entire plateau (GA 13) there was less than 1 percent VSS 1 or 2 at the stand level. When considering the WFR project area and the intensity of the fire, the amount of VSS 1 increased the district-wide scale to 10 percent and the amount of mature trees (VSS 5 and 6, combined) decreased from 40 to approximately 36 percent. Based on fire severity and the total area affected by the Warm Fire, VSS 1 for GA 13 could now be as high as 15 percent with decreases in the amount of VSS 5 and/or 6 district-wide.

Snags and Down Logs: Snags and down logs are important elements of goshawk habitat and are the only element that may change based on the action being proposed. The forest plan defines snags and provides guidelines for three snags per acre for spruce-fir and mixed conifer and two snags per acre for ponderosa pine (Forest Plan pgs. 29-30). As with any major fire, the number of standing dead trees has been greatly increased and the expected down logs will increase in the future as standing trees fall. With over 60 percent of the project area being classified as mixed-high to high fire severity, the number of standing dead trees will greatly exceed the biological need for any wildlife species (table 38, also fire severity and mortality maps figures 5 and 6).

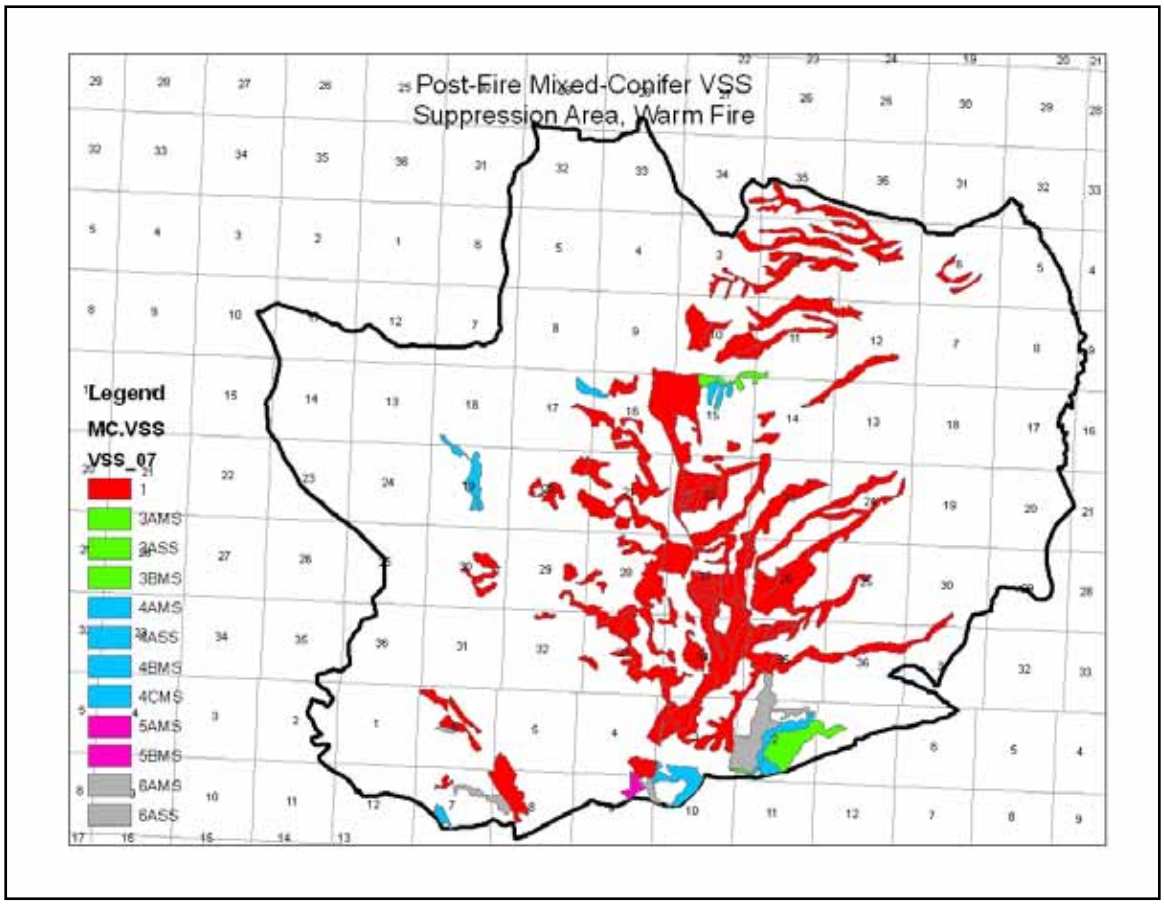

Figure 27. Post-fire VSS for mixed conifer in the Warm Fire suppression area (A, B, and C represent canopy density and SS and MS represent single story and multiple story structure)

Table 38. Number of snags by size class by severity rating immediately after the fire

Severity	Acres	Snags 10-14" per Acre	Snags 14-20" per Acre	Snags 20+"/Acre	Total No. of Snags 20"+
Low	9,278	11	4	1	12,989
Mixed	5,717	41	16	7	38,876
High	7,293	37	24	12	86,782
Very High	15,482	51	29	14	213,653
Totals	**37,770**				**352,300**

Acres and number of snags rounded to the nearest whole number

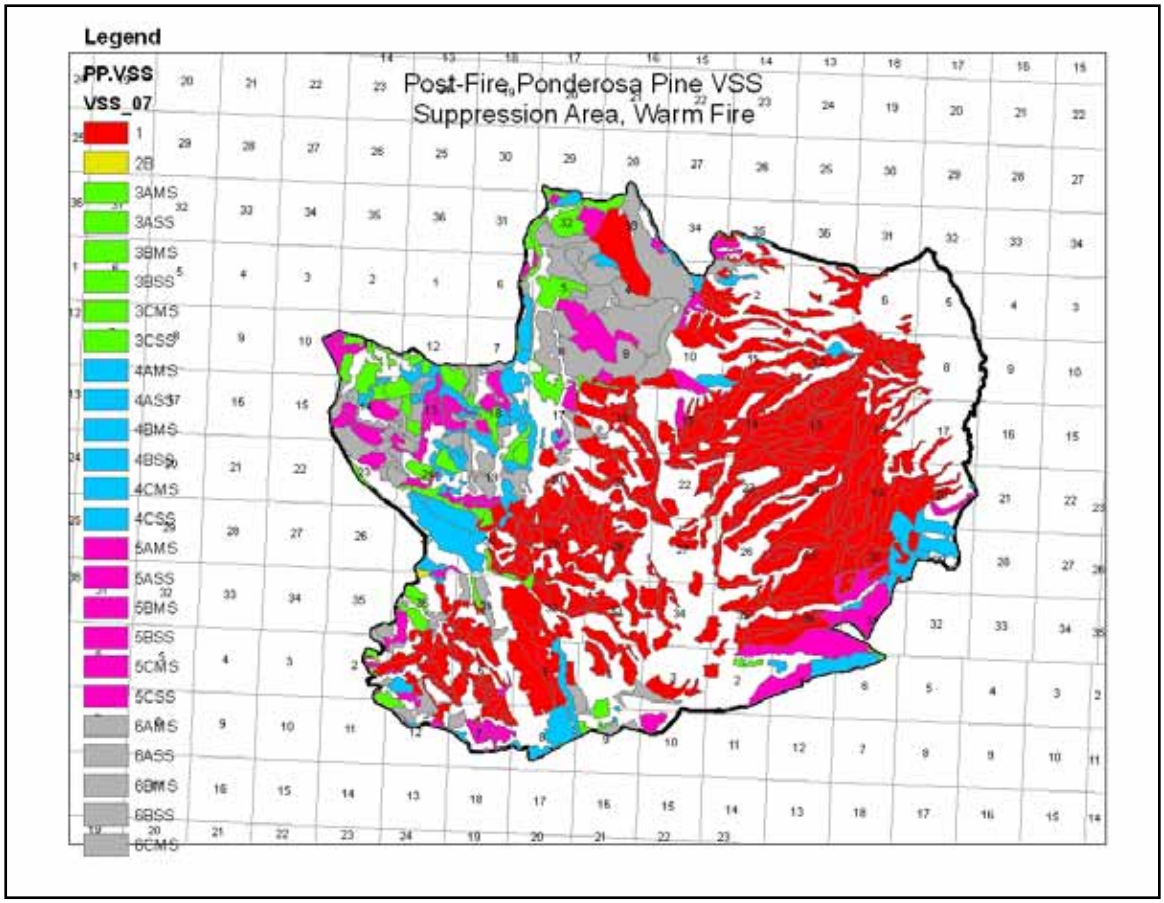

Figure 28. Post-fire VSS for ponderosa pine Warm Fire suppression area

Snags at the Large Scale – GA-13: Snag numbers are generally below desired conditions described in forest plan guidelines at the GA 13 level, especially when distribution is considered.

As discussed above in the mid-scale analysis for the WFR project area, the number of snags over the 39,000-acre project area is more than what is required and exceeds forest plan guidelines. Also as previously described, mitigations at the project level have been included that also exceed guidelines at the smaller scale of sites within treatment areas.

The large number of snags in the WFR area would add approximately 1.5 snags per acre to existing snag levels at the GA level; but would not address the poor distribution of these added snags, and the fact that there would be little habitat gain at the GA landscape level. The snag habitat guidelines were created for “green” forest structure, and indicate levels needed across landscapes in relation to other living tree structures to provide quality habitat. In moderate, high, and severe burn severity areas these snags are on the landscape without the other habitat structures, and would contribute little to improved habitat at the landscape scale. In addition, the bulk of these snags will fall to the ground generally within a short timeframe.

A large addition of snags concentrated in a wildfire area such as the Warm Fire, while providing for some species habitats, does not contribute greatly to goshawk habitat quality at the GA landscape scale, except perhaps along some amount of forest edge in the 10,000 acres of low severity burn area. Conversely, salvage removal of snags over less than 25 percent of the wildfire area in mixed-high and high fire severity will have no effect on the large landscape analysis area, because this is still a limited area compared to the size of the GA. The snags existing at this time will not be present when goshawk habitat is replaced, and will not be the snags that will contribute to a restored structure.

Logs and Down Woody Debris at the Large Scale – GA-13: The contribution of habitat from the Warm Fire, and the effects of removing mortality trees through salvage on log and down woody debris components on the GA is similar to the SFR on snags discussed above. Within a short time period (over the next 10 to 20 years), log and down woody debris will increase tremendously in the mid-scale analysis area (the Warm Fire project area), as thousands of dead trees begin to fall to the ground. Tons per acre accumulations within the fire area will far exceed all habitat guidelines for the goshawk. Averaging the excess within the fire area over the GA landscape will increase the amount but will provide little contribution to habitat due to poor distribution (for a further discussion of logs and down woody debris at the middle and site/stand scale analyses, see the "Fire Risk and Fuels" analysis). Little of the log and down woody debris component will remain in the project area in the far future when goshawk habitat has been restored; what little that may remain would not contribute much at the GA landscape level due to its concentration and poor distribution. This component will actually create increased fire risk to adjacent unburned forest as the tons of fuel created from deadfall in 75 percent of the untreated area of the Warm Fire suppression area accumulates to undesirable fuel loads over the next several decades. There may be some habitat contribution at the GA level along edges and where the fire burned at low intensity, but the acreage will be small compared to the overall size of the GA and contribute little to increased habitat across the GA.

American Peregrine Falcon

The peregrine was delisted from ESA status in 1999 (USDI Fish and Wildlife Service 1999). This was based on a thorough review of the best available information that showed threats to the species had been eliminated or reduced following restrictions on organochlorine pesticides and implementation of successful management programs. Post delisting monitoring requires surveys every 3 years for a total of five surveys (USDI Fish and Wildlife Service 2001). At the time of delisting from ESA, it was added to the Regional Forester Sensitive Species list.

In the Southwest, peregrines persist mainly on mountain cliffs and river gorges. Eyries exist on dominant cliffs that generally exceed 200 feet in height; nests are usually situated on open ledges. Prey abundance and diversity are probably a major factor in nest site selection, which are often near water courses and impoundments due the abundance of avian prey.

The 10 known peregrine territories on the NKRD are associated with the tall cliffs within Kanab Creek Wilderness, in Oak Canyon, and within Saddle Mountain Wilderness. Peregrines may travel up to 17 miles from nesting cliffs to foraging areas. Preferred foraging areas include cropland, meadows, river bottoms, marshes and lakes (Sanders et al. 2004). The project area may provide limited foraging habitat in small stringer meadows and ponds but lacks nesting cliffs and preferred foraging features listed above.

Utah Mountain Kingsnake

Utah Mountain kingsnakes range from Arizona north of the Colorado River on the Arizona Strip through central Utah and eastern Nevada. They have been found in habitats characterized by ponderosa pine, sagebrush and Mexican locust. They are typically found near water and rocky areas (AZGFD HDMS 2002).

These snakes spend most of their time underground and prefer relatively cool temperatures. While basking on the surface they often remain well hidden by undergrowth. They primarily consume snakes, lizards, small mammals, birds, eggs and frogs.

Population trends for this species are unknown, and no management factors have been identified (AZGFD HDMS 2002). Collection is regulated by the State.

Spotted Bat

The spotted bat is distributed across large areas of western North America from southern British Columbia to the central Mexican state of Quertaro. Although widespread in geographic distribution, they are patchily distributed and only locally abundant. They commonly roost in rock cliffs, but forage across much of the Kaibab Plateau. During August 1995 and July 1996, Rabe et al. (1998a) captured and placed radio transmitters on 12 spotted bats on the district south of the Jacob Ryan project area. The bats were captured over small ponds in sub-alpine meadows. One spotted bat was radio tracked to its day roost in the cliffs above the Colorado River and repeatedly foraged in open areas on the plateau surrounded by ponderosa pines. Results of numerous studies summarized by Luce et al. (2007) show that spotted bats prefer foraging in open areas and often near water. Spotted bats are not known to roost within the project area.

Allen's Lappet-browed Bat

Allen's lappet-browed bat occurs throughout most of Arizona, except the southwestern deserts, and into Mexico. Most Arizona captures have been in woodland and coniferous forests. Males often roost in cliffs and rocky slopes, females roost in large, older ponderosa pine snags with exfoliating bark for roosting sites (Rabe et al. 1998b). These bats are insectivorous, feeding mostly by gleaning moths and stationary insects from surfaces but insects are also taken in flight. This species was rarely captured during extensive mist netting surveys on the district from 1994 through 1998. Capture locations were Indian Hollow Tank, West Lake, Big Springs, and Warm Springs Lake. Plan guidelines will be followed to promote retention and recruitment of large diameter snags to provide for rooting sites.

Pale Townsend's Big-eared Bat

This species ranges through much of the Western, Midwestern and Eastern U.S. and is widespread in Arizona. They are found in low deserts up to woodlands and coniferous forests. Population concentrations seem to be strongly correlated with the presence of caves and abandoned mine shafts in which they roost. Pale Townsend's big-eared bats are lepidopteran specialists; their diet consists of 90 percent moths. They take prey from leaves and while in flight along forest edges (AZGFD 2003). There are no known roost sites within the project area; however, they have been captured elsewhere on the Kaibab Plateau while foraging in open meadows and over stock tanks.

Kaibab Least Chipmunk

The Kaibab least chipmunk is a subspecies of the least chipmunk. Least chipmunks occur throughout the Western U.S., upper Midwest and throughout Canada. The Kaibab least chipmunk occurs on the Kaibab Plateau in north-central Arizona, northward into Utah, Wyoming, Idaho, Montana and east into Colorado. The subspecies occurs as a disjunct population on the Kaibab Plateau of north-central Arizona. These small diurnal chipmunks prefer spruce-fir forests but occur in many habitat types. They are found in rocky areas within moist or damp situations and usually in open places in the forest. Summer dens are typically in hollow logs or stumps, in rock piles, or under debris. Least chipmunks feed on and store a variety of small seeds that they can reach from the ground or by climbing bushes. They also use fleshy fruits and berries when available. Habitat recommendations for chipmunk include maintaining two snags and 5 to 7 tons of downed woody debris per acre (Reynolds et al. 1992).

Long-tailed Vole

The long-tailed vole occurs throughout much of the Western U.S, British Columbia and into Alaska. They occur in isolated populations in Arizona including on the Kaibab Plateau in the north-central part of the state. In Arizona they live in meadows, grassy valleys and grassy clearings in forests, sagebrush flats and rocky slopes near or in coniferous forests. Long-tailed voles on the district are most commonly found in grassy areas around springs or in swamps adjacent to lakes. Diet consists of fruits, seeds, and herbaceous plant material.

