Chapter 3 – Affected Environment and Environmental Consequences

This chapter summarizes the physical, biological, social, and economic environments of the project area and the effects of implementing each alternative on that environment. It also presents the scientific and analytical basis for the comparison of alternatives presented here. Only summaries are provided for each resource and all resource reports are incorporated by reference. Most specialist reports will be available for viewing on the 4FRI Web site: http://www.fs.usda.gov/4fri. Those not on the Web site can be made available upon request.

Soils and Watershed

The soils specialist report (Steinke 2013) and water quality and riparian report (MacDonald 2013) are incorporated by reference. See the reports for detailed information including methodology, soil disturbance by treatment type, treatment area, and 6th hydrologic unit code (HUC) watersheds, the disturbed Water Erosion Prediction Project (WEPP) soil erosion modeling runs, soil interpretations by 6th HUC watershed, strata, and terrestrial ecosystem survey (TES) map units, and the data used to evaluate the cumulative effects to soil disturbances.

Affected Environment

Soils

Approximately 94 TES map units were aggregated into 17 strata (specialist report, appendix B). The aggregation of strata was based on similar soils and vegetation types with similar limitations, hazards, and production potentials to management activities. The strata were used in part to design treatments, analyze effects, and are based on the potential plant community (hereafter referred to as PPC) and capability of the soils. Short term for soils is considered 3 years (when leaf fall occurs) up to 10 years. Long term is considered greater than 10 years.

Soil Erosion

Forests generally have very low erosion rates unless they are disturbed. Common disturbances include prescribed fire, wildfire, and harvesting operations. Vegetative recovery after fuel treatments is generally very rapid, with erosion rates typically dropping to pre-fire levels within 1 to 2 years (Elliot et al. 2010). After that, the rapid regrowth of vegetation soon covers the surface with plant litter, and potential erosion is quickly reduced. In one study, Robichaud and Brown (1999) reported that erosion rates dropped from almost 40 Mg ha^{-1} (megagrams per hectare) the 1st year after a fire to 2.3 Mg ha^{-1} the 2nd, and 1 Mg ha^{-1} the 3rd year. If the year is normal or dry, then it is unlikely for there to be any significant erosion (Elliot 2000).

A (soil) tolerance soil loss rate is the rate of soil loss than can occur while sustaining inherent site productivity (TES 1995). Tolerable soil loss values are 2 to 4 tons per acre depending on soil type. Some steep slopes greater than 40 percent have soil inclusions with tolerable soil loss values equal to about 1 ton per acre, but the inclusions are generally minor in extent and generally occur on slopes that are less than 15 percent.

When soil loss exceeds tolerable amounts, soils erode faster than they renew themselves. This results in accelerated soil loss, loss of soil productivity, and delivers high amounts of sediment to connected stream courses. On slopes greater than about 40 percent, the TES identified tolerable limit is 2 tons per acre per year.

Soils in each TES ecological unit were assigned tolerance soil loss rates based on individual soil and climate properties and approximate annual soil renewability levels. Maintaining soil erosion below soil tolerance levels assures soil productivity will be maintained from an erosion standpoint.

Within the analysis area (988,764 acres), a total of approximately 133,850 acres (13 percent) are dominated by soils with severe erosion hazard. About 52,750 acres (5 percent) have soils dominated with moderate erosion hazard. Strata with slight erosion hazard equates to about 805,700 acres (81 percent). Resource protection measures are required to assure accelerated soil erosion and compaction do not impair soil productivity.

Most strata in the ponderosa pine type currently have closed stand structure (Steinke 2007ab, McCusker 2013, Lata 2013) with high canopy covers and densities that have reduced the understory forage productivity. However, there is generally sufficient vegetative ground cover to reduce accelerated erosion. Due to the closed stand structure, most strata have relatively high risk of crown fire that also pose a high risk of moderate or high burn severity to the watershed under normal or extreme fire behavior conditions as the current fire regime condition class (FRCC) in the analysis area is dominated by class 2 and 3 (see specialist report for 6th HUC watershed condition classification).

Soil Condition

Slopes Less than 40 Percent: Soil condition is satisfactory on about 841,500 acres (approximately 85 percent of the analysis area) due to the presence of high and adequate amounts of vegetative ground cover that protects the soil against accelerated erosion and compaction. The other 15 percent of the analysis area is dominated by impaired soils located on some montane meadows, and lesser amounts of inherently unstable/unsuited or unsatisfactory soils.

Although most soils rate out as satisfactory, nutrient cycling is reduced and soil conditions are close to being impaired in dense stands including those in Fire Regime Condition Class (FRCC) 2 and 3. In these areas, the amount of coarse woody debris (CWD) is not quantifiable.

Slopes Greater than 40 Percent: Soil condition on approximately 30,000 acres (strata 42, 43, 47, and portions of 44 and 45) is unsuited or inherently unstable where natural erosion exceeds tolerable erosion. These soils and strata are not suitable for mechanical timber harvesting and identified BMPs would need to be used to protect the soil resource when using prescribed fire.

Montane Meadows: Soil condition on slightly more than 50 percent of the montane meadow acres (strata 1, 2, 4, 6, and 10) are impaired on the Coconino NF and listed as satisfactory on the Kaibab NF (about 44,476 acres). However, it is probable that the soil condition in these montane meadows is impaired on the Kaibab NF. Soil condition in montane meadows located in strata 3, 5, 7, and 8 (about 38,744 acres) is satisfactory.

Wetlands: Strata 9 are wetlands where soil condition is rated as unsatisfactory on the Coconino NF. Most wetlands on the Kaibab NF are fenced to exclude livestock grazing in wetlands. Wetland soils on the Kaibab NF are generally impaired as a result of elk bedding and browsing (about 4,400 acres).

Pinyon-Juniper: Soil condition on pinyon-juniper vegetation types on slopes less than 40 percent (strata 46, about 1,000 acres) is variable and has areas of satisfactory, impaired, and a few areas

of unsatisfactory soil condition. Impaired and unsatisfactory soil conditions generally have overstocked tree canopy, resulting in poor herbaceous understory composition and productivity, poor nutrient cycling function, low vegetative ground cover, and accelerated erosion.

Soil Classification

Soil classification varies by strata (see soils report, appendix B) and is dominated by forest soils in the Alfisol order (boralfs suborder), and grassland soils in the Mollisols order (borolls suborder), and ponderosa pine forests strata where stand density has drastically increased.

Based on soil type and field observations of tree canopy cover (which is variable but commonly exceeds 30 to 50 percent, a closed canopy state), age class, and old stump presence, mollisols (especially deep ones) probably historically supported grassy interspaces or open canopy covers (10 to 30 percent) and mollic integrade soils probably supported somewhat closed stands (slightly greater than 30 percent) on rocky or shallow soils and open stands on moderately deep and deep soils. See the specialist report for detailed soils information and a Coconino NF (Steinke 2007a) and Kaibab NF (Steinke 2007b) study on mollisol and mollic-integrade soils.

Watershed

Watershed Function

The project lies within 82 6th code watersheds (see appendix C of the soils report). Fifth and 6th HUC names, watershed condition class, and acres within and outside of the proposed treatment area (alternative B) are listed. The watershed condition framework (WCF) protocol (USDA 2010b) was used to classify watershed conditions at the 6th HUC level in the spring of 2011 using 12 watershed indicators. The term "analysis area" refers to the larger 988,764-acre boundary.

Overall, the ponderosa pine vegetation type is dominated by functional at-risk 6th HUC watersheds. This includes about 451,500 acres (46 percent of the analysis area) and about 1,214,339 acres, or about 59 percent of the entire 6th HUC acreage associated with the project acres. There are several impaired watersheds, about 316,800 acres (about 32 percent of the analysis area) and about 458,391 acres, or about 22 percent of the entire 6th HUC acreage associated with the project acres. There are a few properly functioning watersheds about 220,400 acres (about 22 percent of the analysis area) and about 394,285 acres, or about 19 percent of the entire 6th HUC acreage associated with the project acres. Functioning condition was defined using 12 indicators to assess watershed condition through the WCF (USDA 2011). Watershed dysfunction in the treatment area is a result in large part from dense forests with FRCC 2 or 3, high density of road networks that can alter hydrology, road proximity to stream courses, and riparian condition less than functional and other factors.

The following 5th HUC watersheds have few to several 6th HUC watersheds in the impaired function condition class totaling at least 33 percent of total 5th HUC area: Cataract Creek Rio de Flag, Spring Valley, Sycamore Creek, Upper Cedar Wash, and Walnut Creek. See appendix C in the specialist report for detailed condition class by 6th HUC watershed and acres.

Water Quality and Quantity

The Arizona Department of Environmental Quality (ADEQ) 2006/2008 Impaired Waters List indicates there are no impaired streams within the project area. However, a segment of Oak Creek

that is located approximately 0.25 mile outside of the project boundary and downstream of proposed treatment areas has been listed as impaired in the ADEQ 2006/2008 305(b) assessment report for two exceedances of the *Escherichia coliform* (E. coli) single sample maximum (SSM) water quality standard.

The ADEQ identified Upper and Lower Lake Mary as impaired for the presence of mercury in fish tissue. Although Upper and Lower Lake Mary are designated as domestic water sources, the levels of total mercury observed do not approach drinking water maximum contaminant levels. In 2002, the EPA added five lakes in the Lake Mary Region (LMR) to Arizona's 303(d) List as impaired for mercury in fish tissue. These lakes included Upper and Lower Lake Mary, Soldiers, Soldiers Annex, and Lower Long Lakes and are all within the project area (ADEQ 2006, 2008).

Water yields from the ponderosa pine vegetation type are likely reduced from historic conditions due to increased stand densities that result in higher evapotranspiration rates.

Stream Courses

Approximately 2,197 miles of stream courses occur within the 988,764-acre analysis area, of which approximately 8.2 miles exhibit perennial flow. The three perennial stream segments within the analysis area include the Rio de Flag, Pumphouse Wash, and Sawmill Wash. Appendix B in the water quality specialist report lists stream reaches that occur within the analysis area and their associated lengths and flow regimes. The ephemeral stream courses are classified as intermittent in the National Hydrology Data.

There are approximately 77.5 miles of protected stream courses in the analysis area. These are areas where specific soil and water conservation practices (SWCP) and best management practices (BMPs) have been developed to prevent adverse impacts to stream courses (see the "Soils and Watershed" section of appendix C). Appendix G in the specialist report provides a list of the protected stream courses within the analysis area, their associated functional condition classes and lengths, and a map of the locations.

Riparian stream segments occur along 92.6 miles of streams within the analysis area. Of these, approximately 85.1 riparian miles (91 percent) occur on the Coconino NF and 7.5 riparian miles (9 percent) occur on the Kaibab NF. Appendix C in the specialist report provides a list of riparian areas by stream reach or name and their associated conditions within the analysis area. Within the analysis area, approximately 47.5 miles of streams are in proper functioning condition, 38.6 miles are functioning at risk, and 6.6 miles are nonfunctional.

Wetlands, Riparian Areas, Springs, Flood Zones, and Road Influences

There are 66 natural lakes, reservoirs, and natural wetland depressions within the analysis boundary that impound water for a sufficient duration to exhibit some wetland characteristics; therefore, they are listed in the U.S. Fish and Wildlife Service (FWS) National Wetlands Inventory database. See table 1 in appendix C of the water quality and riparian report for the list of riparian stream reaches in the analysis area, their associated lengths, and size and condition rating. Tables 1 and 2 in appendix D of the specialist report lists wetland habitats and their associated condition ratings.

There are approximately 145 springs located within the analysis area. Information regarding historic flow or water quality from these springs is minimal. Many springs exhibit downward

trends or static-degraded conditions (MacDonald 2011). See the "Springs" section in chapter 1 for existing and desired condition information and appendix D in the specialist report for spring assessment information.

There are approximately 986,509 acres within the analysis area that are categorized into various flood zone types. See the specialist report for additional information.

Many roads in the analysis area are inadequately engineered or poorly located on the landscape and are consequently in a state of disrepair. See the "Transportation" section in chapter 1 for additional information on existing and desired road conditions.

Environmental Consequences

Soils and watershed environmental consequences are presented in both narrative and table format.

Soils and Watershed

Alternative A – Direct and Indirect Effects

According to the fire specialist report (Lata 2013), about 33 percent of ponderosa pine forest vegetation could burn under high-burn severity conditions. This varies slightly from WEPP soil erosion modeling, which indicated approximately 24 percent of all soils left untreated could be subject to soil erosion above tolerable levels from severe wildfires where all soils burned under a high burn severity condition. Based on recent wildfires, 33 percent is a good and approximate average of high-burn severity in wildfires from a watershed burn severity standpoint.

Therefore, if a 1,000-acre fire were to occur within the analysis area, approximately 200 to 300 acres of high-intensity fire could negatively affect soil properties. High-burn severity from Lata 2013 is an assessment of overstory vegetation and for this soil assessment, high severity is based on the vegetative ground cover present since that is what controls the runoff and watershed condition.

Assuming about 33 percent of wildfires would result in high-burn severity; about 8 percent of all soils in the approximate 595,000 treatment area could result in soil erosion above threshold levels resulting in loss of soil surface and soil productivity (table 32).

An increase in coarse woody debris (CWD) well above the forest standard of 5 to 7 tons per acre in ponderosa pine could contribute excessive ground fuel loads that would burn at high temperatures resulting in mineralization of surface soil horizon and organic matter where about 50 percent of soil nutrients are stored, sterilization, loss of ground cover, and hydrophobic soil conditions. Subsequently, post-fire storm events could result in removal of surface soil at an accelerated rate, loss of soil productivity, and sediment delivery into connected stream courses.

Implementation of alternative A would not increase forest resiliency to natural disturbances and would not improve soil or watershed function as well as all other action alternatives would. Implementation of alternative A would put the majority of soils and watersheds at risk of continued uncharacteristic wildfire effects that could result in loss of soil productivity and sediment delivery to connected stream courses. It does not meet the purpose and need for the project, as it would not move the project area toward soils (soil function/productivity and

understory species), watershed or vegetation (forest structure, forest health, composition, and diversity), and fire behavior desired conditions.

Alternative B – Direct and Indirect Effects

Mechanical activities would not result in any soil loss above tolerable levels according to WEPP modeling. However, prescribed fire effects could result in potential soil erosion above tolerable levels on up to about 2 percent of mechanically, untreated slopes. Slopes greater than 40 percent are proposed for low-intensity prescribed fire only treatments (table 32).

Mechanical treatment and prescribed fire would increase understory response and reduce wildfire threat on about 388,500 acres. Using prescribed fire only on about 199,400 acres would decrease wildfire threat and improve soil condition and productivity. Overall, soil productivity would be improved and maintained on about 587,923 acres (table 33).

Alternative B would improve watershed conditions in 23 percent of the functioning at risk and 42 percent of the impaired watersheds (table 34). In addition, alternative B would decommission 496 miles of road in functioning at-risk watersheds, and decommission 226 miles of roads located in impaired function watersheds. Stream channel treatments would improve waterflow regime on 19 miles of functioning at-risk watersheds and 9 miles in impaired watersheds.

Alternative C – Direct and Indirect Effects

Mechanical activities would not result in any soil loss above tolerable levels according to WEPP modeling. However, prescribed fire effects could result in potential soil erosion above tolerable levels on up to about 2 percent of mechanically, untreated slopes. Slopes greater than 40 percent are proposed for low-intensity fire only treatments (table 32).

Mechanical treatment and prescribed fire would increase understory response and reduce wildfire threat on about 434,000 acres. Using prescribed fire only on about 159,200 acres would decrease wildfire threat and improve soil condition and productivity. Soil productivity would be improved and maintained on about 593,211 acres (table 33).

Alternative C would slightly improve watershed conditions on 23 percent of the functioning at risk and 42 percent of the impaired watersheds (same as alternative B) due to fuels reduction and improved soil productivity from treatments (table 34). Roads and stream channel related effects are the same as described for alternative B.

Alternative D – Direct and Indirect Effects

Mechanical activities would not result in any soil loss above tolerable levels according to WEPP modeling. However, prescribed fire effects could result in potential soil erosion above tolerable levels on up to about 2 percent of mechanically, untreated slopes. Slopes greater than 40 percent are proposed for low-intensity fire treatments with no mechanical thinning (table 32).

Mechanical treatment and the use of prescribed fire only would increase understory response and reduce wildfire threat on about 388,500 acres (table 33). However, about 25 percent of those treated acres would be subject to high-severity surface fire effects that can compromise long-term soil productivity. The prescribed fire only treatment on about 179,000 acres would decrease

wildfire threat and improve soil condition and productivity. Overall, soil productivity would be improved and maintained on about 470,148 acres.

Alternative D would move toward improved watershed function in 8 percent of the functioning at-risk watershed and within 34 percent of impaired watersheds (table 34). Roads and stream channel related environmental consequences are the same as described for alternative B.

Water Quality and Water Yield

Water quality units of measure are: (1) acres of soil disturbance that exceed tolerance thresholds, (2) acres subjected to high-severity burn, (3) acres of ephemeral stream courses restored, and (4) number of springs restored. The units of measure for water yield are: (1) increases in streamflow as measured at downstream gaging stations and (2) increases in snowpack retention as measured at SNOTEL sites and snow courses. For this analysis, short term equated to 1 to 2 years and long term is 5 years or more.

Alternative A

There would be no direct changes to surface water quality. Adverse effects to water quality, quantity, and riparian condition are possible from high-severity wildfire. There would be potential to increase flood flows of sediment and debris-laden storm water in stream courses within and downstream of burned areas. These conditions would adversely affect riparian areas along stream courses through deposition of large amounts of sediment and debris with the potential to damage or overwhelm riparian systems.

Water yield originating from the ponderosa pine vegetation type would continue to decline as a result of forest ingrowth that increases stand density. Increased stand density would result in a corresponding increase in interception of precipitation and evapotranspiration by trees, both of which would reduce soil moisture.

Alternative B

Minor, short-term changes (1 to 2 years) in water quality are possible in water bodies adjacent to or downstream from mechanical vegetation treatments, areas subjected to prescribed fire, areas of temporary road construction and decommissioning, and where stream channel restoration activities are conducted. Long term (5 or more years) surface water quality is expected to improve through more resilient forest conditions that minimize uncharacteristic fire behavior, and through improved vegetative ground cover that minimizes soil erosion and sediment transport to connected stream courses and other water bodies. Since soil disturbance at the 6th HUC level would average 3.3 percent and range from 0.1 to 11.2 percent (Steinke 2013), adverse effects to water quality would be minimal. Protective fencing around springs would improve surface water quality at the individual spring scale. BMPs and SWSCPs as outlined in appendix C of the DEIS would minimize or mitigate most adverse effects to water quality or riparian areas.

Water yield would be expected to increase only slightly in areas where vegetation treatments remove from 25 to 50 percent of the overall tree canopy cover within a given watershed (Troendle et al. 2001, Burton 1997, Swank 1989, Baker 1999, 2003, Ffolliott et al. 1989, Miller 2007). Snow interception by tree canopies would be reduced, leading to increased snowpack in forest openings.

Table 32. Alternatives A–D soil disturbance and erosion by treatment area and aggregate of 6th code watershed by alternative

Indicator	Acres by Alternative				Percent of Treatment Area by Alternative				Percent of 6th Code Watershed by Alternative			
	A	B	C	D	A	B	C	D	A	B	C	D
Soil disturbance from mechanical activities (%)	0	49,238	54,495	49,238	0	8.4	9.2	8.7	0	2.4	2.7	2.4
Soil disturbance from potential high-severity burns (%)		11,758	11,863	3,576	0	2.0	2.0	0.6	0 to 33	0.6	0.6	0.2
Total soil disturbance (high-severity burns and mechanical)		60,995	66,358	52,814	0 to 33	10.4	11.2	9.3	0 to 0.1–31.2	3.0	3.3	2.6
Soil disturbance from mechanical activities and high-severity fire (range: low to high)					NA	0–18.2	2.2–19.4	0.1–14.1	NA	0–11.0	0.1–11.2	0.1–9.6
Potential soil erosion above tolerable soil loss values when 33% is burned in high-severity fire (%)		0	0	0	8	Up to 2	Up to 2	Up to 2	2	0	0	0
Potential soil erosion above tolerable levels when 100% are severely burned		0	0	0	24	Up to 2	Up to 2	Up to 2	5	0	0	0

Table 33. Soil condition and productivity environmental consequences by alternative

Improvement, Maintenance, and Protection of Soil Condition, Function, and Productivity	Alternative A	Alternative B	Alternative C	Alternative D
Acres treated for improvement, maintenance, and protection of soil condition and productivity	0	587,923	593,211	470,165
Increased herbaceous understory productivity (acres)	0	388,500	434,000	388,500 acres with 97,125 acres subject to high-severity surface fire effects that pose risk to long-term soil productivity.
Decreased fire threat, improved soil condition, and long-term productivity protected (acres)	0	587,923	593,211	470,165

Table 34. Comparison of effects to watershed function by alternative

Effects	Alternative A	Alternative B	Alternative C	Alternative D
Hazardous fuel reduction acres resulting in improvement, protection, and maintenance of soil condition and productivity (acres)	0	587,923	593,211	470,148
Potential for high-severity burns (acres/percent within treatment area)	200,000/34%	23,000 to 41,000/4 to 7%	Same as alternative B.	Short term: 23,000–41,000/4–7% potential for crown fire with surface fire intensity similar to alternative A on about 25% of mechanical treatment acres. Long term: 50% revert to FRCC 3.
Ephemeral stream restoration (miles)	0	39 miles of improvement: 19 miles in functioning at-risk watersheds, 11 miles in functioning proper	Same as alternative B.	Same as alternative B.

Effects	Alternative A	Alternative B	Alternative C	Alternative D
		watersheds, and 9 miles in impaired function watersheds.		
Road and route decommission (miles)	0	904 miles decommissioned: 496 miles in functioning at-risk watersheds, 182 miles in functioning properly watersheds, and 226 miles in impaired function watersheds.	Same as alternative B.	Same as alternative B.
Overall change (improvement and maintenance) in watershed function (Existing condition is 22% functioning properly, 46% functioning at risk, and 32% impaired.)	None—high percentages of functioning at risk and impaired watersheds continue.	Improvement in 23% of functioning at-risk watersheds. (This would equal almost a quarter of the 46% that are currently functioning at risk). Improvement in 42% of impaired watersheds. (This would equal almost half of the 46% of impaired watersheds.) 496 miles of open road reduced/removed in functioning at-risk watersheds. 28 miles of improved waterflow regimes: 19 miles would occur in watersheds that are functioning at risk and 9 miles that would occur in watersheds that are currently impaired.	Improvement in 23% of functioning at-risk watersheds. (This would equal almost a quarter of the 46% that are currently functioning at risk). Improvement in 42% of impaired watersheds. (This would equal almost half of the 46% of impaired watersheds.) Roads and stream channels are the same as alternative B.	Improvement in 18% of functioning at-risk watersheds. Improvement in 34% of impaired watersheds. Roads and stream channels are the same as alternative B. Alternative D would not improve overall watershed condition as extensively as alternatives B and C.

Alternative C

Minor, short-term adverse effects to water quality are possible in water bodies within and adjacent to mechanical vegetation and grassland restoration treatment areas. Steinke (2013) estimates soil disturbance of 3.4 percent at the 6th HUC level and 10.9 percent across the treatment area. Overall effects to surface water quality would be similar to alternative B. BMPs and soil and water design features would minimize or mitigate most adverse effects to water quality or riparian areas.

More acres would receive mechanical vegetation treatments than alternative B and more trees would be removed from within Mexican spotted owl (MSO) protected activity areas (PACs) since trees up to 18-inch d.b.h. would be removed. Water yield would,therefore, be expected to be slightly higher than under alternative B since there would be more forest openings and less dense forest conditions. Snow interception by tree canopies would be reduced more under this alternative than under the proposed action, therefore, potentially increasing winter snowpack more than would occur under alternative B.

Alternative D

Soil disturbance that could adversely affect surface water quality is estimated to be 2.9 percent at the 6th HUC level (Steinke 2013). While alternative D would result in the lowest level of soil disturbance that could adversely affect surface water quality of all the action alternatives, alternative D would not meet the purpose and need of achieving resilient forest conditions that promote high surface water quality (through protection of forested ecosystems from uncharacteristic fire behavior). Additionally, restoration of natural fire regimes to fire-dependent landscapes and vegetation types would not occur under this alternative. BMPs and soil and water design features would minimize or mitigate most adverse effects to water quality or riparian areas.

Mechanical vegetation treatments would result in similar effects as alternative B. Since there would be fewer acres prescribed burned, there would be reduced potential for runoff and sediment delivery to stream courses under alternative D.

Summary of Effects for Water Quality: Ephemeral and intermittent drainages in the project area typically respond to seasonal runoff events (spring snowmelt and short duration, high- intensity summer monsoon storms). Surface runoff has the potential to entrain sediment and other pollutants, contributing to short term surface water quality degradation. Sediment delivery ratios normally decline with increasing watershed area, resulting in dilution of sediment delivered to streams from a given activity. It is unlikely that alternatives B, C, and D would contribute enough sediment or other pollutants to ephemeral or intermittent drainages within the project area to result in impairment of any downstream waterbodies.

Springs, Riparian, and Wetland Condition

The units of measure for springs are: (1) initiation of spring discharge from springs that currently do not flow and (2) increases in spring discharge from currently flowing springs following restoration treatments. The units of measure for riparian and wetland condition are: (1) changes to the extents of riparian areas and (2) changes to riparian vegetative communities.

Alternative A

There would be no changes to spring condition. Reduced riparian area and wetland function would be possible. Ongoing reductions in water yield from the ponderosa pine vegetation type would decrease moisture reaching riparian areas since spring discharge rates would be further reduced and water would not reach stream courses or recharge shallow or perched aquifers.

Alternative B

Spring conditions would improve for up to74 springs. Vegetation treatments at the watershed scale combined with prescribed fire could restore or improve hydrologic function of springs that currently have reduced discharge due to evapotranspirational losses of soil water which could otherwise recharge groundwater in perched or shallow aquifers. Riparian and wetland function are expected to improve through increased groundwater recharge and improved surface flows. Decommissioning of roads that have altered flow patterns through increased drainage density (i.e., road ditches that intercept water and lead-out ditches that discharge concentrated ditch flow onto the forest floor) or redirected storm water runoff (i.e., roads and ditches that intersect stream courses and discharge storm water runoff directly to stream courses) would improve overall watershed hydrology, thus improving waterflow to riparian ecosystems. Spring restoration would improve riparian vegetation communities. Restoration of grassland ecosystems through removal of encroaching trees would improve hydrologic function in meadow ecosystems, potentially increasing riparian vegetation in these areas.

Alternative C

In alternative C, riparian and wetland function are expected to improve slightly more than under alternatives B and D since more acres would receive mechanical vegetation treatments than alternative B and more trees would be removed from within MSO PACs since trees up to 18-inch d.b.h. would be removed. More acres would be subjected to low severity prescribed fire, decreasing rainfall interception and evapotranspirational losses. Groundwater recharge and storm water runoff would be slightly higher than under alternatives B and D. Decommissioning of roads that have altered flow patterns or redirected storm water runoff would have the same effect as alternative B. Restoration of 74 springs would improve riparian vegetation communities in these areas. Since more acres of grassland would be restored under alternative C than alternative B, there is increased potential for improvement in riparian ecosystem function where wetland or riparian species occur in restored grasslands.

Alternative D

In alternative D, riparian and wetland function are expected to improve, but to a lesser degree than under alternatives B and C since fewer acres would be subjected to prescribed fire which would otherwise reduce vegetative cover and, therefore, rainfall interception and evapotranspirational losses. Decommissioning of roads that have altered flow patterns or redirected storm water runoff would have the same effect as alternative B. Restoration of 74 springs would improve riparian vegetation communities in these areas. Restoration of grassland ecosystems would have the same effect as alternative B.

Forest Plan Amendments

Alternative B and D

Coconino NF

Amendment 1 would result in removal of more trees in 18 MSO PACs since trees up to 16-inch d.b.h. could be removed in these areas. Removal of additional trees would improve vegetative ground cover over the long term by increasing light interception at the forest floor and providing conditions conducive to the establishment of a more vigorous understory of grasses, forbs, and shrubs. Increased vegetative ground cover would improve soil stability by reducing soil erosion rates. Reduced stand densities would also provide for improved protection of treated areas from the effects of high-severity fire, further improving overall soil stability and watershed conditions. Reduced evapotranspiration resulting from removal of trees up to 16-inch d.b.h. would likely improve soil moisture status. With implementation of measures outlined in appendix C of the DEIS, adverse effects to water quality and riparian function would be minimized. Overall, these effects would provide greater protection of water quality and riparian areas by reducing the potential for sediment delivery to stream courses and riparian habitats, improving soil moisture in upland areas, and improving snowpack retention in treated areas.

Without implementation of amendment 1, maintenance of soil productivity and, therefore, water quality and riparian conditions would not be to the level provided through implementation of the amendment. There would be 18 MSO PACs that would remain at risk of high-severity fire which could degrade soil stability and productivity increasing the risk of adverse effects to water quality and riparian function. Without implementation of this proposed amendment, soil productivity and watershed function, including downstream water quality, would remain at risk from high-severity wildfire and pose risk to the sustainability of PACs, core areas, restricted habitat, and threshold habitat. Deferring monitoring (and incremental treatment of habitat) of MSO to the FWS biological opinion would not affect water quality or riparian areas on the Coconino NF since no activities would occur that have potential to adversely affect these resources.

Amendment 2 would improve soils and watershed conditions on 29,017 acres within the Coconino NF since these treatment areas would be returned to open stand condition representative of historic or reference condition. The lower stand densities and increased interspaces would provide conditions conducive to the establishment of a more vigorous understory of grasses, forbs, and shrubs, thus providing greater soil protection than litter alone. The increased interspaces would likely improve snowpack retention and, therefore, soil moisture status. Lower stand densities would provide greater protection of soils and watershed resources in treated areas from the effects of high-severity wildfire. These conditions would improve water quality and riparian area conditions by reducing sediment delivery to stream courses and riparian areas.

Implementation of measures outlined in appendix C of the DEIS would minimize or mitigate any adverse effects to water quality and riparian function. Without implementation of amendment 2, approximately 29,017 acres on the Coconino NF would remain at an elevated risk of high-severity wildfire. If such a fire were to occur, surface water quality would likely be adversely affected through increased sediment deliver and turbidity. Sediment delivery to riparian areas could degrade riparian function.

Amendment 3 is intended to ensure that no adverse effects occur to significant, or potentially significant, inventoried heritage sites. By doing so, this amendment would improve soils and

watershed resources and, therefore, water quality and riparian area conditions by minimizing disturbance of these sites. While inventoried heritage sites comprise a relatively small proportion of each watershed, reduced ground disturbance would prevent destabilization of soils resources and, therefore, sediment delivery to stream courses and riparian areas. Implementation of BMPs and SWCPs that are designed to minimize or mitigate adverse impacts to soils and water quality would further prevent degradation of soil stability and productivity and, therefore, minimize adverse effects to riparian areas.

Without implementation of amendment 3, adverse effects to inventoried heritage sites and, therefore, soil stability could occur. If soils are destabilized, sediment delivery to connected stream courses and riparian habitats could occur.

Kaibab NF

Amendment 1 would have similar effects as the Coconino NF plan amendment 2 under this alternative although slightly fewer acres (27,637) on the Kaibab NF would be managed for open conditions that are representative of historic or reference conditions that are conducive to the establishment of a more vigorous understory of grasses, forbs, and shrubs that then protect soil surfaces and reduce sediment delivery to stream courses and riparian areas. Without implementation of Kaibab NF plan amendment 1, maintenance of soil productivity and, therefore, water quality and riparian conditions would not be to the level provided through implementation of the proposed amendment. Approximately 27,637 acres would remain at risk of adverse effects of high-severity fire which could degrade soils stability and productivity and adversely affect surface water quality and riparian habitats.

Amendment 2 would have no effect to water quality or riparian areas on the Kaibab NF since it strictly relates to monitoring, definitions, and the incremental treatment of habitat. Managing for less than 10 percent threshold habitat for MSO would have minimal effect on soils, watershed condition, water quality, and riparian areas as this represents a difference of only 2 percent from the current level of 8 percent.

Alternative C

Coconino NF

Amendment 1 would have similar effects as amendment 1 under alternative B. However, under this alternative, soils and watershed resources would be further improved in 56 MSO PAC core areas as a result of reintroduction of low intensity prescribed fire to these PACs. Reduced stand densities followed by improved vegetative ground cover would increase fine root biomass of grasses, forbs, and shrubs that protect soils from erosion. Reintroduction of low-intensity fire would improve nutrient cycling and increase understory vegetative vigor. These conditions would improve water quality and riparian area conditions by reducing sediment delivery to stream courses and riparian areas.

Overall, amendment 1 under alternative C would provide greater improvement in water quality and riparian health that under alternative B. Without implementation of this proposed forest plan amendment, reintroduction of low severity prescribed fire would not occur in 56 MSO PACs, leaving soils and watershed resources at risk of uncharacteristic wildfire that could damage soil stability and productivity and, therefore, adversely affect surface water quality and riparian area conditions.

Mechanical vegetation treatments within the 6,321 acres of MSO restricted habitat (target/threshold) to achieve a residual basal area ranging from 110 to 150 square feet would improve soils and watershed conditions and, therefore, water quality by reducing stand densities that are otherwise conducive to high-severity fire. Vegetative ground cover would improve in these areas, reducing soil erosion potential and protecting surface water quality.

Deferring monitoring (and incremental treatments of habitat) of MSO to the FWS biological opinion would not affect water quality or riparian areas on the Coconino NF since no activities would occur that have potential to adversely affect these resources.

Amendment 2: The effects under alterative C would be the same as those described under alternative B.

Amendment 3: The effects under alternative C would be the same as those described under alternative B.

Kaibab NF

Amendment 1 under alternative C is similar to amendment 1 under alternative B, although 38 more acres would be managed for open conditions that are representative of historic or reference conditions. The historic, reference conditions are conducive to the establishment of a more vigorous understory of grasses, forbs, and shrubs that would protect soil surfaces from erosion and reduce sediment delivery to stream courses and riparian areas. Approximately 38 additional acres would be improved under alternative C than alternative B. Without implementation of this proposed amendment, 27,675 acres on the Kaibab NF would remain at an elevated risk of high-severity wildfire that could adversely affect water quality and riparian habitats through increased sediment delivery to stream courses and increased water turbidity.

Amendment 2 would improve soils and watershed conditions in the proposed Garland Prairie Research Natural Area (RNA) by returning the RNA to a grassland condition. Removal of encroached trees would improve vegetative ground cover in this treatment area, reducing the potential for soil erosion and sediment delivery to stream courses. There would be minimal effect to riparian areas from implementation of this amendment as there are no riparian areas in close proximity to the RNA. Reintroduction of low intensity prescribed fire would improve nutrient cycling and herbaceous understory vigor, further contributing to improved vegetative ground cover. Without implementation of this amendment, encroached trees in the proposed Garland Prairie RNA would continue to pose a risk of high-severity fire and, therefore, risk to water quality in connected ephemeral drainages.

Amendment 3 would allow mechanical vegetation treatments within the 2,090 acres of MSO restricted habitat (target/threshold) to achieve a residual basal area ranging from 110 to 150 square feet. This amendment would improve soils and watershed conditions and, therefore, water quality by reducing stand densities that are otherwise conducive to high-severity fire. Vegetative ground cover would improve in these areas, reducing soil erosion potential and protecting surface water quality. Managing for less than 10 percent threshold habitat for MSO would have minimal effect on soils, watershed condition, water quality, and riparian areas as this represents a difference of only 2 percent from the current level of 8 percent.

The amendment adds definitions and defers MSO monitoring and the incremental treatment of habitat to the FWS biological opinion. Amendment 3 under alternative C would not affect water

quality or riparian areas on the Kaibab NF since no activities would occur that have potential to adversely affect water quality or riparian habitats.

Cumulative Effects

The spatial boundary for the soils and watershed cumulative effects analysis is the 82 6th HUC watersheds that total about 2,032,000 acres (see appendix C of the soils report). The temporal timeframe for past actions is 2 to 3 years based on vegetative and CWD recovery of the site. Vegetative recovery after fuel treatments is generally very rapid, with erosion rates typically dropping to pre-fire levels within 1 to 2 years (Elliot 1999, USDA 2000).

Relative to soils and watershed, there are about 45,000 acres of baseline ground disturbance from roads, private land, grazing allotments, and powerline corridors that occur across the cumulative effects analysis area. The total acres of past, present, and reasonably foreseeable treatment acres within the cumulative effects project area are roughly 282,400 acres (133,000 past and present projects and 150,000 acres of reasonably foreseeable projects) or about 14 percent of the cumulative boundary area. Of these treatment acres, about 15 percent would have ground disturbance (42,400 acres), which is just under 2 percent of the cumulative effects analysis area. The 4FRI project could add an additional 61,000 acres of ground disturbance. The total acreage of disturbed ground would be nearly 148,396 acres, or about **7** percent of the cumulative effects boundary area (see table 35).

Alternative A

Because no actions are proposed, no direct cumulative effects would result. The spatial and temporal boundaries are the same for all alternatives.

Alternatives B, C, and D

In alternative B, when past, present, and reasonably foreseeable actions are considered, including the actions in this alternative, the extent (about 5 percent) and magnitude of soil disturbance would not be exceeded within the cumulative effects boundary (table 35).

In alternatives C and D, the baseline ground disturbance and past, present, and foreseeable activities are the same as described in the introduction of the specialist report. Alternative C would add an additional 66,358 acres of ground disturbance for a total acreage of ground disturbance across the cumulative effects analysis area of nearly 153,759 acres, or about 8 percent of the cumulative effects boundary area (see table 35). Alternative D would add an additional 52,800 acres of ground disturbance for a total acreage of ground disturbance across the cumulative effects analysis area of nearly 140,200 acres, or about 7 percent of the cumulative effects boundary area (see table 35).

In alternatives B, C, and D, further protection of soil and water resources would be provided by the use of BMPs that minimize the potential for soil disturbance. Identified and implemented BMPs are expected to reduce the risk on accelerated erosion, sediment delivery, and nonpoint source pollution to connected stream courses and maintain water quality in all watersheds. In addition to the use of BMPs, the completion and implementation of the travel management EIS would further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, alternatives B, C, and D would not provide a detrimental cumulative effect to soil resources within the cumulative effects boundary.

In alternatives B, C, and D there are four 6th code watersheds where urban development has a large impact on ground disturbance areas. This project, plus current and reasonably foreseeable projects, would impacts these watersheds in the following manner:

- In the Cataract Creek headwaters watershed, there is an 11 percent baseline ground disturbance that increases to 14 percent total cumulative ground disturbance with the 4FRI proposed activities.
- In the Sinclair Wash watershed, there is a 25 percent baseline ground disturbance that increases to 26 percent total cumulative ground disturbance with the 4FRI proposed activities.
- In the Lower Rio de Flag watershed, there is an 18 percent baseline ground disturbance that increases to 20 percent total cumulative ground disturbance with the 4FRI proposed activities.
- In the Middle Oak Creek watershed, there is an 11 percent baseline ground disturbance that increases to 13 percent total cumulative ground disturbance with 4FRI proposed activities.

Implementation of BMPs would minimize any impacts to watersheds and would be especially important in the watersheds that already have a high urban impact.

Table 35. Total cumulative effects analysis area 6th code (acres) by alternative

Effect Indicators	Alt. B	Alt. C	Alt. D
Total Cumulative Effects Analysis Area 6th Code Acres	2,032,080	2,032,080	2,032,080
Proposed Ground Disturbance Acres	60,995	66,358	52,814
Percent of 6th Code Acres Disturbed	3.0	3.3	2.6
Baseline Conditions			
Baseline Ground Disturbance Acres	45,041	45,041	45,041
Total Treatment Acres	149,561	149,561	149,561
Future			
Total Ground Disturbance Acres	22,434	22,434	22,434
Current/Ongoing			
Total Treatment Acres	132,837	132,837	132,837
Total Ground Disturbance Acres	19,926	19,926	19,926
Project Totals			
Total Cumulative Effects Ground Disturbance (Acres)	148,396	153,759	140,214
Total Cumulative Effects Ground Disturbance (Percent)	7.3	7.6	6.9

Vegetation

The vegetation analysis is summarized from the silviculture specialist report. The report is incorporated by reference (McCusker 2013). The analysis is focused on determining whether, or

to what degree, the project meets purpose and need objectives. It responds to two key issues: Issue 2, conservation of large trees and Issue 3, post-treatment canopy cover and landscape openness.

To address Issue 2, the analysis provides a quantitative pre-treatment and post-treatment three-level analysis for MSO, goshawk, old growth, and vegetation structural stage (VSS) for goshawk habitat at the landscape scale (ponderosa pine vegetation type) to gauge movement toward restoration desired conditions. To address Issue 3, the analysis discloses tree group stocking guides that will be used to meet tree group canopy cover requirements and evaluates the following within goshawk habitat: pre- and post-treatment distribution of habitat structure, overall habitat structure (VSS class), forest density metrics, and openness. See the silviculture report for the complete methodology, assumptions, and limitations discussion.

Affected Environment

Cover Types and Vegetation Communities

The cover types have been grouped into communities. Table 36 lists the acres within the project area by cover type. The "Forest Structure" and "Forest Health" sections in chapter 1 include existing and desired conditions for ponderosa pine and pinyon-juniper woodlands (old growth). Existing and desired conditions for grasslands, Gambel oak , and aspen can be found in the "Vegetation Composition and Diversity" section. See the specialist report for details on each vegetation community.

Table 36. Acres of vegetation cover types by restoration unit (RU) in the project area

Cover Type	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Nonvegetated						
Barren	120	134	129	1,301	48	**1,732**
Nonforest Communities						
Grassland	8,230	12,799	22,665	4,987	93	**48,774**
Forest Communities						
Pinyon-Juniper Woodland	1,427	5,884	7,283	8,845	2,219	**25,658**
Oak Woodland	287	1,633	926	523	30	**3,399**
Ponderosa Pine	145,793	129,225	134,301	61,671	41,188	**512,178**
Aspen	368	201	499	403	0	**1,471**
Total Forested Acres:	**147,875**	**136,943**	**143,009**	**71,441**	**43,437**	**542,705**
Total Analysis Area Acres:	**156,225**	**149,876**	**165,803**	**77,730**	**43,578**	**593,211**

All ponderosa pine forested habitat within the analysis area was stratified to meet analysis requirements in the forest plans (USDA 1987, 1988) for MSO and northern goshawk as displayed in figure 35, table 37, and table 38. See the "Wildlife" section for the MSO and goshawk analysis.

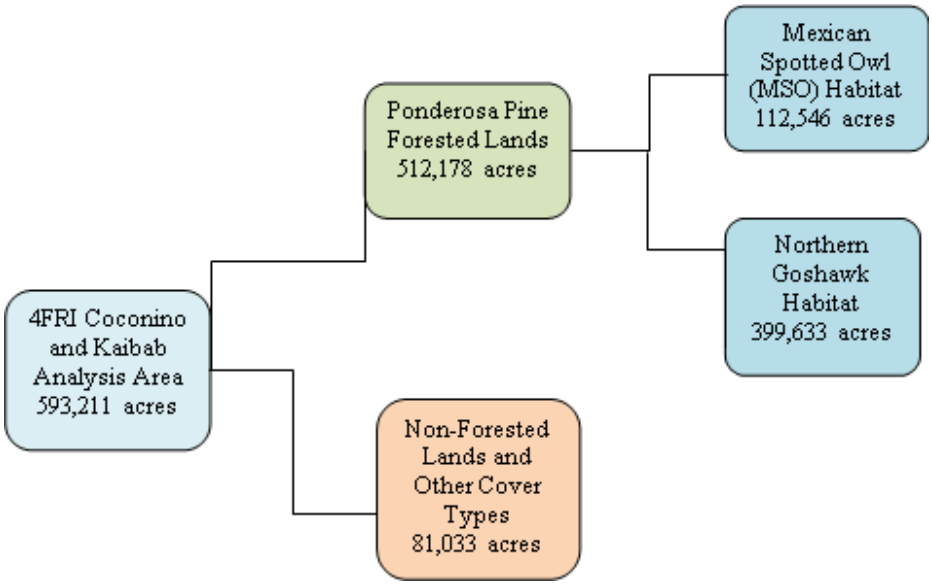


Figure 35. Stratification of ponderosa pine forested lands, other cover types, and nonforested land

Table 37. MSO habitat stratification within the analysis area (acres by RU)

MSO Habitat	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Protected Habitat						
Protected Activity Center (PAC)	29,349	4,268	556	1,393	0	35,566
Pine Oak >40% Slope	648	239	3	0	0	889
Total MSO Protected	29,996	4,507	558	1,393	0	36,455
Restricted Habitat – Pine Oak						
Threshold	873	1,032	0	0	0	1,905
Target	3,941	2,867	0	0	0	6,808
Restricted Other	26,421	38,748	1,575	634	0	67,378
Total MSO Restricted	**31,234**	**42,648**	**1,575**	**634**	**0**	**76,091**
Total MSO Habitat	**61,231**	**47,155**	**2,134**	**2,026**	**0**	**112,546**

Table 38. Northern goshawk habitat stratification within the analysis area (acres by RU)

Northern Goshawk Habitat	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Nest Habitat	1,126	1,174	3,489	435	616	6,839
Post-fledgling Family Area (PFA)						
Uneven-aged	650	2,405	5,086	1,362	2,852	12,354
Even-aged	2,895	1,873	4,910	1,148	582	11,408
Total PFA	**3,545**	**4,278**	**9,996**	**2,509**	**3,434**	**23,761**
Total PFA and Nest	**4,670**	**5,452**	**13,484**	**2,944**	**4,050**	**30,600**
Landscapes Outside Post-fledgling Family Areas (LOPFA)						
Uneven-aged	40,073	40,964	60,374	46,808	19,743	207,962
Even-aged	39,820	35,655	58,309	9,892	17,396	161,071
Total LOPFA	**79,892**	**76,619**	**118,683**	**56,700**	**37,183**	**369,033**
Total Goshawk Habitat	**84,562**	**82,071**	**132,167**	**59,644**	**41,188**	**399,633**

Forest Health

For the purposes of this analysis, forest health is defined by the vigor and condition of the forest stands, and the presence of insects and disease that affect the sustainability of the forest. Pages 17 to 18 in chapter 1 of the DEIS describe existing and desired conditions for stand density and insect and disease, key components of forest health.

Vegetation Diversity and Composition

Page 19 to page 21 in chapter 1 of the DEIS describe existing and desired conditions for vegetation composition and diversity.

Environmental Consequences

The spatial context for environmental consequences is the 593,211-acre analysis area (also referred to as the project area). The baseline year for existing condition is 2010. The baseline description includes all past activities and events that have influenced the existing condition. In the effects discussion, post treatment refers to the time the final activity is accomplished (year 2020), "short-term" effects refers to effects over the 10-year period from the time the final activity was accomplished (year 2030). Beyond 20 years, effects are considered "long term" (year 2050). The environmental consequences are based on the application of the design features and mitigation measures (see sections A through E of appendix D for the vegetation treatment design and associated implementation guides).

All Alternatives

Canopy Density and Openness

In alternative A and in the absence of restoration treatments, existing openness is expected to continue on the same trajectory with at least 75 percent of the ponderosa pine classified as moderately closed to closed by 2020 (table 39). As the forest develops over time and existing

openings gradually fill in, some of the areas would move from an open to moderately closed condition and some of the areas would move from a moderately closed to closed condition. No treatments would be implemented to create a mosaic of interspaces and tree groups. Existing interspace would continue to be encroached upon by expanding tree crowns and ingrowth. Any large scale tree mortality occurring has the potential to enhance interspace and create tree groups.

In alternatives B and D there would be a fairly diverse condition with openness leaning to the closed side of the range. Eleven percent of the ponderosa pine would be very open, 31 percent open, 42 percent moderately closed, and 15 percent closed (table 39). The unknowns are those areas with no treatment proposed under this alternative.

In alternative C, there would be a fairly diverse condition with openness leaning to the closed side of the range. Eleven percent of the ponderosa pine would be very open, 30 percent open, 42 percent moderately closed, and 17 percent closed.

In addition to this analysis, wildlife conducted an evaluation of post-treatment canopy openness for canopy density dependent species. The analysis is summarized in the "Wildlife" section. The complete analysis is in appendix G of the DEIS.

Table 39. Alternatives A–D comparison of canopy density and openness

Alternative	Very Open (%)	Open (%)	Moderately Closed (%)	Closed (%)
Alternative A	45% moderately closed and 3% closed trends toward being 75% closed by 2020			
Alternative B	11	31	42	15
Alternative C	11	30	42	17
Alternative D	11	31	42	15

Mosaic of Interspaces and Tree Groups of Varying Sizes and Shapes

While all treatments with the exception of grassland restoration are designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sizes and shapes, the intensity of the treatment affects the relative tendency toward this condition.

In alternatives B and C, 41 percent of the area treated would be considered high, 25 percent would be moderate, 24 percent would be low, and 10 percent would be very low. In alternative D, 43 percent of the area treated would be considered high, 26 percent would be moderate, 25 percent would be low, and 6 percent would be very low.

The lower intensity treatments within MSO PACs, target/threshold, and goshawk nest habitat would result in irregular tree spacing and subtle expansion of existing forest openings. The higher intensity treatments such as uneven-aged (UEA) 40, intermediate thin (IT) 40, and stand improvement (SI) 40 would be removing more trees and extends greater flexibility in size and shape of interspaces and tree groups generated.

Table 40 displays by alternative acres by treatment intensity as an indication of the relative ability of the treatment to attain a mosaic of interspaces and tree groups and of the post-treatment interspace/tree group condition. Total treatment acres and percent are provided by treatment intensity category (high, moderate, low, and very low).

Table 40. Comparison of alternatives relative to attaining interspaces and tree groups (acres)

Treatment Intensity	Treatment Type	Alt. B	Alt. C	Alt. D
High	Grassland Restoration	11,185	11,230	11,222
	Savanna	45,469	45,462	45,469
	Pine-Sage	5,261	5,261	5,261
	WUI 55	2,268	2,268	2,268
	UEA 40	101,044	95,712	101,044
	IT 40	39,189	39,039	39,189
	SI 40	12,309	12,244	12,309
High (Total Acres and Percent)		**216,725 (43%)**	**211,215 (41%)**	**216,762 (44%)**
Moderate	MSO Restricted	65,024	63,191	65,024
	UEA 25	39,244	39,176	39,244
	IT 25	11,871	11,858	11,871
	SI 25	6,824	6,824	6,824
Moderate (Total Acres and Percent)		**122,963 (24%)**	**121,050 (24%)**	**122,963 (25%)**
Low	UEA AZGFD Design	NA	4,837	NA
	UEA 10	18,204	18,109	18,204
	IT 10	7,766	7,766	7,766
	SI 10	1,914	1,914	1,914
	Goshawk PFA and LOPFA Prescribed Fire Only	90,126	91,057	90,089
	MSO Restricted Prescribed Fire Only	2,354	2,354	2,354
Low (Total Acres and Percent)		**120,363 (24%)**	**126,074 (25%)**	**120,327 (25%)**
Very Low	Goshawk Prescribed Fire Only	6,839	6,839	6,839
	MSO PAC	10,741	10,741	10,741
	MSO Protected Prescribed Fire Only	20,864	25,714	889
	MSO Target and Threshold	8,412	8,412	8,412
	MSO Target and Threshold Prescribed Fire Only	301	301	301
Very Low (Total Acres and Percent)		**47,157 (9%)**	**52,007 (10%)**	**27,182 (6%)**

Forest Structure in Goshawk Habitat

Goshawk habitat forest structure and habitat components were projected out to the years 2020 and 2050 by habitat and restoration unit (RU) scale. Table 41 summarizes the differences in habitat components by alternative. The silviculture report includes additional scales of analysis including restoration subunit.

In alternative A, density in terms of stand density index (SDI) and basal area would continue to increase and remain higher than desired in all habitats. All habitats would show an increase in total CWD, CWD >12 inches, and snags >18 inches between 2020 and 2050 resulting in conditions at or close to desired.

In alternatives B and C in year 2020, all habitats would be within the desired density range with the exception of RU 6 PFA. The pre-treatment RU 6 PFAs would have low stocking (below the desired condition of 70 square feet), typical of RU 6 site conditions with patches of dense VSS 3. The treatments would focus on thinning the dense patches and maintaining canopy cover in the mid-aged, mature, and old (VSS 4, 5, and 6), further reducing overall density. Tons of CWD and snags per acre would be below desired. By year 2050 at the habitat and RU scale, all habitats would remain within the desired SDI range. Basal area would be at or above the desired of 70 square feet. Tons of CWD would exceed the minimum desired with the exception of RU 6 PFA and LOPFA. Snags would remain below desired levels.

In alternative D (2020) at the habitat and RU scale, all habitats would be within the desired density range with the exception of RU 6 PFA (due to these stands being dominated by young forest structural stage). With the exception of RU6 and LOPFA RU 5, tons of CWD would be at or above desired due to the lack of prescribed fire reducing this attribute. Snags per acre would be below desired at all scales. By year 2050, all habitats would remain within the desired SDI range. Basal area would be at or above the desired 70 square feet. Total tons of CWD would exceed the minimum desired with the exception of RU 6 PFA and LOPFA. Snags would have increased yet remain below desired levels.

Table 41. Goshawk forest structure and habitat components in 2020 and 2050 in all RUs

Alternative	SDI % of Maximum		Trees Per Acre	Basal Area			Tons CWD Total		Tons CWD >12"		Snags >18"	
	2020	2050	2020									2050
Nest/PFA Habitat												
A	47	50	192	152	115	132	4.6	7.1	0.8	1.4	0.4	0.9
B	27	33	88	78	72	94	3.0	6.0	0.8	1.8	1.1	0.9
C	27	33	88	78	72	94	3.0	6.0	0.8	1.8	1.1	0.9
D	30	36	109	95	77	99	5.2	7.2	1.1	1.8	0.7	0.9
Landscapes Outside of PFAs												
A	43	46	182	142	105	122	4.2	6.6	0.6	1.2	0.4	0.8
B	21	27	67	60	57	76	2.7	5.0	0.6	1.4	1.0	0.9
C	21	27	67	60	57	76	2.7	5.0	0.6	1.4	1.0	0.9
Alt D	24	29	109	74	77	81	5.2	6.4	1.1	1.4	0.7	0.8

Table 42 characterizes the average overall habitat components in relation to desired (below, above, within) for each alternative.

Table 42. Forest structure desired conditions in goshawk habitat across alternatives

Indicator	Alternative A		Alternative B		Alternative C		Alternative D	
	2020	2050	2020	2050	2020	2050	2020	2050
SDI	Exceeds	Exceeds	RU 6 exceeds	Meets	RU 6 exceeds	Meets	RU 6 exceeds	Meets
Basal Area	Exceeds	Exceeds	RU 6 exceeds	Exceeds – Only RU 6 meets	RU 6 exceeds	Exceeds– only RU 6 meets	RU 6 exceeds	Exceeds
CWD (tons/ acre)	Moving toward	Meets	Below	Only RU 6 PFA and LOPFA meets	Below	Only RU 6 PFA and LOPFA meets	Below	Exceeds
Snags Per Acre	Moving toward	Meets	Below	Below	Below	Below	Moving toward	Exceeds

Canopy Cover

Canopy cover is time consuming to measure and difficult to standardize to obtain consistent results with different observers. Even the definition of the term is dependent on the method of measurement. To resolve this issue, the Forest Vegetation Simulation (FVS) crown width model was used as the basis for developing stocking densities that would achieve desired canopy cover levels. This was accomplished by establishing ponderosa pine seedling tree groups (site index 75) within FVS, and periodically thinning the groups to determine the stocking that would achieve the desired canopy cover when the trees reached 15-inch d.b.h. (midpoint of the VSS 4 size class). This stocking is considered typical for meeting the canopy cover desired conditions and stocking ranges by tree size class are centered on this value.

These stocking levels were compared to a local study specific to northern Arizona ponderosa pine forest (as reported by Shepperd et al. 2001) that predicted canopy cover at the stand level by inferring the relationship between estimated stand basal area and canopy cover. This comparison indicated the algorithmic relationship between basal area and canopy cover overestimated canopy cover in the larger size classes compared to FVS. Based on this comparison, we chose to use the stocking indicated by FVS to meet canopy cover requirements.

The FVS developed stocking guides were then validated thru site visits to areas with variable densities and tree sizes. Comparing the stocking guides to the tree density within VSS 4, 5, and 6 sites that had interlocking or nearly interlocking tree crowns indicated following the stocking guides would meet the desired tree group canopy cover within goshawk habitat.

Alternatives B, C, and D

Table 43 and figure 36 are the stocking guides that would be used in all action alternatives to meet canopy cover requirements in tree groups within goshawk LOPFA habitat. Table 44 and figure 37 are the stocking guides that would be used to meet canopy cover requirements in tree groups within goshawk PFA habitat. See sections A and B of appendix D for more detail on incorporating the stocking guides in treatment design. With the proposed canopy cover forest plan

amendment for canopy cover (see appendix B of the DEIS) on both forests, the alternatives would be consistent with the forest plans.

The forest plan amendment specific to acres managed for an open reference condition would remove meeting the canopy cover requirement on a maximum of 29,017 acres of goshawk LOPFA habitat on the Coconino NF and 27,675 acres on LOPFA habitat Kaibab NF (alternative C).

Table 43. Stocking guides to meet tree group canopy cover requirements within goshawk habitat areas outside of PFAs (LOPFA)

		Typical Number of Trees Per Group Stocking for Different Group Sizes[1]					Typical Intra-group (within-group) Densities[1] (All Group Acreage Sizes)	
VSS	D.B.H. Range	1/10 Acre Group	1/4 Acre Group	1/2 Acre Group	3/4 Acre Group	1 Acre Group	Relative Spacing Range (feet)	Basal Area[2] (ft^2/acre)
1 & 2	0 – 4.9”	19	48	96	144	193	12 – 18	NA
3	5 – 11.9”	14	34	68	102	136	NA	50
4*	12 – 17.9”	5	12	23	35	46	NA	60
5*	18 – 23.9”	3	8	15	23	30	NA	70
6*	24”+	2	5	11	16	21	NA	85

[1] These are typical values for the desired condition. Variation can occur and is desired, however, ranges should center on these values. See chart below.
[2] Rounded to nearest 10 square feet per acre.
* Densities are equivalent to 40 percent canopy cover.

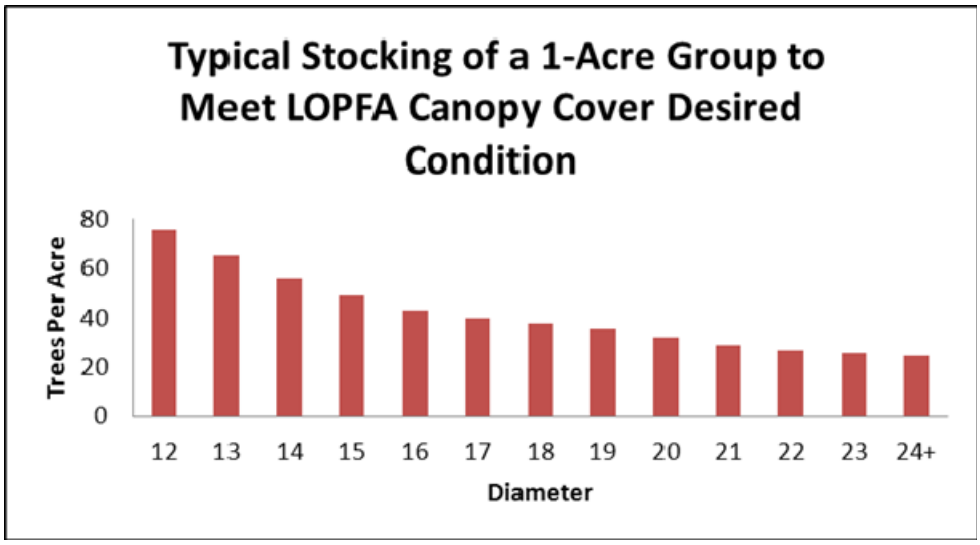


Figure 36. Typical stocking of a 1-acre group to meet LOPFA canopy cover desired condition

Table 44. Stocking guides to meet tree group canopy cover requirements within goshawk PFAs

		Typical Number of Trees Per Group Stocking for Different Group Sizes[1]					Typical Intra-group (within-group) Densities[1] (All Group Acreage Sizes)	
VSS	D.B.H. Range	1/10 Acre Group	1/4 Acre Group	1/2 Acre Group	3/4 Acre Group	1 Acre Group	Relative Spacing Range (feet)	Basal Area[2] (ft^2/acre)
1 & 2	0 – 4.9”	19	48	97	145	193	12 – 18	NA
3	5 – 11.9”	14	34	68	102	136	NA	50
4*	12 – 17.9”	7	18	35	53	70	NA	85
5**	18 – 23.9”	4	10	20	29	39	NA	90
6**	24”+	3	7	14	20	27	NA	110

[1] These are typical values for the desired condition. Variation can occur and is desired, however, ranges should center on these values. See chart below.
[2] Rounded to nearest 10 square feet per acre.
* Densities are equivalent to 55 percent canopy cover
** Densities are equivalent to 50 percent canopy cover

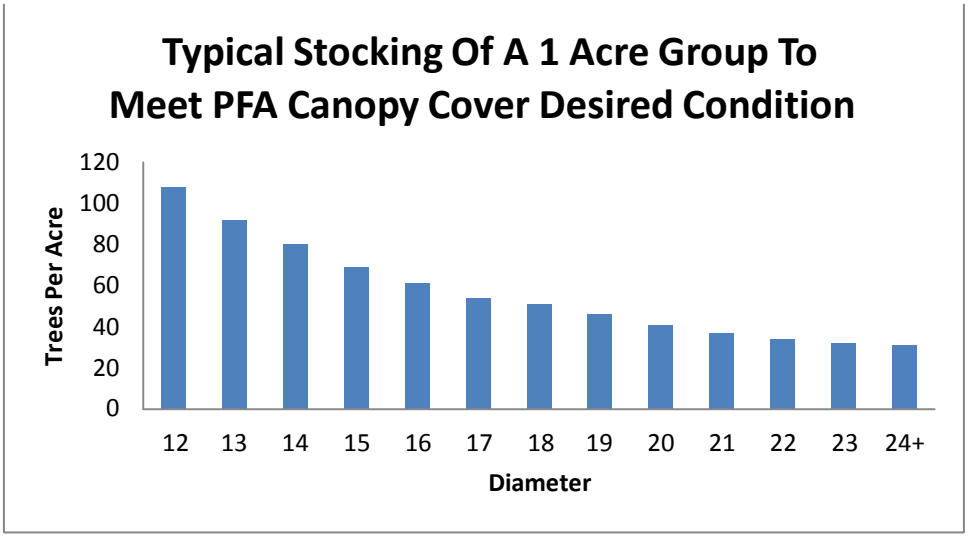


Figure 37. Typical stocking of a 1-acre group to meet PFA canopy cover desired condition

Forest Structure in Even-aged and Uneven-Aged Stands 2020 and 2050

Table 45 and table 46 summarize the differences in VSS distribution by alternative. The silviculture report includes additional scales of analysis including restoration subunit.

Alternative A

The goshawk habitat structural stage analysis indicates that in 2020, overall VSS distribution in all goshawk habitats would continue to be dominated by the young and mid-aged (VSS 3 and 4) structural stages. By 2050, this trend would shift toward the mid-aged and mature structural stages with an overall underrepresentation throughout all habitats in VSS 1, 2, 3, and VSS 6 in the even-aged stands.

Alternatives B and C

The goshawk habitat structural stage analysis for alternatives B and C indicates overall post-treatment VSS distribution in the even-aged goshawk habitats would have good representation of the VSS 1, 3, 4, and 5 age classes in the LOPFA; an underrepresentation of the VSS 5 age class in the PFA; an underrepresentation of the VSS 6 age class in all habitats; and no representation of the VSS 2 age class. The uneven-aged goshawk habitats would have good representation of VSS 1, 3, 4, 5, and 6 in the LOPFA; VSS 6 would be underrepresented in the PFA; and there would be no representation of the VSS 2 age class. This would represent a more balanced overall VSS distribution compared to alternative A with improvement toward the desired representation in the grass/forb/shrub, young, mid-aged, and mature forest stages.

As forest development progresses, projections show the distribution would shift toward the later stages by 2050 with no VSS 1 represented, an underrepresentation of VSS 3, and good overall representation in VSS 2, 4, 5, and 6.

Alternative D

The goshawk habitat structural stage analysis for alternative D indicates overall post-treatment VSS distribution to be similar to alternatives B and C, with slightly higher overall representation in VSS 3, and slightly lower overall representation in VSS 5. By 2050, projections indicate slight overall differences in representation in VSS 3, 4, 5, and 6 compared to alternatives B and C.

Table 45. Alternative A–D in 2020 and 2050 VSS distribution for goshawk LOPFA even-aged and uneven-aged stands (percent of area)

Alternative	VSS 1 (Desired 10%)		VSS 2 (Desired 10%)		VSS 3 (Desired 20%)		VSS 4 (Desired 20%)		VSS 5 (Desired 20%)		VSS 6 (Desired 20%)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
Even-aged LOPFA												
A	7	0	<1	7	35	8	49	47	7	32	2	5
B	13	0	0	13	20	3	39	29	24	34	3	21
C	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	40 (+1)	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B
D	Alt. B	Alt. B	Alt. B	Alt. B	32 (+12)	7 (+4)	33 (-6)	Alt. B	19 (-5)	36 (+2)	Alt. B	16 (-5)
Uneven-aged LOPFA												
A	0	0	1	0	36	8	34	42	14	25	16	25
B	7	0	<1	6	19	2	20	19	35	20	19	53
C	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B
D	Alt. B	Alt. B	1 (+<1)	Alt. B	26 (+7)	8 (+6)	Alt. B	Alt. B	29 (-6)	21 (+1)	17 (-2)	45 (-8)

Note: Cells with "Alt. B" indicate the value is the same as provided in alternative B and numbers in parentheses with a "+" or "-" symbol display the difference from alternative B.

Table 46. Alternatives A–D 2020 and 2050 VSS distribution for goshawk PFA even-aged and uneven-aged stands (percent of area)

Alternative	VSS 1 (Desired 10%)		VSS 2 (Desired 10%)		VSS 3 (Desired 20%)		VSS 4 (Desired 20%)		VSS 5 (Desired 20%)		VSS 6 (Desired 20%)	
	2020	2050	2020	2050	2020			2050	2020			2050
Even-aged PFA												
A	3	0	1	3	36	7	52	58	7	26	1	6
B	9	0	0	9	24	2	45	42	14	38	8	9
C	Alt. B	Alt. B	Alt. B	Alt. B	25 (+1)	Alt. B	46 (+1)	Alt. B	Alt. B	Alt. B	6 (-2)	Alt. B
D	Alt. B	Alt. B	Alt. B	Alt. B	34 (+10)	5 (+3)	44 (-1)	40 (-2)	11 (-3)	37 (-1)	2 (-6)	Alt. B
Uneven-aged PFA												
A	0	0	<1	0	35	5	44	51	15	23	5	21
B	8	0	0	8	17	0	40	28	25	39	10	25
C	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B	Alt. B
D	Alt. B	Alt. B	Alt. B	Alt. B	25 (+8)	3 (+3)	37 (-3)	26 (-2)	24 (-1)	40 (+1)	6 (-4)	23 (-2)

Note: Cells with Alt. B indicate the value is the same as provided in alternative B
Note: Numbers in parentheses with a "+" or "-" symbol display the difference from alternative B

Forest Structure Mexican Spotted Owl Habit (MSO)

MSO habitat forest structure and habitat components projected out to the years 2020 and 2050 in each alternative and by habitat type are displayed in table 47.

Alternative A

Density in terms of basal area and SDI would continue to increase and would remain higher than desired in all habitats in 2020. By 2050, the distribution of size classes would exceed desired in the 12- to 18-inch and the 18- to 24-inch size classes, and would remain below desired in the 24-inch plus size class. Average trees per acre 18 inches and larger would be above 20 in all habitats except restricted other in RU 5 (see table 31 in the silviculture report). Average Gambel oak basal area would be static between 2020 and 2050 and remain below desired in the restricted other habitat. All habitats show an increase in CWD greater than12 inches and snags greater than18 inches between 2020 and 2050.

Alternative B

In 2020:

- Basal area density would be within the desired range in all habitats.
- SDI would be in the extremely high density zone within the target/threshold, protected habitats (with the exception of RU 4), and on the high end of the desired range within restricted other habitat. This would be largely due to the limited mechanical treatment in the protected habitat and the high oak stocking in the restricted habitat.
- The distribution of size classes would be at or exceed the desired minimum in the 12- to 18-inch and the 18- to 24-inch size classes in all habitats.
- Stocking in the 24-inch plus size class would exceed the desired minimum in the restricted other habitat and would be below desired minimum in the target/threshold habitat.
- Average trees per acre 18 inches and larger would be very close to desired minimum in the target/threshold habitat and well below desired minimum in restricted other.
- The overall average Gambel oak basal area would be above the desired minimum in all habitats but would be limited in RU 5 and RU 1 restricted other.
- All habitats would approach the desired minimum CWD greater than12 inches and would be below the desired minimum in snags greater than18 inches.

In 2050:

- Basal area would be above the desired minimum for target/threshold habitat and above the desired range for restricted other.
- The SDI would remain in the extremely high zone within the target/threshold and protected habitats and would be higher than the desired range in restricted other.
- The distribution of size classes would be at, or exceed, the desired minimum in the 12- to 18-inch and the 18- to 24-inch size classes in all habitats.
- Stocking in the 24-inch plus size class would exceed the desired minimum in the restricted other habitat and would remain below desired minimum in the target/threshold habitat.

- Average trees per acre 18 inches and larger would exceed the desired minimum in the target/threshold habitat and would remain below the desired minimum in restricted other.
- Overall, the average Gambel oak basal area would be above the desired minimum in all habitats but would remain limited in RU 5 and RU 1 restricted other.
- All habitats would show an increase in CWD greater than12 inches between 2020 and 2050. Snags greater than18 inches would show an increase in target/threshold and protected habitat while remaining static in restricted other.

Alternative C

In 2020:

- Basal area density would be within the desired range in all habitats.
- SDI would be higher than desired within the target/threshold, protected habitat (with the exception of RU 4), and on the high end of the desired range within restricted other habitat. This would be largely due to the limited mechanical treatment in the protected habitat and the high oak stocking in the restricted habitat.
- The distribution of size classes would be at or exceed the minimum desired in the 12- to 18-inch and the 18- to 24-inch size classes in all habitats.
- Stocking in the 24-inch plus size class would exceed the minimum desired in the restricted other habitat and would be below the minimum desired in the target/threshold habitat.
- Average trees per acre 18 inches and larger would be within 2 trees per acre of minimum desired in the target/threshold habitat and would be well below minimum desired in restricted other.
- Overall average Gambel oak basal area would be above minimum desired in all habitats except RU 5 restricted other where it would be a limited component within that landscape.
- All habitats would be approaching minimum desired CWD greater than12 inches and would be below minimum desired in snags greater than18 inches.

In 2050:

- Basal area would be above the desired range for target/threshold habitat. The average overall basal area in restricted other would be 112 square feet which is the low end of the desired range for MSO nesting/roosting habitat (threshold).
- SDI density would exceed the desired range in all habitats.
- The distribution of size classes would be at, or exceed, the minimum desired in the 12- to 18-inch and the 18- to 24-inch size classes in all habitats.
- Stocking in the 24-inch plus size class would exceed the minimum desired in the restricted other habitat and would remain below the minimum desired in target/threshold habitat.
- Average trees per acre 18 inches and larger would exceed the minimum desired in the target/threshold habitat and would remain below the minimum desired in restricted other.

- Overall average Gambel oak basal area would be above the minimum desired in all habitats except in RU 5 restricted other.
- All habitats would show an increase in CWD great than 12 inches between 2020 and 2050. Snags greater than18 inches would show an increase in target/threshold and protected habitat while remaining static in restricted other.

