USDA United States Department of Agriculture

4FRI Rim Country Project

Draft Environmental Impact Statement

Volume 2

Apache-Sitgreaves, Coconino, and Tonto National Forests
Coconino, Yavapai, Gila, and Navajo Counties, Arizona

Forest Service Southwestern Region MB-R3-04-34 October 2019

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Terrestrial Wildlife

This section includes key effects and conclusions for terrestrial 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 Terrestrial Wildlife Report (Schofer et al. 2018) and Botany and Weeds Report (Crisp 2018) are incorporated by reference. Aquatic species were analyzed separately in the Aquatics Report (Coleman 2018).

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.

Affected Environment

Vegetation Cover Types Within the Project Area

The cover types in the Rim Country project area possess key habitat features outside of the natural range of variation (NRV). These forests have less structural diversity due to more acres occurring as even-aged forest compared to historical conditions. Structure is also limited by the abundance of young and mid-aged trees and the decrease in mature and old-growth trees. These conditions do not meet forest plan direction for the ratio of age-classes interspersed across the landscape.

Habitat structure within the project area can determine the presence or absence of wildlife species. Many wildlife species select habitat provided by large and old trees, including bark gleaners (for example, pygmy nuthatches and hairy woodpeckers which are both MIS), cavity nesters (for example, MSO which is a threatened species), communal roosting species (for example, Allen's lappet-browed bats, a sensitive species), and larger/heavier nesting species (for example, northern goshawks, a MIS and sensitive species). Simplifying structure and declines of habitat features like aspen, Gambel oak, and the herbaceous community reduce habitat for an array for wildlife species from multiple trophic levels, including invertebrate communities and larger carnivores.

Springs, Riparian Areas, and Stream Channels

Many riparian streams in the Rim Country project area, particularly within the Rodeo-Chediski Fire area, are currently non-functioning or functioning-at-risk, with accelerated erosion and increased peak flows.

There are approximately 360 miles of fish-bearing streams in the Rim Country project area. These streams provide habitat for 12 native fish and two gartersnakes, including seven federally-listed species and four Regional Forester sensitive species (see the Aquatics specialist report).

Desired conditions for riparian streams are that they are capable of filtering sediment, capturing and/or transporting bedload (aiding floodplain development, improving flood-water retention, improving or maintaining water quality), and providing ground water recharge within their natural potential. Their necessary physical and biological components provide habitat for a diverse community of plant and wildlife species including cover, forage, available water, microclimate, and nesting/breeding/transport habitat. Stream habitats and aquatic species depend upon perennial streams or reaches and their habitat is maintained by the watershed, soil, and riparian conditions within the ecosystem.

Desired conditions for streams and aquatic habitats are to support native fish and other aquatic species, providing the quantity and quality of aquatic habitat within the natural range of variation. This includes increasing habitat complexity such as pools and large woody debris, reducing downcutting and sedimentation, improving riparian areas that provide channel stability and leaf litter, and providing stream shading to maintain water temperatures.

Assumptions and Methodology

Best Available Science

This analysis is based on best available scientific information. Data sources include research and life history literature and technical reports (see Literature Cited section), forest plan standards and guidelines, participation of researchers and managers from other agencies (as cited in this report), approved survey protocols, professional judgment, and the integration of other specialist reports for this project (Silviculture, Fire and Air Quality, Soils and Watershed, and Transportation) to determine effects on wildlife species and their habitats (see project record for additional information). The Rim Country interdisciplinary team developed spatially-defined databases for use in a Geographic Information System (GIS) from which the majority of the data and information contained in this report were derived. This database includes variables related to forest structure and forest health (such as, wildlife habitat such as snags, downed logs, tree density, size classes, and species, old growth, wildlife habitat classifications, and understory biomass index (see project record for additional information)). See the Silviculture and Fire Ecology and Air Quality Reports for details on the metrics used in this report and their respective modeling approaches, definitions, and assumptions.

Climate Change

The Climate Change Vulnerability Assessment for the Coconino National Forest and Rim Country project area (USDAFS 2017) identifies that 60 percent of the Rim Country project area is at moderate vulnerability, and 13 percent is at high vulnerability. At the ERU level, 50 percent of the mixed conifer was rated as very high vulnerability or risk of type conversion. Eighty-eight percent of the ponderosa pine ERUs were rated as high vulnerability.

The change in understory structure and palatability affects a wide array of wildlife from elk to arthropods, including a suite of prey species for goshawks and MSO. Climate change is predicted to lead to changes in fire patterns, increased evaporation and drought stress, reduced snowpack, and alters hydrologic timing and quantity (Marlon et al. 2009, NFWPCAP 2012).

Certain habitats are more vulnerable to a changing climate. For example, springs are a valuable natural water source for a variety of birds and mammals, particularly in arid environments. These areas may offer critical refugia for rare and narrow endemic species. However, many springs in the Rim Country project area are sensitive to variable precipitation and likely to dry up during prolonged drought. Along with increases in summer temperatures, climate change effects may make it harder for some riparian and wetland species to survive and challenge efforts to reintroduce some species into their historic range (Committee on Environment and Natural Resources 2008).

Recent work locally that focused on the 4FRI landscape supported these findings. Implementation of the proposed Rim Country activities would be in alignment with these recommendation.

Spatial and Temporal Scales

Effects on species and their habitats were evaluated at multiple scales. Depending on the species and specific analysis, this could include the site (based on stand data), watershed, ERU, and/or individual forest. Data used was generated from modeling identified in the Silviculture Report. The timeframe for short-term effects is after treatment (2029), representing conditions after all tree cutting and tree removal occurs, followed by prescribed fire in 2029 and 2039. The timeframe for short-term effects associated with aspen treatment is 2019 (when tree cutting is complete) and 2029 (when one prescribed fire has been conducted). The timeframe for long-term effects is 30 years after treatment, or 2049.

Whenever possible, species-specific habitat and locality data were used. Additionally, data queried by potential natural vegetation type (PNVT) and forest plan management area (Tonto NF) or desired conditions (Coconino and Apache-Sitgreaves National Forests) were used to help with analysis of effects on species' habitats.

Data is typically rounded to the nearest 10 acres, mile, or percentage. Most values have been rounded from their actual decimal values. Totals were calculated before any values were rounded in order to give the most accurate sum. Any apparent inconsistency between the total values reported in a table and a sum resulting from adding up individual values in a table typically accounts for a discrepancy of about 1 percent in the case of rounding percentages or miles, and fewer than 2 acres in the case of rounding acres. Similarly, rounding may have been applied to text discussions and calculated variables reported in tables.

Roads for Hauling Forest Materials in Wildlife Habitat

The Transportation Report assumes that nearly all of the existing roads in the Rim Country project area may at some point in time be used to provide access for a variety of restoration activities, including hauling of forest products resulting from mechanical treatments.

It is proposed in the Tonto Travel Management DEIS that 354 miles of ML2 roads be converted to motorized trails. These have received minimal maintenance over the years and their current condition is not anticipated to improve (narrowing, roughening up, or otherwise modifying the road as it's redefined to a motorized trail). Full size vehicles would be authorized to use these routes under Tonto Travel Management and they would be managed as motorized trails. A motorized trail is defined as "a route 50 inches or less in width or a route over 50 inches wide that is identified and managed as a trail." It is anticipated that pre-haul maintenance is all that would be needed in the future to prepare the motorized trails for use to access areas to be treated.

The Flexible Toolbox Approach for Mechanical Treatments

Appendix 2 of the Wildlife Specialist Report contains the complete Flexible Toolbox Approach for Mechanical Treatments. The proposed approach builds on the methods used in the 1st 4FRI EIS, but expands upon it to give the desired flexibility in mechanical treatments in areas with or without other management constraints (such as Mexican spotted owl (MSO) and goshawk (NOGO) habitat, or sensitive soils).

Analysis Methods to Evaluate Environmental Consequences from Alternatives on Mexican Spotted Owl Habitat

Key features of MSO habitat described in the Recovery Plan include Primary Constituent Elements of habitat important to the MSO such as:

- A range of tree sizes and ages with a preponderance of trees greater than 12 inches in diameter,
- basal area and density of pine and Gambel oak,
- Canopy cover and structure,
- Tree sizes suggestive of uneven-aged management, and
- Large dead trees (snags) with a diameter of 12 inches or greater.

MSO populations are influenced by prey availability. Key features of prey habitat include:

- High volume of fallen trees (mid-point diameter of 12 inches or greater) and other woody debris
- Plant species richness, including woody species
- Residual plant cover to maintain fruits, seeds, and regeneration to provide needs of MSO prey species, and
- Other improvements to prey habitat
- Primary Constituent Elements Related to Canyon Habitat (one or more of the following):
- Presence of water (often providing cooler air temperature and often higher humidity than surrounding areas.
- Clumps or stringers of mixed conifer, pine-oak, pinyon-juniper, and/or riparian vegetation:
- Canyon walls containing crevices, ledges, or caves: and.
- High percentage of ground litter and woody debris.