Kaibab Squirrel

The Kaibab squirrel is a geographically isolated subspecies of the Abert's squirrel and an obligate resident of ponderosa pine forests. The squirrel occurs only on the Kaibab Plateau in extreme north-central Arizona and occurs throughout the project area in suitable habitat. Kaibab squirrels are highly dependent upon ponderosa pine habitat. They nest in them; they feed on bark, staminate flowers, buds, and seeds, and use the interlocking crowns as travel corridors and escape routes. Other foods include fungi, mistletoe, acorns, bones, antlers, insects, and occasionally pieces of grasses and shrubs. Nests are usually located in the branches of large pines from about 16 to 90 ft. above the ground. Nesting also occurs in witches' brooms, a disease or deformity commonly caused by mistletoe where the natural structure is changed creating a dense mass of shoots that grow from a single point, with the resulting structure resembling a broom or a bird's nest (See also Kaibab squirrel discussion under "Management Indicator Species" section).

Kaibab Northern Pocket Gopher

Northern pocket gophers, consisting of more than 55 subspecies, occur throughout much of the Western U.S. and into Canada. The Kaibab subspecies occurs only on the Kaibab Plateau of north-central Arizona. This subspecies occurs in the soils of the high elevation meadows surrounded by spruce-fir or ponderosa pine. Grasses, weeds and shrubs that occur in those meadows provide most of the pocket gophers food requirements.

Management Indicator Species

Regulatory Framework

Based on direction found in the National Forest Management Act (219.19 (a)(1)), the Kaibab forest plan identifies management indicator species (MIS) by geographical areas (GA). The MIS were selected as "indicators for detecting changes in habitat and to monitor the effects of land

management activities on other species." Coordination with the Arizona Game and Fish Department (AZGFD) has provided monitoring of hunted species (i.e. mule deer, turkey and squirrels). Beginning in 2005, monitoring of MIS land birds and squirrels began on the Kaibab National Forest. It will be at least 5 years before estimates of population trends can be made from these data.

MIS for the forest and habitats that they represent are shown in table 39. There are no riparian habitats or suitable grasslands within the project area and MIS associated with those habitats are not carried forward for further analysis.

Table 39. MIS and habitat represented for the Kaibab National Forest

Common Name	Habitat Represented	Project Analysis
Turkey	Late-seral ponderosa pine	Habitat present and species carried forward for analysis.
Mule deer	Early-seral aspen and pinyon-juniper	Habitat present and species carried forward for analysis.
Kaibab squirrel	Early-seral ponderosa pine	Habitat present and species carried forward for analysis.
Northern goshawk	Late-seral ponderosa pine	Habitat present and species carried forward for analysis.
Red squirrel	Late-seral mixed conifer and spruce-fir	Habitat present and species carried forward for analysis.
Juniper (Plain) titmouse	Late-seral pinyon-juniper, and snags in pinyon-juniper	Habitat present and species carried forward for analysis.
Hairy woodpecker	Snags in ponderosa pine, mixed conifer and spruce-fir	Habitat present and species carried forward for analysis.
Pygmy nuthatch	Late-seral ponderosa pine	Habitat present and species carried forward for analysis.
Red-naped (Yellow-bellied) sapsucker	Late-seral aspen and snags in aspen	Habitat present and species carried forward for analysis.
Pronghorn antelope	Early and late-seral grassland	Not carried forward, no suitable habitat in the project area.
Lucy's warbler	Late-seral, low elevation riparian	Not carried forward, no suitable habitat in the project area.
Yellow-breasted chat	Late-seral, low elevation riparian	Not carried forward, no suitable habitat in the project area.
Cinnamon teal	Late-seral wetlands	Not carried forward, no suitable habitat in the project area.
Elk	Early-seral, ponderosa pine, mixed conifer, spruce-fir	Elk are not native to the Northern Plateau. In recent years a few have found their way and inhabit the area, however, management objectives by the AGFD call for no elk on the Kaibab Plateau in order to minimize negative effects on the deer herd there. Therefore, elk are not considered an MIS for GA 13 (page 37, Forest Plan).

Common Name	Habitat Represented	Project Analysis
Lincoln's sparrow	Late-seral, high elevation riparian	Not carried forward, no suitable habitat in the project area.
Aquatic macroinvertebrates	Riparian	Not carried forward, no suitable habitat in the project area.
Arizona bugbane	Forest plan describes habitat where plant is found	Not carried forward, does not occur on the NKRD.

MIS species descriptions and population and habitat trends for the forest have been completed and recently updated (Bratland et al. 2008). Data is available for population trends; however, data sets are not available to provide forest-wide habitat trend information (2008 MIS Report, pgs. 93-94). The forest MIS report (Bratland et al. 2008) was used as the baseline for this analysis and is incorporated by reference. Some forest-wide structural trends are shown in table 40 but this analysis will primarily look at trends at the GA 13, which encompasses the ponderosa pine and mixed conifer forest on the NKRD. GA 16 covers the pinyon-juniper forest to the east and will also be included when discussing MIS that use pinyon-juniper. The northern goshawk is one of the MIS species but will be discussed in detail in the "Sensitive Species" section.

Seral habitat trends since 1986 are displayed for the entire forest in table 40 based on available information. There has been a decrease in all size classes except for immature sawtimber which increased from 12 to 31 percent. The WFR area greatly increased the grass/forb stage at the expense of all size classes for all cover types, however, the percent of area affected is a small percent of the overall forest cover types.

Table 40. VSS trends 1986 and 2002, KNF

Age Class (all conifer species)	1986 Conditions at the Time of the Forest Plan	Percent	2002 Existing Conditions	Percent
Seedling-Sapling	77,580	11	28,955	5
Poles	226,227	34	159,113	26
Immature Sawtimber	81,619	12	188,603	31
Mature Sawtimber	289,625	43	234,256	38
Total	**675,051**	**100**	**610,927**	**100**

Table 41. Comparison of vegetation cover types between suppression area and North Kaibab Ranger District

Cover Type	GA 13 Acres*	Pre-fire Acres within the WFR Project Area	Post-fire Acres within the WFR Project Area	GA 13 Percent
Ponderosa pine	180,735	25,421	11,902	7
Mixed conifer	49,981	5,619	433	<1
Pinyon-juniper	88,145	88,145	128	<1
Aspen	21,975	21,975	1,085	5

*All cover types are from GA 13 with exception of PJ which was from both GA 13 and 16.

Post-fire cover type acres within the WFR project area are based on those acres that had low and mixed-low mortality. High and mixed-high mortality classes no longer provide the structural components to provide habitat for associated species and are not included as a cover type, as they were converted to non-stocked. Table 41 shows the percent of cover types district-wide (GA 13) and for the WFR project area.

Northern Goshawk

In addition to this discussion for the northern goshawk as a MIS, it is also considered in detail in the "Sensitive Species" discussions in both the "Affected Environment" and "Environmental Consequences" sections.

Locally, the majority of the KNF goshawk population occurs within the NKRD on the Kaibab Plateau, where surveys and studies have been conducted for close to 2 decades. The most intensive study has been conducted by the Rocky Mountain Research Station (RMRS), a sub-branch of the Forest Service. The Kaibab Plateau goshawk project started in 1991 and is expected to conclude at the end of the 2008 field season. In addition, all ponderosa pine and ponderosa pine/Gambel oak habitat on the forest was surveyed by USFS personnel, following Forest Service regional northern goshawks protocol. Although most of the NKRD appears to be at carrying capacity, goshawk reproduction on the Kaibab Plateau has been highly variable over 15 years, and overall showed a significant decline from 1991 to 2005, including the portions of the plateau that have been managed by the National Park Service since the inception of the Grand Canyon National Park. Causes being investigated for the decline include change in forest composition and structure resulting from intensive forest management between the 1960s and early 1990s (large seed tree cuts) combined with catastrophic fire and wind throw, and natural environmental variation in prey abundance. Research to date indicates that as the amount of habitat changed by intensive management, fire, and increased wind throw within goshawk territories, the frequency of reproduction decreased. Additionally, inter-annual fluctuations in precipitation and conifer seed production are correlated with, and may be responsible for, variation in prey abundance, which in turn is strongly associated with goshawk reproduction. Together this suggests that goshawk demography is a complex interaction between vegetation composition and structure, and natural variation in goshawk food resources, all of which may be confounded by ongoing drought conditions (Bratland et al. 2008).

Swamping of habitat effects by large variations in food abundance, combined with the periodicity of wet versus dry weather in the Southwest, suggest that identifying the cause-effect responses of goshawks to forest management can only be accomplished through long-term research. Goshawk reproduction over the 16-year study is not sufficient to replace adult mortality on the Kaibab Plateau. However, there seem to be enough juveniles to replace adults, suggesting the plateau acts as source and a sink population. Given that the demographics appear influenced by precipitation patterns, it is difficult to judge if the population is stable or declining. It also appears that the goshawk pairs within the Grand Canyon National Park section of the Kaibab Plateau have lower reproductive rates than those on the national forest. There has been essentially no timber harvest or other forest structure management within this portion of the national park (Bratland et al. 2008).

None of the action alternatives for the WFR project will change the structural stages for any of the habitat types; therefore, there will be no change in forest-wide population and habitat trends.

Turkey

Turkeys depend on diverse habitat to provide for roosting, nesting and foraging needs. Turkeys were selected to represent species using late-seral ponderosa pine habitat for roosting and as a seed source for food. Roosting habitat consists of large, open-crowned trees. Foraging habitat includes cone crops produced by mature ponderosa pine trees, hard mast from oak trees, and seeds from grasses and forbs in early-seral habitat. Large woody debris is also used as cover (Bratland et al. 2008).

Turkeys may overwinter in ponderosa pine if the snow is not too deep. Once snow accumulates, they move into pinyon pine/oak habitats at lower elevations. The WFR project area provides primarily summer habitat, with the east side providing winter habitat (lower elevation, pinyon-juniper habitats). Stands that had low or mixed-low mortality will continue to provide roosting and foraging habitat for turkeys. Stands with higher mortality no longer provide turkey habitat due to the lack of roosting habitat, the ability to produce cone crops, and large woody debris.

Overall habitat trends brought about by the shift in forest objectives and harvest techniques initiated in 1992 have been positive for turkeys (Bratland et al. 2008). Before the fire, there were 25,421 acres of ponderosa pine cover types in the project area (see table 25). Post-fire this number was reduced to 11,902 acres. For the WRP area the pre-fire ponderosa pine represented 15 percent of GA 13 and this was reduced to 7 percent following the fire (see table 25).

Based on AZGFD and breeding bird survey data, it appears that populations on the forest have a variable but overall increasing trend (Bratland et al. 2008). The Warm Fire has resulted in a decrease in available roosting habitat and pine seed within the fire area. The fire was large; therefore, this was a considerable loss of an important food source. The amount of mature ponderosa pine (VSS 5/6) was reduced from 43 to 22 percent (see table 30). At the GA 13 level mature trees were reduced by 3,387 acres (see table 28). Potential foraging habitat is improved due to an increase in grasses and forbs as a result of the fire. However, some of the openings are so large turkeys may not be able to use them. Oak is re-sprouting in areas, and may provide mast for forage as it matures in the future.

Mule Deer

Mule deer were selected because they are economically important and represent species using early-seral stages of aspen and pinyon-juniper habitats. Mule deer are a generalist species that use ponderosa pine, mixed conifer, woodland, and chaparral habitats. Forage items mostly consist of woody browse (Bratland et al. 2008). Aspen habitats are declining on the forest due to overtopping by conifers and limited regeneration due to fire suppression and browsing by ungulates (Bratland et al. 2008).

Mule deer occur across the forest; although especially important on the district, much of which is within the boundaries of the Grand Canyon Game Preserve. The game preserve was established in 1908 to protect game species on the Kaibab Plateau.

The North Kaibab deer herd is famous for providing quality hunts and has a long history of management aimed at promoting trophy bucks. Data from the NKRD indicate an increasing population trend since the early 1990s (Bratland et al. 2008). This area also has relatively high precipitation rates, relative to the rest of Arizona.

The Warm Fire had short-term effects on mule deer forage in higher elevation summer range portions of the fire area immediately after the fire. The project area currently provides the largest amount of the grass-forb stage within GA 13. Recovery of herbaceous forage plants as well as many browse species such as aspen and Gambel oak began in 2006 and 2007 and will be extensive over the next few years. Long-term effects on forage at these higher elevation areas will likely be positive. Negative effects on security cover and winter forage in the mixed-high and high mortality areas will last longer. Likely the most significant effects on mule deer habitat will be mortality of cliffrose and other browse species in the lower elevation pinyon-juniper dominated areas on the east side of the fire. The lower elevations on the east side of the fire provide important deer winter range and transitional range, and vegetation mortality was high in these areas (USDA Forest Service 2007c). Arizona Game and Fish Department and the Kaibab National Forest have initiated discussions on vegetation recovery in this area.

None of the action alternatives for the WFR project will change the structural stages for any of the habitat types; therefore, there will be no change in forest-wide population and habitat trends.

Kaibab (tassel-eared) Squirrel

The Kaibab squirrel is an endemic subspecies of the relatively widespread “tassel-eared squirrel.” Tassel-eared squirrels were selected to represent species using early-seral, ponderosa pine habitat. Recent research indicates that good habitat includes intermediate-aged forest (trees in the 9- to 18-inch size class) intermixed with large trees, where groups of trees have crowns that are interlocking or in close proximity. Tassel-eared squirrels forage, in part, on the forest floor and are associated with tree litter, roots, and mycorrhizal fungi. They also depend on mature trees to provide cones as a food source. Therefore, this species depends on the interspersion of habitat types within the forest to provide arboreal travel routes and food both on the ground and in the trees (Bratland et al. 2008). Current management direction creates the diverse habitat conditions favored by tassel-eared squirrels.

In 1965, 278,000 acres of ponderosa pine within the forest and Grand Canyon National Park were designated as the Kaibab Squirrel National Natural Landmark (KSNNL) (200,000 of which are on the forest). This designation is used by the Department of Interior to represent unique examples of ecological and geological features that comprise our Nation’s natural history. The Warm Fire encompasses 43,737 acres of the KSNNL. Of these acres, 13,686 acres were characterized as high vegetation mortality within the suppression area, and 3,602 acres were characterized as high vegetation mortality in the wildland fire use portion of the fire. Squirrel mortality was likely high in these areas because crown fire moved rapidly through most of the high vegetation mortality areas (USDA Forest Service 2007c). There are 28,960 acres of KSNNL in the project area.

Populations of this species are cyclical with rainfall and associated food availability (Salafsky et al. 2005). Although inherently variable, tassel-eared squirrel populations are currently stable on the forest (Bratland et al 2008).

Suitable habitat has decreased in the WFR project area as a result of the Warm Fire. Ponderosa pine forests characterized as high mortality and part of the mixed-high mortality can no longer be considered Kaibab squirrel habitat, and it will take decades for these areas to recover sufficiently to become habitat again. Individuals and habitat were likely little affected in low vegetation mortality areas, and effects were likely minor in mixed-low mortality areas (USDA Forest Service 2007c). Before the fire, there were 25,421 acres of ponderosa pine cover types in the project area

(table 25). Post-fire this was reduced to 11,902 acres. The amount of ponderosa pine went from 15 percent (pre-fire) to 7 percent of GA 13 (see table 25). Total loss of ponderosa pine from the Warm Fire (13,519 acres) is approximately 1 percent of the forest total. The WFR project will result in no net reduction in ponderosa pine habitat.

None of the action alternatives for the WFR project will change the structural stages for any of the habitat types; therefore, there will be no change in forest-wide population and habitat trends.

Red Squirrel

Red squirrels were selected to represent species using late-seral mixed conifer habitat. However, the best habitat for this species is intermediate-aged forest (trees 9 to 18 inches d.b.h), intermixed with larger trees, where the crowns are close together or interlocking. Red squirrels depend on the upper layer of the forest floor associated with tree litter, roots, and mycorrhizal fungi (Noble 2003).

Red squirrels also depend on mature trees to provide seeds as a food source. Therefore, red squirrels depend on the interspersion of habitats to provide arboreal travel routes, and food at ground level and in the tree canopy. Red squirrels use cavities in trees for nesting and so will use large snags with dead/decaying wood (Noble 2003).

Mixed conifer is a limited cover type on the forest. There has been essentially no management in this cover type on most of the forest due to constraints with the spotted owl recovery guidelines. On the NKRD, management entries into the mixed conifer cover type follow the forest plan. This should benefit red squirrels by diversifying the forest structure while retaining the large tree component.