Alternative D

In 2020:

- Basal area density would be approaching the high end of the desired range within the restricted other habitat and would be within desired for the other habitats.
- SDI would be higher than desired in all habitats with the exception of restricted other RU 5 and protected RU 4. This would be largely due to the limited mechanical and fire treatments in the protected habitat and the high oak stocking and lack of post mechanical treatment burning in the restricted habitat.
- The distribution of size classes would be at or exceed the minimum desired in the 12- to 18-inch and the 18- to 24-inch size classes in all habitats.
- Stocking in the 24-inch plus size class would exceed the desired minimum in the restricted other habitat and would be below desired minimum in the target/threshold habitat.
- Average trees per acre 18 inches and larger would be very close to desired minimum in the target/threshold habitat and would be well below desired minimum in restricted other.
- Overall average Gambel oak basal area would be above desired minimum in all habitats except RU 5 restricted other where it would be a limited component within that landscape.
- All habitats would be approaching desired minimum CWD greater than12 inches and would be below the desired minimum in snags greater than18 inches.

In 2050:

- Basal area and SDI density would exceed desired in all habitats.
- The distribution of size classes would be at or exceed the desired minimum in the 12- to 18-inch and the 18- to 24-inch size classes in all habitats.
- Stocking in the 24-inch plus size class would exceed the desired minimum in the restricted other habitat and would remain below the desired minimum in the target/threshold habitat.
- Average trees per acre 18 inches and larger would exceed desired minimum in the target/threshold habitat and would remain below desired minimum in restricted other.
- Overall average Gambel oak basal area would be above desired minimum in all habitats but would remain limited in RU 5 restricted other.
- All habitats would show an increase in CWD greater than12 inches and snags greater than 18 inches between 2020 and 2050.

Table 47. Alternative A–D MSO habitat forest structure and habitat components projected to the years 2020 and 2050**

Alternative	Basal Area (BA)		SDI (% of maximum)		12.0–17.9″ (% of total SDI)		18.0–23.9″ (Avg. % of total SDI)		24.0″ + (Avg. % of total SDI)		Average Trees per Acre 18″+		Average Gambel Oak BA % of Total BA		Tons CWD >12″		Snags >18″	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
Restricted Target/Threshold*																		
A	171	190	86	88	27	26	16	20	7	10	19.0	26.2	23	22	1.5	2.5	0.6	1.5
B	146	178	75	83	28	23	20	23	9	11	19.3	27.6	27	26	1.0	1.9	0.6	1.5
C	136	171	71	81	23	21	20	20	10	12	18.3	24.2	29	28	1.1	1.9	0.6	1.3
D	149	179	76	84	28	23	19	23	9	11	19.3	27.6	26	25	1.5	2.4	0.6	1.5
Restricted Other																		
A	147	169	72	76	30	28	14	20	7	10	14.1	22.7	17	18	0.7	1.5	0.5	1.1
B	78	111	37	49	22	19	22	19	18	19	11.5	17.0	22	21	0.8	1.6	0.9	0.9
C	78	112	37	49	22	19	22	19	18	19	11.4	17.0	22	21	0.8	1.6	1.0	0.9
D	91	127	46	58	20	18	20	17	17	16	11.9	17.0	23	22	1.1	1.6	0.5	0.9
Protected																		
A	164	181	80	81	31	28	16	22	8	11	17.8	27.5	12	12	1.1	2.4	0.7	1.7
B	154	175	72	76	32	27	17	24	9	12	18.0	28.2	13	13	0.8	2.1	0.7	1.7
C	152	174	71	75	32	27	18	25	9	13	18.1	28.4	13	14	0.7	2.1	0.7	1.7
D	159	178	74	77	32	28	17	24	9	12	18.0	28.0	13	13	1.1	2.3	0.7	1.7

*Restricted target/threshold is displayed as (average target/average threshold) a combined average.

**In comparison to table 7 in chapter 1, two additional evaluation categories have been included: average percent of total SDI by size class and average Gambel oak BA (percent of total BA).

Old Growth

Old growth allocations are based on current conditions within the project area along with forest plan specific management direction. Most sites currently do not fully meet the minimum criteria for old growth conditions as listed in the forest plans. However, the old growth allocated areas are closest to meeting old growth conditions. See chapter 1 for a detailed discussion of forest plan direction and old growth allocations within this project.

Alternatives A–D

In 2020 in ponderosa pine, the average conditions are at or above the minimum criteria with the following exceptions:

All alternatives (A–D):

- **Trees per acre larger than 18-inch d.b.h. and 180 years old**. This condition is deficit in all SUs. The age of these trees is estimated to be in the range of 100 to 140 years old.
- **CWD greater than 12 inches** is estimated to be deficit throughout RU 4 and 6, and in various SUs.
- **Snags per acre** are estimated to be deficit in RU 6.

Alternatives B, C, and D:

- **Trees per acre larger than 18-inch d.b.h. and 180 years old**. This condition would be deficit in all SUs. The age of these trees is estimated to be in the range of 100 to 140 years old.
- **Basal area per acre** would be below the minimum threshold of 90 square feet.
- **CWD greater than 12 inch**es would be deficit throughout RU 5 and 6, and in various SUs.

In all alternatives, ponderosa pine old growth conditions would improve over time in terms of meeting the minimum criteria. In 2050, all RUs would be very close to or exceed the minimum criteria for trees per acre larger than 18-inch d.b.h. with the exception of RU 6. The age of these trees is estimated be in the range of 130 to 170 years old. It is estimated that all the other criteria would be met throughout the allocated old growth acres.

In pinyon-juniper in 2020, the average conditions are at or above the minimum criteria with the exception of tree age and CWD. The age of the 12 inches and larger trees is estimated to be approximately 90 to 120 years old with a few relic trees approaching the 200-year-old criteria. The CWD would be slightly below the equivalent of two pieces per acre. By 2050, the average conditions on the old growth acres would meet or exceed the minimum criteria with the exception of tree age.

Forest Health

Bark Beetle

All Alternatives

Table 48 compares bark beetle hazard ratings by alternative. Alternative A has the highest hazard rating in both the short and long term. Alternatives B and C would have the highest percent of area with a low to moderate hazard rating in both the short and long term. Stands with a hazard rating of low or moderate would be expected to be resistant to successful bark beetle attack and large-scale mortality.

In alternative A, the overall hazard in 2020 is high across 83 percent of the analysis area. This increases to 92 percent in 2050. In alternatives B and C, the overall hazard in 2020 would be high across 26 percent of the analysis area. This would increase to 53 percent in 2050. In alternative D, the overall hazard in 2020 would be high across 45 percent of the analysis area. This would increase to 65 percent in 2050.

Table 48. Alternative A–D 2020 and 2050 bark beetle hazard rating

Hazard Rating	Alternative A Percent of Area	Alternative B Percent of Area	Alternative C Percent of Area	Alternative D Percent of Area
Low – 2020	4	39	38	28
Low – 2050	1	20	19	15
Moderate – 2020	13	36	36	26
Moderate – 2050	7	28	27	20
High – 2020	83	26	26	45
High – 2050	92	53	53	65

Dwarf Mistletoe

All Alternatives

Table 49 summarizes the change in infection level by alternative. In alternative A, by 2050 there would be an increase in the percent of area within the moderate/high infection level group and also an overall increase in the average percent of trees infected. This is an indication that mistletoe infection is intensifying and spreading over time. Alternative C would reduce the percent of moderate/high the most (8 percent reduction), followed by alternative B (6 percent reduction). The percentages for 2050 indicate mistletoe infection would intensify and spread at a slower rate in alternatives B, C, and D than alternative A, with alternative B and C providing the least intensification and rate of spread.

Table 49. Alternative A–D 2020 and 2050 dwarf mistletoe infection level by alternative

Infection Level		Alt. A	Alt. B		Alt. C		Alt. D		
		2020							2050
None/Low	Percent of Area	59	56	61	58	60	57	60	56
None/Low	Average Percent Trees Infected	7	7	6	7	6	7	6	7
Moderate/High	Percent of Area	41	43	39	42	40	43	40	44
Moderate/High	Average Percent Trees Infected	45	47	39	44	39	44	40	44
Extreme	Percent of Area	<1	1	<1	<1	<1	<1	<1	<1
Extreme	Average Percent Trees Infected	89	85	88	88	87	87	88	84

Large Tree/Old Forest Structure Sustained Over Time Across the Landscape

Alternatives B, C, and D

Restoration treatments proposed in alternatives B, C, and D are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Old trees would not be targeted for cutting. Reference the old tree implementation plan in appendix D of the DEIS.

The analysis presented for MSO indicates the post-treatment distribution of size classes has good representation in the 18- to 24-inch size classes in all habitats. Stocking in the 24-inch plus size class would have good representation in the restricted other habitat and would be underrepresented in the target/threshold habitat. The goshawk analysis indicates that mature and old forest structural stages that are currently underrepresented would trend toward improved representation in all habitats.

Treatments within areas currently allocated old growth would maintain existing old growth structural attributes and would be managed to move toward those conditions over time. The ponderosa pine old growth analysis above indicates old growth structural attributes would continue to develop and improve across the landscape.

The forest health discussion presents that the overall sustainability of the ponderosa pine forest would be improved across the landscape including the large/old tree component.

Vegetation Composition and Diversity

All Alternatives

In alternative A, ponderosa pine tree canopy would continue to increase, shading out understory herbaceous vegetation and further reducing forage production and species diversity. Historic grasslands, savannas, and forest openings would not be restored. Oak and aspen growth and vigor would continue to be stagnated due to competition with pine, resulting in lowered resistance to insects and disease and eventual mortality. Oak and aspen regeneration ability would continue to be impaired. Ponderosa pine tree canopy would continue to increase, shading out understory sage and further reducing the sage component and historic pattern within the pine-sage mosaic.

In alternatives B, C, and D, treatments would result in establishment of vigorous aspen regeneration free of competition from overtopping ponderosa pine. Treatments in pine-sage would result in enhancement of the sage component and restore the historic forest pattern within the pine-sage mosaic.

There would be improved vigor of existing oak and establishment of a variety of oak size and age classes across the landscape. Improved oak conditions would be most prevalent within the mechanically treated MSO restricted other habitat (65,024 acres in alternative B and 63,191 acres in alternative C). Overall, post-treatment oak basal area would be 5 percent higher in this habitat in alternatives B and C compared to the alternative A.

Alternatives B, C, and D treatments would restore historic grasslands, savannas, and forest openings by removing ponderosa pine tree canopy that is shading out understory herbaceous vegetation and reducing forage production and species diversity.

Other Direct and Indirect Effects

Residual Tree Damage

In alternatives B, C, and D, some damage to residual trees would be expected with the felling, tractor yarding, and piling operations associated with mechanical treatments in ponderosa pine. Alternative B would result in the most potential damage (386,762 acres), followed by alternative D (386,724 acres), and then alternative C (384,043 acres) (see table 50). Damage would be minimized through contract administration and proper harvest methods.

All piling and/or low-severity burning treatments would reduce understory stocking and reduce intertree competition as well as stimulate understory vegetation (shrubs, forbs, grasses).

Table 50. Alternatives B, C, and D residual tree damage

Ground-disturbing Actions	Alt. B	Alt. C	Alt. D
Felling, tractor yarding, piling	386,762 acres	384,043 acres	386,724 acres

Sustained Yield of Forest Products

In alternative A, there would be no beneficial effect of timber harvest (no biomass output) by meeting the Coconino and Kaibab forest plan goals of providing a sustained yield of forest products and providing a sustained level of timber outputs to support local dependent industries.

Timber harvest of 243,302,331 cubic feet of biomass from the Coconino NF and 122,856,697 cubic feet of biomass from the Kaibab NF would be a direct beneficial effect of alternative B. In alternative C, timber harvest of 245,343,350 cubic feet of biomass from the Coconino NF and 122,393,816 cubic feet of biomass from the Kaibab NF would be direct beneficial effects. In alternative D, timber harvest of 243,299,684 cubic feet of biomass from the Coconino NF and 122,856,697cubic feet of biomass from the Kaibab NF would be the direct beneficial effects. Alternative C would provide the most biomass on both forests (see table 51).

Table 51. Cubic feet of biomass (forest products) by alternative and forest

Forest	Alt. A	Alt. B	Alt. C	Alt. D
Coconino NF	0	243,302,331	245,343,350	243,299,684
Kaibab NF	0	122,856,697	122,393,816	122,856,697
Total		**366,159,029**	**367,737,165**	**366,156,380**

In alternative A, vegetation development (ingrowth and mortality) within current road rights-of-way would continue on the current trajectory. In alternatives B, C, and D, road decommissioning would allow ingrowth of forest vegetation once the road is decommissioned (approximately 2,712 acres).

In alternatives B, C, and D, constructing temporary roads would remove trees and forest vegetation within the road rights-of-way on approximately 735 acres (table 52). Opening decommissioned roads may remove trees and forest vegetation that has become established (within the road right-of-way since the road was last maintained) within approximately 816 acres. Road reconstruction consists of road improvement activities and road realignments activities. Road realignment of 10 miles of road would remove approximately 30 acres of trees and forest vegetation within the area being reconstructed. Thirty miles of road improvement would be expected to occur on small discreet areas and would be expected to remove about 100 acres of forest vegetation. The above listed effects cover the maximum range of management actions.

Table 52. Acres of ground disturbance from road actions in alternatives B, C, and D

Ground-disturbing Actions	Alt. B	Alt. C	Alt. D
Temporary road construction	735	735	735
Temporary opening of decommissioned roads	816	816	816
Road reconstruction	130	130	130

Aspen Fencing

In alternatives B, C, and D, aspen fencing would occur after mechanical and burning treatments and would have no effect to the vegetation. Leaving felled material on the ground for jackstrawing would forego the opportunity to use that material for wood products.

Springs and Channels

In alternatives B, C, and D, springs and ephemeral channels are inclusions within the mechanical and burn treatment areas. Any tree removal that occurs as part of the restoration of these areas would be part of the design for those mechanical treatments that occur around these areas, and the effects to the forest vegetation would be similar to the overall treatment. Fencing would have no effect to the vegetation. Bank recontouring and stabilization would occur along 39 miles of ephemeral channels. This activity would disturb existing forest vegetation. Up to 5 miles of willow reestablishment would occur where evidence indicates historic willow presence. This would create vegetation diversity and allow natural willow expansion into adjacent areas of suitable habitat. The above listed effects cover the maximum range of management actions.

Forest Plan Amendments

The following is a description of how forest plan amendments under this EIS would modify the forest plans' standards and guidelines and what the effects to the vegetation resource would be if the amendment did not occur.

Coconino NF

Amendment 1 in alternatives B and D: If the amendment did not occur, mechanical treatments would be limited to a maximum 9-inch d.b.h. in the 18 PACs, thereby restricting the treatment to a fuels reduction objective and reducing the ability to improve MSO habitat in terms of age class diversity and liberation of overtopped oak. Treatments within MSO habitat would continue to meet the intent of the MSO recovery plan, and the MSO habitat definition would not have an effect on the treatments themselves or their outcomes. Following existing forest plan language concerning MSO population and habitat monitoring or MSO habitat design would not have an effect on the treatments themselves or their outcomes.

Amendment 1 in alternative C: If the amendment did not occur, mechanical treatments would be limited to a maximum 9-inch d.b.h. in the 18 PACs. This would restrict the treatment to a fuels reduction objective and reduce the ability to improve MSO habitat in terms of age class diversity and liberation of overtopped oak. Without the use of prescribed fire in 56 MSO core areas, the opportunity to improve MSO habitat in terms of reducing litter/duff cover and stimulating regeneration and growth of native herbaceous vegetation would be eliminated.

Treatments within MSO habitat would continue to meet the intent of the MSO recovery plan, and the MSO habitat definition would not have an effect on the treatments themselves or their outcomes. Mechanical treatments within the 6,321 acres of target/threshold habitat would follow the denser 150 square feet basal area guidance, thereby reducing the ability to improve MSO nesting/roosting habitat in terms of sustainability, as indicated by high potential for density-related mortality and high bark beetle hazard rating, as well as reducing the ability to improve age class diversity and the liberation of overtopped oak. Following existing forest plan language concerning MSO population and habitat monitoring or MSO habitat design would not have an effect on the treatments themselves or their outcomes.

Amendment 2 in alternatives B, C, and D: If the amendment did not occur, the lack of clarifying language describing the relationship between nonforested areas (interspace) and natural openings across the landscape could result in interspace establishment being eliminated from the treatment design. The only features contributing to landscape openness would be existing natural openings. If that were to occur, it would inhibit the ability to meet desired conditions in terms of creating a mosaic of interspaces and tree groups of varying shapes and sizes, enhancing the representation of all age and size classes, sustaining old forest structure across the landscape, improving forest health, and enriching vegetation diversity and composition.

The plans lack explicit language for measuring canopy cover. Treatments within goshawk habitat would continue to meet the intent of the forest plans with regards to canopy cover, and the lack of explicit language for how or where it is measured would not have an effect on the treatments themselves or their outcomes. The 29,017 acres would be managed under the current forest plan guidelines, and desired conditions consistent with an open reference condition would not be met. Treatments within goshawk habitat would continue to meet the intent of the forest plan

guidelines. Defining these terms is for clarification purposes and would not have an effect on the treatments themselves or their outcomes.

Amendment 3 in alternatives B, C, and D: If the amendment did not occur, it could potentially result in areas not being treated in order to attain a "no effect" determination. Without treatment, these areas would not move toward desired conditions in terms of creating a mosaic of interspaces and tree groups of varying shapes and sizes, enhancing the representation of all age and size classes, sustaining old forest structure across the landscape, improving forest health, and enriching vegetation diversity and composition.

Kaibab NF

Amendment 1 in alternatives B, C, and D: If the amendment did not occur, the lack of clarifying language describing the relationship between nonforested areas (interspace) and natural openings across the landscape could result in interspace establishment being eliminated from the treatment design. The only features contributing to landscape openness would be existing natural openings. If that were to occur, it would inhibit the ability to meet desired conditions in terms of creating a mosaic of interspaces and tree groups of varying shapes and sizes, enhancing the representation of all age and size classes, sustaining old forest structure across the landscape, improving forest health, and enriching vegetation diversity and composition.

The plans lack explicit language for measuring canopy cover. Treatments within goshawk habitat would continue to meet the intent of the forest plans with regards to canopy cover and the lack of explicit language for how or where it is measured would not have an effect on the treatments themselves or their outcomes. The 27,637 acres (alternatives B and D) or the 27,675 acres (alternative C) would be managed under current forest plan guidelines, and desired conditions consistent with an open reference condition would not be met. Treatments within goshawk habitat would continue to meet the intent of the forest plan guidelines. Defining these terms is for clarification purposes and would not have an effect on the treatments themselves or their outcomes.

Alternative 2 in alternatives B and D: If the amendment did not occur, treatments within MSO habitat would continue to meet the intent of the MSO recovery plan, and the MSO habitat definition would not have an effect on the treatments themselves or their outcomes. Managing for 10 percent threshold habitat within the Kaibab NF portion of the project area could result in habitat that is not capable of maintaining a population of MSOs and could not be sustained through time if designated as threshold habitat. Following existing forest plan language concerning MSO population and habitat monitoring or MSO habitat design would not have an effect on the treatments themselves or their outcomes.

Amendment 2 in alternative C: If the amendment did not occur, fire and mechanical treatments would not take place within the Garland Prairie RNA. The effect of no action within the RNA would include continued encroachment of existing interspace by ingrowth and tree crown expansion and no reestablishment of historic openings which would further reduce forage production and understory species diversity. This would result in declining forest health in terms of increased probability of density-related mortality, increased beetle hazard, continued forest conditions that encourage mistletoe spread and intensification, and decreased resilience under a warmer, drier climate.

Amendment 3 in alternative C: If the amendment did not occur, treatments within MSO habitat would continue to meet the intent of the MSO recovery plan and the MSO habitat definition would not have an effect on the treatments themselves or their outcomes. Managing for 10 percent threshold habitat within the Kaibab NF portion of the project area could result in habitat that is not capable of maintaining a population of MSOs and that could not be sustained through time if designated as threshold habitat. Mechanical treatments within the 2,090 acres of target/threshold habitat would follow the denser 150 square basal area guidance, thereby reducing the ability to improve MSO nesting/roosting habitat in terms of sustainability, as indicated by high potential for density-related mortality and high bark beetle hazard rating as well as reducing the ability to improve age class diversity and the liberation of overtopped oak. Following existing forest plan language concerning MSO population and habitat monitoring or MSO habitat design would not have an effect on the treatments themselves or their outcomes.

Cumulative Effects

For the cumulative effects analysis, the spatial context is the larger 988,764-acre analysis area. Cumulative effects are discussed in terms of wildfire and vegetation management activities that have occurred since 2001 and as changes in the existing condition due to present and foreseeable activities, including the effects of the alternative being discussed. The timeframe considered is approximately 10 years in the future at which time the majority of the actions proposed will have been completed and the vegetation response to these actions will have occurred.

Table 53 lists approximate acres of the various vegetation management, fuels treatment, and prescribed fire, as well as wildfires that have occurred within the project area from 2001 to 2010:

- Mechanical vegetation management activities have mainly consisted of tree thinning. This includes 50,940 acres with a fuels reduction emphasis, 14,950 acres with a ponderosa pine restoration emphasis, and 750 acres with an emphasis on improving forest structure, health, and growth. There has also been 12,560 acres of tree removal to restore ponderosa pine savannas and encroached grasslands, 2,650 acres of removal of dead, damaged, or dwarf mistletoe infected trees to improve forest health, 100 acres of tree removal to restore aspen inclusions, and 1,935 acres of habitat improvement treatments that reduced tree density within antelope travel corridors. Within the project area there has been 640 acres of tree and vegetation removal associated with powerline corridor management and protection.
- Fuels treatments that have been accomplished in association with the above listed mechanical treatments include 3,910 acres of mechanical fuels treatments (slash lopping, crushing, piling, and jackpot burning), 5,070 acres of machine piling and burning, and 59,640 acres of broadcast burning. The primary focus of these treatments was to rearrange and reduce activities generated fuels.
- Prescribed burns have been implemented on 47,970 acres to reduce natural fuels accumulations and reintroduce fire to fire-adapted ecosystems.
- Wildfires from 2001 to 2010 have burned on approximately 108,160 acres of the project area. Of these acres, it is estimated that the overall average burn severity to the vegetation was 20 percent high severity, 30 percent mixed severity, and 50 percent low severity. There is wide variability among these percentages from fire to fire.

Table 53. Approximate acres of vegetation management activities and wildfire within the project area from 2001 to 2010

Treatment	Treatment Type	Approximate Acres
Mechanical Vegetation Management	Thinning—Fuels Reduction Emphasis	50,940
	Thinning— Restoration Emphasis	14,950
	Thinning—Stand Improvement	750
	Savanna/Grassland Restoration	12,560
	Sanitation/Salvage	2,650
	Aspen Restoration	100
	Habitat Improvement	1,935
	Powerline Hazard Tree Removal and Right-of-Way	640
Total Mechanical		**84,525**
Fuels Treatments (With Mechanical)	Mechanical Fuels Treatment	3,910
	Pile and Burn	5,070
	Broadcast Burn	59,640
Total Fuels Treatments		**68,620**
Prescribed Burn (Burn Only)		**47,970**
Wildfire		**108,160**

Forest Structure and Diversity – Mosaic of Interspaces and Tree Groups of Varying Sizes and Shapes

The thinning with a restoration emphasis and savanna restoration treatments were designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sizes and shapes. All other treatments listed were incidental to this desired condition. Mixed-severity wildfires resulted in a mosaic of tree mortality and a pattern with indiscriminate interspaces and tree groups. The remaining treatments and low-severity wildfire resulted in some irregular tree spacing.

Forest Structure – All Age and Size Classes Represented

The main objective of thinning with a fuels reduction emphasis was to reduce canopy fuels and the potential for crown fire initiation. Generally, this type of treatment focused on removal of trees in the subordinate crown positions and retaining those trees in the dominate and codominate crown positions and any pre-settlement trees. This type of treatment resulted in a moderately open canopy, even-aged forest structure with very little age and size class diversity.

Thinning treatments with restoration objectives were very similar to the goshawk habitat and MSO restricted other habitat treatments proposed under this EIS and have resulted in similar diversity in age and size class.

Prescribed fire and mechanical fuels treatments associated with the above thinning treatments resulted in periodic tree mortality of seedling/sapling size trees and susceptible pre-settlement trees, further reducing age class diversity.

High- and mixed-severity wildfires caused large-scale mortality across all age and size classes resulting in a nonstocked or single age class representation. Wildfires that burned with a low severity and prescribed burn only treatments had similar effects to forest structure as the post-thinning prescribed fires.

Old Forest Structure Sustained Over Time Across the Landscape

Thinning treatments retained pre-settlement trees and the largest post-settlement trees. Sanitation treatments may have removed some old forest structure. Prescribed fire and low-severity wildfire resulted in periodic tree mortality of susceptible pre-settlement trees. Mixed- and high-severity wildfire killed a large proportion of the old forest structure. Powerline treatments removed any old forest structure that was a hazard to the powerline.

Forest Health

Thinning treatments resulted in forest density within the low to moderate density zones. This, in turn, had a beneficial effect of improved forest growth and reducing the potential for density and bark beetle related mortality. Thinning treatments also removed dwarf mistletoe infected trees, reducing the percent of trees infected as well as creating conditions that slowed or inhibited mistletoe spread. Prescribed fire and low-severity wildfire also led to localized reduction of forest density and dwarf mistletoe infection.

Thinning treatments reduced risks associated with dense forest conditions and improved resilience to the impacts of large-scale disturbance under drier and warmer conditions. Within-forest carbon stocks were reduced by the thinning. Some of the carbon removed has been sequestered for a time in the form of pallets and building materials. Mixed and high-severity wildfires released large amounts of carbon into the atmosphere and resulted in a carbon source as dead material continues to decay. This is especially prevalent in burned areas where the conifer forests have not regenerated.

The savanna/grassland restoration treatments implemented restored historic grasslands, savannas, and forest openings by removing ponderosa pine tree canopy that was shading out understory herbaceous vegetation. Thinning treatments with a restoration objective also restored historic forest openings.

Removing conifer competition with mid-story and understory oak as part of the thinning contributed to maintaining and improving oak growth and vigor. Mixed- and high-severity wildfire killed large oaks that were replaced by oak sprouts, thereby changing oak structure from old to young.

Aspen restoration treatments were very similar to the aspen treatments proposed under this project and have resulted in aspen regeneration and age class diversity.

Some of the fuels reduction thinning within pine-sage on the Tusayan district removed overtopping young pines and improved conditions for understory sage.

Cumulative Effects – Alternative A

Alternative A would not contribute to improving forest health or vegetation diversity and composition, or sustaining old forest structure over time or moving forest structure toward desired conditions.

Cumulative Effects – Alternatives B, C, and D

Alternative B restoration treatments would contribute an additional 509,195 acres toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time and moving forest structure toward desired conditions.

Alternative C restoration treatments would contribute an additional 562,380 acres toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time and moving forest structure toward desired conditions.

Alternative D restoration treatments would contribute an additional 489,029 acres toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time and moving forest structure toward desired conditions.

Cumulative Effects – Present and Foreseeable Vegetation Management Activities

Table 54 lists approximate acres of the various vegetation management, fuels treatment, and prescribed fire that are ongoing (as of 2011) or are foreseeable within the project area. The effects of the thinning with restoration emphasis, savanna/grassland restoration, aspen restoration, as well as prescribed fire are similar to what has been described with the proposed treatments for this EIS. The effects of the thinning with a fuels reduction emphasis will be similar to those that occurred from 2001 to 2010 as discussed above. The salvage involves the removal of down trees as a result of the 2010 tornado and has no effect to forest structure or diversity. The maintenance of powerline corridors will continue as needed and will remove any vegetation that is a hazard to the line.

Table 54. Approximate acres of present and foreseeable vegetation management activities within the project area

Treatment	Treatment Type	Approximate Acres
Mechanical Vegetation Management	Thinning—Fuels Reduction Emphasis	6,670
	Thinning—Restoration Emphasis*	80,940
	Thinning—Stand Improvement	0
	Savanna/Grassland Restoration	11,130
	Sanitation/Salvage	4,290
	Aspen Restoration	5,130
	Habitat Improvement	0
	Powerline Hazard Tree Removal and Right-of-Way	500
Total Mechanical		**108,660**

Treatment	Treatment Type	Approximate Acres
Fuels Treatments (With Mechanical)	Mechanical Fuels Treatment	0
	Pile and Burn	0
	Broadcast Burn	102,470
Total Fuels Treatments		**102,470**
Prescribed Burn (Burn Only)		**5,950**

*Vegetation cumulative effects analysis does include the foreseeable (2013) Flagstaff watershed protection project even though little information is available on treatments. This analysis assumes both mechanical and prescribed fire treatments would occur.

Fire Ecology

Only a summary of the fire ecology analysis is presented here and the report is incorporated by reference. See the fire ecology specialist report (Lata 2013) for the complete analysis. Fire behavior was analyzed at several scales including the project scale (593,211-acre treatment area), RU, subunit, and vegetation type/habitat type in order to provide a thorough analysis of specific fire effects to different areas. Using various scales of analysis provides site-specific information on existing risks and threats to resources and addresses the comments and recommendations received throughout the scoping process. FRCC was analyzed at the project area scale for ponderosa pine and grasslands as they make up 90 percent of the project area. See the specialist report for the complete discussion on analysis methodology.

The following analysis question was used to evaluate movement toward desired conditions by alternative:

> **Analysis Question 1:** Would/how would proposed management actions move the area toward the project's desired condition of having a resilient forest by reducing the potential for undesirable fire behavior and effects? Metrics used to evaluate differences between alternatives include:
>
> - **Type of fire (surface or crown):** Acres (quantitative measure) of each potential fire type following proposed treatments were evaluated.
> - **Canopy characteristics—canopy base height, canopy bulk density, and canopy cover** (quantitative measures used in fire modeling): These are canopy characteristics that are important for modeling fire.
> - **Surface fuel loading for the fire and emissions modeling includes CWD>3″, litter, and duff** (quantitative measure): Used to qualitatively evaluate fire effects.
> - **FRCC** (qualitative measure): FRCC was determined for ponderosa pine and grasslands which make up the largest vegetation types within the treatment area to determine the relative departure of those ecosystems from reference conditions before and following treatments.

Affected Environment

Existing and desired conditions for fire behavior and FRCC are addressed in the "Fire Ecology" section in chapter 1. Most existing condition information is not repeated here.

Fire Behavior at the Landscape Scale

Fire type was modeled for conditions similar to those under which the Schultz Fire burned in 2010. These were not extreme in terms of fuel moisture, temperature (77 degrees Fahrenheit), or relative humidity (14 percent), though fuels were dry and it was windy (steady at 25 mph). These conditions are common in June across the project area.

Fire Behavior by Restoration Unit (RU)

RU 1

RU 1 is currently the most at risk of all the RUs in regards to crown fire and its effects. Approximately 42 percent of the RU has crown fire potential, of which 31 percent would be active crown fire. Values at risk in or adjacent to RU 1 include: Lake Mary, a source watershed for Flagstaff and a popular recreation site for locals and visitors to the area (subunit 1-1); Pulliam Airport, the commercial airport that serves Flagstaff and surrounding communities (subunit 1-1); eastern and southern portions of the city of Flagstaff; the Perkins Telescope (subunit 1-1); numerous MSO PACs (more than any other RU), and Walnut Canyon National

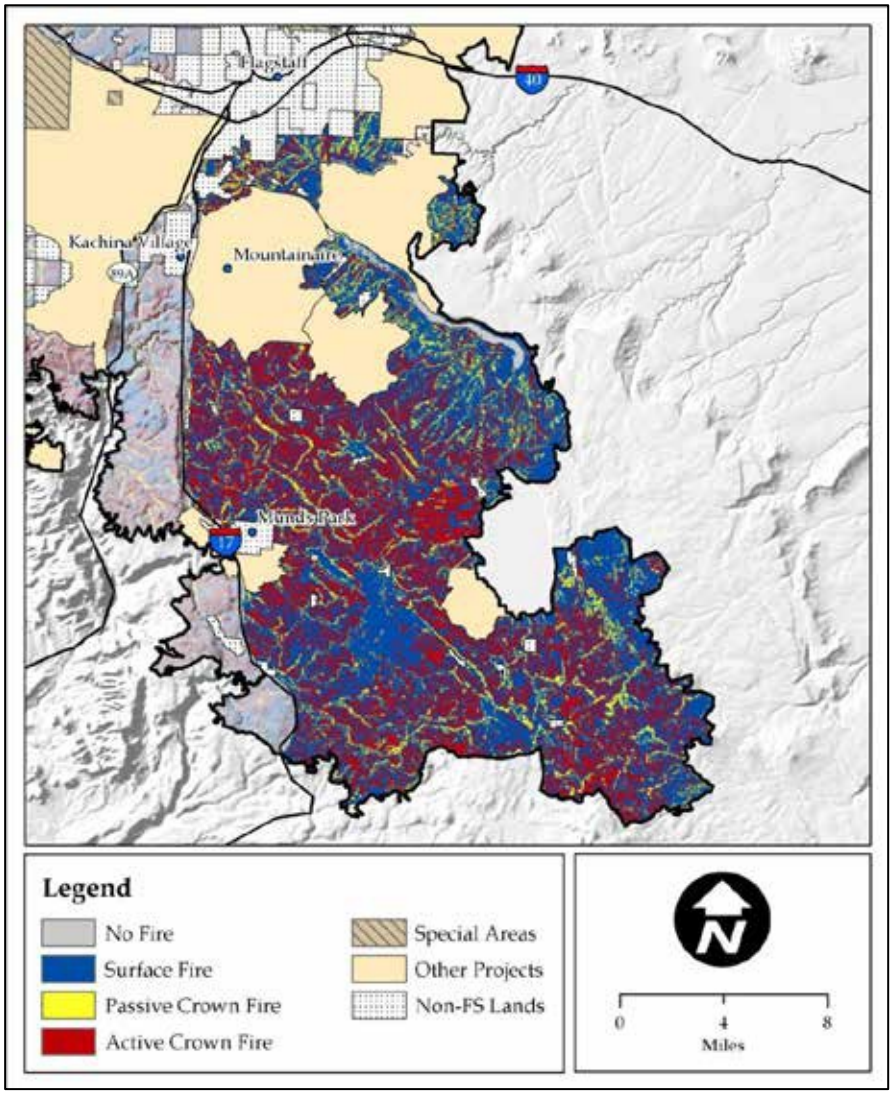


Figure 38. Existing fire potential in RU 1

Monument (subunit 1-1). Figure 38 displays locations of no fire, surface fire, and active/passive crown fire. “No fire” includes areas that could not burn under conditions modeled because of sparse vegetation (such as on some cinder soils) or no vegetation (water, rock, etc.).

RU 3

RU 3 has the second greatest potential for undesirable fire effects and behavior. Approximately 39 percent of RU 3 has crown fire potential, of which 30 percent would be active crown fire. Winds on the Mogollon Rim are generally out of the southwest; therefore, values at risk in this RU include: Interstate 17 and Interstate 40, as well as the communities of Flagstaff, Munds Park, Williams, Belmont, Kachina Village, Parks, and Sycamore and Oak Creek Canyon.

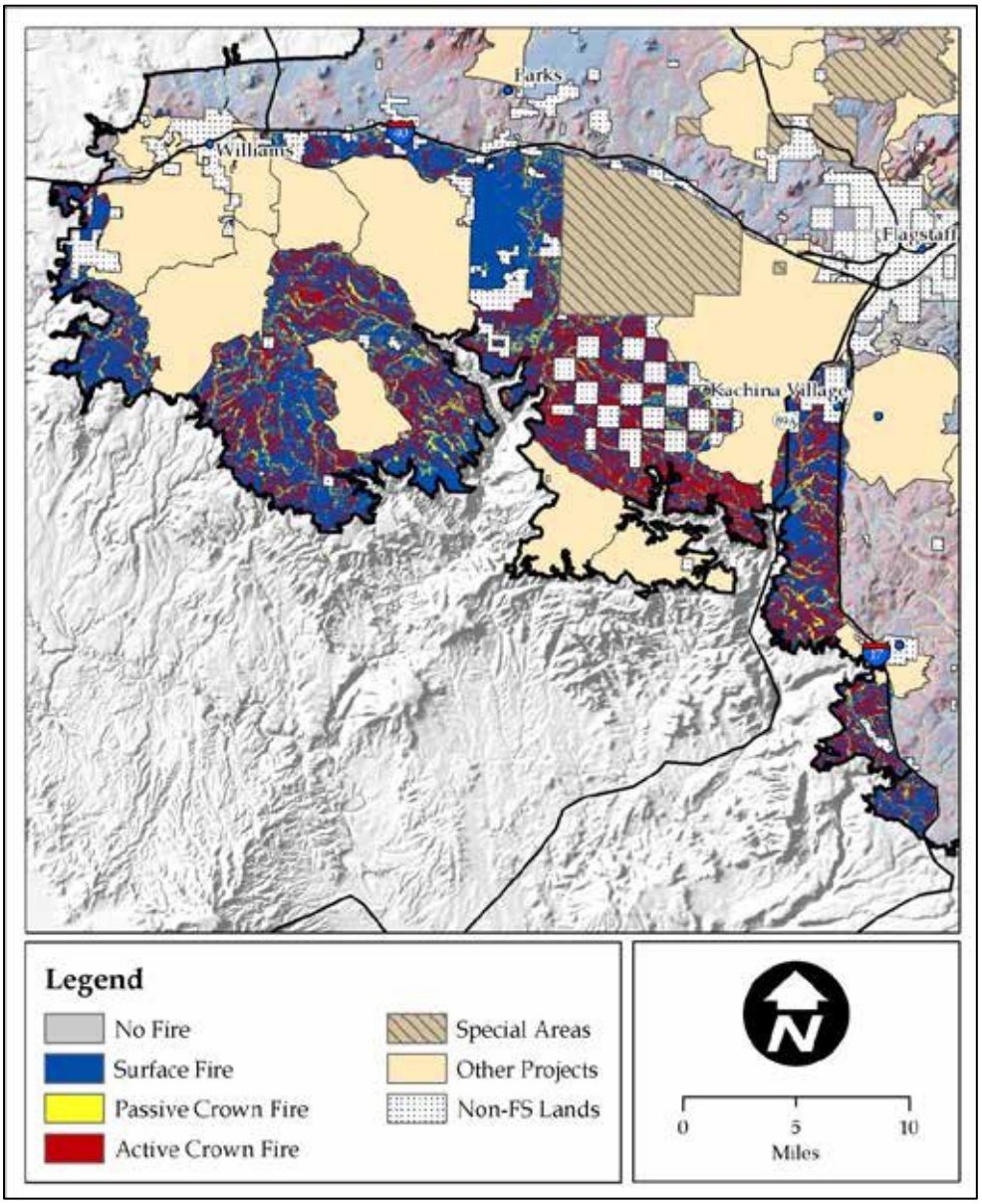


Figure 39. Existing fire potential in RU 3

RU 4

RU 4 has a 32 percent potential for crown fire, of which 25 percent would be active crown fire. RU 4 is located west and north of Flagstaff, and north of Williams and Interstate 40. Wildfire in RU 4 has potential to affect the communities of Flagstaff, Williams, Parks, and Belmont, though the prevailing winds would draw fire away from these communities. There is also potential to impact the Fort Valley Experimental Station northwest of Flagstaff.

Over the last 20 years, RU 4 has been impacted by several large fires, including the Hockderffer (2004, 16,000 acres) and Pumpkin (2000, 8,700 acres) Fires. Areas of potential active crown fire currently exist adjacent to heavy fuel loading in mixed conifer on Kendrick and Sitgreaves Mountains, and the San Francisco Peaks.

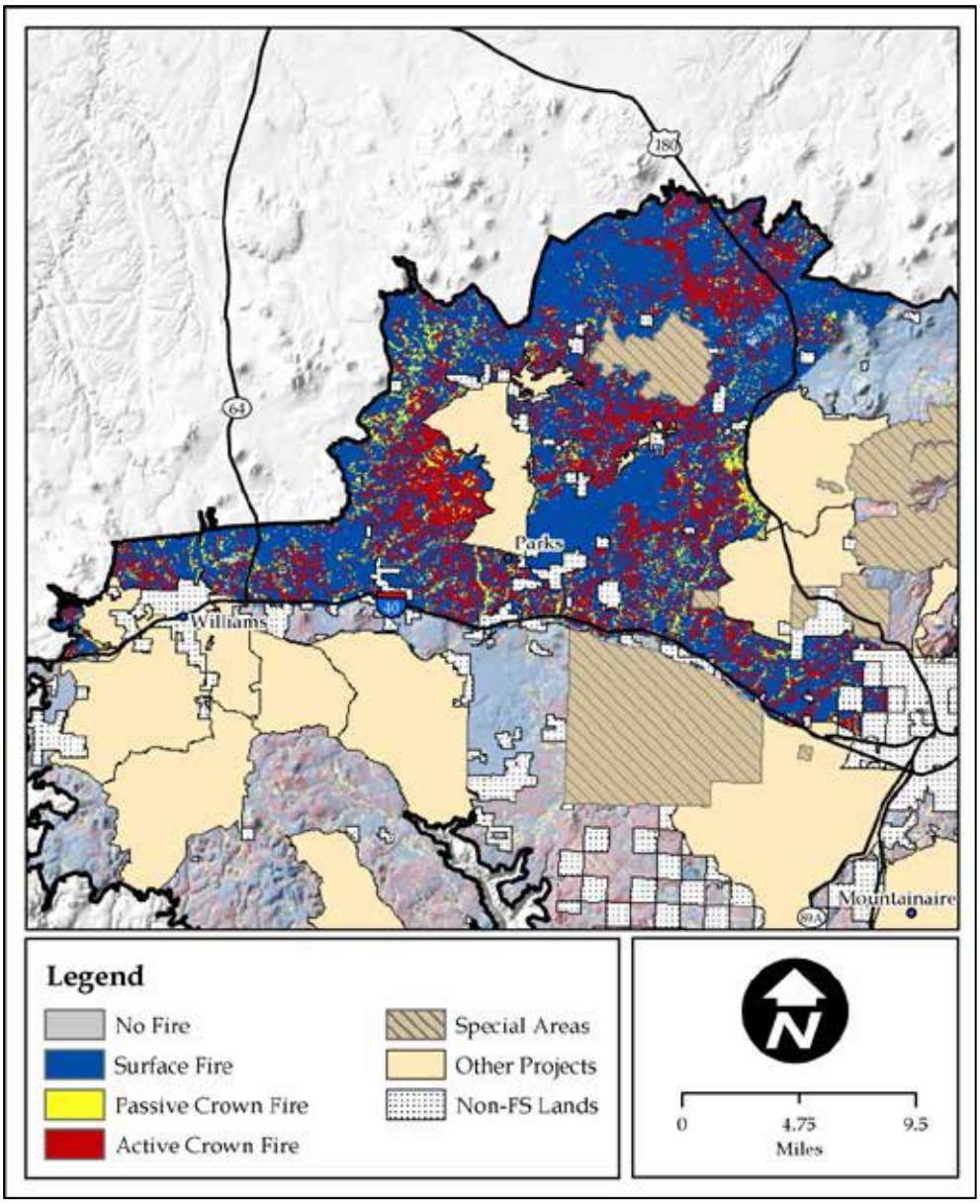


Figure 40. Existing fire potential in RU 4

RU 5

RU 5 has 22 percent potential for crown fire, of which over half would be active crown fire. This RU includes acres burned in the Schultz Fire (2010, 17,000 acres) and acres burned in the Radio Fire (1977, 2,600 acres). The Radio Fire burned area is mostly on Mount Elden which is immediately upslope and adjacent to northern Flagstaff. Housing developments (including Doney Park) and the city of Flagstaff would be adjacent and mostly downslope from any fire occurring in this RU.

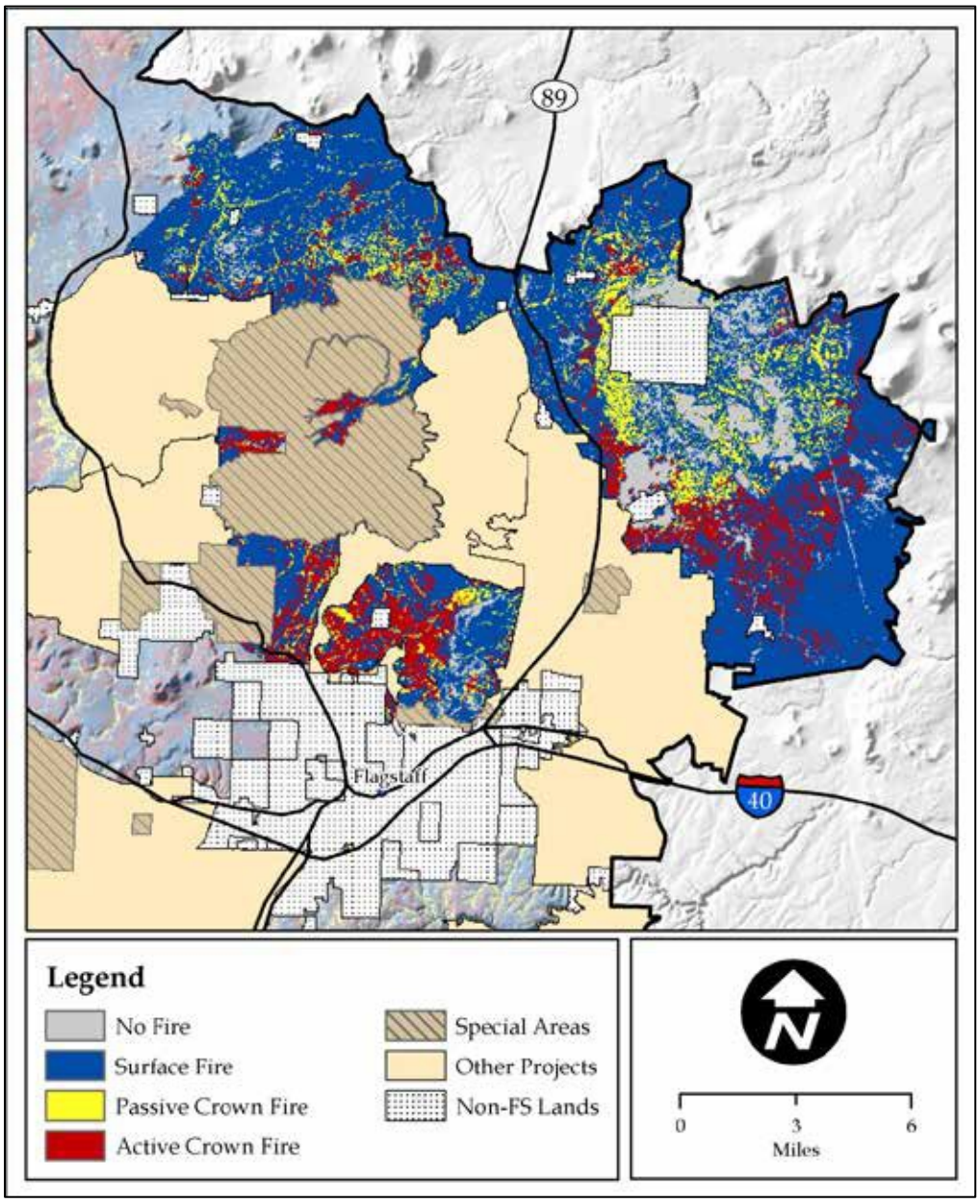


Figure 41. Existing fire potential in RU 5

RU 6

RU 6 has a 19 percent potential for crown fire. Of this percent, over 50 percent would be active crown fire. RU 6 is entirely within the Tusayan Ranger District (Kaibab NF). It is located in close proximity to the town of Tusayan and located immediately south of, and adjacent to, Grand Canyon National Park. RU 6 is the driest of all the RUs. Over half of the RU has been affected by wildfire in the last 10 years. Potential fire behavior in pinyon-juniper which is adjacent to the town of Tusayan is a concern.

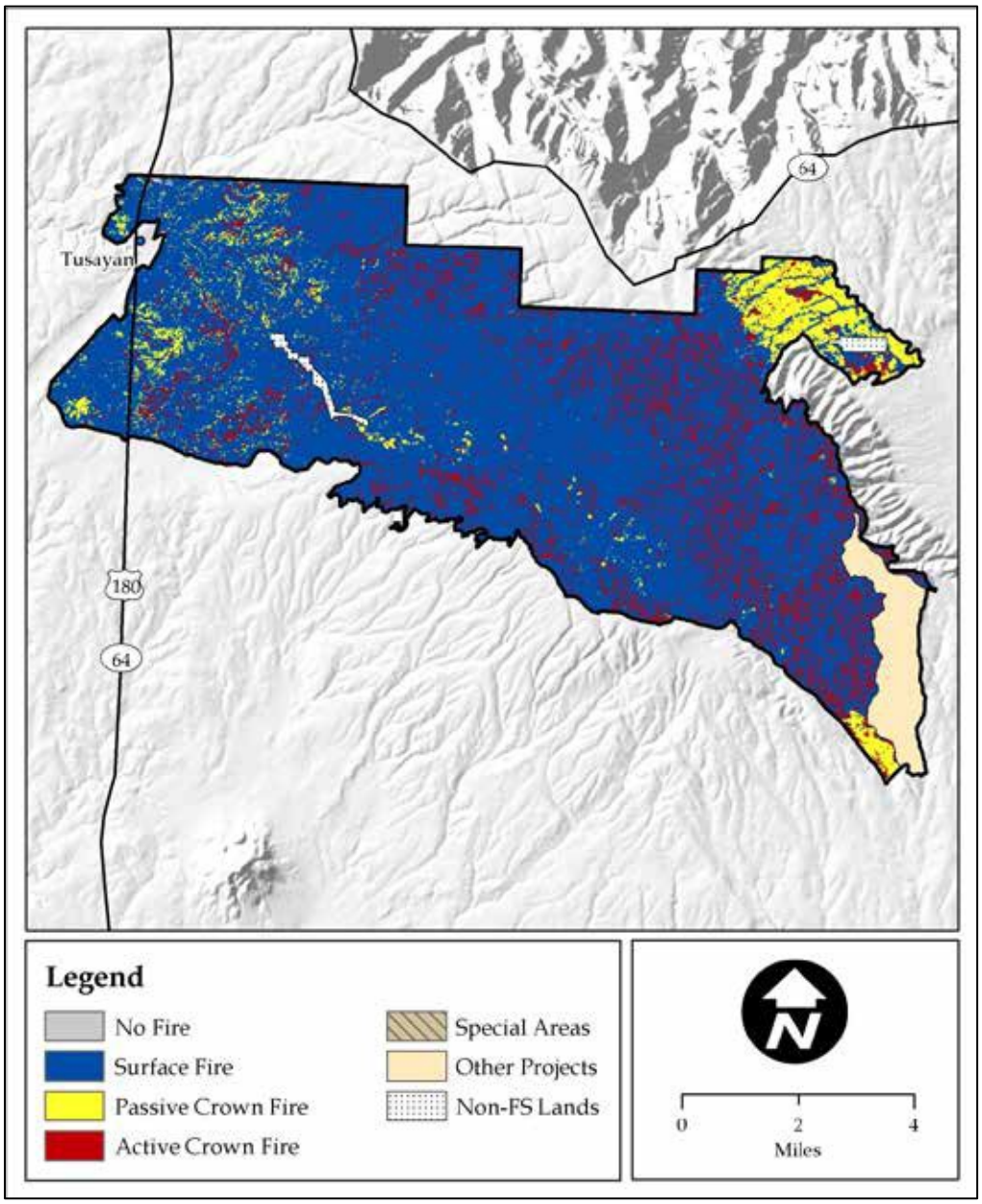


Figure 42. Existing fire potential in RU 6

Canopy Characteristics and Surface Fuels Affecting Fire Behavior

The existing and desired condition for canopy characteristics (canopy base heights and canopy bulk density) and surface fuels (CWD greater than 3 inches, litter, and duff) are presented in chapter 1.

Fire Regime Condition Class (FRCC)

The existing and desired conditions for FRCC are presented in chapter 1.

Environmental Consequences

Throughout this section, changes directly attributable to proposed actions—such as thinning or prescribed fire—are direct effects. These include changes to canopy bulk density, canopy base height, consumption of surface fuel, etc. Changes to the potential behavior and effects of wildfires that result from the direct effects are considered indirect effects.

Alternative A – Direct and Indirect Effects

Fire Behavior at the Landscape Scale

At the landscape scale, 34 percent of ponderosa pine and 9 percent of grasslands would have the potential for high-severity effects from crown fire. The potential for crown fire exceeds the desired condition in ponderosa pine by 24 percent and 6 percent in grasslands. Modeled fire type shows the potential for multiple, large (greater than 1,000 acres), high-severity fires across the landscape, with the actual extents dependent on ignition location and environmental conditions. As canopies close up, surface fuel loading would also continue to increase. In the long term (2050), more area would be subject to high severity surface fire. The changes in canopy fuels would have detrimental effects on understory vegetation and would increasingly suppress surface vegetation (forbs, grasses, and shrubs). The combination of abundant and contiguous canopy fuels, the lack of understory vegetation, and an already high and increasing surface fuel load, would combine to increase the potential for high-severity fire, maintaining the area in a FRCC of 3 into the foreseeable future.

Fire Behavior at the RU Scale

In 2020, no RUs would meet desired conditions for fire behavior, ranging from 42 percent (RU 1) to 14 percent (RU 6) (table 55). In RU 1, there is potential for 60,000 acres of ponderosa pine to burn with high severity (potential crown fire combined with the potential for high severity surface fire), a subset of which would convert to a nonforested vegetation type (Savage and Mast 2005). Should wildfire burn though the Lake Mary watershed, the second order fire effects (debris flows and flooding with sediment-laden water) could jeopardize the water supply (from the lakes) as well as, at least temporarily, require the closure of recreation sites.

Table 55. Modeled fire type for alternative A (2020) by restoration unit* in acres and percent of treatment area

RU	Surface	Passive	Active	No Fire
RU 1	90,633 (58%)	18,251 (12%)	46,463 (30%)	957 (0.6%)
RU 3	92,532 (62%)	14,219 (9%)	42,082 (28%)	886 (0.6%)
RU 4	111,840 (68%)	11,850 (7%)	41,285 (25%)	633 (0.4%)
RU 5	52,931 (70%)	7,265 (10%)	10,100 (13%)	5,800 (6.1%)
RU 6	37,121 (85%)	2,766 (6%)	3,600 (8%)	42 (0.1%)
Total	**385,056 (65%)**	**54,351 (9%)**	**143,530 (24%)**	**8,319 (1.4%)**

* "No fire" includes acres on which there were insufficient fuels to carry fire, including water, rock, cinders, areas of sparse vegetation, etc.

In RU 3, multiple drainages line up with the prevailing winds and have the potential to draw fire toward communities such as Pumphouse Wash (Kachina Village) and Munds Canyon (Munds Park). Adjacency concerns for fire behavior include a number of communities as well as Oak Creek and Sycamore Canyons. Second order fire effects (flooding, debris flows, deposition, erosion, etc.) would have potential to impact Oak Creek and Sycamore Canyons, with the specific locations depending on the slope, proximity, and size of high-severity fire. Overall, with no treatment, there is potential for over 56,000 acres of crown fire (37 percent of the RU), of which over 42,000 (28 percent of the RU) would be active crown fire.

No action in RU 4 would have the potential to affect the communities of Flagstaff, Williams, Parks, and Belmont, though the prevailing winds would tend to blow fire away from most of the populations in Williams, Parks, and Belmont. There is also potential to impact the Fort Valley Experimental Station northwest of Flagstaff. Overall, with no treatment, there is potential for over 53,000 acres of crown fire (32 percent of the RU), of which over 41,000 (25 percent of the RU) would be active crown fire.

The northeastern area of RU 5 has scattered cinder cones and cinder areas which support only sparse vegetation. In these areas, active crown fire is less likely because of decreased potential for high intensity surface fire and decreased canopy fuel continuity. Overall, with no treatment, there is potential for over 17,000 acres of crown fire (23 percent of the RU), of which over 10,000 (13 percent of the RU) would be active crown fire.

Active crown fire in RU6 would mostly be dispersed, with only a few areas of contiguous crown fire. Overall, with no treatment, there would be potential for over 6,000 acres of crown fire (15 percent of the RU), of which over 3,000 (13 percent of the RU) would be active crown fire.

Canopy Characteristics and Surface Fuels Affecting Fire Behavior and Effects

Potential changes to canopy base height and crown bulk density were modeled for the short (2020) and long term (2050) (table 56). Under this alternative, canopy base height and crown bulk density slowly move toward desirable conditions, as a result of the lower branches becoming shaded out by increasing canopy cover. Increasing canopy cover, combined with the other canopy

characteristics at or below desired conditions, would continue to make undesirable fire behavior and effects more likely.

Table 56. Alternative A canopy characteristics 2010 to 2050

Year	Canopy Base Height (feet)	Desired Condition (feet)	Canopy Bulk Density (kilograms per square meter)	Desired Condition (kilograms per square meter)	Canopy Cover (percent)
2010	14.86	18	0.061	0.05	66
2020	16.63	18	0.061	0.05	68
2050	22.22	18	0.059	0.05	72

Total surface fuel loading (CWD greater than 3 inches, litter, and duff) as modeled over 40 years shows a steady increase from approximately 16 to 22 tons per acre. There would be approximately 18,000 acres with surface fuel loading greater than 20 tons per acre (desired condition). These types of fuel loadings could produce undesirable fire effects, including large quantities of emissions. Areas that would have the highest surface fuel loading are often associated with MSO PACs including core areas. RUs 1 and 3 would have the highest surface fuel loading.

Fire Regime Condition Class (FRCC)

Under alternative A (table 57), fire regime/condition class would deteriorate and, by 2050, FRCC 3 acres in ponderosa pine would increase by 13 percent (over 65,000 acres) and FRCC 3 acres in grasslands would increase by 5 percent (almost 3,000 acres).

Table 57. Alternative A FRCC 2010 to 2050 in acres and percent

Vegetation Type	Condition Class	2010	2020	2050
Ponderosa Pine	1	70,680 (14%)	55,534 (11%)	5,049 (1%)
	2	136,311 (27%)	95,923 (19%)	136,311 (27%)
	3	297,866 (59%)	353,400 (70%)	363,497 (72%)
Grasslands	1	10,097 (18%)	6,731 (12%)	1,683 (3%)
	2	40,389 (72%)	42,632 (76%)	45,998 (82%)
	3	5,610 (10%)	6,731 (12%)	8,414 (15%)

Alternatives B, C, and D

The environmental consequences are based on the modeling assumption that one mechanical treatment and two prescribed burns would occur between 2012 and 2019. From 2020 to 2050, no wildfires or additional treatments of any kind were modeled. The effects are based on applying the design features and mitigation displayed in the "Fire" section of appendix C.

Effects Common to All Alternatives

- In the short term (up to 10 years), first entry burns (burns which are the first time fire occurs in an area that has missed 10 to 20 years of fire cycles) would: (1) effectively raise the canopy base height, decrease canopy bulk density, and decrease the likelihood of crown fire; (2) consume a large portion of accumulated litter and duff, along with the majority of dead/down woody fuels less than 3 inches in diameter; and (3) thin out some small trees (particularly seedlings), maintaining a mosaic of groups and interspaces. In areas where fire has been excluded for many decades, a single prescribed fire would be inadequate to reduce fuels (Lynch et al. 2000).
- In the long term, second entry burns are those burns which occur within 2 to 5 years of a first entry burn. For second entry burns, fuel loads would be significantly lower than in first entry burns, producing much less smoke and having lower potential for crown fire or high-severity fire.
- As thinning and first entry burns were completed, burn windows would expand for larger areas so more burning could occur when ventilation was good. The ability to manage unplanned ignitions would expand as 4FRI (and other projects) is implemented.
- Throughout the life of this project, it would be likely that some large and/or old trees would be damaged or killed by prescribed fire as over 30,000 to 50,000 acres of prescribed fire would occur each year. Reducing accumulations of fuel in the vicinity of large and/or old trees is best accomplished by a combination of mechanical and prescribed fire treatments, with the specific need being site specific. However, the damage or mortality to these trees would be mitigated (see "Fire Design Features and Mitigation" in appendix C of the DEIS).
- Potential adaptive management actions for transportation, springs, and roads were reviewed. None of the adaptive actions would result in additional effects that are not already disclosed or addressed in alternatives B, C, and D.

Fire Behavior at the Landscape Scale

Table 58 displays post-treatment fire behavior at the landscape scale for alternatives B, C, and D. In alternative B, the potential for crown fire at the landscape (treatment area) scale would be reduced from 34 percent to 5 percent. Alternative C best reduces the crown fire potential to 4 percent. Alternative D reduces crown fire potential the least (7 percent). See the specialist report which provides environmental consequences by vegetation type and restoration subunit. All action alternatives would meet the desired condition of having crown fire potential on 10 percent or less of the landscape.

Table 58. Alternatives B, C, and D landscape scale (treatment area) fire behavior

Modeled Fire Behavior (Percent of Treatment Area*)	Existing Condition	Alt. B (2020)	Alt. C (2020)	Alt. D (2020)
Surface fire	64	94	94	92
Passive crown fire	9	3	3	4
Active crown fire	25	2	1	3

* Total percentages do not include acres that would not support fire. These acres include area where there were insufficient fuels to carry fire, including water, rock, cinders, areas of sparse vegetation, etc.

Fire Behavior at the RU Scale

At the RU scale, the post-treatment potential for crown fire in alternative B would range from 2 to 8 percent and from 2 to 7 percent in alternatives C and D. Alternatives B and C would meet the purpose and need by moving the project area toward desired conditions of having 10 percent or less crown fire potential. Alternative D meets desired conditions for all RUs except RU 1. Approximately 12 percent of the acres in RU 1 would remain at risk of crown fire.

RU 1

Only alternatives B and C would meet fire behavior desired conditions. Crown fire potential would be reduced to 8 percent in alternative B and 7 percent in alternative C. Potential fire behavior would decrease downslope from the mixed conifer on Mormon Mountain, as well as the city of Flagstaff to the northwest. In alternatives B and C, over 60 percent of active crown fire potential would occur in MSO protected habitat. In alternative D, total crown fire potential would be 12 percent, exceeding desired conditions. Within RU 1, MSO protected habitat would account for over 92 percent of all active crown fire potential.

RU 3

Alternatives B, C, and D would meet fire behavior desired conditions by reducing crown fire potential to 5 percent of the treatment area for alternatives B and C (less than 8,800 acres), and 6 percent for alternative D (9,373 acres). Of the 5 percent, 1 percent would be active crown fire for B and C (less than 2,200 acres), and 2 percent for D. There would still be potential for active crown fire in PACs in Kelly Canyon and Pumphouse Wash, including potential for some active and passive crown fire on slopes greater than 30 and 40 percent. Outside of MSO PACs, there would be some contiguous areas of both passive and active crown fire. However, the majority of potential crown fire would be scattered passive crown fire.

RU 4

Alternatives B, C, and D would meet fire behavior desired conditions. In alternative B, RU 4 would have the potential for 3 percent crown fire (4,585 acres) and alternative C would have the potential for 2 percent (3,505 acres) crown fire. Alternative D would result in the most (5 percent) crown fire potential (7, 148 acres). All alternatives would have the potential for approximately 1 percent active crown fire.

Most of the potential crown fire in RU 4 would be in scattered patches, with few areas of contiguous active crown fire greater than about 15 acres, mostly in areas classified as grasslands or other nonpine vegetation. References to crown fire in grasslands here refer to crown fire in trees growing in the grasslands. There would be larger contiguous acreages of passive crown fire in goshawk PFAs and areas of lower intensity treatments, and some prescribed fire only treatments.

RU 5

Alternatives B, C, and D would meet fire behavior desired conditions. In alternative B, there would be 2 percent crown fire potential, and in alternative D, 4 percent. This would be reduced in alternative C to 2 percent. For all alternatives, the percent of potential active crown fire would be 1 percent or less. There are many areas, some larger than 500 acres, in the north and eastern areas of this RU that are cinder substrate. In these areas, active crown fire would be less likely because of decreased potential for high intensity surface fire.

RU 6

Alternatives B, C, and D would meet fire behavior desired conditions. In alternatives B and C, RU 6 would have 4 percent (2,204) acres with crown fire potential. Of this, 107 acres (less than 1 percent) would have the potential for active crown fire. In alternative D, the potential for crown fire increases to 5 percent. In all alternatives, acres with crown fire potential would occur in nest areas/PFA/dPFA (dispersal post-fledgling area) habitats and the potential for passive crown fire would be widely dispersed with concentrations in areas with components of juniper and oak, particularly on the northeastern and southeastern corners.

Canopy Characteristics and Surface Fuels Affecting Fire Behavior and Effects

Table 59 displays that the canopy characteristics in alternatives B, C, and D would move toward desired conditions immediately post treatment (2020). Alternatives B and C would meet desired conditions in both the short (2020) and long (2050) term when compared to the existing condition (2010). In the long term (2050), canopy bulk density (when averaged across the landscape) in alternative D meets desired conditions. However, when analyzed by desired openness (see the canopy cover column in table 59), canopy bulk density would exceed desired conditions on approximately 28,000 acres resulting in a high potential for crown fire.

Table 59. Alternatives B–D canopy characteristics for ponderosa pine from 2010 to 2050

Alt.	Canopy Base Height (feet)				Canopy Bulk Density (kg/m3)				Canopy Cover (percent)		
	2010	2020	2050	Desired Condition	2010	2020	2050	Desired Condition			
B	14.84	24.73	26.67	18	0.061	0.034	0.040	<0.05	66	55	63
C	14.86	24.71	26.65	18	0.061	0.034	0.040	<0.05	66	55	63
D	14.84	22.79	25.18	18	0.061	0.037	0.043	<0.05	66	58	65

Surface Fuel Loading (CWD Greater Than 3 Inches, Litter, and Duff)

In alternative B, post-treatment surface fuels would be reduced to recommended levels over most of the treatment area (5 to 20 tons per acre). The exceptions are mostly in RU 1 in MSO PACs where there would be surface fuel loadings greater than 20 tons per acre (table 60).

In alternative C, fuel loading would be decreased below 20 tons per acre in most of the treatment areas (table 60). There would be approximately 809 acres with surface fuel loading greater than 20 tons per acre occurring mostly in RU 3 in MSO PACs, a few areas in RU 4, and two areas in RU 5 (see figure 57 in the specialist report). In this alternative and in the immediate short term (up to 2 years post treatment), CWD greater than 3 inches would range from 2.46 to 2.96 tons per acre—below forest plan desired conditions. In the long term (2 plus years post treatment), modeling for this project and research (Waltz et al. 2003) suggest that it would be just a year or 2 before CWD levels once again meet desired conditions. In alternatives B and D, with no maintenance treatments after 2020, CWD greater than 3 inches would exceed current forest plan guidelines by 2050. When considered by desired openness (see the canopy cover column in table 59), both alternatives B and C would meet the recommended tons per acre of surface fuel loading.

In alternative D, all treated areas would remain below 20 tons per acre (meet desired conditions) when considered by desired openness (table 60). However, when considered at the stand level, there would be approximately 3,357 acres with surface fuel loading greater than 20 tons per acre in both the short term (2020) and long term (2050) mostly in MSO PACs or goshawk PFAs in RU 1 and RU 3 where no prescribed fire treatments would occur.

Table 60. Alternative B–D surface fuel loadings in ponderosa pine from 2010 to 2050

Alternative	CWD >3"			Litter			Duff		
	2010	2020	2050	2010	2020	2050	2010	2020	2050
B	4.44	3.46	7.01	3.97	2.48	4.22	3.76	3.42	3.97
C	4.46	2.93	6.45	3.97	2.12	3.22	3.77	3.42	3.94
D	4.44	5.97	8.80	3.97	3.75	4.49	3.76	3.87	4.50

FRCC

Table 61 compares the existing FRCC to expected changes by alternative. In ponderosa pine in the short term (2020), all action alternatives would move toward desired conditions with alternative C moving the most acres out of FRCC 3 (33 percent reduction). In the long term (2050), the percentage of ponderosa pine in FRCC 3 would increase in all alternatives with alternative D most closely resembling the existing condition as approximately 50 percent of the landscape would revert back to FRCC 3.

In grasslands, only alternative C would move toward desired conditions in both the short (2020) and long (2050) term. Alternative D would exceed desired conditions in both the short and long term.

Table 61. Alternatives B, C, and D FRCC in 2020 and 2050

Vegetation Type	FRCC	Existing Condition (2010)	Percent Change in FRCC by Alternative and Year					
			Alt. B		Alt. C		Alt. D	
			2020	2050	2020	2050	2020	2050
Ponderosa Pine	FRCC 1	14	18	15	19	16	8	5
	FRCC 2	27	78	49	81	51	82	45
	FRCC 3	59	4	36	0	33	10	50
Grasslands	FRCC 1	18	15	10	31	35	15	5
	FRCC 2	72	77	80	66	60	74	80
	FRCC 3	10	8	10	3	5	11	15

Other Restoration Treatments (Springs, Streams, Roads)

Streams and springs would not be expected to have much effect on fire behavior or effects in the short term. In the long term, restored hydrology, particularly in springs, may result in increased surface fuel loading near springs, allowing wildfire or prescribed fire to creep closer to the water source than is generally possible now. Forest plan direction includes using prescribed fire to manage fuels in riparian areas.

Many wildfires that have been started by humans begin in proximity to roads. The alternatives may result in fewer human-started wildfires. The more heavily used roads may have functioned as firebreaks in the past. Once decommissioned, surface fuel loadings would eventually grow back, allowing fire to burn across the area. During implementation of the mechanical treatments, temporary roads constructed for access (517 miles) would be available for access to burn units, and/or to be used as fire lines for prescribed fires.

Forest Plan Amendments

Alternative B

Alternative B Amendment 1 (Coconino NF): If amendment 1 is implemented, the resulting decreases in canopy base height, canopy bulk density, and canopy cover would have the indirect effect of slightly decreasing crown fire potential for the 18 MSO PACs that would receive mechanical treatments. An additional indirect effect would be to increase the ability of fire managers to implement prescribed fire within PACs because of decreased potential fire behavior. If amendment 1 is not implemented on the Coconino NF, these 18 PACs (approximately 10,700 acres) would retain the current forest structure that places them at high risk of high-severity fire. Potential fire behavior would make it difficult to implement prescribed fire because of narrow burn windows (weather and fuel conditions that would produce the desired fire effects and behavior). If prescribed fires were implemented on acres adjacent to PACs, it would be more likely that some fire lines would need to be created to avoid burning in the PAC, producing ground disturbance that would be less likely under the proposed amendment. There would be little effect on emissions, except for a slight decrease in potential emissions in the event of wildfire following mechanical treatments within the PACs.

Alternative B Amendment 2 (Coconino NF): If amendment 2 is implemented, it would allow 29,017 acres to be managed for an open reference condition. An indirect effect of managing for open conditions would be to have little potential for active crown fire, moving these acres toward desired conditions. Open conditions would, in the long run, produce fewer emissions because of less litter and debris from trees and the greater herbaceous component to surface fuels. If amendment 2 is not implemented on the Coconino NF, some treatments could be implemented, but these acres would not move as far toward desired conditions as they would be with the amendment.

Alternative B Amendment 3 (Coconino NF): If amendment 3 is implemented, it would allow fire to be used to meet objectives if it was determined to be the best tool. Additionally, it would allow all significant, or potentially significant, inventoried sites that are not considered "fire sensitive" to be included in burn units. If amendment 3 is not implemented, all significant, or potentially significant, inventoried sites within burn units, regardless of if they are considered "fire sensitive" or not, would be managed for "no effect."

Amendment 1 (Kaibab NF): If amendment 1 is implemented, the same effects that are described above (amendment 2 for the Coconino NF) would apply to the 27,637 acres to be managed for an open reference condition.

Amendment 2 (Kaibab NF): If amendment 2 is implemented, it would have minimal effect on the implementation of prescribed fire proposed under alternative B on the Kaibab NF because there would be only minor differences from current conditions.

Alternative C

Amendment 1 (Coconino NF): If amendment 1 is implemented, the resulting decreases in canopy base height, canopy bulk density, and canopy cover would have the indirect effect of slightly decreasing crown fire potential for the 18 MSO PACs that would receive mechanical treatments. An additional indirect effect would be to increase the ability of fire managers to implement prescribed fire within PACs because of decreased potential fire behavior. If amendment 1 is not implemented on the Coconino NF, these 18 PACs (approximately 10,700 acres) would retain the current forest structure that places them at high risk of high-severity fire. Potential fire behavior would make it difficult to implement prescribed fire because of narrow burn windows (weather and fuel conditions that would produce the desired fire effects and behavior). If prescribed fires were implemented on acres adjacent to PACs, it would be more likely that some fire lines would need to be created to avoid burning, producing ground disturbance that would be less likely under the proposed amendment. There would be little effect on emissions, except for a slight decrease in potential emissions in the event of wildfire following mechanical treatments within the PACs.