These forest structure elements are reflected in the evaluation criteria and are used to describe the existing condition of the habitat and the effects of the proposed activities according to FVS modeling over a thirty-year period from the existing condition in 2019, to 2029 and 2049.

- Acres treated and improved by habitat/vegetation type by alternative within MSO habitat type (protected and recovery habitats).
- Changes in basal area by tree size-classes to show effects from uneven-aged management by alternative within MSO habitats.
- Changes in Quadratic Mean Diameter in inches, trees per acre, Stand Density Index, Canopy Cover, and Basal Area Average by alternative in MSO habitats.

To analyze the effects of alternatives on snags, downed logs, and coarse woody debris the following habitat variables were modeled and reviewed:

- Change in number of snags per acre with a diameter of 12 inches and greater by alternative in MSO habitats (average number of snags 12 to 18 inches, 18 to 24 inches, and greater than 24 inches in diameter).
- Change in tons per acre of coarse woody debris surface fuel three inches or greater.

To analyze the effects of alternatives on understory to provide MSO prey habitat measures in MSO Habitats the following variables were modeled and reviewed:

- Snags per acre greater than 12 inches (average of snags 12 to 18 inches, 18 to 24 inches, and greater than 24 inches) and coarse woody debris in MSO habitats.
- Changes in tons per acre of shrub and herbaceous biomass (to maintain fruits, seeds, and regeneration to provide needs of MSO prey species) in MSO habitats.

To analyze the effects of fire by alternative in MSO habitats the following variables were modeled and reviewed:

- Changes in tons per acre by alternative of total surface fuel.
- Changes in potential fire behavior (fire hazard index) by alternative in MSO habitats.
- Changes in risk of crown fire by alternative and MSO habitats.

Uncertainty and Risk

The practice of prescribed fire has evolved over time and it is commonly used as a tool to reduce surface fuels while also maintaining forest structure/wildlife habitat components such as snags, logs, and coarse woody debris. However, prescribed fire is not a precise tool and there is inherent uncertainty and so potential risk with fire management. There is also risk and uncertainty in not addressing uncharacteristic surface fuel loads in fire-adapted ecosystems.

Monitoring data from the Coconino NF has documented loss of key habitat components from prescribed fire. Microhabitat monitoring from burns implemented on the Happy Jack Urban Interface Project on the Mogollon Rim Ranger District through late 2004 showed an eight percent loss of trees greater than 18 inches in diameter, a 21 percent loss of snags, a 71 percent loss of down logs, and a 47 percent loss of Gambel oak trees greater than five inches in diameter. In addition, prescribed burns conducted along Highway 87 and Forest Highway 3 (2005-2006) appear to have incurred loss of canopy cover and basal area. These projects did not include PACs and did not have a list of design features developed to minimize loss of key habitat components. Perhaps most important is that the projects being compared had a fuels reduction emphasis rather than the comprehensive restoration goals in the Rim Country Project.

Prescribed burning is expected to reduce the risk of future high-severity fire by reducing accumulations of fuels and raising canopy base height, both of which can benefit wildlife habitat in both the short and long term. However, it can also modify or destroy key habitat components for wildlife. Based upon the sheer number of acres proposed for burning each year, and because the intention is to apply prescribed fire to nearly all PACs and nest/roost recovery acres, there is a likelihood that more key habitat components could be unintentionally lost to fire than modeling indicates. Some degree of unintended fire behavior could improve wildlife habitat by creating canopy gaps and enriching soils. However, effects on habitat could also create adverse effects.

Wildlife Species Analyzed for this Project

Species that are evaluated here are ones known to occur within or have habitat within or adjacent to the project area. Each species from the above groups (such as, ESA, MIS, etc.) that occurs or has the potential to occur within the project area was analyzed according to the applicable law, regulation, or policy. In some cases, surveys for these species have confirmed their presence in or near the project area. In cases where a species has not been detected, the presence of suitable habitat indicates they could be present and therefore their presence was assumed under this analysis.

The following list of federally threatened, endangered, and proposed species is adopted from the USFWS web page (http://www.fws.gov/southwest/es/arizona), accessed on March 22, 2017). This list includes all federally threatened, endangered, candidate, and proposed species in the counties in the Rim Country project area. For the purpose of this analysis, only those federally-listed threatened, endangered, and candidate species and their critical habitat are analyzed. In addition, Forest Service sensitive species that are known to or have the potential to occur within the Rim Country project area are also analyzed. Species that are not present or do not have potential habitat in the project area were dismissed from further analysis as the project would have no effects on these species (Table 56).

Table 56. Threatened, Endangered, and Forest Service Sensitive (TES) Species Evaluated

Common Name	Scientific Name	Status[1]
Chiricahua leopard frog	*Rana chiricahuensis*	T
Northern leopard frog	*Lithobates pipiens*	S
Lowland leopard frog	*Lithobates yavapaiensis*	S
Mexican spotted owl	*Strix occidentalis lucida*	T
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	T
Bald eagle	*Haliaeetus leucocephalus*	S
Northern goshawk	*Accipiter gentilis*	S
American peregrine falcon	*Falco peregrinus anatum*	S
Burrowing owl (western)	*Athene cunicularia hypugaea*	S
Mexican wolf	*Canis lupus baileyi*	E/10j
Navajo Mogollon vole	*Microtus mexicanus Navaho*	S
Western red bat	*Lasiurus blossevillii*	S
Spotted bat	*Euderma maculatum*	S
Allen's lappet-browed bat	*Idionycteris phyllotis*	S
Pale Townsend's big-eared bat	*Corynorhinus townsendii pallescens*	S

1. Status: E = Federally Endangered; T = Federally Threatened; E/10j population = Endangered/Experimental population (section (10)(j) of the ESA; Eagle Protection Act = Bald and Golden Eagle Protection Act; S = Forest Service Sensitive.

Table 57. Threatened, Endangered, and Forest Service Sensitive (TES) Species Not Evaluated

Common Name	Scientific Name	Rationale for Dropping	Status[1]
Southwestern willow flycatcher	*Empidonax traillii extimus*	Neither the species nor its habitat occurs in the project area	E
Yuma clapper rail	*Rallus longirostris yumanensis*	Neither the species nor its habitat occurs in the project area	E
California condor	*Gymnogyps californianus*	Neither the species nor its habitat occurs in the project area	E
Narrow-headed gartersnake[2]	*Thamnophis rufipunctatus*	Not Addressed in the Terrestrial Wildlife Species Report	T
Northern Mexican gartersnake[2]	*Thamnophis eques megalops*	Not Addressed in the Terrestrial Wildlife Species Report	T
New Mexico meadow jumping mouse	*Zapus hudsonius luteus*	Neither the species nor its habitat occurs in the project area	E
Springerville silky pocket mouse	*Perognathus flavus goodpasteri*	Neither the species nor its habitat occurs in the project area	S
Aquatic insects2	Various species	Not Addressed in the Terrestrial Wildlife Species Report	S/MIS

1. Status: E = Federally Endangered; T = Federally Threatened; E/10j population = Endangered/Experimental population (section (10)(j) of the ESA; P = Federally Proposed; S = Forest Service Sensitive; MIS= Management Indicator Species; 2. Analyzed in the Aquatics Specialist Report.

Federally-listed Threatened, Endangered, Proposed and Candidate Species and Critical Habitat

Chiricahua Leopard Frog (CLF)

Listing Status

The Chiricahua leopard frog (*Lithobates [Rana] chiricahuensis*) was listed as threatened without critical habitat on June 13, 2002 (USFWS 2002). A recovery plan for the species was finalized in 2007 (USFWS 2007). Critical habitat was determined in March, 2012. The Rim Country Project Area occurs in Recovery Units 5 and 6.

Range and Life History

The historical range of the Chiricahua leopard frog included portions of west-central and southwestern New Mexico, and central and southeastern Arizona (in addition to portions of Mexico). The number of populations in much of the species' range has declined drastically over the past 20 years.

Within the species' range, aquatic habitats historically and/or currently used by the frogs include a variety of natural and human-constructed waters between elevations of 3,281 and 8,890 feet (1,000 and 2,710 meters), including rivers, permanent streams and permanent pools in intermittent streams, beaver ponds, cienegas (such as, wetlands), springs, and earthen livestock tanks. They are occasionally found in livestock drinkers, irrigation sloughs or acequias, wells, abandoned swimming pools, ornamental ponds, and mine adits (USFWS 2007: 17).

Species Distribution in the Project Area

Chiricahua Leopard Frog (CLF) populations have been detected at various times and locations since 1995 in the action area. Ellison and Lewis Creek in the Upper Verde Management Area (MA) is NE of Payson, AZ. Crouch, Gentry, and Cherry Creeks, and Parallel Canyon in the Gentry Creek MA is NE of Young, AZ. Both areas have CLF populations within and near these drainages (Figure 82). During 2010-2016, observers detected frogs at 19 sites in the Upper East Verde MA because of favorable monsoons, although water permanency has decreased. Also, 2011 had the most significant monsoon. Recovery activities by state and federal agencies contributed to frog detections throughout those years. (Akins 2018, pers. comm). Since then, recent on-the-ground recovery actions by the Local Recovery Group and documentation of natural dispersal to new sites have contributed to maintaining occupied sites across the project area; this includes six populations in designated critical habitat locations.