In the late 1990s there was an increase in numbers across the forest, followed by a decline around 2000. Red squirrels respond to forage availability and forage is affected by weather. Red squirrel numbers have declined since 1990s, and given the long-term drought, a decreasing trend is expected to continue (Bratland et al. 2008).

Suitable habitat has decreased in the WFR project area as a result of the Warm Fire. Mixed conifer forests characterized as high mortality and part of the mixed-high mortality can no longer be considered red squirrel habitat, and it will take decades for these areas to recover sufficiently to become habitat again. Before the fire, the project area provided 5,619 acres of mixed conifer cover types. Post-fire this was reduced to 433 acres. Prior to the fire, the project area provided 11 percent of the mixed conifer type present across GA 13; and post-fire that has dropped to less than 1 percent (table 25). For the WFR project there will be no net loss of mixed conifer habitat.

None of the action alternatives for the WFR project will change the structural stages for any of the habitat types; therefore, there will be no change in forest-wide population and habitat trends.

Juniper (plain) Titmouse

The juniper titmouse was selected to represent species using the late-seral pinyon-juniper woodlands and the snag component within the pinyon-juniper habitat. Current management should maintain snags well above historic levels within the coniferous forest vegetation types across the forest. Bratland et al. (2008) found data that suggests that juniper titmouse populations are likely decreasing on the forest.

Prior to the fire, approximately 10 percent of the project area was dominated by pinyon-juniper; and post-fire less than 1 percent of the project area is now dominated by pinyon-juniper (table 25). The project area provides less than 1 percent of the pinyon-juniper cover type present across GAs 13 and 16 (table 25).

Most pinyon-juniper stands experienced high intensity fire behavior and high levels of overstory mortality. Much of the area is now skeleton forest/bare ground, and will progress dependent on availability of seed for overstory, understory, and shrub layer development. None of the proposed salvage actions are in pinyon-juniper types and planting would not occur in pinyon-juniper. There would be no effect on habitat or population trends for this species.

None of the action alternatives for the WFR project will change the structural stages for any of the habitat types; therefore, there will be no change in forest-wide population and habitat trends.

Hairy Woodpecker

The hairy woodpecker is a primary cavity excavator and was selected to represent species using the snag component of ponderosa pine and mixed conifer habitats within the forest. Aspen trees are also an important component. Snags or dead parts of live trees are excavated. The desired condition is to have adequate numbers of snags or trees with dead/decaying parts throughout the landscape. Hairy woodpeckers primarily eat insects (Bratland et al. 2008). Current management across the forest should maintain snags well above historic levels within the coniferous forest vegetation types across the forest.

The fire altered many existing pre-fire snags and created many thousands of snags. Approximately 22,775 acres had a fire severity rating of high to very high which currently has a very high number of snags (see table 38). Many of the snags altered or created by the fire will fall to the ground in coming years to become logs. Beetles moving into the dead trees will provide a food source. Studies have found large increases in hairy woodpeckers for the first few years following moderate to high-severity fires (Covert-Bratland et al. 2006) compared to years 6 and 7, post-fire. After a few years, bark beetle and woodborer densities decreased, trees started falling and hairy woodpecker relative abundance decreased and home range size increased (ibid). The fire has created an important, but relatively short-lived foraging habitat.

Studies have also found that hairy woodpeckers use edges of high-severity burned areas more than the interior; 70 percent of the observations were within 25 meters (82 feet) of edges of moderate severity burns (Covert-Bratland et al. 2006). It was hypothesized that these areas provide more protection from both extreme weather conditions and predators, due to foliage cover.

From the 39,110-acre Warm Fire area, approximately 19,800 acres of ponderosa pine and mixed conifer cover types burned with mixed-high and high mortality. The result is approximately half of the project area has increased suitability for beetles moving into dead trees after the fire. However, much of the high mortality areas are over 82 feet from live trees and may be less suitable due to lack of cover.

Bratland et al. (2008) found a nonsignificant increasing trend for hairy woodpeckers in Arizona for 1966-2005. Data also suggests that hairy woodpecker populations have remained stable in ponderosa pine and may be increasing in mixed conifer habitats on the forest (Bratland et al. 2008). Given the forest snag policy, increasing number of acres burned, and severity of the Warm

Fire, hairy woodpecker populations on the forest are expected to increase and then stabilize as snags fall and snag numbers return to a more natural number. The habitat trend for the forest is that fires like the Warm Fire have increased the number of snags to far higher levels than occur naturally. Snags will decrease as dead trees fall but the frequency of wildfires is predicted to remain high creating future spikes in snag numbers. Future fires along with snag retention guidelines in the forest plan will maintain hairy woodpecker numbers.

None of the action alternatives for the WFR project will change the structural stages for any of the habitat types. Because of the numerous project design features and mitigations and the fact that there will be no change in structural stages, it is concluded that there will be no change in forest-wide population and habitat trends.

Pygmy Nuthatch

Pygmy nuthatches were selected to represent species using late-seral, ponderosa pine habitat. They are primary cavity-nesters, excavating dead and well-rotted wood. They use large tree cavities for colonial roosts and, therefore, need large snags or live trees with dead/decaying parts. Pygmy nuthatches are primarily insectivorous. Current forest management should maintain snags well above historic levels within the coniferous forest vegetation types across the forest (Bratland et al. 2008).

Before the fire, there were 25,421 acres of ponderosa pine cover types in the project area and post-fire this was reduced to 11,902 acres. The project area now provides 7 percent of the GA 13 ponderosa pine cover type (table 25). There was a minor reduction of mature ponderosa pine (VSS 5/6) at the GA 13 level; mature trees were reduced by 3,387 acres (see table 28).

The overall population trend for the forest is assumed to be stable to declining on the forest (Bratland et al. 2008).

None of the action alternatives for the WFR project will change the structural stages for any of the habitat types; therefore, there will be no change in forest-wide population and habitat trends.

Red-naped (yellow-bellied) Sapsucker

Yellow-bellied and red-naped sapsuckers used to be lumped as one species. Now red-naped sapsuckers are considered the Western United States ecological counterpart to the more eastern yellow-bellied sapsuckers.

Red-naped sapsuckers were selected to represent species using late-seral aspen habitat and the aspen snag component. They drill rows of holes (sapwells) through the outer bark of aspen and consume cambium and tree sap. Red-naped sapsuckers eat a variety of insects that are attracted to the sapwells. One study of aspen snag fall-down rates in Canada found relative stability for the first 5 years with greatest fall-down rates occurring between 10 and 20 years after death (Lee 1998).

Aspen have been declining across the Southwest, and this same trend has been occurring on the forest. Fire suppression, over-topping and ungulate browsing have all contributed to the decline. Aspen trees decay and fall much quicker than coniferous snags. Pre-fire the project area had 2,531 acres of aspen cover type and post-fire this had dropped to 1,085 acres (table 25). Currently, the project area provides 5 percent of the aspen cover type present across GA 13.

It was estimated that red-naped sapsucker population trends are or will be decreasing with the continued loss of aspen across the forest (Bratland et al. 2008). While the Warm Fire has decreased the availability of mature aspen in the project area, many of the stands mapped as ponderosa pine or mixed conifer had aspen as a component. Now that overstory conifers are dead, aspen is re-sprouting in much of the burned areas. Over the long term, aspen will increase before eventually being replaced by conifers.

None of the action alternatives for the WFR project will change the structural stages for any of the habitat types; therefore, there will be no change in forest-wide population and habitat trends.

Other Species

Bison (Buffalo)

Buffalo were originally brought to Arizona for a "cattalo" experiment, but were sold to the State after the experiment proved unsuccessful. In general, bison breed (mid-July to early September) and calve (late April through May) in House Rock Valley but move to higher country in winter. During hunting season and winter, the majority of the herd is found on a series of points and related habitat along the North Rim of the Grand Canyon National Park that stay snow-free due to consistent winds (Noble, personal communication). The allotment that the bison are supposed to use is the Buffalo Ranch Allotment and is managed by the AZGFD under a memorandum of understanding. Current Forest Service range managers have not identified use by bison in the Warm Fire area (Burger, personal communication). Bison have been known to seek out areas that have recently burned and may be attracted to this area.

Bat Species

There are several key habitat features used for roosting by many bat species. These features include caves, abandoned mines, rock outcrops, cliffs, tree cavities and crevices in and under bark. There are no known caves or abandoned mines in the project area, and rock outcrops or cliffy areas would be avoided during treatment activities; therefore, there would be no effect on bats using these features.

There are several snag-roosting myotis species that are likely to occur in the project area (table 42). Availability of tree cavities and crevices in and under bark may be affected by salvage operations displacing some of these species. However, salvage is only proposed for 23 percent of the project area; therefore, the remaining snags and trees should be adequate to accommodate species that utilize snags.

Table 42. Additional bat species likely to occur in the project area.

Species	Habits
Snag-roosting myotis species	Little brown, Arizona myotis, cave myotis, long-legged, long-eared, and southwestern myotis are all snag-roosting species likely to occur in the project area.

Ponderosa pine has the type of bark most suitable to provide roosting habitat. Fifty-nine percent of the ponderosa pine cover type is in the mixed-high or high mortality classes and the bark may have been scorched or burned, but generally stays attached to the tree for a limited period of time (depending on fire intensity on the individual tree, weather, age and condition of the tree prior to

the fire) and will continue to provide habitat until the bark falls off or the tree falls. Field reviews in the summer of 2007 noted that many of the ponderosa pine still had bark attached. Little is known about microsite conditions related to site selection by roosting bats. Assuming loose bark is the only criteria, the area could support an increase in bat numbers due to the large numbers of standing dead trees.

These species eat a wide variety of flying insects including moths, beetles, flies, gnats and crane flies (Harvey et al. 1999). Habitat conditions should support an increasingly complex insect and arthropod community as vegetation develops, thereby improving the forage resource for most bats.

Neotropical Migratory Birds

Arizona Partners in Flight identified priority bird species for habitats in Arizona (Latta et al. 1999). Pre-fire cover types that are proposed for salvage or regeneration include ponderosa pine, mixed conifer and aspen. Table 43 shows the priority species identified for these habitats.

Table 43 Priority birds species identified by Partners in Flight (Latta et al. 1999)

Habitat	Priority species	Applicable Habitat Management Recommendations
Ponderosa pine	Northern goshawk, olive-sided flycatcher, cordilleran flycatcher, purple martin	Manage for >2 snags per acre in pine cover types and promote longevity of snags
Mixed conifer	Northern goshawk, Mexican spotted owl, olive-sided flycatcher	Olive-sided flycatchers use post-burn areas and areas of insect infestations. Salvage logging should retain the tallest trees.
Aspen	Red-naped sapsucker	Support management that promotes aspen regeneration.

Important bird areas are geographic areas considered unique or important to bird populations. There are no important bird areas on the forest. No important bird over-wintering habitat exists in the NKRD.

Environmental Consequences

Alternatives

The action alternatives have several features in common. These include: (1) 4,800 acres of natural aspen regeneration; (2) 7,625 acres of planting ponderosa pine; (3) 2,353 acres of planting mixed conifers; and (4) slash disposal/fuel treatments would be conducted on logged areas and may include lop and scatter of tops and limbs, chipping, mastication, and/or hand pile or jackpot burning.

Habitat Alteration

Impacts of salvage logging may be assigned to three broad categories: (1) altered stand structure complexity due to removal of standing dead trees or snags; (2) altered ecosystem processes and functions; and (3) altered populations of species and community composition (Lindenmayer and Noss 2006).

Through project design, adequate snag numbers (three to seven per acre) will be retained within treatment areas (see "Project Design Features and Monitoring Common to All Action Alternatives," chapter 2) in addition to the numerous snags within untreated areas. Table 44 shows the percentage of the mixed-high and high mortality classes in the ponderosa pine, mixed conifer and aspen cover types that would not be salvaged, by alternative. These areas in addition to the design features would provide high levels of snags and cavity nesting habitat.

Table 44. Percentage of mixed high and high mortality areas retaining all standing dead trees

Alternative 1	Alternative 2	Alternative 3	Alternative 4
100%	57%	73%	74%

Aspen is a minor component in most stands. Aspen would be expected to regenerate on approximately 4,800 acres. Planting would increase re-establishment of conifers in other burned areas. It is recognized that there are going to be high levels of variation across the landscape after the Warm Fire due to aspen sprouting, variable and sometimes heavy natural regeneration adjacent to existing seed sources, variable planting densities, and survival in areas identified for planting and slow re-colonization of conifers in harsher areas with no seed sources.

All of the harvest would be of dead trees in areas that burned with high and mixed-high mortality. These areas are no longer providing the cover types that they provided pre-fire. Post-salvage, the ponderosa pine and mixed conifer cover types in the project area would continue to represent 7 and less than 1 percent, respectively, of the amount present on GA 13 (see table 25e). The aspen cover type would continue to represent 5 percent of the amount present on GA 13, and pinyon-juniper will remain at less than 1 percent. The aspen cover type is increasing as it is re-sprouting in areas that were dominated by conifers pre-fire.

Table 45 shows the predicted percent of VSS by alternative, for the year 2047. This was calculated based on expected natural regeneration, planting of conifer seedlings, existing stands that had low or mixed-low mortality, and growth over time of all of these areas (for more information, see "Vegetation" section above). All of the action alternatives would decrease the amount of time to restore the desired vegetative conditions as compared to the no action alternative.

Another indirect effect of salvage would be a shift in potential future fire intensities. Fuel modeling uses "resistance-to-control" ratings. For this analysis it is assumed that fires with low/moderate resistance-to-control ratings have lower intensities with lower mortality. Fires with high or extreme resistance-to-control ratings have higher intensities with higher mortality. Fuel modeling found that at 5 years there would be an increased potential for higher intensity fires due to increased fine fuels on the ground as a result of salvage operations, under all action alternatives. At 20 and 40 years, alternatives 2 followed by 3 have the best potential for lower intensity fires with lower vegetation mortality compared to alternative 1 (see "Fuels" section below).

Table 45. Predicted percent of potentially forested acres by VSS by alternative in 2047

VSS	Successional Stage	Percent of Prefire MC, QA and PP Cover Type Acres (by Year)				
		Desired	Current	2012	2027	2047
Alternative 1						
1	Grass-forb/shrub (Nonstocked)	10%	65%	50%	43%	41%
2	Seedling/sapling	10%	1%	15%	20%	18%
3	Young forest	20%	7%	5%	5%	10%
4	Mid-aged forest	20%	9%	9%	8%	5%
5	Mature forest	20%	8%	8%	9%	7%
6	Old-growth	20%	11%	13%	15%	19%
Alternatives 2, 3 and 4						
1	Grass-forb/shrub (Nonstocked)	10%	65%	50%	43%	33%
2	Seedling/sapling	10%	1%	15%	20%	18%
3	Young forest	20%	7%	5%	5%	18%
4	Mid-aged forest	20%	9%	9%	8%	5%
5	Mature forest	20%	8%	8%	9%	7%
6	Old-growth	20%	11%	13%	15%	19%

Displacement and Disturbance

Indirect effects during project activities include disturbance associated with ground-based salvage logging, fuels treatment, planting, and road work.

Salvage activities would have some affect on natural regeneration of aspen and other species. The project was designed to decrease the risk of salvage operations disturbing natural regeneration by salvaging only in those areas that have a lower probability of natural regeneration (i.e. salvage operations will occur within high and mixed-high mortality areas of the project area), limiting salvage to fire-killed trees without green needles, and restricting equipment use based on the soil and watershed project design features.

Some currently closed roads would be opened for salvage operations. Total road densities would not change from existing (6.7 miles per square mile), but open road densities would change during operations, by alternative (see table 46). After project implementation, open road densities would return to the existing levels.

Table 46. Open road densities in the project area

Existing	During, Alt. 2	During, Alt. 3	During, Alt. 4	Post-project, All Alternatives
1.6 mi/mi²	3.2 mi/mi²	2.7 mi/mi²	2.8 mi/mi²	1.6 mi/mi²

Old Growth

The effects on old growth caused by the Warm Fire are explained in the "Affected Environment" section. None of the alternatives will directly affect old growth because harvest will only occur in areas with mixed-high to high fire severity or mortality. These are areas that went through stand-replacing fire and old growth no longer exists. However, indirectly alternatives 2, 3 and 4 will have a positive effect by reducing the amount of time it will take to replace areas now classified as VSS 1 as shown in table 45 where in 40 years there will be no change in mature forest structure but there is a significant increase in VSS 3 (young forest) which indicates that under any of the action alternatives mature trees will again be present in a shorter length of time than under alternative 1, the no action alternative.