Amendment 2 (Coconino NF): If amendment 2 is implemented, it would allow 29,017 acres to be managed for an open reference condition. An indirect effect of managing for open conditions would be to have little potential for active crown fire, moving these acres toward desired conditions. Open conditions would, in the long run, produce fewer emissions because of less litter and debris from trees and the greater herbaceous component to surface fuels. If amendment 2 is not implemented on the Coconino NF, some treatments could be implemented, but these acres would not move as far toward desired conditions as they would be with the amendment.

Amendment 3 (Coconino NF): If amendment 3 is implemented, it would allow fire to be used to meet objectives if it was determined to be the best tool. Additionally, it would allow all significant, or potentially significant inventoried sites that are not considered "fire sensitive" to be included in burn units. If amendment 3 is not implemented, all significant, or potentially significant, inventoried sites within burn units, regardless of if they are considered "fire sensitive" or not, would be managed for "no effect."

Amendment 1 (Kaibab NF): If amendment 1 is implemented, the same effects that are described above (amendment 2 for the Coconino NF) would apply to the 27,675 acres to be managed for an open reference condition.

Amendment 2 (Kaibab NF): If amendment 2 is implemented, there would be an additional 400 acres of mechanical and prescribed fire treatments that would move those acres toward desired condition (over alternatives B and D), as well as allowing more flexibility for laying out burn units in adjacent areas. If amendment 2 is not implemented, some of those acres could be burned under "operational burn," but most would not move as far, or at all, toward desired condition.

Amendment 3 (Kaibab NF): If amendment 3 is implemented, the effects would be minimal, because the biological opinion from the FWS is expected to differ only minimally from current direction.

Alternative D

The effects would be the same as described for alternative B.

Cumulative Effects

The cumulative effects boundary includes the project area, the South Rim of Grand Canyon National Park, and an area approximately 15 miles south and west of the project area to encompass areas that could be affected by fire from prevailing winds. Because RU 6 (Tusayan district) is removed from the main project area, the cumulative effects analysis includes projects and events that specifically affect (or have affected) RU 6 and projects and events that affect (or have affected) the remainder of the project area.

The timeframe considered for past projects is 2000 to 2010. Foreseeable projects extend approximately 10 years into the future. This timeframe accounts for when the majority of actions were or will be completed and for measuring fire effects from prescribed fire and the effects of treatment on potential wildfire behavior.

Past Projects and Natural Disturbances

Eight thinning and broadcast burn projects (2000 to 2010) totaling approximately 42,737 acres (completed near, adjacent to, or within) in RU 6 have affected potential fire behavior and effects in the treatment area. Some of the larger projects include Long Jim, Scott, Ten X, Topeka, and Tusayan East. See the fire ecology report for the complete list of projects by year and acres. Approximately 32,702 acres of wildfire occurred in or around RU 6 from 2000 to 2010. Some of the larger wildfires include Camp 36 (3,052 acres, 2003), Ruby (4,107 acres, 2009), and Mudersbach (7,260 acres, 2005).

In the remainder of the cumulative effects analysis area, approximately 204,839 acres of mechanical treatment/prescribed fire, and 151,782 acres of wildfire from 2000 to 2010 have decreased the potential for active crown fire and crown fire initiation. Some of the larger wildfires include Wildhorse (13,790 acres, 2009) and Schultz (15,075, 2010). Some of the larger vegetation and prescribed fire projects include City (12,400 acres, 2005) and East Clear Creek (19,977 acres, 2006).

The combined effects of mechanical/prescribed fire treatments and wildfires have created a mosaic of stand conditions within the treatment (project) area and much of the cumulative effects boundary, decreasing the potential for undesirable fire behavior and effects. The scattered large blocks of treatments with decreased fire behavior potential would continue to contribute to this mosaic of stand conditions, resulting in a more fire-adapted landscape.

Current, Ongoing, and Foreseeable Actions

Current, ongoing, and reasonably foreseeable management activities including mechanical and prescribed fire treatments would decrease the potential for crown fire by breaking up the vertical and horizontal continuity of canopy fuels. There are seven ongoing and foreseeable projects

within RU 6 that are likely to impact fire behavior and effects within the proposed treatment area. Some of the larger projects include Russell (8,000 acres, 2011) and Tusayan East (2,600 acres, 2011).

There are approximately 204,368 acres of mechanical treatments and 242,617 acres of prescribed fire ongoing or planned within the remainder of the analysis area in forested areas that could impact fire behavior and effects within the proposed treatment area (see fire ecology report).

Cumulative Effects – Alternative A

Alternative A would continue to maintain RU 6 with potential for high-severity fire effects. Alternative A would not contribute to improving the structure, composition, and patterns of the project area. It would not put the ponderosa pine forests—or the vegetative communities that are cohorts of ponderosa pine—on trajectories toward being resilient and sustainable. The treatment area would continue to become less adapted to fire, increasing the potential for undesirable fire behavior and effects when wildfires do occur.

Cumulative Effects – Alternatives B, C, and D

Overall, the combined effects of current, ongoing, and reasonably foreseeable management activities would augment the effects of proposed treatments to decrease the potential size and severity of wildfires. These areas also may augment the potential size and increase the flexibility of locating burn units, because the moderated fire behavior in burned and/or thinned areas would allow prescribed fire to be implemented with broader burn windows and with higher intensity fire while still meeting control and resource objectives.

Treatments proposed in alternative B would move 509,195 more acres toward desired conditions for fire behavior and effects across the project area. When the proposed treatments are considered with past wildfires and past, current, ongoing, and reasonably foreseeable management activities, the effects would complement each other on large (project area), mid (RU), and small (subunit) scales, creating mosaics at all scales of potential fire behavior and effects, dominated by low-severity fire. The proposed treatments would fill in most of the acres between past, current, ongoing, and foreseeable management activities, creating a more cohesive restored landscape across the project area.

Treatments proposed in alternative C would move 562,380 more acres toward desired conditions for fire behavior and effects across the project area. Most of the effects would be identical to alternative B, with the exception of PACS and grasslands that would be treated, further augmenting the cumulative effects of the proposed actions and past wildfires, and past, current, ongoing, and reasonably foreseeable management activities.

Treatments proposed in alternative D would move 489,029 more acres toward desired conditions for fire behavior and effects across the project area. The proposed treatments would fill in most of the acres between past, current, ongoing, and foreseeable projects, creating a more cohesive restored landscape across the project area. Some 388,526 acres would not move as far toward desired conditions, and some areas would retain potential for crown fire and high severity surface fire as surface fuel loading increased following thinning, increasing the potential intensity of surface fires.

Air Quality

The air quality analysis is part of the fire ecology report which is incorporated by reference (Lata 2013). This analysis addresses Issue 1, prescribed fire emissions. Smoke/emissions were evaluated quantitatively by modeled emission quantities in pounds per acre for the most common stand condition under different treatment scenarios. Additionally, changes in those fuel components which produce the greatest percentages of emissions when they burn (litter, duff, and CWD greater than 3 inches) were modeled and mapped for a qualitative assessment.

Emissions and Public Health

Air pollutants called particulate matter include dust, dirt, soot, smoke, and liquid droplets directly emitted into the air by sources such as factories, power plants, cars, construction activity, fires, and natural windblown dust. The Clean Air Act establishes National Ambient Air Quality Standards (NAAQS) for six principal pollutants that pose health hazards: carbon monoxide (CO), lead, nitrogen dioxide, particulate matter less than 10 microns in size (PM_{10}), particulate matter less than 2.5 microns in size ($PM_{2.5}$), ozone, and sulfur dioxide.

The pollutant form of greatest concern from wildland fire—including both prescribed fires and wildfires—is particulate matter (PM) (Ottmar 2001, Graham 2012), although fire also creates other criteria pollutants and visibility impacts. Studies of human populations exposed to high concentrations of particles (sometimes in the presence of SO^2) and laboratory studies of animals and humans indicate there is potential for detrimental effects on human health.

The major subgroups of the population that appear to be most sensitive to the effect of particulate matter include individuals with chronic obstructive pulmonary or cardiovascular disease of influenza, asthmatics, the elderly, and children. Particulate matter also soils and damages materials and is a major cause of visibility impairment.

Radioactive Emissions

Concerns have been raised about the potential for smoke from prescribed fire treatments proposed in 4FRI to contain radioactive substances. During the Cerro Grande Fire of 2000, there was considerable public concern regarding the potential release of radionuclides from the Los Alamos National Laboratory (LANL). The evidence suggests that some adverse health effects did result from breathing high concentrations of particulate matter in the smoke (NMED 2002). Such exposures are associated with any forest fire. Deposition of LANL derived chemicals and radioactive materials from the smoke plume to the soil was minimal (2002 LANL).

Following the Cerro Grande Fire that burned the city of Los Alamos and the LANL in New Mexico in 2000, the U.S. Environmental Protection Agency (EPA), New Mexico Environment Department (NMED), and LANL partnered with the Department of Energy to operate radiological monitoring systems as well as to initiate several studies to assess impacts of the fire. The results of these efforts with regard to air quality and human health impacts indicated that radionuclides originating from the LANL site during the Cerro Grande Fire were restricted to naturally occurring radionuclides. LANL, the Department of Energy, and NMED monitored radionuclide concentrations in smoke from the Las Conchas Fire that burned through the Los Alamos area in the summer of 2011 and reported no significant detection levels. (See the NMED Web site: http://www.nmenv.state.nm.us/aqb/WildfireSmokeResources).

A study that included Lockett Meadow, within the 4FRI analysis area, found levels of radioactive materials in the soil were no different than background levels and would provide no added human health risk (Ketterer et al. 2004, Graham 2012a).

Communication with the EPA (Gerdes 2012, Graham 2012) and studies that addressed these emissions (Schollnberger et al. 2002) indicate that radioactive isotopes and other undesirable chemicals are present in wildfire emissions. Some are naturally occurring chemicals that have always been present at some level in wildfire smoke, and some have resulted from the weapons testing that occurred in the mid-20th century. The level of smoke that the public is exposed to would not pose as great a risk as wildfire would. Radioactive material that may be carried in the smoke plume carries a risk of human health concerns of less than 1 chance in 10 million (NMED 2002) and the greatest health risk is from breathing high concentrations of particulate matter in the smoke.

Smoke Sensitive Areas and Sensitive Receptors

The "Regional Haze State Implementation Plan for Arizona" defines "sensitive receptors" as "population centers such as towns and villages, campgrounds and trails, hospitals, nursing homes, schools, roads, airports, mandatory Class I Federal areas, etc. where smoke and air pollutants can adversely affect public health, safety, and welfare" (see appendix A of the specialist report). Several smoke sensitive areas lay within the airsheds of the areas proposed for treatment (table 62).

Table 62. Smoke sensitive areas and sensitive receptors

Area	Proximity to Implementation Area	Concerns
Flagstaff	Within boundaries or directly adjacent in all directions	Hospital, schools, human habitation, visibility, young children, interstate visibility
Williams	Within boundaries or directly adjacent in all directions	Hospital, schools, human habitation, visibility, young children, interstate visibility
Verde Valley	Less than 10 miles downslope south and southwest.	Hospital, schools, human habitation, visibility, young children
Grand Canyon National Park	Adjacent to the northern boundary of the 4FRI analysis area	Class I airshed, school, human habitation, campgrounds, visibility

The most sensitive smoke receptor in the State of Arizona is the Verde Valley, which is easily impacted with nuisance smoke from the cumulative burning on the southern part of the Kaibab NF, the eastern side of the Coconino NF, and the western side of the Prescott NF, as diurnal drainage of smoke from fires settles into this valley. Considerable coordination between forests takes place when burns and wildfires that can affect the Verde Valley take place, facilitated by the interagency Smoke Management Group housed at ADEQ.

Smoke monitors in the Verde Valley (Sedona and Camp Verde) track emissions concentrations, as well as equipment that captures images of visibility conditions. Spikes are found in particulate matter concentrations as smoke from fire activity on the surrounding forests settles into the valley at night, although levels have not exceeded NAAQS thresholds in the Verde Valley. Many complaints of smoke impacts in the Sedona area are primarily concerned with the reduced quality

of highly valued scenic views of the Red Rocks. Table 63 lists most of the areas that are expected to be impacted to some degree by implementation of prescribed fires in the 4FRI treatment area. Figure 43 displays the general locations of airsheds that could be impacted by 4FRI actions. Airsheds 1, 3, and 5 are expected to experience the majority of the smoke impacts originating from the proposed treatment area, with rare instances of mild impacts in airshed 6.

Table 63. Areas expected to be impacted by proposed prescribed fire treatments

Communities	Roads	Recreation Areas
Camp Verde	Highway 180	Wupatki/Sunset Crater National Monuments
Cornville	Lake Mary Road (County Road 209)	Grand Canyon National Park
Cottonwood	Interstate 17	
Flagstaff	County Road 65	
	Highway 89A	
	Interstate 40	

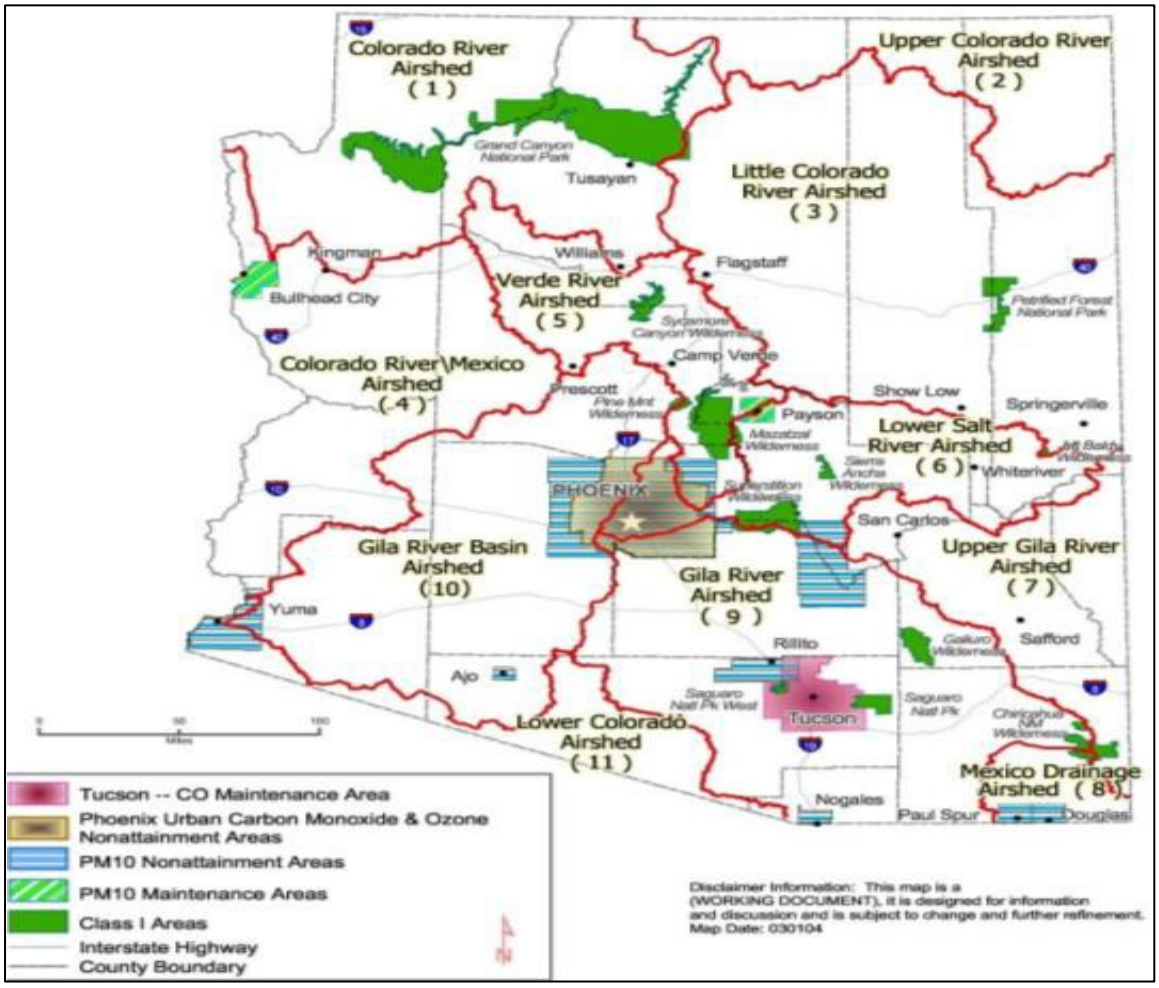


Figure 43. Airsheds defined by the Arizona Department of Environment Quality

Baseline visibility conditions (table 64) have been established for Grand Canyon National Park and Sycamore Canyon Wilderness which are the two Class I areas potentially affected by activities and wildfires in the 4FRI implementation area. Visibility in the Class I area of Sycamore Canyon Wilderness can also be affected by smoke from fires in the southeast portion of the Kaibab NF. The Forest Service is required to adhere to requirements in the Arizona State Implementation Plan to meet natural condition visibility goals.

Table 64. Baseline and 2064 goal in 2003 Arizona State Implementation Plan (SIP) for natural conditions

Class I Area	Baseline Data Years	Baseline Conditions	2064 Goal in 2003 AZ SIP
Grand Canyon NP	1999–2000, 2002–2004	11.6 dv	6.95 dv
Sycamore Canyon Wilderness	2001–2004	15.2 dv	6.96 dv

Regulatory Requirements

Prescribed fire is implemented only with approved site specific burn plans and with smoke management mitigation and approvals. All burning is conducted according to ADEQ standards and regulations. These standards include the legal limits to smoke emissions from prescribed burns as imposed by Federal and State law. The ADEQ enforces these laws by regulating the acres that are treated based on expected air impacts. These regulations ensure that effects from all burning meet Clean Air Act requirements. Prescribed fires are initiated under conditions that allow managers to meet both control objectives (fire behavior) and resource objectives (fire effects, including air quality impacts).

Kaibab NF and Coconino NF Prescribed Fire

The Kaibab NF has burned approximately 8,000 acres per year with prescribed fire in ponderosa pine since 2000. When wildfire acres are added, the Kaibab NF averaged approximately 17,000 acres a year (in ponderosa pine) from 2001 through fall of 2010.

From 2001 through fall of 2010, the Coconino NF averaged a little over 13,000 acres of prescribed fire in ponderosa pine. When wildfire acres are added, the Coconino averaged approximately 20,000 acres in ponderosa pine for that same period. No notice of violation of NAAQS has ever been issued to the Kaibab NF. Over the same period of time, one exceedance occurred on the Coconino NF. It occurred on one monitor for 1 day for an exceedance in PM_{10} in Flagstaff in 2007.

Environmental Consequences

Throughout this section, changes directly attributable to proposed actions, such as thinning or prescribed fire, are direct effects. These include changes to canopy bulk density, canopy base height, consumption of surface fuel, etc. Changes to the potential behavior and effects of wildfires that result from the direct effects are considered indirect effects.

Alternative A

In the short term (less than 20 years), effects of alternative A would include an increased risk of undesirable behavior and effects from wildfires (see "Fire Ecology" section). Average annual acres burned with wildfire would increase, along with the acres burned with high-severity fire and the associated air quality impacts. In the long term, if the current average annual acres burned by wildfire remained the same, it is likely that the entire treatment area would burn with wildfire by 2050, along with the associated air quality impacts. In the absence of wildfire, air quality would remain at current levels.

Environmental Consequences Common to Alternatives B, C, and D

- Implementing prescribed fire as proposed would result in lower emissions than if the area burned in a wildfire because there would be less biomass to burn.
- Prescribed fires implemented for the projects listed would comply with the regulations and requirements of the ADEQ and any burning done in the proposed treatment areas would comply with the NAAQS.
- Air quality impacts would be most likely to those portions of the Little Colorado River Airshed east and northeast of Flagstaff; the Colorado River Airshed north of Williams and including all of the treatment area in RU 6; and the Verde River Airshed. There would be a small chance that there could be some impact to the northern portions of the Lower Salt River Airshed.
- When units are ignited, smoke would be expected to travel on prevailing winds, away from sensitive receptors, and dissipate. Most smoke would dissipate, but some may persist at the surface. Short-term nighttime smoke could settle down the drainages into the towns below, particularly during early morning hours. Nighttime smoke would be expected to reside in low areas downslope from the burn units, because nighttime winds are generally calm. Daytime smoke would be expected to dissipate mostly downwind from the burn unit. Burn plans written for implementation of the proposed prescribed fires would include modeling to determine the most appropriate conditions under which to burn in order to minimize smoke impacts.
- In the short term, as first entry burns are implemented, impacts would increase noticeably. Acres with high fuel loading would be burned, in a first step toward restoring the natural fire regime. In subsequent entries, the same acres would produce less smoke, along with maintaining an ecosystem that is resilient to fire and benefits from it. In the long term, once an area has been burned once, there would be less fuel and, thus, lower emission potential. The combination of lower fuel loads and larger burn units would allow more acres to be burned without exceeding NAAQS.

Alternative B

Under this alternative, prescribed fire would be implemented on up to 58,792 acres annually to produce an average fire return interval of 10 years across 584,924 acres proposed for prescribed fire. Initial entry burns would produce much more emissions per acre than subsequent burns (see discussion on page 159 to page 161 in the fire report). However, even if the slash was removed from the forest and although the prescribed fires would be spread over many years, the acres to be burned would increase significantly and maintenance burning would be required across the treatment area to maintain a low fuel load and a healthy forest.

Smoke impacts may increase under this alternative because both the Coconino and Kaibab NFs already burn almost as much as they can (given burn windows and other limitations on prescribed burning, including emissions). Under alternative B, the number of acres available for prescribed fire would increase by 584,924 acres, which would average an additional 58,792 acres a year. This, in turn, would increase the flexibility for the forests in laying out burn units and managing prescribed fires. With potential for larger burn units, it would be possible to burn "hotter," so that, although more acres may be burned at one time, the heat created by increased fire behavior could provide more "lift" for the smoke, increasing dispersal and minimizing smoke impacts.

Alternative C

Under this alternative, an average of 59,321 acres would need to receive prescribed fire every year. The effects (indirect) would be almost identical to those in alternative B, with the exceptions being the additional acres of MSO habitat and grasslands proposed for burning. Most acres in PACs and nest cores would be first entry burns that would initially produce a greater volume of smoke. However, surface fuel loads would not be burned in one entry; therefore, smoke would be dispersed over time. In the long term, the alternative would minimize wildfire emissions and effects and allow prescribed fire to be used in the future with lower emissions.

Alternative D

Alternative D proposes to treat 388,526 with mechanical thinning treatments only. Approximately 17,875 acres would need to burn each year to meet a 10-year fire return interval. At some point, these acres (as with most acres within the treatment areas) are likely to burn with wildfire. Under those circumstances, there would be little warning, little control over the smoke, and a great deal more smoke than if prescribed fire was used.

Alternative D proposes to thin but not burn 70 percent of the treatment area. Approximately 388,526 acres would produce emissions as displayed in figure 44 in the column labeled "only mech" (refers to mechanical) treatment before wildfire and 178,753 (burn only) acres would produce emissions displayed in the column labeled "wildfire after burn only treatments."

Forest Plan Amendments

See "Fire Ecology Environmental Consequences" section.

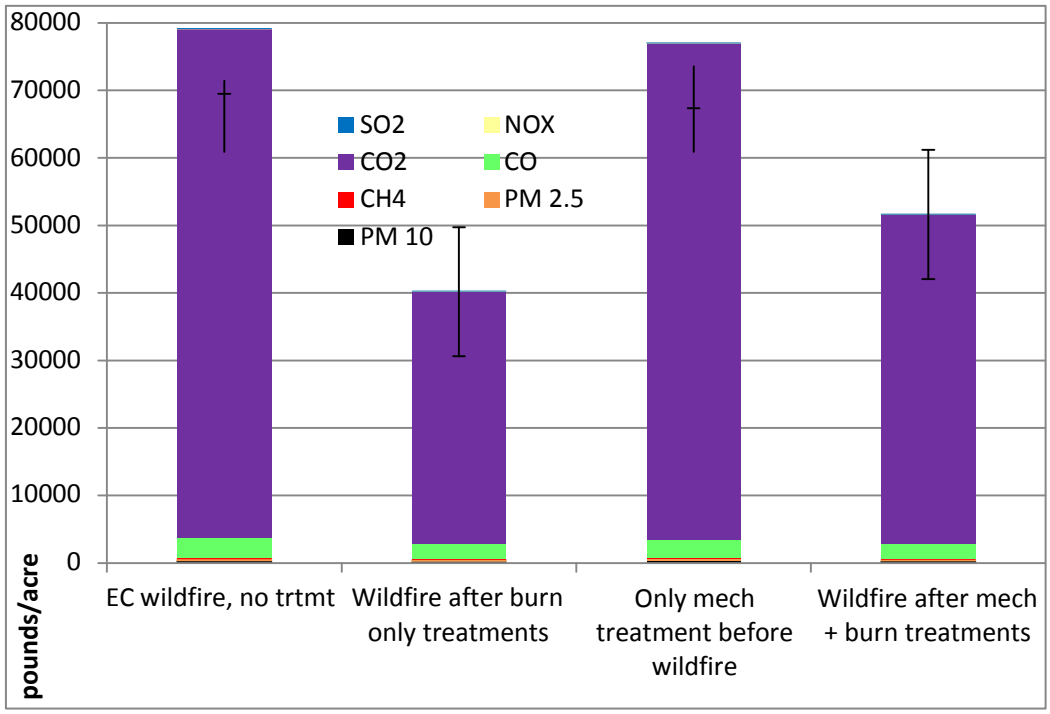


Figure 44. Emissions from surface fuels burning in wildfires after various treatments

Cumulative Effects

The cumulative effects of prescribed fires on the Coconino, Kaibab, and Prescott NFs over the last 12 years has resulted in one exceedance of NAAQS on one monitor for 1 day for PM_{10} in Flagstaff in 2007. Past treatments and wildfires in the last 10 years have decreased the potential emissions by removing canopy fuels, mostly from thinning on approximately 63,000 acres, and by increasing canopy base height, from wildfire and prescribed fire. Low-severity fire would have consumed surface fuels, further decreasing potential for emissions on approximately 151,000 acres. In some areas of high-severity fire, canopy fuels were consumed leaving tree stems and branches which have the potential to smolder for days or weeks (see "Fire Ecology" section for complete list of projects considered for cumulative effects).

There are approximately 18,436 acres of prescribed burns planned in RU 6 and Grand Canyon National Park by 2020. The Colorado River Airshed and the Little Colorado River Airshed have potential for air quality impacts from fires occurring within RU 6 and Grand Canyon National Park. It is likely that similar burn windows will be needed for many of the fires in the park and parts of RU 6.

The emissions from 244,000 acres of prescribed fire in the remainder of the analysis area would be managed in compliance with regulations and requirements of the ADEQ. There would be potential for air quality impacts to the Peaks and Sycamore Canyon Wilderness areas. The Colorado River Airshed, the Little Colorado River Airshed, and the Verde River Airshed are likely to have some air quality impacts from fires occurring in the southern part of the analysis area.

Alternative A

Air quality would be unaffected by prescribed fire from the treatment area, but would be affected by prescribed fires from other projects as noted above. Emissions from 244,000 acres of prescribed fire from current, ongoing, and reasonably foreseeable projects would be managed in compliance with regulations and requirements of the ADEQ. As with prescribed fires, wildfires occurring in the untreated areas would produce more emissions in areas that were not treated and could augment the effects of prescribed fires on air quality. Areas with potential for impact would be the Colorado River Airshed, the Little Colorado River Watershed, and the Verde River Watershed. Class 1 airsheds that could be affected include Grand Canyon National Park and Sycamore Canyon Wilderness.

Alternatives B and C

All prescribed fires would be implemented in compliance with ADEQ regulations and requirements as well as forest plan direction to meet legal standards and provide for public safety. Emissions from prescribed fires proposed in alternatives B and C would utilize many of the same burn windows that the approximately 244,000 acres of current, ongoing, and reasonably foreseeable projects would use. However, the increased acres of prescribed fire would allow more flexibility for implementation, making it possible to burn more acres at once with the same impacts. Areas with potential for impact would be the Colorado River Airshed, the Little Colorado River Watershed, and the Verde River Watershed. Class 1 airsheds that could be affected include Grand Canyon National Park and Sycamore Canyon Wilderness. As more acres are treated, there will be broader burn windows, potentially resulting in more days of prescribed fire and days of air quality impacts.

Alternative D

RU 6 is adjacent to Grand Canyon National Park, a Class 1 airshed and one of the most heavily visited national parks in the United States. Burn windows for the burns proposed in the action alternatives would be the similar to those for the current, ongoing, and reasonably foreseeable future actions.

The potential for undesirable air quality impacts from prescribed fire would be the same as other alternatives because all prescribed fires are regulated by the same laws regarding allowed emissions. Areas with potential for impact would be the Colorado River Airshed, the Little Colorado River Watershed, and the Verde River Watershed. Class 1 airsheds that could be affected include Grand Canyon National Park and Sycamore Canyon Wilderness. In most of the area that was thinned and not burned (388,526 acres), there would be potential for greater wildfire emissions from increased surface fuel loading. When combined with emissions from current, ongoing, and reasonably foreseeable management actions, there would be potential for greater air quality impacts when wildfires burned in these areas than in areas that had been previously treated with low-severity fire.

Terrestrial and Semiaquatic Wildlife and Plants

This section includes key effects and conclusions for terrestrial, semiaquatic, and plant threatened, endangered, and proposed species and critical habitat listed under the Endangered Species Act of 1973, as amended, Forest Service Southwestern Region Sensitive Species, forest

management indicator species, and migratory birds. The wildlife (Noble et al. 2013) and botany report (Crisp 2013) are incorporated by reference. Aquatic species were analyzed separately.

See the specialist reports (project record) for detailed information on methodology, analysis assumptions, best available science and data, habitats, populations, and effects that are not repeated in this section.

Vegetation Cover Types and Habitat Stratification

The dominant cover types within the project area are described in the "Vegetation" section. All ponderosa pine forested habitat within the project area was stratified to meet analysis requirements in the forest plans (USDA 1987, 1988) for Mexican spotted owl (MSO) and northern goshawk.

Wildlife Habitat Condition in the Project Area

Forest structure, forest health, vegetation composition and diversity, and fire behavior are highly departed from desired conditions. Chapter 1 of the DEIS describes how existing conditions are affecting wildlife habitat and function.

Habitat Connectivity

Current forest structure is much denser in terms of trees per acre and canopy continuity than pre-settlement conditions for ponderosa pine in northern Arizona. Concern was expressed by the public that the scale and intensity of vegetation treatments would affect the connectivity of species that require closed canopy conditions. Chapter 1 of the DEIS provides the existing condition of canopy openness. The "Vegetation" section in this chapter evaluates how each alternative would affect canopy density and openness.

Using the post-treatment vegetation modeling output and extensive list of design features that would be incorporated into project implementation, the wildlife analysis evaluated potential impacts to habitats. In summary, the evaluation found that adequate areas of densely forested habitat would remain available to wildlife adapted to closed canopy conditions during the period of time between 4FRI treatments and the actual attainment of desired conditions across the broader landscape. This habitat would bridge the time between treatment and attaining truly sustainable forest conditions, allowing species adapted to closed canopies to adjust, adapt, or eventually relocate over time rather than face an abrupt transition in forest conditions. This bridge habitat would include about 13 percent of the landscape within the 4FRI project boundary that would be deferred from treatment. Nearly 42 percent of the ponderosa pine treatment area would have a moderately closed canopy and 17 percent would remain in a closed condition. Another 17 percent of the treated area would have a mix of open and closed conditions. Restoration units near the Mogollon Rim would provide the greatest percentage of bridge habitat after treatment. In addition, landscape-scaled corridors would be designated to account for movement of closed canopy species across the area. The complete analysis for bridge habitat for canopy-dependent wildlife can be found in appendix G of the DEIS and appendix 3 of the wildlife report.

Federally Listed Threatened, Endangered, Proposed Candidate Species, and Designated Critical Habitat, and Forest Service Sensitive Species

The following list of federally threatened, endangered, and proposed species was adopted from the Coconino and Kaibab NFs' lists of species. Only those federally listed threatened, endangered, candidate species and their critical habitat, along with Forest Service sensitive species that are known or have potential to occur within the 4FRI project area were analyzed (table 65). Table 66 lists species that are not present or do not have potential habitat in the project area and were, therefore, dismissed from further analysis.

Table 65. Threatened, endangered, candidate, and sensitive species evaluated in this analysis

Scientific Name	Common Name	Status
Amphibians (1)		
Lithobates pipiens	Northern Leopard Frog	S
Birds (7)		
Strix occidentalis lucida	Mexican Spotted Owl and critical habitat	T
Haliaeetus leucocephalus	Bald Eagle	S
Accipiter gentilis	Northern Goshawk	S/MIS/Mig Bird[1]
Falco peregrinus anatum	American Peregrine Falcon	S
Aechmophorus clarkia	Clark's Grebe	S
Athene cunicularia hypugaea	Burrowing Owl (western)	S/Mig Bird
Buteo regalis	Ferruginous Hawk	S/Mig Bird
Insects (3)		
Piruna polingii	Four-spotted Skipperling	S
Speyeria nokomis nitocris	Nitocris Fritillary	S
Speyeria nokomis Nokomis	Nokomis Fritillary	S
Mammals (10)		
Mustela nigripes	Black-footed Ferret	E
Microtus mogollonensis Navaho	Navajo Mogollon Vole	S
Microtus longicaudus	Long-tailed Vole	S
Sorex merriami leucogengys	Merriam's shrew	S
Sorex nanus	Dwarf Shrew	S
Lasiurus blossevillii	Western Red Bat	S
Euderma maculatum	Spotted Bat	S
Idionycteris phyllotis	Allen's Lappet-browed Bat	S
Corynorhinus townsendii pallescens	Pale Townsend's Big-Eared Bat	S

Scientific Name	Common Name	Status
Eumops perotis californicus	Greater Western Mastiff Bat	S
Reptiles (1)		
Thamnophis rufipunctatus	Narrow-headed Garter Snake	S
Plants (9)		
Cimicifuga arizonica	Arizona bugbane	S
Astragalus rusbyi	Rusby milkvetch	S
Clematis hirsutissima var. hirsutissima	Arizona leatherflower	S
Hedeoma diffusum	Flagstaff pennyroyal	S
Helenium arizonicum	Arizona sneezeweed	S
Penstemon clutei	Sunset Crater beardtongue	S
Penstemon nudiflorus	Flagstaff beardtongue	S
Rumex orthoneurus	Blumer's dock	S
Salix bebbiana	Bebb's willow	S

Status: E = Federally Endangered; T = Federally Threatened; C = Federal Candidate; S = Forest Service Sensitive; Mig Birds = Migratory Birds

[1] Analyses for MIS and migratory birds can be found below.

[2] Note that MSO are analyzed as a threatened species under the ESA.

Table 66. Threatened, endangered, candidate, and sensitive species not addressed in this analysis

Scientific Name	Common Name	Rationale	Status
Amphibians (3)			
Lithobates chiracahuensis	Chiricahua leopard frog	Neither the species nor its habitat occurs in the project area	T
Bufo microscaphus microscaphus	Southwestern (Arizona) toad	Neither the species nor its habitat occurs in the project area	S
Lithobates yavapaiensis	Lowland leopard frog	Neither the species nor its habitat occurs in the project area	S
Birds (6)			
Empidonax traillii extimus	Southwestern willow flycatcher	Neither the species nor its habitat occurs in the project area	E
Gymnogyps californianus	California condor	Not known to occur in project area (random occurrence may happen)	E/Exp-NonE
Rallus longirostris yumanensis	Yuma clapper rail	Neither the species nor its habitat occurs in the project area	E
Coccyzus americanus occidentalis	Western yellow-billed cuckoo	Neither the species nor its habitat occurs in the project area	C

Scientific Name	Common Name	Rationale	Status
Buteogallus anthracinus	Common black hawk	Neither the species nor its habitat occurs in the project area	S
Pipila aberti	Abert's towhee	Neither the species nor its habitat occurs in the project area	S
Mammals (2)			
Perognathus amplus cineris	Wupatki Arizona pocket mouse	Neither the species nor its habitat occurs in the project area	S
Reithrodontomys montanus	Plains harvest mouse	Neither the species nor its habitat occurs in the project area	S
Reptiles (2)			
Thamnophis eques megalops	Northern Mexican garter snake	Neither the species nor its habitat occurs in the project area	C
Heloderma suspectum suspectum	Reticulate Gila monster	Neither the species nor its habitat occurs in the project area	S
Plants (19)			
Packera franciscana (*Senecio fransciscanus*	San Francisco Peaks ragwort	Neither the species nor its habitat occurs in the project area	T
Purshia subintegra	Arizona cliffrose	Neither the species nor its habitat occurs in the project area	E
Agave delamateri	Tonto Basin agave	Neither the species nor its habitat occurs in the project area	S
Agave phillipsiana	Grand Canyon agave	Neither the species nor its habitat occurs in the project area	S
Arenaria aberrans	Mt. Dellenbaugh sandwort	Species is not known to occur in the analysis area	S
Botrychium crenulatum	Crenulate moonwort	Species is not known to occur in the analysis area	S
Carex ultra	Cochise sedge	Species is not known to occur in the analysis area	S
Chrysothamnus molestus	Disturbed rabbitbrush	Species is not known to occur in the analysis area	S
Cirsium parryi ssp. *mogollonicum*	Mogollon thistle	Species is not known to occur in the analysis area	S
Desmodium metcalfei	Metcalf's tick trefoil	Species is not known to occur in the analysis area	S
Erigeron saxatilis	Cliff fleabane	Habitat for this species is on steep canyon walls and is not likely to be affected by management actions including burning.	S
Eriogonum ericifolium var. ericifolium	Heathleaf wild buckwheat	Neither the species nor its habitat occurs in the project area	S

Scientific Name	Common Name	Rationale	Status
Eriogonum ripleyi	Ripley wild buckwheat	Neither the species nor its habitat occurs in the project area	S
Helianthus arizonensis	Arizona sunflower	Species is not known to occur in the analysis area	S
Heuchera eastwoodiae	Eastwood alum root	Species is not known to occur in the analysis area	S
Pellaea lyngholmii	Lyngholm's brakefern	Neither the species nor its habitat occurs in the project area	S
,Platanthera zothecina	Alcove bog orchid	Neither the species nor its habitat occurs in the project area	S
Polygala rusbyi	Hualapai milkwort	Neither the species nor its habitat occurs in the project area	S
Salvia dorrii ssp. mearnsii	Verde Valley sage	Neither the species nor its habitat occurs in the project area	S

Status: E = Federally Endangered; T = Federally Threatened; C = Federal Candidate; S = Forest Service Sensitive; E/Exp-NonE = Experimental nonessential

Mexican Spotted Owl (MSO)

All ponderosa pine/Gambel oak forest habitat within the project area was stratified by MSO habitat potential to meet analysis requirements in the forest plans (USDA 1987, 1988). See the preceding "Vegetation" section for a description of the stratification. For the purposes of this analysis, the project area is the larger 988,764-acre unit and the ponderosa pine treatment area is 512,178 acres.

There are 99 protected activity centers (PACs) within the project area. The project area includes all State, private, and Federal lands as well as designated wilderness, current and recent project areas on the individual ranger districts, and mixed conifer vegetation. The treatment area contains about 36,455 acres of MSO protected habitat of which 35,566 acres are within 72 designated PACs that are considered occupied. The remaining protected habitat (889 acres) occurs on steep slopes where timber harvest has not occurred in the previous 20 years. There are about 76,091 acres of restricted habitat, including 8,713 acres of threshold and target habitat. For the purpose of the MSO discussion, the treatment area includes only those ponderosa pine lands managed by the FS which are proposed for mechanical and/or prescribed fire activities.

Six critical habitat units (CHUs) occur partially or completely within the 4FRI project area (see the wildlife specialist report for approximate locations and descriptions. Figure 45 displays all MSO habitat within the 4FRI treatment area.

Surveys and Monitoring

Annual MSO monitoring on the Coconino and Kaibab NFs is highly variable. Some PACs are rarely monitored while others are monitored nearly every year. Monitoring summaries for each forest from 1987 to 2011 are presented in the wildlife report.

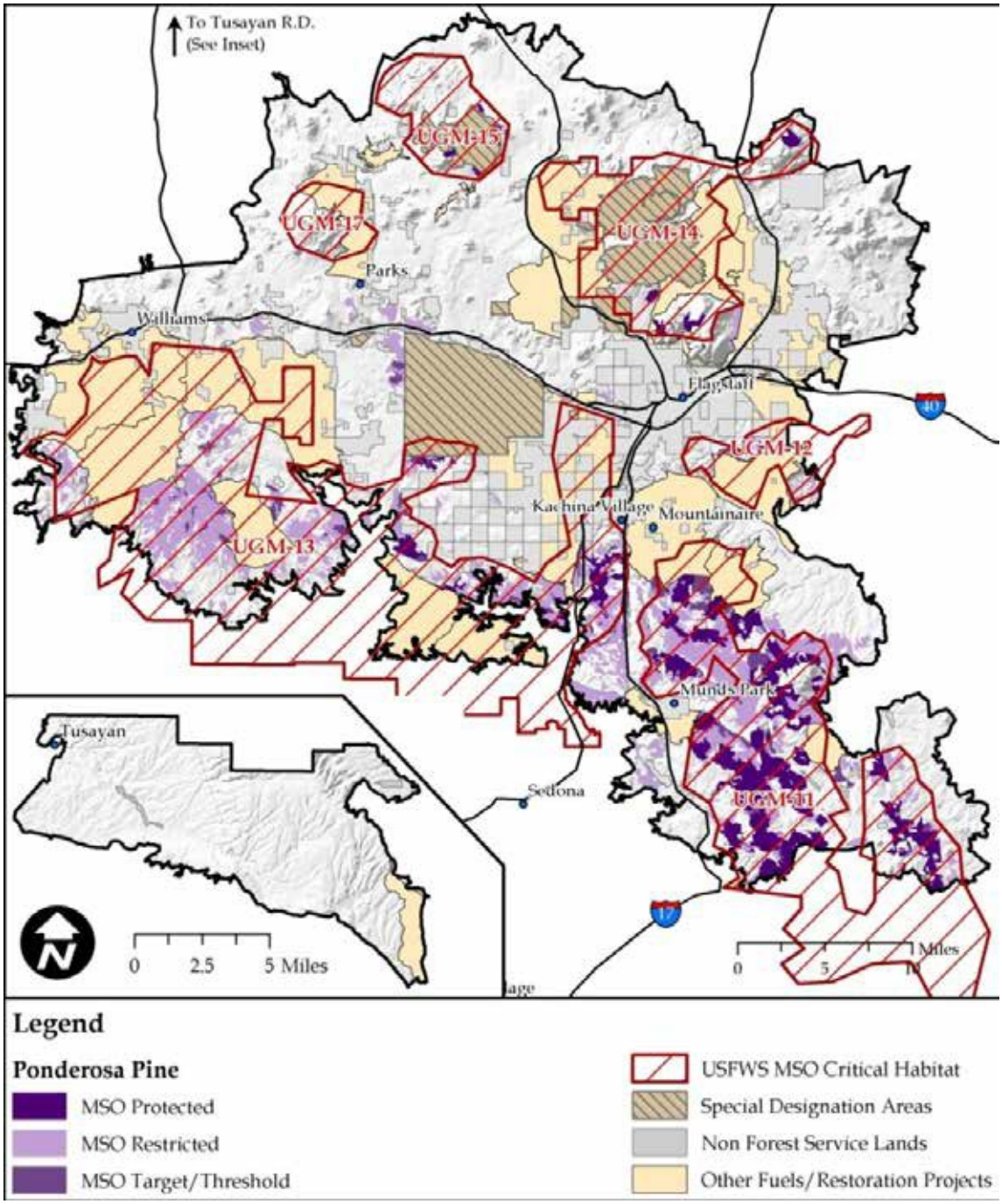


Figure 45. Mexican spotted owl habitat within the 4FRI treatment area

Summary of Habitat Conditions

All MSO habitats are at risk from stand density-related mortality. There is an imbalance in tree size classes leading to a lack of diversity in tree ages and structural diversity. There is a deficit of large trees (greater than 18-inch d.b.h.)—particularly trees greater than 24-inch d.b.h.—and there are threats to existing big and old trees because of competition from smaller trees. Large snags

are also deficit when compared to forest plan and MSO recovery plan desired conditions[10]. Snags and CWD requirements are met on less than 10 percent of the habitat (see chapter 1, table 7). Canopy cover in habitat selected by MSOs is higher than average forest values and can range from 50 percent to greater than 80 percent (USDI 1995). There is decreased quality in prey habitat due in part to uncharacteristic canopy connectivity from ingrowth of smaller trees inhibiting herbaceous understory development.

The existing condition for surface fuels within the 4FRI treatment area is directly related to forest density. As a result, MSO habitat also has a higher fuel buildup at ground level. According to fire modeling, about half of the total MSO habitat in the treatment area would support some form of crown fire with nearly a third of MSO habitat (33,549 acres) at risk of active crown fire (table 67). Although the desired condition is returning fire behavior to predominantly surface fire, current fuel loading presents threats to MSO prey habitat from both the risk of crown fire and uncharacteristic surface fire.

Table 67. Predicted fire behavior in existing MSO habitat

MSO Habitat Type	Habitat Acres	Surface Fire Acres (% of Habitat)	Passive Crown Fire Acres (% of Habitat)	Active Crown Fire Acres (% of Habitat)	Conditional Acres (% of Habitat)
Protected	36,757	18,610 (51)	3,141 (9)	9,930 (27)	14,847 (41)
Target/ Threshold	8,713	4,292 (49)	926 (11)	2,854 (33)	3,479 (40)
Restricted	67,378	35,465 (53)	6,608 (10)	20,764 (31)	25,187 (37)

MSO Habitat – Environmental Consequences

Alternative A – Direct and Indirect Effects

The vegetation analysis evaluates the effects to forest structure in MSO habitat including snags, down logs, and CWD. Overall, alternative A does not meet the purpose and need for the project. While individual projects would move some habitat toward desired conditions, MSO habitat at the 4FRI landscape level would continue to degrade over time in terms of forest structure and health. Development of the large tree component would continue to be compromised by density dependent competition and mortality. Tree growth rates would stagnate, compromising future recruitment into larger size classes. Understory development would remain suppressed and continue to decline.

Other habitats important to prey species such as meadows, aspen, springs, and ephemeral channels would continue to degrade or be lost entirely over the long term. Roads within the 4FRI that have been identified for closure under travel analysis process assessments would remain open, negatively impacting forest attributes important to MSO and allowing potential for disturbance to birds to remain. No 4FRI specific disturbance would occur but disturbance from other projects and from the existing road network would continue. MSO habitats would be on a

[10]No specific desired conditions exist for snags in the 12-inch to 18-inch category in MSO habitat.

trajectory moving further from desired conditions as described in the Coconino and Kaibab forest plans.

Alternatives B, C, and D – Direct and Indirect Effects

The environmental consequences for alternatives B, C, and D reflect the incorporation of forest plan standards and guidelines, BMPs, and Forest Service Manual and Handbook direction. See the "Wildlife" portion of appendix C for design features and mitigation. Habitat elements used to evaluate the alternatives for MSO include: forest structure and density, MSO prey habitat, fire effects, other habitat changes, and disturbance.

- At the project area scale, improvements to prey habitat through spring, ephemeral channel, meadow, and aspen treatments within protected habitat would be limited and site specific. However, these treatments would enhance prey habitat in areas proximate to nesting owls where foraging is key during the reproductive season. MSOs in the UGM feed primarily on peromyscus mice and voles (Ganey et al. 2011), and restoration treatments could benefit these species by improving understory vigor and productivity (Kalies et al. 2012, Martin and Maron 2012). Analysis of adaptive management actions for springs and ephemeral channels indicated they would not result in additional effects which are not already disclosed/addressed in the individual alternative discussions.
- Overall changes to PAC habitat would be limited, but would focus on improving important structural elements like large tree development and retention, and reduced risk of high-severity fire. Treatments in restricted "other" habitat would provide diversity in habitat structure which would enhance prey populations and increase forest resiliency while providing for owl dispersal.
- Fire and smoke effects from prescribed fire may disturb individual birds in and adjacent to the treatment area, but timing restrictions and low-severity burn prescriptions would reduce impacts and largely lead to no or only short-term effects. However, the amount of burning across the landscape under alternatives B, C, and D creates the potential of smoke settling into a PAC, potentially leading to adverse effects to individual owls.
- Road maintenance, reconstruction, temporary road construction, and decommissioning within PACs would all take place outside of the breeding season. Project activities would be phased to ensure that not all MSO habitats are treated simultaneously, thus reducing the overall effects by spreading them across a broad area and over time. Review of adaptive management actions for road-related activities indicated they would not result in additional effects that are not already disclosed/addressed in the individual alternative discussions.

Forest Structure in PACs

Forest structure, such as trees 18-inch d.b.h. and greater, describes nest and roost site characteristics. In alternatives B, C, and D changes in forest structure within PACs would be small and reflect the careful design of treatments to move forest structure toward desired conditions while retaining dense stands with closed canopies. Trees 12 to 18 inches d.b.h. decrease across all alternatives. These mid-aged trees are currently in abundance. The largest drop in the mid-aged size class would be in alternative C and would be consistent with the lower minimum basal area associated with the draft recovery plan guidance for nest/roost characteristics. Implementation of alternative C would require a forest plan amendment, see

appendix B. All alternatives would increase trees greater than 18 inches d.b.h. Results would be similar among alternatives, but alternative C would yield the largest increase in big trees. Increases in large trees would include trees greater than 24 inches d.b.h. as well. Ponderosa pine basal area would decrease in all action alternatives, which is a treatment objective, with alternative C showing the largest decrease and alternative D the smallest decrease due to the lack of prescribed fire.

Forest Structure in Ponderosa Pine – Oak Restricted Habitat

Current forest plan and MSO recovery plan direction require that at least 10 percent of MSO restricted habitat be designated as threshold habitat. Threshold habitat represents forest structure simultaneously meeting nesting and roosting criteria. There is deficit in the amount of existing threshold stands across the landscape. No stands simultaneously meeting threshold conditions would be brought below minimum threshold values in any alternative. The recovery plan also defines target habitat as areas approaching, but not currently meeting, forest structure conditions described in table III.B.1 of the MSO recovery plan (USDI 1995: page 92). Target stands should be managed toward achieving nesting and roosting habitat. Treatments would decrease the percentage of trees less than 18 inchs d.b.h. and increase trees greater than 18 inches d.b.h. in all action alternatives.

Trees 12- to 18-inch d.b.h. would decrease and trees greater than 24 inches d.b.h. would increase in all action alternatives. Changes in threshold habitat would be similar to those in PACs due to the limited scale of work being proposed. Target habitat would see more change, but typically this would be limited to a couple percentages per tree size class or a couple trees per acre 18-inch d.b.h. and larger; trees greater than 24-inch d.b.h. would consistently increase in all RUs. Changes in restricted “other” habitat would follow the same pattern with the scale of change being a few percentages or trees per acre.

All action alternatives would have the same mechanical treatments in restricted “other” habitat. Because alternative C would adopt a minimum basal area value of 110 as recommended in the MSO recovery plan, more trees in the 12- to 18-inch d.b.h. class would be cut. As a result, fewer trees would grow into the 18- to 23.9-inch d.b.h. category relative to alternatives B and D. Growth rates for trees 18- to 23.9-inch d.b.h. would increase in alternative C, moving more trees into the next size class of 24 inches and greater d.b.h. Therefore, alternative C would have fewer trees 18- to 23.9-inch d.b.h. but the most trees 24-inch d.b.h. and larger. Alternatives B and D produced similar values for forest structure in restricted habitat. BA would be higher for both pine and oak under alternative D because of the limited use of fire in this alternative.

Canopy Structure

Stand density index (SDI) is an important measure of forest density and can inform canopy structure. Percent maximum SDI in target and threshold habitat would range from the low to mid-70s (“extremely high density”) in all action alternatives. Treatments in restricted “other” habitat would result in percent maximum SDI values in the upper 30s (“high density”) for alternatives B and C, and 46 in alternative D. Alternatives B and C would result in similar densities and alternative D had the highest densities in terms of percent maximum SDI. All values would result in forest conditions with closed canopies. Given post-treatment values for basal area and trees per acre by tree size class, canopy cover would be 50 percent or greater at the group level (see silviculture report for details).

Only ponderosa pine would be harvested, so while individual trees of other species might be affected by mechanical and burning operations, the existing variability in overstory species would remain after treatments. Prescribed fire would improve subcanopy flight space for MSOs by lifting crown base height. Combined, these factors should improve the elements of canopy structure such as cover, density, flight space, and maintain species diversity in the overstory.

Prey Habitat

Prey habitat is another key component of MSO habitat. In threshold habitat, snags greater than 18-inch d.b.h. would decrease by 0.1 to 0.2 snags per acre across all action alternatives, relative to alternative A. In target habitat, snags in alternative B would equal alternative A, snags in alternative C would decrease by 0.2 per acre and in alternative D snags would increase by 0.1 per acre. Snag values would be about equal across alternative in restricted "other" habitat. In both threshold and target habitats logs would decrease in all alternatives but still remain about double the forest plan guidelines. Logs would be similar across all alternatives in restricted "other" habitat, remaining at or above forest plan guidelines in each alternative. CWD would be at the upper end of forest plan guidance in threshold and target habitats for alternatives B and C, and exceed forest plan guidance in alternative D. Values for CWD in restricted "other" habitat would be within forest plan direction for alternatives B and C, and exceed recommended values in alternative D in three of four RUs. RU 5 would have lower amounts of CWD, with alternatives B and C below 4 tons per acre. Alternative D would have about 6.3 tons per acre in RU 5, the lowest average in any RU under alternative D. The limited number of acres proposed for burning in alternative D would result in the most prey structure remaining on the ground. In other words, without broadcast burning occurring across most restricted habitat, alternative D would retain the largest amount of surface fuels. However, this could decrease herbaceous response and not represent an actual improvement to prey habitat above the other alternatives while increasing the risk of a surface fire becoming a crown fire.

Understory response would be low in MSO habitat, reflecting the desired condition for relatively dense forests with closed canopies. The relative index for biomass response remained below 30 pounds per acre in threshold habitat and below 70 pounds per acre in target habitat. Alternative C had the highest response and alternative D the lowest. Results for restricted "other" habitat were much higher, relative to areas managed for nesting and roosting habitat, with values generally ranging from 130 to 180 pounds per acre except for RU 5 where results for alternatives B and C were about 283 pounds per acre. Alternative D would again be consistently lower than alternatives B and C.

All action alternatives were more than three times the values for the no action alternative, reflecting the improvements to prey habitat the proposed treatments could achieve. However, the relative biomass response would be based largely on changes in basal area. It would not include broadcast burning benefits to understory plants such as reduced pine litter and associated nutrient pulse. Therefore, the advantages from implementing alternatives B and C are underrepresented when comparing results to treatments proposed under alternative D.

Fire Effects

All three action alternatives would move large acreages of ponderosa pine forest out of FRCC 3 immediately after treatments are completed. Alternative C moves all treated acres out of FRCC 3. Alternative B has the next fewest acres in FRCC 3 after treatment and alternative D has the most acres remaining in FRCC 3 of the action alternatives. In comparison, nearly 60 percent of total

acres would be in FRCC 3 under alternative A. Simultaneously, alternatives B and C would move nearly a fifth of total treated acres into FRCC 1. In 2020, alternative D would have fewer acres in FRCC 1 than the existing conditions. Moving the overall landscape toward FRCC 1 would decrease the risk of undesirable fire behavior and effects to MSO habitat.

Fire modeling resulted in similar patterns, in terms of meeting desired conditions, as that shown for FRCC. Patterns for changes in fire behavior in protected habitat are similar to those for ponderosa pine forest in general. Action alternatives would move most of the habitat into surface fire conditions in 2020. However, alternatives B and C would move most of the ponderosa pine and about three-quarters of MSO protected habitat into conditions likely to support surface fire. Alternative D would move most of the ponderosa pine but less than 60 percent of the protected habitat toward surface fires. The remaining acres would remain vulnerable to high-severity fire. It is worth noting that the wildlife analysis for the Kaibab forest plan concluded the Kendrick PAC consisted of mixed-conifer habitat. The Kaibab NF used a mid-scale analysis (100 to 1,000 acres) for evaluating effects of the proposed land management plan. The 4FRI analysis was analyzed on a finer scale that delineated individual pine-oak stands within the Kendrick PAC. About 173 acres of pine-oak habitat outside the core area were identified for burn-only treatment in the Kendrick PAC during the 4FRI analyses of potential PAC treatments. The nearby Stock Tank PAC, administered by the Coconino NF, has about 15 acres of pine-oak habitat occurring on the Kaibab NF that is also proposed for burn-only treatments. The 15 acres are within the PAC but outside of both the core area and Kendrick Peak Wilderness.

Disturbance

Disturbance could occur as a result of project-related activities including moving and operating harvest machinery, hauling forest materials, building fire line, managing prescribed burns, smoke, personnel in the field, and road maintenance and reconstruction. Noise disturbance from project activities may disturb foraging MSO. Noise would not be expected to disturb nesting or roosting MSO because haul routes are planned to either avoid PACs (occur more than a ¼ mile from core areas) or employ timing restrictions to avoid disturbance during the nesting season. Alternatives B and D would mechanically treat 84,177 acres of MSO habitat. Alternative C would mechanically treat 82,344 acres of MSO habitat; about 1,833 acres less than alternative B or D.

Core areas would be protected from prescribed fire by using roads, natural barriers, or new fire line to contain burn units. Building line would occur outside the nesting season. Noise and smoke related to burning could disturb owls. Design features would include timing restrictions so that habitat in and around PACs would not be prescribed burned during the breeding season (March 1 to August 31). The area excluded from burning around PACs would be determined on a PAC-by-PAC basis. Roads, topography, and prevailing weather patterns would be identified so that an adequate buffer would be defined around PACs. Burning within the buffer would be conducted in association with PAC burning outside the breeding season. This would include core areas in alternative C. Site-specific buffers would be designed so that noise and settling smoke from burning outside the buffer would not disturb resident owls in the PACs during the breeding season. Appropriate distances for individual PACs would be decided by biologists, fuels specialists, and the FWS. As a result, smoke and noise are not expected to result in negative effects to MSO. Alternative B would treat 107,696 acres with prescribed fire, alternative C would treat 112,546 acres of MSO habitat, and alternative D would prescribe burn 3,543 acres of MSO habitat.

Other Features within MSO Habitat

Roads

About 164 miles of road (table 68) are proposed for decommissioning within MSO habitat (17 percent of the 962 total open roads in MSO habitat) in each action alternative. Roads proposed for decommissioning by MSO habitat type and total miles of proposed road decommissioning are the same in each alternative. About 15 percent of the 793 miles of road within MSO critical habitat is proposed for decommissioning. Road decommissioning within MSO habitat would improve habitat conditions for MSOs and their prey.

Table 68. Alternatives B, C, and D miles of road decommissioning in all MSO habitat

MSO Habitat	Miles of Roads Proposed for Decommissioning	Existing Road Miles	Percent of Roads Proposed for Decommissioning
Protected	49	251	20
Core Area[1]	5	20	20
Target/Threshold	17	82	21
Restricted Other	98	624	16
Total	**164**	**957**	**17**

[1] Core area acres are a subset of protected habitat totals

Road maintenance (nearly 98 miles) and temporary road construction (about 7 miles) would affect almost 105 miles of roads in protected habitat (table 69). Road maintenance and temporary road construction within PACs would take place outside of the breeding season. The term "temporary roads" in this instance includes nonsystem roads that currently function as open roads on the landscape. These roads would also be decommissioned outside of the breeding season after 4FRI project implementation.

A road system for hauling harvested materials out of the forest was identified to implement restoration activities. Haul routes were evaluated across the entire project area relative to MSO PAC habitat. This broad-scale effort was evaluated in a site-specific manner as roads around each individual PAC were examined in terms of functional haul routes and avoiding disturbance to MSOs. The objective was to assess road systems for hauling materials with the goal of avoiding or minimizing impacts to MSOs. The miles associated with road maintenance, construction, and reconstruction are the same in alternatives B, C, and D.

Dust abatement treatments would occur in selected areas where private landownership concerns could arise. Eight road segments have been identified for dust abatement, totaling less than 7 miles in length. The average dust abatement treatment length would be about 0.9 miles, ranging from 0.3 to 2.5 miles. Treatments would consist of magnesium chloride ($MgCl_2$) or lignin. The effectiveness of $MgCl_2$ is related to humidity levels (Batista et al. 2004); therefore, lignin would probably be used most often in the 4FRI landscape. Treatments would be temporary and only occur on particular road segments in association with hauling. None of the proposed treatment segments would be near open water. Because of the limited application spatially and temporally, and because locations do not include sensitive areas such as open water, dust abatement is not expected to result in measurable effects to wildlife or their habitat.

Table 69. Alternatives B, C, and D road maintenance, temporary roads, and reconstruction in MSO habitat in miles

MSO Habitat	Road Maintenance	Temporary Road Construction	Road Reconstruction	Total Miles of Road Work
Protected Total	97.6	7.2	0	104.8
Target/Threshold Total	40.9	5.3	≤0.05	46.3
Restricted	319.1	63.5	1.0	383.6
Total	**457.6**	**76.0**	**1.05**	**534.7**

About 115 miles of roads in restricted habitat (table 68) would be decommissioned across 15 different subunits, including nearly 17 miles within target and threshold habitat. About 458 miles of road maintenance would occur in MSO habitat. New temporary road construction would total about 76 miles (table 69). Over a mile of road would be relocated to protect ephemeral stream channels. Two road segments would be relocated in target (1) and threshold (1) habitat, totaling less than 0.04 mile in length and the balance would be in restricted "other" habitat. No road relocation would occur in protected habitat.

Springs, Ephemeral Channels, Meadows, and Aspen

Spring and ephemeral stream restoration activities would be the same in all action alternatives. Restoration of springs and ephemeral channels would be evidence based and designed to improve vegetation composition. Pre-settlement trees would remain where present and the largest trees available would be left where there is evidence of other pre-settlement trees. Twenty-three springs are in MSO habitat, including protected (5) and restricted (18) habitats. Over 4 miles of ephemeral stream channel restoration is proposed within MSO habitat. Spring and channel restoration would occur in four of the six CHUs occurring within the treatment area, enhancing prey habitat. Restoration activities proposed for springs and ephemeral channels would include two prescribed fires in a 10-year period: first entry and second entry maintenance prescribed fires. The wildlife report contains additional information on the location of springs and streams within MSO habitat.

Up to 135 acres of meadow treatments are proposed in 12 different PACs, depending on the alternative. Meadow treatments within PACs are intended to improve existing meadow habitat by removing encroaching conifers. Meadow habitat within PACs is important because it represents important prey habitat. Meadow treatments average 11 acres per PAC, ranging from 1 acre (Howard Mountain) to 28 acres (Meadow Tank). Treatment types vary by alternative and all PACs with proposed meadow treatments are located on the Coconino NF. Mechanical treatments would remove post-settlement trees, unless replacement trees would be necessary for evidence of pre-settlement trees. Meadow treatment objectives related to prescribed fire include removal/reduction in litter, raising a stand's crown base height, or deliberate tree mortality intended to restore the function of the habitat.

Approximately 1,471 acres of aspen, another important habitat for MSO prey, occur in the treatment area. Aspen treatments vary by alternative. Up to 209 acres of aspen are proposed for treatment in PAC habitat and up to 959 acres are proposed for treatment within critical habitat (UGM-11, UGM-13, UGM-14, UGM-15, and UGM-17).

Forest Plan Amendments

The MSO amendments are designed to allow treatments that were developed to create and sustain nesting and roosting habitat. If the amendments were not included as part of this alternative, the results of implementing the alternatives would be different from those analyzed below. By adhering to a 9-inch d.b.h. limit for cutting trees within PACs, about two-thirds of the PAC acres proposed for mechanical treatment would retain uncharacteristic basal areas and ladder fuels, and no fuels reduction would occur in 56 core areas. The result would be a higher risk of potential crown fire, elevated rates of density dependent tree mortality, and increasing the risk of overstory mortality from insects and disease. Post-treatment PAC habitat conditions would continue to limit the ability to retain large pine and oak trees and slow the development of future large trees and snags. Large pine and oak trees and snags are key components of nesting and roosting habitat. Restricting PAC treatments to 10 percent of the recovery unit would continue the risk of habitat loss for an extended period of time.

Not designating 10 percent of restricted habitat as threshold habitat on the Kaibab NF would not be expected to affect MSOs (see following analysis). Similarly, designating 10 percent of restricted habitat as threshold habitat would also not be expected to affect MSOs. Habitat use by MSOs across the Williams Ranger District is in mixed conifer forest on top of the mountainous cinder cones or in Sycamore Canyon. If MSO use of this habitat occurs, it is likely for foraging or dispersal. Managing for an extra 2 percent of nesting and roosting habitat would not likely affect either behavior. However, maintaining high tree densities in areas that historically did not likely have the canopy closure and stem densities associated with owl nesting and roosting habitat would negatively affect other wildlife species (see amendment analyses for sensitive, management indicator, and migratory bird species). Similarly, managing future nesting and roosting habitat with a lower minimum basal area value, as described in the MSO recovery plan, would not likely affect MSOs in the short term. By definition, these are areas with no known resident owls. However, these minimum values represent stand or area averages, with groups of trees creating higher and lower values. Managing future nesting and roosting habitat at the higher basal area values may decrease the ability to maintain these areas in the long term due to the risk of potential crown fire and insect and disease related mortality.

The amendments proposed for managing canopy cover and open reference conditions in goshawk habitat (Coconino and Kaibab NFs), management in the proposed Garland Prairie RNA (Kaibab NF), and cultural resource determinations (Coconino NF) would not affect MSOs or their habitat.

Cumulative Effects – All Alternatives

The complete analysis for cumulative effects to MSOs is discussed in detail in the wildlife specialist report. Cumulative effects were evaluated across the 4FRI treatment area plus a ½-mile buffer beyond. The cumulative effects area includes 110 PACs. Effects from recent/past projects (since 1996) are assumed to potentially contribute to short-term effects in association with 4FRI treatments which would extend through the year 2020. Current and ongoing projects could potentially contribute to long-term effects (considered 30 years post-treatment or the year 2050).

Projects before 1996 are incorporated into existing conditions. Aspects of existing conditions that are a result of these early projects include a deficit in large trees and snags and even-aged conditions. Pre-1996 projects also had heavy selection pressure for preferred tree genetics to provide healthy trees with good form. Wildlife habitat in the form of nesting, feeding, and loafing sites was reduced by selecting for disease-free trees with symmetric shapes, eliminating forktop

trees, trees with unusual branching patterns, and replanting with selected genetic stock from nurseries.

Current and ongoing projects identified in MSO habitat within the 4FRI area have or will treat a total of about 6,500 acres. This equates to nearly 3,000 acres of protected habitat and about 3,500 acres of restricted habitat. Most acres treated from these projects involve mechanical harvest or burning treatments, but also include slash disposal, invasive weed treatments, and limited acres of animal damage control, erosion control, and disease tree harvest (see appendix 12 of the wildlife report).

Most of the habitat identified as part of the ongoing and foreseeable cumulative effects analysis would occur outside of MSO habitat. However, there are treatments specifically designed to treat MSO habitat. Total acres of MSO habitat treatment is not yet known because some projects are still in the planning and analysis stages. However, the best estimate at this time includes about 10,155 acres of protected habitat and approximately 23,800 acres of restricted habitat under consideration for vegetation treatments.

Alternative A

Maintaining existing conditions would extend the current deficit of trees greater than 24-inch d.b.h. Growth could be further suppressed and mortality rates increased if long-term climate patterns continue toward hotter and drier growing conditions. Within-stand mortality resulting from competition for rooting space, water, and nutrient availability could lead to patches of more open conditions. This could reduce potential nesting and roosting habitat even in locations where individual trees might eventually grow into larger size classes.

Pine-oak habitat would remain outside the historical range of variability in terms of tree densities and age class distribution under alternative A. Loss of large diameter oak would continue, as would the suppression of young oak by competing pine trees. Large-scale stochastic events could continue to slow or prevent development of new MSO nesting and roosting habitat.

The lack of road closures along with firewood cutting, would maintain the same threat to large snag persistence. Ecosystem function would continue to decline with continued tree encroachment into spring, channel, meadow, and aspen habitats.

The ability to retain sustainable and resilient ecosystems would be further compromised by vulnerability to high-severity fires. The overt threat of high-severity fire could limit options for treating uncharacteristic fuel loads through the use of unplanned ignitions, compounding the fire risk through time. By not treating adjacent to MSO habitat, the risk of high-severity fire remains high from ignitions starting outside of pine-oak habitats as well as fire igniting within MSO habitat.

Cumulative Effects for Alternatives B, C, and D

Changes to MSO habitat structure as a result of these (4FRI, ongoing, and foreseeable) actions are expected to be minimal. None of the treatments would be expected to measurably decrease the number of trees greater than 12-inch d.b.h. Trees 18-inch d.b.h. or greater would be unaffected by the fuel reduction/restoration treatments. Total basal area of pine would decrease, but given the focus on small trees, their removal may not substantially alter total stand basal area. Gambel oak would not be targeted for removal and the total basal area of Gambel oak is not expected to change substantially in the long term.

The reduction in small trees should open the space between ground level and crown base height, improving MSO flight paths for foraging. However, d.b.h. limits from past projects commonly resulted in loss of forest structure and a decrease in inherent heterogeneity in tree spacing. Reduced crown fire risk and increased understory production that result with diameter-capped treatments tend to be short-term because creation of interspace and irregular tree spacing typically cannot be attained.

Changes are expected in MSO prey habitat. Decreases would occur in CWD, logs, and snags. Burn prescriptions and ignition techniques should limit overall losses of logs and snags. Burned snags will fall and provide logs, and trees killed by fire will become snags. The longevity of fire-killed snags would be less than that of snags formed from other processes. However, maintenance burning should provide pulses of snags and logs through time. Less CWD is expected to be present as a result of prescribed fire.

Thinning and burning should increase tree growth rates and self-pruning of the lower tree branches through time should gradually replenish CWD. Improving growing conditions should decrease density-related mortality of larger and older trees. Improving recruitment into the larger size classes will improve MSO habitat and the ability to provide large snags that remain on the landscape longer than smaller diameter or fire-created snags. The combination of thinning and burning should improve species richness in the herbaceous understory, increase plant abundance, and improve fruit and seed production. The projects considered for cumulative effects are areas that were omitted from the 4FRI planning effort because planning was already in progress or recently completed. Treating within these polygons will reduce fire threat for MSO habitat within the respective project polygon as well as reducing the threat of high-severity fire starting in these projects and burning habitat outside the polygons.

Cumulative effects include local disturbance from noise and potentially additional disturbance from smoke. The individual projects include the Williams Ranger District (Bill Williams Mountain) and projects distributed across the Flagstaff district from the San Francisco Peaks to the edge of the Mogollon Rim. Given the various stages of planning or implementation, project effects are dispersed both spatially and temporally. Given the scale of the 4FRI treatment area (593,211 acres), the amount of MSO habitat within the treatment area (112,546 acres) and the period of time over which treatments will be implemented (10 or more years), the cumulative effects are expected to be negligible relative to the scale of both time and space within which potential effects would occur.

Critical Habitat (Alternatives B, C, and D)

The primary constituent elements essential to the conservation of the owl include those physical and biological features that support nesting, roosting, and foraging. Primary constituent elements for MSO critical habitat within pine-oak forest provide one or more habitat needs for nesting, roosting, foraging, and include:

Forest structure:

- A range of tree species of different sizes and ages;
- Thirty to 45 percent of the trees 12-inch d.b.h. or greater;
- Shade canopy of 40 percent or more;
- Snags of 12-inch or greater d.b.h.; and

MSO prey habitat:

- High volume of fallen trees and other woody debris;
- A wide range of tree and plant species, including hardwoods;
- Adequate levels of residual plant cover to maintain fruits, seeds, and plant regeneration.