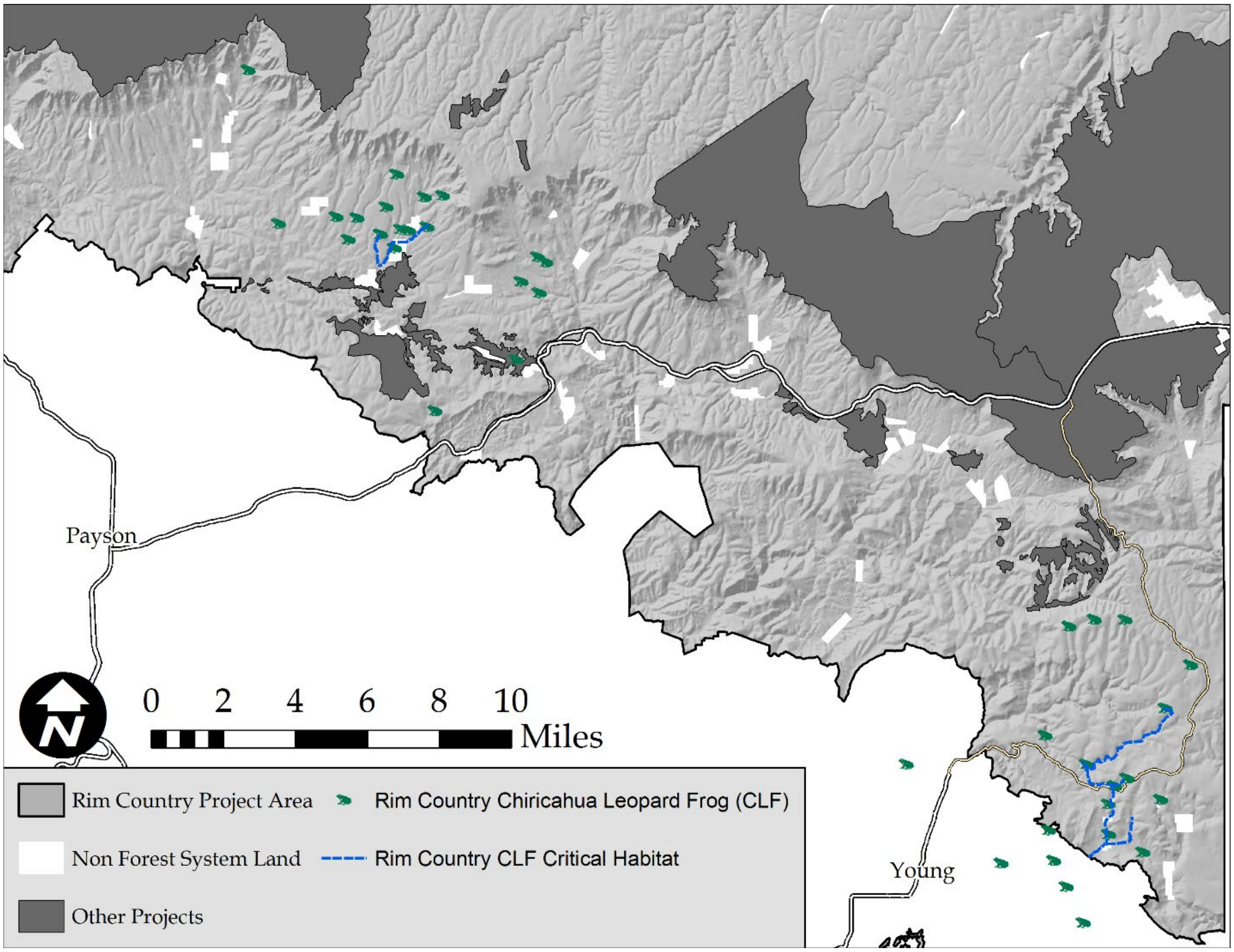

Figure 82. Occupied CLF Habitat within the Project Area

The CLF Recovery Plan identifies suitable habitat to include all perennial waters within: 1) elevational range of the frog (3,400 to 9,000 feet), 2) a mixture of aquatic and perimeter vegetation to provide oviposition sites, thermoregulation, and refuge from predators, 3) absence or low densities of nonnative aquatic species, and 4) a variety in substrate and range of shallow to deeper water for potential hibernacula (USFWS 2007).

Critical Habitat and Primary Constituent Elements in the Project Area

Based on observations of various ranids in Arizona and New Mexico (USFWS 2007: 14-15), reasonable dispersal distances for the species are: (1) one mile overland, (2) three miles along intermittent drainages, and (3) five miles along permanent water courses (USFWS 2007: D-2, 3). In 2012, the FWS designated 10,348 acres in Arizona, New Mexico, and Mexico as CLF critical habitat. This critical habitat falls within eight recovery units (RUs) and is made of 39 units of critical habitat. Two are in the project area. The Ellison and Lewis Creek Unit encompasses a small portion of the westernmost portion of the Apache-Sitgreaves National Forests and also portions of the Tonto and Coconino National Forests. The Crouch, Gentry and Cherry Creeks and Parallel Canyon Unit is on the Tonto National Forest.

Mexican Spotted Owl (MSO)

Listing Status

The MSO was listed as a threatened species under the ESA in March 1993 (USDI FWS 1993). A detailed account of the taxonomy, biology, and reproductive characteristics of the MSO is found in the Final Rule listing the MSO as a threatened species (USDI FWS 1993), in the Recovery Plan (USDI FWS 1995), and in the Revised Recovery Plan (USDI FWS 2012). Information on MSO in the Upper Gila Mountain Recovery Unit (UGM) is also summarized in Ganey et al. (2011). The information provided in these documents is incorporated here by reference as summarized below.

The FWS recommends recovery actions concentrate on recovery units with the highest owl populations (USDI FWS 2012). The UGM supports over half the known population of MSOs (Ganey et al. 2011). Owls appear to be more continuously distributed in the UGM, relative to other Recovery Units, and the central location of the UGM within the overall range of the MSO facilitates gene flow across their range (Figure 84). Therefore this Ecosystem Management Unit is important to the overall range-wide stability of MSOs. Modeling and Habitat Evaluation.

The 2012 Revised Recovery Plan (USFWS 2012) and individual forest plans describe the different levels of MSO habitat management, including protected, recovery, and other forest and woodland types. The stated objectives for managers are to ensure a sustained level of owl nest/roost habitat well distributed across the landscape and create replacement owl nest/roost habitat where appropriate while achieving a diversity of stand conditions across the landscape to ensure habitat for a diversity of prey species.

Species Distribution in the Project Area

Delineating MSO Habitat in the Rim Country Project Area

Following Recovery Plan direction, individual forest plans direct managers to conduct a districtwide or larger landscape analysis to ascertain whether minimum recommendations for nest/roost habitat exist across the forest. One of the strengths of landscape-scale planning is the ability to compare habitat across ecological scales as encouraged in the Recovery Plan.

A new recovery layer was created within the Rim Country project area, including designation of recovery nest/roost and foraging habitat as described in the Recovery Plan. This landscape-scale approach better meets the goal of providing continuous replacement nesting and roosting habitat over space and time, as described in the Recovery Plan.

Pine-oak habitat on the Tonto contains mostly ponderosa pine-Gambel oak to the east and pine –evergreen oak to the west. PACs and recovery habitats on the Tonto NF could not all be characterized as pine-oak or mixed conifer and so required queries using additional criteria. A geophysical model (GM) was used to identify recovery habitats based on slope and aspect (modeled recovery habitat). We also assumed that most canyons and drainages would contain some ponderosa pine.

The results of the queries were reviewed in meetings with biologists with on-the-ground familiarity of the Tonto, Coconino and Apache-Sitgreaves National Forests. This review was to ensure that stands also provided the best functional habitat; for example, stands were dropped from consideration when:

1. Remotely-sensed data was found to misidentify juniper as oak in the understory (this was a problem on the Payson Ranger District).
2. Small bubbles of isolated habitat were identified.

Proximity to PAC habitat was also an evaluation criterion. We sought to either augment PAC habitat or designate recovery habitat in previously undesignated pine-oak stands. Fire potential was also considered in developing the spatial configuration of MSO habitat on the landscape. Predominant winds are from the southwest, so we rarely identified additional owl habitat southwest of existing PACs unless stands were on northerly aspects. Because of the fire potential, areas southwest of PACs were revaluated for treatments that would reduce the risk of high-severity fires entering PACs. A final emphasis was placed on removing stands misclassified as recovery habitat.