Snags and Downed Logs

Snag Retention Characteristics

Research on cavity nesting birds in post-fire landscapes has been done in the northern Rocky Mountains (Hutto 1995; Russell et al. 2007; Saab and Dudley 1998; Saab et al. 2007; Smucker et al. 2005). Hutto (1995) found that bird communities in the northern Rocky Mountain conifer forest following high severity crown fires are unique because of a greater abundance of woodpeckers, flycatchers and seed eaters. The fire regimes of ponderosa pine and mixed conifer forests of northern Arizona are different than those of the forests studied by Hutto and the other studies, where stand-replacing fires are more common.

Studies in the Southwest have found that the typical pre-settlement ponderosa pine forest was a pure park-like stand made up of scattered groups of 2 to 20 trees defined by surrounding openings that provided root space for grouped trees that usually included scattered individual trees (Covington and Moore 1994b; Covington, W. personal communication 2006*)*. This was maintained by low intensity surface fires that had return intervals of 1 to 24 years (Schussman and Smith 2006). Fire regimes for the project area range from high frequency, low intensity in ponderosa pine to mixed severity in the mixed conifer and pinyon-juniper (for more fire information see also "Fuels" section below).

A study in ponderosa pine forests in New Mexico found that bird species richness was similar pre- and post-fire across all burn severities (Kotliar et al. 2007). Burned forests in northern Arizona do provide habitat for numerous bird species. Kotliar et al. (2007) found four species with higher densities post-fire; American robins, mourning doves, broad-tailed hummingbirds and western bluebirds. Hairy woodpeckers showed a nonsignificant trend of increasing densities with increasing burn severity. Covert-Bratland et al. (2006; 2007) showed that high-severity burned areas are beneficial foraging areas, support 18 times the abundance of hairy woodpeckers than unburned areas, and that burned trees provide readily available roost trees during difficult winter conditions.

Research indicates that larger diameter snags are more widely used by cavity nesting birds than smaller diameter snags, that broken top snags are more widely used than snags with intact tops, and that live trees with dead portions resulting from injury are also widely used by cavity-nesting birds (Cunningham et al. 1980; Chambers and Mast 2005; Saab and Dudley 1998). Research also indicates that certain primary cavity nesting birds select nest sites in clumps of snags (Chambers and Mast 2005; Saab and Dudley 1998). A study of snags used in ponderosa pine and mixed conifer forests in northern Arizona found that in both forest types, snags with cavities were larger

in diameter, retained less bark than snags without cavities, and were mostly in ponderosa pine and Gambel oak (Ganey and Vojta 2004).

Beschta et al. (2004) identified a concern that the removal of large trees would greatly reduce the number of snags and downed logs available for wildlife. They also identify the importance of snags in or near riparian zones, retention of live trees within burn perimeters, and retention of the oldest and largest trees, both live and dead.

The project design feature for snag retention incorporates the results from these studies and focuses on retaining groups of snags, targeting existing clusters of the largest diameter snags available (see chapter 2 and appendix A for project design features). No live trees would be salvaged and there would be no salvage within 100 feet of drainage channels. Treatment units abutting green forest would have no entry buffers to retain the most valuable foraging habitat for hairy woodpeckers, and treated and nontreated areas would be interspersed across the project area.

Snag Longevity

Several studies have examined fall rates of ponderosa pine snags following wildfire. Fall rates are typically relatively high in the first 4 to 7 post-fire years after which the fall rate decreases (Chambers and Mast 2005). Keen (in Chambers and Mast 2005) reported 42 percent of ponderosa pine snags 10-18 inches d.b.h remained standing 7 years post-fire; whereas Chambers and Mast (2005) reported about 60 percent of snags in this diameter class standing 7 years post-fire (in USDA Forest Service 2007c). Both studies found about 60 percent of snags in the 20- to 28-inch size class standing 7 years post-fire.

Larger snags generally stay standing longer. Chambers and Mast (2005) found all of the snags 30-42 inches standing 7 years post-fire. In another study of burned ponderosa pine forest in northern Arizona there were few standing snags left after 27 years (Passovoy and Fulé 2006).

Snag Retention Densities

Because of high pre-fire tree densities and the preponderance of high severity crown fire, post-fire forest structure in ponderosa pine forest throughout the Warm Fire cannot be considered to be typical of historical range of variation (HRV) for post-fire forest structure. The number of snags and logs that will be added to the forest floor during the next 5 to 10 years are likely to be much greater than post-fire snag and log levels typical of HRV conditions in ponderosa pine forests (USDA Forest Service 2007c).

Ganey (1999) looked at snag densities on two forests in northern Arizona. He found that USFS snag standards were seldom met even in unlogged forests. He stated that if snag densities in these unburned forests represent “natural” conditions, current snag standards may be unrealistic and difficult to attain. Covington and Moore (1994b) also found that management direction based on current forest conditions does not address habitats provided under pre-settlement conditions.

Forest plan direction for snag retention is found in the forest-wide direction for MSO and northern goshawk. This direction is for “substantive amounts” of snags in MSO habitat (applied to all mixed conifer for this project). The goshawk direction includes at least three snags per acre in mixed conifer and at least two snags per acre in ponderosa pine. Leaving at least three to five snags per acre in ponderosa pine and five to seven snags per acre in mixed conifers in addition to

leaving large areas untreated should provide for adequate snag habitat through the next decade as these levels exceed what may have occurred historically.

Cunningham et al. (1980) reviewed selection and use of snags in ponderosa pine forest and recommended a density of 5.2 snags per hectare (ha) for mature ponderosa pine. That would convert to two snags per acre. This recommendation was for live stands. In the project area proposed for salvage, there is high mortality and no potential for snag recruitment at least until green forest again occupies the area. Project design features leave more than twice this recommendation to help compensate for lack of recruitment; nevertheless, it is expected that all snags will eventually fall and areas will be deficient in snags.

Downed Log Densities

A study of coarse woody debris in burned ponderosa pine forests in northern Arizona found that the total amount stayed relatively constant from 8 to 27 years post-fire, but changed from sound to rotten. In that study there were few standing snags left after 27 years, so there was little additional coarse woody debris added (Passovoy and Fulé 2006).

Forest plan direction for downed log retention is found in the goshawk guidelines. In mixed conifer forest at least five logs per acre and in ponderosa pine forest at least three logs per acre should be retained. Again, because of the high mortality in the areas to be salvaged, once the retained snags fall, there will be no downed log recruitment for some time into the future. Retention of more downed logs now will help retain these features longer into the future.

Conclusion

Snag retention will be maximized over time because of the following: (1) the abundance of standing dead trees (snags) in the project area; (2) only portions of the high and mixed-high mortality areas are proposed for salvage; (3) snags and downed logs would be left above forest plan direction in areas proposed for salvage; and (4) that retention would focus on clusters of the largest diameter snags available (thus increasing snag longevity). Therefore, snag resources will remain available across the project area for species associated with these features until the snags fall, rot or burn.

Forest Conditions in the Future

In 40 years the action alternatives will move forest conditions closer to forest plan desired levels than alternative 1 (no action) showing the benefit of the action alternatives (for more detailed discussion see “Vegetation” section).

Direct Effects to Individuals

The implementation of the project design features would reduce or eliminate adverse effects; however, there remains the potential for loss of individuals. This could be species with relatively low mobility (i.e. snakes) or nests with eggs or young if salvage occurs during the breeding season. Salvage activities are proposed for trees that are dead; therefore, effects would be restricted to those species that nest in or on dead trees or on the ground.

Mitigation and Monitoring

Several design features are incorporated into the project to reduce effects to wildlife (see chapter 2). These include forest plan standards and are included in the analyses for specific species, as appropriate.

Assumptions

Assumptions used for this analysis:

- Salvage is expected to take approximately 2 years under all alternatives, with no seasonal restrictions except where nests (goshawk or condor) are found and areas with severely erosive soils in alternative 3.
- Some older existing spur roads would be re-opened for salvage activities then closed upon completion of the project. These roads were all assumed to be open for calculating open road densities in table 46.

Cumulative Effects

Depending on the species, the cumulative effects analysis area will mainly include the project area and GA 13, unless noted otherwise. Past actions include timber harvest and wildfire. Fire severity and time since fire influenced the severity of the Warm Fire and mortality of forested stands. These effects were calculated into the existing condition. Ongoing activities include camping, hiking, hunting, OHV use, road and trail maintenance, special uses, firewood cutting, livestock grazing and associated developments. Table 10 at the beginning of chapter 3 shows the known past, ongoing and reasonably foreseeable future actions in the project area and GA 13. Specific types of actions which could affect individual species or their habitat are included in the species-specific analysis. The WFR project area had a history of forest management prior to the fire.

The Jacob-Ryan Vegetative project is the largest proposed timber/fuels treatment that is currently being planned near the project area. The Jacob-Ryan project area is northwest of the north part of the project area and is part of GA 13. The two action alternatives considered for the Jacob-Ryan project would use mechanical tree thinning and prescribed burning over approximately 26,000 acres to reduce ponderosa pine tree density, fuel loading and achieve or make progress toward forest plan desired tree size class distribution within both even- and uneven-aged stands, within and outside of goshawk PFAs and nest stands. The upper size limit that can be harvested would be less than 18 inches d.b.h for alternative 2 or less than 12 inches d.b.h for alternative 3. Because the WFR project is only removing dead trees within areas with high tree mortality on slopes less than 20 percent, the WFR project will not add to any habitat structural affects that may be caused by the Jacob-Ryan project. Both projects have mitigations for reserving adequate snags and down logs as directed by the forest plan, therefore, the WFR project will not add to any cumulative effects for habitat snag and down log components.

In general, pine beetle species prefer ponderosa pines that were heavily damaged or killed by fire (McHugh et al. 2003). The Warm Fire Assessment (USDA Forest Service 2007c) found that there is a minimal risk of widespread beetle activity, but there will be additional tree mortality caused by bark beetles attacking fire-damaged trees. Some species of beetles would be expected to be increasing in the project area. A field review in fall of 2006 noted the presence of beetles in the project area (Young, personal communication).

Wildlife species are closely adapted to their environments and respond to climate variation. The effects of climate change on populations and range distributions of wildlife are expected to be species specific and highly variable, with some effects considered positive and some negative.

In response to projected climate change, the geographic ranges of North American flora and fauna are expected to shift upward in elevation and northward (Inkley et al. 2004). Temperature, rainfall, soil moisture, and the specific physiological requirements of each species are expected to be driving forces in the shifts. Range shifts of wildlife are likely to depend on factors such as the availability of migration corridors, suitable habitats and the concurrent movement of forage and prey.

Climate variability makes predictions about drought, rainfall, timing of the rainfall, and temperature extremes highly uncertain. There is much uncertainty about ecological interactions and trends at the local or site-specific scale and it would be highly speculative to make predictions at this scale. Because of the speculative nature of these changes, it is impossible to predict changes in wildlife species in the project area based on climate change. However, continuing drought conditions combined with climate change may delay or prohibit recovery of some vegetation species. Although there may be direct effects to associated wildlife, information at this time is too limited to quantify potential scenarios. Based on project design to harvest only dead trees in areas of high tree mortality and to retain snag and down logs, no additional negative affects will be added cumulative for the project area or for GA 13. There is expected to be long-term beneficial affects as compared to the no action alternative by planting trees in a grouped and clumped pattern with associated openings in areas that currently have no seed source, reducing recovery times when stands are once again forested.

Threatened and Endangered Species

California Condor

Direct and Indirect Effects

The project area is over 3 miles from the nearest site where nesting has been attempted. Project related activities would have no effect on condors attempting to nest at that site. If condor nesting activity is identified within 0.5 mile of any treatment area, the district biologist will identify appropriate temporal or spatial limitations to human disturbance during the nesting season (see “Project Design Features” in chapter 2).

Salvaging would open up areas, increasing potential transitory foraging habitat. Mule deer carcasses or gut piles present during or after hunting season would provide scavenging opportunities and would be more accessible to condors after salvage due to the more open nature of the salvaged areas.

Condors are curious birds and may be attracted to the area during activities. If condors arrive and remain in or near human activity centers, additional measures would be taken such as: (1) avoid contact with the condors and contact the district biologist immediately, (2) education, and (3) police worksites at the end of each day. Policing worksites would reduce the potential for interaction. The district biologist would coordinate with the appropriate Agency personnel and necessary actions would be taken.

Cumulative Effects

During the first 5 years of the re-introduction program, there were several causes of mortality, with no one standing out. Actions were taken to reduce some of these, where possible. During the second 5-year period, lead poisoning stands out as the leading cause of mortality. The project area lies in Arizona Game Management Units 12A-East and 12A-West. In 2005, hunters drawn for deer, bighorn sheep and buffalo hunts in Units 12A-E and 12A-W qualified for the free non-lead ammunition program. In 2006, hunters drawn for deer, antelope, bighorn sheep and buffalo rifle and muzzleloader hunts were qualified for free non-lead ammunition. Approximately 60 percent of the hunters participated in the program (Condor Review Team 2007). Four adult condors died and all four deaths were likely a result of ingesting lead fragments during the 2006 fall hunting season. However, Arizona Game and Fish has continued to support and pursue success of this program. Results of hunters taking voluntary lead reduction efforts increased to 83 percent in 2007 and 90 percent in 2008. There were no instances of condor mortalities due to lead ingestion in either year.

Other Warm Fire related projects, including removal of fire-killed hazard trees along the highways and main forest access roads, include the same project design features that are incorporated to protect California condors.

There is also the potential for condors to get hit on the highways if they come in to feed on road-killed deer. However, the potential for deer to be killed on the highway should be reduced now due to the hazard tree removal that has taken place, increasing visibility of motorists.

This proposal, in combination with these other projects, is not likely to negatively affect the condor population.

Statement of Findings

The California population is an experimental population, nonessential. The action alternatives may have insignificant and/or discountable effects on the California condor. The action alternatives would **not likely jeopardize the California condor**. This determination is based on: (1) no known breeding sites in or near the project area; (2) no or possible beneficial affect resulting from salvage on availability of hunter or winter-killed deer; and (3) implementation of project design features (see chapter 2).

Mexican Spotted Owl

All action alternatives propose planting of 2,353 acres of mixed conifer species. Because planting of mixed conifer is proposed over only 6 percent of the analysis area, and given the limited opportunities for planting Douglas-fir (need additional shade, cooler and moister microsites) and widespread aspen regeneration, there is no predicted measurable difference in mixed conifer cover types between alternatives (McCusker, personal communication*;* see “Vegetation” section above).

Over 20 percent of MSO habitat within the project area burned with low and mixed-low mortality classes and is expected to continue to provide suitable habitat. None of these areas are proposed for salvage. About 76 percent of functional MSO habitat was lost due to high and mixed-high mortality classes. Within the areas that were once MSO habitat with high and mixed-high mortality, about 48 percent is proposed for salvage under alternative 2. Areas not salvaged (i.e., 52 percent of the high and mixed-high severity mortality classes) would contribute large

quantities of snags around the salvage areas as would the retention of five to seven snags per acre within the salvage areas. The snags retained on the landscape will eventually result in high levels of downed logs. Table 47 displays the acres of MSO habitat proposed for salvage, by alternative.

Table 47. Acres of MSO habitat proposed for salvage by alternative

Habitat	Existing	High and Mixed High Mortality Habitat	Alt. 2	Alt. 3	Alt. 4
Restricted	6,336	4,852	2,113	1,115	0
Target	2,531	1,848	1,036	866	0
Threshold	514	429	311	293	0
Total	**9,381**	**7,129**	**3,460**	**2,274**	**0**

Direct and Indirect Effects

Even though there have been many surveys, no MSO has ever been known to nest on the NKRD and no protected activity centers (PACs) have ever been established. Because the project area lacks most primary constituent elements post-fire, there would be no direct effects on MSO. Indirect effects would result from changes in nonfunctional habitat related to decreased snag density and subsequent downed logs following harvest, speeded forest recovery timelines in planted areas, and long-term changes due to natural regeneration. Changes to the key components of mixed conifer habitat were caused by the fire. It may take well over a century for stands to grow and provide closed canopy structure in large tree size classes. It will likely take even longer for the complex habitat structure described in the MSO Recovery Plan to develop in the mixed-high and high intensity burn areas and areas may never recover without active management (Savage and Mast 2005). Drought, climate change, and distance from seed sources will only extend these timelines.

Table 48 shows how the alternatives compare in relation to the primary constituent elements of critical habitat.