Critical habitat includes both protected and restricted habitat, as defined in the MSO recovery plan. Six CHUs occur within or overlap the 4FRI project area, encompassing about 488,974 total acres. Approximately 91,047 acres of protected and restricted critical habitat in the 4FRI treatment area are within designated CHU boundaries. Effects to critical habitat are averaged across habitats (see discussion of effects to protected and restricted habitats by alternative in preceding discussion). Many of the differences between alternatives are limited when assessed at the scale of critical habitat. Overall, proposed mechanical treatment acres are similar between alternatives, but vary in terms of acres proposed for prescribed fire.

Comparisons of most attributes are done for the year 2050 to allow for changes in forest development to become more readily apparent. The main exception is the relative index value for understory development which is compared for the year 2020 when herbaceous response to treatments is maximized. After that, tree growth would increase and the canopy would continue developing, causing a persistent decrease in understory response through 2050.

Forest Structure

The distribution of tree size classes would be similar among alternatives, with alternatives B and C nearly identical, and alternative D frequently 1 or 2 percentages below them for trees greater than 18-inch d.b.h. All action alternatives had the same values for trees per acre 18-inch d.b.h. and greater. Forest densities would remain high, limiting the benefits of MSO treatments in terms of forest health and resiliency, but treatments would focus on releasing large trees from competition, increasing growth rates of large trees, and retaining or creating nesting and roosting habitat.

Pine basal area would be reduced by all the action alternatives. Total basal area post treatment would be about the same in alternatives B and C. Gambel oak basal area and total basal area would consistently be higher in alternative D. The higher basal area values in alternative D would result from the limited acres of prescribed fire in this alternative.

The basal area, trees per acre, and SDI values post-treatment would provide for canopy cover. No species other than ponderosa pine would be targeted for selection, unless small trees of other species are within a crown diameter of old tree ponderosa pine or large Gambel oak (see design features in the wildlife report) would remain in the canopy ensuring species diversity and structural heterogeneity. Some oak would be lost to fire, particularly in alternatives B and C. Design features would be in place to minimize loss of larger oak. Fire would also be expected to stimulate oak sprouting. Canopy continuity would be maintained in protected and target and threshold habitats, but some defined tree groups and canopy openings would be created in restricted “other” habitat. Combined, this would retain nesting and roosting habitat in protected and target and threshold habitats and move restricted “other” habitat toward a blend of denser forest with an interspersion of increased foraging opportunities.

MSO Prey Habitat

Snag habitat would be provided in MSO habitat. Results for snags greater than 12-inch d.b.h. (the measure for critical habitat) would be similar among alternatives. Nevertheless, alternative C would consistently rank lower and alternative D would consistently rank higher in snag densities. Most CHUs would average five or more snags per acre greater than 12-inch d.b.h., although UGM-12 and UGM-13 would average 2.5 to 3 snags per acre. Creating more large trees and improved growth rates for large trees should help ensure future snag recruitment (USDI 1995). Logs per acre would be maintained across critical habitat with similar results among action alternatives, although the pattern would continue with relatively lower values in alternative C and higher values in alternative D. Values for CWD would be similar between alternatives B and C, but typically several tons per acre higher in alternative D. This is directly correlated with the reduced acres of prescribed fire in alterative D. It is expected that low severity prescribed fire would leave a patchy mosaic in alternatives B and C, including unburned areas. Small mammals, including key MSO prey species, tend to respond positively to restoration-based treatments (appendix 7 of the wildlife report). Levels of CWD exceed forest plan guidance in all alternatives.

The pattern in understory response would be different from other habitat components in that alternatives B and D were similar, with alternative B consistently higher. Overall, a greater response would occur under alternative C as a result of higher treatment intensity. Prey populations would be expected to benefit from retaining these structural elements after treatments and prey species response would be expected to be greatest in alternative C and least in alternative D.

Fire Effects

Fire effects by alternative for protected and restricted habitats, including the no action alternative, are discussed in the previous MSO habitats discussion. In association with those discussions are displays of FRCC and fire behavior for ponderosa pine forest in general, as well as for each action alternative. The results would be the same for critical habitat: treatments would move all or most of the acres of MSO habitat from FRCC3 to FRCC1 and 2. Fire behavior would shift from 30 to 40 percent active crown fire, to 1 to 6 percent active crown fire in restricted habitat.

Patterns for changes in fire behavior in protected habitat are similar to those for ponderosa pine forest in general: action alternatives would move most of the habitat into surface fire conditions in 2020. Alternatives B and C would move most of the ponderosa pine and about three-quarters of MSO protected habitat into conditions likely to support surface fire. Alternative D would move most of the ponderosa pine but less than 60 percent of the protected habitat toward surface fires. The remaining acres would remain vulnerable to high-severity fire.

Consistency with MSO Biological Opinions (2012)

Based on a review of the 2012 land and resource management plan (LRMP) biological opinions (BO) (USDI 2012a, 2012b) and information discussed in the above effects analysis, implementation of any of the action alternatives would be consistent with the forestwide programmatic LRMP biological opinions for the Coconino and Kaibab National Forests and that a forest plan amendment is not necessary.

Black-footed Ferret (Endangered)

There are presently no known naturally occurring populations of black-footed ferret. There are no known records of black-footed ferrets on the Coconino or Kaibab NFs. Black-footed ferrets are dependent upon prairie dogs for food and burrows, and Gunnison' prairie dogs are the only prairie dog species that occurs in northern Arizona. Within the project area, prairie dogs occur in grasslands. Open linkages have been mapped within the project and are identified for prairie dogs (wildlife report, appendix 4).

Environmental Consequences

Alternative A – Direct and Indirect Effects

Habitat conditions for black-footed ferret would remain in their current condition, notwithstanding natural processes. Because there are no known black-footed ferrets on the project area, the probability of direct effects to black-footed ferrets from the current condition are low. Understory biomass would continue to decline over the next 40 years (appendix 8 of the wildlife report). This, in turn, leads to less available habitat for species such as the ferret that rely on prairie dogs for food.

Stability of key ecosystem components such as species composition, forest structure, soil characteristics, and hydrologic function are at moderate to high risk of loss in the event of high-severity disturbance, such as high-severity wildfire, on 76 percent of grasslands. This alternative would result in the most stress on meadow and grassland habitats and, thus, would have the greatest negative contribution to potential black-footed ferret habitat.

Cumulative Effects of Alternative A

The area analyzed for cumulative effects to black-footed ferret encompasses the grasslands within the project area and the associated prairie dog complexes. Direct and indirect effects are unlikely to occur since there are no known locations of black-footed ferrets on the project area and potential habitat will be surveyed prior to implementation. There are no effects to black-footed ferret therefore, no cumulative effects.

Summary of Alternatives B, C, and D – Direct and Indirect Effects

Direct effects are unlikely to occur in any action alternative since there are no known locations of black-footed ferrets on the project area and potential habitat would be surveyed prior to implementation. Short term and localized effects from mechanical thinning and prescribed fire would result in the potential collapsing of burrows and displacement of prairie dogs in active prairie dog towns. In all alternatives, there would be restored connectivity of grasslands which would have a beneficial impact on prairie dog populations contributing to potential black-footed ferret habitat. There would be additional opportunities for prairie dogs to colonize new areas and recolonize areas where trees have encroached previously occupied habitat in Government and Garland Prairie, Kendrick Park, and other grasslands.

Alternative C treats the most acres and elicits the greatest response in understory (see wildlife report, appendix 8). Potential for high-severity fire in grasslands would be reduced with the removal of encroaching trees, and prescribed fire and mechanical treatments in grasslands would improve the stability of the key ecosystem elements by almost doubling acres in FRCC1 and reducing FRCC3 by half (see fire ecology report).

Alternative D produces the lowest response of understory biomass (see appendix 8 in the wildlife report) as there would be 20,645 fewer acres of prescribed fire only. There would be little change in high-severity fire potential and the lack of prescribed fire in grasslands reduces the acres in FRCC 1 by 3 percent and increases the acres in FRCC 3, reducing the stability of key ecosystem elements (see fire ecology report). The lack of burning means no nutrient pulse into the system, further limiting understory response. This alternative provides the least amount and lowest quality of habitat for prairie dogs hence less habitat for black-footed ferrets.

Forest Plan Amendments

The MSO amendments would allow managing for lower tree densities and basal area, creating canopy gaps, and increasing understory response. Not including amendments for MSO habitat would not affect ferret habitat because protected habitat does not overlap with grasslands or the forest matrix occurring between grasslands. The amendments would not affect resident or dispersing prairie dogs and, so, would not affect ferrets.

Not including the amendment related to management of canopy cover and open reference conditions within ponderosa pine forest would prevent the ability to include open rooting space between tree groups and prevent the restoration of grasslands and savanna. This would prevent the restoration of forested areas that used to support grasslands and decrease the ability to maintain existing grasslands, savannas, and meadows. Decreased dispersal would reduce the ability of prairie dogs to naturally establish new prairie dog towns and limit the "rescue effect" of genetic exchange between fragmented populations. If some prairie dogs are genetically resistant to plague, dispersal of these animals may be key to eventually establishing black-footed ferret habitat. Forest thinning, the creation of interspace, and reestablishing grasslands, savannas, and meadows would assist in enhancing the probability of successful dispersal.

Not managing the proposed Garland Prairie RNA (alternative C only) for the grassland characteristics it was intended to support would result in similar, though more localized, dynamics. Not including actions related to openness and grassland restoration would omit or limit herbaceous response, decreasing prairie dog food and cover.

Cumulative Effects for All Action Alternatives

The area analyzed for cumulative effects to black-footed ferret encompasses the grasslands within the project area and the associated prairie dog complexes. Direct and indirect effects are unlikely to occur since there are no known locations of black-footed ferrets on the project area and potential habitat will be surveyed prior to implementation. There are no direct or indirect effects to black-footed ferrets, therefore, no cumulative effects.

California Condor (Endangered/Experimental Population)

Reintroduction of captive-bred condors in Arizona began in 1996 at the Vermilion Cliffs National Monument Release Site. Condors were reintroduced under Section 10(j) of the Endangered Species Act (ESA) (USDI 1996a). Under this designation, the protections for an endangered species are relaxed, providing greater flexibility for management of a reintroduction program. The Arizona portion of the designated nonessential experimental population area boundary extends south from Utah to Interstate 40. U.S. Highway 191 (parallel to the New Mexico State border) is the east boundary and Interstate 15 to U.S. Highway 93 near Las Vegas, Nevada, is on the west. When condors leave this area, they receive full protection of the ESA, which may have

regulatory implications. Portions of the Coconino and Kaibab NFs north of I-40 are within the designated experimental population area.

Between 2002 and 2006, The Peregrine Fund obtained more than 50,000 relocation fixes from an average of 17 GPS-equipped condors (Austin et al. 2007). Condor use is focused on the north and south rims and river corridor of the Grand Canyon, Kaibab Plateau, and Kolob area in southern Utah (approximately 70 miles north of the release site on the Paria Plateau). Condors do not spend much time south of the Grand Canyon. When they have traveled into the southern extent of the designated recovery zone, they head back north relatively rapidly. There are few reports of condors on the Coconino NF or the Williams or Tusayan Ranger Districts of the Kaibab NF (Parrish, pers. comm.). The Arizona condor population was at 74 as of March 2011 (AGFD 2012). The project would not affect nesting or roosting habitat and, because condors rarely occur within the project area, would not affect foraging habitat. Therefore, no further analysis will be conducted.

Forest Service Sensitive Species

Sensitive species are defined in Forest Service Manual 2670.5 as "those plant and animal species identified by a regional forester for which population viability is a concern, as evidenced by: (a) significant current or predicted downward trends in population numbers or density, or (b) significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution (USDA 2005).

The presence of 31 Forest Service sensitive species and golden eagles (protected under the Bald and Golden Eagle Protection Act) carried forward for analysis (table 70) was determined by consulting forest records, results of surveys conducted on the forests, and use of the FAAWN database (Patton 2011). The most recent Regional Forester's Sensitive Species list was transmitted to forest supervisors on October 1, 2007, and is the basis for the species used for this analysis. Species in bold font apply to both the Coconino and Kaibab NFs. Other species apply to the Coconino NF.

See the "Aquatics" section for the sensitive species evaluation. Table 66, presented earlier, displays those species (with rationale) that were dismissed from this analysis.

The environmental consequences incorporate the springs, streams, and road adaptive management actions.

Table 70. Forest Service sensitive species or habitat occurrence in the project area

Common (Scientific Name)	Species or Habitat Occurrence in Project Area
Amphibians (1)	
Northern Leopard Frog *(Lithobates pipiens)*	In Arizona, northern leopard frogs are absent from most historic locations. Northern leopard frogs were reported in several subunits (1-2, 1-3, 1-4, 1-5, 1-6, 3-4, 3-5, 4-4, 4-5, 5-1) within the project area. Their range within the project boundary is now limited to permanent waters around Stoneman Lake. There are 6 occupied/critical breeding sites and 10 potential breeding sites in the project, or within a ¼ mile of the project area boundary, and they occur within subunits 1-2, 1-5, and 1-6. Best potential habitat within the project area is tanks and springs that provide permanent water. Although potential habitat occurs in

Common (Scientific Name)	Species or Habitat Occurrence in Project Area
	livestock waters in all cover types within RUs 1, 3, 4, and 5, the primary breeding and dispersal habitat occurs in RU 1 where the amphibian linkage is designated. RU 1 has 8,230 acres of grassland and 145,793 acres of ponderosa pine, 24 miles of riparian habitat and ephemeral streams, and 32 springs.
Birds (7)	
Bald Eagle (*Haliaeetus leucocephalus)*	There are two nesting pairs of bald eagles within the project boundary. One breeding area occurs above the Mogollon Rim near Lower Lake Mary. The same pair has used two different nest locations along Lower Lake Mary (Coconino NF). The area is periodically monitored by AGFD and Northern Arizona Audubon Society. The alternate nest location is adjacent to FR 296A and has a higher level of disturbance within the area. The second breeding area is at Whitehorse Lake on the Kaibab NF. This nest was first documented in May 2012 and is located in an area of high recreation use. The nest was monitored by AGFD and confirmed active with one fledged nestling. Bald eagles occurring on the Coconino and Kaibab NFs are primarily winter visitors. There are currently 38 eagle roosts spatially identified in GIS for the project area, of which 19 have confirmed use by bald eagles. The remaining 19 roosts are identified as characteristics roosts and do not have documented use by bald eagles. Bald eagle confirmed and characteristic winter roosts are found in seven sites. Potential habitat within the treatment area is 512,178 acres of ponderosa pine but is habitat primarily within 2.5 miles from bodies of permanent water (i.e. Upper and Lower Lake Mary, Horseshoe Lake, Mormon Lake, and Roger's Lake) and along major roadways (i.e. Interstates 17 and 40, U.S. Highways 89A and 89N and Forest Highway 3).
Northern Goshawk (*Accipiter gentilis***)**	On the Coconino NF, opportunistic sightings and limited surveys were conducted in the 1980s and in 1990. Annual surveys were initiated in 1991. As of 2008, there were 70 known territories on the Coconino NF (see wildlife report, table 29). Goshawk territories have been established based on the results of surveys. Goshawk surveys were conducted in 2011 and 2012. There are currently 68 goshawk territories on the southern portion of the Kaibab NF, including 36 goshawk PFAs on the Kaibab NF portion of the project area. Goshawk surveys were conducted in 2011 and 2012. There are 30,600 acres of goshawk PFA, dispersal PFA and nest areas, and 369,033 acres of non-PFA.
American Peregrine Falcon (*Falco peregrinus anatum***)**	There are 20 confirmed nesting pairs of peregrine falcons within the project area. Nests occur in eight subunits (1-1, 1-6, 3-1, 3-4, 3-5, 4-3, 4-4, and 5-1). Known nest locations, tall cliffs, open waters, and meadows provide potential habitat within the project boundary. Foraging habitat in the treatment area is primarily 48,774 acres of grassland, 39 miles of riparian habitat and ephemeral streams, and 74 springs and wetlands.
Clark's Grebe (*Aechmophorus clarkia)*	There is confirmed nesting at Mormon Lake southeast of Flagstaff (Coconino NF). Most potential habitat is located on Anderson Mesa (subunits 1-2 and 1-4), Marshall Lake (subunit 1-3) and Mormon Lake (subunit 1-5) (Coconino NF).Neither resident Clark's grebe nor their habitat have been identified on the Kaibab NF and they are not considered a sensitive species on the forest.
Burrowing Owl (western) (*Athene cunicularia hypugaea***)**	Breeding Bird Atlas surveys confirmed nesting from approximately 100 feet elevation near Gladsden to 6,600 feet elevation in a prairie dog colony near Flagstaff (Coconino NF). However, burrowing owls have not been confirmed within the project area. There are 48,774 acres of grassland habitat within the treatment area that provides potential habitat for prairie dogs and, consequently, burrowing owls.

Common (Scientific Name)	Species or Habitat Occurrence in Project Area
Ferruginous Hawk (*Buteo regalis)*	Breeding Bird Atlas surveys confirmed nesting ferruginous hawks occupying a fairly narrow range of elevations, from 4,700 feet to 6,400 feet (Corman and Wise-Gervais 2005) with no documented nesting on the Coconino or Kaibab NFs. Ferruginous hawks forage in montane subalpine grasslands in the Flagstaff vicinity. There are 48,774 acres of grassland habitat within the treatment area that provide potential habitat for prairie dogs and, consequently, ferruginous hawks. The hawk is not considered a sensitive species on the Kaibab NF.
Insects (3)	
Four-spotted Skipperling (*Piruna polingii***)**	The four spotted skipperling is associated with mixed broadleaf deciduous and montane willow riparian forest, wetland cienega, and montane subalpine grasslands. Of these habitats, only montane subalpine grassland and wetland cienega occur in the treatment area. There are 48,774 acres of montane subalpine grassland and 74 springs in the treatment area.
Nitocris Fritillary (*Speyeria nokomis nitocris)*	Habitat includes mixed conifer, ponderosa pine, spruce-fir, montane willow riparian forests, and wetland cienega vegetation types. Of these, only the ponderosa pine and wetland cienega occur in the project area. It is a sensitive species for the Coconino NF. It has not been recorded on the Kaibab NF and is not considered a sensitive species for the forest where the habitat is too dry and water too ephemeral to provide habitat. Potential habitat within the project area is found throughout the 470,990 acres of ponderosa pine, 51 springs, and 85 miles of riparian habitat in RUs 1, 3, 4, and 5 within the treatment area.
Nokomis Fritillary (*Speyeria nokomis Nokomis)*	Within the project area, they are known from drainages in the San Francisco Mountains. It is a sensitive species on the Coconino NF. It has not been recorded on the Kaibab NF and is not considered a sensitive species for the forest where the habitat is too dry and water too ephemeral to provide habitat. Potential habitat within the project area is found in RUs 1, 3, 4, and 5. Within these RUs, there are 51 springs and 85 miles riparian habitat that provide habitat in the treatment area.
Mammals (9)	
Navajo Mogollon Vole (*Microtus mogollonensis Navaho***)**	Hoffmeister (1986) delineated the range for this vole from Navajo Mountain southward to the western part of the Mogollon Plateau, extending from near Mormon Lake westward toward the town of Williams and up to the Tusayan district. They occur within open forests and in larger grassland areas such as Garland and Government Prairies on the Williams district (Ganey and Chambers 2011). There are 512,178 acres of ponderosa pine and 48,774 acres of grassland within the treatment area.
Long-tailed Vole (*Microtus longicaudus*)	Small mammal surveys have not documented long-tail voles; however, they are expected to occur within the project area. Potential habitat within the treatment area is 48,744 acres of grassland, 51 springs, 85 miles of riparian habitat, and ephemeral streams. The vole is not found on the Williams or Tusayan RDs, only considered on North Kaibab RD for the Kaibab NF.
Merriam's Shrew (*Sorex merriami leucogengys***)**	Merriam's shrew is distributed throughout the west and Hoffmeister (1986) shows them distributed along the Mogollon Rim. No surveys have been completed. However, Merriam's shrews are expected to occur in ponderosa pine forests within the project area. There are 512,178 acres of ponderosa pine within the treatment area.

Common (Scientific Name)	Species or Habitat Occurrence in Project Area
Dwarf Shrew ***(****Sorex nanus****)***	The species is known to occur on the San Francisco Peaks and White Mountains (Hoffmeister 1986), however, shrews have not been documented in the project area. Potential habitat within the treatment area is 25,658 acres of pinyon-juniper, 512,178 acres of ponderosa pine, and 48,744 acres of grassland. The shrew is not found on the Williams or Tusayan RDs and only occurs on North Kaibab RD for the Kaibab NF.
Western Red Bat ***(****Lasiurus blossevillii****)***	In the Grand Canyon, Hoffmeister (1971) reports the western red bat were only found in the bottom of the canyon near Phantom Ranch and along Bright Angel Creek approximately 6 miles from the project area. On rare occasion, red bats have been documented near Kachina Village (subunit 3-4) and upper West Clear Creek Wilderness and Page Springs Fish Hatchery. The latter two locations are outside of the project area. One bat was radio-tracked near Kachina Village within the project area and roosted in a clump of Gambel oak in dry ponderosa pine forest (Chambers, pers. comm. 2010). Given they are an uncommon summer resident on the Coconino NF, they could conceivably be a rare visitor on the Kaibab NF as well. However, extensive netting on both the Williams and Tusayan districts failed to produce records of western red bats. There are 34 caves within 300 feet of the treatment area boundary. A 300-foot buffer around cave entrances and sinkhole rims is a design feature applicable to all action alternatives. Potential foraging habitat within the treatment area includes 512,178 acres of ponderosa pine and 48,774 acres of grassland. Roosting habitat may occur along the 39 miles of riparian habitat and ephemeral streams.
Spotted Bat ***(****Euderma maculatum****)***	Historic records suggest that the spotted bat is widely distributed, rare across its range, but can be locally abundant. In Arizona, spotted bats commonly roost singly in crevices in rocky cliffs and they have also been found in caves (Chambers, pers. comm. 2009). Cliff habitat and surface water are characteristic of localities where they occur. Meadows, openings, and open forests with diverse herbaceous ground cover provide habitat for prey species. There are 512,178 acres of ponderosa pine and 48,774 acres of grassland within the treatment area. Spotted bats have been captured in coniferous forests on the Kaibab Plateau over 25 miles from the project area and in other western states. Netting efforts have not resulted in captures on the Coconino NF or the Williams RD, but spotted bats were captured on the Tusayan district, RU 6 (Solvesky, pers. comm.2008). There are no known roost locations within the project area. Surveys of abandoned mines and natural caves on the districts did not detect any spotted bats (Corbett 2008).
Allen's Lappet-browed Bat ***(****Idionycteris phyllotis****)***	A study conducted within the project area (RUs 1, 3, and 6) documented lappet-browed bats using snags for maternity roosts. Female roost trees were all within ponderosa pine forests. They occur across the ponderosa pine belt on the Coconino and Kaibab NFs and occurrences are documented in the project area in subunits 1-5, 3-3, 5-1, and 6-3. Potential habitat within the treatment area is 512,178 acres of ponderosa pine and 25,658 acres of pinyon-juniper.
Pale Townsend's Big-Eared Bat ***(****Corynorhinus townsendii pallescens****)***	A 2007 bat roost inventory and monitoring project documented Townsend's big-eared bats on both the Kaibab and Coconino NFs (Solvesky and Chambers 2007). Pale Townsend's are known to occur within the project area (subunits 4-3, 5-2, 3-3, 1-3, and 3-5). They use a wide range of habitats, including ponderosa pine forest. Potential habitat includes 512,178 acres of ponderosa pine and 48,774 acres of grassland within the treatment area. There are 34 caves within 300 feet of the treatment area boundary. A 300-foot buffer around cave entrances and sinkhole rims is a design feature applicable to all action alternatives.
Greater Western Mastiff Bat *(Eumops perotis californicus)*	The range for this bat includes all Arizona counties, except Yavapai, Navajo, Apache, and Santa Cruz. A specimen was collected after death near Flagstaff in 1992. They have been documented roosting in the Grand Canyon and foraging across the Kaibab Plateau over 25 miles from the project area. Potential habitat within the project area is 512,178 acres of

Common (Scientific Name)	Species or Habitat Occurrence in Project Area
	ponderosa pine and 48,774 acres of grassland habitat. There are no known roost locations on the Coconino NF or the south zone of the Kaibab NF, although roost habitat may occur on or near the Tusayan district (RU 6) (Solvesky, pers. comm. 2008). The bat is not considered a sensitive species on the Kaibab NF.
Reptiles (1)	
Narrow-headed Garter Snake *(Thamnophis rufipunctatus)*	On the Coconino NF, narrow-headed garter snakes are currently known from Oak Creek Canyon and a few sightings from the Verde River, approximately 5 and 8 miles respectively from the project area. Population numbers in Oak Creek Canyon have decreased significantly, particularly in the lower third of the canyon. Since the late 1980s, they have been entirely absent downstream of Oak Creek Canyon. Based on cottonwood/willow and mixed broadleaf riparian habitats, this species is considered a potential resident of all Coconino NF districts. Neither this species nor its habitat occurs on the Kaibab NF. There are no known locations of narrow-headed garter snake within the project area; however, 42 miles of riparian habitat and ephemeral drainages could provide potential habitat. The entire area within subunit 3-5 was considered for potential impacts to downstream habitat in Oak Creek. Their habitat has not been identified on the Kaibab NF and is not considered a sensitive species on the forest.
Plants (9)	
Arizona Bugbane *(Cimicifuga arizonica)*	The plant occupies mesic canyons in the Oak Creek Canyon, West Fork of Oak Creek and its tributaries, and West Clear Creek (Coconino NF). The first two areas are in or near the analysis area boundary. Monitoring for Arizona bugbane has occurred on the Coconino and Kaibab NFs since 1993. See table 7 in the botany report for the plant site location in relation to 16 past treatments.
Rusby Milkvetch *(Astragalus rusbyi)*	There are numerous occurrences of Rusby milkvetch in the Hart Prairie (2010) and Wing Mountain (2012) projects on the Coconino NF. Occurrences have also been recorded on the Kaibab NF in the Frenchy Project Area (2003) and on the adjacent Camp Navajo (Springer 2009). Coconino Rural Environmental Corps (CREC) (2011) detected numerous locations of this plant in the A-1 Mountain area. Figure 6 and table 8 in the botany report displays occurrences in the project area.
Arizona Leatherflower (*Clematis hirsutissima var. hirsutissima*)	Within the project area, many populations occur near Lower Lake Mary, in Skunk Canyon, and in Fay Canyon. Arizona leatherflower also occurs on the Tusayan district of the Kaibab NF near Ten X Tank (Kaibab NF). Habitat includes rocky hillsides with slopes from 12 to 40 percent with aspects generally from 320 to 40 degrees (Arizona Game and Fish Abstracts 1993). Other scattered populations occur on Harold Ranch Road in east Flagstaff (private land), in Mountainaire (private land), Fort Valley, and near Hoe Tank on the Mogollon Rim district, which is outside the current project area but within ponderosa pine habitat. Table 9 in the botany report displays plant site locations where vegetation and prescribed fire projects have occurred. Prescribed fire projects (Skunk RX Burn), trail projects and grazing would be implemented near known populations and the potential for wildfire would remain. These actions combined with 4FRI actions would continue to affect habitat but none of these actions would lead to a trend toward Federal listing.
Flagstaff Pennyroyal (*Hedeoma diffusum*)	There are two major population areas for this species on the Coconino NF. The first population within the project area extends roughly from Flagstaff, east to Marshall Lake and Fisher point, then south to the vicinity of Mountainaire, then to Lower Lake Mary. A second population area (outside the project area) is near the rim of Oak Creek Canyon and its tributaries (Boucher 1984, Phillips 1984). On the Kaibab NF, it occurs in wilderness and would not be affected by the project. Table 10 in the botany report displays site locations that would be affected by alternatives.

Common (Scientific Name)	Species or Habitat Occurrence in Project Area
Arizona Sneezeweed (*Helenium arizonicum*)	This endemic species ranges from the Mormon Lake area (Coconino NF) southeastward to the White Mountains area where it grows in drainages, near springs, ponds, and other wet areas. This species has been observed in ephemeral drainages in the Upper Lake Mary watershed (Coconino NF). Numerous groups were detected in the Antelope Park area (Coconino NF) by CREC crews in 2011. There are no known locations of Arizona sneezeweed on the Kaibab NF. Table 11 in the botany report documents site locations within project treatment units.
Sunset Crater Beardstongue (*Penstemon clutei*)	The range of this species is limited to the Sunset Crater volcanic field near Flagstaff, including the Coconino NF and Sunset Crater National Monument. There are many locations of Sunset Crater beardtongue in the northeast corner of the project area. Many of these are in treatment units where burning or operational burning would occur. See table 12 in the botany report.
Flagstaff Beardtongue *(Penstemon nudiflorus)*	Flagstaff beardtongue grows in dry pine forests, pine/oak, pine/oak/juniper, and pinyon-juniper forests. It occurs on dry slopes, in openings, and along edges of openings and in forested areas. Table 13 in the botany report documents site locations within project treatment units by alternative.
Blumer's Dock (*Rumex orthoneurus*)	The known distribution of Blumer's dock in the project area is limited to a few enclosures around springs and wet areas. The known occurrences of Blumer's dock within the project area are limited to the Hart Prairie Area, where it shares the habitat with Bebb's willow. There may be other occurrences at other locations in the project area where suitable habitat exists. Documented threats to Blumer's dock include grazing, water diversions, mining, and recreation (USDI 1999).
Bebb's Willow (*Salix bebbiana*	Bebb's willow is a sensitive species for the Coconino NF only. Protection of Bebb's willow was a concern brought up by the public during scoping. The Coconino NF has long recognized the rarity on the landscape for Bebb's willow. The Fern Mountain Botanical Area (established in 1987 in the Coconino forest plan) contains a unique Bebb's willow community. Elsewhere in the project area, Bebb's willows are confined to single plants or groups of plants and the unique Bebb's willow community type is not present. Within the project area, documented locations include the Hart Prairie and Mormon Lake areas on the Coconino NF. There are Bebb's willows in two stands scheduled for treatment in the Mormon Lake area. These include location 435 site 3, which is scheduled for burning only and 454 site 3, which is scheduled to be thinned and burned. Location 454 site 3 is the area surrounding Double Spring which is proposed for spring restoration. Several groups of Bebb's willow occur in the area of Sawmill Spring in location 548 site 3, 704/6, 704/12, 531/7, and 541/13. Many of these plants are dead or decadent and some are heavily browsed. Location 548 site 3 is proposed for channel restoration and operational burning in this project. Location 704 sites 6 and 12 are proposed for thinning and burning accompanied by operation burning. Location 531 site 7 and location 541 site 13 are in a MSO PAC and are proposed for thinning and burning.

Sensitive Species Environmental Consequences

Alternative A Summary of Effects Common to All Forest Sensitive Species

Habitat would remain at high risk from undesirable fire effects from high-severity wildfire (see "Fire Ecology" section). Fire that results in undesirable fire effects could adversely affect potential habitat by removing understory and overstory vegetation and altering soil structure and nutrients. For sensitive plants, these types of changes to the habitat could adversely affect habitat and populations by damaging soil, killing existing plants, and reducing or destroying seed banks. Springs and ephemeral channels would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future (see water quality and riparian report) which could degrade existing and potential habitat. Lack of movement toward historic conditions could result in reduced food and reproductive sites and reduced habitat connectivity. Trees would continue to encroach on habitats and understory biomass would continue to decline over the next 40 years (see wildlife report, appendix 8). Increased trees and reduced understory biomass would impact cover and forage, reducing the quantity and quality of habitats, and increasing predation potential.

In terms of nesting and roosting habitat, tree densities—as measured by percent maximum SDI—would continue to be in the high to extremely high density range, slowing growth rates and, thereby, limiting the development of larger diameter (≥ 18-inch) trees and snags, both of which are important for nesting and roosting.

Alternative A Cumulative Effects

For semiaquatic species such as the northern leopard frog, degradation of habitat facilitated by this alternative would cumulatively combine with other forest activities, high impact recreational use, livestock grazing, habitat loss, and degradation on private lands and climate change, and would continue to fragment key aquatic and dispersal habitat.

For terrestrial species, birds, and insects, degradation and fragmentation of habitat would cumulatively combine with other forest activities, high impact recreational use, livestock grazing, use of nonjurisdictional roads, habitat loss and degradation on private lands, and climate change would continue to fragment key nesting and foraging habitat. Prescribed fire treatments in adjacent projects and grazing may result in short-term impacts to habitat, but these are not expected to result in long-term cumulative impacts and are expected to be localized in nature. Continued dense forest conditions would limit the growth and sustainability of large trees slowing development of potential roost areas. Other activities including utility line and road reconstruction and maintenance, high-impact recreation, and climate change would combine to result in degradation of nesting and roosting habitat. See table 71 for the cumulative effects baseline and assessment of ongoing and reasonably foreseeable actions.

For all sensitive plants, alternative A results in the potential for severe effects from wildfire that could adversely affect the habitat and populations by damaging soil, killing existing plants, and by reducing or destroying the seed bank. Noxious or invasive weeds would increase and contribute to degradation of the habitat and loss of individuals and populations.

Alternatives B, C, and D Summary of Effects

See table 71 for the effects and sensitive species effects determinations for alternatives B, C, and D.

Table 71. Alternatives B, C, and D sensitive species environmental consequences determination

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	Amphibians
Northern Leopard Frog	Mitigations measures would reduce the likelihood of direct impacts to frogs from mechanical thinning, temporary road construction, spring, seep and ephemeral drainage restoration, road decommissioning, prescribed fire, and the spread of chytrid fungus. Seventy-four springs/seeps would be restored, with 32 of those in RU 1, which contains all critical and potential breeding sites. Restoration would increase riparian vegetation increasing availability of food and reproductive sites over the long term, resulting in direct beneficial effects to habitat. Twenty-four miles of ephemeral streams would be restored in RU 1 resulting in improved cover and waterflow that provides escape from predators and prevents water loss for migrating leopard frogs. Spring and channel restoration would result in short-term disturbance to vegetation during implementation. Restored vegetation would be expected to recover within a 1- to 3-year period (soil report). Approximately 127 acres of breeding and dispersal habitat would be impacted by road reconstruction. About 615 acres of forested habitat may be improved within breeding and dispersal habitat. Constructing 71 miles of temporary roads would temporarily disturb vegetation and reduce habitat quality for leopard frogs. **In all alternatives** the likelihood of large high-severity wildfires adversely affecting potential habitat by destroying understory and overstory vegetation would be reduced in RU 1 by 37 percent in ponderosa pine and 5 percent in grasslands. **Specific to alternative C**: The installation of 15 weirs in drainages within RUs 1, 3, and 5 could potentially act as barriers and limit the ability to occupy additional areas. The alternative results in the greatest response in understory (wildlife report, appendix 8) and increases the likelihood of successfully foraging around and migrating between livestock tanks due to decreased risk of predation. The likelihood of large high-severity wildfires adversely affecting potential habitat by destroying understory and overstory vegetation would be reduced in RU 1 by 37 percent in ponderosa pine and 18 percent in grasslands. **Specific to alternative D**: The lowest response of understory biomass occurs. It would result in less cover reducing the likelihood of successfully foraging around and migrating between livestock tanks due to increased risk of predation. The lack of burning further limits understory response, however, the reduction of prescribed fire could reduce direct impacts to frogs migrating overland between stock tanks. The likelihood of large high-severity wildfires adversely affecting potential habitat by destroying understory and overstory vegetation would be reduced in RU 1 by 32 percent in ponderosa pine and 1 percent in grasslands. **Cumulative Effects**: Direct impacts from mechanical thinning, temporary road construction, prescribed fire, and other restoration activities would combine with ongoing activities that have similar effects. Current, ongoing, and reasonably foreseeable projects listed in appendix 12 of the wildlife report include fuels reduction, forest health, aspen regeneration, tornado rehabilitation, and powerline development and maintenance. Cumulatively, activities are not expected to result in long-term effects and are expected to be localized in nature. **Effects Determination**: **Implementation of alternatives B, C, and D may impact individuals, but are not likely to cause a trend to Federal listing or loss of viability**.

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	Birds
Bald Eagle	Direct effects would be from activities that cause disturbances (smoke, auditory, or visual) to bald eagles nesting or foraging within or adjacent to the project. There would be no direct adverse effects to nesting eagles as project design features would eliminate disturbance near known nesting sites. Subunit 1-3 could have a restricted burning period to reduce smoke impacts to two nests. Specialists reviewed the other nest site on the Kaibab NF and determined it would not be impacted from smoke. There would be no effect to nesting or roosting eagles, however, short-term disturbance to foraging bald eagles would occur during mechanical treatments, prescribed fire, hauling of timber, and other project activities which may cause visual or auditory disturbance to foraging bald eagles. Disturbance would be localized and of short duration, and may affect individual birds but would not affect the overall distribution or reproduction of the species. There are no anticipated adverse effects to prey species or prey species habitat. Thinning would improve old tree longevity, resulting in beneficial effects. Snags used by bald eagle would slightly increase post treatment (2020) and continue to increase in the long term. **Alternative D** would provide 5 percent less developing old growth in the short term (post treatment) and 5 percent less long term (30 years post treatment) compared to **alternatives B and C.** **Cumulative Effects**: Current, ongoing, and reasonably foreseeable projects are listed in appendix 12 of the wildlife specialist report and include fuels reduction, forest health, aspen regeneration, tornado rehabilitation, and powerline development and maintenance. Implementation of other project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. All alternatives would improve and develop quality potential nesting and roosting habitat by developing groups of large trees and snags that are more fire resilient. This positive effect would be combined with similar effects from activities such as the travel management efforts that may decrease the frequency of disturbance on the majority of potential roost sites, slightly counteracting the effects of utility line and road construction and maintenance, and short-term disturbances from vegetation management and prescribed fire. **Effects Determination**: **Alternatives B, C, and D may impact individuals, but are not likely to cause a trend to Federal listing or loss of viability**.
American Peregrine Falcon	About 816 acres of habitat would be impacted by road reconstruction. Springs and channel actions would improve habitat. There would be short-term disturbance to vegetation during implementation but restored vegetation would be expected within a 1-year period. About 2,712 acres of forested habitat would be positively affected from road decommissioning. Eliminating disturbance along roadways would be expected to improve the quality of habitat in the long term. Constructing temporary roads would temporarily disturb vegetation and potentially reduce available habitat on 1,671 acres for peregrine prey. Use of these roads by machinery and equipment could crush animals moving across the road. These effects may impact individuals but are expected to be short term, occurring only during project implementation. Vegetation would be restored over the long term. No direct effects from mechanical treatments, temporary road construction, prescribed fire, or spring and riparian habitat and ephemeral streams restoration is expected due to eyrie locations (cliff ledges in rugged canyons). Activity disturbances would be localized, of short duration, and low intensity, and may affect individual birds but would not affect the overall distribution or reproduction of the species. Restoring habitats toward historic conditions and increasing water yield across the forest to improve marsh, pond, or lake habitat can increase prey base for peregrine falcons, resulting in an indirect beneficial effect. **Specific to alternative C:** Increased acres of grassland restoration would have a greater beneficial effect to peregrine prey. Constructing 15 weirs that would impact 3 acres would not have a discernible impact to prey species habitat at the project level.

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	Specific to alternative D: The alternative produces the lowest response of understory biomass. The reduced understory biomass would result in fewer habitats for peregrine prey. **Cumulative Effects:** Other present and reasonably foreseeable projects are listed in appendix 12 of the wildlife specialist report. Those projects where thinning and burning occurs could affect the prey base on a short-term basis by impacting individuals of prey species due to disturbance of prey species' habitat and harm from fire. However, projects would be implemented at different times and/or different locations, thus disturbances to the prey base would be minimized. Other past, present, and ongoing projects have implemented thinning (2,304 acres) and prescribed fire (8,951 acres) in grasslands and prescribed fire (11 springs) and mechanical treatment (6 springs) improving habitats for peregrine prey species in the long term. **Effects Determination**: **Alternatives B, C, and D may impact individuals, but are not likely to cause a trend to Federal listing or loss of viability**.
Clark's Grebe	There would be no direct effects to Clark's Grebe eggs, young, or adults from mechanical treatment and/or prescribed fire. Management in adjacent ponderosa pine, grasslands, and ephemeral drainages could indirectly affect habitat by increasing water yield and improving marsh, pond, and lake habitats increasing availability of food and reproductive sites for these species over the long term, resulting in direct beneficial effects to habitat. **In alternative C**, the research areas are not located within subunits where grebe habitat exists. **Cumulative Effects:** Thinning and prescribed fire have occurred in both ponderosa pine and juniper with projects such as Anderson Mesa Prescribed Burn, Lake Mary, Elk Park and Mormon Lake Basin Fuels Reduction and Forest Health projects, and Picket Agra Ax reducing tree densities potentially increasing water yield into grebe's habitat. Implementation of BMPs would curtail soil erosion and minimize potential for inflow into potential Clark's grebe habitat. Impacts from livestock grazing and increased drought from climate change are expected to be somewhat decreased by a reduction of tree densities increasing water yield into grebe's habitat. **Effects Determination**: **Alternatives B, C, and D would have no impact to the Clark's grebe.**
Burrowing Owl (Western)	There are no documented nesting burrowing owls in the project area, however, potential nesting habitat does exist. Direct effects could occur if motorized equipment runs over aboveground nests or burrows. While 10 to 15 percent of the immediate area in grasslands may be disturbed in the short term, the area is expected to quickly be covered with new needle duff and improved herbaceous vegetative cover and improved soil productivity in the longer term (more than 2 years) (soil resources report). Indirect effects include effects to owl habitat, owl prey species, or prey species habitat. Restoring habitats toward historic conditions could increase potential nesting and foraging habitats. Meadow restoration would improve and increase available habitat for prairie dogs, which would provide nesting habitat for owls. Treatments would increase available habitat for prairie dogs with 11,185 acres of grassland restoration. Prescribed fire would remove cover and food. However, it is anticipated that meadows and open areas would rebound afterwards, with more vigorous herbaceous vegetation and healthier understory habitats for insects and small mammals, increasing food sources and resulting in an indirect beneficial effect. **Specific to alternative C**: Decreases tree encroachment in grasslands by treating 48,206 more acres of grassland, thus decreasing impacts to the larger prairie dog population. Treatments would occur within open linkages providing additional opportunities for Gunnison's prairie dogs to colonize new areas and recolonize areas where trees have encroached previously occupied habitat in Government and Garland Prairie, Kendrick Park, and other grasslands. Alternative C treats the most acres and elicits the greatest response in understory (appendix 8 of the wildlife report). As a result, the habitat as a whole would be more likely to support a greater prairie dog population in grassland systems in the project area, thus supporting more potential owl habitat.

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	Specific to alternative D: The alternative does not include prescribed fire across the mechanical treatments and there are about 20,645 fewer acres of prescribed fire only, further limiting understory response. This alternative provides the least amount and lowest quality of habitat for prairie dogs hence less habitat for burrowing owls. **Cumulative Effects**: Activities such as implementation of the travel management decisions are likely to decrease motorized use in grasslands, thus decreasing impacts to prairie dog populations. This, combined with forest restoration activities, could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving prairie dog colonies. Past, present, and reasonably foreseeable projects are listed in appendix 12 of the wildlife specialist report. Past projects have implemented thinning on 2,304 acres and prescribed fire on 8,951 acres in grasslands. Short-term and localized effects from mechanical thinning and prescribed fire would result in the potential collapsing of burrows and displacement of prairie dogs. This impact may combine with short-term cumulative impacts from localized dispersed camping, wildfire, and wildfire suppression activities to temporarily displace prairie dog populations (and, thus, burrowing owls) in a limited area. The thinning of 2,304 acres and prescribed fire on 8,951 acres in grasslands would add to the acres of treatments in this project to reduce tree densities in grasslands and connect open corridors across the analysis area providing additional potential habitat for burrowing owls. **Effects Determination**: **Alternatives B, C, and D would have no impact to burrowing owls**.
Ferruginous Hawk	There are no direct effects to ferruginous hawks as none are known to nest in the project area. Indirect effects to the ferruginous hawk include effects to prey species or prey species habitat. **Alternative B**: While 10 to 15 percent of the immediate area in grasslands and 10 to 20 percent in savanna may be disturbed in the short term, grasslands are expected to quickly be covered with new needle duff and improved herbaceous vegetative cover in the longer term (more than 2 years). Savanna restoration would increase available habitat for prairie dogs with 11,185 acres of meadow and 45,469 acres of savanna treatments, resulting in an indirect beneficial effect. Project activities may cause visual or auditory disturbance to foraging ferruginous hawks; however, these are short-term effects and would be minimized due to activities being temporally and spatially separated. This disturbance would be localized, of short duration and low intensity, and may affect individual birds but would not affect the overall distribution or reproduction of the species. **Alternative C** treats the most acres and elicits the greatest response in understory. This would improve habitat for ferruginous hawks prey species. **Alternative D** provides the least amount and lowest quality of habitat for prey species, hence less habitat for ferruginous hawks. **Cumulative Effects**: Past, present, and reasonably foreseeable projects are listed in appendix 12 of the wildlife specialist report. Past projects have implemented thinning on 2,304 acres and prescribed fire 8,951 acres in grasslands. Short-term and localized effects from mechanical thinning and prescribed fire would result in the potential collapsing of burrows and displacement of prairie dogs. This impact may combine with short-term cumulative impacts from localized dispersed camping, wildfire, and wildfire suppression activities to temporarily displace prairie dog populations (and, thus, ferruginous hawks) in a limited area. The thinning of 2,304 acres and prescribed fire on 8,951 acres in grasslands would add to the acres of treatments in this project to reduce tree densities in grasslands and connect open corridors across the project area providing additional potential habitat for ferruginous hawks. **Effects Determination**: **Alternatives B, C, and D would have no impact to ferruginous hawks.**

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
Insects	
Four-spotted Skipperling	Under **alternative B**, approximately 74 springs would be restored on potential habitat. There would be short-term disturbance to vegetation during implementation of stream and spring restoration projects; however, restored vegetation would be expected to recover within a 1- to 3-year period (soil resources report). Indirect effects from mechanical treatments, temporary road construction, and prescribed fire would disturb or remove understory vegetation, in effect reducing availability to adult butterflies and/or caterpillars. However, these would be short-term effects and would be minimized due to activities being temporally and spatially separated. Moving these habitats toward historic conditions could increase heterogeneity providing both direct habitat connectivity and habitat stepping stones facilitating landscape movement. **In alternative C**, the overall increase in grassland treatments would have a greater beneficial impact on the development of understory vegetation, increasing availability of food and reproductive sites and improving habitat connectivity resulting in indirect beneficial effects. **In alternative D,** the understory response is not anticipated to be as robust due to the lack of prescribed fire after mechanical treatments. **Cumulative Effects**: Cumulative activities such as implementation of travel management decisions are likely to decrease motorized use in grasslands and meadows, thus decreasing impacts to butterfly habitat. This combined with forest restoration activities could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving butterfly populations. Short-term and localized effects from mechanical thinning, temporary road construction, and prescribed fire would result in the temporary reduction of understory vegetation reducing plant availability to adult insects, a primary food source. This impact may combine with short-term cumulative impacts from localized dispersed camping, wildfire and wildfire suppression activities, ungulate grazing, and drought from climate change to temporarily displace butterflies in a limited area. **Effects Determination**: **Alternatives B, C, and D may impact the four-spotted skipperling, but are not likely to cause a trend to Federal listing or loss of viability.**
Nitocris Fritillary	Approximately 47 springs and 32 miles of ephemeral streams would be restored in potential habitat on the Coconino NF. The impacts and benefits associated with springs and stream restoration and indirect effects of other activities would be the same as described above for the four-spotted skipperling. C**umulative Effects:** Past, present, and reasonably foreseeable projects are listed in appendix 12 of the wildlife report and include projects within wet areas within the ponderosa pine, springs, and wet meadows. Past activities within springs, wet meadows, and riparian streams have been limited with mechanical treatments implemented on three springs and 1.3 miles of riparian habitats and prescribed fire on eight springs and 2.8 miles of riparian habitats. There are 44 springs within a half mile of the project boundary that may be improved through current and reasonably foreseeable projects that reduced tree densities and increased understory vegetation improving functional condition. These projects would combine with this forest restoration project to improve habitat for nitocris fritillary. The cumulative effects are the same as described for the four-spotted skipperling. **Effects Determination**: **Alternatives B, C, and D may impact the nitocris fritillary, but are not likely to cause a trend to Federal listing or loss of viability**.

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
Nokomis Fritillary	Approximately 51 springs/seeps and 85 miles of ephemeral streams would be restored in potential habitat. The impacts and benefits associated with springs and stream restoration, and indirect effects of other activities would be the same as described above for the four-spotted skipperling. **Cumulative effects** are the same as described above for nitocris fritillary. **Effects Determination**: **Alternatives B, C, and D may impact the Nokomis fritillary, but are not likely to cause a trend to Federal listing or loss of viability.**
Mammals	
Navajo Mogollon Vole	Under alternative B, thinning and prescribed fire activities may disturb individual voles, resulting in direct adverse effects. Prescribed fire would result in the removal of cover and food; however, it is anticipated that meadows and open areas would rebound afterwards, with more vigorous herbaceous vegetation and healthier understory habitats. Such activities would occur across the project area at different times; thereby reducing impacts to this species. In addition, the effect would be short term and would have no impact to the population viability of voles. The potential for high-severity fire within grasslands would be slightly (1 percent) reduced with a greater reduction in ponderosa (34 percent) (fire ecology report). Decommissioning of roads means more snags would be available in the future within vole habitat. Springs (74) and ephemeral stream channel restoration (39 miles) would have short-term disturbance to vegetation limiting habitat for the vole; however vegetation would be expected to recovery within a year, increasing availability of food for small mammals over the long term, resulting in indirect beneficial impacts. **Alternative C** adds 48,206 acres of grassland restoration treatments and restores larger grasslands such as Garland and Government Prairie where voles are known to occur. In **alternative D**, the lack of prescribed fire after thinning treatments would deteriorate patterns of surface vegetation, as shrubs and other species adapted to fire decline (Huffman and Moore 2004, Moir 1988). Landscape patterns and mosaics that would have been created or maintained with fire would have to be maintained mechanically. The lack of fire means no nutrient pulse into the system, further limiting understory response. **Cumulative Effects**: Activities that impact the vole include fuels reduction, forest health, aspen regeneration, tornado rehabilitation, and powerline development and maintenance. Past and ongoing grassland activities include 8,951 acres of prescribed fire and 2,034 acres of mechanical treatments. Short-term impacts added to similar impacts from nearby projects were considered. Implementation of other project activities could occur simultaneously, however, it is not anticipated to combine to cause a negative effect. All alternatives could increase potential habitat quality and quantity and reduce risk of uncharacteristic, high-severity wildfire. This positive effect would be combined with similar effects from activities such as implementation of the travel management efforts that may decrease the frequency of disturbance on the majority of potential roost sites, slightly counteracting the effects of utility line and road reconstruction and maintenance, and short-term disturbances from vegetation management and prescribed fire. Short-term and localized effects from mechanical thinning, temporary road construction, and prescribed fire would result in the temporary reduction of understory vegetation and soil compaction. This impact may combine with short-term cumulative impacts from localized dispersed camping, wildfire and wildfire suppression activities, ungulate grazing, and drought from climate change to alter availability of both food and cover for voles and temporarily displace voles in a limited area. Livestock are managed in systems designed to allow forage a chance to recover from livestock grazing, reducing the potential for cumulative effects. However wild ungulates would continue to reduce vegetative understory and affect plant composition. **Effects Determination**: **Alternatives B, C, and D may impact the Navajo Mogollon vole, but are not likely to cause a trend to Federal listing or loss of viability.**

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
Long-tailed Vole	The direct and indirect effects are the same as described for the Navajo Mogollon vole. **Cumulative Effects**: Past, present, and reasonably foreseeable projects considered are listed in appendix 12 of the wildlife report and include projects within springs, seeps, riparian areas, and streams. Past activities within springs, riparian areas, and streams have been limited with mechanical treatments implemented on 11 springs, 50 acres of riparian areas, and 1.3 miles of riparian streams, and prescribed burning on 6 springs, 17 acres of riparian areas, and 2.8 miles of riparian streams. There are 44 springs within a half mile of the project boundary that may be improved through current and reasonably foreseeable projects that reduced tree densities and increased understory vegetation, improving functional condition. These projects would combine with this forest restoration project to improve habitat for long-tailed vole. Other past, present, and ongoing projects have implemented thinning on 2,304 acres and prescribed fire on 8,951 acres in grasslands, improving habitats for long-tailed vole in the long term. The action alternatives results in impacts that may combine cumulatively with other forest and nonforest activities including wildfire and wildfire suppression activities, livestock grazing, recreation, and increased temperatures and predicted vegetation shifts at higher elevations from climate change. All these activities result in impacts by affecting vole habitat and potentially directly affecting vole burrows. The action alternatives would have a much larger beneficial cumulative effect from meadow, grassland, and ponderosa pine restoration treatments. This change, combined with reduced motorized use within these areas, would result in less disturbance and fragmentation to vole habitat. **Effects Determination**: **Alternatives B, C, and D may impact the long-tailed vole, but are not likely to cause a trend to Federal listing or loss of viability**.
Dwarf Shrew	Thinning and prescribed fire activities may disturb individual shrews, resulting in direct adverse effects. Using prescribed fire would result in the removal of cover and food. The effect would be short term. Meadows and open areas would rebound afterwards, with more vigorous herbaceous vegetation and healthier understory habitats. Activities would occur across the project area at different times; thereby reducing impacts to this species. There would be no effects to population viability of shrews. Spring and ephemeral channel restoration would improve riparian vegetation, increasing availability of food for small mammals over the long term, resulting in indirect beneficial impacts. **Cumulative Effects:** Cumulative activities such as implementing travel management are likely to decrease motorized use in grasslands and meadows, thus decreasing impacts to shrew habitat. This, combined with forest restoration activities, could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving small mammal populations. Short-term and localized effects from mechanical thinning, temporary road construction, and prescribed fire would result in the temporary reduction of understory vegetation. This impact may combine with short-term cumulative impacts from localized dispersed camping, wildfire and wildfire suppression activities, ungulate grazing, and drought from climate change to temporarily displace shrews in a limited area. Climate change is also expected to result in a higher frequency of high-severity wildfires (Marlon et al. 2009) and prolonged periods of drought (Furniss et al. 2010), which would also cumulatively contribute to decreases in vegetative ground cover. **Effects Determination**: **Alternatives B, C, and D may impact the dwarf shrew, but are not likely to cause a trend to Federal listing or loss of viability**.
Merriam's Shrew	The direct and indirect effects are the same as described for the dwarf shrew with the following additions. Indirect benefits could potentially result from restoring meadows encroached by pine trees and reducing uncharacteristic tree densities and patterns in the ponderosa pine forest resulting from fire exclusion. These efforts would aid in restoring openings and edge habitat within the forest and improving understory vegetation that would benefit Merriam's shrew and their prey. Coarse woody debris would increase slightly in the short term and would continue to increase over the long term. Exclosures around restored spring and ephemeral channels would

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	improve riparian vegetation, increasing availability of food for small mammals over the long term, resulting in indirect beneficial impacts. **Cumulative Effects:** Current, ongoing, and reasonably foreseeable projects are listed in appendix 12 of the wildlife report and include fuels reduction, forest health, aspen regeneration, tornado rehabilitation, and powerline development and maintenance. Cumulative activities such as implementing travel management are likely to decrease motorized use in grasslands and meadows, thus decreasing impacts to shrew habitat. This combined with forest restoration activities could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving small mammal populations. Short term and localized effects from mechanical thinning, temporary road construction, and prescribed fire would result in the temporary reduction of understory vegetation. This impact may combine with short-term cumulative impacts from localized dispersed camping, wildfire and wildfire suppression activities, ungulate grazing, and drought from climate change to temporarily displace shrews in a limited area. Development of private and State land has the greatest potential impact to shrew habitat. **Effects Determination: Alternatives B, C, and D may impact the Merriam's shrew, but are not likely to cause a trend to Federal listing or loss of viability.**
Western Red Bat	In alternatives B, C, and D, thinning and prescribed fire could potentially disturb red bats if they are roosting in trees or hibernating among leaf litter. However, most prescribed fire would occur in the spring and fall and burn plans within a half mile of known roosts/hibernacula would be designed to limit smoke at critical times (April through July and mid-winter). Actions are expected to result in a slight short-term decrease in snags followed by an increase over the long term. This short-term loss of snags is not expected to affect the overall distribution of western red bats on the forest. Prescribed fire after mechanical treatments would result in the removal of cover and food; however, it is anticipated that meadows and open areas would rebound afterwards, with more vigorous herbaceous vegetation and healthier understory habitats, thereby enhancing prey habitat. Restoring openings and edge habitat within the forest and improving understory vegetation would benefit western red bats and their prey. Moving these habitats toward historic conditions would also increase resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire. Spring and ephemeral channel restoration would improve riparian vegetation, increasing availability of food for prey species over the long term, resulting in indirect beneficial effects. **Cumulative Effects**: These short-term impacts added to similar impacts from other past, present, and reasonably foreseeable projects were considered. Implementation of other fuel reduction project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. Ungulate grazing within the project area reduces understory vegetation, which reduces plant availability to adult insects, a primary food source. Generally, grazing systems are managed on a rotational grazing system to allow forage a chance to recover from livestock grazing, reducing the potential for cumulative impacts. However, wild ungulates would continue to reduce vegetative understory and affect plant composition in meadows and around waters. **Effects Determination**: **Alternatives B, C, and D may impact the western red bat, but are not likely to cause a trend to Federal listing or loss of viability**.
Spotted Bat	Under **alternative B,** thinning and prescribed fire activities could potentially disturb spotted bats if they are roosting in rock crevices within the ponderosa pine treatment area. Prescribed fire occurring when bats are rearing young (April through July) or in deep hibernation (mid-winter) can have negative effects on local populations. However, most prescribed burning would occur in the spring and fall and burn plans within a half mile of caves, mines, or cliff habitats would be designed to limit smoke at critical times (April through May and mid-winter). Other effects from prescribed fire are the same as described for the greater western mastiff bat.

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	Alternative C treats the most acres and elicits the greatest response in understory and the greatest availability of food for bats. **Alternative D** produces the lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect adverse effects to spotted bat. **Cumulative Effects**: Current, ongoing, and reasonably foreseeable projects are listed in appendix 12 of the wildlife report and include fuels reduction, forest health, aspen regeneration, tornado rehabilitation, and powerline development and maintenance. Past and ongoing grassland activities include 8,951 acres of prescribed fire and 2,034 acres of mechanical treatments. There may be potential short-term disturbance to potential foraging and roosting habitat with long-term benefits. Short-term disturbance to bats would occur during thinning, hauling, and prescribed fire activities and may cause disturbance in nearby areas for the duration of the activity. These short-term impacts added to similar impacts from other past, present, and reasonably foreseeable mechanical vegetation management and fuels reduction projects were considered. Implementation of other vegetation management and fuel reduction project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. Ungulate grazing within the project area reduces understory vegetation, which reduces plant availability to adult insects, a primary food source. Generally, grazing systems are managed on a rotational grazing system to allow forage a chance to recover from livestock grazing, reducing the potential for cumulative impacts. However wild ungulates would continue to reduce vegetative understory and affect plant composition in meadows and around waters. **Effects Determination: Alternatives B, C, and D may impact spotted bat, but are not likely to cause a trend to Federal listing or loss of viability.**
Allen's Lappet-browed Bat	In **alternatives B, C, and D**, thinning and prescribed fire activities could potentially disturb Allen's lappet-browed bats if they are roosting in trees within the ponderosa pine and pinyon-juniper treatment areas. Prescribed fire occurring when bats are rearing young (April through July) or in deep hibernation (mid-winter) can have negative effects on local populations. However, most prescribed fire would occur in the spring and fall, and burn plans within a half mile of known roosts/hibernacula or unsurveyed caves and mine shafts would be designed to limit smoke at critical times (April through May and mid-winter). Prescribed fire may also result in the loss of individual snags which could affect roosting bats; however, mitigation including managing for retention of all snags 18 inches in diameter and greater would reduce the impact. The alternatives are expected to result in a slight short-term increase in snags followed by a continuing increase over the long term. Prescribed fire would result in the removal of cover and food; however, it is anticipated that meadows and open areas would rebound afterwards, with more vigorous herbaceous vegetation and healthier understory habitats. The reduction of dense forest canopy and increased growth in the herbaceous vegetation on the forest floor would result in indirect beneficial impacts to bats. Forest conditions after treatment would improve bat habitat within the project area. Increasing diversity and density of understory vegetation provides habitat for prey population. Treatments would aid in restoring openings and edge habitat within the forest and improving understory vegetation that would benefit Allen's lappet-browed bats and their prey. Moving these habitats toward historic conditions would also increase resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire. Decommissioning of roads means more snags would be available in the future within Allen's lappet-browed bat habitat providing more roosting structures. Spring and channel restoration would improve riparian vegetation, increasing availability of food for bats over the long term, resulting in indirect beneficial effects. **Cumulative Effects:** Cumulative effects are the same as described above for the western red bat with one addition. Implementation of the travel management decisions has reduced the number of roads near Allen's lappet-browed bat roost locations.

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	Effects Determination: **Alternatives B, C, and D may impact Allen's lappet-browed bat, but are not likely to cause a trend to Federal listing or loss of viability.**
Pale Townsend's Big-Eared Bat	The direct and indirect effects of **alternatives B, C, and D** are the same as described above for the western red bat with the following additions: The proposed decommissioning of roads means more snags would be available in the future within Townsend's big-eared bat habitat providing more roosting structures. Spring and channel restoration would improve riparian vegetation, increasing availability of food for Noctuids and, therefore, Townsend's big-eared bat over the long term, resulting in indirect beneficial impacts. In **alternative C**, the overall increase in grassland treatments would have a beneficial impact on Townsend's big-eared bat prey resulting in indirect beneficial effects. **Alternative D** produces the lowest response of understory biomass of all the action alternatives limiting prey and resulting in indirect adverse effects to Townsend's big-eared bat. **Cumulative Effects**: Past and ongoing grassland activities include 8,951 acres of prescribed fire and 2,034 acres of mechanical treatments. Short-term impacts added to similar impacts from other past, present, and reasonably foreseeable projects were considered. Implementation of other fuel reduction project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. Ungulate grazing within the project area reduces understory vegetation, which reduces plant availability to adult insects, a primary food source. Generally, grazing systems are managed on a rotational grazing system to allow forage a chance to recover from livestock grazing, reducing the potential for cumulative impacts. However, wild ungulates would continue to reduce vegetative understory and affect plant composition in meadows and around waters. Travel management implementation has reduced the number of roads near Townsend's big-eared bat roost locations. **Effects Determination**: **Alternatives B, C, and D may impact pale Townsend's big-eared bat, but are not likely to cause a trend to Federal listing or loss of viability.**
Greater Western Mastiff Bat	Disturbance from thinning and prescribed fire activities would be highly unlikely. In addition, direct effects to roosting from project implementation are not anticipated. Prescribed fire would result in the removal of cover and food; however, it is anticipated that meadows and open areas would rebound afterwards, with more vigorous herbaceous vegetation and healthier understory habitats. Indirect effects would result from vegetation modification activities such as thinning and prescribed fire. These activities would disturb or remove understory vegetation, subsequently reducing availability to insects. These effects would be short term and would be minimized due to activities being temporally and spatially separated. Efforts would aid in restoring openings and edge habitat within the forest and improving understory vegetation that would benefit greater western mastiff bats and their prey. Moving these habitats toward historic conditions would also increase resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire. Exclosures around restored spring and ephemeral channels would improve riparian vegetation, increasing availability of food for bats over the long term, resulting in indirect beneficial impacts. **Alternative C** treats the most acres and elicits the greatest response in understory and the greatest availability of food for bats. **Alternative D** produces the lowest response of understory biomass limiting prey and resulting in indirect adverse effects to greater western mastiff bat. **Cumulative Effects**: Current ongoing and reasonably foreseeable projects are listed in appendix 12 of the wildlife report and include fuels reduction, forest health, aspen regeneration, tornado rehabilitation, and powerline development and maintenance. Past and ongoing grassland activities include 8,951 acres of prescribed fire and 2,034 acres of mechanical treatments. There may be potential short-term disturbance to potential foraging and roosting habitat with long-term benefits. Short-term disturbance to bats would occur during thinning, hauling, and prescribed

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	fire activities and may cause disturbance in nearby areas for the duration of the activity. These short-term impacts added to similar impacts from other past, present and reasonably foreseeable projects were considered. Implementation of other fuel reduction project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. Ungulate grazing within the project area reduces understory vegetation, which reduces plant availability to adult insects, a primary food source. Generally, grazing systems are managed on a rotational grazing system to allow forage a chance to recover from livestock grazing, reducing the potential for cumulative impacts. However wild ungulates would continue to reduce vegetative understory and affect plant composition in meadows and around waters. **Effects Determination**: **Alternatives B, C, and D may impact greater western mastiff bat, but are not likely to cause a trend to Federal listing or loss of viability.**
Reptiles	
Narrow-headed Garter Snake	There would be no direct effects to narrow-headed garter snakes from mechanical treatment and/or prescribed fire. The project would not be directly treating the habitat. Treatments in subunits connected to these watersheds could potentially lead to increased sedimentation and/or ash flow into narrow-headed garter snake habitat (see aquatic species and watershed reports). However, this increase in sediment or ash over background levels would not have negative impacts on habitat for this species. Conversely, moving the forested uplands toward historic conditions would increase resilience of these systems and decrease the risk of uncharacteristic, high-severity wildfire. Protective stream buffer strips would be employed along the Sterling Canyon stream course for both alternatives B and C to reduce the risk of sediment and ash flow into Upper Oak Creek. Spring restoration would increase riparian vegetation increasing availability of food and reproductive sites for these species over the long term, resulting in direct beneficial effects to habitat. In alternative D, there would be no prescribed fire on slopes greater than 15 percent along the upstream portion of Oak Creek within subunit 3-5, eliminating the need for a protective stream course buffer along the entire length of Sterling Canyon. **Cumulative Effects**: The area analyzed for cumulative effects for narrow-headed garter snake is subunit 3-5. No cumulative effects to narrow-headed garter snake would occur from implementing any of the alternatives, when added to past, present, and reasonably foreseeable future activities. Ongoing and foreseeable future projects include tornado rehabilitation and the Turkey Barney Fuels Reduction and Forest Health project. Implementation of other projects could occur simultaneously; however, it is not anticipated to combine to cause a negative effect. BMPs are implemented for all projects and would curtail soil erosion and minimize potential for inflow into potential narrow-headed garter snake habitat. **Effects Determination: Implementation of alternatives B, C, and D may impact narrow-headed garter snake, but are not likely to cause a trend to Federal listing or loss of viability.**
Plants	
Arizona Bugbane	Mitigation applicable to alternatives B, C, and D would protect shady, mesic microclimate needed for survival and reproduction and reduce risk associated with increased noxious or invasive weeds. **Cumulative Effects:** The cumulative effects boundary is the range of Arizona bugbane within the Coconino and Kaibab NFs. The time limit is from the year 2000 to present. Past impacts include grazing, recreation, wildfire, and natural disturbances such as flooding, drought, tornados, and mortality in overstory trees. Natural events have affected the habitat and distribution of Arizona bugbane in some areas. Ongoing and foreseeable vegetation projects have treatments similar to 4FRI. Impacts to ongoing and foreseeable impacts (vegetation projects, grazing) are mitigated by treatment design; therefore, the cumulative effects are nonsignificant.