Habitat criteria for nest/roost habitat was met for 39,461acres and 188,533 acres was designated as other recovery habitat as defined in the Recovery Plan (Table 58). All of the mixed conifer in the project area is recovery habitat.

Table 58. Acres of Mexican Spotted Owl (MSO) Habitat

MSO Habitat	Apache-Sitgreaves Acres	Coconino Acres	Tonto Acres	Total Acres
Protected Activity Center (Protected Habitat)	35,081 acres (56 PACs)	48,310 Acres (94 PACs)	27,498 Acres (46 PACs)	110,890 Acres (196 PACs)
Nest/Roost Recovery Habitat – Pine Oak	4,180	11,033	5,513	20,726
Foraging/Non-Breeding Recovery Habitat – Pine Oak	33,139	61,971	30,107	125,217
Nest/Roost Recovery Habitat – Mixed Conifer	6,700	6,019	1,688	14,407
Foraging/Non-Breeding Recovery Habitat – Mixed Conifer	8,923	18,837	3,285	31,045
Nest/Roost Recovery Habitat - Geo Phys Model	NA	NA	4,328	4,328
Foraging/Non-Breeding Recovery Habitat - Geo Phys Model	NA	NA	32,271	32,271
% Geo Phys Model Recovery Nest/Roost Recovery Habitat - Geo Phys Model	NA	NA	11%	11%
Total MSO Recovery Acres	52,942	97,860	77,192	227,994
Total MSO Habitat Acres	88,023	146,170	104,690	338,884

A similar process was initiated to consider the potential for specialized treatments inside PACs. A total of 196 PACs (110,890 acres) occur in the Rim Country project area, with 94 on the Coconino, 56 on the Apache-Sitgreaves National Forests and 46 PACs on the Tonto National Forest. An additional 39,748 acres either fall outside of the Rim Country boundary area (11,269 acres) or occur in other project areas (28,479 acres). These 39,748 acres would be treated as those projects planned and consulted with FWS. Twenty nine of these PACs would have some other type of restoration (riparian, wet meadow, grassland, aspen, etc. see Actions common to Alternatives 2 and 3 below). In the 4 FRI Rim Country project area up to 82,411 acres are proposed for other thinning and/or burning, or other restoration activities in Alternatives 2 and 3 (see Effects Analysis sections below).

Once the status of the PAC was determined, potential mechanical treatments were considered in terms of whether they could:

- Decrease the amount of time required for growing/increasing tree height and diameter;
- Decrease overall tree density while maintaining the density of large trees, and
- Increase canopy base height to improve flight zone (such as, improve owl foraging ability) and also reduce the threat of surface fires becoming crown fires.

It was determined that 12 of the 196 PACs assessed did not need mechanical treatments, and that mechanical treatments were possible in 24,875 acres of PACs. One hundred and seventy-one (171) miles of stream restoration, 2,881 acres of riparian restoration, and 489 acres of grassland/meadow restoration were identified in PACs. PACs were not considered for treatment if they were treated in previous projects, or if their habitat was not suitable for Rim Country treatments (some occur in designated wilderness or canyons, were previously burned, have conditions inside and outside the PAC that do not need active management, or there is not enough information to identify a need for treatment). Prescribed fire only was recommended for 49,066 acres in PACs, including using prescribed fire in core areas.

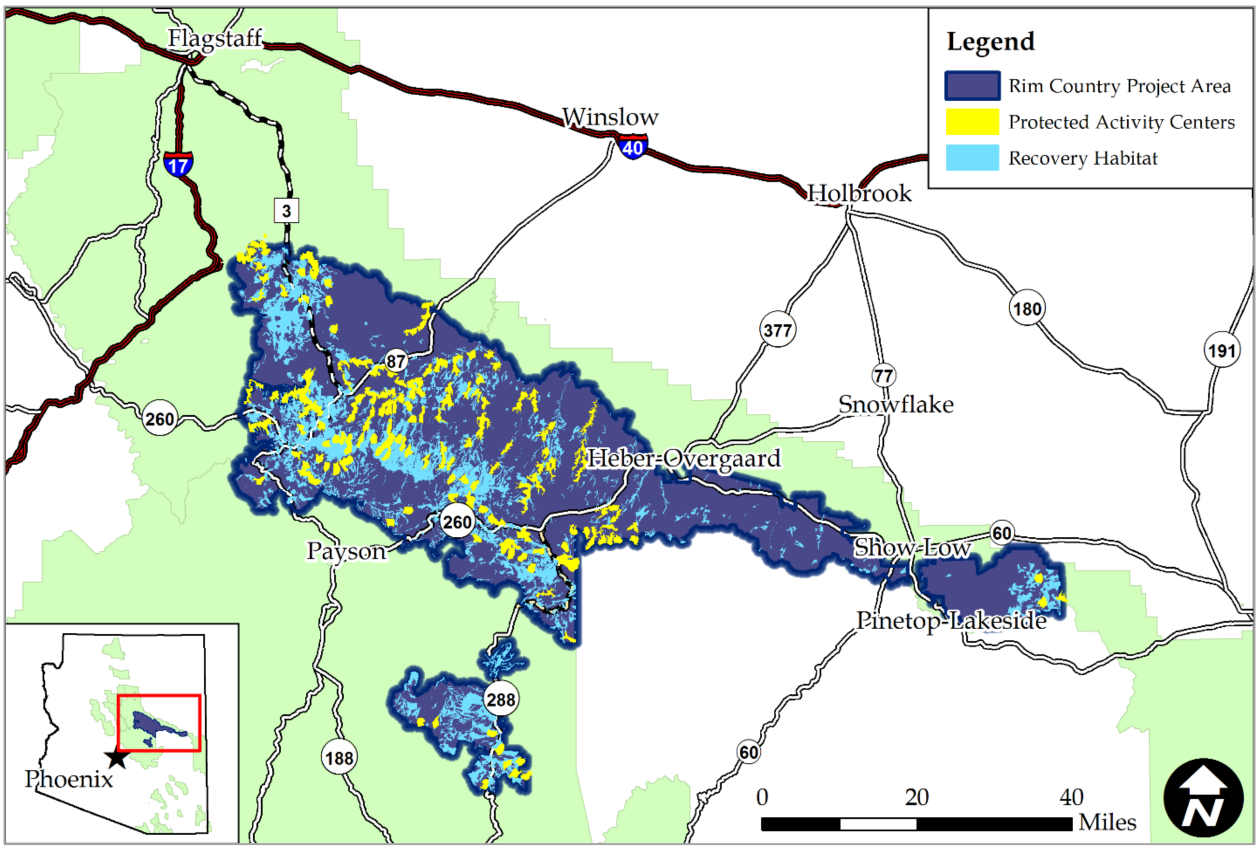

Figure 83. Mexican spotted owl habitat

Critical Habitat and Primary Constituent Elements in the Project Area

MSO critical habitat was designated by the FWS in 2004 (USDI FWS 2004). Critical habitat is defined as protected and recovery habitats within designated areas which contain the primary constituent elements (PCEs) necessary for conservation of the species (USDI FWS 2004). A detailed list of PCEs can be found in the Evaluation Criteria section below.

Two critical habitat units occur partially or completely within the Rim Country project area (Figure 84). They encompass 488,974 acres of Forest Service land, including mixed-conifer forest, but do not include state, private, Naval Observatory, or certain wildland-urban interface areas. A total of 266,149 acres of MSO habitat occurs within the critical habitat units in the Rim Country project area. In addition, non-MSO habitat occurs within critical habitat units and designated MSO habitat occurs outside of critical habitat units (72,735 acres).