Table 48. Primary constituent elements

Element	Alternative 1	Alternatives 2 and 3	Alternative 4
Related to Forest Structure			
A range of tree species, composed of different tree sizes	Not applicable, live forest structure and composition determined by fire.	Not applicable, live forest structure and composition determined by fire.	Not applicable, live forest structure and composition determined by fire.
Shade canopy created by tree branches	Not applicable, shade canopy determined by fire.	Not applicable, shade canopy determined by fire, no live trees proposed for salvage.	Not applicable, shade canopy determined by fire, no designated MSO habitat proposed for salvage.
Large snags	All dead trees would be retained.	At least 5-7 snags per acre would be retained in MSO habitat where salvage occurs.	All dead trees (snags) would be retained in MSO habitat.

Element	Alternative 1	Alternatives 2 and 3	Alternative 4
Related to Prey Species			
High volumes of fallen trees and woody debris	All fallen trees and woody debris would be retained.	At least 7 logs per acre would be retained in MSO habitat.	All fallen trees and woody debris would be retained in MSO habitat.
Wide range of tree and plant species	Range of tree and plant species dependent on response after fire.	Conifers would be planted to hasten recovery of conifer species and improve distribution of size classes. Mixed conifer species would be emphasized in MSO habitat where there is a moderate to high probability for success.	Conifers would be planted to hasten recovery of conifer species and improve distribution of size classes. Mixed conifer species would be emphasized in MSO habitat where there is a moderate to high probability for success.
Adequate levels of residual plant cover to allow regeneration	Regeneration dependent on response after fire.	Salvage would have some effect on regenerating vegetation but designation of skid trails would reduce these effects.	No salvage would occur in MSO habitat and regeneration is dependent on response after fire.

Fuel modeling found that in 5 years there would be an increased potential for higher intensity fires due to increased fine fuels on the ground as a result of salvage operations under all action alternatives. At 20 and 40 years, alternatives 2 followed by 3 have the best potential for lower intensity fires with lower vegetation mortality compared to alternative 1 (see “Fuels” section).

Alternative 1

Under this alternative, natural processes would continue. Dead trees would remain and would eventually fall and become downed logs. However, no fire-created snags are expected to be standing by the time a green forest again reoccupies the site and provides the primary constituent elements currently lacking. Similarly, there is a low likelihood that much down wood resulting from fire effects would occupy these sites by the time mature to old-growth forest characteristics occurred within the project area. Aspen and other sprouting vegetation would respond, and grasses and forbs would become established but conifers (ponderosa pine) would be slower to recover compared to the other alternatives, which include planting. Over the short term (5 years), this alternative has the potential for lower intensity fires with lower mortality.

However, over the long term (20 and 40 years) this alternative is less effective at reducing fire intensities and compares to alternative 4 which treats the fewest acres. Low intensity ground fire would risk eliminating developing forests in areas with unnaturally heavy fuel loading resulting from Warm Fire effects. Smoldering of down wood could decrease soil health (Monsanto and Agee 2008). This would delay forest ecosystem recovery by additional decades (see Fuels section). Safety issues related to unnaturally high fuel loads may restrict the ability to manage future fires.

Alternative 2

Alternative 2 proposes to salvage approximately half of MSO habitat with high and mixed-high mortality. This alternative includes snag and downed log retention project design features, even though they do not provide primary constituent elements or functional habitat without the live forest and tree canopies and MSO are not known to use the area. In areas previously mixed conifer (MSO habitat) that would be salvaged, higher levels of snags and downed logs would remain. In these areas, at least five to seven snags and at least seven logs per acre would be retained (see table 38). Plan direction for MSO restricted habitat is to leave "substantive amounts" of snags and logs; while forest-wide direction for goshawks in mixed conifer habitat is to leave at least three snags and five logs per acre. However, it is unlikely that any of the fire-created snags will be standing by the time a green forest again reoccupies the site and provides the primary constituent elements currently lacking. The other half of the MSO habitat in the project area would provide abundant dead trees (snags) until they fall and become downed logs.

At 5 years the potential for higher intensity fires is highest under this alternative, due to salvaging over more acres and more resultant fuels on the ground. At 20 and 40 years post-salvage, this alternative has the best potential for lower intensity fires with lower vegetation mortality compared to alternative 1.

Alternative 3

Alternative 3 proposes to salvage approximately one-third of MSO habitat in high and mixed-high mortality areas. The other two-thirds would remain as dead trees (snags) until they fall and become downed logs.

This alternative includes snag and downed log retention project design features, even though they do not provide primary constituent elements or functional habitat without the live forest and tree canopies and MSO are not known to use the area. In areas previously mixed conifer (MSO habitat) that would be salvaged, higher levels of snags and downed logs would be left. In these areas, at least five to seven snags and at least seven logs per acre would be retained. Plan direction for MSO restricted habitat is to leave "substantive amounts" of snags and logs; while forest-wide direction for goshawks in mixed conifer habitat is to leave at least three snags and five logs per acre. However, it is unlikely that any of the fire-created snags will be standing by the time a green forest again reoccupies the site and provides the primary constituent elements currently lacking.

This alternative is slightly less effective than alternative 2 at reducing fire intensity and mortality at 20 and 40 years post-salvage, but would be better than alternatives 1 and 4 (see "Fuels" section).

Alternative 4

This alternative does not propose any salvage in areas that were previously mixed conifer (MSO habitat). All dead trees would be retained and would fall over time. They do not provide primary constituent elements or functional habitat without the live forest and tree canopies.

Cumulative Effects

Due to constraints associated with the spotted owl guidelines, there has been very little forest management within the mixed conifer cover types in GA 13. Management entries that have

occurred follow the amended forest plan and should benefit associated species by diversifying the forest structure while retaining the large tree component.

Approximately 430 acres of the MSO habitat in the project area were treated in the 1980s, and 700 acres were treated from 1990-1992. Records do not show treatments occurring in MSO habitat since that time. However, all MSO habitat within the WFR project area was affected to some degree by the Warm Fire.

Currently, hazard tree removal projects are underway along State highways and Forest System roads. The hazard tree removal projects affected 864 acres of MSO habitat (Sanders March 2007) paralleling the road network. The majority of snags has been or will be removed; though snags will be left where they are not a risk. The remaining snags and intermittent green trees will provide future downed logs. Other vegetation treatment projects are located outside of the analysis area or treat areas outside of MSO habitat (i.e. Jacob-Ryan projects that treat ponderosa pine and pinyon-juniper cover types).

None of the action alternatives affect any currently suitable MSO habitat. Alternatives 2 and 3 will retain blocks of snags in MSO habitat; alternatives 1 and 4 would retain all snags and logs in MSO habitat. However, it is unlikely that any of the fire-created snags will be standing by the time a green forest again reoccupies the site and provides the primary constituent elements that define MSO habitat.

Statement of Findings

All action alternatives would have insignificant and/or discountable effects on MSO and designated critical habitat. Therefore the determination for MSO and its critical habitat is **may affect, but not likely to adversely affect**. This determination is based on: (1) no owls documented in the project area (or the NKRD in general); (2) there are no occupied territories or PACs on the Kaibab Plateau; (3) no currently suitable habitat would be salvaged; (4) only a portion of the currently unsuitable MSO habitat would be salvaged in alternatives 2 and 3; (5) areas salvaged would retain adequate levels of snags and downed logs even though it is not functional habitat due to the loss of green trees and forest canopy; (6) the proposed salvage areas in alternative 2 represent less than 1 percent of Critical Habitat Unit CP-10 (which is 918,847 acres although only a portion of that is designated critical habitat); and (7) none of the dead trees are expected to remain upright by the time other primary constituent elements again develop on site and, if another ground fire occurs in the project area within the next century, down logs resulting from the Warm Fire would also likely be absent before MSO habitat occupies the site. The U.S. Fish and Wildlife Service concurred with this determination for MSO critical habitat.

Sensitive Species

Bald Eagle

There are no known winter roosts on the NKRD. However, bald eagles are seen near Big Springs and during winter in mule deer winter range (Sanders et al. 2004).

Direct and Indirect Effects

Alternative 1

Under this alternative, there would be no effect on potential foraging habitat in the project area.

Alternatives 2-4

None of the action alternatives propose any activities in the pinyon-juniper habitats that are on the upper end of the mule deer winter range, therefore, salvage of dead trees would not affect current winter foraging habitat.

The part of the project area proposed for salvage provides more summer/fall range for deer and may provide a food source for migrating bald eagles from deer carcasses and gut piles of deer killed by hunters during the hunting season. Salvage would open up the stands, making them more accessible for scavenging by bald eagles.

Cumulative Effects

Because no green trees are proposed for cutting, this project will have no direct or indirect effects on potential bald eagle roosts, and is not anticipated to have cumulative effects on bald eagles.

Statement of Findings

Implementation of any of the action alternatives would have **no impact** on individual bald eagles and/or their habitat. This determination is based on: (1) no breeding habitat; (2) no known winter roosts documented in this portion of the ranger district; and (3) highest quality winter foraging habitat is on deer winter range and is not affected by any of the alternatives.

Northern Goshawk

It is recognized that there are going to be high levels of variation in vegetation across the landscape after the Warm Fire due to aspen sprouting, variable and sometimes heavy natural regeneration adjacent to existing seed sources, variable planting densities and survival in areas identified for planting and slow re-colonization of conifers in harsher areas with no seed sources.

The guidelines do not specifically address burned forests. The major factor identified for goshawk nesting and to a lesser degree foraging is closed canopy stands. All areas proposed for treatment have high and mixed-high mortality stands where most, if not all, trees are dead.

The alternatives include project design features to retain snags and downed logs that will provide structure for prey species in the years to come and include a snag buffer adjacent to green forest. Alternatives that include tree planting will also speed regeneration of ponderosa pine and mixed conifer in the project area. Salvage will reduce ground fuels, allowing the return of fire into these fire-adapted ecosystems.

Monitoring of goshawk territories on the Kaibab Plateau is ongoing, and will provide information on how goshawks respond post-fire and/or salvage (see “Affected Environment” section).

Direct and Indirect Effects

Alternative 1

No standing dead trees would be salvaged. There would be an abundance of snags, and understory vegetation would provide foraging habitat for prey using more open areas. Once snags begin to fall, downed logs will increase, providing cover for some prey species. In areas with no seed source, recovery of goshawk breeding habitat (large mature trees) would not occur for a very long time, possibly hundreds of years.

Over the short term (5 years), this alternative has the potential for lower intensity fires, with lower mortality. However, over the long term (20 and 40 years) this alternative is less effective at reducing fire intensities (see fuels report) putting adjacent goshawk habitat at a higher risk.

Alternatives 2-4

The Warm Fire had severe impacts on the goshawk population eliminating a minimum of 6 territories and reducing the quality of habitat on the remaining 11 (see "Affected Environment" section above). However, based on the design features for all action alternatives where only dead trees with no green needles will be harvested, there will be no change to any VSS class, or canopy density of green trees, or reduction of any green tree size class. There will be no reduction in live mature trees (old growth). The only possible effect by any action alternative will be from possible short-term disturbance from salvage operations and removal of standing dead trees. There will be a beneficial effect where trees are planted (in areas where there are no seed trees) to increase the restoration process. Any potential effects to the goshawk due to salvage operations were eliminated completely or minimized through project design and mitigation (see the following). Any disturbance to nesting goshawks will be mitigated by not allowing disturbance within .25 mile of known active goshawk nest sites between March 1 and September 30.

There will be a reduction in the number of standing dead trees; however, forest plan guidelines of residual snags and down logs will be exceeded.

Treatment units are strips along ridges with the bottom areas protected with buffers. There is a 200-foot no treatment buffer along all drainage bottoms that have sign of scour that may provide potential travel corridors; anything greater than 20 percent slope also will not be treated. Treatment will only occur in sites with high to moderate fire severity where most of the green canopy was destroyed. The roadless area on the northeast side of the project boundary will not be treated. In alternative 4, mixed conifer habitat will not be treated.

In addition to the large areas left untreated, all areas treated within MSO critical habitat (alternatives 2-3) will have five to seven snags per acre retained. In all other treated areas, three to five snags per acre will be retained targeting the largest diameter trees. In alternative 4, no sites that were previously mixed conifer or spruce fir will be treated.

Down logs requirements now and in the future will be met by the following:

- Leave a minimum of 15 to 20 tons per acre of coarse woody debris (CWD) on ponderosa pine and dry mixed conifer sites (i.e., MSO habitat). For all other vegetation types leave 5 to 10 tons per acre.
- Within MSO critical habitat at least seven downed logs per acre will be retained. In other areas five logs will be retained. Logs will be at least 12 inches at midpoint and at least 8 feet long. Many of the standing dead trees are expected to fall in the foreseeable future and log density will increase.

The action alternatives move the project area closer to the desired conditions for goshawk habitat at a faster rate than alternative 1 (no action). Salvage would only occur in areas with mixed-high and high mortality that lack habitat components needed for nesting and PFA habitat. As a result, all alternatives would have similar effects on mature and old forest (VSS 5 and 6) as only time will allow residual live and regenerated stands to mature and move into these age classes.

Currently, 17 percent of the project area is in VSS 5/6 (mature forest). Under all alternatives, this would change to 24 percent by the year 2047 (see table 45).

Fuel modeling found that at 5 years there would be an increased potential for higher intensity fires due to increased fine fuels on the ground as a result of salvage operations. Alternative 2 will have the highest potential for high intensity fire immediately following salvage operations. After 20 years and at 40 years, alternatives 2 followed by 3 have the best potential for lower intensity fires with lower vegetation mortality compared to alternative 1 (see "Fuels" section below).

Cumulative Effects

Project Area

Forest management on the NKRD prior to the Warm Fire had affected portions of some the PFAs (see table 34) in the project area. Past treatments and residual vegetation influenced how fire burned through the area. The fire itself had major impacts on many of the territories in the project area. It is estimated that six territories (PFAs) can no longer function. Four nests (PFAs) have been active during the last 2 years and seven PFAs may have enough remaining habitat to have the potential of being occupied but productivity will probably be reduced from what it was prior to the fire (see "Sensitive Species, Affected Environment" section). Monitoring of goshawk territories on the Kaibab Plateau is ongoing, and will provide information on how goshawks respond post-fire and/or post-salvage.

A total of 933 acres will have trees removed along highways, forest system roads and trails within the WFR project area. Any of the action alternatives from this proposal would then remove more dead trees. Because the areas to be salvaged currently do not provide suitable nesting habitat, they would not contribute cumulatively to effects on goshawk habitat in the project area.

Geographical Area (GA) 13

GA 13 lies in the middle of the NKRD at elevations of 7,000 to 9,000 feet and is predominately ponderosa pine and mixed conifer forest. GA 13 includes approximately 274,986 acres; the project area is approximately 39,000 acres or 14 percent of the GA. There are a total of 123 goshawk territories within the Kaibab Plateau (GA 13 and the Grand Canyon National Park). Of the 123 territories, 107 are totally or partially within the GA 13 outside of the park. There is approximately 63,217 acres of PFA, or 23 percent of GA 13, with the remaining acres being foraging habitat. Approximately 29,194 acres (or 11 percent) of the Warm Fire (both suppression and WFU areas) were burned with high or mixed-high mortality by the Warm Fire (see table 12).

There are several projects in table 10 located in GA 13. The Jacob-Ryan project lies north of the project area and proposes to modify approximately 26,000 acres of ponderosa pine forest, moving vegetative conditions closer to forest plan desired conditions. Thinning from below (up to 18 inches d.b.h), followed by prescribed burning would move PFAs and foraging areas closer to desired conditions for goshawk habitat management. Dry Park Vegetation Management and Fracas Habitat Improvement are also mechanical treatments in ponderosa pine that will move vegetation toward goshawk desired conditions. Lookout and Burnt Saddle Fuels Reduction projects are prescribed burns in the understory of ponderosa pine habitats. All of these projects were or are being designed to move vegetative conditions toward goshawk desired conditions. It is assumed that conditions on these 34,750 acres (or 13 percent of the GA) will maintain or improve PFA and foraging habitat. In addition, these treatments are designed to move the forest toward sustainable conditions. Because the areas to be salvaged in this project currently do not

provide suitable nesting habitat, and salvage would not change or modify any current vegetative structural stages, it would not contribute cumulative effects to goshawk populations in GA 13.

Statement of Findings

The change in management direction per the 1996 amended forest plan was intended to shift into a sustained-yield approach for long-term renewable resources applied at the ecosystem scale. The focus in terms of wildlife habitat is to provide for a diversity of vegetation structural stages by including habitat goals in the design of all vegetation treatments. The forest plan now manages more by forest ecology rather than timber management. Harvest objectives have become re-creating patterns of natural forest patch dynamics (Bratland et al. 2008). The current management direction, which provides for a continuous flow of habitat structural stages through time, emphasis on retaining groups of large trees, and maintaining large sized reserve trees spread throughout the other age classes, was designed to account for the needs of the goshawk and their prey species.