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	Effects Determination: Alternatives B, C, and D may impact individuals of Arizona bugbane but are not likely to result in a trend toward Federal listing or loss of viability.
Rusby Milkvetch	**Alternatives B, C, and D** direct effects include the immediate loss of individual plants or population groups through management actions. In the long term, there would be benefits from reduced competition and increased amounts of sunlight and nutrients. Burning is a disturbance that can release nutrients, reduce plant competition, and increase the amount of available sunlight. Survey and mitigation would reduce the risk of increased noxious or invasive weeds and damage or loss from springs, channels, and road activities. **Cumulative Effects**: The cumulative effects boundary is the range of Rusby milkvetch which is confined to the volcanic fields of the San Francisco Peaks, approximately 1,152,000 acres (Priest et al. 2001). Only a portion of this area—the ponderosa pine forest—is suitable habitat. Several large wildfires have occurred in the project area; but cumulatively, this represents less that 5 percent of the available habitat. Implementation of travel management on both forests, combined with such actions as road decommissioning in this project, would reduce the impacts of vehicle traffic in the habitat of Rusby milkvetch. Implementation will continue in projects (such as Hart Prairie, Wing Mountain, Frenchy, and Pomeroy) in the range of Rusby milkvetch. Other actions including grazing and foreseeable trail construction (Mt. Elden, Dry Lake Hills) when combined with 4FRI would continue to occur in the range of Rusby milkvetch and continue to affect it. Cumulatively, none of these actions would lead to a trend toward Federal listing. **Effects Determination**: **Alternatives B, C, and D may impact individuals of Rusby milkvetch but are not likely to result in a trend toward Federal listing or loss of viability**.
Arizona Leatherflower	With mitigation, alternatives B, C, and D direct and indirect effects are similar to those for Rusby milkvetch. **Cumulative Effects:** The temporal timeframe for cumulative effects is 2007 when the species was returned to the Southwestern Region's sensitive species list after being absent from it for nearly 10 years. The cumulative effects boundary is the occupied habitat within the project boundary. Past actions such as grazing, fire suppression, wildfires, timber, recreation, and plant collecting have occurred and have contributed to existing conditions; however, effects of high-severity fire are unknown. Actions on nonforest lands may have affected the occurrence and distribution of Arizona leatherflower in other areas. Many areas in and near Flagstaff that provided potential habitat for the plants have been altered or developed, making the habitat no longer suitable. At least one population on private land was destroyed during a road realignment project. Implementation of travel management combined with project road decommissioning would reduce the impacts of vehicle traffic in the habitat. **Effects Determination: Alternatives B, C, and D may impact individuals of Arizona leatherflower but are not likely to result in a trend toward Federal listing or loss of viability.**
Flagstaff pennyroyal	With mitigation, the direct and indirect effects of alternatives B, C, and D are similar to those discussed for Rusby milkvetch. **Cumulative Effects**: The cumulative effects temporal timeframe is from 2000 to present. The spatial boundary is the range of Flagstaff pennyroyal in the project area including the areas roughly from Flagstaff, east to Marshall Lake and Fisher point, then south to the vicinity of Mountainaire, then to Lower Lake Mary on the Coconino NF, and a limited amount of habitat along the edge of Sycamore Canyon on the Kaibab NF. Activities on nonforest lands in suitable habitat have reduced about 10 percent of the total historical range. The species occurs in several recently analyzed or implemented fuels reduction projects (including Kachina 2003, Mountainaire 2006, Elk Park 2007, see botany report for complete information). These projects covered about 75 percent of the total acreage of the potential habitat managed by the Coconino NF. These projects did not adversely affect the abundance or distribution of Flagstaff pennyroyal

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	and when combined with the effects of this project, would not adversely affect this species. About 831 acres of prescribed fire would occur (foreseeable) in the Skunk project (Coconino NF) and 20,197 acres would occur on the Eastside project (Coconino NF). In past and foreseeable projects, effects to Flagstaff pennyroyal were mitigated or would be mitigated to nonsignificant levels. Other ongoing and foreseeable actions include dispersed recreation and new motorized trails. When combined with 4FRI actions, there would be no measurable cumulative impact. Any impact would be nonsignificant. Implementation of travel management decisions on both forests, when combined with such actions as road decommissioning in this project, would reduce the impacts of vehicle traffic in the habitat of Flagstaff pennyroyal. **Effects Determination: Alternatives B, C, and D may impact individuals of Flagstaff pennyroyal but are not likely to result in a trend toward Federal listing or loss of viability**.
Arizona sneezeweed	With mitigation, direct and indirect effects to Arizona sneezeweed are similar to those for Rusby milkvetch. **Cumulative Effects**: The cumulative effects temporal timeframe is from 1999 (when the species was added to the Southwestern Region's sensitive species list) to present. The boundary includes the range of Arizona sneezeweed within the project area which is roughly from the Mormon Lake area southward to the project boundary. Past natural events such as persistent drought that began in 1996 and lasted for over 10 years probably affected the abundance and distribution of the species due to its affinity for moist soil. The drought compounded such effects as fire severity and impacts from grazers seeking water sources, which decreased in availability during the drought (see "Climate Change" section for additional information). Alteration of habitat through diversion of water for use to water animals might have also affected the habitat. There have been no past fuels reduction projects in the area where Arizona sneezeweed was documented during surveys. There are no past cumulative effects from actions associated with fuels reduction projects such as tree removal, burning, or road construction and maintenance activities, which are also part of 4FRI. Other ongoing and foreseeable actions include dispersed recreation and new motorized trails. When combined with 4FRI actions, there would be no measurable cumulative impact. Any impact would be nonsignificant. Implementation of travel management decisions on both forests, when combined with such actions as road decommissioning in this project, would reduce the impacts of vehicle traffic in the habitat of Arizona sneezeweed. **Effects Determination: Alternatives B, C, and D may impact individuals of Arizona sneezeweed but are not likely to result in a trend toward Federal listing or loss of viability.**
Sunset Crater Beardstongue	In alternatives B, C, and D, a few units would be treated using the grassland restoration or grassland mechanical prescriptions. In those units, the effects would be similar to mechanical treatment for other species such as Rusby milkvetch. See table 12 in the report which documents site locations within project treatment units by alternative. **Cumulative Effects:** The temporal timeframe for cumulative effects is from 1973 (when the effects of fire to Sunset Crater beardtongue were first noted by a former Coconino NF wildlife biologist) to present. In 1992, a tornado occurred within the habitat and a subsequent salvage sale occurred. Monitoring in 1996 found no adverse effects from the storm or the salvage sale. Two fuels reduction projects (Eastside, 2006 and Jack Smith/Schultz, 2006) are ongoing but are not directly affecting the species due to the small portions of the habitat affected and actions are limited prescribed fire. Several large wildfires have occurred in the habitat: Burnt Fire (1973), Wild Bill Fire (1993), Hochderffer (1996), Cinder Hills Fire (2009), and Schultz Fire (2010). The Schultz Fire caused severe environmental damage including flooding and soil erosion, some of which extended into the habitat. Post-fire rehabilitation actions affected some of the potential habitat. The long-term effects on habitat and native plants include noxious or invasive weed invasion and continued disturbance of the habitat. The cinder hills area that contains most of the habitat is heavily used for recreation (ongoing activity). The Schultz Fire Sediment Reduction Project (2012) is currently being analyzed. Indirect effects include an ongoing source of

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	disturbance for an indefinite period of time. Continued growth in Doney Park could possibly decrease in the amount of suitable habitat available on nonforest lands. Several utility corridors are present in the potential habitat. The ongoing and foreseeable construction, expansion, and maintenance of these corridors would result in loss of individuals along the corridor routes. Given the baseline condition, ongoing and foreseeable projects/activities, when combined with the 4FRI actions that would affect habitat, would not significantly impact the habitat or the species. **Effects Determination**: **Alternatives B, C, and D may impact individuals of Sunset Crater beardtongue but are not likely to result in a trend toward Federal listing or loss of viability.**
Flagstaff beardtongue	The direct and indirect effects of alternatives B, C, and D to Flagstaff beardtongue are similar to those for Rusby milkvetch with one exception: There are no documented occurrences of Flagstaff beardtongue in areas being analyzed for spring and channel restoration so there would be no direct or indirect effects from those actions. **Cumulative Effects:** The cumulative effects temporal timeframe is from 1999 to present. This represents the length of time that Flagstaff beardtongue has been on the Southwestern Region's sensitive species list. The cumulative effects area is the project boundary. Past fuels projects occurred in approximately 10 percent of the cumulative effects area and did not adversely affect the abundance or distribution of the species. The total acreage of several large fires that have occurred within potential habitat is about 10,500 acres which represents less than 10 percent of the potential habitat. Severe wildfires can potentially destroy plants and alter habitat, but the effects of these fires on Flagstaff beardtongue and its habitat are unknown. Impacts from ungulate grazing in certain areas include past and present loss of individual plants and alteration of habitat through trampling and compaction. Dispersed recreation is an ongoing activity that occurs in the habitat. Several utility corridors are present in potential habitat. Construction, expansion, and maintenance of these corridors would result in loss of individuals along the corridor routes. Implementation of travel management decisions on both forests, when combined with such actions as road decommissioning in this project, would reduce the impacts of vehicle traffic in the habitat. Past, present and foreseeable actions, when combined with 4FRI actions, would have no adverse effects in the short or long term because they would not lead to a significant decrease in habitat or number of plants present in the project area. **Effects Determination: Alternatives B, C, and D may impact individuals of Flagstaff beardtongue but are not likely to result in a trend toward Federal listing or loss of viability.**
Blumer's dock	Alternatives B, C, and D's effects from mechanical treatment, prescribed fire, and road related actions are similar to those described for Rusby milkvetch but are somewhat less important to this species since it is dependent on wet areas for its survival. Direct effects of spring and channel restoration would include deaths of individual plants or population groups during implementation. Management actions such as digging, soil disturbance, and related activities associated with spring restoration may impact individual plants if they are present on the site. These risks would be mitigated by surveying and avoiding plants. Restoration work for springs and channels would benefit the habitat and provide areas for natural generation or reintroduction (see specialist report for examples of past projects where habitat has been improved). The alternatives would reduce fire risk to many understory plants including Blumer's dock. The potential for noxious or invasive weeds would be mitigated (see appendix C of the DEIS). **Cumulative Effects:** The cumulative effects temporal timeframe is from 1991—when the nearby Tonto NF prepared a management plan for Blumer's dock—to the present. Persistent drought in the northern Arizona area that began in 1996 and lasted for over 10 years probably affected the abundance and distribution of Blumer's dock due to its affinity for wet areas. The drought compounded such effects as fire severity and impacts from grazers. Several utility corridors are present in the potential habitat of Blumer's dock. The presence of these corridors provides corridors for dispersal of noxious or invasive weeds along the utility corridor and in

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	adjacent forested areas. These past events have formed the baseline for the current existing condition. Dispersed recreation is an ongoing activity that occurs in certain areas of the habitat. Management activities that were analyzed as part of the Hart Prairie project (2010) will continue to be initiated including several activities in or near the Hart Prairie Preserve and Fern Mountain Botanical Area. Ongoing activities include construction and/or reconstruction of several enclosures that will provide refugia for Blumer's dock. Construction, expansion, and maintenance of utility corridors would result in loss of individuals along the corridor routes. When alternatives B, C, and D activities are combined with ongoing and foreseeable activities, the result is expected to have minor but beneficial effects to the habitat. **Effects Determination**: **Alternatives B, C, and D may impact individuals of Blumer's dock but are not likely to result in a trend toward Federal listing or loss of viability.**
Bebb's Willow	With mitigation, alternatives B, C, and D's direct and indirect effects for Bebb's willow on the Coconino NF are similar to those for Rusby milkvetch. There are no documented locations of Bebb's willow within the project area on the Kaibab NF, but Bebb's willows may be present in some areas such as around springs and channels. These areas would be surveyed before implementation and mitigation measures and design features would be incorporated as needed into alternatives B, C, and D actions. With survey and mitigation as needed, the direct and indirect effects on Bebb's willow on the Kaibab NF are the same as described above. **Cumulative Effects**: The cumulative effects boundary is the Coconino NF portion of the project area. The temporal timeline is from 1987 (with publication of the "Coconino National Forest Land and Resource Management Plan") to the present. Cumulative effects to Bebb's willow on the Kaibab NF were excluded from this discussion because there are no documented occurrences in the Kaibab portion of the project and Bebb's willow has no special status on the Kaibab NF. Fern Mountain Botanical Area (186 acres) is dominated by Bebb's willow and represents a unique riparian community. Approximately 1,300 Bebb's willow plants occur in the Hart Prairie area in the botanical area and the Hart Prairie Preserve. Past management actions, including establishment of the botanical area and restoration actions conducted by The Nature Conservancy and the Forest Service, represent the baseline (existing condition) for the species. Management activities that were analyzed as part of the Hart Prairie project (2010) will continue to be initiated including several activities in or near the Hart Prairie Preserve and Fern Mountain Botanical Area. Ongoing activities include construction and/or reconstruction of several enclosures that would provide refugia for Bebb's willow, which would improve the distribution of age classes. The Apache Maid Allotment analysis, which is a concurrent but unrelated analysis, includes the Railroad Spring area. Spring restoration sites in the project may provide locations and opportunities for Bebb's willow restoration. Given the baseline condition, ongoing and foreseeable projects, when considered with 4FRI actions, would be beneficial to habitat and populations. **Effects Determination**: **Alternatives B, C, and D may impact individuals of Bebb's willow but are not likely to result in a trend toward Federal listing or loss of viability.**
Forest Plan Amendments – All Species	Alternatives B, C, and D each contain nonsignificant forest plan amendments to address issues related to MSO and northern goshawk issues on the Coconino and Kaibab NFs. These amendments focus on allowing treatments in MSO PACs and northern goshawk habitats that are currently outside the authority of the current plans. These amendments are needed to accomplish the objectives of restoration as defined in the 4FRI. The expected results are increased resiliency and forest health in the treated areas as well as reduction in fire risk in these areas. With design features and actions mitigated, no amendment is expected to change the analysis for sensitive plants or for noxious or invasive weeds. Minor but insignificant changes to the amount of canopy cover and interspaces would result. These changes could result in minor but insignificant increases in growing space for all understory plants including sensitive plants and noxious or invasive weeds. The results would be minor increases in resources for sensitive plants and a slight increase in opportunities for new occupation but these effects are minor and

Species	Alternatives B, C, and D Environmental Consequences (Direct, Indirect, Cumulative)
	discountable. There may also be a minor but insignificant increase in disturbance resulting from treatments that would occur because of these treatments, but the increase would not significantly increase the risk of noxious or invasive weed invasions. Amendment 2 (alternative C only) to the Kaibab NF plan: The effects to sensitive plants and noxious or invasive weeds resulting from the change in management of this area would be the same as those to similar areas discussed in the report. The area was analyzed in the 1988 plan as a potential RNA but the process to designate and establish the RNA was never completed. As a result, restrictions to the area currently remain in place. The restrictions on management activities in the area that result from the RNA designation would no longer apply when the revised forest plan is completed and implemented. In the draft revised forest plan (2012), the area would be managed as the Garland Prairie Management Area. The treatments proposed in alternative C would benefit the understory vegetation community in the RNA by reintroducing natural processes and reducing competition from trees to grassland plants and would achieve the goal of restoring fire. Management actions in alternative C would move the area toward this condition, which would be complementary to the objectives of the Kaibab NF plan (1988) and 4FRI.

Northern Goshawk

This analysis addresses policy requirements and responds to key issues raised by the public including Issue 2, conservation of large trees, and Issue 3, canopy cover and post-treatment landscape openness in the context of impacts to goshawk and post-treatment viability. Metrics used to evaluate impacts are described in environmental consequences. The analysis utilizes and incorporates by reference the silviculture report (McCusker 2013).

Surveys

Most of the ponderosa pine, ponderosa pine/Gambel oak, and mixed-conifer habitats on the Coconino NF have been surveyed according to Southwestern Region protocol for the northern goshawk. Northern goshawk territories have been monitored every year since 1989, with an average of 43 territories monitored from 1991 to 2001. As of 2008, there were 70 known territories on the Coconino NF. The occupancy rate of territories has declined over the last 11 years. However, the goals of monitoring are to gain information on territory occupancy and reproduction; data collected on the forest are not designed to detect changes in population trends.

Data for the Kaibab NF show a similar decline in occupied territories using data from 1996 to 2007. There are currently 68 goshawk territories on the southern portion of the Kaibab NF, including 36 goshawk PFAs on the Kaibab NF portion of the project area. However, if future weather patterns produce good precipitation, the population could stabilize. Continued reduction of forest stem density and basal area should ameliorate the stochastic nature of weather by reducing the threat of large-scale, high-severity fire, thereby helping stabilize the population. See the wildlife report for monitoring details and the history of goshawk occupancy on the forests.

Summary of Habitat Condition

The existing and desired conditions for forest structure and vegetation features relevant to prey species in goshawk habitat are summarized in chapter 1.

Scales of Analysis

An analysis at three spatial scales is required by the Coconino and Kaibab NF forest plans for goshawk habitat. Evaluations of post-fledgling family area (PFA) habitat (used for nesting, breeding, and primary foraging during the nesting season) and landscapes outside of the PFA (referred to as LOPFA which is used primarily for foraging), was conducted at the project, subunit, and RU levels. An additional fourth scale of analysis was conducted at the landscape scale, and it included all of the ponderosa pine within the project area.

Nest areas are the smallest unit of northern goshawk habitat and potentially the most limiting. Just over one-quarter of nest areas fall within either protected or restricted MSO habitat. The PFA area immediately surrounding the nest area provides the closest foraging opportunities as well as alternate nesting sites. Similar to the nest area, about the same portion of the PFA, slightly less than one quarter, is considered MSO habitat.

Project Level Analysis

Within nest areas, PFA, and dispersal PFA (dPFA), all of the acres within the respective goshawk strata were included in the calculations for VSS and changes to VSS within these areas. For the LOPFA, only those acres that were managed to northern goshawk prescriptions were included, which would be about 78 percent of the acres.

The existing ratios of VSS within nest areas/PFA/dPFA at the project level are distributed with about four-fifths or 87 percent of the areas in the mid-seral VSS 3 and VSS 4. This is about double the acreage desired for mid-seral structure in goshawk habitat. Additionally, young seral forest is about a level of magnitude below desired conditions for the distribution of VSS classes across the landscape.

Restoration Unit (RU) Level of Analysis

The VSS distribution for the RU level is thoroughly analyzed in detail in the silvicultural report. The VSS distribution is dominated by VSS 3 through VSS 6 in uneven-aged PFAs and LOPFAs. Eighty to 100 percent of the habitat is VSS 3 and 4 in even-aged PFA and LOPFA. The only exception is RU 5 where 64 percent of the LOPFA is in VSS 3 and 4. Over a quarter of the LOPFA in RU 5 is VSS 1 and the remainder is in VSS 5 and 6.

Landscape Level of Analysis

For the landscape perspective, the ponderosa pine vegetation is addressed, encompassing the entire treatment area where changes would occur if the 4FRI is implemented. The existing condition is not that different from the other goshawk strata analyzed above.

Environmental Consequences

Alternative A

There would not be any direct effects from the alternative. Individual forest projects would continue to move some acreage toward desired conditions, but the overall landscape would change slowly. VSS distribution within PFAs would develop more slowly, relative to the action alternatives, and move toward more VSS 5 and 6 as trees develop and mature. As modeled in the silviculture analysis, this would minimally meet forest plan direction for late successional habitat

with a combined total of 37 percent of the landscape by 2050. There would be no groups of VSS 1 or 2 by 2050, limiting regeneration to individual trees scattered under existing canopies.

With few openings and a relatively continuous canopy, "volunteer" regeneration would not be likely to support a continuous flow of trees into larger size classes. This would not promote a sustainable distribution of age classes, would not provide the variety of habitats used by key goshawk prey species, and so overall would not meet the desired conditions (see "Vegetation Analysis"). By 2050, overall VSS ratios would approach forest plan direction in even-aged LOPFA habitat, but uneven-aged stands would not regenerate stands of VSS 1 and 2, and VSS 3 and 4 would remain high occupying about 50 percent of the LOPFA.

Alternative A would not improve prey species habitats associated with springs, along ephemeral channels, or in aspen, meadows, grasslands, and savannas. Use of any open roads would continue the current level of disturbance occurring within PFAs and would not improve the quality of the adjacent habitat.

Alternatives B, C, and D

In total, the Coconino NF has 45,415 acres of occupied goshawk habitat. Alternative B would treat about 38 percent of the forestwide occupied habitat, alternative C would treat about 39 percent, and alternative D about 33 percent. On the Kaibab NF there are 124,938 acres of occupied goshawk habitat forestwide. The main difference in forestwide occupied habitat between forests is largely due to the Kaibab NF hosting over 20 years of goshawk research on the North Kaibab Ranger District. All alternatives would treat about 11 percent of the forestwide occupied goshawk habitat on the Kaibab NF.

Forest Structure

All action alternatives would move the VSS balance in PFA habitat toward desired conditions through treatments designed to enhance goshawk habitat. Alternatives B, C, and D would have similar results in moving the LOPFA toward balancing VSS ratios immediately post treatment (2020) by increasing the amounts of VSS 5 and 6 by primarily treating the abundant VSS 3 and 4 size classes. By 2050, all action alternatives would create more VSS 5 and 6 than is described in the forest plans, but compared to the no action alternative, the treatments would move goshawk habitat in a trajectory toward desired conditions. Prescribed burning in VSS 3 and 4 under alternatives B and C would move more acres into VSS 5 and 6 than would occur in alternative D. Post-treatment conditions would change the VSS distribution and promote an interspersion of regeneration groups and interspace, leading to future uneven-aged development within the existing forest. Under all scenarios, VSS 5 and 6 would exceed 50 percent of the landscape by the year 2050.

Analysis at the Subunit, Restoration Unit, and Landscape Scale

When analyzed at the subunit scale, the changes in scale did not change the patterns of habitat response to proposed treatments. The analysis of VSS changes among the subunits is discussed in the silviculture report. The existing conditions of VSS are listed in tables by subunit and RU in appendix 9 of the wildlife report.

At the RU scale, the trends in changes are similar as are the reasoning for the resultant cause and effect discussed above. The VSS distribution for the RU level is thoroughly analyzed in detail in the silvicultural report. See appendix 10 of the wildlife report for pie charts displaying the relative

percent of VSS by RU by alternative over time. These provide a visual picture of the relative changes to goshawk nesting habitat among the RUs.

At the landscape scale, the existing condition is again similar to the other goshawk strata analyzed above. The changes to the VSS distribution for ponderosa pine vegetation in the treatment areas without consideration of special species status are similar to those seen at the various scales discussed above.

Alternatives B and C show essentially identical changes at this scale. The changes in percent VSS are attributed to removing the VSS 3 and 4 size trees through mechanical harvest and prescribed fire and leaving the large trees that comprise VSS 5 and 6. Alternative D shows slightly less increase in VSS 5 and 6, or acres of large trees, due to the lack of prescribed fire in the dense VSS 3 and 4 size classes occupying the majority of the area.

Prey Habitat

The vegetation analysis describes the changes in the physical features associated with prey species habitat in ponderosa pine including CWD, logs, and snags. All alternatives would meet forest plan direction for CWD by providing 5 to7 tons per acre by the year 2050 (table 41). Alternative D would provide the most CWD and alternatives B and C the least as a result of the differences in the use of prescribed fire. Logs would be below forest plan guidance, but the action alternatives would provide as many or more logs per acre than the no action alternative. While numbers varied by alternative, PFA habitat would generally support more logs per acre than LOPFA. Snags would increase over time but be below forest plan direction in all alternatives. However, alternative A would provide the least amount of snags, alternatives B and C the most, and results from alternative D would be in the middle regardless of which goshawk habitat is modeled (PFA or LOPFA). See the wildlife report for the detailed analysis of effects to prey species.

The main difference among the action alternatives is prescribed fire. Alternative D would have considerably less prescribed fire smoke when compared to alternatives B and C. First-entry burns would be expected to produce more smoke, and results from second-entry burns would be expected to better simulate the evolutionary environment of goshawks in the Southwest. The first-entry burns would be expected to produce elevated levels of smoke due to the uncharacteristic levels of litter and woody debris that have accumulated since the late 1800s. The direct effect of this could be smoke inhalation by incubating adults or nestlings, or extended absence of the adults during brooding or when the chicks are very young. This could potentially lead to loss of egg viability, loss of nestlings, or permanent damage to the developing lungs of goshawk chicks.

Alternatives B and C would move the most acres of PFA habitat toward desired conditions with the combination of mechanical and prescribed fire treatments. Alternative D would move slightly fewer acres toward desired conditions.

Other Activities in Alternatives B, C, and D

Roads

An impact associated with the mechanical treatments would be the use of temporary roads for vehicles and equipment. About 32 miles of temporary roads would be constructed within 25 known occupied PFAs and 8.7 miles would be within 8 dispersal PFAs: 19 PFAs (26 percent) would have less than 1 mile of temporary road construction; 11 PFAs (15 percent) would have 1

to 2 miles of temporary road construction; and 3 PFAs (4 percent) would have more than 2 miles of temporary road construction. Forty PFAs (55 percent) in the project area would not have temporary road construction. About 8 miles of temporary roads would be constructed within PFA nest areas. Two PFAs would have more than 1 mile of temporary road construction.

The effects of temporary road construction to goshawk PFA and nest habitat include removal of trees and understory vegetation along the road alignment. During the use of the temporary road, the habitat quality of the narrow linear configuration of the road would not be good for goshawks or prey species. Implementing breeding season timing restrictions would eliminate disturbance impacts to nesting goshawks. After the road is closed and obliterated, the disturbed area would provide habitat in the created opening for early seral stage prey species discussed earlier.

Relocating road segments would account for about 0.7 mile within nine PFAs. Four nest areas would be impacted by about 0.2 mile of reconstructed road. The impacts from reconstructed roads are similar to those associated with temporary roads. Reconstruction would move the disturbance associated with the road use from the original location to the new location. Given the probable close proximity of the old and new alignments, the degree of disturbance between the two locations would probably not be discernible. With each mile of road impacting approximately 3 acres, about 2 acres of habitat would be impacted by reconstructed roads. No acres would be impacted in alternative A.

About 517 miles of temporary roads would be constructed and decommissioned when treatments are complete (no new permanent roads would be constructed). Up to 40 miles of existing, open road would be reconstructed. About 30 miles of this reconstruction would be to improve roads for hauling harvested materials (primarily widening corners to improve turn radiuses) and about 10 miles would consist of relocating roads out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.

A total of 73 PFAs would have some sort of hauling occurring on roads in the PFA. Implementing a breeding season timing restriction for activities occurring within goshawk PFAs would eliminate most of the disturbance potential to goshawks from all of the proposed activities (see design features in appendix C for specific timing restriction language). The breeding season timing restriction is taken directly from the forest plan and would limit human activity within the PFA from March 1 through September 30 each year. If territories are monitored and found to be unoccupied, the breeding season timing restriction may be suspended for that particular season. Timing restrictions would prevent hauling during the breeding season in all but three PFAs.

The three PFAs without timing restrictions on hauling are in an area with some of the highest projected amounts of project activity and associated hauling traffic. Depending on active nest site selection and occupancy, timing, volume of materials hauled in a season, and other factors related to operations, logging truck traffic could potentially pass through up to two of the above three PFAs during the nesting season. Goshawk surveys would be done before hauling to evaluate occupancy and location of active nests in these three PFAs.

Noise disturbance from logging trucks was monitored for nesting goshawks in a study coordinated between the Kaibab NF, Rocky Mountain Research Station, U.S. Army, and a private sound consultant. Results from this field based, controlled experiment found no evidence of negative effects from truck noise. Observed goshawk response to logging truck noise was limited to, at most, looking in the direction of the hauling road (Grubb et al. 2012). However, this study

measured the effects of a single truck on nesting goshawks. Thousands of truck trips may cause more pronounced behavior, depending largely on the distance to the nest and any intervening topography and vegetation. Disturbance from hauling will vary based on which nest site is selected during the time that hauling occurs. Therefore, road disturbance, even with thousands of truck trips, may cause little or no disturbance. Conversely, an active nest could occur in an area where past road noise has been minimal, but which could support high levels of road use that particular year. In summary, hauling may cause no noise disturbance to goshawks, but there would be potential to disrupt reproduction and rearing of young by, at most, one to two pairs of goshawks. Reducing potential disturbance to somewhere between zero to 2 PFAs out of 73 total PFAs meets forest plan direction "to minimize disturbance in the nest area."

In alternatives B, C, and D, decommissioning 904 roads would improve the quality of the habitat in those areas where the roads are decommissioned. While the physical structure and features of the habitat for goshawks and their prey may not measurably change along the former road alignment, eliminating disturbance along the roadway would be expected to improve the quality of habitat beyond the immediate area of the road for the goshawk and its prey species. With each mile of open road impacting approximately 3 acres of habitat, about 2,712 acres of forested habitat may be impacted. This would not have a discernible impact to goshawk habitat across the landscape. Implementing these activities under the breeding season timing restrictions would eliminate disturbance to nesting goshawks.

Dust abatement treatments would occur in selected areas where private land ownership concerns could arise. Eight road segments have been identified for dust abatement, totaling less than 7 miles in length. The average dust abatement treatment length would be about 0.9 mile, ranging from 0.3 to 2.5 miles. Treatments would consist of $MgCl_2$ or lignin. The effectiveness of $MgCl_2$ is related to humidity levels (Batista et al. 2002); therefore, lignin would probably be used most often in the 4FRI landscape. Treatments would be temporary, only occurring on particular road segments in association with hauling. None of the proposed treatment segments would be near open water. Because of the limited application spatially and temporally, and because locations do not include sensitive areas such as open water, dust abatement is not expected to result in measurable effects to wildlife or their habitat.

Springs, Ephemeral Channels, and Aspen

Improving springs and restoring ephemeral channels in alternatives B, C, and D would improve prey species habitat in those areas where the treatments occur. Implementing breeding season timing restrictions would alleviate disturbance to goshawks during the nesting season during activities. Adaptive management actions in alternative C does not change the percent of habitat treated.

Mechanical treatments in aspen in the action alternatives would improve the quality of the aspen habitat for goshawk prey species including the red-naped sapsucker. There would be greater improvement in alternatives B and C, which implement prescribed fire with the mechanical treatments, than in alternative D which only uses mechanical treatments in aspen. Alternative A would not improve any acres of aspen habitat and would, therefore, maintain the current decline in aspen habitat. Implementing the breeding season timing restrictions for any activities within PFAs would eliminate disturbance to nesting goshawks.

Other Activities

The effects of MSO prescriptions on goshawk habitat in the action alternatives are reflected in the vegetation data already analyzed. MSO prescriptions would impact approximately 22 percent of the goshawk habitat across the landscape. MSO habitat likely supports lower densities of rodent prey species than would habitat treated to meet goshawk habitat direction in the forest plan (see appendix 8 in the wildlife report). However, MSO treatments in protected and target and threshold habitats would be similar to the desired conditions for goshawk nesting habitat. Treatments in MSO restricted other habitat should improve prey habitat. Because goshawks are generalist species, MSO based management treatments would not be in conflict with maintaining goshawk territories in MSO habitat.

For the research proposals in alternative C, impacts of the silvicultural prescriptions have been reflected in the vegetation data already analyzed. Constructing 15 weirs that would impact 3 acres would not have a discernible impact to goshawk habitat at the project level. Impacts to goshawks or their prey species habitat would be limited to the immediate vicinity of the locations of the individual projects. Alternatives B and D would not have any impacts to changing the physical structure or quality of the goshawk habitat from this facet of the project as it is not included in these alternatives.

Cumulative Effects

Most past vegetation treatment projects after 1996 have been designed to move the landscape toward the desired conditions for northern goshawks. Those same projects have also included breeding season timing restrictions for activities within goshawk PFAs. This project would contribute to the cumulative effects of moving the landscape toward desired conditions for the northern goshawk.

Alternatives B and C contribute most to moving the landscape toward desired conditions. Alternative D does slightly less to move toward desired conditions. While some desired physical features may be achieved in alternative A, it does not contribute to the cumulative effects of moving the landscape toward desired conditions. See appendix 12 of the wildlife specialist report for the projects and their size, location, objectives, and wildfires addressed as part of cumulative effects

Other Protected Species

Golden Eagle

Golden eagles are protected under the Bald and Golden Eagle Protection Act (Eagle Act). Because of their resemblance to bald eagles, project design features and mitigation have been developed (see “Environmental Consequences”).

Sightings of golden eagles have been documented, and winter surveys are conducted annually on the Flagstaff district (Coconino NF) and Williams district (Kaibab NF) within the project area. Bald eagle annual winter surveys also document golden eagle sightings. There are 18 confirmed golden eagle nests representing 17 nesting areas in the project area (see wildlife report). There are 11 additional potential nests but they have not yet been confirmed. Potential and confirmed nesting golden eagles within the project are located in subunits 1-1, 1-3, 1-6, 2-0, 3-1, 3-4, 3-5, 4-1, 4-2, 4-3, 4-4, 5-2 and 6-2. Golden eagles often nest in areas of high rabbit populations. Golden eagles are well known for subduing large prey; however, most of their diet consists of ground

squirrels, rabbits, and prairie dogs. Potential foraging habitat within the treatment area is primarily 48,774 acres of grassland.

Environmental Consequences – All Alternatives

In alternative A, there are no direct effects to golden eagles. There would be no meadows treated within the project area and trees would continue to encroach, reducing potential habitat for small mammals and consequently golden eagles. Dense forest conditions would still occur, slowing growth rates and limiting development of larger diameter (≥18 inch) trees important for nesting and roosting as well as maintaining high fire hazard potential that would continue to place potential breeding, nesting, and foraging habitat at risk with respect to stand-replacing fire.

The effects for alternatives B, C, and D reflect design features and mitigation as described for the bald eagle (see appendix C in the DEIS). In alternatives B, C, and D, mechanical treatments, prescribed fire, road construction and decommissioning, and the hauling of timber and other restoration activities may cause visual or auditory disturbance that would be localized, of short duration, and low intensity. Effects of mechanical treatments would not be expected to substantially interfere with normal feeding behavior. Acres of prescribed burning and mechanical treatment would result in short-term effects and would be minimized due to activities being spatially and temporally separated.

The effects of alternative C are similar to those of alternatives B and D. Alternative C restores more acres of potential foraging habitat, and the added mechanical treatments within grasslands would maintain and improve more foraging habitat. There are no nests or roosts within the additional grassland treatments or research areas; therefore, no additional effects would occur from disturbance. Alternative D has the same effects as alternative B with one exception. The lack of prescribed fire after thinning treatments would affect surface vegetation patterns as shrubs and other species adapted to fire continue to decline (Huffman and Moore 2004, Moir 1988). The loss of habitat effectiveness would indirectly lead to adverse effects for golden eagles by limiting prey habitat.

Cumulative Effects – All Alternatives

The area analyzed for cumulative effects for the golden eagle is the project area and a ½-mile buffer around the project boundary. Past, present, and reasonably foreseeable projects are listed in appendix 12 of the wildlife report and past projects have implemented thinning on 2,304 acres and prescribed fire on 8,951 acres in grasslands.

In alternative A, continued pine tree encroachment into grasslands and private development in grasslands would result in a cumulative impact along with such activities as grazing and high impact recreational use to limit meadow and grassland habitats. Prescribed fire on 98,800 acres in adjacent projects may result in short-term impacts to habitat, but these are not expected to result in long-term cumulative impacts and are expected to be localized in nature. This alternative would result in the most stress on meadow and grassland habitats and, thus, would have the greatest negative contribution to potential golden eagle habitat.

In alternatives B, C, and D, there would be no effect to nesting eagles; however, there may be potential short-term disturbance to potential foraging habitat with long-term benefits. Short-term disturbance to foraging eagles would occur during thinning, hauling, temporary road construction, and prescribed fire activities and may cause eagles to forage in nearby areas for the duration of

the activity. Other activities occurring that may have similar effects include temporary disturbances caused by prescribed fire (104,750 acres) and thinning (104,990 acres) in adjacent projects, or effects to roosting habitat from utility infrastructure development and maintenance (500 acres). These short-term impacts added to similar effects from other activities were considered. Implementation activities of other fuel reduction project activities could occur simultaneously; however, it is not anticipated it would combine to cause a negative effect.

Determination of Effects for All Alternatives

The proposed treatments and activities **would not result in take as defined in the Eagle Act for golden eagles.** All nests would be protected from disturbance during project implementation. Project design features would mitigate potential for disturbance from noise or smoke to nesting golden eagles. Project activities would not substantially interfere with foraging behavior. Restoration treatments would improve foraging habitat and reduced potential of high-severity fire impacting nest locations.

Forest Plan Amendments – Sensitive and Other Protected Species

Not incorporating these amendments would affect the habitat of most sensitive species addressed in this report (see the wildlife report for the complete analysis). The MSO amendments would allow managing for lower tree densities and basal area, creating canopy gaps, creating and sustaining more large pine and oak trees in the long-term, more large snags through time, and increasing understory response. Not incorporating these amendments would allow:

- uncharacteristically dense forest conditions, fewer big pine and oak trees, and increased fire risk for wildlife using forested habitats in 18 PACs (related to the proposed mechanical treatments in all action alternatives);
- uncharacteristically dense forest conditions, lower crown base height, and increased fire risk in 56 PACs (related to the proposed prescribed fire treatments in alternative C only);
- fewer PACs attaining the desired post-treatment condition due to sequencing of treatments through time (all action alternatives);
- uncharacteristically dense forest conditions, fewer canopy openings, and fewer large pine and oak trees in restricted habitat that would be managed as threshold habitat where no resident MSOs exist on the Kaibab NF (all action alternatives);
- tree densities maintained well above the minimum basal area stand values recommended in the MSO recovery plan across all PACs, target, and threshold habitats (i.e., not using the best science available; alternative C only); and
- understory conditions would continue to decline across MSO habitat, affecting prey habitat and likely decreasing the total prey biomass for raptors and carnivores.

Not including the amendment related to management of canopy cover and open reference conditions within ponderosa pine forest would prevent the ability to include rooting space necessary to sustain dense groups of trees, reduce forest densities and associated forest health (measured by the percent maximum SDI), and prevent the restoration of grasslands and savanna. This would decrease the ability to maintain dense groups of trees along with shrub and herbaceous vegetation, decreasing foods for herbivores, granivores, insectivores, and so for carnivores as well. Grassland species and dispersing individuals of prey species (primarily

rodents and lagomorphs) that aid in maintaining prey populations in forested habitat would be reduced as trees continue to encroach upon open habitats. Simultaneously, habitat for species that depend on closed canopy would gradually increase.

Not managing the proposed Garland Prairie Research Natural Area for the grassland characteristics it was intended to support would result in similar dynamics, i.e., the development of forest structural characteristics used by some species while reducing habitat effectiveness for open habitat species.

Currently, many of the sensitive species depend on habitats or habitat elements related to canopy openings. Existing closed-canopy forests limit or eliminate many of the necessary habitat components needed by these species. The desired condition of closed canopy tree groups interspersed with open rooting space that supports herbaceous vegetation would provide key habitat components for these species of status as well as species adapted to closed-canopy forests. Achieving this situation is the reason for the amendments and this interspersion of habitats, which is a fundamental part of the desired condition, would not be attained without incorporating the amendments into the action alternatives.

Forest Service Management Indicator Species (MIS)

Table 72 summarizes (with rationale) the MIS species not analyzed. Table 73 summarizes the MIS species analyzed. The table provides the current forestwide habitat and population trends. The effects analysis is organized by habitat type with habitat trends presented in narrative and population trends summarized in tables with some exceptions. Both habitat and population trends are displayed in tabular form for snags in ponderosa pine (hairy woodpecker), late-seral aspen and snags in aspens (red-naped sapsucker), and early-seral aspen and pinyon-juniper (mule deer). Aquatic MIS are analyzed separately in the "Aquatics Species" section of this chapter.

Table 72. MIS not analyzed in the analysis

Management Indicator Species	Key MIS Habitat Component Indicator	Comments
Aquatic Macroinvertebrates **Kaibab NF only**	Riparian	Only an indicator of stream quality in North Canyon Creek on the North Kaibab Ranger District, Kaibab NF. Outside of project area.
Mexican Spotted Owl (*Strix occidentalis lucida)*	Late-seral mixed conifer and spruce-fir	There is no mixed conifer or spruce-fir habitat being treated in the proposed treatment area.
Red Squirrel (*Tamiasciurus hudsonicus*)	Late-seral mixed conifer and spruce-fir	There is no mixed conifer or spruce-fir habitat being treated in the proposed treatment area.
Yellow-breasted Chat (*Icteria virens*)	Late-seral, low-elevation, riparian habitat (< 7,000′)	There are 6 miles of proposed ephemeral stream channel restoration with riparian vegetation on the Coconino NF; only a fraction of this habitat occurs below 7,000 feet elevation. Riparian vegetation within these ephemeral channels does not include woody vegetation. No stream restoration with riparian habitat would occur on the Kaibab NF. The proposed restoration would not remove woody riparian vegetation. Thinning and prescribed fire could increase water yield for up

Management Indicator Species	Key MIS Habitat Component Indicator	Comments
		to 5 years. This would not affect the late-serial riparian habitat.
Lucy's Warbler (*Vermivora luciae*)	Late-seral, low-elevation, riparian habitat (< 7,000′)	There are 6 miles of proposed ephemeral stream channel restoration with riparian vegetation on the Coconino NF; only a fraction of this habitat occurs below 7,000 feet elevation. Riparian vegetation within these ephemeral channels does not include woody vegetation. No stream restoration with riparian habitat would occur on the Kaibab NF. The proposed restoration would not remove woody riparian vegetation. Thinning and prescribed fire could increase water yield for up to 5 years (see watershed report). This would not affect the late-seral riparian habitat.
Lincoln's Sparrow (*Melospia lincolnii*)	Late-seral, high-elevation riparian habitat (> 7,000′)	There are 6 miles of proposed ephemeral stream channel restoration with riparian vegetation on the Coconino NF. Riparian vegetation within these ephemeral channels does not include woody vegetation. No stream restoration with riparian habitat would occur on the Kaibab NF. The proposed restoration would not remove woody riparian vegetation. Thinning and prescribed fire could increase water yield for up to 5 years (see water quality report). This would not affect the late-seral riparian habitat.
Cinnamon Teal (*Anas cyanoptera*)	Wetlands	There are no proposed activities within wetland habitat. The 6 miles of proposed ephemeral stream restoration with riparian habitat is not teal habitat. Thinning and prescribed fire could increase water yield for up to 5 years. This would not affect the wetland habitat.

Table 73 displays MIS analyzed in this analysis, key habitat component indicator for each species, and the habitat within the treatment area. It summarizes current forestwide habitat and population trends, acres of forestwide habitat, and acres and percent of habitat analyzed in the project area. Data and best available science utilized for this analysis is described below.

The presence of species carried forward for analysis was determined by surveys conducted on the forest, surveys conducted by the Arizona Department of Game and Fish, and the FAAWN database (Patton 2011). Ten MIS whose distribution on the forest encompasses part or all of the treatment area were included in the effects analysis. The analysis is based also on the forest plan and projected changes in acreage of quality habitat under all of the alternatives.

Data and Best Available Science

MIS and the habitats they represent are listed in the most recent Kaibab NF (USDA 2010a) and Coconino NF (USDA 2002) forestwide management indicator species reports. As the MIS analysis was conducted throughout 2012, information from the draft report (Overby, pers. comm. 2012) was used in association with discussions with the Coconino NF biologist. A thorough review of the best available science, including the biology, ecology, and effects of management on individual species was included in the 2010 update of the Kaibab NF forestwide MIS report.

Information on species, their population trends, and habitat trends presented in the MIS forestwide reports are incorporated by reference.

Determining MIS presence and associated trend calls included data from the annual songbird surveys conducted on both the Coconino and Kaibab NFs. Surveys were initiated on the Kaibab NF in 2005 and on the Coconino NF in 2006. Initially each forest conducted its own survey effort, starting the season with 2 weeks of field training. The Rocky Mountain Bird Observatory took over the sampling effort and associated data analysis in 2007. One component of the bird survey effort is a sympatric tree squirrel survey. Initial results from this effort were included in the Abert's squirrel effects analysis.

Population status and trend updates for all game species were provided by the AGFD for the 4FRI (see appendix 6 in the wildlife report) and incorporated into the analysis. Goshawk surveys are completed annually on both the Coconino NF and Kaibab NF. The goshawk field survey effort was coordinated between the two national forests in 2011 because of the scale of the restoration project and 6,485 acres were surveyed. The coordinated effort will continue in 2013.

The forest vegetation simulator (FVS) tree growth model was used to determine changes in forest stand dynamics (for more information on FVS, see the silviculture report). This information was used for changes in seral stages for ponderosa pine stands. Where possible, data on forestwide vegetation was taken from the forestwide reports for MIS species. If acreages were not available, potential natural vegetative type (PNVT) acreage was used. PNVT acreage for different vegetation types was developed for each forest as part of the forest plan revision process. The vegetation model (VDDT) from forest plan revision was used to determine available acres of early and late seral ponderosa pine habitat at the forestwide scale for the Coconino NF.

Table 73 and table 74 summarize MIS habitat and population trends by alternative.

Table 73. MIS analyzed and forestwide current habitat and population trends

Management Indicator Species	Key MIS Habitat Component Indicator	Habitat Component Analyzed	Current Forestwide Habitat Trend		Current Forestwide Population Trend		Acres of Key MIS Habitat Forestwide		Acres/Percent of Habitat Analyzed within Project Area	
			CNF	KNF	CNF	KNF	CNF	KNF	CNF	KNF
Aquatic Macroinvertebrates	Riparian	See aquatics MIS section								
Northern Goshawk	Late-seral ponderosa pine	Ponderosa pine	Decreasing	Increasing	Inconclusive	Decreasing	80,773	200,000	56,615/70%	27,921/14%
Pygmy Nuthatch	Late-seral ponderosa pine	Ponderosa pine	Decreasing	Increasing	Stable	Stable to declining	80,773	200,000	56,615/70%	27,921/14%
Turkey	Late-seral ponderosa pine	Ponderosa pine	Decreasing	Increasing	Increasing	Increasing	80,773	200,000	56,615/70%	27,921/14%
Abert's Squirrel (Coconino NF) /Tassel-eared Squirrel (Kaibab NF)	Early seral ponderosa pine	Ponderosa pine	Stable	Stable	Inconclusive	Stable	152,836	40,000	14,525/10%	7,411/ 18%
Rocky Mountain Elk	Early seral ponderosa pine, mixed conifer, and spruce-fir	Ponderosa pine	Stable	Stable	Stable to decreasing (latest AGFD data)	Stable to decreasing (latest AGFD data)	152,836	40,000	14,525/10%	7,411/ 18%
Hairy Woodpecker	Snags in ponderosa pine, mixed conifer and spruce-fir	Snags in ponderosa pine	Declining	Increasing	Stable or slightly increasing	Stable	900,426	681,158	322,772/ 36%	189,407/ 28%
Red-naped Sapsucker	Late-seral aspen and snags in aspens	Aspen and aspen snags	Stable(s)/ Decreasing (l)	Stable	Stable to Increasing (s)/Stable to Decreasing (l)	Stable (s)/ Decreasing (l)	10,000	28,500	875 to 1,083/ 9% to 11%	387 to 389 acres/1%

Management Indicator Species	Key MIS Habitat Component Indicator	Habitat Component Analyzed	Current Forestwide Habitat Trend		Current Forestwide Population Trend		Acres of Key MIS Habitat Forestwide		Acres/Percent of Habitat Analyzed within Project Area	
			CNF	KNF	CNF	KNF	CNF	KNF	CNF	KNF
Mule Deer	Early seral aspen and pinyon-juniper	Aspen	Declining	Declining	Declining	Stable to Increasing	10,000	28,500	875 to 1,083/ 9% to 11%	389/1%
		Pinyon juniper	Stable	Stable			630,000	657,900	10,786/1%	12,560/1%
Juniper Titmouse	Late-seral pinyon-juniper, and snags in pinyon-juniper	Pinyon-juniper and snags in pinyon-juniper	Stable	Increasing	Stable to slightly decreasing	Decreasing	630,000	657,900	10,786/1%	12,560/1%
Pronghorn	Early and late seral grasslands	Grassland	Stable to Declining	Stable	Declining to Stable (AGFD data)	Declining to Stable (AGFD data)	260,050	216.000	22,672/9%	25,871 to 26,152/12%

Table 74. MIS habitat and population trends by habitat and alternative

Species	Alternative A	Alternatives B, C, and D
Late Seral Ponderosa Pine—Coconino NF		
Northern Goshawk	In the long term (30 years), alternative A would result in an 11.5% increase in quantity of habitat with increased VSS 5 and 6 but the quality of the habitat would decrease as canopies closed and tree densities increased. A net increase in quantity of habitat with a decrease in quality of habitat coupled with some decreases in amounts of prey species' habitat and unknown to decreasing population trends for MIS prey species would be expected to have static impact on the population trend for goshawk.	Alternatives B and C would produce the largest increase in the quantity of late seral ponderosa pine habitat as well as the most improvement in the quality of habitat for goshawks and their prey species as all elements move toward desired conditions. Alternative D increases habitat quantity and improves habitat quality for goshawk and its prey species less than alternatives B and C. A net increase in quantity of habitat coupled with an increase in quality of habitat combined with increased habitat components for prey species and positive changes to prey species' habitat and increasing population trends would change population trend for the goshawk in the long term to increasing. Alternatives B, C, and D would likely continue the stable forestwide population trend in the short term while moving toward an increasing trend.
Pygmy Nuthatch	Alternative A would not result in an immediate change to the quantity or quality of habitat and would likely continue the current population trend of stable in the short term. With the likelihood of wildfires, the long-term population trend could change to decreasing.	Alternatives B, C, and D would protect nesting habitat and increase the quantity and quality of late-seral habitat over a large area of ponderosa pine habitat on the forest. Alternatives B, C, and D would likely continue the stable forestwide population trend in the short term while moving toward an increasing trend. Alternatives B, C, and D would likely change the forestwide population trend to increasing in the long term due to increasing in late-seral habitat over a large area of ponderosa pine habitat on the forest. Alternatives B and C would have similar impacts on the species, and alternative D would not be as beneficial.
Turkey	Alternative A would not result in an immediate change to the quantity or quality of habitat. Alternative A would likely continue the current forestwide population trend as increasing in the short term. With the likelihood of wildfire, loss of Gambel oak to shading from pines, and lack of understory development, the long term forestwide population trend could change to decreasing.	Alternatives B, C, and D would increase quantity and quality of the habitat. Population trend is influenced by other habitat factors than development of late-seral ponderosa pine, with the main factor being the State hunt structure. Alternatives B, C, and D would likely continue the forestwide population trend as increasing in both the short and long term; alternative D would not be as beneficial as alternatives B and C.
Late Seral Ponderosa Pine—Kaibab NF		
Northern Goshawk	Habitat quantity would increase by 11.5% in VSS 5 and VSS 6 but the quality of the habitat would deteriorate as canopies closed and tree densities increased and potential	Alternatives B and C would produce the largest increase in the quantity of late-seral ponderosa pine habitat as well as the most improvement in the quality of habitat for goshawks and their prey species as all elements move toward desired conditions. Alternative

Species	Alternative A	Alternatives B, C, and D
	understory production decreased. A net increase in quantity of habitat with a decrease in quality of habitat coupled with some decreases in amounts of prey species' habitat and unknown to decreasing population trends for MIS prey species would result in a static impact on the population trend for the goshawk.	D increases habitat quantity and improves habitat quality for goshawk and its prey species less than alternatives B and C. A net increase in quantity of habitat coupled with an increase in quality of habitat combined with increased habitat components for prey species and positive changes to MIS prey species' habitat and increasing population trends would be expected to have positive impact on the population trend for goshawk in alternatives B, C, and D.
Pygmy Nuthatch	Alternative A would not result in an immediate change to the quantity or quality of habitat and would likely continue the current population trend of stable to declining in the short term. With the likelihood of large-scale, stand-replacing wildfires the forestwide population trend could change to decreasing in the long term. With the likelihood of large-scale stand-replacing wildfires in the future, it is possible that the long term forestwide population trend could change to decreasing.	Alternatives B, C, and D increase the quantity and quality of late-seral habitat over a large area of ponderosa pine habitat on the forest. Alternatives B, C, and D would likely continue the stable forestwide population trend in the short term while moving toward an increasing trend. Alternatives B and C would have similar impacts on the species, and alternative D would not be as beneficial. Alternatives B, C, and D would likely change the forestwide population trend to increasing in the long term due to increases in late-seral habitat over a large area of ponderosa pine habitat on the forest. Alternatives B, C, and D continue the stable forestwide population trend in the short term while moving toward an increasing trend in the long term due to an increase in late-seral habitat over a large area of ponderosa pine habitat on the forest.
Turkey	Alternative A would likely continue the current forestwide population trend for the turkey as increasing in the short term. With the likelihood of wildfires, loss of Gambel oak to shading from pines, and lack of understory development, it is possible that the population trend could change to decreasing.	Alternatives B, C, and D would likely continue the forestwide population trend as increasing in both the short and long term. The population trend is influenced by other habitat factors than the development of late-seral ponderosa pine, with the main factor being the State hunt structure. Alternative D would not be as beneficial as alternatives B and C.
Management Indicator Species	**Alternative A**	**Alternatives B, C, and D**
Early Seral Ponderosa Pine – Coconino NF		
Elk	Alternative A would not result in an immediate change to the quantity or quality of habitat used by elk. Forage would decrease in the long term due to closure of the forest. Alternative A would likely continue the decrease in forestwide elk population trend due to removal of habitat components for elk in both short and long term and the	Alternatives B, C, and D would improve other forest habitat beside the increase of early-seral habitat for elk and would change the current decreasing population trend to increasing. However, population trends are influenced more by hunting than by forest management and they would remain as a decreasing trend until desirable population levels are determined.

Species	Alternative A	Alternatives B, C, and D
	current trend of the AGFD efforts to decrease the local herd size on the forest.	
Abert's Squirrel	Alternative A would continue to provide habitat for the short term. Long term, the unnatural stand densities would reduce habitat quality and quantity. Alternative A would not change the current stable, forestwide Abert's squirrel population trend in the short term but in the long term, would change the trend to decreasing due to the threat of high-severity fire in overly dense, continuous stands of forest.	In the short term, the habitat quality could be reduced, however, in the long term tree growth and increased canopy connectedness would improve habitat. Alternatives B, C, and D could have short-term impacts that could change the forestwide population trend to decreasing in the short term since the project area includes approximately 41 percent of the ponderosa pine habitat on the forest. For the long term, alternatives B, C, and D would likely change the forestwide population trend to an increasing trend. These habitat trends are based on other habitat components than early-seral ponderosa pine habitat.
Early Seral Ponderosa Pine – Kaibab NF		
Elk	Alternative A would not result in an immediate change to the quantity or quality of habitat used by elk. Forage would decrease in the long term due to closure of the forest. Alternative A would likely continue the decrease in forestwide elk population trend due to removal of habitat components for elk in both short and long term and the current trend of the AGFD efforts to decrease the local herd size on the forest. Alternative A would likely continue the decrease in forestwide elk population trend due to the removal of habitat components for elk in both short and long term, and the current trend of the AGFD efforts to decrease the local herd size on the forest.	Alternatives B, C, and D would improve other forest habitat beside the increase of early-seral habitat for elk and would change the current decreasing population trend to increasing. However, population trends are influenced more by hunting than by forest management, and they would remain as a decreasing trend until desirable population levels are determined.
Tassel-eared Squirrel	Alternative A would continue to provide habitat for the short term. Long term the unnatural stand densities would reduce habitat quality and quantity. Alternative A would not change the current stable forestwide Abert's squirrel population trend in the short term, but in the long term could shift the trend to decreasing due to the overly dense stands and chance for large-scale removal of habitat from fires in the long term.	In the short term, the habitat quality could be reduced, however, in the long-term tree growth and increased canopy connectedness would improve habitat. Alternatives B, C, and D could have short-term negative impacts, but it is not known if that would change the forestwide population trend to decreasing in the short term since the project only includes approximately 37 percent of the ponderosa pine habitat on the forest. However, for the long term, alternatives B, C, and D would likely change the forestwide stable population trend to an increasing trend. These habitat trends are based on other habitat components than early-seral ponderosa pine habitat.
Snags in Ponderosa Pine – Coconino NF		
Hairy	Alternative A would increase the	The three action alternatives are designed to restore

Species	Alternative A	Alternatives B, C, and D
Woodpecker	amount of late-seral stands in the long term. The risk of a large-scale wildfire is high. Alternative A would not change the short-term forestwide habitat or population trend for the hairy woodpecker since it continues the current level of activities on the forest. In the long term, it is likely the forestwide habitat and population trends would be stable to decreasing for the species due to the threat of large stand-replacing wildfires.	ponderosa pine stands closer to historical range of variation. This results in forest structure that includes large trees and an abundance of snags. Alternatives B, C, and D would likely continue the stable forestwide habitat and population trend in the short term, with decreased snag habitat in the short term. In the long term, alternatives B, C, and D would change the forestwide habitat and population trend to increasing.
Snags in Ponderosa Pine – Kaibab NF		
Hairy Woodpecker	Alternative A would increase the amount of late-seral stands in the long term. The risk of a large-scale wildfire is high. Alternative A would not change the short-term forestwide habitat or population trend for the hairy woodpecker since it continues the current level of activities on the forest. In the long term, it is likely the forestwide habitat and population trends would be stable to decreasing for the species due to the threat of large stand-replacing wildfires.	The three action alternatives are designed to restore ponderosa pine stands closer to historical range of variation. This results in forest structure that includes large trees and an abundance of snags. Alternatives B, C, and D would likely continue the stable forestwide habitat and population trend in the short term, with decreased snag habitat in the short term. In the long term, alternatives B, C, and D would change the forestwide habitat and population trend to increasing.
Late-seral Aspen and Snags in Aspens – Coconino NF		
Red-naped Sapsucker	Alternative A would continue the declining habitat trend. Alternative A would likely not change the decreasing red-naped sapsucker forestwide population trend in the short term, and it would likely remain decreasing in the long term. Approximately 11 percent of the aspen on the district would not be treated and would likely continue to decline or be lost to wildfires.	Alternatives B, C, and D would change the forestwide habitat trend to stable in the short term and increasing in the long term. In the long term, the forestwide population trend would likely either be stable or increasing as a result of treating about 9 to 11 percent of the aspen habitat on the forest. Nevertheless, it will take time to recruit large trees and snags into the system.
Late-seral Aspen and Snags in Aspens – Kaibab NF		
Red-naped Sapsucker	The forestwide MIS assessment (USDA 2010a) shows a likely decreasing habitat and population trend in the future without aspen restoration. In the short term, alternative A would not change the current stable forestwide trends for red-naped sapsuckers or their habitat. However, it would change both the forestwide habitat and population trends to decreasing in the long term.	Alternatives B, C, and D would continue the forestwide population and habitat trend as stable. While they would improve habitat in the areas proposed for treatment, this would only represent 1 percent of the aspen on the forest and would not change the population or habitat trend for the red-naped sapsucker in the short or long term.

Species	Alternative A	Alternatives B, C, and D
Early-seral Aspen and Pinyon-Juniper – Coconino NF		
Mule Deer	Alterative A would not change the forestwide habitat trend in aspen or pinyon-juniper habitat in the short or long term. Early-seral aspen would continue to decline due to the lack of recruitment. The pinyon-juniper habitat would remain stable because the project would only affect 2 percent of the habitat on the forest. Alternative A would not change the mule deer population trend in the short term because the population trend is due mainly to hunting and not management actions. There is potential for a decreasing trend in the long term due to the potential of large-scale, stand-replacing wildfires.	Alternatives B, C, and D would promote the development and recruitment of aspen early-seral habitat. This could change the forestwide habitat trend toward stable in the short and long term because the alternatives would improve 9 to 11 percent of the aspen forestwide. The alternatives would not change the current stable forestwide habitat trend for pinyon-juniper habitat due to the fact that less than 1 percent of the pinyon-juniper habitat forestwide would be affected. The action alternatives would likely keep the mule deer forestwide population trend at stable both in the short and long term due to improvement in other habitat components that would benefit the deer, however, forestwide population trends are more affected by hunting than forest management.
Early-seral Aspen and Pinyon-Juniper – Kaibab NF		
Mule Deer	Alterative A would not change forestwide habitat trend in either aspen or pinyon-juniper habitat in the short or long term. Early-seral aspen would continue to decline due to the lack of recruitment. The pinyon-juniper habitat would continue to be stable due to the fact that the project would only affect 1 percent of the habitat on the forest. Alternative A would not change the mule deer forestwide population trend in the short term, since the population trend is due mainly to hunting and not management actions. There is potential for a decreasing population trend forestwide in the long term due to the potential of large-scale stand-replacing wildfires.	Alternatives B, C, and D would promote the development and recruitment of aspen early-seral habitat, but would not change the short and long term early-seral forestwide habitat because it would only affect about 1 percent of the aspen forestwide. Alternatives B, C, and D would not change the current stable forestwide habitat trend for pinyon-juniper habitat due to the fact that less than 1 percent of the pinyon-juniper habitat forestwide would be affected. Alternatives B, C, and D would likely move the mule deer forestwide population trend to stable both in the short and long term due to improvement in other habitat components that would benefit the deer, however, forestwide population trends are more affected by hunting than forest management.
Late Seral Pinyon-Juniper and Snags in Pinyon-Juniper Habitat – Coconino NF		
Juniper Titmouse	Alterative A would not change forestwide habitat or population trend in the short or long term. The trends would continue to be stable due to the fact that the project would only affect 1 percent of the habitat on the forest.	Alternatives B, C, and D would help reduce tree density and develop understory components in pinyon-juniper stands, but would not change the short or long term forestwide habitat or population trends from stable because less than 1 percent of the pinyon-juniper habitat forestwide would be affected.
Late Seral Pinyon-Juniper and Snags in Pinyon-Juniper Habitat – Kaibab NF		

Species	Alternative A	Alternatives B, C, and D
Juniper Titmouse	Alterative A would not change forestwide habitat trend in pinyon-juniper habitat in the short or long term. Pinyon-juniper habitat would continue to be stable due to the fact that the project would only affect 1 percent of the habitat on the forest. Alternative A would not change the juniper titmouse forestwide population trend in the short or long term.	Alternatives B, C, and D would help reduce the tree density and develop understory components in the pinyon-juniper stands but it would not change the short or long term forestwide habitat or population trends from stable because less than 1 percent of the pinyon-juniper habitat forestwide would be affected.
Early and Late Seral Grasslands – Coconino NF		
Pronghorn	Alternative A would not change the current stable trend for pronghorn populations and forestwide habitat in the short term, but in the long term, it would change both forestwide habitat and population trends to decreasing due to the continued decline in grassland conditions from conifer and shrub encroachment.	Alternatives B and D would keep the forestwide grassland habitat trend at stable to increasing depending on how much conifer and shrub are removed. The alternatives would likely have the forestwide pronghorn population trend as stable to increasing but the forest population trends are largely influenced by hunting and drought. Alternative C would change the forestwide grassland habitat trend to increasing in both short and long term due to the removal of trees in current grasslands and the restoration of historical grasslands. It would keep the forestwide pronghorn population trend as stable to increasing.
Early and Late Seral Grasslands – Kaibab NF		
Pronghorn	Alternative A would not change the current stable trend for pronghorn populations and forestwide habitat in the short term, but in the long term it would change both forestwide habitat and population trends to decreasing due to the continued decline in grassland conditions from conifer and shrub encroachment.	The alternatives would likely keep the forestwide pronghorn population trend as stable to increasing but the population trends for pronghorn are largely influenced by hunting and drought. Alternative C would change the forestwide grassland habitat trend to increasing in both the short and long term.

Forest Plan Amendments

Not incorporating the amendments would affect the habitat of most of the MIS addressed in this report (see the wildlife specialist report for the complete analysis). The MSO amendments would allow managing for lower tree densities and basal area, creating canopy gaps, creating and sustaining more large pine and oak trees in the long term, more large snags through time, and increasing understory response. Not incorporating these amendments would allow:

- uncharacteristically dense forest conditions, fewer big pine and oak trees, increased fire risk for wildlife using forested habitats in 18 PACs (related to the proposed mechanical treatments in all action alternatives);

- uncharacteristically dense forest conditions, lower crown base height, and increased fire risk in 56 PACs (related to the proposed prescribed fire treatments in alternative C only);
- fewer PACs attaining the desired post-treatment condition due to sequencing of treatments through time (all action alternatives);
- uncharacteristically dense forest conditions, fewer canopy openings, and fewer large pine and oak trees in restricted habitat that would be managed as threshold habitat where no resident MSOs exist on the Kaibab NF (all action alternatives);
- tree densities maintained well above the minimum basal area stand values recommended in the MSO recovery plan across all PACs, target, and threshold habitats (i.e., not using the best science available; alternative C only); and
- understory conditions would continue to decline across MSO habitat, affecting prey habitat and likely decreasing the total prey biomass for raptors.

Not including the amendment related to management of canopy cover and open reference conditions within ponderosa pine forest would prevent the ability to include rooting space necessary to sustain dense groups of trees, reduce forest densities and associated forest health (measured by the percent maximum SDI), and prevent the restoration of grasslands and savanna. This would decrease the ability to maintain dense groups of trees along with shrub and herbaceous vegetation, decreasing foods for herbivores, granivores (seed-eaters), insectivores, and so for carnivores as well. Grassland species and dispersing individuals of prey species (primarily rodents and lagomorphs) that aid in maintaining prey populations in forested habitat would be reduced as trees continue to encroach upon open habitats. Simultaneously, habitat for species that depend on closed canopy would gradually increase.

Not managing the proposed Garland Prairie Research Natural Area for the grassland characteristics it was intended to support would result in similar dynamics, i.e., the development of forest structural characteristics used by some species while reducing habitat effectiveness for open habitat species.

Currently, many of the MIS depend on habitats or habitat elements related to canopy openings or early seral conditions. Existing closed-canopy forests limit or eliminate many of the necessary habitat components needed by these species. The desired condition of closed canopy tree groups interspersed with open rooting space that supports herbaceous vegetation would provide key habitat components for these species of status as well as species adapted to closed-canopy forests. Achieving this situation is the reason for the amendments. This interspersion of habitats, which is a fundamental part of the desired condition, would not be attained without incorporating the amendments into the action alternatives.

Cumulative Effects for Management Indicator Species

The affected environment for cumulative effects varies by species (table 75). The analysis includes the combined impacts of all activities within the area as evaluated by each alternative. The effects of projects that already have been implemented were used to help describe current conditions of the project area and will not be discussed in this section. Ongoing and reasonably foreseeable activities are listed in the "Cumulative Effects" section in the wildlife report. Cumulative effects can be an integral part of the effects analysis for wildlife and are discussed for each species.

Table 75. Area of analysis for cumulative effects by species

Area of Analysis	Species	Reason for Selection
Within analysis area	Pygmy nuthatch, turkey, Abert's squirrel, hairy woodpecker, red-naped sapsucker, juniper titmouse	Abert's squirrel use limited areas centered on their nest trees. Birds may move to other areas, but their nesting habitat is the most limiting factor for these species.
½-mile around analysis area	Goshawk	The ½-mile buffer takes into account potential disturbance activities for these species found within the analysis area.
Game Management Unit (GMU)	Elk, mule deer, pronghorn	These species have wider mobility; GMUs are designed to encompass herd movements.

Alternative A

Coconino and Kaibab NFs

The cumulative effects of these treatments under the 4FRI "no action" alternative would improve the habitats of goshawk, pygmy nuthatch, turkey, hairy woodpecker, elk, mule deer, and Abert's squirrel in the long term. Movement corridors and savannah treatments incorporated into ponderosa pine on the Kaibab NF would benefit pronghorn by creating forage and movement corridors. Aspen treatments would have limited effects to red-naped sapsuckers in the short term, but should improve habitat in the long term. Firewood gathering would affect the goshawk, pygmy nuthatch, hairy woodpecker, red-naped sapsucker, and juniper titmouse by removing snags and logs needed for nesting or prey species. Because only a small amount of pinyon-juniper habitat will be treated, impacts to populations of titmice are not expected. The proposed activities could benefit pronghorn locally by creating openings to support browse and improve landscape permeability. Right-of-way maintenance would benefit species that use open habitat like pronghorn, elk, and turkey by keeping liner strips of grassland open across the forest. These areas could also support prey species for goshawks. Right-of-way maintenance can also remove snags, logs, shrubs, and large trees, negatively affecting species tied to these habitat features such as the pygmy nuthatch, hairy woodpecker, and mule deer. Development on private lands, particularly in the grassland and savanna habitats, would reduce habitat quantity and quality and affect movement corridors for pronghorn, deer, and elk. Additionally, the exurban development and additional training ranges on the Navajo Army Depot would likely limit use by, and movement of, deer and elk in many of these areas.

In summary, the following cumulative effects apply to the MIS for both the Coconino and Kaibab NFs:

- For the goshawk and pronghorn, the improvement of habitat across the southern part of the forest would not change the forestwide habitat trend, but would help stabilize forestwide population trends.
- The forestwide habitat trend for the pygmy nuthatch would be improved by thinning projects that retain and enhance the large tree component within the ponderosa pine forest. This may help the forestwide population trend to stabilize.

- The tassel-eared squirrel, mule deer, elk, red-naped sapsucker, wild turkey, hairy woodpecker, and juniper titmouse forestwide population and habitat trends would not change.

Alternatives B, C, and D

Kaibab NF

The planned thinning and burning of 35,790 to 50,041 acres of ponderosa pine habitat would help reduce small tree densities and help move habitat toward historical stand structures. These treatments would have the same benefits discussed in alternative A, but when added to the additional treatments in the action alternative, would provide for improvement across the landscape. These treatments would affect the goshawk, pygmy nuthatch, turkey, hairy woodpecker, elk, mule deer, and Abert's squirrel by improving their habitats in the long term. The pygmy nuthatch forestwide habitat trend would be improved by thinning projects that retain and enhance the large tree component within the ponderosa pine forest. The ponderosa pine savanna treatments would benefit the pronghorn by creating forage and corridors for movement between areas.

The proposed aspen treatments are planned for areas that are a high priority for restoration. While this would only impact about 4 percent of the forest aspen, when combined with the proposed treatments in the action alternatives, these areas are most at risk of being lost in the near future. These treatments would have limited improvement of the red-naped sapsucker in the short term, but should improve their habitat in the long term.

Firewood gathering and travel management requirements together help determine where the public collects firewood. Since travel off-road is allowed in firewood areas only, this will limit how far the public will go to gather firewood. This will likely leave a high density of dead and down woody material in areas that are further from the road. Within firewood areas close to roads, less dead woody material will remain available and could fall below forest plan requirements for snags, logs, and dead and down woody material. Proposed treatments should help limit the amount of area not meeting forest requirements. This would affect the goshawk, pygmy nuthatch, hairy woodpecker, red-naped sapsucker, and juniper titmouse by removing snags that are needed for nesting or prey species. Pinyon-juniper thinning and burning, right-of-way maintenance, and development on private and other Federal lands would have the same impacts as described above for alternative A. The cumulative effects along with proposed activities in the action alternatives for MIS are as follows:

- For all the species, the cumulative effects of the above projects will not change the predicted forestwide habitat and population trends.

Coconino NF

The planned thinning and burning in ponderosa pine of 96,736 to 157,842 acres of ponderosa pine habitat would help reduce small tree densities and help move habitat toward historical stand structures. These treatments would have the same benefits discussed in alternative A, but when added to the additional treatments in the action alternative, they would provide for improvement across the landscape. These treatments would affect the goshawk, pygmy nuthatch, turkey, hairy woodpecker, elk, mule deer, and Abert's squirrel by improving their habitats in the long term.

The proposed aspen restoration is planned for areas that contain the majority of the aspen outside of the wilderness areas. This would impact 46 percent of the forest aspen clones. These treatments would have limited improvement of the red-naped sapsucker in the short term, but should improve habitat components in the long term. When combined with proposed treatments in the action alternatives, this would improve most of the aspen clones outside of wilderness areas.

Firewood gathering and travel management requirements together help determine where the public collects firewood. Off-road travel is only allowed for loading cut firewood. This would decrease miles driven off road by people scouting for firewood and would limit how much firewood is removed away from roads and increase firewood removal along roads. Proposed treatments should help limit the amount of area not meeting forest requirements. This would affect the goshawk, pygmy nuthatch, hairy woodpecker, red-naped sapsucker, and juniper titmouse by removing snags that are needed for nesting or prey species. Pinyon-juniper thinning and burning, right-of-way maintenance, and development on private and other Federal lands would have the same impacts as described above for the Kaibab NF.

The cumulative effects along with proposed activities in the action alternatives for MIS are as follows:

- For all species, the cumulative effects of the above projects would not change the predicted forestwide habitat and population trends.

Migratory Birds and Important Bird Areas (IBA)

Arizona Partners in Flight (APIF) identifies physiographic areas and priority migratory bird species by broad habitat types (Latta et al. 1999). In March 2008, the FWS released its 2008 "Birds of Conservation Concern Report" (USDI 2008). The Coconino and Kaibab NFs occur within the two bird conservation regions (BCR): the Southern Rockies/Colorado Plateau (BCR 16) and Sierra Madre Occidental (BCR 34). For the Kaibab NF, the treatment area only occurs within BCR 34. This analysis considered high priority bird species from both the APIF and the FWS birds of conservation concern (see wildlife specialist report). See the wildlife report which display acres of treatment by habitat type. Environmental consequences are based on the application of design features and mitigation. See the "Wildlife" section in appendix C in the DEIS.

Environmental Consequences

Ponderosa Pine Habitat Type

The following species are analyzed for this vegetation type: northern goshawk, flammulated owl, olive-sided flycatcher, Cordilleran flycatcher, Grace's warbler, Lewis's woodpecker, purple martin, and Cassin's finch. All but the northern goshawk and purple martin would have potential removal of nesting habitat that would result in the potential to kill young of the year. Due to the low amount of removing nest habitat while young are still in the nest, there no measureable negative effects to any these birds' populations from alternatives B, C, and D.

Aspen Habitat Type

The red-naped sapsucker is the only species within the aspen habitat. Only a small percentage of aspen or snags would be removed and not all removed trees would have active nest sites due to

either not being nest trees or treatments occurring outside of breeding season. However, there would be potential of loss of young of the year. The removal of any eggs or fledgling would not result in a measurable negative effect to the red-naped sapsucker population from alternatives B, C, and D.

Pinyon-Juniper Habitat Type

The following species are analyzed for this vegetation type: gray vireo, pinyon jay, juniper titmouse, black-throated gray warbler, and gray flycatcher. There would be potential for young of the year being killed by removal of pinyon-juniper habitat through burning and mechanical treatment for these species. The project only occurs within less than 1 percent of the pinyon-juniper that occurs over both forests. Not all treatments would occur during the breeding season. The removal of any eggs or fledgling would not result in a measurable negative effect any of these species' population from alternatives B, C, and D.

High Elevation Grasslands Habitat Type

The following species are analyzed for this vegetation type: Swainson's hawk, ferruginous hawk, burrowing owl, grasshopper sparrow, and Bendire's thrasher. Only the burrowing owl, grasshopper sparrow, and Bendire's thrasher have potential for mechanical treatments of removing nest with young of year, or for the grasshopper sparrow and Bendire's thrasher the loss of nest sites through burning. Due to the limited amount of habitat that would be affected by implementation of the project and not all habitat would be affected during the nesting season, it would not result in a measurable negative effect on any of these species' populations from alternatives B, C, and D.

Forest Plan Amendments

Not incorporating these amendments would affect the habitat of most of the migratory birds addressed in this report (see the wildlife report for complete analysis). Not including the amendments would not be expected to affect the Anderson Mesa Important Bird Area (IBA). The MSO amendments would allow managing for lower tree densities and basal area, creating canopy gaps, creating and sustaining more large pine and oak trees in the long-term, more large snags through time, and increasing understory response. Not incorporating these amendments would allow:

- uncharacteristically dense forest conditions, fewer big pine and oak trees, and increased fire risk for wildlife using forested habitats in 18 PACs (related to the proposed mechanical treatments in all action alternatives);
- uncharacteristically dense forest conditions, lower crown base height, and increased fire risk in 56 PACs (related to the proposed prescribed fire treatments in alternative C only);
- fewer PACs attaining the desired post-treatment condition due to sequencing of treatments through time (all action alternatives);
- uncharacteristically dense forest conditions, fewer canopy openings, and fewer large pine and oak trees in restricted habitat that would be managed as threshold habitat where no resident MSOs exist on the Kaibab NF (all action alternatives);

- tree densities maintained well above the minimum basal area stand values recommended in the draft recovery plan across all PACs, target, and threshold habitats (i.e., not using the best science available; alternative C only); and
- understory conditions would continue to decline across MSO habitat, affecting prey habitat and likely decreasing the total prey biomass for raptors.