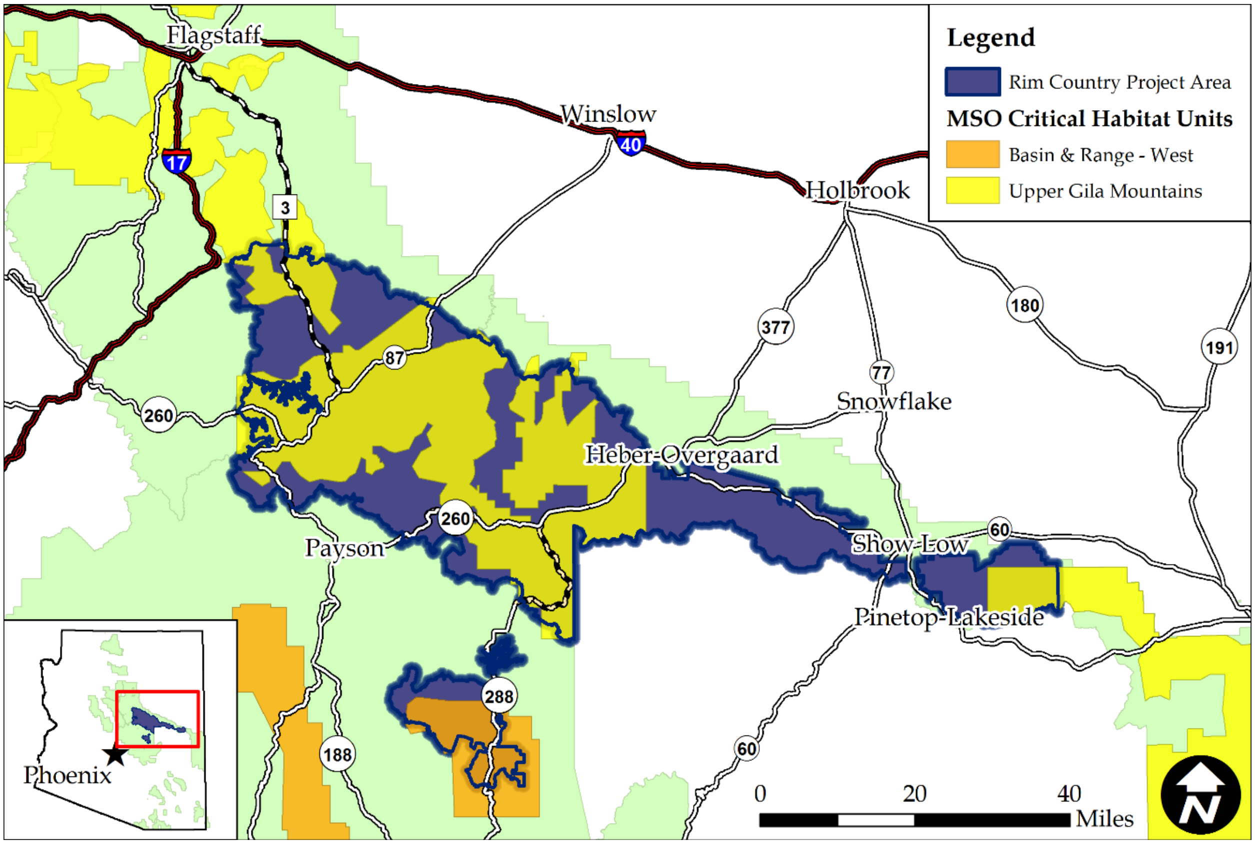

Figure 84. Mexican Spotted Owl critical habitat units

Western Yellow-billed Cuckoo (WYBCU)

Listing Status

The western distinct population segment of the yellow-billed cuckoo was listed as a threatened species under the ESA on October 3, 2014 (USFWS 2013, 2014b; 78 FR 61622, 79 FR 59992). Within the population segment (see Figure 1 at 79 FR 59994, in the final listing rule (79 FR 59992; October 3, 2014)), the habitat areas used by the species for nesting are located from southern British Columbia, Canada, to southern Sinaloa, Mexico, and may occur from sea level to 7,000 feet (ft.) (2,154 meters (m)) in elevation (or slightly higher in western Colorado, Utah, and Wyoming). Critical habitat for the yellow-billed cuckoo population segment was proposed on August 15, encompassing 546,335 acres across the western United States (USFWS 2014a; 79 FR 48548). The discussions of the status of this species in these documents are incorporated herein by reference. A revised proposed rule that may include additional proposed critical habitat is under development.

Range and Life History

In Arizona, the species was a common resident in the (chiefly lower) Sonoran zones of southern, central, and western Arizona (Phillips et al. 1964). The yellow-billed cuckoo now nests primarily in the central and southern parts of the state, as well as at revegetation sites along the lower Colorado River (MacFarland and Horst 2015; USFWS 2013, 2014a, 2014b, McNeil et al. 2013). In the Southwest, the Western yellow-billed cuckoo (WYBC) usually occurs in association with large blocks of mature riparian cottonwood-willow woodlands and dense mesquite associations (USFS 2011a). Habitat features of the WYBC indicate a preference for areas with a closed canopy and a sub-canopy layer (USFS 2011a). Dense understory foliage appears to be an important factor in nest site selection, while cottonwood trees are an important foraging habitat in areas where the species has been studied in California (USFS 2011a). Nesting west of the Continental Divide occurs almost exclusively close to water (USFWS 2001).

Species Distribution in the Project Area

The western distinct population of the yellow-billed cuckoo is not known to occur in the project area. No critical habitat areas have been identified within the Rim Country project area for the cuckoo, though proposed critical habitat units are seven miles east and south of the project area.

There have been no systematic surveys for the WYBCU on the Apache-Sitgreaves National Forests; however, there are some incidental known occurrences, all of them on the Apache side. The cottonwood-willow riparian forest cover type occurrence on the Sitgreaves side of the Apache-Sitgreaves National Forests is not likely to provide habitat extensive enough for nesting. On the Tonto National Forest, in previous years there have been detections of cuckoos in Rye Creek on the Payson-Tonto Basin border near Rye and Gisela creeks Cuckoos have also been found along the Verde River and Cherry Creek (Tonto Basin portion). It is possible that cuckoos could be present in some of the drainages in the Rim Country footprint.

Proposed Critical Habitat and Primary Constituent Elements in the Project Area

The 4 FRI Rim Country Project area does not contain proposed critical habitat for Yellow-billed Cuckoos, but it is likely that the species does occur here. Critical habitat Unit 19, Beaver Creek, is approximately seven miles east of the project area and Unit 22 (Tonto Creek) is approximately seven miles southeast of the project area.

3. Primary Constituent Element 1—Riparian woodlands. Riparian woodlands with mixed willow cottonwood vegetation, mesquite-thorn forest vegetation, or a combination of these that contain habitat for nesting and foraging in contiguous or nearly contiguous patches that are greater than 325 ft. (100 m) in width and 200 ac (81 ha) or more in extent. These habitat patches contain one or more nesting groves, which are generally willow dominated, have above average canopy closure (greater than 70 percent), and have a cooler, more humid environment than the surrounding riparian and upland habitats.
4. Primary Constituent Element 2—*Adequate prey base*. Presence of a prey base consisting of large insect fauna (for example, cicadas, caterpillars, katydids, grasshoppers, large beetles, dragonflies) and tree frogs for adults and young in breeding areas during the nesting season and in post-breeding dispersal areas.
5. Primary Constituent Element 3—*Dynamic riverine processes*. River systems that are dynamic and provide hydrologic processes that encourage sediment movement and deposits that allow seedling germination and promote plant growth, maintenance, health, and vigor (for example, lower gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial rivers and streams). This allows habitat to regenerate at regular intervals, leading to

riparian vegetation with variously aged patches from young to old. Because the species exists in disjunct breeding populations across a wide geographical and elevational range and is subject to dynamic events, the river segments described below are essential to the conservation of the western yellow-billed cuckoo, because they maintain stability of subpopulations, provide connectivity between populations and habitat, assist in gene flow, and protect against catastrophic loss. The occupied rivers and streams that are proposed for designation contain physical and biological features that are representative of the historic and geographical distribution of the species. All river segments proposed as western yellow-billed cuckoo critical habitat are within the geographical area occupied by the species as defined by the species' DPS at the time of listing (such as, currently) and contain the features essential to the conservation of the species. The features essential to the conservation of the species and refined primary constituent elements are present throughout the river segments selected, but the specific quality of riparian habitat for nesting, migration, and foraging would vary in condition and location over time due to plant succession and the dynamic environment in which they exist.

Mexican Wolf

Listing Status

The Mexican wolf, *Canis lupus baileyi*, is an endangered subspecies of gray wolf protected by the Endangered Species Act (80 FR 2488, January 16, 2015) (ESA). On January 12, 1998, the U.S. Fish and Wildlife Service published an Endangered Species Act section 10(j) rule for the Mexican wolf that provided for the designation of specific populations of listed species in the United States as "experimental populations". The Mexican wolf has been reintroduced on national forests in Arizona and New Mexico. These wolves have been designated as a non-essential experimental population, pursuant to section 10(j) of the Endangered Species Act as amended.

Wording from the USFWS 2014 EIS for the proposed revision to the Regulations for the Non-essential experimental population of the Mexican Wolf.

Disturbance-causing land-use activity means any activity on Federal lands within a 1-mi (1.6-km) radius around release pens when Mexican wolves are in them, around active dens between April 1 and July 31, and around active Mexican wolf rendezvous sites between June 1 and September 30, that the Service determines could adversely affect reproductive success, natural behavior, or persistence of Mexican wolves. Such activities may include, but are not limited to—timber or wood harvesting, prescribed fire, mining or mine development, camping outside designated campgrounds, livestock husbandry activities (for example, livestock drives, roundups, branding, vaccinating, etc.), off-road vehicle use, hunting, and any other use or activity with the potential to disturb wolves. The following activities are specifically excluded from this definition:

i. Lawfully present livestock and use of water sources by livestock;
ii. Livestock drives if no reasonable alternative route or timing exists;
iii. Vehicle access over established roads to non-Federal land where legally permitted activities are ongoing if no reasonable alternative route exists;
iv. Use of lands within the National Park or National Wildlife Refuge Systems as safety buffer zones for military activities and Department of Homeland Security border security activities;
v. Fire-fighting activities associated with wildfires; and
vi. Any authorized, specific land use that was active and ongoing at the time Mexican wolves chose to locate a den or rendezvous site nearby.