Implementation of any of the action alternatives **may impact northern goshawk individuals or habitat, but would not likely contribute to a trend toward Federal listing or cause a loss of viability.** This determination is based on: (1) harvesting only dead trees in moderate to high tree mortality areas will not change forest vegetative structure; (2) current unsuitability for nesting of stands to be salvaged; (3) focus on retention of snags and downed logs; (4) planting based on historical stocking levels and species composition; and (5) a project design feature for potential timing restriction if an active goshawk nest is found. Because of the above factors, none of the action alternatives would be expected to affect forest-wide habitat or population trends for this species.

American Peregrine Falcon

Direct and Indirect Effects

All Alternatives

The project area may provide foraging habitat in stringer meadows, but lacks preferred foraging habitats (river bottoms, meadows, marshes and lakes). Salvage would have no effect on the meadow features or the suitability for use by peregrine falcons. Retention of all snags (alternative 1) or salvage in some areas (alternatives 2-4) would have no effect on the potential for incidental foraging by birds nesting well outside of the project area.

Cumulative Effects

Since there would be no direct or indirect effects, there would not be any cumulative effects.

Statement of Findings

Implementation of any of the action alternatives **would have no impact on individual peregrine falcons or their habitat**. This determination is based on: (1) no suitable cliff nesting habitat in the project area; (2) lack of any preferred foraging habitat in the project area; and (3) no effects on secondary foraging habitat.

Utah Mountain Kingsnake

These snakes are typically found near water and rocky areas. Rocky areas do occur within the project area, but water is limited to created stock tanks. The fire itself probably had little effect on

this species, as there are few reports of fire-caused injury to herptofauna (Smith 2000). Since this species is a burrower, it would be protected below ground during the fire. Many herptofauna show little response to understory and mixed-severity fires (Smith 2000).

Direct and Indirect Effects

Alternative 1

Natural regeneration of aspen, conifers, and shrubs would provide cover. Standing dead trees would fall over time, providing additional cover for kingsnakes and their prey species.

Alternatives 2-4

These alternatives would increase the establishment of conifers in some of the area. Areas salvaged would include retention of snags, which would eventually fall and provide cover on the ground. These snakes are typically found near water and rocky areas; salvage would not affect the availability of these features or affect burrows located in these areas. A soil and water project design feature requires a minimum of 100 feet between skid trails to reduce soil compaction. This would also reduce the potential for impacting burrows or individuals aboveground. These snakes spend most of their time underground but forage aboveground. Depending on season of salvage logging, individual snakes could be affected.

Cumulative Effects

Other actions which could affect this species include hazard tree removal, highway traffic, and recreational use.

Hazard tree removal would have similar effects to those described above and may have impacted individual snakes. In general, some species of snakes move to highways to “sun” or increase their body temperature. There is no information showing that this is an issue for this species. Collection of reptiles is regulated by the State and should not be contributing significant effects. These alternatives, in combination with the above activities would not contribute significant cumulative effects to this species or its habitat.

Statement of Findings

Implementation of any of the action alternatives **may impact individual Utah mountain kingsnakes and/or their habitat**, **but would not likely contribute to a trend toward Federal listing or cause a loss of viability to the population or the species.** This determination is based on: (1) avoidance of preferred habitat such as rocky areas and absence of perennial riparian areas; (2) 100-foot buffers on intermittent and ephemeral drainages; and (3) spacing of skid trails to reduce soil compaction would lessen potential for mortality of individuals.

Spotted Bat

Although widespread in geographic distribution, they are patchily distributed and only locally abundant. They commonly roost in rock cliffs, but forage across much of the Kaibab Plateau.

Direct and Indirect Effects

Alternative 1

There would be no disturbance under the no action alternative and no direct effects. Natural regeneration of aspen, conifers, and shrubs would occur. Standing dead trees would fall over time.

There are no subalpine meadows with water which are where spotted bats are known to forage. Spotted bats are not known to roost or forage within the project area.

Alternatives 2-4

Direct effects from the proposed alternatives are unlikely due to the lack of water sources and meadows within the project area. The proposed action and its associated activities will have no effects on the population trend of spotted bats or their habitat.

Allen's Lappet-browed Bat

This bat species occurs throughout most of Arizona in woodland and coniferous forests. Large, older ponderosa pine snags are important for female roosts.

Direct and Indirect Effects

Alternative 1

There would be no direct effects under the no action alternative. Natural regeneration of aspen, conifers, and shrubs would occur. Standing dead trees would fall over time reducing the number of snags.

Alternatives 2-4

Direct effects may include disturbance of maternity colonies. Maternity colonies are easily disturbed and often result in abandonment. Standing dead trees will be removed under the action alternatives but snags will be retained at numbers that exceed the forest plan guidelines. Only a small area of the overall Warm Fire will be treated. The action alternatives associated activities may effect the local population of Allen's lappet-browed bats but is not likely to affect the population trend.

Pale Townsend's Big-eared Bat

This bat species is widespread throughout Arizona. They seem to be strongly correlated with the presence of caves and abandoned mine shafts in which they roost.

Direct and Indirect Effects

Alternative 1

There would be no direct effects under the no action alternative. Natural regeneration of aspen, conifers, and shrubs would occur. Standing dead trees would fall over time reducing the number of snags.

Alternatives 2-4

Removal of standing dead trees over some of the area would have no effect on foraging habitat. Since there are no suitable roost sites in the project area, roosting would not be affected. Alternatives 2-4 with their associated activities will have no effects on the population trend of Pale Townsend's Big-eared bats or their habitat.

Kaibab Least Chipmunk

This species is found in rocky areas within moist or damp situations and usually in open places in the forest. Summer dens are typically in hollow logs or stumps, in rock piles, or under debris.

Direct and Indirect Effects

Alternative 1

There would be no direct effects under the no action alternative. Natural regeneration of aspen, conifers, and shrubs would occur.

Alternatives 2-4

Treatments under alternatives 2-4 may initially reduce or displace chipmunk populations, but populations have been known to recover to numbers at or above pre-project levels possibly due to increases in forage and cover. Proposed treatments will only be over a small part of the overall Warm Fire area and involve removing only standing dead trees. Residual snags, down logs, and coarse woody debris (CWD) will be retained through mitigations that exceed forest plan guidelines. Because chipmunks are a generalist species, they would quickly adapt to the transformed environment. Alternatives 2-4 and their associated activities will have no effects on the population trend of Kaibab least chipmunks or their habitat.

Long-tailed Vole

This species occurs in isolated populations in Arizona including the Kaibab Plateau. On the NKRD they are most commonly found in grassy areas around springs or in swamps adjacent to lakes.

Direct and Indirect Effects

Alternative 1

There would be no direct effects under the no action alternative. Natural regeneration of aspen, conifers, and shrubs would occur.

Alternatives 2-4

Because there will be no activity related to salvage (including equipment staging) occurring in meadows or adjacent to lakes, physical disruption to long-tailed voles would be minimal. The proposed action and its associated activities may affect the local population of long-tailed voles, but is not likely to affect the population trend.

Kaibab Squirrel

The Kaibab squirrel is a geographically isolated subspecies of the Abert's squirrel and an obligate resident of ponderosa pine on the NKRD and the north rim of the Grand Canyon National Park.

Direct and Indirect Effects

Alternative 1

There would be no direct effects under the no action alternative. Habitat was lost in all areas with high fire severity. Natural regeneration of aspen, conifers, and shrubs would occur. However, without planting it will be many years before regenerated pine sites become squirrel habitat again.

Alternatives 2-4

Removal of standing dead trees will occur only in areas where there was high to moderately-high fire severity. Because only standing dead trees will be removed, no existing squirrel habitat will be impacted. Alternatives 2-4 with their associated activities will have no effects on population trend of the Kaibab squirrel or its habitat (for additional discussions see the Kaibab squirrel discussion under the "Management Indicator Species" section below).

Kaibab Northern Pocket Gopher

This subspecies occurs in the soils of high elevation meadows surrounded by spruce-fir or ponderosa pine.

Direct and Indirect Effects

Alternative 1

There would be no direct effects under the no action alternative. Natural regeneration of aspen, conifers, and shrubs would occur.

Alternatives 2-4

Because there will be no thinning related activities, including equipment staging, occurring in meadows, soil compaction in these areas would not occur. Physical disruption of pocket gophers would also not occur due to these animals fossorial behavior. Use of heavy equipment may result in temporary loss of some grasses and herbaceous vegetation but the amount of area disturbed would be limited to primarily skid trails. Over time grasses and herbaceous plants will become more widespread and vigorous providing increased foraging and burrowing opportunities for pocket gophers. Alternatives 2-4 and their associated activities will have no effects on the population trend of Northern pocket gophers or their habitat.

Management Indicator Species (MIS)

The Warm Fire had a tremendous negative effect on wildlife habitat converting vegetative structural stages (VSS) over large areas that were fully stocked forested stands to a grass/forb stage (VSS 1). However, none of the action alternatives would change the percent of green cover types or structural stages from current (post-fire) conditions. All of the harvest would be of dead trees in areas that burned with high and mixed-high mortality. These areas are no longer providing the vegetation cover types that they provided prior to the fire. Possible impacts from the action alternatives on vegetative recovery because of soils were discussed; impacts were found to be within acceptable limits meeting forest plan standards and guides (see "Vegetative Resources" and "Soil and Water Resource" sections in chapter 3). One possible effect that will be evaluated further in this section is the removal of standing dead trees (snags).

Forest Conditions in the Future

In 40 years the action alternatives will move forest conditions closer to forest plan desired levels than alternative 1 (no action) showing the benefit of the action alternatives (for more detailed discussion see "Vegetation" section).

Northern Goshawk

Areas that burned with high and mixed-high mortality are no longer providing the habitat that they provided pre-fire. Snags and downed logs would be retained, planting would be based on historical stocking levels and species composition, and a design feature has been incorporated for a timing restriction if an active goshawk nest is found.

While increases in snag-associated species may benefit goshawks, the relationship between snags and potential prey is not linear, i.e., more snags do not equate to a direct relationship of more goshawks. Prey size, availability, and prey habitat are all factors affecting how much effort a goshawk may commit to hunting particular individuals. It is doubtful much beyond the edge of green forest even qualifies as goshawk habitat. Hence, for lack of better data, we are not assuming the Warm Fire mixed-high and high mortality areas represents goshawk habitat.

In summary, although goshawk populations appear to be decreasing on the forest and ponderosa pine habitat is continuing to become further degraded from unsustainable changes in forest conditions from both fire suppression and large-scale, high severity crown fires, the action alternatives are not affecting actual goshawk habitat and, hence, are not expected to affect forest-wide trends in goshawk populations or goshawk habitat (for a more detailed discussion of the effects analysis for goshawks, see “Sensitive Species” section). The action alternatives would not cause measurable changes to species habitat or population trends on the project area or across GA 13.

Turkey

Approximately 37 percent is in the low and mixed-low mortality classes and would continue to provide suitable habitat where it existed prior to the fire. The other 63 percent lacks roost trees and the ability to produce cone crops and currently lacks downed logs. Native grasses and forbs will become re-established post-fire. These species are particularly important for turkey hens and poults, which forage for insects and seeds in late spring and summer. However, turkeys are not likely to forage far from cover so much of the overall benefits of increased grasses, forbs, and associated invertebrates will not directly benefit turkeys. However, the areas near green forest and adequate cover should benefit this species. Turkeys should be able to use areas occupied by aspen and shrubs as cover, allowing them to expand their use of foraging areas. Because no alternatives harvest green trees, islands of habitat will slowly develop across the project area as surviving trees grow and aspen and planted trees develop.

Direct and Indirect Effects

Alternative 1

Standing dead trees will fall over time, providing downed logs for cover, and grasses and forbs would regenerate to provide foraging habitat, but the distance to roost trees and cover would affect use. Those areas closer to the edge of the fire or to low or mixed-low mortality areas would be more suitable. In the long run, forest recovery may be hampered by future ground fires igniting the heavy ground fuels load and burning any re-growth since the Warm Fire.

Alternatives 2-4

All salvage areas in all action alternatives would maintain snags that would provide downed logs over time. Planting of ponderosa pine in the action alternatives would increase the percent of the burned area that would be in young forest by 2047 providing cover to allow more of the large

openings to be used. Conditions will be restored more quickly with the action alternatives than under alternative 1 (no action).

Cumulative Effects

The Warm Fire had significant negative effects to turkey habitat. Treatments prescribed in the action alternatives will not modify the vegetative structural stages; therefore, there will be no impact. Planting activities proposed in the action alternatives will have long-term positive effects by reducing the amount of time for forest recovery.

There are two hunting seasons for turkeys. There is an archery season in middle to late September, and the general season in mid-October. These are managed by the AZGFD to maintain sustainable, populations. Implementation of the action alternatives would not contribute to negative cumulative effects to this species or its habitat.

Statement of Findings

Based on the analysis for turkeys, the action alternatives would not affect existing suitable habitat. All of the areas that burned with high and mixed-high mortality are no longer providing the habitat that they provided pre-fire. Activities proposed for the action alternatives **would not cause measurable changes to species habitat or population trends** on the project area or across GA 13 or across the forest.

Mule Deer

Mule deer were selected as an indicator for early-seral aspen habitat. Binkley et al. (2006) looked at periods of mule deer population increases on the North Kaibab Plateau in relation to aspen regeneration. They did find increased deer numbers following the 1880s and 1890s when regular surface fires ceased, and again in the 1970s and 1980s, coincident with widespread logging. They did recognize some uncertainty as there may be other factors such as lack of predation that contributed to population trends as well.

The forest visitor map shows that the area east of AZ 67 is restricted from motorized access during the winter (December 15 to April 15). However, some salvage operations are proposed in this area, and may occur during the winter. Alternative 3 requires logging on frozen or snow-covered soils on those sites with severe erosion hazard ratings.

Direct and Indirect Effects

It is predicted that approximately 4,800 acres of the project area will regenerate to aspen naturally. Aspen will increase across the project area, regardless of alternative. In addition, browse species such as Ceonothus will re-sprout and provide summer forage. Loss of other key forage species such as cliffrose and 4-wing salt brush resulted from the fire and impacts on their re-establishment are discussed below.

Alternative 1

The project area would continue to recover naturally. Aspen would continue to increase; standing dead trees would eventually fall, potentially limiting access to some of the area depending on depth of downed logs. No additional impediments to natural shrub regeneration would occur. In the long run, forest recovery may be hampered by future ground fires igniting the heavy ground fuels load and burning any re-growth since the Warm Fire.

Alternatives 2-4

The part of the project area proposed for salvage provides summer and fall habitat. Over the short term (during project activities), vulnerability to hunters could increase due to higher open road densities, although impacts from the regulated hunt are not expected to affect population trends due to regulation by the Arizona Game and Fish Department. Over the long term, the proposed alternatives would be beneficial to deer by causing accelerated development of hiding cover due to planting of seedlings. Recovery and establishment of hiding cover would be quicker under the action alternatives than if the area was left to regenerate naturally under the no action alternative.

Aspen would continue to increase across the project area. Some aspen regeneration would be affected by salvage activities, but the soil and water project design feature for a minimum distance between skid trails would help reduce this. Similarly, skid trails could affect shrub regeneration. Although direction on skid trail placement is intended to limit this effect, aspen and shrub regeneration in the salvaged areas would be impacted by all action alternatives.

Salvage east of AZ 67 varies by alternative. Alternative 2 would treat the most with 9,114 acres. Alternative 3 would treat 5,756 acres, and emphasizes reducing effects to soils by salvaging during the winter when soils are frozen. Alternative 4 would treat 5,541 acres excluding MSO critical habitat. Summer habitat is not limiting to deer numbers as is the winter habitat, which is at lower elevations in pinyon-juniper habitat east of the project area and not affected by this project.

All of the salvage would occur in areas previously occupied by ponderosa pine or mixed conifer species, with mixed-high or high vegetation mortality. Without the tree canopy to intercept snow or provide thermal cover, these stands would not provide suitable habitat during the winter, and displacement during operations is not anticipated to be a problem.

Cumulative Effects

The cumulative affects of past management activities as well as large-scale natural events have been incorporated into the existing condition. Removal of fire-killed trees along the highways will increase visibility of motorists and reduce the potential for road kill.

There are several hunting seasons for mule deer in the area. They start with an archery season in middle to late September, general rifle seasons late October to early November and late November to early December, and juniors only season between the two general seasons. These are managed by the AZGFD to sustain populations for hunting. Implementation of any of the action alternatives would not contribute cumulative effects to this species or its habitat due to the numbers harvested being regulated by the AZGFD.