Not including the amendment related to management of canopy cover and open reference conditions within ponderosa pine forest would prevent the ability to include rooting space necessary to sustain dense groups of trees, reduce forest densities and associated forest health (measured by the percent maximum SDI), and prevent the restoration of grasslands and savanna. This would decrease the ability to maintain dense groups of trees along with shrub and herbaceous vegetation, decreasing foods for herbivores, granivores (seed-eaters), insectivores, and so for carnivores as well. Grassland species and dispersing individuals of prey species (primarily rodents and rabbits/hares) that aid in maintaining prey populations in forested habitat would be reduced as trees continue to encroach upon open habitats. Simultaneously, habitat for species that depend on closed canopy would gradually increase.

Not managing the proposed Garland Prairie Research Natural Area for the grassland characteristics it was intended to support would result in similar dynamics, i.e., the development of forest structural characteristics used by some species while reducing habitat effectiveness for open habitat species.

Currently, many migratory birds depend on habitats or habitat elements related to canopy openings or early seral conditions. Existing closed-canopy forests limit or eliminate many of the necessary habitat components needed by these species. The desired condition of closed canopy tree groups interspersed with open rooting space that supports herbaceous vegetation would provide key habitat components for these species of status as well as species adapted to closed-canopy forests. Achieving this situation is the reason for the amendments. This interspersion of habitats, which is a fundamental part of the desired condition, would not be attained without incorporating the amendments into the action alternatives.

Cumulative Effects for Migratory Birds

Because of their seasonal movement, the primary management concern for migratory birds is nesting habitat and, for bald eagles, winter roost sites. The cumulative analysis area for migratory birds is the project area. Past, present, and reasonably foreseeable activities are listed in appendix 12 of the wildlife report. The effects of projects already implemented were used to describe existing conditions of the project area and will not be discussed in this section.

There is an estimated 86,290 acres of thinning from other projects within the treatment area that would thin ponderosa pine habitat. There is an estimated 153,211 acres of burning in the treatment area. There would also be 4,416 acres of ponderosa pine savanna restoration occurring on the Kaibab NF. There are 683 acres of planned aspen restoration and subsequent barrier construction planned on the Kaibab NF and 4,637 acres of planned aspen restoration with associated barriers on the Coconino NF. In total, 5,320 acres of aspen restoration are planned or ongoing within the 4FRI analysis area.

Both the Coconino and Kaibab NFs have begun implementing travel management within the treatment area. These efforts would affect impacts from firewood cutting, hunting, and

recreational camping across both forests. On the Coconino NF, the public is allowed to travel cross country to collect cut firewood with the proper permit. On the Kaibab NF, the public is only allowed to drive off-road to collect firewood within designated areas. While there are species-specific rules for cutting dead trees, it is not uncommon for larger snags to be cut. This occurs in areas closer to roads and decreasing miles of open road should decrease the loss of the resource. The Kaibab NF will allow for retrieval of elk during hunting season in all GMUs while the Coconino NF will allow elk retrieval in all GMUs except 5a and 5b. The Coconino NF designated 300-foot-wide off-road camping corridors on select roads for people wanting to park vehicles away from roads. On the Coconino NF, areas without camping corridors will have parking allowed up to 30 feet off of roads. The Kaibab NF will allow vehicle parking up to 30 feet away from all open roads but does not have designated areas for driving off-road beyond that distance for camping.

The Kaibab and Coconino NFs have planned 7,040 acres of pinyon-juniper to be treated within the project area. Grassland restoration treatments include removal of encroaching conifers and prescribed fire to rejuvenate grasses and forbs. Within the project areas, there are 9,840 acres of planned grassland treatments.

Both forests have ongoing maintenance of utility rights-of-way (power and gas lines). This involves thinning and burning within the rights-of-way to keep the area clear of trees and shrubs. Utility rights-of-way include 32,344 acres, with the majority of the area on the Coconino NF.

Grazing is occurring through the project area on both forests. Grazing is an ongoing activity and the timing of season of use varies by allotment. On average, 30 to 40 percent of the forage is allowed for utilization by livestock and wildlife. There is no proposal to increase any livestock numbers within these allotments. Therefore, there is no additional affects beyond existing conditions.

There are approximately 150,000 acres of non-Forest Service administered lands within the project area. These areas include housing tracts, Navajo Army Depot, vacation homes, and ranchland. The Navajo Army Depot is planning development of new training ranges and thinning and prescribed fire. The Department of Defense is planning 17,049 acres of thinning and burning in ponderosa pine and some grasslands restoration. The Greater Flagstaff Forest Partnership is planning to burn and thin 535 acres of ponderosa pine habitat around the Flagstaff area.

Alternatives B, C, and D

Resulting forest structure from planned thinning and burning of 243,917 acres of ponderosa pine habitat outside of the 4FRI should result in habitat resembling the historical range of variation. In the long term, wildlife species are less likely to be adversely affected by treatments that result in habitat conditions consistent with those of their evolutionary past and so are expected to respond positively to the ongoing and proposed thinning projects (Kalies et al. 2010). These treatments would improve habitat for most birds species associated with the ponderosa pine cover type in the long term (e.g., bark gleaners, woodpeckers, and flycatchers), but may negatively affect foliage gleaners in the short term (Patton and Gordon 1995, George et al. 2005).

The proposed aspen restoration is planned for areas that are a high priority for restoration on both forests. Cumulatively, this would treat the aspen outside of wilderness that are at most risk of

being lost in the near future. These treatments would yield limited improvements for the red-naped sapsucker in the short term, but should improve their habitat components in the long term.

Firewood gathering and travel management requirements together help determine where the public collects firewood. The public will be limited in where they can travel off road to gather firewood on both the Coconino and Kaibab NFs. This would likely leave higher densities of dead and down woody material in areas further from roads. Less dead woody material would be expected to remain within firewood areas and areas closer to roads. Designated firewood areas on the Kaibab NF may not always meet forest plan requirements for woody material once wood gathering activities occur. Areas adjacent to roads may be deficit on the Coconino NF. This could have a negative effect on species that use snags or down material in the ponderosa pine, aspen, and pinyon-juniper. In grasslands, the travel management requirements would benefit grassland species by preventing cross-country travel in their habitat.

Pinyon-juniper thinning and burning has the potential to both remove habitat and improve habitat for birds that use this habitat type. The proposed activities could result in loss of young of year depending on timing of activities. The effects to pinyon-juniper associated species are expected to be limited because only a small amount of this habitat would be treated within the cumulative effects analysis area.

Utility right-of-way maintenance would help keep strips of land open and create the equivalent of relatively narrow, liner grasslands. While this may affect individual birds, there is not likely to be a cumulative effect to any species because of the limited space and spatial configuration of this habitat.

Development on private land and other Federal lands continue to remove habitat within and adjacent to the project area. With development of the additional training ranges on the Navajo Army Depot, this will likely move more species out of the area. The cover type with the most development occurring is within grasslands and savanna habitat. This would reduce the amount of habitat.

The Coconino NF has implemented an innovative management strategy to protect wetlands from grazing and prolonged drought within the Anderson Mesa IBA by regulating the timing and duration of livestock grazing in permitted areas. Wetlands are being protected from livestock by constructing fences that still allow passage of wildlife. Habitat restoration, including the restoration of grasslands, is in progress. Ranchers are actively engaged through the Diablo Trust and numerous conservation organizations have assisted in achieving conservation objectives for the site.

The cumulative effects for migratory birds could result in some incidental mortality caused by project implementation activities. How much mortality would be proportional to how many acres are treated during the spring nesting season of April, May, June, and July. Seasonal restrictions would limit project implementation activities between March 1 and September 30 in goshawk nest area and PFAs and within MSO PACs, which would reduce potential of loss for species listed in ponderosa pine habitat. Prescribed burning occurs also in the fall, outside of the spring nesting season. Since only a small percentage of habitats would be treated at any one time, the loss of eggs or nestlings would not result in a measurable negative effect to the migratory birds populations listed above.

Other Forest Plan Required Analyses

Hiding and Thermal Cover

Providing for hiding and thermal cover is required by both forest plans. Both plans direct at least 10 percent hiding cover and 10 percent thermal cover be provided in assessment areas. An additional 10 (Coconino NF) to 20 percent (Kaibab NF) of cover can be classified as either hiding or thermal (unless the needs of species listed as threatened or endangered under the ESA conflicts with this direction) (USDA 1987, 1988). Wildlife cover on the Coconino NF should be assessed in 10,000-acre blocks while the Kaibab describes cover assessments in terms of project areas. Both are intended to ensure that cover is provided across the area under consideration and not concentrated in some regions and absent from others. However, neither scale meets the intent of the forest plans when applied to the 4FRI treatment area. Ten-thousand-acre blocks are small relative to 4FRI and the project area is too large. Therefore, wildlife cover was evaluated at the subunit scale, allowing for an assessment of unit areas fully distributed across the treatment area.

The size of tree groups and canopy cover developed for the 4FRI are from the scientific literature and site conditions assigned by the terrestrial ecosystem survey. The resulting forest structure is designed to meet or move toward forest plan direction (e.g., even-aged stands cannot attain uneven-aged conditions in a single entry). This approach does incorporate the best science available to better meet the intent of the forest plans. Because this approach meets the intent of the forest plans, no forest plan amendment was needed. Final assessments for cover categories included a combination of treatment intensity, VSS category, canopy cover, and woody plant species other than pine. All data and documentation related to hiding and thermal cover is located in appendix 5 of the wildlife specialist report, and analysis details can be found on pages 17 to 19 of the wildlife report.

Habitat Capability

The NFMA directs the Forest Service to maintain enough habitat adequately distributed across each forest to maintain populations of designated MIS. Habitat capability index (HCI) modeling was not used in the 4FRI wildlife analyses because the HCI approach does not meet direction for use of the best available science. Instead, ecosystem management can be viewed in terms of the evolutionary environment or range of natural variability under which habitats and their associated species evolved (Fulé et al. 2002, Abella 2008). This analysis compared MIS habitat elements such as early seral habitat, late-seral habitat, or large snags, to the desired conditions specifically developed to represent the historical range of variation.

The comparison of habitat elements was done among alternatives and through time using the FVS. Although the HCI model was not specifically used (forest-specific models are no longer available on either the Coconino or Kaibab NFs), the approach used in this analysis is consistent with the intent of the forest plans in terms of maintaining appropriate habitats on the landscape. All data related to assessing a surrogate for HCI is located in MIS effects analysis (see wildlife report).

Other Analysis

Habitat Connectivity

Using the vegetation analysis, the wildlife analysis evaluated potential impacts to habitats from treatments in alternatives B, C, and D. A full discussion of bridge habitat for canopy-dependent

wildlife can be found in appendix G of the DEIS and in appendix 3 of the wildlife report. In addition, landscape-scale closed canopy corridors would be included as part of each action alternative (see appendix 4 of the wildlife report).

Environmental Consequences – Alternatives B, C, and D

In alternatives B, C, and D, 13 percent of the landscape within the 4FRI project boundary would be deferred from treatment. Nearly 42 percent of the ponderosa pine treatment area would have a moderately closed canopy and another 17 percent would remain in a closed condition after treatment. An additional 17 percent of the treated area would have a mix of open and closed conditions. Restoration units near the Mogollon Rim would provide the greatest percentage of bridge habitat after treatment. Old growth allocations account for 38 percent of the ponderosa pine treatment area and are well distributed across the landscape.

A patch-mosaic of small deferrals would be created in stands all across the 4FRI project area to provide safeguards for wildlife features such as nests and hiding cover. Implementation guidance in MSO and northern goshawk habitats includes provisions for higher density and canopy cover.

Aquatics

This section includes key effects and conclusions for aquatic threatened, endangered, and proposed species and critical habitat listed under the Endangered Species Act of 1973, as amended, Forest Service Southwestern Region sensitive species, and Coconino and Kaibab NFs aquatic management indicator species (MIS).

The fisheries specialist (Childs 2013) report is incorporated by reference. See the specialist report for detailed information on methodology, analysis assumptions, best available science and data, habitats, populations, and effects that are not repeated in this section.

Aquatic Federally Listed Threatened, Endangered, Proposed Candidate Species, and Designated Critical Habitat, and Forest Service Sensitive Species

Only those aquatic federally listed threatened, endangered, candidate species along with Forest Service sensitive species that are known or have potential to occur within the project area are analyzed. Table 76 lists species considered and provides a summarized existing condition narrative. Table 77 describes the affected environment for species evaluated.

The threatened, endangered, and sensitive species lists for the Coconino NF was reviewed and a list of species was created for this project based on known occurrence or, in the absence of survey data, the presence of suitable habitat. The following is a description of the species, their habitat, and an analysis of the effects of implementation of each alternative on each species.

Three species (Gila chub, razorback sucker, and Colorado pikeminnow) were eliminated from further analysis because these species do not have critical habitat, potential habitat, or occupied habitat in the analysis area. Gila trout was eliminated from further analysis because this species does not have occupied habitat in the analysis area, and because this species will not be reintroduced into any waters in the analysis area in the foreseeable future.

Table 76. Aquatic threatened, endangered, candidate, and sensitive species evaluated in this analysis

Common Name	Scientific Name	Status[1]	Occurrence[2]	Coconino NF Forestwide Habitat (miles)	Potential Habitat in Affected Environment (miles)	Occupied Habitat in Affected Environment (miles)
Fish						
Gila chub	*Gila intermedia*	E, WC	Δ	13.3[4]	0	0
Spikedace	*Meda fulgida*	E, WC	Δ	134.3[4]	36.8[4]	0
Colorado pikeminnow	*Ptychocheilus lucius*	E[3], WC	Δ	55.6	0	0
Loach minnow	*Tiaroga cobitis*	E, WC	H	95.8[4]	36.8[4]	0
Razorback sucker	*Xyrauchen texanus*	E, WC	Δ	55.6[4]	0	0
Roundtail chub	*Gila robusta*	C, WC, FS-S	O, Δ	350.9	77.9	77.9
Longfin dace	*Agosia chrysogaster*	WC, FS-S	O, Δ	236.7	77.9	77.9
Desert sucker	*Catostomus clarki*	WC, FS-S	O, Δ	236.7	77.9	77.9
Sonora sucker	*Catostomus insignis*	WC, FS-S	O, Δ	236.7	77.9	77.9
Macroinvertebrates						
California floater	*Anodonta californiensis*	FS-S	H	368.6	77.9	0
A mayfly	*Homoleptohyphes quercus*	FS-S	O	77.7	72.6	72.6

[1] Status: T = Federally listed as threatened, E = Federally listed as endangered, C = Candidate for Federal listing as threatened or endangered, WC = Wildlife of special concern in Arizona (1996 AGFD classification pending revision to Article 4 of the State regulations), FS-S = Forest Service sensitive species

[2] Occurrence: O = Species known to occur in the project area or in the general vicinity of the area, Δ = Species occurs downstream of project area, H = Species occurred historically in project area

[3] Colorado pikeminnow is listed as endangered; the species is listed as "experimental nonessential" in Arizona.

[4] All habitat is also critical habitat.

Table 77. Aquatic threatened, endangered, candidate, sensitive, and MIS species evaluated in this analysis and their affected anvironment

Common (Scientific Name)	Affected Environment
Threatened and Endangered Aquatic Species	
Spikedace (*Meda fulgida*) and critical habitat	Spikedace is historic to the Verde River. However, the species has not been detected for years in this system and may be extirpated. There are 134.3 miles of spikedace critical habitat within the Coconino NF boundary. Within the analysis area, the species has 36.8 miles of critical habitat, in the middle and lower Oak Creek. Although unoccupied, this habitat is analyzed for potential effects from the proposed alternatives.
Loach Minnow (*Tiaroga cobitis*) and critical habitat	Loach minnow has been extirpated from the Verde River, and it has not been detected in that stream since 1938 (Minckley 1993). There are 95.8 miles of loach minnow critical habitat within the Coconino NF boundary. Within the analysis area, the species has 36.8 miles of critical habitat, in the middle and lower Oak Creek. Although unoccupied, this habitat is analyzed for potential effects from the proposed alternatives.
Aquatic Candidate Species	
Roundtail Chub (*Gila robusta*)	Roundtail chub is widespread in moderate to large rivers of the Colorado River Basin. In Arizona, it still occurs in the main stem and tributaries to the Verde and Salt Rivers. There are 350.9 miles of potential roundtail chub habitat within the Coconino NF boundary. Within the analysis area, the species occupies 77.9 miles (22.2 percent) of perennial streams, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.
Southwestern Region Forest Service Aquatic Sensitive Species	
Longfin Dace *(Agosia chrysogaster)*	There are 236.7 miles of potential longfin dace habitat within the Coconino NF boundary. Within the analysis area, the species occupies 77.9 miles (32.9 percent) of perennial streams, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.
Desert Sucker *(Catostomus clarki)*	There are 236.7 miles of potential desert sucker habitat within the Coconino NF boundary. Within the analysis area, the species occupies 77.9 miles (32.9 percent) of perennial streams, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.
Sonora Sucker *(Catostomus insignis)*	There are 236.7 miles of potential Sonora sucker habitat within the Coconino NF boundary. Within the analysis area, the species occupies 77.9 miles (32.9 percent) of perennial streams, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.
California Floater *(Anodonta californiensis)*	There are 368.6 miles of potential California floater habitat within the Coconino NF boundary. Within the analysis area, there are 77.9 miles (21.1 percent) of potential perennial stream habitat, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.
A Mayfly *(Homoleptohyphes quercus)*	There are 77.7 miles of potential A mayfly habitat within the Coconino NF boundary. Within the analysis area, the species occupies 72.6 miles (93.4 percent) of perennial streams, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, and West Fork of Oak Creek.

Common (Scientific Name)	Affected Environment
Aquatic Management Indicator Species (MIS)	
Macroinvertebrates	As a group, aquatic macroinvertebrates are identified in both the Coconino NF and Kaibab NF forest plans (as amended) as MIS for high and low elevation late-seral riparian areas. There are 368.6 miles of potential macroinvertebrate habitat within the Coconino NF boundary. Within the analysis area, macroinvertebrates occupy 83.7 miles (22.7 percent) of perennial streams, including Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.

Environmental Consequences

Potential impacts to aquatic resources are compared to the sediment outputs predicted in the soils and hydrology specialist report (Steinke 2013, MacDonald 2013). The primary environmental consequence to aquatic habitat and associated species from timber and vegetation treatments would be increased ground disturbance which has the potential to increase the rate of soil erosion over natural background levels. The analysis focuses on the predicted ground disturbance and its effect in regards to the following:

- Changes in sediment and erosion.
- Alterations to channel morphology—increased sediment has the potential to alter stream channel morphology.
- Changes to stream temperatures—alterations in morphology can change the width to depth ratio of channels, and shallower wider channels can lead to more drastic diurnal fluctuation in stream temperature and higher and lower temperature extremes.
- Effects on riparian vegetation—loss of upland watershed vegetation can lead to flashier hydrographs which erode stream channels, lowering the water table impacting riparian vegetation.
- Macroinvertebrate assemblage—alteration in channel morphology or increases in sediment can alter the macroinvertebrate assemblage.

Stream Habitat

Alternative A

It is predicted (Lata 2013) that up to 33 percent of soils could burn under high burn severity if left untreated and the soils analysis indicates there would be erosion above the tolerance level and a loss of soil productivity. The result to stream courses and perennial streams, including their threatened, endangered, and sensitive species and habitat, would be effects similar to those observed following the Schultz Fire in 2010 (flooding, soil erosion, debris flows, channel realignment, destruction of riparian areas, sedimentation, and embeddedness of stream substrates, etc.).

The effects of increased sedimentation on fishes include ash flows that can negatively impact water quality by increasing pH and decreasing dissolved oxygen levels (Earl and Blinn 2003),

both of which can quickly kill fish. Alternative A would not mitigate these potential negative impacts.

However, it is difficult to compare the known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to threatened, endangered, or sensitive species or their habitat from alternative A, there would be no cumulative effects.

Effects Common to Alternatives B, C, and D

Direct effects of vegetation management on stream systems should be minor when Forest Service BMPs are followed (Southwestern Region FSH 2509.22) (see appendix C of the DEIS for all mitigation and BMPs). Limiting vegetation management activities from impacting stream courses should lead to minor or inconsequential direct effects to streams habitat and their associated biota. Buffer strips of at least 70 feet to 120 feet (BMP 8; Steinke 2013) would be used to protect stream courses.

None of the action alternatives propose for ignitions to occur within riparian areas or along stream channels, but fire would be allowed to back downslope into these areas. If fire burns riparian areas, there is the potential for some ash and localized erosion to occur, however, these effects should be minor in degree and extent.

All action alternatives propose some prescribed fire on slopes greater than 15 percent, so there would be a short-term risk of sedimentation or ash flow resulting from these treatments. However, BMPs would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent.

The primary negative impacts to aquatic systems and their associated biota from vegetation treatment and prescribed fire come as indirect effects including: increased sediment, loss of riparian vegetation, altered macroinvertebrate assemblages, lowering of groundwater tables and decreased perennial flows, increased stream temperature, larger peak flows, stock tank impacts, and changes in channel form (Bisson et al. 2003, Swank et al. 1989).

There would be an increased risk of sediment and ash flow into stream courses in alternative B and C over alternative D, which has less prescribed fire.

The perennial streams within the project area that contain fish and/or macroinvertebrates are Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork Oak Creek (see specialist report). Effects from the action alternatives to aquatic resources are compared with regard to sediment outputs predicted from the soils and water quality and riparian specialist's report (Steinke 2013, MacDonald 2013).

BMPs should greatly reduce the risk to perennial streams of short-term impacts (sedimentation) from prescribed fire activities. BMPs would also reduce the risk of short-term impacts resulting from spring and stream restoration, road decommissioning, and dust abatement measures.

Forest Plan Amendments

Effects from the proposed forest plan amendments would not be measurable to aquatic species or their habitat.

Threatened, Endangered, and Forest Service Sensitive Aquatic Species Habitat

Threatened, endangered, and Forest Service sensitive aquatic species in and adjacent to the project area are all located on the Coconino NF. Units and subunits (and relevant 6th Code HUC watersheds) that contain these species are: 1-3 (Pumphouse Wash), 1-4 (Sawmill Wash), 1-5 (Munds Canyon), 3-3 (Cedar Creek, Little LO Spring Canyon, Lower Sycamore Creek, Middle Sycamore Creek, Upper Sycamore Creek), 3-4 (Pumphouse Wash), 3-5 (Middle Oak Creek, Munds Canyon, Upper Oak Creek, West Fork Oak Creek), and 5-1 (Lower Rio de Flag). All other watersheds within the analysis area do not contain threatened, endangered, and sensitive aquatic species habitat. Table 78 displays the environmental consequences of the proposed alternatives.

Cumulative Effects

The geographic setting and boundary for the cumulative effects analysis is the 82 6th HUC watersheds within or intersecting the project boundary for a total of about 2,032,000 acres. The timeframe for past actions is 2 to 3 years based on vegetative and CWD recovery of the site.

The cumulative impacts to soils and watershed from past, present, and reasonably foreseeable actions as presented in the "Soils and Water" section of chapter 3 and the soils specialist report is incorporated by reference.

Table 78. Aquatic threatened, endangered, candidate, and sensitive species environmental consequences

Species	Alternative A	Alternatives B, C, and D
Threatened and Endangered Aquatic Species		
Spikedace and critical habitat Loach Minnow and critical habitat	**Species Determination** Spikedace and loach minnow are not currently present within the affected environment. Therefore, alternative A would have **no effect** on spikedace or loach minnow. **Critical Habitat** Within the analysis area, critical habitat for spikedace and loach minnow exists in the middle and lower portions of Oak Creek (USDI 2012). Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. Ash flows produced from forest fires can negatively impact water quality. Stream morphology can be changed by sediment deposition. Alternative A (no action) would not mitigate these potential negative impacts. However, it is difficult to compare the known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to spikedace and loach minnow or their habitat from alternative A, there would be no cumulative effects. Therefore, alternative A would have **no effect** on spikedace or loach minnow critical habitat.	**Species Determination** Spikedace and loach minnow are not currently present within the affected environment. Therefore, alternative B would have **no effect** on spikedace or loach minnow. **Critical Habitat** Within the analysis area, critical habitat for spikedace and loach minnow exists in the middle and lower portions of Oak Creek (USDI 2012). The soils report (Steinke 2013) indicates that prescribed fire treatments could result in soil erosion in areas where slope exceeds 15 percent. There would be a short-term risk (1–2 years) of sedimentation or ash flow resulting from these treatments. However, BMPs would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. Alternative C proposes more acres of mechanical vegetation treatment than alternative B, but vegetation treatments should result in negligible soil erosion if BMPs are followed. Alternative D proposes far fewer acres of prescribed fire than either alternative B or C, but alternative D would not meet the purpose and need of the project. The short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the forest, including restoring the health of watersheds and streams in which spikedace and loach minnow live. Spring and stream restoration, as well as road decommissioning activities, could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Therefore, considering direct, indirect, and cumulative effects, alternatives B, C, and D **may affect but are not likely to adversely affect** spikedace or loach minnow critical habitat.

Species	Alternative A	Alternatives B, C, and D
Candidate Species		
Roundtail Chub	**Species Determination** Within the analysis area, roundtail chub occupies 77.9 miles of perennial stream (22.2 percent of its habitat on the Coconino NF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. Ash flows produced from forest fires can negatively impact water quality. Stream morphology can be changed by sediment deposition. Alternative A would not mitigate these potential negative impacts. However, it is difficult to compare the known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to roundtail chub or its habitat from alternative A, there would be no cumulative effects. Therefore, alternative A would have **no effect** on roundtail chub or its habitat.	**Species Determination** Within the analysis area, roundtail chub occupies 77.9 miles of perennial stream (22.2 percent of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. The soils report (Steinke 2013) indicates that prescribed fire treatments could result in soil erosion in areas where slope exceeds 15 percent. There would be a short-term risk (1–2 years) of sedimentation or ash flow resulting from these treatments. However, BMPs would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. Alternative C proposes more acres of mechanical vegetation treatment than alternative B, but vegetation treatments should result in negligible soil erosion if BMPs are followed. Alternative D proposes far fewer acres of prescribed fire than either alternative B or alternative C, but alternative D would not meet the purpose and need of the project. The short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the forest, including restoring the health of watersheds and streams in which roundtail chub live. Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Therefore, considering direct, indirect, and cumulative effects, alternatives B, C, and D **may affect but are not likely to adversely affect** roundtail chub or its habitat.
Southwestern Region Forest Service Sensitive Species*		
Roundtail Chub	**Species Determination** Within the analysis area, roundtail chub occupies 77.9 miles of perennial stream (22.2 percent of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Perennial streams on the Coconino NF within and	**Species Determination** Within the analysis area, roundtail chub occupies 77.9 miles of perennial stream (22.2 percent of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. The soils report (Steinke 2013) indicates that prescribed fire treatments could result in soil erosion in areas where slope exceeds 15 percent. There would be a short-term risk (1–2 years) of sedimentation or ash flow resulting from these treatments. However, BMPs would

Species	Alternative A	Alternatives B, C, and D
	adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. Ash flows produced from forest fires can negatively impact water quality. Stream morphology can be changed by sediment deposition. Alternative A would not mitigate these potential negative impacts. However, it is difficult to compare the known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to roundtail chub or its habitat from alternative A, there can be no cumulative effects. Therefore, alternative A is **not likely to cause a trend to Federal listing or loss of viability** of roundtail chub.	be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. Alternative C proposes more acres of mechanical vegetation treatment than alternative B, but vegetation treatments should result in negligible soil erosion if BMPs are followed. Alternative D proposes far fewer acres of prescribed fire than either alternative B or C, but alternative D would not meet the purpose and need of the project. The short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the forest, including restoring the health of watersheds and streams in which roundtail chub live. Spring and stream restoration, as well as road decommissioning activities, could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Therefore, considering direct, indirect, and cumulative effects, alternatives B, C, and D **may impact individuals, but are not likely to cause a trend to Federal listing or loss of viability** of roundtail chub.
Longfin Dace Desert Sucker Sonora Sucker California Floater	**Species Determination** Within the analysis area, longfin dace, desert sucker, and Sonora sucker occupy 77.9 miles of perennial stream (32.9 percent of its habitat on the Coconino NF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. These perennial streams also represent potential habitat for the extirpated California floater. Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. Ash flows produced from forest fires can negatively impact water quality. Stream morphology can be changed by sediment deposition. Alternative A (no action) would not mitigate these potential negative impacts. However, it is difficult to	**Species Determination** Within the analysis area, longfin dace, desert sucker, and Sonora sucker occupy 77.9 miles of perennial stream (32.9 percent of its habitat on the Coconino NF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. These perennial streams also represent potential habitat for the extirpated California floater. The soils report (Steinke 2013) indicates that prescribed fire treatments could result in soil erosion in areas where slope exceeds 15 percent. There would be a short-term risk (1–2 years) of sedimentation or ash flow resulting from these treatments. However, BMPs would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. Alternative C proposes more acres of mechanical vegetation treatment than alternative B, but vegetation treatments should result in negligible soil erosion if BMPs are followed. Alternative D proposes far fewer acres of prescribed fire than either alternative B or C, but alternative D does not meet the purpose and need of the project. The short-term risks incurred by the proposed vegetation treatments and prescribed fire are

Species	Alternative A	Alternatives B, C, and D
	compare the known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to longfin dace, desert sucker, Sonora sucker, or California floater or their habitat from alternative A, there can be no cumulative effects. Therefore, alternative A is **not likely to cause a trend to Federal listing or loss of viability** of longfin dace, desert sucker, Sonora sucker, or California floater.	necessary for the long-term benefit of the forest, including restoring the health of watersheds and streams in which longfin dace, desert sucker, and Sonora sucker live. Spring and stream restoration, as well as road decommissioning activities, could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Therefore, considering direct, indirect, and cumulative effects, alternatives B, C, and D **may impact individuals, but are not likely to cause a trend to Federal listing or loss of viability** of longfin dace, desert sucker, Sonora sucker, or California floater.
A mayfly	**Species Determination** There are 77.7 miles of potential A mayfly habitat within the Coconino NF boundary. Within the analysis area, the species occupies 72.6 miles (93.4 percent) of perennial stream, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, and West Fork of Oak Creek. It is often associated with silt, fine sand, gravel, and woody debris. It is not thought that sediment impairs this species or its habitat and there is no clear understanding as to why this species range has declined. Since there are no direct or indirect effects to A mayfly from alternative A, there would be no cumulative effects. Therefore, alternative A is **not likely to cause a trend to Federal listing or loss of viability** of A mayfly.	**Species Determination** There are 77.7 miles of potential A mayfly habitat within the Coconino NF boundary. Within the analysis area, the species occupies 72.6 miles (93.4 percent) of perennial stream, including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, and West Fork of Oak Creek. It is often associated with silt, fine sand, gravel, and woody debris. It is not thought that sediment impairs this species or its habitat, and there is no clear understanding as to why this species range has declined. Since there are no direct or indirect effects to A Mayfly from alternatives B–D, there would be no cumulative effects. Therefore, alternatives B–D are **not likely to cause a trend to Federal listing or loss of viability** of A mayfly.

Species	Alternative A	Alternatives B, C, and D
Management Indicator Species		
Macroinvertebrates High and Low Elevation Late-seral Riparian Indicator Species	**Determination** There are 368.6 miles of potential macroinvertebrate habitat (perennial stream) within the Coconino NF boundary. Within the analysis area, there are 83.7 miles (22.7 percent) of potential perennial stream habitat, including Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. Ash flows produced from forest fires can negatively impact water quality. Stream morphology can be changed by sediment deposition. Alternative A would not mitigate these potential negative impacts. However, it is difficult to compare the known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to macroinvertebrates or their habitat from alternative A, there can be no cumulative effects. Overall, forestwide riparian condition trend is mostly toward proper functioning condition, with some static areas (Steinke 2013). Overall trend in riparian acreage since 1987 is probably static to slightly upward with the addition of some riparian acreage in land exchanges (Steinke 2013). Macroinvertebrate population trends in high and low elevation streams on the forest are static. Alternative A **would not change macroinvertebrate habitat quality or quantity on the forest, nor would it change current forestwide trends**.	**Determination** There are 368.6 miles of potential macroinvertebrate habitat (perennial stream) within the Coconino NF boundary. Within the analysis area, there are 83.7 miles (22.7 percent) of potential perennial stream habitat, including Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. The soils report (Steinke 2013) indicates that prescribed fire treatments could result in soil erosion in areas where slope exceeds 15 percent. There would be a short-term risk (1–2 years) of sedimentation or ash flow resulting from these treatments. However, BMPs would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. Alternative C proposes more acres of mechanical vegetation treatment than alternative B, but vegetation treatments should result in negligible soil erosion if BMPs are followed. Alternative D proposes far fewer acres of prescribed fire than either alternative B or C, but alternative D would not meet the purpose and need of the project. The short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the forest, including restoring the health of watersheds and streams in which macroinvertebrates live. Spring and stream restoration, as well as road decommissioning activities, could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Overall forestwide riparian condition trend is mostly toward proper functioning condition, with some static areas (Steinke 2013). The overall trend in riparian acreage since 1987 is probably static to slightly upward with the addition of some riparian acreage in land exchanges (Steinke 2013). Macroinvertebrate population trends in high and low elevation streams on the forest are static. Considering direct, indirect, and cumulative effects, alternatives B, C, and D **may impact individuals, but would not change macroinvertebrate habitat quality or quantity on the forest, nor would they change current forestwide trends.**

* The environmental consequences include a biological evaluation for the Southwestern Region Forest Service sensitive species

Noxious and Invasive Weeds

The noxious and invasive weed analysis is part of the botany specialist report which is incorporated by reference (Crisp 2013).

Noxious and invasive weed direction originated from a three-forest analysis (USDA 2005). The noxious weed FEIS/ROD was incorporated into the forest plans by amendment 20 to the Coconino forest plan and amendment 7 to the Kaibab forest plan. The species displayed in table 79 were evaluated for presence/absence in the treatment area. The species ranking is from the noxious weed FEIS and relates to the prioritization process that used various criteria including difficulty of control, successes with control efforts elsewhere, and life cycle (perennial vs. annual).

The options listed in table 79 in the objective column include prevention, eradication, and control. Prevention means minimizing introduction of a weed species into the project area and usually by combining with eradication to allow for elimination of spot populations as they arise. Eradication means attempting to totally eliminate a species from the forests. Control means preventing seed production throughout a target patch and reducing the area covered by a species, whereas contain means to prevent the species from expanding beyond the perimeter of existing patches.

Table 79. Treatment area noxious and invasive weeds evaluation

Species*	Common Name	Species Rank	Objective	Known to Occur in Treatment Areas (Y/N)
Euphorbia esula	leafy spurge	1	Eradicate	Y
Centaurea solstitialis	yellow starthistle	2	Eradicate	N
Centaurea melitensis	Malta starthistle	3	Eradicate	N*
Alhagi maurorum Syn. *Alhaghi pseudoalhagi*	camelthorn	4	Contain/Control	Y
Acroptilon repens	Russian knapweed	5	Contain/Control	Y
Cardaria draba	whitetop	6	Eradicate	Y
Salvia aethiopis	Mediterranean sage	7	Eradicate	Y
Carduus nutans	musk thistle	8	Eradicate	Y
Centaurea diffusa	diffuse knapweed	9	Contain/Control	Y
Centaurea stoebe ssp. Micranthos Syn. *Centaurea maculosa, Centaurea biebersteinii*	spotted knapweed	10	Eradicate	Y
Onopordum acanthium	Scotch thistle	11	Eradicate/Control	Y
Elaeagnus angustifolia	Russian olive	12	Contain/Control	N*
Tamarix spp.	tamarisk	13	Contain/Control	Y

Species*	Common Name	Species Rank	Objective	Known to Occur in Treatment Areas (Y/N)
Rubus procerus Syn. *R. armeniacus or R. discolor*	Himalayan blackberry	14	Contain/Control	N*
Cynoglossum officinale	houndstongue	15	Eradicate	N
Arundo donax	giant reed	16	Contain/Control	N*
Potentilla recta	sulfur cinquefoil	17	Prevent/Eradicate	N*
Linaria dalmatica	Dalmatian toadflax	18	Contain/Control	Y
Ailanthus altissima	tree of Heaven	19	Contain/Control	N*
Cirsium vulgare	bull thistle	20	Contain/Control	Y
Ulmus pumila	Siberian elm	21	Contain/Control	N*
Bromus tectorum	cheatgrass	22	Contain/Control specific populations	Y
Avena fatua	wild oats	23	Contain/Control	N*
Dipsacus fullonum	common teasel	24	Eradicate	N*
Chrysanthemum leucanthemum Syn *Leucanthemum vulgare*	oxeye daisy	Unassigned	Prevent/Eradicate	N
Cirsium arvense	Canada thistle	Unassigned	Prevent/Eradicate	N*
Halogeton glomeratus	halogeton	Unassigned	Prevent/Eradicate	N*
Isatis tinctoria	dyers woad	Unassigned	Prevent/Eradicate	N*
*Myriophyllum spicatum***	Eurasian water milfoil	Unassigned	**	N

N* = these species are not known to occur within treatment areas for the project, but are of concern due to their proximity and potential effects to restoration treatments. Partners have expressed concern for these species. Their rating system is explained below (Smith 2012).
** Unassigned.

In addition to the species identified for treatment in the forest plan, external partners expressed concern for other noxious or invasive weed species. Their rankings, goals for management, and rationale (discussed below) were incorporated into analysis and monitoring plan.

High Risk – these species currently have limited geographic distribution within the treatment areas. If current inventories indicate their presence within treatment areas, these species would be given priority and would be eradicated as soon as practicable. These species include leafy spurge, camelthorn, spotted knapweed, diffuse knapweed, Russian knapweed, white top, Mediterranean sage, Scotch thistle, tamarisk, and musk thistle.

Medium Risk – these species have widespread distribution within the treatment areas in large populations and include cheatgrass, Dalmatian toadflax, bull thistle, and wild oats. Areas would

be prioritized for treatment based on risk to conservation value (presence or proximity of threatened, endangered, and sensitive species) and areas of high wildlife habitat value (e. g., pine-sagebrush ecotone).

Watch List – watch list species include Malta starthistle, Russian olive, yellow starthistle, Himalayan blackberry, giant reed, sulfur cinquefoil, tree of heaven, Siberian elm, halogeton, dyer's woad, Eurasian water-milfoil, oxeye daisy, Canada thistle, and common teasel. If these species are detected, aggressive eradication efforts would be a priority and addressed as soon as practicable.

Environmental Consequences

Alternative A

Direct, Indirect, and Cumulative Effects

There would be no direct effects. Weed infestations that might have been detected and treated would go unnoticed and continue to expand unless detected by other surveys or independent observations. The cumulative effects boundary is the Coconino and Kaibab NFs and the temporal timeframe is from 1995 to the present. Indirectly, increases in fire hazard and severity would increase the risk of noxious weed invasions in the project area. Warmer climate conditions may affect ecosystems by altering biotic and abiotic factors and increase the extent and severity of disturbances for some species (Bradley et al. 2010, Hellmann et al. 2008, Middleton 2006). Climate may favor the spread of invasive exotic grasses into arid lands where the native vegetation is too sparse to carry a fire. When these areas burn, they typically convert to nonnative monocultures and the native vegetation is lost (USDA 2010). Ongoing FS management actions combined with the Arizona Department of Transportation, Coconino County, and city of Flagstaff would continue to address and mitigate effects of noxious or invasive weeds and reduce the spread into new areas.

Alternatives B, C, and D

Direct and Indirect Effects

Direct effects include ground-disturbing activities that would have the potential to increase the acreage and/or density of the existing infestations within the project area. Management activities that would create localized severe disturbance include burned areas from slash piles, the creation of log decks, bare soil created through temporary road construction, road reconstruction (both road improvement and road relocation), decommissioning, stream channel restoration, and use by machinery during mechanical thinning. Broadcast burning and hand thinning would be sources of disturbance but the level of disturbance would not be as severe. Direct and indirect effects of temporary road construction, road reconstruction, road maintenance, or decommissioning include disturbance and increased risk of dispersal of existing weed species and populations and the introduction of new species. However, reducing the road mileage would help reduce the risk of present and future dispersal of noxious or invasive weeds along roadways (Rooney 2005). Spring and channel restoration would increase disturbance in the treated areas. With the incorporation of mitigation and best management practices (BMPs) (see appendix C of the DEIS), these effects would be reduced to nonsignificant levels.

Cumulative Effects

The cumulative effects boundary is the Coconino and Kaibab NFs within the project area boundary. This temporal timeframe includes management actions related to noxious or invasive weeds since 1995 to the present.

Beginning in 1995, the Coconino and Kaibab NFs began surveying and documenting noxious or invasive weed occurrences. Since 1997, noxious or invasive weed surveys were generally conducted on forest projects that would have management actions associated with soil disturbance. In 2005, the three-forest noxious weeds FEIS document and its provisions were incorporated into the Coconino NF and Kaibab NF by amendments 20 (Coconino NF) and 7 (Kaibab NF).This document represented a major change in the management of noxious or invasive weed control on the forests by allowing the use of herbicides on forest lands. All of the above actions were beneficial management actions that supported management control objectives for noxious or invasive weeds on the forest. These past actions have influenced the existing condition or baseline.

Forest Plan Amendments

The evaluation of how proposed plan amendments may affect noxious weeds is located in the "Plants" section of table 71, which describes alternatives B, C, and D sensitive species environmental consequences determination.

Heritage Resources

A summary of the heritage analysis is presented here, and the complete heritage specialist report (Gifford et al. 2013) is incorporated by reference.

The ponderosa pine ecosystem is the focus of the 4FRI forest restoration project. The area of potential effect (APE) is 988,930 acres. Within the project area, cultural resources range temporally from prehistoric times through the historic period and into the modern day. Prehistoric sites include rock art, cliff dwellings, pit houses, multiple room pueblos, artifact scatters, and traditional cultural properties. Historic resources consist of logging railroad grades, trails and historic roads, cabins and homesteads, Forest Service administrative sites, Basque sheep camps, mining camps, Civilian Conservation Corps remains, and Native American shelters such as sweat lodges and brush shelters.

Throughout the analysis area, archaeological site densities range from 1 to 66 sites per square mile (from the 4FRI heritage site density model—see Gifford 2011 for a full explanation of how the model was developed). Within the analysis area, there are 5,513 recorded archaeological sites with 123,716 acres on the Coconino NF and 214,485 acres on the Kaibab NF that have been previously surveyed for cultural resources. There are 15 sites on the Kaibab NF and 13 sites on the Coconino NF that are listed in the National Register of Historic Places (NRHP). There are 257 sites on the Kaibab NF and 1,007 sites on the Coconino NF that are eligible for the NRHP.

Cultural resources also include Native American traditional use areas and places known as traditional cultural properties (TCPs). These TCPs hold a central and important position in Native American culture. Three prominent examples found within the project area are the San Francisco Peaks on the Coconino National Forest and Red Butte and Bill Williams Mountain on the Kaibab

NF. See the tribal relations report and appendix A in the heritage report for more information on management of TCPs).

Heritage Strategy

The proposed activity in the 4FRI DEIS includes ground-disturbing activities such as mechanical thinning, hand thinning, stream restoration, temporary road construction, existing and temporary road closures, fencing, and prescribed fires. In consultation with the Arizona State Historic Preservation Officer (AZ SHPO), the Coconino and Kaibab forests developed a document called the "Four Forest Restoration Initiative Heritage Resources Strategy and NHPA Compliance" (Gifford 2011), otherwise referred to as the "heritage strategy." There were three elements identified in the heritage strategy that would assist in reaching a no adverse effect determination for this project.

- The first is the focus on appendix J of the "Southwestern Region Heritage Programmatic Agreement." Appendix J outlines the consultation protocols and strategies for implementing large-scale fuels reduction, vegetation treatment, and habitat improvement projects.
- The second component is the archaeological site density model created by the Coconino and Kaibab NFs. This model, created using existing site inventory data, identified high and low site density areas and assists in the design of survey strategies for specific project locations.
- The third aspect is the heritage strategy. Following appendix J, areas of intensive ground disturbances and areas of high site densities receive 100 percent survey. However, as per the strategy, areas of low site density can receive up to 25 percent of new or additional survey if existing surveys are not considered adequate. Sample survey needs are to be determined by heritage resources managers on a project-by-project or individual task order basis (see Gifford 2011 for details on the survey strategies).

Phased Section 106 Compliance

Because of the size of this undertaking, implementation would be phased over several years. Appendix J allows for the phasing of Section 106 compliance evaluations. Appendix J, the heritage strategy, and the initial 4FRI Section 106 report describe the methods to be used to achieve a no adverse effect determination for 4FRI as a whole.

Individual task orders or specific project areas would be evaluated by forest heritage staff for inventory needs and then surveyed to the appropriate level as defined in the heritage strategy. A Section 106 report would be produced for each project area as they are identified. Consultation with the AZ SHPO and tribes would be completed prior to implementing each task order.

Environmental Consequences

The environmental consequences for alternatives B, C, and D include applying the design features and mitigation measures displayed in appendix C of the DEIS.

Alternative A

Direct and Indirect Effects

Existing fuels in and around archaeological sites would continue to increase. This may result in more frequent and intense wildfires which could result in site and artifact damage such as spalling of rock art and cracking of artifacts as well as post-fire erosion. Fire suppression actions, particularly bulldozer operations, may also damage or destroy surface and subsurface archaeological sites resulting in the loss of those resources and their research potential. Additionally, sites are more visible after a fire, especially high-intensity fires, and much more vulnerable to vandalism.

Soil erosion due to uncharacteristic wildfires could have both a direct and indirect effect on cultural resources. Rain and snowmelt can cause channels to form within denuded sites, or mud slides from nearby slopes may deposit soil and debris within site boundaries leading to the loss of data potential and characteristics that make historic properties eligible for the National Register of Historic Places.

Environmental Consequences Common to Alternatives B, C, and D

Prior to initiating project-specific task orders, the forests would consult with federally recognized tribes to identify traditional use areas and, if necessary, develop project-specific mitigation measures to accommodate traditional use of the forest by tribal members.

Alternative B

Direct and Indirect Effects

Unnatural fuel loading should be reduced in and around National Register listed or eligible cultural resources. Uncharacteristic fire behavior should also be reduced. Thinning and low-intensity prescribed fires could reduce current fuel loads which would then assist in preventing extensive heat damage during wildfires. There would be less need for fire suppression activities, consequently reducing the threat of ground-disturbing activities like bulldozer fire line construction.

Mechanical thinning treatments, temporary road construction, and closures, skidding, and other ground-disturbing activities associated with 4FRI would have the potential to affect cultural resources. Impacts could include rutting, erosion, dislocation, or breakage of artifacts and features, and destruction of sites and site stratigraphy. Using prescribed fire also has the potential to affect fire sensitive sites. These potential effects would be addressed through site avoidance strategies and implementing the site protection measures listed in the “Southwestern Region Programmatic Agreement” (PA) (appendix J and in the heritage strategy).

Initial reduction of heavy fuels may lead to an increase in site visibility, public visitation, and possible vandalism. Those issues would be reduced through management actions that include project specific as well as long-term monitoring. Initial entry prescribed burns would be periodically revisited and burned to reduce natural fuel accumulation, and archaeological site monitoring would be part of that process. Possible road decommissioning could also assist in limiting access to some archaeological sites, thus reducing post-burn visibility and visitation at those sites.

There is the possibility that cultural resources would be discovered during project implementation. Discovery guidance is found in appendix J of the Southwestern Region PA.

See the "Tribal Relations" section and "Environmental Justice" section in the economics report regarding impacts to Native American traditional use areas and impacts from smoke on tribal communities.

Alternative C

Direct and Indirect Effects

This alternative includes a strategy for preserving an undisclosed numbers of large trees (large tree implementation plan) while meeting restoration objectives. It is more of a socio-political concern to contemporary culture rather than an impact to historic properties. Many of the ground-disturbing activities associated with this alternative would be similar to those identified in alternative B, and would have the same potential to affect cultural resources. Key components of this alternative include additional mechanical and prescribed fire on specific grasslands, and wildlife and watershed research and restoration. This alternative includes similar actions as alternative B, while having additional specific desired conditions for large trees and expanded grassland restoration as the primary differences.

One concern for heritage resources under this alternative is the increases in mechanical treatments. The 4FRI heritage survey strategy would address this concern. Per the strategy, intensive ground-disturbing activities would be inventoried for historic properties at 100 percent prior to implementation, thus identifying cultural resources prior to ground-disturbing actions. If additional high impact or intense mechanical treatments would be needed under this alternative, additional archaeological survey would be necessary per the heritage survey strategy. Potential effects to cultural resources would be avoided using the protection measures in the heritage protocol and Section 106 clearance report, or the adverse effects would be mitigated.

One potential benefit of this alternative would be the preservation of culturally modified trees. The 4FRI heritage survey strategy incorporates various levels of survey but not 100 percent across the entire project area. Since sample surveys do not identify all historic resources, leaving a larger number of 16-inch and above trees in place may preserve some of these unrecorded culturally modified trees. Conversely, one negative aspect of leaving large trees in place was noted during the bark beetle infestation on the Coconino NF. During that period, a number of larger ponderosa pines died in drier parts of the forest. Some of those trees had taken root in archaeological sites. When these dead trees fell, they uprooted portions of sites. Both of these examples are very limited in scale and would be minimized through implementing the 4FRI project. Landscape-level forest restoration could potentially decrease bark beetle impacts through a healthier forest and culturally modified trees on the Coconino and Kaibab NFs occur primarily in aspen stands, not ponderosa pine, the focus of this project. Therefore, any effects under the 4FRI would be very limited. Also see the "Tribal Relations" section and "Environmental Justice" section in the economics report for potential impacts to tribes.

Alternative D

Direct and Indirect Effects

Alternative D focuses on reducing prescribed fire in comparison to the proposed action (B). The alternative was developed in response to social concerns regarding smoke impacts in and around the area. Actions under alternative D are similar to those found in the proposed action (alternative B) with the principle difference being decreases in levels of prescribed fire and other options to remove thinning debris. Potential impacts to cultural resources would be similar to alternative B. The heritage strategy is flexible enough to respond to all of the various levels of implementation under alternatives B, C, and D.

Alternative D may benefit some fire sensitive cultural resources in areas of the forest with lower site densities. Per the heritage strategy, burn units with high site densities would be surveyed at 100 percent. In areas of low density, the heritage strategy option would be to survey an additional 25 percent if necessary. Current forest data, along with the 4FRI site density models and local heritage personnel's resource knowledge, would be used to identify and protect the majority of fire sensitive sites found in both high and low density areas. Nonetheless, there would always the possibility that small numbers of these fire sensitive sites could be affected and a reduction in prescribed fire may assist in preserving them.

A 30 percent reduction of prescribed fire would leave a significant amount of post-thinning debris and slash on the forests. Without prescribed fire, actions identified in the alternative such as chipping, shredding, mastication, and offsite removal of material would be required. Some of these activities may include ground-disturbing actions that could have an effect on cultural resources. Forest and district archaeological staff could address these effects by increasing the amount of archaeological survey within the area of these ground-disturbing activities and ensuring that cultural resources are avoided or the adverse effects are mitigated.

Consultation with Native Americans has indicated that some groups in surrounding communities have concerns regarding the amount of smoke that may result from project prescribed fire. The proposed reduction in burning under this alternative addresses those concerns. Also, see the "Tribal Relations" section and "Environmental Justice" information in the economics report for additional discussion about smoke impacts to tribal communities.

Forest Plan

For all alternatives, the potential impact to heritage resources from the proposed forest plan amendments is included in the "Tribal Relations" section.

Cumulative Effects

The spatial scale for cumulative effects is the area of potential effect (APE). Past, present, and foreseeable projects in appendix F of the DEIS were reviewed and used for the analysis.

Alternative A

Under the no action alternative, the proposed large-scale, landscape level forest health project would not occur, and there would be no additional effects as a result of this project. The present and foreseeable future undertakings would continue to have the potential to affect cultural resources. These undertakings will go through the Section 106 review process and all cultural

resources that are listed on the National Register or eligible for the register would be avoided or the adverse effects would be mitigated. Any cumulative effects to cultural resources that could occur would not be considered to be adverse. High-intensity wildfires would threaten cultural resources because fuels will continue to accumulate and sites located within and near burn areas could be subjected to a potential increases in soil erosion.

Alternatives B, C, and D

Alternatives B, C, and D have the potential to increase the amount of ground-disturbing activities, including mechanical treatments, increased prescribed fire acres in alternative B, temporary road construction, skidding, stream restoration, fence construction, and other ground-disturbing activities. Alternative D may involve other means of slash and debris removal. Actions such as chipping, shredding, and mastication as well as removal of material offsite may include an increase in ground-disturbing actions. In alternatives B, C, and D, protection measures (as described the heritage strategy and Section 106 report) include the presence of archaeological monitors during mechanical activities, hand thinning within site boundaries, keeping ground-disturbing activities out of site boundaries by flagging and avoiding the sites, and post-prescribed fire site monitoring. These measures would be used to minimize the effects of low-intensity burns. Also, as noted for alternative A, all undertakings would go through the Section 106 review process and all cultural resources that are listed on the National Register or eligible for the National Register would be avoided or the adverse effects would be mitigated. The potential cumulative effects to cultural resources from increased ground-disturbing activities and prescribed fire resulting from these alternatives as well as the past, present, and forseeable future projects are, therefore, not considered to be adverse.

There would be a possibility for an increase in archaeological site vandalism resulting from increased visibility once the project is implemented. This visibility would be greater than that caused by past, present, or foreseeable future undertakings in the area. However, protection measures such as reducing vegetation on sites, or incorporating sites into wildlife bridge habitat locations, for example, would help to reduce the visibility of sites that were avoided during project implementation. In addition, the management practice of implementing low to moderate intensity prescribed fire typically does not sterilize soil or completely remove ground fuels like a high-intensity, uncontrolled wildfire. Low-intensity fires also tend to leave some trees in place that would eventually cover the surface with a recurring needle cast so artifacts will not be as visible. Sites are periodically monitored both during project implementation as well as for NHPA Section 110 purposes by Agency and volunteer personnel. Proposed road closures would reduce access to some of these areas as well, reducing the potential for increased vandalism. The cumulative effect of increased visibility is not considered to be adverse.

The cumulative effects on cultural resources resulting from any potential increase in erosion are also minimal. Reducing fuel loads and implementing low to moderate intensity prescribed fires would not cause soil sterilization or hydrophobic soils as high-intensity wildfires would. As noted previously, low-intensity prescribed fires leave some vegetation in place and revegetation occurs soon afterwards if soils are not sterilized. However, as implementation occurs, archaeologists would monitor for erosion concerns examining sites in the project areas, focused on slopes, drainages, and other high probability areas with cultural resources present. The cumulative effects to cultural resources caused by an increase in erosion are not considered to be adverse.

Overall, the cumulative effects on cultural resources as a result of alternatives B, C, and D are not considered to be adverse.

Tribal Relations

A summary of the tribal relations analysis, including the consultation process (table 80), is presented here. The complete specialist report (Johnson et al. 2013) is incorporated by reference.

The 4FRI project is situated across a landscape that is aboriginal to at least 16 American Indian tribes. Many of these tribal aboriginal lands overlap one another and areas of prominence which are considered sacred by tribes here in the southwestern United States. American Indian Law requires consultation between the U.S. Forest Service and federally recognized American Indian tribes; however, recognizing that we share a common interest to maintain the health of the forest, consultation extends beyond the legal requirements. With the knowledge that American Indian people have inhabited the 4FRI area for centuries, tribal consultation will consider traditional knowledge in order to restore and maintain a healthy forest ecosystem.

Consultation Process

The following tribes and tribal chapters who have historic ties and an interest in the Coconino and Kaibab National Forests were consulted with (table 80) and include: Kaibab Band of Paiute Indians, Navajo Nation including Coppermine, Coalmine, Naness, Lechee, Leupp, Bodaway, Cameron, Tuba City, Dilkon and Tolani Lake Chapters, Kaibab Band of Paiute Indians, San Juan Southern Paiute, White Mountain Apache, Yavapai-Apache Nation, San Carlos Apache, Hualapai, Yavapai-Prescott Indian Tribe, Havasupai, Tonto Apache, Pueblo of Zuni, Pueblo of Acoma, Hopi, and Fort McDowell Yavapai Nation.

Tribal consultation is primarily direct face-to-face meetings between federally recognized tribes and the Federal government. Consultation may include sharing of information through letter carried mail, email, and followup telephone calls which supplement the face-to-face meetings. Tribes that do not participate in tribal consultation continue to receive information via email and hand delivered mail. Information is shared unless a tribe asks specifically to not be informed. The tribal relations specialist report (project record) contains an up-to-date complete listing of information sharing and consultations with federally recognized tribes regarding the 4FRI. Tribal consultation will be ongoing throughout the entire span of the 4FRI project.

Contemporary Uses and Traditional Cultural Properties (TCPs)

Traditional Cultural Properties: American Indian resources may consist of shrines, trails and historic roads, and shelters such as sweat lodges and brush shelters. Traditional use areas and places are known as traditional cultural properties/places (TCPs). TCPs are places traditionally used by cultural groups over generations. TCPs within the project area include the San Francisco Peaks on the Coconino NF, and Red Butte and Bill Williams Mountain on the Kaibab NF. Natural springs are also considered TCPs and/or sacred sites by some tribes. Many plants are gathered for ceremonial use on or near TCPs. See appendix A of the heritage report for additional discussion on management of TCPs.

Table 80. Summary of 4FRI project tribal consultation

Date	Tribe(s)	Type of Contact	Location
September 10, 2009	Havasupai, Hopi, Hualapai, Kaibab Band of Paiute Indians, Pueblo of Zuni, Navajo Nation, and Yavapai-Prescott	The Kaibab NF supervisor sent an invitation to seven federally recognized tribes to discuss the 4FRI and other forest projects.	NA
September 28, 2009	Havasupai, Hopi, Hualapai, Kaibab Band of Paiute Indians, and Pueblo of Zuni	An initial presentation on the 4FRI was given during the Kaibab NF intertribal meeting.	Kaibab NF
May 5, 2010	Hopi, Pueblo of Zuni, Hualapai, Yavapai-Apache, Navajo Nation, and Yavapai-Prescott	The forest emailed information on the 4FRI as an early "heads up" on upcoming consultation.	NA
January 27, 2011	Hopi, Navajo Nation, Hualapai, Pueblo of Zuni, Pueblo of Acoma, Yavapai-Prescott, Yavapai-Apache, Ft. McDowell Yavapai, Tonto Apache, White Mountain Apache, San Carlos Apache, Havasupai, emailed to Hopi, Navajo Nation, Yavapai-Prescott, Ft. McDowell Yavapai, Hualapai, Havasupai, White Mt Apache, Yavapai-Apache, and Pueblo of Zuni	The forests mailed scoping letters to tribal leaders and emailed letter to representatives (also see chapter 1 of the DEIS).	NA
February 8, 2011	Havasupai, Hopi, Hualapai, Kaibab Band of Paiute Indians, Navajo Nation, Yavapai-Prescott Indian Tribe, and Pueblo of Zuni	The Kaibab NF supervisor sent a letter to seven federally recognized tribes with a copy of the SOPA and notification of the 4FRI project.	NA
May 12, 2011	Hopi, Navajo Nation, Hualapai, Pueblo of Zuni, Pueblo of Acoma, Yavapai-Prescott, Yavapai-Apache, Ft. McDowell Yavapai, Tonto Apache, White Mountain Apache, San Carlos Apache, Havasupai, emailed to Hopi, Navajo Nation, Yavapai-Prescott, Ft. McDowell Yavapai, Hualapai, Havasupai, White Mt Apache, Yavapai-Apache, and Pueblo of Zuni.	The forests sent the heritage report.	NA
August 22, 2011	Navajo Nation Kaibab Band of Paiute Indians, White Mountain Apache, Yavapai-Apache Nation, San Carlos Apache, Hualapai Tribe, Yavapai-Prescott Indian Tribe, Havasupai, Tonto Apache, Pueblo of Zuni, Pueblo of Acoma, Hopi Tribe, and Fort McDowell Yavapai Nation.	The second 4FRI scoping letter was sent to 20 tribal leaders (also see chapter 1 of the DEIS). No additional comments were received. See chapter 1 for a summary of concerns and issues raised throughout consultation.	NA
October 4, 2012	Havasupai	The Kaibab NF supervisor provided an update on the 4FRI project to the tribal council.	Supai, AZ

Contemporary Uses: The entire 4FRI project area is managed by the U.S. Forest Service and is aboriginal land to the consulting tribes. Along with aboriginal ties to the land, many tribal members also use the forest for traditional resources and ceremonies and for gathering medicinal plants for other traditional and cultural purposes. Traditional gatherings and ceremonies are conducted throughout the forests and may or may not occur at the knowledge of the land manager. Additionally these activities may occur over the span of an hour, to several hours or several days.

The forests recognize the importance of maintaining these traditions to area tribes and will accommodate traditional use of Forest Service lands by American Indians provided it complies with existing laws and regulations. In an attempt to reduce the likelihood of conflicts between traditional tribal activities and operations related to the 4FRI, consultation and coordination is a critical component between the tribes and forests regarding the timing and locations of specific planned activities and operations.

Years of government-to-government consultation have identified numerous traditional uses in or near the 4FRI project area. Examples of these uses include collection of forest products such as medicinal plants, tree boughs, ceremonial firewood, and pinyon nuts (see table 81), and ongoing use of ceremonial sites, shrines, and traditional gathering areas. Plant collecting is almost always conducted in more than one area in order to not deplete any particular plant species. In some cases, specific traditional use areas have been identified on the forests through project-level consultation. However, it is assumed most traditional use areas have not yet been identified. While some traditional uses consistently occur in one location, others may occur in a variety of locations based on the availability of resources.

Table 81. Example of forest products and their traditional use

Forest Product	Use
Juniper boughs	Shade structures
Small fir trees	Ceremony dances
Fir, pinyon, and juniper boughs	Ceremony dances
Cattails	Ceremony dances
Poles	Corrals, shades
Green oak up to 6″	Bows, Kiva ladder rungs
Ponderosa logs	Traditional ceremonial structures
Willow branches	Basketry
Yucca	Basket, soap

Threats to Contemporary Uses and TCPs

Wildfires are a threat to all forest products; however, fire suppression in the forest has also caused damage in the form of preventing the healthy production of juniper boughs, limiting the growth and production of small fir trees, and limiting the number of large ponderosa logs for ceremonial structures. Habitat for some native plants desired by tribal traditional collectors is disappearing and natural springs are drying up due to overstocked forests. Some of the affected plant collection

areas and springs that were used historically still have associated cultural values that are important to the tribes. Concerns expressed by tribes during tribal consultation include:

- TCPs are at risk of being damaged or lost from high-severity fire;
- Springs and plant collection areas are at risk of being damaged or destroyed by high-severity fire;
- Overstocked stands are reducing the sunlight available for cultural and medicinal plants;
- Springs that are important to tribal ceremonies are drying up;
- A lack of low-intensity fire is reducing regeneration of plant collection areas;
- Smoke may affect some tribal communities;
- Tribes need access for ceremonies and traditional gathering; and
- Tribes are concerned about the preservation of cultural resources.

Environmental Consequences

The following mitigation (see appendix C in the DEIS for complete list) are common to alternatives B–D. The environmental consequences are based on applying these measures.

- Consult with Native Americans when projects and activities are planned in sites or areas of known religious or cultural significance (HR/TR-2);
- Project undertakings would be inventoried for cultural resources and areas of Native American religious use (HR/TR-3);
- Prior to initiating project-specific task orders, the forests would consult with federally recognized tribes to identify traditional use areas and, if necessary, develop project-specific mitigation measures to accommodate traditional use of the forest by tribal members (HR-TR-7);
- When areas are selected for treatment, detailed maps of the area would be presented to tribes through ongoing tribal consultation to determine if other sensitive areas of tribal importance could potentially be impacted (HR-TR-8); and
- Treatment timing would be adjusted to coincide with seasonal plant gathering and ceremonial use (HR-TR-9).

Alternative A

TCPs are at risk from high-severity fire because it can destroy the setting of the TCP including seed and habitat for native plants. Soil erosion due to high-severity wildfire could have a direct and indirect effect on traditional collecting areas. Rain and snowmelt could cause channels to form, or mud slides from nearby slopes could deposit soil and debris over traditional areas leading to the loss of biological communities for both plant and animal species used by tribes. This erosion could negatively impact areas where traditional use plants grow, thereby limiting opportunities for collection and traditional use. Additional indirect effects of erosion (as a result of wildfire) are damage to cultural resources when they are unearthed and displaced.

In this alternative, overstocked stands would continue to reduce the sunlight available for native cultural and medicinal plants. A lack of low-intensity fire would further reduce the regeneration of plants collected by native people. Over time, alternative A may result in the reduction of pre-settlement native plants, some of which have been collected since historical times by American Indians for food and medicine. Additionally, as tree density (overstocking) increases, historic water sources such as springs and seeps (that are important locations to American Indians) may dry up, affecting historic uses.

With continued drying trends across the Southwest, the forests would likely issue forest closures and fire restrictions, thus affecting traditional uses and ceremonies. Access could be limited during active fire suppression activities.

Alternative B

Alternative B proposes restoration treatments that would result in reduced fuel loading and a more open forest structure and pattern. Mechanical and prescribed fire treatments would reduce the potential for uncharacteristically intense fire behavior. This would reduce the potential for severe impacts to National Register listed or National Register eligible heritage resources (which are known to be of interest to the tribes representing the "footprints of their ancestors"). Mechanical treatment and low-intensity prescribed fires would reduce current fuel loads which would help to prevent extensive heat damage to traditional collection and gathering areas from future wildfires. There would be less need for fire suppression activities, consequently less of a threat from ground-disturbing activities like bulldozer fire line construction in sensitive areas.

Mechanical thinning treatments, temporary road construction, decommissioning, and other ground-disturbing activities associated with the 4FRI have potential to affect traditional collecting and gathering, ceremonial areas, and TCPs by temporarily displacing collecting gathering and ceremonial activities. Impacts would not be as disruptive as those periods of wildfire suppression. Access concerns would be addressed through ongoing consultations between the forests and American Indian groups. In addition, mitigation was developed to minimize disruption of activities and includes adjusting treatment timing to coincide with seasonal plant gathering and ceremonial use.

Using prescribed fire also has the potential to affect fire sensitive areas. However, as early as the first growing season after the initial reduction of heavy fuels, an increase in understory plant growth would be expected. Mechanical treatments may provide better habitat for these plants to thrive. Fire and ground disturbance can also enhance certain plant species such as wild tobacco. Overall, treatments could provide a prolific diversification of certain plant species. Local tribal people could potentially have greater access to collecting areas as existing roads are improved. The demand for groundwater that is currently occurring from dense tree growth would be reduced. Treatments may promote an increase in water flowing from springs and possibly restore springs that have dried up. Activities proposed in alternative B would result in greater opportunity for contemporary tribal uses such as native plant collection and enhancement of TCPs such as springs.

All action alternatives (B–D) create the potential for increased smoke. Most of the smoke from fire use on the Coconino and Kaibab NFs would carry from the southwest to the northeast and to the Havasupai Reservation and western portions of the Navajo Nation Reservation. Many people living in these areas are seniors with health conditions and sensitivity to smoke. The effects of

limited communications may hinder receiving adequate information about smoke. Some may not have access to an Internet Web site to receive information on planned prescribed fires. In addition, there may be language barriers and cultural differences. Tribal consultation would continue throughout project implementation and will strive to inform tribes on the timing, type, and amount of smoke tribes may experience during implementation. See the complete environmental justice analysis in the economics report.

Alternative C

Many of the ground-disturbing activities associated with this alternative are similar to those identified in alternative B, and have the same potential to affect traditional collecting and gathering, ceremonial areas, and TCPs. Key components of this alternative include additional acres of mechanical and prescribed fire on specific grasslands, wildlife and watershed research, and inclusion of the large tree implementation plan.

One concern for traditional collecting and gathering, ceremonial areas, and TCPs under this alternative is the increase in mechanical treatment acres. If additional high impact or intense mechanical treatments occur under this alternative, additional tribal consultation would be necessary. Protection of cultural resources are discussed in the "Heritage" section (see the "Heritage" section and appendix C of the DEIS for additional information).

Alternative D

Alternative D would reduce the use of prescribed fire across the project area in comparison to the proposed action (alternative B). This would reduce the potential for smoke to impact tribal communities. Potential impacts to traditional collecting and gathering, and ceremonial areas and TCPs are the same as described in alternative B.

Forest Plan Amendments – All Alternatives

Amendment Theme—Management in MSO Habitat: The amendments that address management in MSO owl habitat (see appendix B) would be primarily related to the definition of target and threshold habitat, the size and amount of trees to be cut, prescribed fire and MSO monitoring. There would be no discernible effects to heritage resources or tribal relations from defining target and threshold habitat or MSO owl monitoring. Applying prescribed fire and the size and amount of trees to be cut within MSO habitats would have the same direct, indirect, and cumulative effects as described for each action alternative.

Amendment Theme—Management of Canopy Cover and Ponderosa Pine with an Open Reference Condition Within Goshawk Habitat: These amendments (see appendix B) would provide desired percentage of interspaces, distance between tree groups, clarification of where cover is measured, add definitions, and acreage to be managed in an open condition. There would be no discernible effects to heritage resources or tribal relations from these amendments. The direct, indirect, and cumulative effects would be the same as described for each action alternative.

Amendment Theme—Effect Determination for Cultural Resources on the Coconino NF: This amendment (see appendix B) would delete the standard that would require achieving a "no effect" determination and adds the words "or no adverse effect" to the remaining standard. Currently management actions on the Coconino NF strive to achieve a "no effect" for cultural resources; however, during implementation of this project it would be extremely unlikely to ever

achieve a "no effect" on cultural resources. Though surveys and monitoring of heritage resources would occur and BMPs would be implemented, there would be a chance that heritage resources would be impacted (see "Heritage Resources" section). There would be no additional discernible effects to heritage resources or tribal relations from this amendment. The direct, indirect, and cumulative effects would be the same as described for each action alternative.

Amendment Theme—Management of the Proposed Garland Prairie RNA on the Kaibab NF: This amendment (see appendix B) would add language to allow prescribed fire and mechanical treatments in order to maintain and/or restore the ecological qualities of the proposed RNA. There would be no additional discernible effects to heritage resources and tribal relations from this amendment. The direct, indirect, and cumulative effects would be the same as described in the action alternatives.

Cumulative Effects – All Alternatives

In **alternative A** there would be no changes in current management and the forest plans would continue to be implemented. Approximately 82,592 acres of vegetation treatments and 96,125 acres of prescribed fire projects would continue to be implemented adjacent to the treatment area. Within the next 5 years, approximately 86,771 acres of vegetation treatments and 142,869 acres of prescribed fire and maintenance burning would be implemented adjacent to the treatment area by the Forest Service. The Kaibab and Coconino NFs have tribal relations specialists who would continue to consult with tribes on the preservation of cultural resources, implementation of project activities, and appropriate post-treatment monitoring for these projects.

Over the majority of acres described above, current fuel loads would be expected to decrease over time as projects are implemented. This would result in decreased wildfire severity and erosion potential. However, traditional use plants, TCPs, and traditional use areas do not occur evenly across the area nor do the projects propose to treat those areas equally. Therefore, the cumulative impacts under this alternative are limited or unknown. Other prominent landmarks identified as TCPs (including springs) in the project area would be left untreated and could be severely impacted if a wildfire burned through these areas. If not treated, springs would likely continue to dry up or have the potential to be polluted by excessive runoff by flash flooding as a result of rain on burned slopes.

Alternative B has the potential to increase the amount of ground-disturbing activities, including mechanical treatments, temporary road construction, skidding, stream restoration, fence construction, and other ground-disturbing activities. When considered together with past, present, and foreseeable future actions, these activities would have the potential to affect cultural resources such as traditional collecting, gathering, ceremonial use areas, and TCPs. All undertakings that would have the potential to affect cultural resources would go through tribal consultation. In addition, protection measures such as the possibility of tribal monitors during mechanical activities, keeping ground-disturbing activities out of sensitive areas by flagging, avoiding the sensitive areas, and post-prescribed fire monitoring to assess the effects of the low-intensity fires would help to minimize the effects. The potential cumulative effects to cultural resources and TCPs such as springs from increased ground-disturbing activities and the use of prescribed fire resulting from this alternative are, therefore, not considered to be adverse. The cumulative effect of increased visibility is not considered to be adverse.