Thinning and burning projects have the potential to affect wolves, especially when reproduction and denning activities are disrupted. The Forest Service would work closely with the wolf field team to identify sensitive areas and avoid temporal disruptions that could negatively affect Mexican wolves.

Range and Life History

The Mexican wolf is a top predator native to the southwestern United States and Mexico that lives in packs and requires large amounts of forested terrain with adequate ungulate (deer and elk) populations to support the pack. Predator eradication programs in the mid to late 1800's to mid-1900's resulted in the near extinction of the Mexican wolf. Extinction was averted with the inception of a captive breeding program founded with seven Mexican wolves.

In the United States, Mexican wolves were reintroduced to the wild in 1998 in the Mexican Wolf Experimental Population Area, an area designated for Mexican wolf reintroduction in Arizona and New Mexico. The Mexican wolf population in this population area has exhibited robust growth in recent years. As of December 31, 2016, a population of at least 113 wild Mexican wolves inhabited the population area, the largest population size reached to date (USFWS 2017b).

The threats to the Mexican wolf have generally remained consistent over time, including human-caused mortality and related legal protections, extinction risk due to small population size, and loss of genetic diversity (USFWS 2017).

Species Distribution in the Project Area

Figure 85 shows areas of potential wolf habitat and includes parts of the Rim Country planning area classified as high quality. Radio-collared wolves on the Black Mesa District of the Apache-Sitgreaves National Forests have recently been located within the Rim Country boundary (USFS 2017), before returning to the east. In 2018, another lone male passed through Rim Country from the Gila Wilderness in NM to the Kaibab National Forest west of Flagstaff. Also in 2018, un-collared wolves were confirmed in the Heber/Overgaard area. Given wolves' capacity for long-distance dispersals (Mech et al 1995), we could reasonably predict that more individuals could occur within the Rim Country project area during the planning and implementation of the project. Coordination between the Forest Service and the Inter-Agency Field Team (IFT) would occur before phases of implementation to verify wolf occurrences in projects area.

The following figure is from Martínez-Meyer et al. 2017, Figure 19. Reclassified intermediate habitat suitability scenario for the Mexican wolf based on the combination of climatic suitability, land cover use, human population density, and road density.

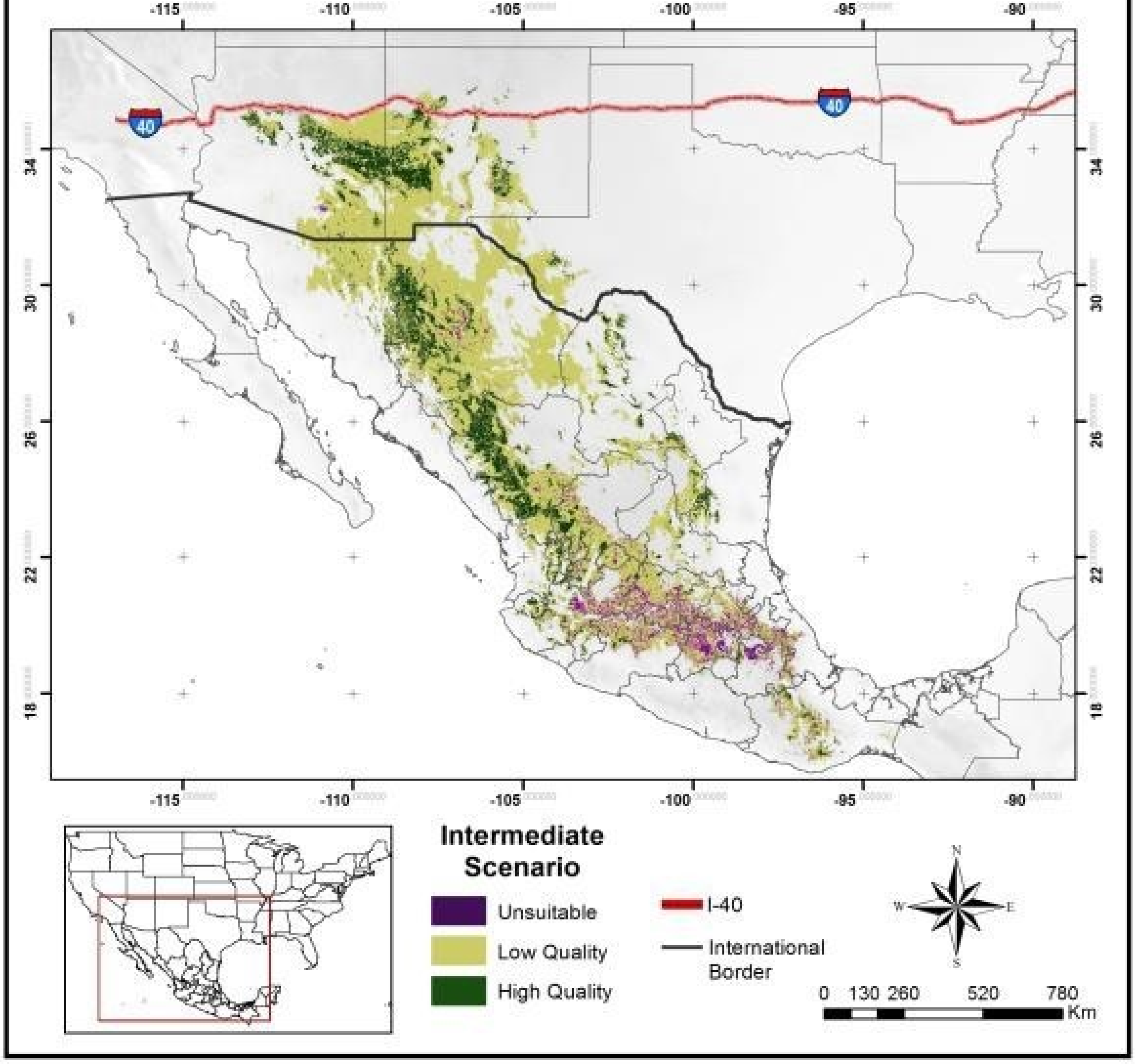

Figure 85. Focal area for Mexican wolf recovery strategy, including the MWEPA in the United States, and the Sierra Madre Occidental in Mexico

Forest Service Sensitive Species

Sensitive species are defined 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 (FSM 2670.5(19))."

The most recent Regional Forester's Sensitive Species list was transmitted to Forest Supervisor's in September 2013 and is the basis for the species used for this analysis. If survey information was not available, the assumption was made that potential habitat was occupied. The presence of species carried forward for analysis was determined by consulting forest records, results of surveys conducted on the forest, and use of the FAAWN database (Patton 2011) and NRM.

Thirteen RFSS occur within the project area. In-depth descriptions of these species and further information can be found in the Wildlife Specialist Report. The Northern Goshawk and analysis for this species is included below because key issues were raised by the public regarding treatment in goshawk habitat.

Northern Goshawk (NOGO)

This analysis addresses policy requirements and responds to key issues raised by the public including Issue 2, Treatments in Goshawk Habitat and Issue 3, Large Tree Retention. Indicators include changes in the amount and/or quality of goshawk nesting and post-fledging family area (PFA) habitat. Specific measures include:

6. Acres treated by habitat/vegetation type by alternative in PFAs and areas outside of PFAs.
7. Changes in tree size-classes by alternative in PFAs and areas outside of PFAs.
8. Percent canopy cover by alternative in PFAs and areas outside of PFAs.
9. Number per acre of snags logs, and tons per acre coarse woody debris in PFAs and areas outside of PFAs.
10. Changes in percent shrub and herbaceous biomass (to maintain fruits, seeds, and regeneration to provide needs of goshawk prey species) in PFAs and areas outside of PFAs.
11. Changes in potential fire behavior (Fire Hazard Index) by alternative in PFAs.
12. Changes in risk of crown fire by alternative in PFAs.

This report utilizes and incorporates by reference the vegetation cover type and vegetation existing condition information provided in the Silviculture Report and the respective forestwide MIS reports.

Forest Plan Compliance and Analysis Framework

Forest plan direction for northern goshawks applies to goshawk habitat outside of Mexican spotted owl habitat. In ponderosa pine forest, one or the other set of guidance applies and Mexican spotted owl guidance takes precedence in areas of overlap.

Habitat Strata and Scales of Analysis

PFAs are about 600 acres in size (including the nest areas, replacement nest areas, and habitat most likely to be used by fledglings during early development). PFAs were considered occupied. The Coconino Revised Forest Plan (2018), Tonto Forest Plan (1985), and A-S Revised Forest Plan (2015) have direction to include a minimum of six nest areas and replacement nest areas within each PFA. Nest areas would be about 25 to 30 acres in size (minimally 30 acres (Coconino National Forest)), and based on active nest sites followed by the most recently used historical nest sites.