Statement of Findings

An analysis of aspen habitat trends across the forest found that fire suppression, leading to increasing conifers, and managed and unmanaged (ungulate) grazing have all contributed to the decline of aspen. Aspen continues to be overtopped by conifers and regeneration is limited. Because mule deer are generalists and the NKRD consists of good deer habitat, it is unlikely that the gradual change in the condition of aspen could lead to detectable changes in deer numbers. However, the Warm Fire will help aspen regeneration and all action alternatives identify aspen development as a goal. By the year 2047, it is predicted that for all alternatives, the project area will provide 33 percent of all aspen habitat present on the forest.

In summary; mule deer populations appear to be decreasing on the forest (Bratland et al. 2008); however, aspen habitats in the project area would increase and provide a significant portion of the forest-wide habitat. As habitat quality of aspen in other parts of the forest continue to decline due to competition with and shading from conifer, aspen habitats in the project area will become increasingly important. Aspen habitat will continue to increase across the project area and will contribute to maintaining mule deer habitat and populations distributed across the forest. The action alternatives **would not cause measurable changes to species habitat or population trends** on the project area or across GA 13, or across the forest.

Kaibab Squirrel

Direct and Indirect Effects

Alternative 1

There would be no conifer planting under alternative 1 (no action); therefore, a larger percent of the project area would remain in grass/forb stage by the year 2047 and there would be less young forest. In the long run, forest recovery may be hampered by future ground fires igniting the heavy ground fuels loading and burning any re-growth since the Warm Fire.

Alternatives 2-4

Kaibab squirrels were identified as an indicator for young ponderosa pine; however, they use a mix of forest structural stages, depending on late-seral habitat for key life functions. The fire reduced the acres of ponderosa pine by approximately 35 percent within the project area (see table 25). However, forest wide this loss is not significant, equating to approximately 1 percent of the total acres. From 1986 to 2002 immature and mature sawtimber size classes increased 31 and 38 percent, respectively (Bratland et al. 2008). So the trend for the size classes of ponderosa pine for which the squirrel was chosen as a MIS is sharply up, and this trend will continue regardless of the proposed treatments for this project based on the number of acres currently occupied by younger size classes.

Ponderosa pine forests characterized as high mortality and part of the mixed-high mortality can no longer be considered Kaibab squirrel habitat. It will take decades or longer for these areas to recover sufficiently to become habitat again. Salvage in these areas would have no negative effects on Kaibab squirrel habitat or forest-wide trends.

Planting ponderosa pine seedlings in large areas previously occupied by ponderosa pine would facilitate development of forest structure at a faster rate than not doing anything and would benefit Kaibab squirrels by possibly reducing the recovery time. Currently 27 percent in ponderosa pine would increase to 36 percent in 2047 with an increase of young forest (5 to 12 inches) for all species except juniper from 7 to 10 percent (table 25). Projected young forest would increase to only 10 percent under alternative 1 but would increase to 18 percent under alternatives 2-4 (table 25) based on planting success.

Cumulative Effects

Effects of past actions influenced the way the fire burned, and are incorporated into the existing condition. There are several other ongoing or foreseeable projects on the NKRD. One is the Jacob-Ryan Vegetation Management project, which is located north and west of the Warm Fire. It proposes to move approximately 26,000 acres of ponderosa pine forest closer to forest plan desired conditions by not cutting trees over 18 inches d.b.h, thinning from below, and prescribed

burning (see “Cumulative Effects” section, table 10). Dry Park Vegetation Management and Fracas Habitat Improvement are also mechanical treatments in ponderosa pine that will move vegetation toward desired vegetative conditions. Lookout and Burnt Saddle Fuels Reduction projects are prescribed burns in the understory of ponderosa pine habitats. All of these projects were or are being designed to move toward forest plan desired conditions. These habitat characteristics should also create diverse habitat conditions favored by tassel-eared squirrels.

There is an archery tree squirrel season that runs from middle to late September. That is followed by the general season from mid-October through the end of November. These are managed by the AZGFD to maintain sustainable, huntable populations.

Implementation of any of the action alternatives would not contribute cumulative effects to this species or its habitat, because the seral stages represented by this squirrel are in excess of the forest plan desired amounts across the forest, and the WFR will only remove dead trees in areas no longer considered squirrel habitat.

Statement of Findings

Based on the analysis for Kaibab squirrels, the action alternatives would not affect existing suitable habitat. All of the harvest would be of dead trees in areas that burned with high and mixed-high mortality and these areas are no longer providing the habitat that they provided pre-fire. While planting would speed the recovery of forested stands, it will take many decades before the project area provides intermediate-aged forest intermixed with large trees. The action alternatives **would not cause measurable changes to species habitat or population trends** on the project area or across the forest.

Red Squirrel

Direct and Indirect Effects

Alternative 1-4

Because of the high fire severity and the characteristic of mixed conifer stands having a dense forest structure, all but 8 percent of the red squirrel habitat within the WFR area was lost and can no longer be considered squirrel habitat. The majority of the mixed conifer and almost all of the spruce-fir occurs on the NKRD (Bratland et al. 2008). There was approximately 49,981 acres of mixed conifer (includes spruce-fir) in GA13. Approximately 10 percent was lost in the Warm Fire (table 25).

None of the alternatives (including the no action) will have any impact on squirrel habitat. The action alternatives (alternatives 2-4) will only remove dead trees from within high and mixed-high fire severity areas and this will have no impact on red squirrel habitat because these areas are no longer habitat.

Planting mixed conifer species (Alternatives 2-4) in MSO habitat would facilitate an increase in young forest. There is projected to be 10 percent under alternative 1 compared to 18 percent under the action alternatives (table 25). These statistics include all species; though the response of mixed conifer is assumed to be similar. These acres would not be mature stands but would move toward mature stands at a faster rate than areas that are not planted.

Cumulative Effects

The proposed removal of dead trees will have no cumulative effects. No other projects known in the future will be treating mixed conifer or spruce-fir sites. In addition to the acres proposed for planting under the action alternatives, an additional 1,607 acres is planned to be planted (both ponderosa and mixed conifer species) within the Warm Fire area. Even with these plantings, there is not expected to be an increase in the number of mixed conifer acres in 2047 from the 2 percent that currently exists (see table 7).

Statement of Findings

Based on the analysis for red squirrels, the action alternatives would not affect existing suitable habitat. All of the harvest would be of dead trees in areas that burned with high and mixed-high mortality, and these areas are no longer providing the habitat that they provided pre-fire. Planting would benefit this species by increasing mixed conifer cover types at a faster rate than would occur without planting. However, it will take many decades for these stands to provide mature forest conditions. Because of the length of time needed to develop mature forest, and the potential for natural events (drought, insect and disease, wildfire) that could affect the length of time, the action alternatives **would not cause measurable changes to species habitat or population trends** on the project area, within GA 13, or within the forest.

Hairy Woodpecker

The ubiquitous hairy woodpecker (*Picoides villosus*) is one of the most abundant primary cavity nesters in northern Arizona. This species was selected as a MIS to represent the snag component of the ponderosa pine, mixed conifer, and mixed conifer with aspen habitats within the Kaibab National Forest.

Hairy woodpeckers are at least stable in Arizona and the surrounding area. Hairy woodpeckers are listed by NatureServe as demonstrably widespread, abundant, and secure globally, nationally, and statewide. Locally, several research projects conducted on both the Kaibab and Coconino National Forests determined hairy woodpecker abundance and density. Over the course of 6 years in three unburned ponderosa pine sites, Covert (2003) determined that hairy woodpecker density did not differ by site or year indicating a stable population. Salafsky (2002) found similar densities in unburned ponderosa pine forest on the Kaibab Plateau within the KNF. This study also estimated density for mixed conifer habitat over 3 years and found comparable densities on average, with an increasing trend across the years. Considering all the surveys from the literature and the KNF, the data suggest that hairy woodpeckers have remained stable in ponderosa pine and may be increasing in the mixed conifer. The stability determined by Covert-Bratland et al. (2006) would likely be found on the KNF (Bratland et al. 2008).

The relatively low numbers of individuals in unburned forests are markedly different from those found in burned ponderosa pine. Pope (2006) found a fivefold increase in density in prescribed low-intensity burned areas. Covert-Bratland et al. (2006, 2007) showed that high-severity burned areas are beneficial foraging areas, support 18 times the abundance of hairy woodpeckers than unburned areas, and that burned trees provide readily available roost trees during difficult winter conditions (Bratland et al. 2008).

For the total Warm Fire there are 48,062 acres of ponderosa pine, mixed conifer, spruce-fir, and aspen. A total of 29,194 acres (61 percent) burned at a mixed-high to high severity that resulted in

most (if not all) trees being killed. The remaining area burned at a mixed-low to low severity where individual or small patches of trees were killed.

See the discussion of hairy woodpeckers under sensitive species above regarding snags.

Snags Across the Project Area

Due to the severity of the fire over a large area, there are thousands of snags currently standing in all size classes. As an example, there are over 15,000 acres burned with high severity, and the current status of 13.8 large trees (>20″) per acre would equate to over 213,000 large snags across the project area. There would be this magnitude again over the remainder of the Warm Fire area.

A small percentage of the Warm Fire is proposed for salvage (approximately 5,500 acres (9 percent) in alternatives 3 and 4; and 9,114 acres (16 percent) in alternative 2) out of the approximately 55,000 acres burned in the total Warm Fire. Out of just the project area of 39,111 acres, salvage would only occur in 14 percent in alternatives 3 and 4, and salvage activities would occur on approximately 23 percent in alternative 2. In areas with almost 100 percent mortality (high and mixed-high mortality), only a portion of these areas is proposed for salvage (table 49). In addition to the residual snags left within the areas treated, other areas not proposed for salvage would also provide abundant snags and abundant downed logs when they fall.

Table 49. Percentages of cover types with high or mixed-high mortality proposed for salvage

Cover Type	Alt. 2	Alt. 3	Alt. 4
Ponderosa pine	41%	28%	31%
Mixed conifer*	39%	31%	5%
Aspen	78%	12%	49%

* Mixed conifer percent based on acres of D-F and WF, as per Warm Fire Assessment

Conclusion

Snag retention will be maximized over time because of the following: (1) the abundance of standing dead trees (snags) in the project area; (2) only portions of the high and mixed-high mortality areas are proposed for salvage; (3) snags and downed logs would be left above forest plan direction in areas proposed for salvage; and (4) that retention would focus on clusters of the largest diameter snags available (thus increasing snag longevity). Therefore, snag resources will remain available across the project area for species associated with these features until the snags fall, rot or burn.

Direct and Indirect Effects

Field observations in the fall of 2006 noted beetles seemed to be moving into the stands (Young, personal communication). Beetles are expected to increase in the dead trees for a few years, providing a foraging source for hairy woodpeckers and likely temporarily increasing woodpecker densities in the area.

Alternative 1

Under this alternative all burned areas would provide the maximum foraging and nesting habitat for hairy woodpeckers. This will benefit hairy woodpeckers more than any other alternative in the short term. This alternative provides the least security for local woodpecker populations in the long term by maintaining the highest fuel loads of any alternative. Additionally, the unnaturally high fuel loads may limit future firefighting abilities. Combined, this may represent the lowest likelihood of re-establishing sustainable forest within the project area.

Alternatives 2-4

Hairy woodpecker densities would, in general, have an inverse correlation with the amount of salvage logging conducted. Therefore, we expect slightly lower densities of hairy woodpeckers in all action alternatives relative to the no action alternative, with alternative 2 having the lowest densities of woodpeckers.

The Warm Fire resulted in a severe disturbance for an area over 48,000 acres (61 percent being in mixed-high to high severity) in the ponderosa pine, mixed conifer, spruce-fir, and aspen which will result in a very large increase in the hairy woodpecker population. With or without removal of any trees, hairy woodpecker numbers will decline over time. Winter home ranges increased from 19 to 167 acres 2 to 6 years after a burn. It is thought that this is because of the decline in prey resources (Bratland et al. 2008). Removal of trees may result in a smaller increase (as compared to no harvesting), but based on the small percentage of area actually harvested (5,541 to 9,114 acres depending on alternative) the increase in the population will remain substantial. Project design such as removing trees in large blocks and leaving a density of dead trees along the borders will further mitigate the reduction in population increases.

It is recommended that burned trees are removed in large patches of high-severity burn and that high densities of snags are left along the edges for nesting and roosting (Bratland et al. 2008). The WFR project has the following design features:

- A 25 meter no-cut buffer would be applied in salvage units adjacent to contiguous live forest. All snags would be retained in these buffers. This design criteria is specifically intended to benefit hairy woodpeckers.
- Within treatment areas that supported mixed conifer conditions pre-fire (MSO Recovery Plan 1995), a minimum of five to seven snags per acre will be retained in groups that provide for worker safety. In other areas, a minimum of three to five snags per acre will be retained. These groups of snags will target existing clusters of the largest diameter snags available and slope will be minimized, to the degree possible. Retention amounts will be measured on average across a treatment area and may exceed these minimums.
- All drainage channels and ponds would receive at least a 100-foot no disturbance buffer from the edge of the channel.
- Only limited harvest will occur on slopes greater than 20 percent to protect soils. This will leave additional blocks of snags across treatment units.
- Treatment areas are staggered with untreated areas, leaving large blocks of snags interspersed among treatment units independent of the above design criteria.

There will be no recruitment of new snags in the high mortality areas until the stands regenerate and mature and new large snags are created. Planting of conifers would speed the recovery of habitat (see table 45). This will ensure forest succession occurs in areas distant from seed sources. This could lead to snag availability occurring decades sooner than if planting does not occur, depending on the location of seed sources.

Fuel modeling found that at 5 years there would be an increased potential for higher intensity fires due to increased fine fuels on the ground as a result of salvage operations under all action alternatives. This would significantly reduce total snag availability in areas where trees are not resprouting naturally. After 20 years and at 40 years, alternative 2 followed by 3 have the best potential for lower intensity fires with lower vegetation mortality compared to other alternatives (see “Fuels” section).

Cumulative Effects

Past treatments and residual vegetation influenced how the fire burned through the area. Post-fire actions (hazard tree removal, planting, etc.) had similar effects as this project would have and included snag retention direction. Other vegetation treatment projects in table 12 are located outside of the project area, would retain snags and/or treat areas outside of hairy woodpecker habitat (i.e. lower elevation big game winter ranges). Implementation of any of the action alternatives would not cause negative cumulative effects to this species or its habitat.

Statement of Findings

Based on the analysis for hairy woodpeckers, the action alternatives would affect suitable foraging habitat and species distribution across the project area. The scale of the salvage proposals (5,541 to 9,114 acres or 11 to 19 percent of the Warm Fire habitat) retaining 89 to 81 percent of 48,062 acres of hairy woodpecker habitat within the Warm Fire area makes it unlikely any of the action alternatives would affect forest-wide habitat or population trends. The action alternatives **would not cause measurable changes to species habitat or population trends** on the project area or across the forest.

Pygmy Nuthatch

Kotliar et al. (2002) reported the effects of fire and post-fire salvage logging from one study in the Southwest. This study found several species that increased post-fire (hairy woodpecker, three-toed woodpecker, olive-sided flycatcher, mountain bluebird, western wood-pewee, house wren and red-breasted nuthatch), but only a few species that were more abundant in unburned forest (pygmy nuthatch, hermit thrush and mountain chickadee).

Direct and Indirect Effects

Alternative 1

Pygmy nuthatches may prefer unburned forest and are more abundant there; however, ponderosa pine forests characterized as high mortality and part of the mixed-high mortality may provide limited habitat. These stands would continue to provide foraging and nesting habitat until snags fall. In the long run, forest recovery may be hampered by future ground fires igniting the heavy ground fuels that would accumulate once the current snags fall. Under these conditions, any forest development since the Warm Fire would again be lost to fire.

Alternatives 2-4

Pygmy nuthatches may prefer unburned forest and are more abundant there; however, ponderosa pine forests characterized as high mortality and part of the mixed-high mortality may provide limited habitat. Salvage in these areas would reduce the number of snags but mitigation to retain snags and the remaining large areas of standing dead trees that would not be harvested would provide an abundance of snags one or more orders of magnitude above estimated levels within the HRV.

Planting of seedlings in large areas previously occupied by ponderosa pine and mixed conifer along with natural regeneration would benefit pygmy nuthatches. Planting will reduce the amount of time needed to recover forest conditions needed by the nuthatch (see table 25 for predicted VSS in 2047).