The cumulative effects on TCPs, gathering, and ceremonial areas resulting from any potential increase in erosion would also be minimal. Reducing fuel loads and implementing low to moderate intensity prescribed fires would not cause soil sterilization or hydrophobic soils as high-intensity wildfires do. Low intensity prescribed fires would leave some vegetation in place and revegetation would occur soon afterwards if soils were not sterilized. However, as implementation occurs, monitors would check for erosion concerns by examining culturally sensitive locations like TCPs and ceremonial sites in the project areas, including focusing on slopes, drainages, and other high probability areas with cultural resources present. The cumulative effects to cultural resources caused by an increase in erosion are not considered to be adverse.

In **alternative C,** the addition of the LRTP would have little additional effect on cultural resources, TCPs, ceremonial areas, and gathering and collecting areas. However, an increase in prescribed fire acres, as well as similar actions identified under alternative B—such as mechanical treatments, prescribed fire, stream restoration, and fence construction—would have the potential to affect these resources. These issues are identified under the cumulative effects section under alternative B and not repeated here. As noted previously, all undertakings that have the potential to affect cultural resources would go through tribal consultation. An increase in these types of activities would not result in an adverse effect to cultural resources as long as tribal consultation is conducted prior to project implementation, protection measures are imposed, and post-project implementation monitoring is conducted when appropriate.

As with alternatives B and C, similar increases in activities under **alternative D** such as mechanical treatments and ground disturbances can add to the effects on cultural resources. Additionally, specific to this alternative, is a reduction in the prescribed fire acres which may involve other means of slash and debris removal. Actions such as chipping, shredding, and mastication as well as removal of material offsite may include an increase in ground-disturbing actions. As noted above, all undertakings that have the potential to affect cultural resources would not have an adverse effect if the measures identified above are implemented. Protection of cultural resources measures are discussed in the "Heritage" section (see "Heritage" section in chapter 3 and appendix C of the DEIS). Overall, the cumulative effects on cultural resources as a result of alternative D are not considered to be adverse.

Socioeconomics

A summary of the socioeconomic report is presented here. The specialist report (Jaworski 2013) is incorporated by reference. The analysis describes the current conditions and trends related to the social and economic environment of the planning area, including: population and demographic changes, potential environmental justice populations, and employment and income conditions. Economic impacts were modeled using IMPLAN Professional Version 3.0 with 2010 data. Economic efficiency analysis was conducted with QuickSilver Version 6. Social impacts use the baseline social conditions presented in the "Affected Environment" section, National Visitor Use Monitoring (NVUM) profiles (USDA 2011a and USDA 2011b), and information from the Coconino and Kaibab economic and social sustainability assessments (USDA 2010, 2008) to discern the primary values that the forests provide to area residents and visitors.

Affected Environment

Communities in the vicinity of proposed treatments include Flagstaff, Munds Park, Mormon Lake, Tusayan, and Williams, Arizona. Much of the related processing of the 4FRI forest products is expected to occur in Winslow, Arizona.

These communities are heavily influenced by their proximity to protected public lands, particularly Grand Canyon National Park. Tourism is a major economic driver, particularly in Tusayan and Williams. The economies are increasingly dependent on management, education, and tourism sectors, while consumptive natural resource industries have declined. Over the past 20 years, the population in the study area has grown substantially, indicating that the area offers both economic opportunity and natural amenities.

Population

The study area is home to 4,270,020 people (U.S. Census Bureau 2010). Table 82 displays population data for the counties, State, and nation in 1990, 2000, and 2010. Maricopa County is by far the largest county in the study area. Maricopa County alone accounts for approximately 60 percent of Arizona's population. All counties within the study area are fast growing (over 10 percent population growth in a 10-year period). Population growth in Yavapai and Maricopa Counties was similar from 1990 to 2010, growing approximately twice as fast as Navajo and Coconino Counties. While Maricopa County's growth is driven by economic diversity and activity, Yavapai, Coconino and Navajo Counties' growth is more amenity-based because of the easy access to open space and Federal lands. Slower growth in Navajo and Coconino Counties reflect their lower population density and corresponding lower levels of public services like health care and transportation. In Yavapai County, both the population density and median age are much higher than Navajo and Coconino Counties, reflecting the influence of retirees on the county's population growth.

Table 82. Population change 1990 to 2010

Geographic Area	1990 Population	2000 Population	Percent Growth 1990–2000	2010 Population	Percent Growth 2000–2010
Coconino County	96,591	116,320	20.4%	134,421	15.6%
Maricopa County	2,122,101	3,072,149	44.8%	3,817,117	24.2%
Navajo County	77,658	97,470	25.5%	107,449	10.2%
Yavapai County	107,714	167,517	55.5%	211,033	26.0%
Arizona	3,665,228	5,130,632	40.0%	6,392,017	24.6%
United States	248,709,873	281,421,906	13.2%	308,745,538	9.7%

Source: U.S. Census Bureau 2010

Economic Diversity, Employment, and Income

Per capita income in the study area is similar to per capita income in the State and nation. Navajo and Coconino Counties have lower per capita income than the other study area counties, the State, and the nation (table 83). This is consistent with the finding in the "Environmental Justice" section that Navajo and Coconino Counties have higher poverty rates relative to the study area, the State, and the nation. A greater proportion of personal income in Navajo County is made up of

nonlabor income (such as transfer payments), which indicates that low-income assistance programs may be a greater portion of household income. Yavapai County has a slightly higher rate of nonlabor income but given the demographics of this county and its higher per capita income, these payments are more likely to consist of earned interest and social security payments to retirees. Another indicator that poverty is the greatest concern in Navajo County is that its unemployment rate has consistently been 30 to 50 percent higher than the other counties in the study area.

Table 83. Per capita income, labor, and nonlabor income, and unemployment

Geographic Area	Per Capita Income (2010 Dollars)	Labor (2009)	Nonlabor (2009)	Unemployment (2010)
Coconino County	19,703	62%	38%	8.9%
Maricopa County	25,350	66%	34%	9.1%
Navajo County	16,745	47%	53%	15.7%
Yavapai County	22,619	43%	57%	10.5%
Arizona	23,618	62%	38%	10.0%
United States	26,059	64%	36%	9.6%

Source: U.S. Census Bureau 2010, table DP03

Maricopa County has the most diverse economy in the study area, with only retail trade and government sectors accounting for more than 10 percent of employment. The other counties in the study area have lower economic diversity with some distinctive differences in sectors of employment. Yavapai County, as would be expected of a retirement community, has the largest percentage of its employment in health and social services compared to the rest of the study area. This diversity reflects the demographics driving the local economy. By contrast, Coconino County, which has a larger tourism base to its economy, has the highest percentage of accommodations and food services and arts, entertainment, and recreation within the study area. Navajo County has a smaller percentage of employment in service industries that would support tourism or retirement age in-migration, but has the highest employment rates in government and consumptive natural resource sectors (agriculture, forestry, fishing and hunting, and mining). Wage differences and higher unemployment may also be tied to these factors. Within Navajo County, poverty, unemployment, and income appear to be unevenly distributed geographically. Most employment centers are south of I-40 in Winslow and other more centralized communities. North of I-40, the county is dominated by three Indian reservations (see figure 46 for race and ethnicity information) where there are fewer employment opportunities, lower population density, and less opportunity for amenity-based population and economic growth as seen in parts of Coconino and Yavapai Counties.

Wildfire and Forestry Related Economic Environment

Table 84 shows the economic contribution of forestry related sectors to the local economy. In terms of employment, forestry related sectors account for approximately one-third of 1 percent of study area employment. This is less than the Statewide contribution, where forestry related jobs account for approximately 0.63 percent of total employment. The same trend is observed in employee compensation and output—the forestry sector in the study area is relatively smaller than in other parts of the State. However, the economic contribution of forestry related sectors in

Navajo County is proportionally greater than the economic contribution of forestry related sectors in the other study area counties and the State. In addition, a new wood products plant is planned for the Winslow area which would further increase forestry related employment in Navajo County. These findings indicate that the study area is currently less specialized in forestry than the rest of the State, except for Navajo County.

Table 84. Economic contribution of forestry related sectors in the study area

Geographic Area	Employment		Employee Compensation (in USD Millions)		Output (in USD Millions)	
	Value	Percent of Total	Value			Percent of Total
Coconino County	182	0.25	4	0.13	15	0.19
Maricopa County	6,784	0.31	192	0.20	801	0.26
Navajo County	683	2.04	33	2.49	245	6.56
Yavapai County	154	0.22	5	0.22	12	0.16
Study Area Total	7,803	0.33	221	0.22	955	0.29
Arizona	20,169	0.63	575	0.42	1,713	1.26

Source: MIG 2009

Annually, millions of dollars are spent suppressing wildfires in the United States. In 2007, there were 27 large fires in the U.S. that cost $547 million to suppress (WFLC 2010). Between 2000 and 2008, the percentage of the Forest Service budget spent on extinguishing wildfires expanded from 25 to 44 percent (WFLC 2010). Furthermore, suppression costs account for only a fraction of the total cost of wildfires. The Western Forestry Leadership Coalition (WFLC) estimates that total wildfire related expenses range from 2 to 30 times the reported suppression costs (2010).

A principal reason for the increasing cost is the growing number of homes located in the wildland-urban interface. Suppression activities are frequently undertaken when wildfire threatens private property. A century of fire suppression has led to increased fuels and, therefore, frequency of high-intensity wildfire. The spread of the WUI has increased the probability that wildfires will occur near private residences. These two factors—the growth of the WUI and the use of suppression tactics—increase the cost of wildfire and the importance of forestry treatments to reduce fuels that have increased high-intensity fires. Table 85 presents the extent of the WUI in the study area counties and the western United States.

One-quarter of Coconino County homes, nearly 20 percent of Navajo County homes, and approximately 10 percent of Yavapai County homes are located within the WUI. Both Coconino and Yavapai Counties are also in the top quintile for existing fire risk. These factors make it more likely the Coconino and Yavapai Counties will experience large, expensive wildfires.

Table 85. Wildland-urban interface, planning area, and westwide (2000)

Geographic Area	WUI Area with Homes	WUI Homes as Percent of Total Homes	Westwide Rank by Existing Wildfire Risk
Coconino County	21.5%	25.6	55 of 413
Navajo County	26.5%	18.7	93 of 413
Maricopa County	16.9%	0.3	161 of 413
Yavapai County	23.5%	9.7	71 of 413
Western U.S.	13.9%	3.9	NA

Source: Guide et al. 2008

Nonmarket Values

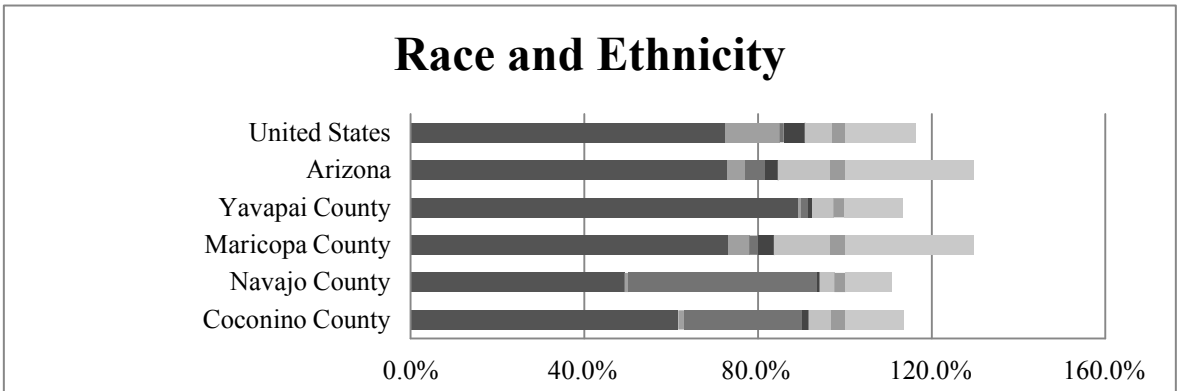
The economic value of Forest Service management is not entirely captured in market transactions. Much of the value of national forests is "nonmarket" in nature—meaning that many of the benefits that forests provide to humans do not have a price. The lack of a price, however, should not be equated with an absence of value. Indeed, nonmarket values from forests provide economic benefits to adjacent communities and forest visitors. Healthy forests provide numerous ecosystem services, including clean water and air, biodiversity, forest products, and many other goods and services.

Where appropriate, discussion of how the alternatives may affect nonmarket values is presented. However, due to the qualitative nature of these discussions, direct comparisons between changes in market and nonmarket values are generally not possible.

Environmental Justice

In 1994, President Clinton issued Executive Order (EO) 12898. This order directs Federal agencies to focus attention on the human health and environmental conditions in minority and low-income communities. The purpose of EO 12898 is to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects on minority and low-income populations.

The emphasis of environmental justice is on health effects and/or the benefits of a healthy environment. The CEQ has interpreted health effects with a broad definition: "Such effects may include ecological, cultural, human health, economic or social impacts on minority communities, low-income communities, or Indian Tribes …when those impacts are interrelated to impacts on the natural or physical environment" (CEQ 1997). According to the U.S. Census Bureau (2010) data reported in figure 46, study area counties differ substantially in their racial and ethnic composition.



	Coconino County	Navajo County	Maricopa County	Yavapai County	Arizona	United States
White	61.7%	49.3%	73.0%	89.3%	73.0%	72.4%
Black or African American	1.2%	0.9%	5.0%	0.6%	4.1%	12.6%
American Indian and Alaska Native	27.3%	43.4%	2.1%	1.7%	4.6%	0.9%
Asian	1.4%	0.5%	3.5%	0.8%	2.8%	4.8%
Native Hawaiian and Other Pacific Islander	0.1%	0.1%	0.2%	0.1%	0.2%	0.2%
Some Other Race	5.2%	3.4%	12.8%	4.9%	11.9%	6.2%
Two or More Races	3.1%	2.5%	3.5%	2.5%	3.4%	2.9%
Hispanic or Latino (of any race)	13.5%	10.8%	29.6%	13.6%	29.6%	16.3%

Figure 46. Race and ethnicity

Source: U.S. Census Bureau 2010, table DP-1

Coconino and Navajo Counties have high concentrations of American Indian residents, due to the presence of five reservations in Coconino County and three reservations in Navajo County. Maricopa and Yavapai Counties also contain Indian reservations; however, their concentrations of American Indian residents are small relative to Coconino County, Navajo County, and Arizona.[11] Maricopa County has the highest proportion of Hispanic/Latino residents in the study area, although it is equivalent to Arizona's proportion (29.6 percent). In contrast, Yavapai County is less diverse than both the State and nation. Approximately 90 percent of Yavapai County residents self-identify as white. As a result, environmental justice issues are more likely to occur in Coconino and Maricopa Counties than Yavapai County. However, a finding of low racial/ethnic diversity does not eliminate the need to consider potential disproportionate impacts of Forest Service management actions. A county may have a low overall concentration of minority

[11] Coconino County contains all or part of the Navajo Indian Reservation, Hualapai Indian Reservation, Hopi Indian Reservation, Havasupai Indian Reservation, and Kaibab Indian Reservation. Navajo County contains part of the Navajo Indian Reservation, Hopi Indian Reservation, and Fort Apache Indian Reservation. Maricopa County contains all or part of the Fort McDowell Yavapai Nation, the Gila River Indian Community, and the Salt River-Pima Indian Community. Yavapai County contains all or part of the Yavapai-Prescott Indian Reservation, the Yavapai-Apache Nation Indian Reservation, the Hualapai Indian Reservation, and the Camp Verde Indian Reservation.

residents, but still have areas with a high concentration of minority residents who could be adversely affected by management actions.

The incidence of poverty in Coconino and Navajo Counties is not evenly distributed among racial and ethnic groups. Approximately 50 percent of American Indian residents in Coconino County and 70 percent of American Indian residents in Navajo County live in poverty (U.S. Census Bureau 2000). The high proportion of American Indian residents in these counties, therefore, increases the poverty rate relative to other study area counties and the State.

Based on the minority status and poverty data (see specialist report), Coconino County appears most at risk for environmental justice issues. The largest minority group in the county, American Indians, also experience a very high poverty rate. Furthermore, Coconino County contains the most acreage that could be affected by the first stage of the 4FRI, which suggests that the consequences of management actions would be felt most acutely by Coconino County residents. In contrast, although Navajo County also has a high proportion of American Indian residents and a high poverty rate, the first stage of the 4FRI treatments would not occur in the county. Navajo County would be chiefly affected by employment associated with the proposed plant in Winslow.

In response to a comment from the June 2012 NEPA update public meeting, the possibility of smoke related environmental justice consequences in Snowflake, Arizona, were evaluated. The community does not have a meaningfully greater percentage of minority residents than the State, and Snowflake has a smaller proportion of individuals living in poverty than either the State or nation (U.S. Census Bureau 2010). In addition, the community is geographically distant from the project area and, therefore, unlikely to experience acute smoke effects. As a result, Snowflake is not considered an environmental justice community in this analysis.

The air quality analysis finds that Flagstaff, Williams, Verde Valley, and Grand Canyon National Park are smoke sensitive areas within proximity to the proposed treatments. The communities of Camp Verde, Cornville, Cottonwood, and Flagstaff are expected to be affected by the proposed prescribed fire treatments. Camp Verde, Cornville, Cottonwood, and Flagstaff all have lower concentrations of minority residents and lower poverty rates than the study area as a whole (U.S. Census Bureau 2000). Therefore, the potentially disproportionate effect of smoke emissions on these communities is not an environmental justice issue. However, the implications of smoke emissions on the 4FRI area communities, particularly vulnerable communities, are addressed in both the air quality and social analyses.

Numerous tribal communities are in airsheds that may be affected by the 4FRI prescribed fires. The potential for disproportionate smoke emissions effects to tribal communities is addressed in the environmental consequences analysis. Effects to tribal uses are addressed in the tribal relations report.

Environmental Consequences

Alternative A – Direct and Indirect Effects

No changes to visitor spending or recreational activities are anticipated under alternative A. Visitors to the Kaibab and Coconino NFs would continue to contribute approximately 3,000 jobs and $110 million in labor income to the study area economy on an average annual basis.

Forest restoration activities would continue to occur on both forests with possible minor interruption of recreational opportunities. Over the long term, fewer treated forest acres would increase the probability of uncharacteristic wildfire under alternative A. Large wildfires destroy trails, campsites, and other forest infrastructure. Major and destructive fires decrease tourism to the local area, which would reduce recreation related employment and income in the regional economy.

The forests would continue to provide forage for 110,173 cattle animal unit months (AUMs) and 13,616 sheep AUMs. These activities support approximately 130 jobs and $2.15 million in labor income to the study area economy on an average annual basis. The increased probability of uncharacteristic wildfire on untreated land could lead to the destruction of pasture, reduce forage availability, and lead to soil erosion. These conditions could reduce available AUMs. Therefore, over the long term, untreated land could lead to a reduction in grazing related employment and income.

Under alternative A, both forests would continue to provide forest products and support restoration activities. However, the scale of these activities would be substantially smaller than activities under this project. The provision of forest products unrelated to the 4FRI treatments would be the same under all alternatives and, therefore, are not described in detail in this report. Much of the harvesting and processing of forest products would occur in Winslow (Navajo County). Employees are expected to come from both Navajo County and surrounding counties. The proximity of Winslow to Coconino County suggests that cross-county commuting is particularly likely between Navajo and Coconino Counties.

Historically, the Coconino and Kaibab NFs have annually spent an average of $7,154,801 and $4,456,770 on wildfire, respectively. Under alternative A, wildfire suppression costs would, on average, increase due to fuel buildup and the expanding wildland-urban interface. The per acre administrative burden (cost of time and other resources) of planning, implementation, and monitoring forest restoration activities would be highest under alternative A. The 4FRI benefits from economies of scale —a single environmental compliance document addresses nearly 600,000 acres of restoration activities. Furthermore, the large treatment area reduces cost to government through increased private sector interest in engaging in harvesting and restoration activities on the forests. In contrast, restoration activities under alternative A would occur piecemeal, requiring numerous environmental compliance documents and increased administrative costs.

The cost to the government to treat an area equivalent to the 4FRI project area would be approximately $12 million annually. Discounted at 4 percent over a 10-year period, this is equivalent to a cost of more than $100 million. In contrast, the certainty of a sustained supply under the 4FRI would encourage private sector restoration, significantly reducing costs to government.

Alternative A would not produce measurable social consequences relative to the existing condition. Quality of life and social values would not be affected. As with current conditions, wildfire could displace recreational activities, compromise forest scenery, and degrade air quality. Uncharacteristic wildfire conditions would reduce the quality of life of area residents and forest visitors.

The communities that surround the 4FRI project area, particularly in Coconino and Navajo Counties, have large minority populations, a relatively high population, and individuals vulnerable to smoke. None of the alternatives eliminates smoke, either from wildfire or prescribed fire. Alternative A would treat the fewest acres with prescribed fire. However, it would also do the least to restore fire-adapted forests. As a result, smoke from uncharacteristic wildfire is most likely under this alternative.

Cumulative Effects

Forest restoration activities are emphasized in the existing and proposed forest plans in the region. Restoration activities would continue to occur in the region regardless of the 4FRI decision. Between 2001 and 2010, approximately 132,495 acres have been treated on the Coconino and Kaibab NFs. Ongoing and reasonably foreseeable projects will treat an additional 110,940 acres. These actions will occur regardless of the 4FRI selected alternative. Since 2000, approximately 80,000 acres (78,734) have been treated on private, State, and other federally managed lands in the project area. The effect of past, present, and reasonably foreseeable treatment activities in the project area would improve forest health relative to existing conditions even without implementation of the 4FRI.

Environmental Consequences Common to Alternatives B, C, and D

Table 86 displays the change in employment and income between current conditions and the action alternatives. The changes in employment and income under alternatives B, C, and D reflect a temporary reduction in recreation related employment and income due to recreation displacement and an increase in employment and income due to the 4FRI harvesting and processing activities.

Table 86. Change in employment and labor income from alternative A

Measure	Alt. B	Alt. C	Alt. D
Change in Employment	1,615	1,615	1,615
Change in Labor Income	$75.6 million	$75.6 million	$75.6 million

Table 87 summarizes the net present value of the 4FRI treatments. Over the 10-year treatment period, assuming a 4 percent discount rate, the 4FRI would be expected to produce a $100 million benefit. This would be the discounted cost savings to the government of the 4FRI relative to the average cost per acre that the government pays for restoration treatment. This figure can be viewed as a proxy for the economic value of the 4FRI treatments.

Table 87. Net present value of stewardship contracts

Measure	Alt. B	Alt. C	Alt. D
Net Present Value of Stewardship Contracts	$100 million	$100 million	$100 million

Alternatives B, C, and D would provide approximately 360,000 CCF of timber and 8,000 dry tons of biomass on an average annual basis throughout the 10-year treatment period. Harvesting and

utilization activities related to the 4FRI would support approximately 1,674 jobs and $77.6 million in labor income in the study area economy on an average annual basis throughout the 10-year project period. The proposed plant in Winslow, Arizona (Navajo County), would account for much of the expected employment. Forest Service project administration would require 35 employees who are currently on staff.

Approximately 2 percent of the Coconino and Kaibab NFs would be unsuitable for recreational uses at any given time due to the 4FRI restoration activities. As section 4.6 of the NVUM surveys for the forests demonstrate, when individuals are unable to visit their preferred site, most would engage in substitute behavior that would continue to have an effect in the local economy (USDA 2011a, USDA 2011b). As a result, the 4FRI treatments would not be expected to measurably reduce the economic impact of recreation in the study area. However, if recreational activities were reduced one-to-one with the reduction in suitable recreation areas (i.e., by 2 percent), approximately 2,940 jobs and $108 million in labor income would be supported on an average annual basis for the duration of the project. This would be a decrease of approximately 60 jobs and $2 million in labor income relative to alternative A. This possible decrease in employment and income is reflected in table 86.

The 4FRI treatments would entail one major pasture burn per year per allotment. Over the 10-year treatment period, a 10 percent reduction in AUMs is expected. At the end of the 10 years, a return to pre-treatment AUM levels would occur. Therefore, during the 10-year treatment period, cattle AUMs would decrease to approximately 100,000 and sheep AUMs would decrease to approximately 12,250. At current levels, grazing supports approximately 130 jobs and $2.15 million in labor income in the local economy, annually. The brief duration and advance notice of disturbances due to the 4FRI treatments would make it easier for ranchers to adapt to changes. As a result, no reductions in grazing related employment would be expected. However, minor reductions in rancher income would be possible if ranchers purchased more expensive private forage or reduced their stocking levels. However, post-treatment soil and forage quality would be expected to increase. Therefore, over the long term, ranchers would benefit from the 4FRI activities.

Some individuals may not be able to recreate at their preferred sites during the treatment period. If these individuals engage in substitute behavior (e.g., recreating at a different site in the local area), there would be no impact to visitor spending. However, there would be social and nonmarket consequences to recreation displacement. Individuals may get less fulfillment or enjoyment from recreating at an alternate site, which would adversely affect quality of life. Due to the short duration and relatively few sites that would be expected to be affected, the quality of life implications of recreation displacement would be small.

Truck traffic volume would increase on Forest Service and nearby roads. Approximately 120,000 truck trips per year would be expected to result from 4FRI activities. The increased truck volume would increase commute times and the incidence of noise and dust in the vicinity. Individuals who use and live near those roads would have their quality of life adversely affected. A site specific design feature for dust abatement would minimize this effect (see appendix C for specific road segments where this would occur).

None of the alternatives would reduce employment and income relative to current conditions, therefore, no environmental justice issues related to disproportionate adverse economic effects would occur. The mill in Cameron, which is on the Navajo Nation, may benefit from increased

supply from the 4FRI. However, any effect to the mill would likely be small. Changes in employment and income associated with the mill would more likely be affected by activities unrelated to the 4FRI, such as potential growth in Tuba City.

Smoke emissions resulting from wildfires and prescribed fires have health and quality of life consequences. Smoke would be most likely to affect vulnerable populations, children, the elderly, and individuals in poor health. Tribal areas in the Colorado River, Little Colorado River, and Verde River airsheds would be likely to experience air quality effects. Elders would be more likely to experience acute health effects. Limited communications technology, language barriers, and cultural differences may limit the effectiveness of informing residents of upcoming prescribed fires.

On both forests, the proposed forest plan amendments address management in MSO habitat, management of canopy cover, management of select areas for open reference conditions, and propose using vegetation and prescribed fire treatments in the proposed Garland Prairie Research Natural Area on the Kaibab NF (alternative C only). Economic activity would not be affected by the proposed amendments, therefore, their implementation (or not) would not lead to differences in local employment or economic efficiency. Social conditions would not be affected by the proposed amendments. Since no social or economic effects would result from implementation of the proposed amendments, low income and minority populations would not be disproportionately affected.

Alternative B – Direct and Indirect Effects

Under alternative B, wildfire suppression costs would, on average, decrease due to the restoration of fire-adapted forests. The decrease in wildfire suppression costs would allow more Forest Service expenditures to be directed toward forest health (e.g., fire management for resource benefit) and visitor services activities. The per acre administrative burden (cost of time and other resources) of planning, implementation, and monitoring forest restoration activities would be lower than alternative A. The 4FRI benefits from economies of scale—a single environmental compliance document addresses nearly 600,000 acres of restoration activities. Furthermore, the large treatment area would reduce cost to the government through increased private sector interest in engaging in harvesting and restoration activities on the forests. As shown in table 87, the 4FRI stewardship contracts have potential to provide a $100 million net benefit over the 10-year project period.

The environmental justice implications are described in the “Environmental Consequences Common to Alternatives B, C, and D” section.

Cumulative Effects

Forest restoration activities are emphasized in the existing and proposed forest plans in the region. Restoration activities would continue to occur in the region regardless of the 4FRI decision. Between 2001 and 2010, approximately 132,495 acres have been treated on the Coconino and Kaibab NFs. Ongoing and reasonably foreseeable projects will treat an additional 110,940 acres. Since 2000, approximately 80,000 acres (78,734) have been treated on private, State, and other federally managed lands in the project area. Reasonably foreseeable activities will treat 142,869 acres in the project area. These actions will occur regardless of the 4FRI selected alternative.

The effect of past, present, and reasonably foreseeable treatment activities in the project area would improve forest health relative to existing conditions even without implementation of the 4FRI. Under alternative B, due to the expected increase in the size of the timber harvesting and processing industry in the region, the local economic impact of current and future restoration activities would increase. The estimated employment and income consequences of non-4FRI treatment activities, therefore, are likely underestimated in the related environmental compliance documents.

Other ongoing and reasonably foreseeable vegetation treatments in the project area would reduce the opportunities for substitute behavior when the preferred recreation site is unavailable. As a result, individuals may choose to stay home, which would decrease visitor spending and consumer surplus to a greater extent than estimated in the direct and indirect effects analysis.

Planned expansions and improvements to recreation opportunities within the project area, however, may counterbalance the visitor use consequences of treatment. Increased recreation opportunities will increase both the number and appeal of substitute recreation activities in the study area.

The extent to which these two forces (vegetation treatment and recreation opportunity improvement) would balance each other is unknown. Therefore, the cumulative effects to the social and economic impacts from recreation cannot be precisely described. Based on available information, the net effect to visitor spending and consumer surplus from ongoing and reasonably foreseeable actions is not expected to change.

Alternative C – Direct and Indirect Effects

The direct and indirect effects are the same as described in alternative B.

Cumulative Effects

Cumulative effects are the same as described in alternative B.

Alternative D – Direct and Indirect Effects

The economic consequences are the same as described in alternative B.

Alternative D would treat the fewest acres with prescribed fire, which would reduce smoke emissions related to prescribed fire. However, alternative D would also be less effective than alternatives B and C in terms of reducing the risk and hazard of uncharacteristic wildfire. Therefore, severe wildfire smoke would be more likely under alternative D (and alternative A). Tribal areas in the Colorado River, Little Colorado River, and Verde River airsheds would be likely to experience air quality effects. Elders would be more likely to experience acute effects. Technological and cultural constraints to effective communication would make smoke effects more pronounced, as averting behavior is limited. However, burn plans written for implementation of the proposed prescribed fires would include modeling to determine the most appropriate conditions under which to burn in order to minimize smoke impacts. Since wildfire is unplanned, the potential for severe effects to human health and quality of life are higher during wildfire events. Under those circumstances, there would be with little warning, little control over the smoke, and a great deal more smoke than if prescribed fire was used.

Cumulative Effects

The cumulative effects are the same as described for alternative B.

Recreation

A summary of the recreation report is presented here and the specialist report (Minor 2013) is incorporated by reference. The potential impact of the project to recreational opportunities was not raised as a concern by the public. Please refer to the specialist report for methodology, data, and supporting information.

This analysis evaluates the following questions in order to respond to/meet forest plan direction:

- Would project activities affect provision of a variety of recreation opportunities? (Measure: acres of opportunities provided.)
- Would smoke from pile burning and prescribed fire affect provision of recreation opportunities? (Measure: describe and compare potential effects.)
- Would the proposed restoration activities diverge from reference conditions identified for the forest and in the mapped recreation opportunity spectrum (ROS) settings? (Measure: acres meeting ROS settings.)
- Would proposed road construction or other management activities result in inconsistencies in the designated ROS classes in the project area? (Measure: miles of roads or acres of treatment in ROS classes impacted by roads in the project area.)
- Would proposed temporary road construction or other management activities result in inconsistencies in the designated ROS classes in the project area? (Measure: miles of roads or acres of treatment in ROS classes impacted by roads in the project area.)

Affected Environment

The Coconino and Kaibab NFs provide diverse outdoor recreation opportunities, connecting people with nature in a variety of settings. See the specialist report for maps that display general locations of recreation settings within the project area. The 4FRI project area is included in the Northern Arizona Council of Governments (NACOG) region that includes Coconino, Navajo, Apache, and Yavapai Counties. In comparison with Arizona State figures, more residents in the NACOG region participate in outdoor recreation activities more times throughout the year than in other regions of Arizona. The entire list of activities people participate in is available on the FS Natural Resource Manager Web site (http://apps.fs.usda.gov/nrm/nvum/results/).

According to national visitor use monitoring (NVUM), most visitors to the Coconino NF use day-use developed sites (such as picnic areas, observation points, and trailheads) and undeveloped areas (the general forest area with no developed facilities). On the Kaibab NF, the majority of visitors use overnight developed sites (campgrounds) and day-use developed sites. In all of these sites, visitors may engage in a number of different recreation activities (they are not limited to camping when staying at a campground). See the socioeconomic report for additional information on population growth, demographics, and tourism related economics that affects recreation use.

There are approximately 220 miles of dispersed camping corridors along the designated road system on the Coconino NF portion of the project where restoration activities would take place.

This represents about 37 percent of designated camping corridors on the Coconino NF. About 4.2 percent of visitors to the Coconino report that they dispersed camp in undeveloped areas (USDA 2012). The Kaibab NF provides short road segments for recreation access including dispersed camping. Less than half of the short road segments would be affected by restoration activities. Approximately 9.2 percent of recreationists indicated that they dispersed camp in undeveloped areas (USDA 2012c).

The recreation opportunity spectrum (ROS) is a classification system that describes different outdoor recreation settings across the forests using seven standard classes that range from primitive, undeveloped settings to urban, highly developed settings. Attributes typically considered in describing the settings are size, scenic quality, type and degree of access, remoteness, level of development, social encounters, and the amount of onsite management. Over 60 percent of the project is in the roaded natural ROS class, approximately 20 percent is in semiprimitive motorized, and there is less than 10 percent in each of the remaining classes. The 4FRI project does not include restoration activities in developed recreation sites, special areas, or designated wilderness. ROS classes and miles of road by ROS class are displayed in tabular and map form in the specialist report.

Throughout much of the project area, numerous resource management activities have occurred including vegetation management, road maintenance, developed recreation site construction, trail construction and maintenance, prescribed fires, hazard tree removal, utility corridor clearing, and others. In addition, there have been numerous wildfires in the area. Not all projects have met or currently meet the characterizations and mapped ROS classes at this time.

Environmental Consequences

The environmental consequences are organized to sequentially follow the analysis questions presented earlier. The environmental consequences are based on the application of design criteria and mitigation developed to eliminate or reduce adverse effects of the proposed actions on sensitive resources. See the “Recreation” section of appendix C in the DEIS.

Alternative A – Direct and Indirect Effects

There would be no immediate direct, indirect, or cumulative effects on existing recreational settings or facilities. Since no direct management actions would occur, the existing recreational settings would not change. Although stand densities would remain unnaturally high in much of the project area, some visitors are not aware of the unnatural condition of the forest, and their experience and perception of forest conditions would continue to be largely positive.

In the short term, there would be no change in recreation opportunities. In the long term, up to 589,923 acres could be affected in the event of large-scale, high-intensity wildfire or insect or disease outbreak. There would be no effects to recreation opportunities from pile burning or prescribed fires.

The ROS settings are currently natural appearing, but forest conditions make the settings vulnerable to wildfire and insect or disease outbreaks. There would be no change from existing conditions to ROS.

Cumulative Effects

The cumulative effects area is the ponderosa pine forest on the Coconino and Kaibab NFs. The cumulative effects period is 20 to 30 years. Past human activities and natural disturbance processes have influenced the current condition of the project area. Management activities and natural processes have affected, or continue to affect, vegetation structure, spatial arrangement and pattern, composition and diversity, natural processes (such as fire), and movement toward increased forest resiliency and function. The specialist report provides an overall assessment of positive and negative cumulative effects of past, present, and future projects on recreation.

Cumulatively, the no action alternative (when considered with past, present, and future projects) would not immediately change recreation opportunities and the associated recreation settings on the forests. Increased demand for ponderosa pine forest settings is expected. This alternative is expected to result in declining forest health, unhealthy stands (that have resulted from past wildfires and past timber sales), and a less sustainable forest. There would be a decline in the quality and availability of satisfactory recreation settings as well as the slow decline in provision of distinct ROS classes.

The no action alternative would result in the forest being more susceptible to large intensity wildfire or beetle attack. This would result in a decrease in recreation opportunities while at the same time, the desire for recreation use is increasing as a result of population growth and the public is increasingly dependent on national forests for recreation and leisure activities. Thus, this alternative would result in a cumulative decrease in the ability of the Coconino and Kaibab NFs to meet recreation demands over the long term.

Past vegetation management activities have resulted in an even-aged forest structure that is generally undesirable for recreation settings. It has contributed to the scarcity of large, mature trees and a lack of open structure—two setting characteristics (Ryan 2005) that have been identified as desirable to forest users. Past fire suppression activities have contributed to overstocked forest conditions, increased fuels, and decreased understory vegetation health. The current and planned vegetation management treatments and burning projects on both forests—as well as opportunities for managed wildfire—result in cumulative improvements in forest health and sustainability in the ponderosa pine, but are at such a small scale that benefits to the recreation settings in the ponderosa pine forest on the Coconino and Kaibab NFs are small and localized. In the event of a large, high-intensity wildfire, or large scale insect infestation resulting from existing conditions, the desired recreation settings and ROS class characteristics forest users seek would be so altered that the cumulative effects would result in a lack of desired recreation settings and long-term changes in ROS classes.

Motorized travel management implementation, in combination with the no action alternative, is expected to have mostly positive effects on recreation settings due to prohibition of cross-country motorized travel. The quality of many recreation settings in ROS classes were declining due to increased motorized use and increasing occurrences of cross-country travel. Present and future activities may result in degradation along heavily used camping corridors, but these would be small and localized.

Desired recreation setting characteristics such as large, mature trees, healthy understory, and diversity of tree age classes, sizes, and species are also at high risk from the effects of climate change. While drought cycles are common in the Southwest, increasing temperatures and decreases in precipitation in combination with overstocked forest conditions and high fuel loads

are predicted to result in an increase in high-intensity wildfires (Westerling et al. 2006, Marlon et al. 2012, University of Arizona 2012). Unmanaged forests have shown increases in tree stress and mortality as a result of global warming, and old, mature trees are especially vulnerable (Ritchie 2008, Van Mantgem et al. 2009, Williams et al. 2010). Increased tree mortality and loss of large, mature trees would result in a cumulative decrease in recreation settings.

Alternatives B, C, and D Direct and Indirect Effects

Alternative B - Recreation Opportunities

There would be short term and temporary decreases in the provision of recreation opportunities on parts of the Coconino and Kaibab NFs. Some forest users would be dissatisfied with their lack of access to portions of the project area during management activities such as thinning projects and prescribed fires. Areas may be closed to the public due to hazardous conditions which would result in forest user displacement and user dissatisfaction.

There could also be an increase in crowding in nearby open forest areas. Since this project would affect 40,000 acres at one time, or 2 percent of the south Kaibab and Coconino NFs, it is unlikely that crowding ratings would increase more than 25 percent in areas that have already been identified as having crowded conditions.

Direct effects of pile burning, prescribed fires, and fire line preparation are the potential for short-term displacement of recreationists during implementation (campers may need to be moved out, trail users may not be able to use a trail during firing operations), or visitor dissatisfaction (seeing slash piles or pile burning, smoky conditions from pile or prescribed fires while people are visiting the area); however, these effects are expected to be of short duration and intensity (fire line preparation would likely last less than a year and smoky conditions in any one particular area are likely to last a week or less).

Indirect effects would include recreation user displacement (potentially including trail users, hunters, anglers, winter users, firewood gatherers), increased use of special areas and designated wilderness, and potential crowding in areas not receiving forest management treatments. Restoration activities would help to assure long-term provision of recreation opportunities.

Mitigations that include provision of information about treatment and burning locations would help to inform visitors of places to avoid or other locations that are not receiving active treatments. Mitigations to provide information about the location of restoration activities as well as places where there are no activities planned may help reduce visitor frustration about finding a camping location and assist campers in making choices about where they will engage in camping activities (see the “Recreation” section in appendix C of the DEIS).

Recreation Settings

Direct and indirect effects to recreation settings from mechanical treatments would result in short term (immediate to 5 years), temporary changes in up to 72 percent of ROS settings quality (urban to roaded natural) in the project area. The short-term effects would persist one or more seasons until activity slash is treated and the treated area recovers to an “unaltered” or “undisturbed” natural appearance.

Effects of mechanical treatments are expected to take longer (immediate to 10 years) to recover in the two semiprimitive ROS settings since these would have less evidence of treatment or development to begin with and would require more time to naturalize. Twenty-eight percent of the project area is in the two semiprimitive ROS settings in the project area. Mitigation measures have been designed to ensure that direct effects of project activities are short term, and important recreation values are protected in the long term. ROS classes are expected to be changed 1 to 5 years after treatment, but following completion of vegetation treatments should display many of the characteristics described for each setting.

As required in the Kaibab NF forest plan, temporary changes in ROS classes are documented in the recreation report and the timeline for meeting the mapped ROS classes is 15 years from the beginning of project implementation (5 years following the last projected treatment). There would be one exception to this for aspen treatments. Since these activities require fencing or creation of barriers until trees can withstand ungulate grazing, it is anticipated aspen stands would not meet desired ROS classes until at least 20 years following project implementation.

There would be short term and temporary changes in ROS classes as well as decreases in the scenic quality of trailside recreation settings due to restoration activities (see report for examples). Following completion of treatments, trailside settings are expected to naturalize quickly (within 1 to 3 years) and the scenic quality of the settings would be improved.

There would be short-term disturbance and temporary changes in ROS classes and roadside recreation settings during road reconstruction. Recreation visitors may be inconvenienced and have to wait during some activities, or roads may be temporarily closed causing displacement. Long-term effects would be improved water quality at stream crossings, and safer and better maintained roads for forest user enjoyment (see the soils and water quality and riparian report).

Decommissioning of existing and unauthorized roads would improve recreation settings over time and would improve ROS classes. Temporary road construction would result in short-term disturbance and temporary changes in ROS classes. New linear features would be added to recreation settings reducing the scenic quality for 3 to 10 years. There may be some increase in illegal motorized vehicle use of these roads until they are decommissioned. Once these roads have been decommissioned, they are usually not apparent to the casual user. Mitigation measures would be used to close off entrance and exit locations of these roads, as well as use of BMPs (see appendix C of the DEIS). Opening closed roads would have similar effects as reopening temporary roads; however, decommissioning would result in the roads revegetating and becoming natural appearing over time. Since these roads would not be reopened, in the long term the decommissioned roads would meet and improve ROS classes.

Spring improvements would improve and meet ROS classes. Channel restoration would improve recreation settings over time. There would be short to moderate term changes in ROS settings where aspen are treated. Ephemeral channel restoration fencing and aspen restoration fencing and jackstrawing would cause temporary changes in the ROS class setting characteristics since the natural appearing environment would be somewhat altered. When fencing is removed or jackstrawed trees burn or begin to break up and decompose, treatment areas would meet ROS classes. This alternative would provide for restoration treatments along both utility corridors and road rights-of-way. Mitigation measures that include feathering abrupt edges of corridors and rights-of-way should result in ROS class compliance. Based on information compiled for this project (Noble 2013), the mechanical treatments would improve all understory characteristics.

Thinning and prescribed fire would increase most understory characteristics with the possible exceptions of shrubs and Gambel oak. A healthier, more varied understory would result in improved recreation settings on at least 388,489 acres where thinning and prescribed fire would occur, as well as some improvement on 199,435 acres of prescribed fire only.

This alternative provides for the long-term protection of recreational settings and facilities on 388,489 acres where mechanical thinning and burning would occur by improving stand conditions and reducing fuel loading, and would lower the risk of high-intensity fire somewhat on 199,435 acres where prescribed fire would occur. Maintaining healthy, green forests and reducing the risk of large-scale, high-intensity fires in the project area would have a positive effect on protecting and maintaining high quality recreation settings into the future.

Forest Plan Amendments

Coconino NF

Three nonsignificant forest plan amendments (see appendix B) would be required on the Coconino NF to implement the proposed action:

- **Amendment 1** would amend the Coconino forest plan to comply with the new MSO recovery plan's desired conditions, standards and guidelines, and monitoring. While constructed features such as trails or recreation sites are generally placed outside of PACs, older trail alignments or recreation sites may precede delineation of these areas, and may be located within or adjacent to PACs. For recreation, this would result in potential reductions in the risk of wildfire in MSO PACs compared to compliance with the existing forest plan language and direction. It would also open up these PACs, somewhat creating the potential for views beyond the immediate foreground. This would have a slight positive effect on recreation settings and scenic quality associated with the settings.
- **Amendment 2** would result in making progress toward the desired forest structure and move about 29,000 acres toward historic reference conditions. It would help to meet the desired conditions of restoring natural processes and forest health and providing for high scenic and recreational values. It would also meet Coconino forest plan goals and objectives for recreation including: "Manage the recreation resource to increase opportunities for a wide variety of developed and dispersed experiences" and "there is a range of recreational setting opportunities for people to enjoy the area's many scenic and aesthetic qualities. The diversity and quality of recreation opportunities, settings, and experiences are within acceptable limits of change to ecosystem stability and condition." It would make more progress toward restoration than implementing the existing forest plan direction. There would be improvement in recreation settings and scenic quality associated with the settings.
- **Amendment 3** would allow for managing to achieve a "no adverse effect" determination for significant, or potentially significant, inventoried heritage sites. This amendment would not affect recreation resources associated with this project.

Kaibab NF

Two nonsignificant forest plan amendments (see appendix B) would be required on the Kaibab NF to implement the proposed action:

- **Amendment 1** would result in making progress toward desired forest structure and move about 27,000 acres toward historic reference conditions. It would help to meet the desired conditions of restoring natural processes and forest health and providing for high scenic and recreational values. It would also meet Kaibab forest plan goals and standards for recreation: "Manage a wide spectrum of desired settings that provide opportunities for the public to engage in a variety of developed and dispersed recreation activities, in concert with other resource management and protection needs" and "Where existing conditions do not meet mapped ROS or SIOs, design and implement project to move the area toward desired conditions."
- **Amendment 2** would not affect recreation resources associated with this project.

Cumulative Effects

The cumulative effects area for alternative B is the ponderosa pine forests on the Coconino and Kaibab NFs, and the cumulative effects period is 20 to 30 years.

Past human activities and natural disturbance processes have influenced the current condition of the project area. Management activities and natural processes have affected, and continue to affect, vegetation structure, spatial arrangement and pattern, composition and diversity, natural processes (such as fire), and movement toward increased forest resiliency and function. The specialist report provides an overall assessment of positive and negative cumulative effects of past, present, and future projects on recreation.

The cumulative effects of alternative B and past, present, and future projects would have short term and local negative cumulative effects on the provision of recreation opportunities and the associated recreation settings on the forests. Forest users seeking ponderosa pine recreation settings may be displaced or restricted, and the quality of recreation sites may temporarily decrease during management activities for this project and other current or future projects.

Alternative B would restore the ponderosa pine forest health and sustainability to over 500,000 acres; this, combined with other restoration activities, would decrease the risk of high-intensity wildfire or large insect outbreaks. Increasing numbers of recreation users and demand for ponderosa pine recreation settings will continue to strain the Agency's capacity and in some areas of concentrated use, the resource capacity. With increasing demand for ponderosa pine forest settings, the large-scale improvements to forest health and sustainability of this project and similar vegetation and burning projects such as Upper Beaver Creek Forest Restoration, Hart Prairie Forest Restoration, Marshall Forest Restoration, Rim Lakes Forest Restoration, and others are expected to result in cumulative retention or improvement in the quality of recreation settings and an increase in the ability of the Coconino and Kaibab NFs to meet recreation demands over the long term.

Past vegetation management activities have resulted in an even-aged forest structure that is generally undesirable for recreation settings. It has contributed to the scarcity of large, mature trees, and a lack of open structure—two setting characteristics (Ryan 2005) that have been identified as desirable to forest users. Past fire suppression activities have contributed to

overstocked forest conditions, increased quantities of fuels, and decreased understory vegetation. The current and planned vegetation management treatments and burning projects on both forests, as well as opportunities for managed wildfire, cumulatively result in improvements in forest health and sustainability in the ponderosa pine that are large and widespread. In the event of a wildfire or insect infestation, the restored forest would likely experience more typical low-intensity fire and small scale insect infestation. The cumulative effects to desired recreation settings and ROS class characteristics forest users seek would be maintained and improved.

Utility corridor clearing in combination with alternative B would result in short term and localized negative cumulative effects on both forests.

Motorized travel management implementation in combination with alternative B is expected to have mostly positive effects on recreation settings due to prohibition of cross-country motorized travel and decommissioning of user-created routes and some existing forest roads. The quality of many recreation settings in ROS classes were declining due to increased, unconfined motorized use and increasing occurrences of cross-country travel. Present and future activities may result in additional degradation along camping corridors, but these would be short term and localized. There would be positive cumulative effects and an overall improvement in ROS classes as a result of these activities. In some areas, motorized restrictions resulting from travel management implementation may combine with temporary access restrictions that would be necessary under this alternative to make portions of the forests unavailable for motorized access.

Road and trail construction projects in combination with alternative B would result in negative effects to small and localized recreation settings across both forests. Little new road construction is proposed now or in the future. Motorized trails projects (proposed in other projects) include new construction, road to trail conversion, and route decommissioning in appropriate ROS classes. This would have positive cumulative effects in more primitive ROS classes when decommissioned routes naturalize, and expected characteristics are reestablished.

Desired recreation setting characteristics such as large, mature trees, healthy understory, and diversity of tree age classes, sizes, and species are also at high risk from the effects of climate change. While drought cycles are common in the Southwest, increasing temperatures and decreases in precipitation in combination with overstocked forest conditions and high fuel loads are predicted to result in an increase in high-intensity wildfires (Westerling et al. 2006, Marlon et al. 2012, University of Arizona 2012). Unmanaged forests have shown increases in tree stress and mortality as a result of global warming, and old, mature trees are especially vulnerable (Ritchie 2008, Van Mantgem et al. 2009, Williams et al. 2010). Alternative B and other restoration projects would cumulatively result in improved forest structure, composition, and diversity and more resilient forest conditions with decreased tree stress and potential for decreased mortality.

Alternative C – Direct and Indirect Effects

Recreation Settings

The effects described in alternative B would be the same for alternative C with the exception of the number of acres restored. Approximately 10 percent more acres would receive restoration treatments and this would further reduce the risk of large-scale, high-intensity fires in the project area. This would have a slightly more positive effect on protecting and maintaining high quality recreation settings over time. Alternative C would result in 10 percent more temporary changes in

ROS classes during project implementation. Assuming a linear relationship, up to 10 percent more forest users would be affected by the additional treatments.

Alternative C would construct up to 15 weirs and 20 weather stations (disturbing approximately 3 acres) as part of watershed improvements and metrics. Effects to recreation settings would be to increase the visibility of human disturbances on 3 acres within the project area. Mitigation measures are included in order to assure that constructed features use natural or natural appearing materials that reduce the visibility and contrast as much as possible (see appendix C of the DEIS).

Recreation Opportunities

There would be some reduction of recreation opportunities during active forest thinning and prescribed burning. It is estimated that there would be a 10 percent increase or about 66,000 acres could be affected at one time. Areas may be closed to the public due to hazardous conditions which would result in forest user displacement and user dissatisfaction. There could also be an increase in crowding in nearby open forest areas. The effects from pile burning (smoke) are the same as described in alternative B.

This alternative would provide for the long-term protection of recreational settings and facilities on 434,001 acres where mechanical thinning and burning would occur by improving stand conditions and reducing fuel loading, and would lower the risk of high-intensity fire somewhat on 159, 211 acres where prescribed fire only would occur. Maintaining healthy, green forests and reducing the risk of large-scale, high-intensity fires in the project area would have a positive effect on protecting and maintaining high quality recreation settings into the future.

See alternative B for roads and other management activities. Weir construction (see alternative C description) would result in short-term decreases in ROS classes. Mitigation measures (see appendix C of the DEIS) would be used so that natural or natural appearing materials are used in weir construction, and the landscape architect would be involved in design of the fixtures so that they would meet the ROS class.

Forest Plan Amendments

Coconino NF

Three nonsignificant forest plan amendments (see appendix B) would be required on the Coconino NF to implement alternative C:

- **Amendment 1:** Increase the size of trees that could be removed in 18 MSO PACs and could allow use of low-intensity prescribed fire within 56 PAC core areas. Old, large diameter trees are often an important part of the scenic quality of recreation settings. While constructed features such as trails or recreation sites are generally placed outside of PACs, older trail alignments or recreation sites may precede delineation of these areas and may be located within or adjacent to PAC's. For recreation, this would result in more potential reductions in the risk of wildfire in MSO PACs compared to compliance with existing forest plan language and direction and more than would be implemented in action alternatives B or D. It would open up these PACs more, creating the potential for views beyond the immediate foreground. This would have a somewhat greater positive effect on recreation settings and scenic quality associated with the settings than action alternatives B or D.

- **Amendment 2**: The effects to recreation would be the same as with alternative B.
- **Amendment 3**: There would be no effects to recreation resources from implementation of this amendment.

Kaibab NF

Three nonsignificant forest plan amendments (see appendix B) would be required on the Kaibab NF to implement alternative C:

- **Amendment 1**: The effects of this alternative would be the same as for alternative B.
- **Amendment 2**: The effects of mechanically treating and prescribed burning Garland Prairie RNA would be similar to those described earlier in this chapter for savanna treatments. There would be short-term (1 to 5 years) disturbances that would temporarily lower the scenic quality of RNA settings. In the long term, these treatments would result in improved plant vigor and species diversity (Noble 2013) that would be positive for scenic drivers, hikers, equestrians, and others.
- **Amendment 3** would have no effects on recreation resources.

Cumulative Effects

Cumulative effects of alternative C are the same as alternative B. The other projects such as construction of weirs and weather stations would result in no or very small, localized cumulative effects.

Alternative D

Direct and Indirect Effects

The short term and temporary decreases in the provision of recreation opportunities on the Coconino and Kaibab NFs and dissatisfaction would be the same as described in alternative B.

This alternative has the most risk of damage due to human-caused fire starts since only about a quarter of the area would receive prescribed fire treatments. Studies have shown that hikers demand decreased slightly in areas recovering from crown fire and increased in areas recovering from prescribed fire (Hesseln et al. 2004).

The completion of restoration activities would provide some protection of 388,489 acres across both national forests from mechanical thinning, but less than alternatives B or C because prescribed burning would occur on only 178,790 acres or 30 percent of the project area. The proposed activities would help to assure provision of recreation opportunities, but these would be limited since prescribed fire would not be used to help maintain forest health and resilience.

Direct effects of vegetation management and mitigation measures are the same as for alternatives B and C. See the “Scenery” section for impacts to scenic quality in terms of recreation settings.

Direct effects of pile burning, prescribed fire, and fire line preparation have the least potential for short-term displacement of recreationists during implementation since much less area would be treated through these methods. This alternative would cause the fewest days of smoky conditions due to pile burning or prescribed fire. Fire line preparation would occur on about one-quarter of the area, the least of the action alternatives.

The immediate effects of pile burning include small (less than 1/10 of an acre) bare, blackened areas on 99 acres that may persist in this condition until vegetation begins to move in or sprout usually within 1 to 3 years following burning. Prescribed fire would occur on about one-third of the project area. The immediate effects following prescribed burning are the same as described in alternatives B and C.

The effects of roads on recreation resources would be the same as alternatives B and C.

There are approximately 357 miles of dispersed camping corridors along the designated road system on the Coconino NF portion of the project where restoration activities would take place. This represents about 61percent of designated camping corridors on the Coconino NF. About 4.2 percent of visitors to the Coconino report that they dispersed camp in undeveloped areas. The direct effects of alternative D would be similar or slightly greater than alternative B or C since processing slash—whether by chipping/shredding/mastication and/or hauling—would take longer to complete than cutting and burning, and the machinery used to process slash would result in longer reduction of natural quiet. Winters (2002) found greater support through average approval ratings was found for signs at recreation sites, seasonal closures, restrictions on use, and controlled burns; less support was indicated for mechanical interventions.

Initial ground recovery may be faster with slash removal and less prescribed fire, but the potential for crown fire or high intensity ground fire is reduced on only a third of the treatment acres. There would still be some camper displacement along some of the designated camping corridors during implementation when there are temporary closures.

Indirect effects of mechanical treatments on both forests in terms of crowding in designated camping corridors would be similar as described in alternatives B and C with mechanical treatment-only areas having slash treated with mechanical methods or removal. However, initial recovery would be faster than those areas receiving prescribed fire, but the risk of fire starts would be greater with this alternative.

There may be longer hiking and motorized user temporary closures with alternative D since slash would be mechanically treated: chipped/shredded/masticated or transported away from the site. There would be shorter temporary closures associated with prescribed fire activities since only a third of the treatment area would be burned.

There would be short-term and temporary changes in ROS classes as well as decreases in the scenic quality of trailside recreation settings due to restoration activities. These could include visible skid trails and log landings on nearby roads, increased noise from mechanical thinning, and slash treatment or removal. There would be 99 acres of blackened areas where slash piles would be burned. Following completion of treatments, trailside settings are expected to naturalize quickly (within 1 to 3 years) and the scenic quality of the settings would be improved. Understory vegetation would respond, but not as much as alternative B or C. The effects to hunters, anglers, and firewood gathering are the same as described in alternatives B and C.

Direct and indirect effects to recreation settings of mechanical treatments would be a short term, temporary change in ROS setting quality until the effects of logging and slash treatment activities fade and become vegetated and the treated area recovers to an “unaltered” or “undisturbed” natural appearance. Mitigation measures would ensure that direct effects of project activities are short term, and important recreation values are protected in the long term.

This alternative does less than alternative B or C to provide for the long-term protection of recreational settings and facilities on the project area since total prescribed fire would be reduced to 178,790 acres. Stand conditions would be improved from thinning, but fuels loading would be reduced on only about a third of the project area. The risk of high-intensity fire would be the greatest of all action alternatives, but less than the no action alternative. This alternative has the least positive effect in terms of moving toward desired conditions and protecting and maintaining high quality recreation settings into the future.

Slash resulting from mechanical treatments would be disposed of through various methods including chipping, shredding, mastication, and removal of biomass offsite. These methods would best protect the scenic quality and natural appearing quality of ROS classes and recreation settings of all alternatives. However, these slash treatment methods also contribute to already high fuels loadings and would increase the risk of high-intensity wildfire occurring (see fire ecology report).

The effects to ROS classes from roads, springs, channels, aspen, utility corridors, and road rights-of-way treatments are the same as described in alternatives B and C.

The understory is expected to be improved but not as much as alternatives B and C. About one-quarter of the area proposed for restoration would have well improved recreation settings, the remainder would have somewhat improved recreation settings.

Alternative D would result in some reduction of recreation opportunities during active forest thinning and prescribed burning, and potentially longer slash treatment duration than alternative B or C. It is estimated that up to one-tenth of the project area, or about 40,000 acres, could be affected at one time. Areas may be closed to the public due to hazardous conditions which would result in forest user displacement and user dissatisfaction. There could also be an increase in crowding in nearby open forest areas.

Smoke from pile burning would be minimal with alternative D. Only 99 acres would be thinned, hand piled, and burned.

Smoke from prescribed fire would occur on about a third of the acreage as alternative B or C. Short-term effects are the same as described in alternatives B and C. This alternative provides for the long-term protection of recreational settings and facilities on 388,489 acres where mechanical thinning would occur, improving stand conditions, and would reduce the fuel loads on 178,790 acres where prescribed burning would occur. The risk of high-intensity wildfire would be lessened in the short term, but lack of prescribed fire and repeat burning would result in increasing risk of wildfire over time.

The quality of scenery viewing would be reduced in the short term (1 to 3 years) during project implementation due to logging operations, but because slash would be treated or removed rather than being piled or burned, these effects would be shortened and reduced. Prescribed fires would occur on about 178,753 acre with short-term effects. The areas would begin to recover and naturalize. Mitigation measures to provide information about scheduled burns would be available so that recreation visitors could make informed decisions about choosing the places they recreate.

The effects of spring improvements, ephemeral channel improvements, and fencing would be the same as with alternatives B and C. Effects of utility corridor and road rights-of-way would also be the same.

Forest Plan Amendments

Coconino NF

Three nonsignificant forest plan amendments (see appendix B) would be required on the Coconino NF to implement alternative D:

- **Amendment 1**: The effects of this forest plan amendment would be the same as with alternative B.
- **Amendment 2**: The effects to recreation from this plan amendment would be the same as alternatives B and C.
- **Amendment 3** would have no effect on recreation resources.

Kaibab NF

Two nonsignificant forest plan amendments (see appendix B of the DEIS) would be required on the Kaibab NF to implement the proposed action:

- **Amendment 1**: The effects of this amendment would be similar to alternatives B and C.
- **Amendment 2** would have not effects on recreation.

Cumulative Effects

The cumulative effects boundary and timeframe is the same as described in alternative B.

Alternative D would result in the forest being more susceptible to wildfire. The effects of this alternative and other projects would result in a declining quality of recreation opportunities while at the same time, the desire for recreation use is increasing as a result of population growth and the public is increasingly dependent on national forests for recreation and leisure activities. Thus, this alternative would result in a cumulative decrease in the ability of the Coconino and Kaibab NFs to meet recreation demands over the long term, although not as much as the no action alternative.

The impact of past vegetation management activities and fire suppression activities are the same as described in alternative B. The current and planned vegetation management treatments and burning projects on both forests, as well as opportunities for managed wildfire result in cumulative improvements in forest health and sustainability in the ponderosa pine, but these are limited in scope and would have less of a cumulative effect in ponderosa pine forest types on the Coconino and Kaibab NFs since the quantity of prescribed burning under this alternative would be greatly reduced. This would result in more localized benefits to the recreation settings in the ponderosa pine forest on the Coconino and Kaibab NFs and less of a cumulative benefit toward maintaining resilient ponderosa pine forest types to provide recreational opportunities.

In the event of a wildfire, there would be a greater chance of high intensity ground fire as a result of high fuels loadings. Since wildfire risks are only reduced a third as much in alternative D, the desired recreation settings and ROS class characteristics forest users seek would be altered, and the cumulative effects would result in a lack of desired recreation settings and long-term changes in ROS classes.

This alternative would likely require additional mechanical means to chip or haul activity slash resulting from thinning activities. This would likely result in temporary restrictions to parts of the

forest that may combine with motor vehicle restrictions included with travel management implementation to restrict vehicle access to larger parts of the forest, thus temporarily decreasing recreation opportunities, but not necessarily recreation quality. These cumulative impacts on recreational opportunities are expected to be localized to where the treatment work is taking place and would be limited to weeks or months in time.

Desired recreation setting characteristics such as large, mature trees, healthy understory, and diversity of tree age classes, sizes, and species are also at high risk from the effects of climate change. Alternative D and other vegetation management projects would cumulatively result in improved forest structure, but less improvement in forest composition and diversity. The forest resilience would be improved in the short term, but risk of wildfire would still be high and with it, the potential for large-scale fires that could kill many trees, including vulnerable old, mature trees.

Lands and Minerals

A summary of the lands and minerals report is presented here. The specialist report (Rowe 2012) is incorporated by reference. See the report for the complete methodology and analysis process.

No key issue (large trees, emissions from prescribed fire, or post-treatment landscape openness) addressed in the DEIS has any effect on lands special uses and/or minerals and, therefore, they do not serve as indicators for analyzing the effects of the project on these resources. However, the project would have an indirect effect in the form of reduced fire risk. Therefore, the indicator used for this analysis is the number of acres with reduced fire risk.

Lands Special Uses

Lands special use authorizations include permits, term permits, leases, and easements that authorize occupancy and use of National Forest System lands. Authorized activities include uses such as utility corridors, roadways, communications sites, and research projects, as well as many other uses. The terms of these authorizations vary based upon the type of use.

As of March 2012, there were 496 active lands special use permits in the project area. Additionally, there are approximately 30 to 40 temporary permits issued each year for commercial filming, photography, and other short-term uses. Research permits are also regularly issued within the project area; while many are short term in nature, there are also long term research permits.

Most lands special use permits allow vegetation clearing around the facilities they authorize to provide for access and/or fuel reduction. Within the project area, the bulk of this vegetation treatment occurs in association with power, gas, and other utility corridors. Of the 496 permits in the project area, 37 fall into this category. They represent approximately 32,345 acres of vegetation that are being managed regularly. Not all of these acres lie within the project area, however, as permit acreages are recorded for the entire authorization and generally not broken down by township and range.

Recent years show an increasing demand for lands special uses. As development in communities in and around the forests increase, their need to utilize public lands in support of their infrastructure will also increase. Proposals for powerlines, rights-of-way, communications sites,

water transmission lines, and roadways have increased steadily and will continue to do so in future years. Increased interest in renewable energy sources, such as wind and solar, has also contributed to the increased demand.

Minerals

Locatable minerals production on the Coconino NF includes manganese, gypsum, flagstone, and pumice. Saleable minerals production includes cinders, crushed aggregate, fill rock and dirt, and landscape rock. There are no oil or gas leases. Potential geothermal resources are associated with the San Francisco Volcanic Field.

Presently, no known coal, oil, or gas reserves are located on the Kaibab NF. The primary economic mineral resource consists of limited locatable mineral deposits. Many are small and, in today's economic climate, not commercially viable. There are, however, uranium deposits that are of higher grade than approximately 85 percent of the world's known uranium deposits (International Atomic Energy Agency 2009; World Nuclear Association 2009; as cited in the special uses-minerals-lands specialist report for the Kaibab forest plan revision, 2011). Salable minerals consist of sand and gravel deposits, building materials, and cinders. The area of the Tusayan district that was designated as part of the Grand Canyon Game Preserve is withdrawn from mineral entry.

The "Coconino-Kaibab Rock Pit Environmental Analysis," currently underway, would allow the use and development of 19 rock pits on the Coconino NF and 20 on the Kaibab NF. Many of these pits would be new sources. Most of the rock would be used by the forests, but some may be made available for sale to counties, cities, and other agencies.

Environmental Consequences

Alternative A

Under this alternative, no restoration activities would occur. Stand and vegetation structures would not be improved, which would make the landscape in the project area less resilient to disturbance and would provide increased fuels for wildland fires. Increased fire danger, and the potential for increased intensity of wildland fires, would impact lands special uses by threatening the structures they authorize in both the short term (10 years) and long term (20 years and more). Any structures associated with active minerals sites would also be similarly threatened. Long-term effects could be the destruction of these facilities by fire, and possibly the closure of fire-damaged areas for rehabilitation. There may be short term, temporary effects in the form of restricted access to sites during fire suppression activities or post-fire rehabilitation. See the fire ecology report for detailed information on existing and foreseeable fire risk.

Effects of All Action Alternatives (B, C, and D)

All action alternatives would improve forest health by providing for a variety of restoration activities. While they vary in specific approaches, the overall effect on lands special uses and minerals would be the same. Increased forest health would lower the risk wildland fires and lower the potential for fires of high intensity. This would reduce the threat to the structures authorized for lands special uses and mineral projects.

Of the action alternatives, alternative C treats the most acres; therefore, it provides the greatest improvement to forest health and reduced risk of fire.

All action alternatives would require construction of 524 miles of temporary roads and the reconstruction of 10 miles of existing roads, which would result in increased demand for mineral materials for road surfacing. This could result in the need for new source pits, if existing pits proved insufficient. It could also result in the need for new source pits in the future, if existing pits are depleted by this project.

There could be short term, temporary impacts to land special uses and mineral projects as site-specific restoration activities were implemented. For example, access to sites may be temporarily restricted while thinning or burning was occurring. The duration of these impacts would be only as long as the site-specific activities were occurring, for example, the amount of time that thinning was occurring in the vicinity of a particular permit area or mineral site. Prior to any site-specific implementation, the Forest Service would work with affected permit or claim holders to determine site-specific concerns, such as timing restoration activities to avoid periods of high use or access needs by the permit holders. Such mitigation would minimize potential adverse effects to these resources. Under all alternatives, there is no foreseeable irretrievable or irreversible commitment of resources.

Effects of Forest Plan Amendments Under Each Action Alternative

Each action alternative would require amendments to one or both forest plans. Because each amendment addresses a specific resource concern, potential effects are analyzed in terms of the management prescription and how it would affect lands and minerals special uses (rather than in terms of acres treated). Analysis is presented in terms of "additional effects," meaning those beyond what would be imparted by the alternatives themselves.

Amendments Addressing Mexican Spotted Owl (MSO)

These are the most complex amendments being considered under the project, because they address six different elements in managing MSO habitat and because the proposed amendment language for four of these elements varies for each alternative. Additionally, two elements apply only to the Coconino NF and one applies only to the Kaibab NF. These amendments are summarized in table 2 in chapter 1 and appendix B of the DEIS.

In alternatives B–D, restoration would still occur and the number of acres treated would be the same. There would be no overall change in the effect to lands and minerals special uses.

Amendments Addressing Goshawks

This amendment would apply to both forest plans under all action alternatives. This amendment would not alter the acres treated for restoration activities and, therefore, would have no additional effects to lands and mineral special uses.

Amendment Addressing Garland Prairie Proposed Research Natural Area (RNA)

This amendment would apply to the Kaibab forest plan only. Under alternative C, it would add language to allow prescribed fire and mechanical treatments in order to maintain and/or restore the ecological qualities of the proposed RNA.

This amendment would have no long-term effect on lands and mineral special uses. There could be short-term, temporary impacts as site-specific restoration activities were implemented under alternative C. Project-specific mitigations would minimize these effects. These short-term effects and mitigations are described above in "Effects Common to All Action Alternatives."

Amendment Addressing Cultural Resources

This amendment would apply to the Coconino forest plan only. Under all action alternatives, it would delete the standard referring to a "no effect" determination and would add the words "or no adverse effect" to the remaining standard. Management would strive to achieve a "No effect" or "no adverse effect" determination.

This amendment would have no additional effect on lands and mineral special uses, as authorization of such uses already requires archaeological and cultural screening.

Cumulative Effects

Actions considered in determining cumulative environmental effects are those known or anticipated to occur within the project area over the next 10 to 15 years. The cumulative effects analysis area is the same as the project area.

Appendix F of the DEIS lists all past, present, and future projects that may have a cumulative effect on the current project. Projects pertinent to lands and lands special uses were extracted into a separate document for this analysis (see appendix A of the lands specialist report).

The Forest Service has completed 270,894 acres of vegetation and prescribed fire treatments. Approximately 32,345 additional acres have been treated by permit holders as part of routine maintenance around authorized facilities (SUDS record search, April 2012). These actions have indirectly reduced the risk of fire to infrastructure authorized by lands special use permits and minerals permits.

Appendix A of the specialist report lists several ongoing and future fuels treatment projects within the project area, which are summarized in table 88. Under all alternatives, these actions would continue, as well as the routine clearing done by permit holders. These projects would contribute to forest health and restoration of the forest to its natural vegetative structure, which would, in turn, contribute to the reduction of fires that could produce severe effects to lands special uses and minerals (such as damaging or destroying infrastructure).

Table 88. Past, present, and future Forest Service actions with vegetation and/or fuels treatments within the project area

Project Type	Acres Treated (Prescribed Fire and Vegetation Treatments)
Past (2000–2010)	270,894
Current/Ongoing	178,717
Reasonably Foreseeable (Future)	229,640
Private/State/Other non-NFS lands	37,634
Lands Special Uses – Routine Maintenance	32,345
Total	**749, 230**

Alternative A

Permit holders would continue to conduct routine vegetation clearing on 32,345 acres as part of routine facilities maintenance, and 716,885 acres would be treated in planned fuels projects. Fire risk would be reduced on a total of 749,230 acres. Forest health would not be increased and the risk of wildland fires of high intensity would not be reduced. There would be no measurable cumulative effects to special use site access.

Alternatives B, C, and D

Under alternatives B, C, and D, the number of treated acres would be nearly doubled, to over 1.3 million (table 89). This would double the number of acres with reduced risk of wildfire. Overall forest health would be improved and the risk of severe wildland fires that could endanger lands special use and mineral sites would be reduced.

Table 89. Combined acres treated under current project and past, present, and foreseeable projects

Alternative	Acres Treated Under This Project	Total Treated Acres in Project Area
A	0	749, 230
B	587,923	1,337,153
C	593,211	1,342,441
D	556,279	1,305,509

Scenery

A summary of the scenery report is presented here. The specialist report (Minor 2013) is incorporated by reference.