Goshawks and Rim Country

There are 106 PFAs on the Coconino, Tonto, and A-S National Forests, totaling 60,180 acres in the Rim Country project area. Of these acres, 22,320 are within other project areas (Figure 86). Approximately 37,860 acres of PFA habitat would be treated with mechanical thinning and/or prescribed fire in the proposed action. A PFA was only counted once if a portion of that PFA occurs on more than one forest. Figure 86 shows the distribution of goshawk PFAs in the Rim Country project area. The Rim Country Flexible Toolbox Approach for Mechanical Treatments identifies PFAs as areas where special prescriptions would promote habitat variables needed by this species.

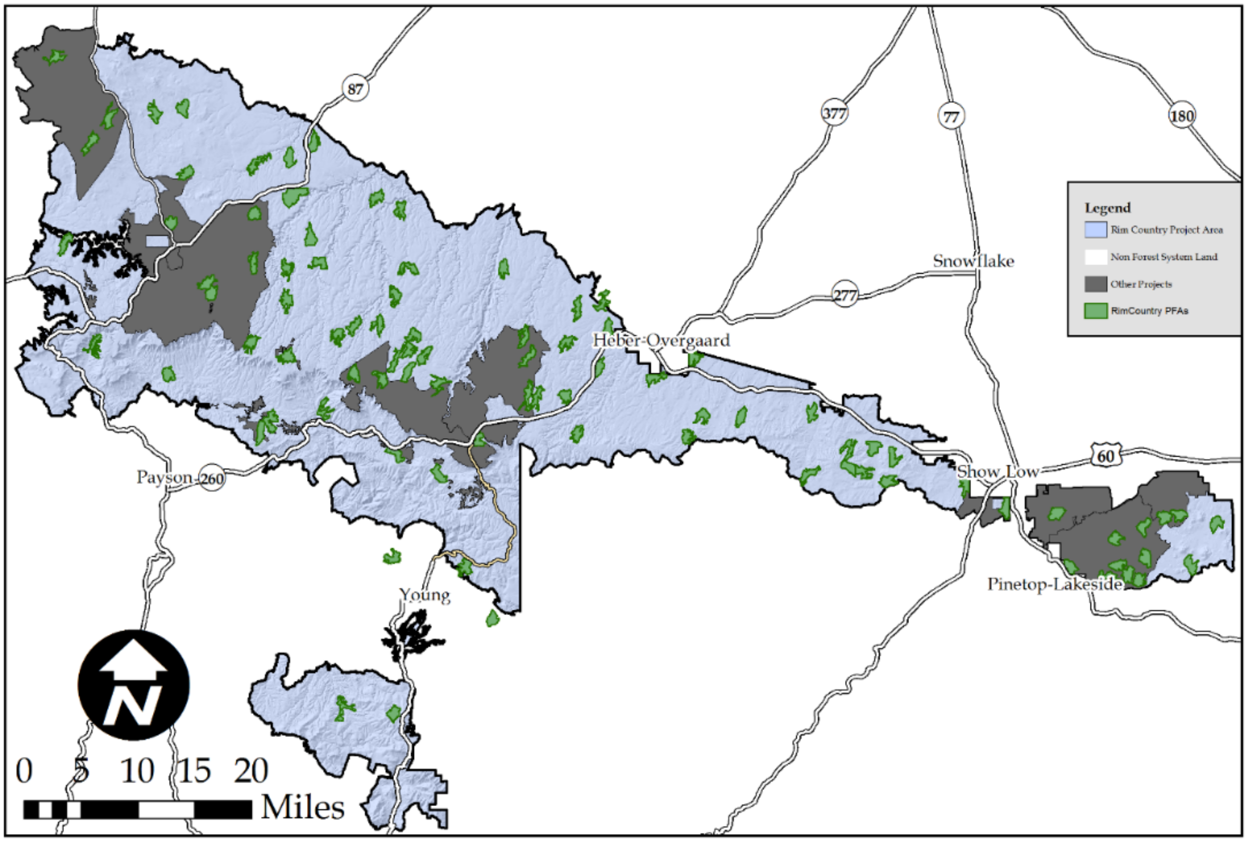

Figure 86. Goshawk PFAs

Bald Eagle

The FWS removed the bald eagle in the lower 48 States of the United States from the Federal List of Endangered and Threatened Wildlife as of August 8, 2007 (USDI FWS 2007d). Eagles are currently protected under the Golden and Bald Eagle Protection Act and are a Forest Service sensitive species.

The FWS recommends using the Conservation Assessment and Strategy for Bald Eagles in Arizona (Driscoll et al. 2006) in conjunction with the Bald Eagle National Management Guidelines (USDI FWS 2007e) to protect bald eagles in Arizona. These guidelines were incorporated into the Rim Country as design features or mitigation.

Bald eagles in central Arizona prefer to nest on cliff ledges or pinnacles or in tall trees (USDI FWS 1982). Bald eagles are habitat generalists and opportunistic feeders, typically taking the easiest and most abundant prey, regardless of whether it is dead or alive (Joshi 2009). They mainly forage on waterfowl and fish found along major streams; however, they do hunt in the uplands and forage on various mammal species, especially in the winter.

Nesting

Bald eagle numbers in Arizona have increased since 2008, with the number of breeding areas recorded increasing from 56 in 2008 to 85 in 2017. Active breeding areas increased from 44 in 2008 to 60 in 2017. The number of young fledged has increased from 53 in 2008 to 63 in 2017. Nesting success is partially attributed to the AZGFD Bald Eagle Nest Watch Program and to Forest Service closures around nest sites (Show Low Lake and Chevelon Canyon on the Apache-Sitgreaves National Forests).

There are seven nesting pairs of bald eagles within or near the project area (Table 59. Bald Eagle nests).

Table 59. Bald Eagle nests

Breeding Area	Location: Forest/Ranger District	Status in 2018/Recent Nesting History
Fool Hollow Lake	A-S, Lakeside	Active Nest in 2018.
Chevelon Canyon Lake	A-S, Black Mesa	Unknown. Successful nest in 2016, 2 fledged.
76	Tonto, Tonto Basin RD	Active. Successful nest in 2016, 2 fledged.
Silver Creek	Private, Adjacent to Tonto NF, Payson	Active. 2 fledged in 2015. Active nest in 2018.
Show Low Lake	A-S, Lakeside	Active.
Woods Canyon	A-S, Black Mesa	Active. 1 fledged in 2016, 1 fostered from Show Low Lake. Fledged 1 in 2018.
O.W. / Canyon Creek	Tonto, Pleasant Valley	Unknown. First nest attempt in 2018, nest failed.

Wintering

Bald eagles occurring on the Coconino and Apache-Sitgreaves National Forests are primarily winter visitors. Bald eagles overwintering in northern Arizona are primarily migratory individuals that breed in the northern U.S. and Canada (Grubb et al. 1989). They are often seen scavenging on carrion, including large and small mammals, or around some of the waters supporting fish and waterfowl. The AZGFD provided important wintering bald eagle habitat areas to consider for the 4FRI Rim Country analysis. These included the Lakeside Ranger District of the A-S's various lakes: Mogollon Plateau: Lower Lake Mary Road; Rattlesnake Canyon: Lake Mountain, Verde River Valley, Wingfield Mesa, Mogollon Plateau, Jack's Canyon; Mogollon Plateau: Slim Jim Ridge; Mogollon Rim: West Chevelon Canyon; Chevelon Canyon Lake; Mogollon Rim: Cottonwood Wash; Sierra Anchas: Dupont Canyon; Willow Springs Lake; and the Buckhead Mesa Landfill.

Small to moderate-sized groups of bald eagles (typically two to 48) roost in clumps of large trees in protected locations such as drainages and hillsides (Grubb and Kennedy 1982, Dargan 1991, Grubb 2003). Bald eagle winter night roosts typically consist of clumps of large (average diameter at breast height of 30 inches) trees on steep slopes that tend to occur on east-facing aspects (Joshi 2009). Group sites are typically in stands of ponderosa pine trees of less than an acre up to 43 acres, most often on north or northeast-facing slopes close to daytime foraging areas (Dargan 1991). Day roosts are often trees or snags near water or roadways. Bald eagles are highly mobile in the winter and can fly great distances in search of aquatic or terrestrial prey and suitable nighttime roosting habitat.

Golden Eagle

Golden Eagle nesting within the Rim Country project area has been recorded on the eastern boundary on the Verde River, outside of the project area on Deadman's Mesa and approximately 2 miles north of the project area on the Tonto National Forest, Pleasant Valley Ranger District. South of the project area in the Sierra Anchas, 7 Golden Eagle historic and active nest sites are within 1 to 3 miles of the project area. Approximately three miles north of Rim Country on the Apache-Sitgreaves National Forest, Black Mesa District there is an active nest site (2015) North of Heber, AZ. in Black Canyon and another NE of Chevelon Crossing.