Because of the abundance of snags in the project area (see table 38); the fact that under half of the high and mixed-high mortality areas proposed for salvage; that snags and downed logs would be left above forest plan direction in the areas that are proposed for salvage; and that retention would focus on clusters of the largest diameter snags available (thus increasing longevity), species associated with snag and logs would have these features available until they fall, rot or burn.

Cumulative Effects

Past treatments and residual vegetation influenced how the fire burned through the area. Other projects in the area have or would remove hazard trees, which will not have cumulative effects because only dead trees are removed. An additional 1,600 acres are to be planted in the project area. If successful, this along with proposed plantings, may shorten the recovery time. The difference would be so slight that modeling would not predict a significant difference. Therefore, implementation of any of the action alternatives would not contribute cumulative effects to this species or its habitat.

Statement of Findings

All of the harvest would be of dead trees in areas that burned with high and mixed-high mortality; these areas are no longer providing the habitat that they provided pre-fire. Currently 27 percent of the WFR project area is stocked with ponderosa pine which is 7 percent of GA 13. The action alternatives will increase this level to 36 percent in 2047 while the no action alternative will only increase to 28 percent with natural regeneration (see table 25). This will be only a slight increase at the GA 13 level.

In summary, although pygmy nuthatch populations appear to be stable to declining on the forest (Bratland et al. 2008), and ponderosa pine habitat is continuing to become further degraded from unsustainable changes in forest conditions from both fire suppression and large-scale high severity crown fires, the action alternatives are not affecting unburned habitats (primary habitat) in the short term and may actually decrease the recovery time, which may actually increase it slightly in the long term. The action alternatives **would not cause measurable changes to species habitat or population trends** on the project area, across GA 13, or at the forest level.

Red-naped Sapsucker

One study found that aspen snag longevity showed an initial period of relative stability for approximately 5 years after death. Afterwards, the probability of fall-down increased with the greatest fall-down occurring between 10 and 20 years after death (Lee 1998).

Under all alternatives, it is predicted that approximately 4,800 acres of the project area will regenerate to aspen naturally. Aspen will increase across the project area, regardless of alternative from 3 percent currently to 22 percent in 2047 (see table 25). Aspen is projected to increase from the current 1,085 acres within the WFR project area to 8,051 acres by 2047.

Direct and Indirect Effects

Alternative 1

While fire behaves differently in aspen than in coniferous forests, forest recovery may be hampered by future ground fires igniting the heavy ground fuels load and burning any re-growth since the Warm Fire.

Alternatives 2-4

Restoration will be the same for aspen as alternative 1 (see above). In the short term, salvage equipment would have an affect upon a limited percentage of the project area and some of this will impact aspen regeneration. Young trees could be killed from equipment tires or tracks and trampled during tree felling. Unlike coniferous species which sprout solely from seed, aspen can also regenerate from below ground systems so impacts are expected to only delay tree development. Nevertheless, the project was designed to decrease the risk of salvage operations disturbing natural regeneration. Project design features include requirements for most equipment to be on skid trails, while feller-bunchers may make a single entry off of skid trails. There would be a minimum distance of 100 feet between skid trails. The area in landings and skid trails will be limited to only 10 percent of the salvage units. Over the long term it is not anticipated that the mortality experienced by aspen shoots will affect aspen distribution (restoration) across the project area.

Cumulative Effects

The projected increase in aspen with all alternatives is from 5 percent to 37 percent at the GA 13 level (using current GA 13 aspen levels). Since aspen reproduction is stimulated by disturbance, any negative effects of mechanical harvest will be short term and is not projected to decrease stocking in the future. Past treatments and residual vegetation influenced how the fire burned through the area. Post-fire followup actions (hazard tree removal, planting, etc.) had similar effects as this project would have (i.e. damage to aspen sprouts). Other vegetation treatment projects are located outside of the analysis area, but would likely result in increased aspen where competing conifers are reduced. No negative cumulative effects to this species or its habitat would result from the action alternatives.

Statement of Findings

In summary, although red-naped sapsucker populations are likely decreasing on the forest due to loss of aspen (Bratland et al. 2008), aspen habitats in the project area will increase and provide a significant portion of the GA 13 habitat. As habitat quality of aspen in other parts of GA 13 continue to decline due to competition with and shading from conifer, aspen habitats in the project area will become increasingly important. Aspen habitat will continue to increase across

the project area and will contribute to maintaining red-naped sapsucker habitat. The action alternatives would not cause measurable changes to species habitat or population trends on the project area or across GA 13 or across the forest.

Mexican Spotted Owl

The MSO and it critical habitat was discussed in detail in the "Threatened and Endangered Species" sections in both the "Affected Environment" and the "Environmental Consequences" sections. Neither the NKRD nor the Grand Canyon National Park has ever detected any MSO in the forest from on top of the Kaibab Plateau.

Both the MSO and red squirrel are MIS which represent late-seral mixed conifer and spruce-fir. The possible direct and indirect effects of the WFR were discussed for the red squirrel and areas discussing mixed conifer and spruce-fir are applicable here (see section on red squirrel for greater detail).

Based on the analysis, the action alternatives would not affect existing mixed conifer or spruce-fir habitat. All of the harvest would be dead trees in areas that burned with high and mixed-high mortality and are no longer providing the habitat that they provided pre-fire. Planting may benefit the MSO by increasing mixed conifer cover types at a faster rate than would occur without planting. However, it will take many decades for these stands to provide mature forest conditions. Because of the length of time needed to develop mature forest, and the potential for natural events (drought, insect and disease, wildfire) that could affect the length of time, the action alternatives **would not cause measurable changes to species habitat or population trends on the project area,** within GA 13, or within the forest.

Other Species

Bison

The project area is not included in the area permitted for use by bison. However, they may be drawn into the area by the available forage and find access through fences damaged by the fire. This area is part of a cattle grazing allotment, and is currently being rested for at least 2 years post-fire. Fences will be repaired prior to resumption of livestock grazing. While the fire improved foraging habitat for bison, if they are observed in the area they will be moved. The action alternatives would not cause measurable changes to species habitat or population trends.

Bat Species

Availability of tree cavities and crevices in and under bark would be affected by salvage. Because of the abundance of snags in the project area, the fact that only portions of the high and mixed-high mortality areas are proposed for salvage, and that snags would be left above forest plan direction in the areas that are proposed for salvage (see table 49), species associated with these features would have these features available until they fall, rot or burn. The Warm Fire had a higher fire severity than what was expected under historic fire regimes (see "Fuels" section). Therefore, an influx of snag habitat at this scale cannot be considered a natural event.

Ponderosa pine bark generally stays attached to the tree for a limited period of time (depending on fire intensity on the individual tree, weather, age and condition of the tree prior to the fire) and will continue to provide habitat until the bark falls off or the tree falls. All alternatives would

maintain suitable snag and bark habitat for these species in the project area. The degree of available habitat for tree (snag) bats would vary by the amount of proposed salvage in each alternative.

Bat densities would, in general, have a direct correlation with the amount of salvage logging conducted. How the salvage operations are laid out and the patterns in which snags are retained will also determine overall impacts to bat species. The action alternatives **would not cause measurable changes to species habitat or population trends** on the project area or across GA 13.

Statement of Findings

Alternative 1 would maximize roosting habitat for these species. In alternatives 2-4, not entering over half of the high and mixed-high mortality areas, as well as no harvesting in areas over 20 percent slope, leaving stream buffers, leaving buffers along "green forest" edges, and not harvesting in the roadless area will retain snags well above historic levels. Selection of clumps of larger diameter snags for retention will further maximize benefits to forest bats after project implementation. Implementation of any of the action alternatives **may impact individual bat species and/or their habitat, but would not likely contribute to a trend toward Federal listing or cause a loss of viability to the population or the species**.

Neotropical Migratory Birds

As outlined in the memorandum of understanding (MOU) between the Forest Service and the U.S. Fish and Wildlife Service signed in 2008, any possible effects from this project on migratory birds will be evaluated. Response of migrant birds to salvage harvest depends on their individual habitat preferences and needs. A study in Montana found that fire severity and time since the fire greatly influenced bird species abundance (Smucker et al. 2005). This same trend was found in a study in New Mexico (Kotliar et al. 2007). Priority species identified by Arizona Partners in Flight (Latta et al. 1999) were shown in table 43. Applicable habitat management recommendations from the literature and forest plans guidelines used to address them are shown in table 50.

Table 50. Applicable habitat management recommendations and how they are addressed

Habitat	Applicable Habitat Management Recommendations	How Recommendations are Addressed
Ponderosa pine	Manage for >2 snags per acre in pine cover types and promote longevity of snags.	All alternatives would leave more than 2 snags per acre in pine cover types (direction is 3-5 snags per acre), focusing on retention of clusters of snags of the largest diameter available.
Mixed conifer	Olive-sided flycatchers use post-burn areas and areas of insect infestations. Salvage logging should retain the tallest trees.	No live trees would be removed and snag retention guidelines call for leaving existing clusters of the largest diameter snags available. They should also be the tallest.
Aspen	Support management that promotes aspen regeneration.	Aspen will increase across the project area under all alternatives.

Direct, Indirect, and Cumulative Effects

The project was designed to meet forest plan guidelines and applicable management recommendations cited above. There is the potential for loss of individual nests with eggs or nestlings if salvage occurs during the breeding season even with the implementation of project design features. The trees to be salvaged are dead; therefore, effects would be restricted to those species that nest in or on dead trees or ground nesters. The priority species identified by PIF that are cavity nesters include the cordilleran flycatcher, purple martin and red-naped sapsuckers, which could be affected if harvest occurred during the breeding season.

Unintentional take will be mitigated by restricting salvage to less than 43 percent of the high and mixed-high mortality areas in alternative 2 and smaller treatment areas for alternatives 3-4. Only acres of high and mixed-high mortality areas are proposed for salvage. Alternative 3 includes more specified winter harvest and has the least potential for effects to cavity nesting species. Alternative 2, which would potentially have the greatest effect would treat 9,114 out of a total of 252,691 acres of ponderosa pine, mixed conifer, and aspen for GA 13 (all of the conifer type on the NKRD). These species have a much larger distribution than GA 13. There could be unintentional take of individuals. The scale of the salvage proposals (5,541 to 9,114 acres or 11 to 19 percent of the Warm Fire habitat) retaining 89 to 81 percent of 48,062 acres of habitat within the Warm Fire area makes it unlikely any of the action alternatives would affect forest-wide habitat or population trends.

Consistency with Regulatory Framework

Endangered Species Act of 1973, as amended 1978, 1979, 1982, and 1988 (16 U.S. C. 1531)

This act provides direction to the Forest Service to establish objectives for habitat management and recovery through the forest plan for the conservation and protection of endangered and threatened species. This project is consistent with the forest plan and is, therefore, consistent with these guidelines. A list of federally listed species was developed from the hazard tree removal environmental assessment (USDA Forest Service 2007a) and checked with the USFWS list for Coconino County (www.fws.gov/Southwest/es/arizona).

An analysis of effects on Regional Forester Sensitive Species was conducted and documented in a biological evaluation (see project record) and discussed in chapter 3 of this analysis. An initial analysis of effects on listed species is noted under the “Wildlife” section in chapter 3. A biological assessment has been prepared, and consultation with the USFWS has been completed prior to a decision on this project.

Neotropical Migratory Birds Executive Order #13186 (January 10, 2001)

“Responsibilities of Federal Agencies to Protect Migratory Birds” requires including effects of Federal actions on migratory birds as part of the environmental analysis process.

Kaibab National Forest Land and Resource Management Plan

The Kaibab forest plan includes forest-wide direction for management of Mexican spotted owl habitat, northern goshawk habitat and old growth. This direction was incorporated into development of the alternatives. There has been no use of the area (and NKRD) by Mexican spotted owls, but restricted habitat (designated critical habitat) was mapped prior to the fire.

Stands to be salvaged no longer provide primary constituent elements. Goshawk direction was incorporated into the project. Snag retention levels were set to provide more than an adequate numbers of snags and vary based on vegetation present prior to the fire (ponderosa pine vs. mixed conifer).

There is also direction specific to the GA. Most of the project area (36,041 acres or 92 percent) is in GA 13, which is a suitable timber area. Standard No. 2 calls for the identification of habitat management areas for threatened, endangered or sensitive wildlife species (Forest Plan, pg. 44).

Standards No. 9 and 10 provide direction on wildlife analyses for TES species. These standards have been met through project design, alternative development, and effects analyses.

Approximately 8 percent of the project area lies in GA 16, which includes the Buffalo Ranch and is primarily pinyon-juniper. No salvage actions are proposed in the part of the Warm Fire that lies in GA 16. A small portion of this GA has been identified for reforestation planting activities. This is consistent with this GA, as it emphasizes wildlife habitat, with management of the timber resource to protect and enhance wildlife habitat and watershed values.

Grand Canyon National Game Preserve (GCNGP)

Section 1 of the Grand Canyon Game Preserve Act states “the Reserve should be set aside for the protection of game animals and be recognized as a breeding place therefore.” The only additional duty imposed by the act is in section 2: to protect game animals from trespass, namely: “hunting, trapping, killing, or capturing of game animals upon the lands of the United States within the limits of said areas shall be unlawful, except under such regulations as may be prescribed from time to time by the Secretary of Agriculture, which may not interfere with the operation of local game laws.” The Kaibab forest plan was developed within this framework. It incorporates the Grand Canyon Game Preserve Act goals by attempting to create sustainable forest conditions that mimic the HRV (i.e., trees spaced in groups and clumps defined by surrounding openings, an emphasis on retaining large trees with associated logs and snags, and an interspersion of tree age classes to support this approach through time). The resulting structure provides a range of habitats for game species, including turkeys, squirrels, and deer that is sustainable through time in the context of a fire-adapted ecosystem. This project implements the forest plan direction.

The EIS for the forest plan noted that neither the law authorizing the establishment of the preserve, nor the Secretary’s regulations applying to preserves guide wildlife habitat management or other resources in the area. The Forest Service and Arizona Game and Fish Department (AZGFD) have agreed to allow hunting on lands managed by NKRD, and management activities are designed to maintain huntable populations of game animals where possible. The entire project area is within the GCNGP and these areas would continue to provide breeding places for huntable species.

While the Warm Fire itself dramatically altered the landscape, subsequent salvage would have little effect on mast, ground cover, and young aspen stems, important for a variety of game species (i.e. mule deer, turkeys and rabbits). Mature forest and associated habitat components will be reduced for many decades by the fire, but this project would not affect remaining unburned areas. Mule deer are evaluated as a MIS for this project. Habitat for wild turkey and other game species is also evaluated as a project level MIS. Jackrabbits, cottontails, and coyotes will not be affected by salvage operations. Based on the analysis for these species, the action alternatives

would not affect existing suitable habitat or affect species distribution on the project area or across the NKRD. The action alternatives would speed the recovery of game habitat by reducing the risk of higher intensity fire over the long term and establishing ponderosa pine trees in selected areas that are distant from natural sources. Therefore, the proposed alternatives are consistent with the intent of the GCNGP Act.

Kaibab Squirrel National Natural Landmark (KSNNL)

National natural landmarks (NNLs) are areas representing the best examples of the ecological and geological features composing our Nation's natural history. A NNL is a nationally significant natural area that has been designated by the Secretary of the Interior. In 1965, the Kaibab Squirrel NNL was designated because of the public interest in the Kaibab squirrel as a unique mammal (Kaibab squirrels were thought to be a distinct species at the time, but current science no longer supports a distinct species and their status has since been changed to subspecies of tassel-eared squirrel), extensive mature to old-growth ponderosa pine stands and because of the history of the North Kaibab's deer herd. The KSNNL consists of approximately 278,000 acres of pure ponderosa pine on the KNF and GCNP, with approximately 200,000 acres on the KNF.

Tables 51 and 52 show the acres proposed for salvage and planting and natural regeneration in the KSNNL.

Table 51. Acres salvaged in KSNNL

Alternative	Acres Salvaged
2	5,763
3	3,307
4	4,120

Table 52. Acres planted and regenerated in KSNNL under all action alternatives.

Cover Type	Acres
Mixed conifer	796
Ponderosa pine	6,379
Quaking aspen	2,684
Total	9,859

The KSNNL includes no specific management direction, but implementation of any of the action alternatives would improve habitat for the Kaibab squirrel over the long term and speed the development of late-seral ponderosa pine forest.

Kaibab squirrels are not associated with extensive stands of fire-killed trees and salvage would have no effect on live mature pines stands that still provide habitat. The action alternatives include planting and the associated fuels reduction, and will aid in managing sustainable, fire-adapted forests through time. This meets the intent of the area designation.