Currently the scenery resources of Coconino NF are managed through application of the visual management system (VMS). The VMS was used to develop visual quality objectives (VQOs) that are prescribed in the forest plan for all lands within the Coconino NF. The VQO classifications range from preservation, retention, partial retention, modification, to maximum modification. The

VMS process has been updated in the scenery management system (SMS), which has been incorporated into the Kaibab NF forest plan via amendment 6 for the Williams and Tusayan Ranger Districts (USDA 2010).

This analysis evaluates the following questions in order to respond to/meet forest plan direction (questions 1 through 3) and key issues from scoping/public involvement (question 4 through 5):

1. To what degree would the proposed restoration activities affect the scenic integrity of the treatment area? (Measure: acres not meeting scenery integrity objectives (SIO).)
2. Would visual disturbances detract from the natural appearance or be outside of the historic range of variability? (Measure: qualitative description of anticipated disturbances.)
3. Would the proposed restoration activities sustain the valued scenic character and its scenery attributes through time? (Measure: acres meeting scenic character and scenery attributes.)
4. In what ways would prescribed fire smoke affect scenery? (Measure: qualitative description.)
5. Are large, mature trees retained as part of the scenic character? (Measure: Percent of old growth allocation in ponderosa pine and pinyon-juniper.)

A summary of the analysis completed for scenic resources is presented here. Please refer to the specialist report for methodology, data, and supporting information.

Affected Environment

The 4FRI project area encompasses the Arizona communities of Flagstaff, Mountainaire, Munds Park, Kachina Village, Mormon Lake, Doney Park, Parks, Williams, and Tusayan. Major access routes include Interstates 40 and 17, U.S. Highways 89, 180, and 66, State Route 64, County Road 73, and Lake Mary Road (Forest Highway 3). These communities and routes receive high use and users have high concern for scenery.

The treatment area's dominant scenic identity is the continuous ponderosa pine forest, interspersed with grasslands, meadows, or sagebrush that overlays the undulating volcanic and sedimentary landforms. The treatment area is viewed at foreground, middle ground, and background distances from sensitive roadways, trails, and recreation sites located within and around the boundary.

Historic conditions better match scenic preferences for large, mature trees and forests with a more open structure (Ryan 2005), and current photos (see chapter 1 of the DEIS and figure 10 in the specialist report) are more representative of the higher density, continuous canopies, and similar ages classes found today. The vegetation is the dominant scenic attribute in the treatment area. There are substantial opportunities for improvement of the ecological function and for scenery attributes. The existing vegetation density and lack of high frequency, low-intensity fires are inconsistent with the desired scenic character and its sustainability:

- The dense conifer vegetation often obscures views of existing scenic attributes within the forest canopy and understory, and greatly restricts viewing access to potential scenic attributes.

- Intertree spaces and openings have been filled with small and medium sized trees, where if these were open, they would allow for sunlight to reach the forest floor adding to the scenic quality as well as helping provide for greater understory vegetation composition and abundance.
- Currently there is a risk of large scale, high-intensity fire that could result in elimination of the vegetation scenic attributes that are desired.
- Seeps, springs, and ephemeral drainages have had conifers encroach and overtop other species reducing their function over time. When these features are functioning properly, they provide high scenic quality and auditory, tactile, and visual features not found without the presence of water.
- Throughout the forest, unauthorized routes and redundant roads have been created. These detract from the scenic quality of the area by forming unnatural linear features that are uncharacteristic of the landscape. Decommissioning the routes and roads will restore characteristic features.

Scenery Attribute Risk Determination

Scenic stability uses a descriptive six level rating scale from very high stability to no stability to identify the degree to which the scenic attributes of the valued scenic character are likely to be perpetuated within the ecosystem. The highest scenic stability ratings indicate resilient ecosystems that are functioning within their reference conditions. Lower scenic stability ratings indicate areas where intensive vegetation management practices intended to restore ecosystem health and function could also benefit scenery by restoring and/or maintaining valued attributes of scenic character. Areas of higher scenic stability need less intensive management activities to maintain their valued scenic character attributes.

Scenery Attributes

- The ponderosa pine forest has an open appearance with tree groups of varying ages, sizes, and shapes and a mosaic of interspaces and openings. **This scenery attribute is at high risk.**
- Old age ponderosa pine trees are well represented across the treatment area. **This scenic attribute is at moderate risk.**
- The ponderosa pine and pinyon-juniper forests in the treatment area have a healthy, diverse understory. **This scenic attribute is at moderate risk**.
- The treatment area has a resilient forest where frequent, low-intensity fires occur without widespread crown fire or high-intensity surface fires. **This scenery attribute is at high risk.**
- Much of the forest has open appearance of tree groups and openings making the forest more resilient to mortality from insects and disease. **This scenery attribute is at moderate risk.**
- Within the ponderosa pine and pinyon-juniper forests, there is a healthy, resilient understory of trees and shrubs including Gambel oak, aspen, and sagebrush. Prairies and grasslands provide important contrast to the forested landscape**. The scenic attributes**

of Gambel oak, grasslands, and pine-sagebrush are a moderate risk, aspen is at high risk.

Minor Scenery Attribute

- Springs, seeps, and ephemeral channels are important scenery attributes because of the diversity they provide, including contrast in color, shape, and texture. In addition, the presence of water, even if seasonal, increases the valued scenery. **The scenic attributes of seeps, springs, and ephemeral channels are at moderate risk.**
- While roads provide important scenery viewing platforms, as well as access to the forest, scenic quality is improved by decommissioning some closed forest roads and unauthorized routes. **The scenery attributes of decommissioned roads are at moderate risk.**

Environmental Consequences

Alternative A – Direct and Indirect Effects

The treatment area would continue to be mostly natural appearing for several years. Important scenic attributes such as scattered groups of trees of all ages with grassy openings, evidence of frequent low-intensity fire, large mature tree character, diverse understory, prominent aspen, Gambel oak and grasslands, and functioning riparian systems and ephemeral channels that historically contributed to the attractiveness of the area would continue to decline.

Views into the project area from roads, trails, recreation sites, and residential areas would be further reduced due to the overstocked condition of the stands, and the grass/forb/shrub understory component would continue to decline in composition and decrease in abundance. Unauthorized routes and closed roads would not be decommissioned, and would continue to be visible linear features uncharacteristic in the landscape. If unauthorized routes and decommissioned roads were unused, they would naturalize in 10 to 20 years.

In the event of an uncharacteristic high-intensity wildfire such as the Schultz Fire (Coconino NF, 2010), the existing landscape character would be suddenly altered with little opportunity to slow or control the change. The landscape would be changed to such a degree that very few of the scenic objectives could be met in the short or long term. An uncharacteristic high-intensity, large-scale wildfire would redefine and reshape the existing landscape character for decades if not centuries. The appearance and character of the area would shift from densely forested to patchy and open. The overstory component and green canopy would be absent or drastically reduced, depending on the intensity of the fire. For a few decades, the landscape would be dominated by blackened, dead standing trees; if allowed to come down on their own, the trees would likely fall in a dense, jackstraw pattern. Although short term, smoke from high-intensity wildfire would cause scenic quality to be diminished and obscure views to scenic attributes. Emergency fire suppression would result in short-term impacts (see specialist report for details).

A vegetation type change could occur especially if there is widespread drought and/or if trends toward higher temperatures and less annual precipitation continue. These changes would be visible throughout the treatment area in the foreground of forest roads and trails, and as middle ground and background views from communities and developed recreation sites. There would be

long-term (more than 20 years) impacts to major landscape attributes such as ponderosa pine forests with large, mature trees.

This alternative would not meet the project desired conditions or forest plan direction. It would not move the treatment area toward scenic stability. Over time, scenic stability would decrease and move to very low. No action would result in continuation of current risks to scenic attributes and it is reasonable to assume that these risks would increase each year and could be exacerbated by climate change. The alternative would not meet long term scenic integrity objectives since these are dependent upon improving the condition of scenic attributes so that they are more resilient to ecological stressors.

Cumulative Effects

The cumulative effects analysis area is the ponderosa pine forest on the Coconino and Kaibab NFs. The timeline for analysis is 20 to 30 years because most long-term effects of the alternatives are assessed out to a 20- to 30-year timeframe (with the exception of large-scale, high-intensity wildfire which is more difficult to project).

The cumulative effects of past management activities are visible as the existing conditions. Vegetation management practices, fire suppression, and overgrazing have resulted in the current even-aged forest structure, overstocked conditions, and sparse understory trees, shrubs, grasses, and forbs.

The short term cumulative effects (1 to 5 years) of the alternative combined with similar current and future restoration treatments and prescribed burning projects are expected to be negligible, unless additional large-scale, high-intensity wildfires occur in the ponderosa pine type. In the absence of large, high-intensity wildfires, long term cumulative effects of the alternative, present and future vegetation management, and prescribed burning projects would be small and localized. The desired landscape character of an open forest with tree groups of varying sizes, shapes, and ages, presence of large, mature trees, and healthy, diverse understory would not be met. Other scenic effects could include bare ground from grazing and recreation use and unhealthy forest conditions resulting from disease and drought. These combined effects could result in a trend toward declining landscape attributes, and less sustainable landscape character.

If wildfires burn large areas, the scenic quality would be decreased, and there would be long-term negative changes (10 to 100 years) in scenic character. The scenic attributes that contribute to high scenic integrity—such as an open forest with tree groups of varying ages, sizes, and shapes, large, mature trees, and healthy, diverse understory—would not be present. The scenic impact of a high-intensity wildfire combined with scenic impacts from adjacent land development, powerline development and maintenance, and dispersed recreation use could result in a cumulative impact of greatly diminished scenic integrity in burned areas for up to a decade or more. In some places there would be a chance that climate change could contribute to type changes in parts of the ponderosa pine forest so that these characteristics would be replaced with difference landscape characteristics, which would also cumulatively impact scenic attributes.

Environmental Consequences Common to Alternatives B, C, and D

- There would be short-term effects to scenery from restoration treatments in aspen stands.

- Spring restoration includes removal of some vegetation and prescribed burning near the sites. There are minimal to low effects to SIO from these treatments. Effects would be similar to those described for mechanical treatment and prescribed fire, although at a much smaller scale.
- Channel treatments would have short-term effects (lasting 1 to 5 years) on scenic attributes. Bare soil would be exposed, rocks and logs moved, and some disturbance from vegetation restoration would be visible for a few years until the desired understory vegetation begins to fill in and reestablish. These activities would have low effects to SIO. Following treatment, these areas would be improved and would make progress toward desired conditions.
- All fencing actions (aspen, ephemeral channels) would introduce unnatural linear features into the landscape that would not be natural appearing. Since these are isolated areas scattered around the over 500,000-acre project area, introduction of linear features would have low effects. If the fences are maintained, wood fencing would have very low effects and would meet the SIO. If they fall into disrepair, this would detract from their appearance, but they would still meet the SIO. Wire fencing materials would be more noticeable than wooden fences. Wire and metal posts can be shiny and their color can contrast with the natural surroundings. Mitigation measures would be used to introduce the fewest contrasting elements where wire fencing is used, and effort would be made to site locate the fencing where it would be least noticeable. Wire fencing would have low effects and would meet the SIO.
- Placement of jackstraw treatment would not meet the requirements for foregrounds of high concern level roads in high SIO areas. Even if these sites were allowed to drop one SIO level, they would still not meet the basic definition of moderate SIO that "noticeable deviations must remain visually subordinate to the landscape character being viewed" (USDA 2000).
- Beyond the foreground 300 feet, jackstraw piling may be suitable and would be mitigated by carefully locating piles. These areas would drop to moderate SIO for 10 to 20 years. As jackstraw barrier begins to deteriorate, trees lose their brown needles, branches break off, and logs lose their bark and grey out, the jackstraw piles compress and become less noticeable. It is anticipated that the aspen would be large enough to withstand ungulate browsing by the time the jackstraw piles have deteriorated or burned in followup prescribed fire activities. These areas would improve over time to the mapped SIO.
- Potential effects from road reconstruction include exposure of bare soil, tree stumps, and contrasting color and texture of surfacing materials. These effects would usually be short term (1 to 5 years) and become less noticeable as natural vegetation is reestablished and the surfacing material begins to be incorporated into the soil horizon.
- The construction of new roads would add new, unnatural linear features into the landscape on a temporary basis. Trees would be removed, soil exposed, and roadbeds constructed including minimal drainage features. This would have moderate effects on the mapped SIO. In high SIO (about 50 percent of the area), the new road construction would drop these areas one level to moderate until the roads are decommissioned and begin to naturalize, about 5 years later. Mitigation measures and BMPs would hasten

recovery. The new temporary roads would naturalize over time and become less noticeable to the casual observer.

- There would be short-term effects (up to 5 years) from road decommissioning as the roads have drainage established, are roughened, seeded, and mulched with pine needles and small slash. Mitigation measures and BMPs would be used. The existing closed roads would naturalize over time and become unnoticeable to the casual observer.
- Hand thinning usually has little or no short-term effects on scenery. Trees are cut down and then cut into segments that can be treated. Effects may include slash from limbing and topping trees. Project mitigations require slash to be treated.

Alternative B – Direct and Indirect Effects

There would be a low to moderate effect on scenic quality during and immediately following mechanical treatment methods. The presence of skid trails, landings, and piled or scattered slash would also result in a moderate reduction of the scenic quality until harvesting activities are completed and mitigation measures are implemented. The effects in these areas would be short term (lasting 1 to 5 years after treatment) since skid trails would be rehabilitated and activity generated slash would be treated or mostly removed to be utilized. The ground disturbance resulting from using machines to pile slash would be noticeable for 1 to 3 years after project completion, depending on how quickly the areas revegetate. Scraped trees would heal or scars would become less noticeable over time.

Where utility corridors cross the restoration area, proposed mechanical treatments adjacent to the corridors will help to improve the scenic quality. Mitigation measures have been developed to feather treatments or increase their intensity close to the corridors. This will have the effect of reducing the contrast between the cleared corridors and dense stands adjacent to them.

Effects from pile burning would be primarily limited to the immediate dead and live fuels of the slash pile, although some scorching and mortality of residual trees would be expected. Smoke from pile burning would be dense when the piles are ignited and as they burn, but would be short term in most cases.

Prescribed fire would likely result in short term, moderate reduction in scenic quality. The presence of charred surface vegetation and red or black trees would present a contrast to the otherwise green surroundings. These contrasts would soften and become less noticeable within two or three growing seasons after project completion as the understory component (grass, aspen, and oak seedlings, etc.) moved in, as singed trees either recovered or die, and as dead standing trees fell down. Smoke from prescribed fire would be heaviest during the initial burns and would reduce visibility of the scenic landscape in the short term. Some residual smoke could be expected to continue in small localized areas where stumps or roots smolder for up to a few weeks. The residual smoke would have little, if any, effect on visibility of scenic attributes.

Effects may last longer and be more pronounced in areas of moderate to high fire intensity. In these locations, standing dead trees may be present for a decade or more until they fall down. Understory vegetation would take some time to recover but is expected to look more natural appearing within 5 years. Since it is expected that this would be produced over no more than 10 percent of the treatment area, effects would be localized and limited.

Repeat burning would result in fewer effects than described above since fuel loadings would be reduced by initial prescribed burns. Effects are expected to be noticeable for a shorter duration, and within 2 to 3 years, the areas will be natural appearing. Smoke from repeat burning would not be as heavy as initial burns and would be expected to be shorter in duration.

When the treatments are all completed, it is expected that many of the ecological stressors would be lessened, and the scenic stability would move from low to high on 589,923 acres within the restoration area. The proposed treatments and prescribed burning would make progress toward desired conditions and would improve forest health and resilience. The treatments would increase scenic stability for large, mature trees. The treated areas would have more of the desired landscape characteristics and would make progress toward meeting SIO. The 4FRI project would help achieve the desired conditions for scenery as defined in the forest plans.

Forest Plan Amendments

Coconino NF

Three nonsignificant forest plan amendments (for more details refer to appendix B of the 4FRI DEIS) would be required on the Coconino NF to implement the proposed action:

- **Amendment 1**: The effects of this amendment would be to move vegetation in these areas slightly closer to restored conditions. They would slightly improve scenic stability in MSO PACs, but these areas would still be at risk for disturbances such as high-severity wildfire or large scale insect and disease outbreaks.
- **Amendment 2** would move vegetation closer to desired conditions, improve scenic stability, and overall scenic integrity. It would result in improved forest structure and pattern, forest health, and vegetation composition and diversity, and overall forest resiliency, all of which would relate directly to decreased risks to scenery from natural disturbances.
- **Amendment 3** would have no effect on scenery.

Kaibab NF

Two nonsignificant forest plan amendments (see appendix B) would be required on the Kaibab NF to implement the proposed action:

- **Amendment 1** would move vegetation closer to desired conditions, improve scenic stability, and overall scenic integrity. It would result in improved forest structure and pattern, forest health, and vegetation composition and diversity, and overall forest resiliency, all of which would relate directly to decreased risks to scenery from natural disturbances.
- **Amendment 2** would defer all MSO monitoring to the project's FWS biological opinion. This amendment would have no effects on scenery.

Cumulative Effects

The short term cumulative effects (1 to 5 years) of alternative B combined with similar current and future restoration treatments and prescribed burning projects are expected to be widespread. There would be evidence of restoration treatments, and the scenic quality would be decreased in

some places in most of the ponderosa pine on the Coconino and Kaibab NFs. For example, in areas where restoration treatments result in skid trails or removal of vegetation for staging areas or log decks, there could be a cumulative impact to scenic attributes where activities such as dispersed recreational use, grazing, or adjunct private land or infrastructure development is also occurring. In general, these cumulative impacts to scenic attributes would be localized in scale (1 to 10 acres) and would most likely be of short-term duration (1 to 5 years).

In the long term (5 to 20 or 30 years), there would be large and widespread improvement in the health and sustainability of scenic attributes that make up the landscape character of the ponderosa pine forest. Forest users would experience an open forest with tree groups of varying ages, sizes, and shapes, large, mature trees, and healthy, diverse understory. In many places, the scenic integrity objectives would be met.

When natural stressors such as wildfires or insect outbreaks occur, or human activities such as new utility corridors, a new recreation site, or a new private subdivision are developed, the cumulative effects of alternative B and other projects would result in small and localized changes in the scenic character of the ponderosa pine forest. When drought conditions or unusual weather events as a result of climate change occur, the ponderosa pine forest would be healthier and more resilient to such events, thus counteracting the effects of climate change which are likely to detract from scenic attributes. The overall trend from this alternative would be toward improving landscape attributes and sustainable landscape character.

Alternative C – Direct and Indirect Effects

Effects would be similar to alternative B. About 10 percent more acres would be mechanically treated and about 1 percent more acres burned than alternative B. Alternative C would improve understory species abundance and composition slightly more than alternative B since the combined thinning and prescribed fire has been found to be a more effective tool (Laughlin et al. 2008). This alternative would result in slightly better understory response and slightly more large trees, which would better meet scenic objectives.

This alternative adds construction of up to 15 weirs and 20 weather stations (3 acres of disturbance) to support watershed research. The construction of these features would create contrast with the characteristic natural landscape. Mitigation measures would assure the weirs are constructed of natural appearing materials and are of a shape and form that does not create too much contrast. This would help blend with the surrounding landscape. A weather station located outside of the immediate foreground (300 feet) would use nonreflective surfaces, and careful siting would help these features blend with the surrounding landscape.

Forest Plan Amendments

Coconino NF

Three nonsignificant forest plan amendments (see appendix B) would be required on the Coconino NF to implement alternative C:

- **Amendment 1:** This alternative would increase the size of trees that could be removed in 18 MSO PACs and allow use of low intensity prescribed fire within 56 PAC core areas. Old, large diameter trees are an important part of the scenic quality. There may a slight decrease in scenic quality as a result of removing larger diameter trees, but it

would also result in slightly greater reduction of tree density in these areas which is important for scenic stability. Of these areas, 56 would also receive low intensity prescribed burns. While there would be short-term effects from tree removal and burning, there would be slightly higher improvement in overall scenic stability than with alternative B or D. The amendment would allow for more treatments which would open up these PACs more, creating the potential for views beyond the immediate foreground. This would have a somewhat greater positive effect on scenic quality than action alternative B or D.

- **Amendment 2:** The effects to scenery would be the same as with the alternative B Coconino NF forest plan amendment 2.
- **Amendment 3:** There would be no effects to scenery from this amendment.

Kaibab NF

Three nonsignificant forest plan amendments (see appendix B in the 4FRI DEIS for details) would be required on the Kaibab NF to implement alternative C:

- **Amendment 1:** The effects of this alternative would be the same as for alternative B Kaibab NF forest plan amendment 2.
- **Amendment 2:** There would be a short-term (1 to 5 years) decrease in scenic quality from mechanically treating and prescribed burning Garland Prairie RNA. (The details of effects from mechanical thinning and prescribed fire are found under alternative B.) Those effects would be similar to those described earlier in this chapter. In the long term, these treatments would result in improved plant vigor and species diversity (Noble 2013), which would be positive for scenic drivers, hikers, equestrians, and others. There would be an improvement in the scenic stability and scenic integrity for this area with this amendment.
- **Amendment 3** would have no effects on scenery.

Cumulative Effects

The cumulative effects would be similar to alternative B. There would be slightly more negative short term cumulative effects in localized areas (those with skid trails, pile burns, and staging areas) since this alternative would mechanically treat and burn about 10 percent more acres, and prescribed burn about 1 percent more acres. However, there would also be slightly more positive long term cumulative effects from counteracting drought and insect damage likely to occur as a result of climate change since there would be more mechanical treatment and burning to facilitate greater forest resiliency.

Alternative D – Direct and Indirect Effects

The short term (1 to 5 years) visual disturbances from restoration activities would be within the reference conditions of the area. In the short term (1 to 5 years), the disturbances would be visible and would lower the scenic quality. In about one-third of the area where both thinning and prescribed fire occur, the results would be similar to those found with alternative B. In the remainder of the restoration area only receiving mechanical treatments, the natural appearance of the area would begin to recover, but over time, these improvements would become static and begin to deteriorate again. Throughout project implementation, it is expected that the valued

scenic character would begin to improve, but the risks to scenic attributes would only improve in the short term (1 to 5 years), and the risk of high-intensity fire would begin to increase in the landscape. In addition, if a wildfire were to start, it is likely that while it would be mostly a surface fire, it might be moderate and high intensity, and many trees would be scorched and killed as a result, thus reducing scenic quality. This alternative would result in about one-third as much understory vegetation improvement than with alternative B or C.

Forest Plan Amendments

The effect of forest plan amendments is the same as described for alternative B.

Cumulative Effects

The short term cumulative effects (1 to 5 years) of alternative D combined with similar current and future restoration treatments and prescribed burning projects are expected to be widespread, but of small scale (1 to 10 acres) where they occur. For example, in areas where there would be evidence of mechanical thinning treatments, together with evidence of grazing and dispersed recreation impacts or infrastructure development (utility lines), the scenic quality would be cumulatively decreased in these places.

In the long term (5 to 20 or 30 years), initially there would be widespread improvement in forest structure, but vulnerability to wildfire would remain high, thus limiting forest resiliency. While this alternative would counteract impacts to large trees and understory vegetation resulting from climate change and the resulting drought and vulnerability to insect outbreaks and disease, it would be very limited. Specifically, the understory would not be as healthy or diverse, and understory vegetation would continue to be cumulatively impacted by grazing, recreational use, and abiotic factors such as drought.

When natural stressors such as wildfires or insect outbreaks occur, or human activities such as new utility corridors, a new recreation site, or a new private subdivision are developed, the effects of alternative D could serve to slightly counteract the scenic effects of these activities and other projects, but it would be limited compared to other alternatives. When drought conditions or unusual weather events as a result of climate change occur, the ponderosa pine forest would not be as resilient to such events. The overall trend to scenic quality resulting from this alternative in combination with other activities and projects would be toward level or downward for improving landscape attributes and sustainable landscape character.

Range

A summary from the range specialist report is presented here and the complete report is incorporated by reference (Hannemann 2013). Refer to the specialist report for additional information that includes: methodology, the grazing history of the project area, and supporting information. This analysis incorporates questions designed to evaluate movement toward desired conditions and concerns brought up by the public during scoping: (1) How would project activities affect livestock grazing management in the project area? (2) How would project activities affect livestock forage in the project area? (3) Would livestock grazing affect the restoration of understory species? (4) How would livestock grazing affect the ability to return fire as a natural process to the project area? and (5) How would climate change affect the range resource and how would the project affect climate change (relative to range)?

Affected Environment

The affected environment for the range analysis is the project area. Only allotments within the project area have been considered. Within the project area, approximately 791,250 acres are within grazing allotments and 197,779 acres are not grazed by livestock. The amount of each allotment lying within the project area averages 65 percent and varies between 0.002 to 100 percent.

There are 49 livestock grazing allotments of which 47 are active allotments and 2 are vacant (see the specialist report for figures displaying allotments within the project area). Of the 49 allotments, 40 permit cattle grazing and 9 permit sheep grazing.

There are 229 main pastures located within the project area. Main pastures are the large pastures that are used more than 20 days per year by livestock. Total allotment acres and acres by RU can be found in the specialist report in table 2. Restoration units were used for display purposes only and were not used in the analysis. See the specialist report for details on allotment grazing management systems, current numbers of permitted livestock, and seasons of use within the project area.

A study was conducted in 2011 on the trends of understory vegetation within the project area (Brewer 2011). Currently the range has seen a shift to warm season species dominance in many areas of northern Arizona as a result of relative lower winter moisture and higher summer moisture. The warm season plant that has benefited most from this shift is blue grama. Because blue grama is a dense mat forming species, many areas have seen an increase in perennial plant cover and ground cover. The trends of forage production during this time period have been static.

Environmental Consequences

The environmental consequences for alternatives B, C, and D are based on the application of resource protection measures and are based on the environmental consequences in the silviculture, fire, and wildlife (herbaceous understory analysis) reports. See the “Range” section in appendix C of the DEIS for the complete list of resource protection measures.

Alternative A – Direct and Indirect Effects

The expected reduction in understory vegetation would reduce the amount of forage available to livestock. Over time, livestock numbers would be reduced. A reduction in forage followed by a decrease in livestock numbers has been recorded through the last 100 years throughout the project area. There is no reason to believe that this trend would not continue under alternative A. Uncharacteristic wildfire would have an adverse impact on livestock grazing management and forage until the area recovers and structural improvements are replaced.

All Alternatives – Direct and Indirect Effects

- Mechanical treatment and prescribed burning would increase understory vegetation. Understory species and composition would change primarily by increasing shade intolerant understory species and decreasing shade tolerant species. The increase in forage would have a short term (within 3 years) and long term (10-year) beneficial effect to livestock grazing.

- Spring exclosure areas would not be available for livestock grazing and would have an adverse impact on available forage within a pasture. However, these exclosures would not be large enough and would not amass in any particular pasture to reduce pasture stocking rates. In addition, by the time these exclosures would be completed, it is anticipated the increase in pasture forage by tree thinning and burning would help to offset the forage lost within the exclosures. Spring projects would not have a measureable impact on the capacity of allotment or grazing management.
- The ephemeral drainage improvements would have a benefit to livestock grazing management by increasing forage by improving bank stability and decreasing the amount of sediment to downstream stock tanks.
- Aspen exclosure areas would not be available for livestock grazing and would have an adverse impact on available forage within a pasture. However, the majority of these exclosures would not be large enough or amassed in any particular pasture to reduce pasture stocking rates. Aspen projects would not have a measureable impact on the capacity of allotment or grazing management.
- Road and route decommissioning would have a beneficial effect to livestock grazing by growing additional forage in the old roadbed. Constructing temporary roads would have a temporary adverse effect to livestock grazing when the forage on the road was disturbed. Road reconstruction would have no effect on livestock grazing. No road project would have a measureable impact on the capacity of allotment or grazing management.
- There are no long term, unavoidable adverse effects in alternatives B–D related to livestock grazing because effects would be short term in nature and wouldn't affect grazing permit capacity. There would also be no irreversible and irretrievable commitments of resources because forage would grow back in the next growing season after treatments or after managed grazing. Alternatives B, C, and D would be in compliance with the Coconino and Kaibab National Forest plans for livestock grazing.

Alternative B – Direct and Indirect Effects

Alternative B would affect all grazing allotments within the project area and 184 main summer pastures with mechanical and prescribed fire treatments. Ten pastures would be affected by prescribed fire-only treatments. Mechanical treatments by allotment would vary from 0 to 35,658 acres. See the specialist report for detailed information on acres affected by allotment. Prescribed fire only treatments by allotment would vary from 0 to 19,458 acres. Mechanical and prescribed fire treatments would have a benefit to livestock grazing management by an increase in forage (also see effects common to all action alternatives). Treating up to two pastures per year per allotment would have an adverse effect to livestock grazing management and forage until the burn area shows range readiness (see "Effects Common to All Action Alternatives").

The alternative would reduce the risk of fire burning with high severity through multiple pastures, burning fences and other structural range improvements, and adversely affecting livestock management.

Alternative C – Direct and Indirect Effects

Alternative C would affect 192 main summer pastures with mechanical and prescribed fire treatments. Two pastures would be affected by burning only treatments. Table 7 in the specialist report displays the total acres of vegetation and prescribed fire treatments within each allotment. Thinning treatments by allotment vary from 0 to 36,895 acres. Prescribed fire only treatments by allotment vary from 0 to 17,939 acres. Mechanical and prescribed fire treatments would have a benefit to livestock grazing management by an increase in forage. Up to two pastures per year per allotment would have an adverse effect to livestock grazing management and forage until the burn area shows range readiness ("Effects Common to All Action Alternatives").

Alternative C reduces the risk of uncharacteristic wildfire through thinning 434,189 acres and burning 593,473 acres within the project area over the next 10 years. These treatments would reduce heavy fuel loading, break up the tree canopy, raise the tree canopy, and burn fine ground fuels (Lata 2013). These actions reduce the risk of uncharacteristic wildfires that can burn with high severity through multiple pastures, burning fences and other structural range improvements, and adversely affecting livestock management.

Alternative D – Direct and Indirect Effects

Alternative D would affect 184 main summer pastures with mechanical and prescribed fire treatments. Ten pastures would be affected by prescribed fire only treatments. Nine pastures that have mechanical treatments would not have prescribed fire. Mechanical treatments by allotment would vary from 0 to 35,658 acres. Prescribed fire only treatments by allotment would vary from 0 to 18,799 acres. Mechanical and prescribed fire treatments would benefit livestock grazing management by increasing forage. Up to two pastures per year per allotment would have an adverse effect to livestock grazing management and forage until the burn area shows range readiness. The nine pastures that do not have prescribed fire would not need to be rested from livestock grazing. However, the pastures would not have the added benefit of increased forage that prescribed fire provides.

The alternative would reduce the risk of fire burning with high severity through multiple pastures, burning fences and other structural range improvements, and adversely affecting livestock management.

Forest Plan Amendments

Alternative B and D

Coconino NF

Amendment 1: The amendment would affect grazing in that it would increase forage which would benefit livestock grazing. According to the fire analysis (Lata 2013), the amendment would result in a slight decrease in crown fire potential for the 18 MSO PACs that would receive mechanical treatments. If amendment 1 is not implemented on the Coconino NF, these 18 PACs (approximately 10,700 acres) would retain the current forest structure that places them at high risk of high-severity fire. If prescribed fires were implemented on acres adjacent to PACs, it is more likely that some fire lines would need to be created to avoid burning in the PAC, producing ground disturbance that would be less likely under the proposed amendment. Ground disturbance would result in short-term reduction in forage for authorized livestock. The monitoring portion of the amendment would not affect grazing management.

Amendment 2 would allow 29,017 acres to be managed for an open reference condition. There would be increased understory vegetation which benefits grazing management. According to the fire analysis (Lata 2013), an indirect effect of this amendment would be a reduced potential for active crown fire which would benefit grazing. If amendment 2 were not implemented, it is likely that another type of restoration treatment would have been developed which would reduce the risk of severe fire behavior and improve forest structure, forest heath, and understory productivity. Restoration actions in general would benefit grazing management. The canopy cover portion of the amendment would have no effect on grazing management.

Amendment 3 would have no effect on grazing management.

Kaibab NF

Amendment 1 would allow over 27,000 acres to be managed for an open reference condition. There would be increased understory vegetation which would benefit grazing management. According to the fire analysis (Lata 2013), an indirect effect would be a reduced potential for active crown fire which would benefit grazing. If amendment 2 were not implemented, it is likely that another type of restoration treatment would have been developed which would reduce the risk of severe fire behavior and improve forest structure, forest heath, and understory productivity. Restoration actions in general would benefit grazing management. The canopy cover portion of the amendment would have no effect on grazing management.

Amendment 2 defers all MSO monitoring to the project's FWS biological opinion. Based on past experience with other projects, this would not be likely to affect grazing management.

Alternative C

Coconino NF

Amendment 1: The effects (benefits) of implementing amendment 1 in MSO habitat is the same as described for alternative B. In alternative C, additional acres of MSO habitat would receive prescribed fire which would further benefit grazing management.

Amendment 2: The effects of implementing amendment 2 would be the same as described for alternative B.

Amendment 3 would have no effect on grazing management.

Kaibab NF

Amendment 1: If amendment 1 was implemented, the same effects that are described above for alternative B would apply to 27,765 acres that would be managed for an open reference condition.

Amendment 2: Amendment 2 would have no effect on grazing management. Grazing is currently excluded from the proposed RNA.

Amendment 3: If amendment 3 (MSO habitat management on the Kaibab NF) was implemented (or not implemented), the effects would be minimal to grazing management. Grazing authorizations would continue to comply with the forest plan requirements that apply to grazing in MSO habitat.

Cumulative Effects – All Alternatives

The spatial area considered for cumulative effects analysis includes 100 percent of the acres within allotments that occur within the project area. This is a logical boundary because changes to grazing management in one pasture of an allotment affect the management in the entire allotment. The project area occupies an average of 65 percent of each allotment that the project area intersects, with several being wholly within the project area and the minimum occupancy of a single allotment being less that .01 percent.

The timeframe for these combined effects is 10 years because changes in condition and trend in the vegetation depend on the presence of favorable growing conditions after cattle leave the pasture. If growing conditions are favorable, plant height and canopy cover would completely recover from the impacts of the proposed forest management activities within 1 year. If growing conditions are not favorable, plant recovery would occur more slowly (up to 2 to 3 years). Vegetation recovery from the other activities and natural events may take this long depending on annual weather conditions, particularly annual precipitation.

Cumulative Effects Baseline

The baseline includes the vegetation and prescribed fire projects from 2001 to 2010 including 140,614 acres of mechanical thinning and 119,751 acres of prescribed fire within the project boundary, most on the same locations. The baseline also includes the use of up-to-date grazing systems and adaptive management on all the allotment acres of the cumulative effects area, and the use of over 20 livestock/elk exclusions to protect aspen and over 15 exclosures to protect riparian areas.

Past restoration projects (see specialist report, cumulative list of projects) within the project area have increased forage and understory vegetation. Forest Service policy has changed over time and the forests are now allowed to be managed for uneven-aged tree management and to allow fire to return to its nature role in the ecosystem. Current grazing management conducted utilizing adaptive management procedures in order to meet objectives established in existing allotment management plans is also part of the existing baseline.

Areas included with the cumulative effects analysis area, external to National Forest System lands, are primarily lands under private ownership and lands under the jurisdiction of the State of Arizona and National Park Service. Grazing on adjacent forest land is grazed very similarly to grazing within the project area. Livestock grazing occurs in the majority of these areas except within Walnut Canyon National Monument. Private lands within communities are not typically utilized by livestock with the exception of horses. Private lands outside of communities typically provide forage for livestock consisting mostly of small livestock operations, but can provide for larger livestock operations when the private land is in larger blocks. State lands are also utilized by livestock with many of these State lands managed in conjunction with Forest Service allotments. There are no indications that livestock use within these areas is going to change dramatically during the next 10 years. In addition, these lands are not large enough that livestock use could be moved to these areas to offset the effects of the proposed treatments.

Livestock Grazing Management and Livestock Forage

The cumulative effect to livestock grazing management and livestock forage for alternative A is no change in the short term but a long-term decrease in forage with an increase in trees. Within

the cumulative effects boundary, 588,182 acres related to the 4FRI project boundary would not be treated and would have no change in the short term, but there would be a long-term decrease in forage with an increase in trees. When other current and foreseeable projects are considered, an additional 146,891 acres will be treated (31,492 mechanical thinning and prescribed fire, 49,466 acres of thinning only, and 65,933 acres of prescribed fire only) and affect 15 percent of the allotment acres. Livestock grazing management would be affected by these treatments the same as the other alternatives. Pastures would be rested and deferred as these treatments are completed. With less treatment acres, pasture rotations will be less affected.

The alternatives B, C, and D proposed treatments and the other current/foreseeable projects generally overlap in time and space (see cumulative effects description in appendix F). When the 4FRI acres are combined with vegetation and prescribed fire projects, 74 percent of the cumulative effects boundary (89 percent of all allotments) would have reduced forage. However, this would be a short-term effect with a typical duration of 1 year after burning.

In the long term, forage would increase on these same acres in the cumulative effects boundary. In terms of grazing management, even though 705,695 acres have reduced forage for a period of 1 year, this would not affect grazing management because mitigation restrictions would apply to all planned and ongoing projects. No more than one main pasture per allotment would be burned per year on the majority of the allotments, and this would not add to the grazing management effects because these mitigation restrictions also apply to these ongoing projects.

Livestock Grazing Impacts to Fire

The cumulative effect of livestock grazing on meeting the objective of restoring fire to the landscape for alternative A would not change because of the minimal and managed direct or indirect effect of current grazing (see effects analysis). The same would be true for alternatives B, C, and D, with minimal and managed direct and indirect effects of livestock management with the proposed treatments (see effects analysis). The ability to meet fire objectives in alternatives B, C, and D when considered with ongoing and foreseeable projects that includes 65,933 acres of prescribed fire (see cumulative effects report) would not be affected due to current grazing management strategies that are in place and the use of adaptive management.

Livestock Grazing Impacts to Understory

The cumulative effect of livestock grazing to achieving increased understory response for alternative A would not change because of the minimal and managed direct or indirect effect of current grazing (see effects analysis). The same would be true for alternatives B, C, and D, with minimal and managed direct and indirect effects of livestock management with these proposed treatments. The ability to achieve increased understory response in alternatives B, C, and D when considered with ongoing and foreseeable projects that includes 31,492 mechanical thinning and prescribed fire, 49,466 acres of thinning only, and 65,933 acres of prescribed fire only treatments (see cumulative effects report) would not be affected due to current grazing management strategies in place and the use of adaptive management. Livestock grazing would adapt to changes in forage conditions through time.

Transportation

A summary of the transportation report is presented here. The specialist report (Fleishman 2013) is incorporated by reference.

Currently, there are approximately 4,278 miles of roads within the analysis area that are managed under Forest Service jurisdiction. Of this total, approximately 3,334 miles are open roads and 944 miles are closed roads. In addition to the roads that are currently managed by the Forest Service, there are approximately 374 miles of additional unauthorized roads that have been identified within the analysis area, for a total of approximately 4,652 miles of roads on Forest Service lands within the project area. See the specialist report for details on miles (and locations) of road by operational maintenance level (1 through 5).

Not all of the 4,278 miles of road within the 990,000-acre analysis area would be needed for removal of forest products. A haul route analysis identified approximately 2,297 miles of existing road necessary for removal of forest products after harvest.

Environmental Consequences

The analysis focuses on two items related to the purpose and need of the project:

- How access to the project area is met by alternative in order to implement the project. The unit of measure is miles of system road and miles of temporary road.
- How each alternative moves toward a safe and more affordable transportation system that is identified within each forests respective travel analysis project (TAP) documents. The unit of measure is miles of decommissioned roads, miles of open road for a more affordable road system, and miles of road maintenance for road safety.

The timeframe for the analysis is the life of the project (about10 to 15 years).

Alternative A

Direct and Indirect Effects

Under alternative A, current road management would continue on the two forests, including maintenance of the open road system. The current transportation system would be adequate to access the project area as defined in each forest's respective travel management decisions in both the short term (current to 10 years) and long term (greater than 10 years from current). No harvest activities would occur and no new temporary roads would need to be constructed.

Additional NEPA analyses would be necessary to carry out on-the-ground closure activities identified in the TAPs. Therefore, this alternative does not move toward a safe and more affordable road system. Road maintenance would continue, primarily on maintenance level 3 through 5 roads, as well as a limited basis on level 2 roads.

Cumulative Effects

There are no actions proposed from this alternative, hence there are no cumulative effects.

Alternatives B, C, and D

Assumptions used to evaluate environmental consequences include the following:

- Maintenance of open existing roads may include road maintenance activities described in the Forest Service Operations and Maintenance Handbook (FSH 7709.59) such as, but not limited to, road blading, draining maintenance, culvert installation, culvert replacement, spot surfacing and resurfacing, removal of slides and slumps, removal of danger trees, removal of roadside vegetation for improved site distance on the roads, dust abatement, removal of overhanging vegetation to allow for access, and installation of signs. This activity would be expected to occur on approximately 2,297 miles of road. Dust abatement would be expected to occur on about 7 miles of road.
- Road reconstruction would include road improvement activities on about 30 miles of roads and road relocation on about 10 miles of roads.
- Road improvement activities are defined as activities that result in an increase of an existing road's traffic service level, expansion of its capacity, or a change in its original design function. Road improvement activities would include, but are not limited to, widening corners to improve turn radiuses, straightening of road segments to improve haul safety, installing turnouts to improve haul safety, and changing alignments at road intersections to improve site distance and haul safety. These activities may result in limited removal of vegetation. These activities would occur on approximately 30 miles of roads within the project area.
- Road relocation in the vicinity of ephemeral, intermittent, and perennial streams would be designed to lessen the impact on these waters. Road reconstruction may include relocating roads out of drainages, construction of rock rip-rap, installation of new culverts, and construction of low water crossings. Up to 10 miles of road within the project area would have this road treatment. The desired condition for stream road segments is to have ephemeral, intermittent, and perennial watercourses slow the speed of waterflow, have access to the flood plain, transport sediment, and maintain longer sustained base flows on the landscape, rather than a flush of peak flows. Flood plains would function to lessen the impacts of floods on human safety and health.
- Temporary roads that are necessary for treatment purposes would be used during project implementation to provide for access to the area to implement the proposed activities (see alternative descriptions for road related activities and miles).
- Once treatment has occurred, temporary roads would be decommissioned. Unneeded, closed (ML 1) roads would be decommissioned as needed and returned to a more natural state. Decommissioning of system roads and unauthorized routes would use an adaptive management framework outlined in the specialist report (see specialist report, appendix A) and would also utilize design features outlined in the soil and water specialist report. This would occur on approximately 517 miles of temporary roads within the analysis area and on approximately 42 miles of system roads within the analysis area.

Direct and Indirect Effects

The 2,297 miles of haul route maintenance activity does not provide for full access to the area to be able to implement the proposed action and would require additional temporary roads. There would be a short-term benefit to transportation system safety through improved surfacing and

signage during the life of the project. If the roads are not on a long term maintenance schedule, the effect to the safety of the transportation system would decrease as drainages and road surfaces continue to degrade. A long term road maintenance schedule after the life of this project is outside the scope of this analysis.

An indirect effect of the proposed thinning activities would be improved site distance from the removal of vegetation. This effect would decrease over time as vegetation becomes reestablished. However, the desired condition is for an open stand condition and these effects would be effective in both the short term and a portion of the long term. Routine maintenance activities that occur during the life of this project would also maintain site distances. The negative effects of roads on soil and water resources would be decreased (see the soil and water quality and riparian specialist report). The spot surfacing and graveling component of this activity would require the use of a local rock source (either commercial or rock sources on Forest Service land), but would not deplete all available rock sources in or adjacent to the project area. The total amount of material necessary is not quantifiable at this time, but would be identified with specific road packages as implementation proceeds. There would be energy use necessary for this activity for equipment to be able to maintain roads and haul trucks to transport material. The amount of energy use would be minimized for haul needs of material by utilizing the closest pit available for the material type needed for the project.

Road reconstruction actions in the vicinity of ephemeral, intermittent, and perennial streams would have a limited effect to the needed transportation system for access because the existing transportation system could be utilized (in its current location). Reconstruction would provide a related short-term and long-term benefit to soil and water resources that are discussed within the soil and water quality specialist report. The reconstruction away from streams would provide a slight (due to number of miles) but major improvement in the ability to maintain roads, and as such, would provide a short-term and long-term benefit to a more affordable and safe road system (on those miles that would be treated). Reconstruction by definition would require the use of a local rock source (either commercial or rock sources on Forest Service land), but would not deplete all available rock sources in or adjacent to the project area.

Temporary and closed system roads would provide access to the area to implement the project. This would be primarily a short-term effect that would occur during the first 10 years of the project. A small, unquantifiable portion of this effect would be expected to occur after a 10-year timeframe due to implementation timeframes associated with contracts. Effects to soil and water resources, as well as recreation resources, would be expected to occur during this timeframe and are discussed within the respective specialist reports. Temporary road construction would be governed by contract specifications to minimize resource impacts to soil and water, wildlife, and recreation resources, and would utilize design features within these specialists' reports to minimize impacts to the respective resources.

The decommissioning of 42 miles of current system roads on the Coconino NF would begin to move the road system toward a safe and more affordable transportation system. The bulk of this work would be expected to occur in the short term of the first 10 years of the project. The 42 miles of decommissioned system road would be a long term beneficial effect and would move toward a more affordable transportation system.

Decommissioning would occur on approximately 904 miles of road in these alternatives. This activity would occur after the removal of forest products and would not have an effect on having

a transportation system in place (to provide access for implementation). There may be a negative effect to access from implementing prescribed fire in alternatives B and C. There may be a negative effect on approximately 904 miles of roads in both the short term and the long term, and an indirect effect to implementation if roads slated for decommissioning are to be used as fire lines/containment lines for prescribed burns. This would primarily be a long-term effect on maintenance due to the timeframe for naturalization of decommissioned roads (10 years).

In alternative D, the acres of prescribed fire would be decreased, and the corresponding road mileage that would be used to access prescribed fire sites would be decreased to about 225 miles of road. Alternative D also has an indirect effect to implementation if 225 miles of road slated for decommissioning are used as fire lines/containment lines for prescribed fires. The decommissioning of about 904 miles of road would have a short term and long term positive effect on creating a safe and more affordable transportation system.

Forest Plan Amendments

On both forests, the proposed forest plan amendments address management in MSO habitat, management of canopy cover, managing select acres for an open reference conditions, and propose using vegetation and prescribed fire treatments in the proposed Garland Prairie RNA on the Kaibab NF (alternative C only). No road activities would be affected by implementing (or not implementing) the proposed amendments.

Cumulative Effects

The cumulative effects boundary is the approximately 990,000-acre analysis area. The timeframe of the cumulative effects analysis for past projects is 10 years. Table 4 in the specialist report displays the projects within the analysis area and the corresponding roads related decisions within the projects.

There are about 251 miles of road decommissioning within previous projects. This project would add an additional 904 miles of decommissioned roads. The total of about 1,155 miles of decommissioned roads would move the cumulative effects analysis area closer to a safer and more affordable road system.

In addition (see table 4 in the specialist report), there are 0.8 mile of road reconstruction in other projects that add to the 10 miles of road reconstruction from the 4FRI project for a total of 10.8 miles of road reconstruction. This would have a limited effect on creating a safer and more affordable road system. As stated above, the 30 miles of road improvement will improve safety. Thus, there are a total of about 1,198 miles (1,155 miles of decommissioned roads, 30 miles of road improvements, and 10.2 miles of relocated roads) of action proposed between past, present, and future foreseeable roads projects and the 4FRI project that would contribute toward a safer and more affordable road system.

Climate Change

Introduction

Climate scientists agree that the earth is undergoing a warming trend, and that human-caused elevations in atmospheric concentrations of carbon dioxide (CO_2) and other greenhouse gases (GHGs) are among the causes of global temperature increases. The observed concentrations of

these greenhouse gases are projected to increase. Climate change may intensify the risk of ecosystem change for terrestrial and aquatic systems, affecting ecosystem structure, function, and productivity (USDA 2010).

Southwestern ecosystems have evolved under a long and complex history of climate variability and change. Taking into consideration the number of mega-droughts and other climate related variation, through time, southwestern systems have some built-in resilience (see silviculture report). However, between 1984 and 2006, an estimated 18 percent of southwestern coniferous forest was lost to increased fire and bark beetle outbreaks likely resulting from drought and high average temperatures (Williams et al. 2010) (see wildlife report).

This analysis synthesizes the direct and indirect environmental consequence information from the specialist reports (as applicable). It incorporates by reference the two planning documents, the "Kaibab National Forest's Climate Change Approach for Plan Revision" (USDA 2012) and the "Southwestern Region Climate Change Trends and Forest Planning" (USDA 2010). See the specialist reports for cumulative effects analyses that consider climate.

Current Conditions and Trends

Southwest Climate Influences

Only a summary of the Southwest climate influence is described here as the "Southwestern Region Climate Change Trends and Forest Planning" (USDA 2010) is incorporated by reference. The climate of the southwestern United States is often referred to as dry and hot; however, it is very complex. While low deserts of the Southwest experience heat and drying winds in the early summer, forested mountain areas and plateaus may experience cold and drifting snow during winter. Climate variability is the norm within this region, as temperature and precipitation fluctuate on time scales ranging from seasons to centuries. The major feature that sets climate of the Southwest apart from the rest of the United States is the North American Monsoon, which, in the U.S., is most noticeable in Arizona and New Mexico. Up to 50 percent of the annual rainfall of Arizona and New Mexico occurs as monsoonal storms from July through September (Sheppard et al. 2002) (USDA 2010).

While many factors influence climate in the Southwest during a particular year or season, predictable patterns hold across the years and decades to define the region's climate. In summary:

- The overall aridity relates to a global circulation pattern known as Hadley circulation, which creates a semipermanent high-pressure zone over the Southwest.
- Relatively high temperatures with dynamic daily swings define this geographic region.
- Mountains and other differences in elevation affect local climate patterns.
- The North American Monsoon works to bring moisture from the tropics into the region during the summer months (USDA 2010).

Based on current projections, the primary regional level effects of climate change most likely to occur in the Southwest include: warmer temperatures, decreasing precipitation, decreased water availability with increased demand, and increased extreme disturbance events. These climate change factors could, in turn, affect ecological, weather related disturbances, and socioeconomic demands, including increases in:

- Frequency of extreme weather events (intense storms);
- Wildfire risks;
- Outbreaks of insects, diseases, and spread of nonnative invasive species;
- Water scarcity coupled with increased demand;
- National forest socioeconomic uses and demands; and
- Changes in habitat quality and quantity for certain desired wildlife and plant species (USDA 2012).

Climate Change Threats to Local Resources

The purpose of the 4FRI project is to reduce the threats to resources that would be intensified with climate change. Currently, over 50 percent of the forested acres in the project area have reduced resiliency. Reduced resiliency increases the potential for severe effects from wildfire, density-related mortality in trees, and reduced resiliency to insect and disease. Currently, over 34 percent of the project area could sustain high-severity effects from crown fire. Treatments have been designed to increase forest resiliency and sustainability. Resiliency should increase the ability of the ponderosa pine forest in the project area to survive natural disturbances such as fire, insects and disease, and the extreme weather events associated with climate change. Some resources at risk in the project area include rare and endemic plants, soil and watersheds, and recreation settings:

Rare and Endemic Plants: As environmental conditions change, the ability of rare and endemic plant species to adapt may be negatively affected. Water availability may decrease in some areas while temperatures generally increase. Climate change, coupled with other factors such as habitat loss, could lead to extirpations and increased risks of extinction.

Soils and Watersheds: Uncharacteristic wildfires could result in a loss of soil productivity and sediment delivery to connected stream courses. Decreased soil moisture due to less precipitation expected from climate change and impaired or unsatisfactory soil conditions from wildfire events may lead to an overall decrease in long term soil productivity. There may also be a loss of sequestered carbon through burning of the overstory and increased erosion rates.

Recreation Settings: Desired recreation setting characteristics such as large, mature trees, healthy understory, and diversity of tree age classes, sizes, and species would be at high risk from the effects of climate change. Unmanaged forests have shown increases in tree stress and mortality as a result of global warming, and old, mature trees are especially vulnerable (Ritchie 2008, VanMantgem et al. 2009, Williams et al. 2010).

Climate change has the potential to affect burn frequency, carbon storage, and noxious weeds:

Burn Frequency and Carbon Storage: Woods et al. (2012) found that, although burn frequency affected the rate and total amount of carbon storage in a ponderosa pine forest, both 20-year and 10-year fire return intervals produced forests that were net carbon sinks, while the no action alternative forest became a net carbon source. Figure 47 displays carbon storage per acre comparing a no action “baseline” scenario with 10- and 20-year fire return intervals in a ponderosa pine forest of northern Arizona (adapted from Woods et al. 2012).

Noxious Weeds: Climate change is expected to be a source of widespread disturbances, and disturbance is a major factor in noxious weed invasions. Higher temperatures would occur and precipitation cycles would be modified from current patterns over large areas.

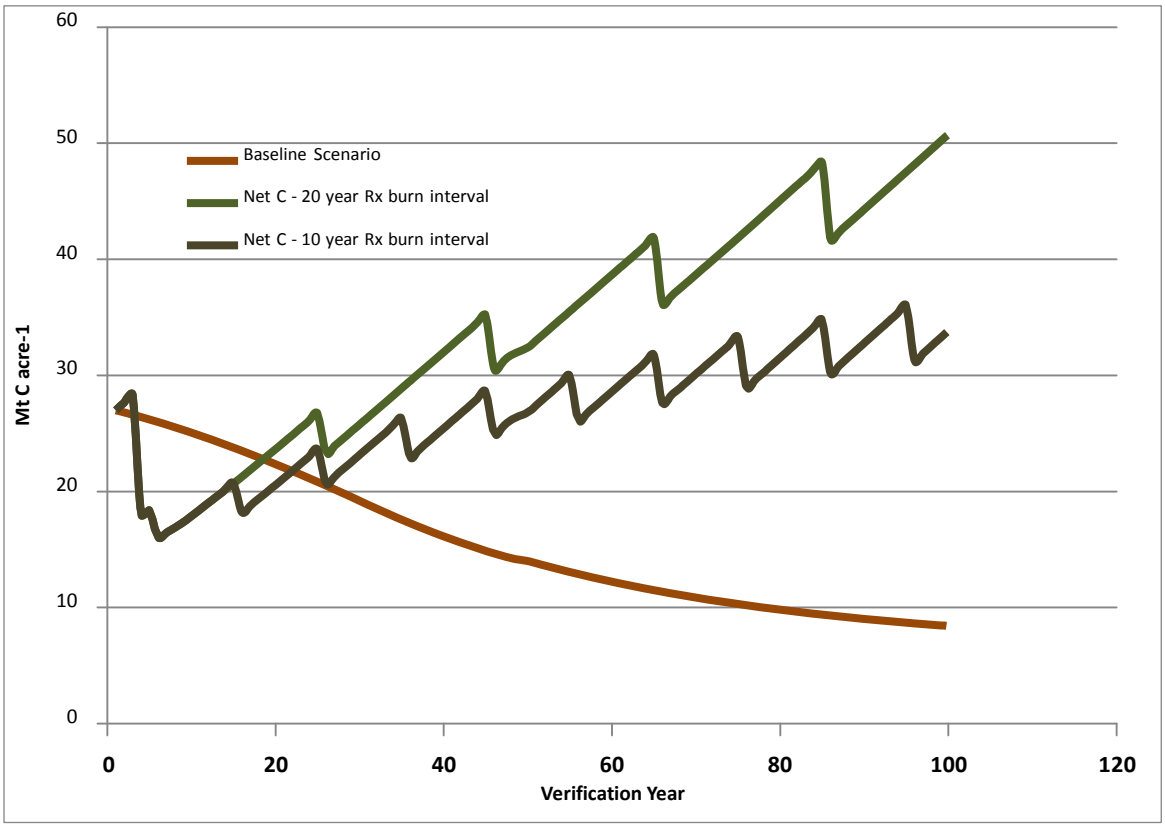


Figure 47. Carbon storage per acre comparing the no action baseline scenario with 10- and 20-year fire return intervals (Woods et al. 2012)

Strategies to Address Climate Change

In 2010, The Nature Conservancy (TNC) hosted a series of climate change workshops with the objective being to address climate change questions related to forest and wildlife health, and impacts to communities within the 4FRI area. Long term (2040 to 2060), high priority strategic recommendations from the workshop included thinning to create a mosaic of clumps and groups of trees with intermixed openings, treating more acres with prescribed burns, and allowing more wildland fire to burn (see wildlife report).

This is in alignment with the strategy developed by the Southwestern Region of the Forest Service (USDA 2010). Actions to address climate change are those that:

- Enhance adaptation by anticipating and planning for disturbances from intense storms,
- Reduce vulnerability by restoring and maintaining resilient native ecosystems,
- Increase water conservation and plan for reductions in upland water supplies,

- Anticipate increases in forest recreation,
- Use markets and demand for wood and biomass for restoration, renewable energy, and carbon sequestration, and
- Monitor climate change influences.

The 4FRI project encompasses several of the strategies to address climate change including (but not limited to) creating groups of trees with openings, returning fire to the landscape, and improving soils and watershed conditions.

Environmental Consequences

The scope of this analysis is confined to the project area which encompasses almost 1 million acres. This scale is most relevant to the questions (USDA 2009) addressed by the analysis:

1. How would climate change affect movement toward the project's purpose and need which focuses on restoring function and resiliency to the ecosystem? The indicators are:
   - Qualitative assessment of how the indicators of climate change would affect vegetation, fire risk and behavior, rare and endemic plants, noxious weeds, soil productivity and watershed function, wildlife species and habitat, and socioeconomic use and demand, including grazing and recreation.

2. How would the project impact climate change in terms of storing or releasing carbon into the atmosphere? The indicator is:
   - Short-term and long-term emissions and alterations to the carbon cycle caused by mechanical treatments and use of prescribed fire.

Alternative A

For vegetation resources, under the projected future climate conditions, dense forest conditions resulting from the no action alternative would be at a high risk of density related and bark beetle mortality. Vegetation would have limited resilience to survive and recover from potential large-scale impacts. Under drier and warmer weather conditions, the potential impacts of these risks to the ecosystem would be increased. Carbon stocks would remain high.

Individual tree growth would be low to the point of stagnation. As tree density increases, many areas would experience higher mortality (release of carbon) than growth (carbon storage). This trend would result in areas becoming a carbon source to the atmosphere (see silviculture report).

Although fire-excluded forests contain higher carbon stocks, this benefit is outweighed in the long term by the loss that would be likely from uncharacteristic stand-replacing fires if left untreated (Hurteau et al. 2011). In alternative A, 34 percent of the area would have the potential for high-severity fire effects from crown fire. Large-scale fire events that could occur with no treatment (alternative A) could release significant amounts of carbon into the atmosphere. Kolb et al. (2007) have shown that biomass and carbon may fail to recover. The Horseshoe Fire (on the Kaibab NF) was still a net carbon source 15 years after the fire (figure 48 and figure 49). Savage & Mast (2005) showed that these conditions can persist for decades (see fire ecology report).

Figure 48. Fifteen years after the Horseshoe Fire (photo from November 2011)

Figure 49. Healthy ponderosa pine forest

Alternative A would not improve the ability of rare and endemic plant species to adapt to suitable areas. Climate change coupled with other factors such as habitat loss could lead to extirpations and increased risks of extinction.

Approximately 34 percent of the project area would be at risk from severe high effects from crown fire. Larger and more frequent fires would be expected (Marlon et al. 2009). Climate may favor the spread of invasive exotic grasses into arid lands where the native vegetation is too sparse to carry a fire. When these areas burn, they typically convert to nonnative monocultures and the native vegetation is lost (USDA 2010).

Implementation of alternative A would put soils and watersheds at risk of continued uncharacteristic wildfires that could result in loss of soil productivity and sediment delivery to

connected stream courses. Soil erosion models indicate that approximately 24 percent of all soils left untreated could be subject to soil erosion above tolerable levels from severe wildfires if all soils burned under condition of high-burn severity (see water quality and riparian report).

In alternative A, approximately 82,592 acres of ongoing vegetation treatments and 96,125 acres of ongoing prescribed fire projects would continue to be implemented adjacent to the treatment area. Approximately 86,771 acres of vegetation treatments and 142,869 acres of prescribed fire and maintenance burning would be implemented adjacent to the treatment area by the forests in the foreseeable future (within 5 years). Alternative A does not contain thinning activities that would open the canopy and allow for improved soil condition and productivity in about 600,000 acres of the project area. Within these acres, long-term soil productivity is not expected to be improved from the beneficial effects from an increase in grass species that corresponds to a larger root network essential in loosening up and improvement of soil structure and promotes better water infiltration, air exchange, and soil microbial cycling of nutrients. Water storage in soil is not expected to improve and with an expected decrease in precipitation as is predicted with climate change, there would be less water available to plants.

In the no action alternative under drier and warmer weather conditions, individual tree growth would be limited to the point of stagnation. As tree density increases, many areas would experience higher mortality. Wildlife species requiring closed canopy forest conditions or old or large tree, snag, and log structure would be negatively impacted in the long term. Open forest, savanna, and meadow and grassland habitats would potentially increase in the long-term (see wildlife report).

For uses such as authorized grazing, allotment use is managed to respond to seasonal and annual changes in forage production. Increased temperatures combined with decreased precipitation could lead to lower plant productivity and cover which, in turn, could decrease litter cover. In the past, to address drought, some allotments were completely destocked while others were reduced to as little as 20 percent stocking. Allotment management would change as forage productivity changes from climate (see range report).

For recreation resources, climate change was only evaluated as part of cumulative effects. In alternative A, increased tree mortality and loss of large, mature trees would result in a cumulative decrease in recreation settings within the project area.

Alternatives B, C, and D

Under projected, future climate conditions, restoration treatments (e.g., mechanical treatment, prescribed fire) in alternatives B, C, and D would promote low-density stand structures, characterized by larger, fire-resistant trees (see silviculture specialist report). Mechanical treatment and prescribed burning would help to mitigate the negative impacts of stand-replacing fire in dry, dense forests by consuming less biomass and releasing less carbon into the atmosphere (Finkeral and Evans 2008, Wiedinmyer and Hurteau 2010).

Some of the carbon within the estimated 366,159,029 cubic feet (alternative B) to 367,737,165 cubic feet (alternative C) of biomass removed by mechanical thinning would be sequestered for a time in the form of building materials (silviculture specialist report). This assertion is supported by Ryan et al. (2010) who found that wood products which substitute standard building materials such as steel and concrete produce far less greenhouse gas emissions during their production

while simultaneously sequestering carbon (Fire Ecology Report). Finkeral et al. found that while the treatment initially produced a 30 percent reduction in the carbon held in trees, it significantly reduced the threat of an active crown fire, which they predicted would kill all the trees and release 3.7 tons of carbon per acre in any untreated areas.

Alternatives B-D reduce the potential for high-severity effects from crown fire by about 27 percent when compared to alternative A. Mechanical treatment and prescribed fire that produce only low- to moderate-severity effects would reduce onsite carbon stocks and releases carbon into the atmosphere at a lower rate than high-severity fire.

The low to moderate effects that would result from alternatives B-D should afford for greater carbon storage in southwestern fire-adapted ecosystems over time (Hurteau and North 2009). Research by Hurteau and North (2009) has also shown that the long-term gains acquired through prescribed fire and mechanical thinning outweighs short-term losses in sequestered carbon. In the long term (e.g., 100 years), thinning and burning would create more resilient forests less prone to stand-replacing events and, subsequently, able to store more carbon in the form of large trees.

For rare and endemic plant species, the actions proposed in alternatives B–D would provide more resiliency to local vegetative communities (see silviculture and wildlife understory analysis), restore natural fire regimes, and reduce the risk of habitat loss due to severe high effects (see fire ecology report). These actions are particularly important to all endemic species analyzed with one exception, Bebb's willow (see botany report).

In alternatives B–D, potential increase/spread of noxious or invasive weeds caused by disturbance would be reduced to a nonsignificant level by incorporating the mitigations, BMPs, and noxious or invasive weed treatments for the project. Increasing forest resiliency and function within the project area would diminish the impacts of climate change.

It is important to understand that in order to realize a management based net gain in soil carbon, there must be an increase in carbon entering the soil through a productivity increase over current levels or a decrease in decomposition and erosion (Neary et al. 2002). Productivity in arid forest ecosystems is low due to moisture limitations and the decomposition rates are among the lowest in the continental U.S. (Neary et al 2002), which is true for this project area.

It is likely that the forests within the project area have more stored carbon than pre-European settlement due to a change in stored carbon from understory to stand level tree productivity (Neary et al. 2002). As stated above, heavily stocked sites are subject to rapid removal of stored carbon through wildfires. The action alternatives propose removal of overstory through harvest on about 388,000 acres in alternatives B and D, and up to about 434,000 acres in alternative C. This is expected to actually decrease the amount of carbon sequestered over current stand conditions, but the harvest action will convert the existing stored carbon onsite to belowground storage, thus reducing its potential loss from wildfire (Neary et al. 2002). Implementation of alternatives B–D would reduce the risk of uncharacteristic wildfire that could result in loss of soil productivity, downstream water quality, and watershed function as well would improve overall soil productivity in the long-run through increased understory vegetation. The increase in ground cover of grasses, forbs, and shrubs, which have higher fine root turnover rates than large, woody plants would result in greater soil organic matter content over time.

The thinning, under the action alternatives, would improve soil condition and productivity for soil infiltration and nutrient cycling because an increase in grass species corresponds to a larger root

network essential in loosening up and improvement of soil structure and promotes better water infiltration, air exchange, and soil microbial cycling of nutrients, thus improving the ability of the soil to store water which would mitigate the potential loss of overall net precipitation that is expected with climate change. Decomposition rates are also likely to increase with a grass/forb ecosystem compared to a lignin based forest ecosystem, so there may be an increased loss of soil carbon after treatments as the site transitions to a grass/forb understory. Erosion is expected to decrease across the site with the removal of 900 miles of roads and the reduced risk of stand-replacing wildfires and the expected increase in soil productivity, thus potentially increasing carbon storage onsite. Neary et al. (2002) suggests that "perhaps the best carbon sequestration strategy in these inherently low productivity ecosystems is to return their structures to within their historical range of variability." The action alternatives would move toward a more sustainable carbon sequestration scenario for the project area, especially for soil carbon. Carbon sequestration is a means to counter expected human impacts that exacerbate climate change.

Risks associated with dense forest conditions would be reduced and forest resiliency large-scale disturbance under drier and warmer conditions would be improved by implementing the treatments proposed under alternative B–D. The increased acres of mechanical and prescribed burning in alternative C would be expected to increase forest health and resiliency more than alternative B or D. Individual tree growth would improve, resulting in larger average tree sizes. Wildlife species requiring habitat elements associated with closed canopy forest conditions or old or large tree, snag, and log structure would be more sustainable as forest resiliency improved. Open forest, savanna, and meadow and grassland habitats would remain stable in the long term (wildlife specialist report).

Alternatives B–D would increase forage in 89 percent of the allotments in the project area. Collectively, there would be the no discernible additive (adverse) effects or benefits that were offset by the increase in forage, decrease in moisture, or increase in temperature. Livestock grazing would continue to use adaptive management to match forage production with livestock numbers in a grazing management system (range specialist report).

For recreation resources, climate change was only evaluated as part of cumulative effects. Alternatives B–D, as well as other restoration projects, would cumulatively result in improved forest structure, composition and diversity, and more resilient forest conditions, decreased tree stress, and potential for decreased mortality. This would reduce the risk of losing desired recreation setting characteristics such as large, mature trees, healthy understory, and diversity of tree age classes, sizes, and species.

Short-term Uses and Long-term Productivity

NEPA requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). As declared by Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101). This disclosure focuses on soil, water, and vegetation resources.

Soils and Water

Overall, ponderosa pine, aspen, and grassland restoration along with other proposed treatments including prescribed fire would be expected to increase ecosystem resiliency to uncharacteristic fire, and move soils and watersheds toward satisfactory and functional condition in both the short and long term and maintain or improve long-term soil productivity and water quality (see soils specialist report and water quality and riparian specialist report).

Vegetation

Short-term effects of tree removal and prescribed fire would reduce intertree competition, and free up growing space for residual trees and understory vegetation. Under all alternatives, the proposed actions and associated design features would not affect long-term productivity of forest vegetation and timber resources (see silviculture specialist report).

Unavoidable Adverse Effects

Alternatives B, C, and D

There would no unavoidable adverse effects to soil and water resources. Potential adverse effects would be minimized or mitigated through appropriate use of resource protection measures such as SWCPs and BMPs as outlined in the "Soil and Watershed Conservation Practices Handbook" (Forest Service Handbook 2509.22)(USDA 1990) and site-specific BMPs included in appendix C.

There would be no unavoidable adverse effects related to forest vegetation and timber resources as adverse effects are mitigated by design features, BMPs, and mitigation.

For MSO, fire and smoke effects from prescribed burning may disturb individual birds in and adjacent to the treatment area, but timing restrictions and low-severity burn prescriptions would reduce impacts and largely lead to no effects or only short-term effects; however, the amount of burning across the landscape under alternatives B, C, and D would create the potential of smoke settling into a PAC. If this did occur, it could potentially lead to adverse effects to individual owls.

For MIS there is likely to be a short-term decrease in habitat quantity and quality for Abert's squirrel (Coconino NF) and the tassel eared squirrel (Kaibab NF). Habitat quality and quantity would increase in the long term.

In the short term (1 to 5 years), visual disturbances from restoration activities would be within the reference conditions of the area. In the short term (1 to 5 years), the disturbances would be visible and would lower the scenic quality. Potential short-term effects include exposure of bare soil, tree stumps, and contrasting color and texture of surfacing materials. The effects would become less noticeable as natural vegetation is reestablished and the surface material begins to be incorporated into the soil horizon.

Alternatives B, C, and D would cause short term and temporary decreases in provision of recreation opportunities on parts of the Coconino and Kaibab NFs. There may be short-term displacement of recreationists during implementation and a temporary decrease in the quality of recreation settings due to the presence of slash, skid trails, log landings, temporary road construction, and creation of dust and noise from logging operations and log hauling. Logging operations including loss of herbaceous cover, disorderly management activities, and noise and

dust, as well as lack of information, have been found to decrease the quality of recreation settings and user satisfaction.

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. Irretrievable commitments are those that are lost for a period of time such as the temporary loss of timber productivity in forested areas that are kept clear for use as a power line rights-of-way or road.

An irretrievable commitment of resources is associated with alternative A. In alternative A, there is the likelihood that there would be additional larger fires with larger areas with higher severity fires than occurred historically. Post-fire effects that require decades of recovery would be irretrievable in the short term and potentially the long term. For example, topsoil which is critical to healthy surface vegetation would take centuries to recover. The loss of old growth and old trees would be irretrievable as it would require decades and centuries to recover. When considered with climate change, it is unknown exactly what the ecological trajectory would be for the replacement of old growth and old trees (see fire ecology report).

Cumulative Effects

A summary of past, present, and reasonably foreseeable management actions and natural disturbances that were evaluated by most resources is located in appendix F. See the project record for the comprehensive master list of all projects and for additional information on each project.

Other Required Disclosures

NEPA at 40 CFR 1502.25(a) directs "to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with other environmental review laws and executive orders."

- All affected tribes would be consulted as each project phase (specifically mechanical treatment, spring and channel restoration, and prescribed fire activities) is prepared for implementation per consultation requirements of the National Historic Preservation Act.
- The Arizona State Historic Preservation Office (SHPO) has approved a programmatic agreement for the project and has concurred and provided Section 106 clearance for the project. See the project record for documentation.
- The FWS, in accordance with the ESA implementing regulations for projects with threatened or endangered species, provided informal project design input as the preferred alternative was developed. Formal consultation will begin after the DEIS formal comment period. See the project record for documentation.
- In order to implement springs, streams, and temporary road construction and decommissioning, a 404 permit would be required from the U.S. Army Corps of Engineers. Water quality certification from ADEQ may necessary.

- At this time, there is uncertainty whether a National Pollution Discharge Elimination System (NPDES) permit would be required for stormwater discharges from logging roads associated with this project. Although the Environmental Protection Agency has published a final rule exempting logging road stormwater discharge from NPDES permitting requirements, the United States Supreme Court is currently reviewing the matter. Until the Supreme Court rules, it will be uncertain whether a NPDES permit is required for this project.