Forest Service Management Indicator Species

The 2018 Coconino Revised Forest Plan identifies three wildlife species as management indicator species (MIS) to monitor ecosystem health. The 2015 Apache-Sitgreaves Revised Forest Plan also identified three focal species which were analyzed and will be monitored at the Forest level. The current Tonto National Forest Plan identifies 28 wildlife MIS, with 18 species known or assumed to occur within the Rim Country project area.

The 2018 Coconino Revised Forest Plan identifies three wildlife species as management indicator species (MIS) to monitor ecosystem health. The 2015 Apache-Sitgreaves Revised Forest Plan also identified three species. The current Tonto National Forest Plan identifies 28 wildlife MIS, with 18 species known or assumed to occur within the Rim Country project area.

The proposed project would affect ponderosa pine, mixed conifer, aspen, pinyon-juniper, grassland/savannah, ephemeral streams, and spring habitats. MIS or their respective habitat components that do not occur within the proposed Rim Country project area would not be analyzed. The presence of species carried forward for analysis was determined by surveys conducted on the forests and the FAAWN (Forest Attributes and Wildlife Needs) database (Patton 2011).

Eighteen MIS whose distribution across the Rim Country National Forests encompasses part or all of the project area are included in the terrestrial effects analysis (Table 60). The analysis is also based on forest plan direction and projected changes in quality habitat under the alternatives.

Table 60. Terrestrial Management Indicator Species (MIS) or Focal Species Analyzed

Management Indicator Species	Forest(s)	Key MIS Habitat Component Indicator	Habitat within Project Area
Pronghorn antelope (*Antilocapra americana*)	Coconino	Great Basin grassland, montane-subalpine grassland	Montane–subalpine grassland
Mexican spotted owl (*Strix occidentalis lucida*)	Coconino	Late-seral pine-oak, dry/wet mixed conifer and spruce-fir	Ponderosa pine–oak, dry mixed conifer
Northern goshawk (*Accipiter gentilis*)	Tonto	Late-seral ponderosa pine	Ponderosa pine
Pygmy nuthatch (*Sitta pygmaea*)	Coconino; Tonto	Late-seral ponderosa pine	Ponderosa pine
Turkey (*Meleagris gallopavo merriami*)	Tonto	Late-seral ponderosa pine, mixed conifer	Ponderosa pine
Rocky Mountain elk (*Cervus elaphus*)	Tonto	Early seral ponderosa pine, mixed conifer, and spruce-fir	Ponderosa pine, mixed conifer
Hairy woodpecker (*Picoides villosus*)	Tonto	Snags in ponderosa pine, mixed conifer and spruce-fir	Snags in ponderosa pine
Abert's squirrel (*Sciurus aberti*)	Tonto	Early seral ponderosa pine	Ponderosa pine
Violet green swallow (*Tachycineta thalassina*)	Tonto	Ponderosa pine; mixed conifer cavities	Ponderosa pine; Mixed conifer
Ash-throated flycatcher (*Myiarchus cinerascens*)	Tonto	Pinyon-juniper woodland	Pinyon-juniper
Gray vireo (*Vireo vicinior*)	Tonto	Pinyon-juniper woodland	Pinyon-juniper
Townsend's solitaire (*Myadestes townsendi*)	Tonto	Pinyon-juniper woodland	Pinyon-juniper

Management Indicator Species	Forest(s)	Key MIS Habitat Component Indicator	Habitat within Project Area
Juniper (Plain) titmouse (*Baeolophus ridgwayi*)	Tonto	Pinyon-juniper woodland	Pinyon-juniper
Northern (Common) Flicker (*Colaptes auratus*)	Tonto	Pinyon-Juniper woodland (snags)	Pinyon-Juniper
Arizona gray squirrel (*Sciuris arizonensis*)	Tonto	Riparian-High Elevation (3000 ft. plus)	General Riparian
Western bluebird (*Sialia mexicana*)	Tonto	Forest openings in ponderosa pine/mixed conifer type	Ponderosa pine-oak, mixed conifer
Western wood peewee (*Contopus sordidulus*)	Tonto	Riparian-High Elevation	Riparian tall overstory
Black hawk (*Buteogallus anthracinus*)	Tonto	Riparian-High Elevation	Riparian tall overstory

Information on species, their population trends, and habitat trends presented in this analysis is incorporated into the wildlife specialist report. Analysis of MIS for the Coconino National Forest (USDA FS 2011), Tonto National Forest Forestwide MIS report (USDA FS 1985a) is also incorporated by reference. For more in depth discussions of habitat types and species selection as well as forest wide population trends, see the Wildlife Specialist Report (USDA FS 1985a).

A discussion of habitats and bird species found in these habitats is included in the Wildlife specialist report.

Important Bird Areas

The Mogollon Rim Snowmelt Draws Important Bird Area is the only one within the project area. It covers approximately 72,162 acres and encompasses drainages located within eight kilometers of the edge of the Mogollon Rim, an abrupt cliff that represents the southern extension of the Colorado Plateau. This edge of the Rim has a narrow band of moist vegetation (especially maples) associated with greater precipitation formed by the upward deflection of air at the rim face. The habitat of this bird area includes ponderosa pine, white fir, Douglas fir, southwestern white pine, quaking aspen, and Gambel oak. Young plants of these canopy trees, plus canyon maple and New Mexico locust, dominate the understory woody species.

See the Arizona Important Bird Areas Program website for more information at http://aziba.org.

About 45,673 acres of habitat would be treated within the project area, equaling about 61 percent of the Important Bird Area. While most acres proposed for treatment are within ponderosa pine habitat, treatments in the Important Bird Area would also occur in mixed conifer, aspen and oak/maple habitats. In addition, road decommissioning, restoration of springs, and over 30 miles of riparian restoration activities are proposed within the area.

Other Species of Concern

Locally Important Species

The Forest Plans of the 4FRI Rim Country forests provide desired conditions and guidelines for the protection of locally important species on each of the forests. Most of the terrestrial species considered rare and endemic on the forests are outside the Rim Country project area. No further documentation is required for the following species except for the Arizona black rattlesnakes and Arizona toad (see wildlife specialist report).

Environmental Consequences

Environmental consequences consist of species analyses, beginning with federally threatened and endangered species followed by Forest Service sensitive species, management indicator species, migratory birds, and effects on Important Bird Areas. Following the analysis of direct and indirect effects for each species group is a review of cumulative effects.

Effects from Climate Change

Alternative 1

Alternative 1 would not prevent, delay, or ameliorate predicted effects from climate change. The dense forest conditions resulting from Alternative 1 are at a high risk to density-related and bark beetle mortality and have limited resilience to survive and recover from potential large-scale fire events and the interactions of these influences with climate change. Under drier and warmer weather conditions, the potential effects of these risks on the ecosystem would be increased. Individual tree growth would be limited to the point of stagnation. As tree density increases, many areas would experience higher mortality. Species requiring closed canopy forest conditions or old or large tree, snag, and log structure would be negatively affected in the long term. Patches of open forest, savanna, and meadow and grassland habitats would potentially increase in the long term as groups of dense forest succumb to the above mortality agents.

Alternatives 2 and 3

Risks associated with dense forest conditions would be reduced and resilience to the effects from large-scale disturbance under drier and warmer conditions would be improved by implementing the proposed treatments. Individual tree growth rates would improve, creating and retaining more large and old trees. Habitat elements associated with closed canopy forest conditions would be reduced, but would be more sustainable. Risk from insects, fire, and their interactions with climate would be reduced. Because of law, regulation, and policy, more closed canopy habitat would be available than what likely occurred historically. Ensuring the growth and retention of large trees would maintain large snag and log structure across the forest over time. Open forest, meadow, savanna, and grassland habitats would be enhanced and habitat effectiveness increased as encroaching trees were removed and habitat for grassland and pollinator species became less fragmented. These habitats would remain stable in the long term. The increased acres of mechanical and prescribed fire under Alternative 2 would realize the most benefit in terms of forest health and resiliency. The limited acres of treatment under Alternative 3 would be expected to maintain higher fuel loadings, resulting in more limited gains in forest resiliency due to increased flame lengths, lower canopy base height, and persistent ladder fuels. Alternative 3 would retain the densest forests and therefore achieve the least in terms of large tree growth rates and resilience.

Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitat

Chiricahua Leopard Frog (CLF)

Alternative 1 (No Action)

Under Alternative 1, habitat conditions for wildlife would largely remain in their current condition. Thinning and prescribed fire would still occur in RU 5 as a result of current and reasonably foreseeable projects. However, the landscape would continue to move away from desired conditions (see Affected Environment above and the Silviculture and Fire Ecology and Air Quality Reports). Alternative 1 would have no direct effect on Chiricahua leopard frogs; however there would be substantial indirect effects. Dense forest conditions would still occur and the high fire hazard potential would persist. Large crown-wildfires could adversely affect potential habitat by destroying understory and overstory vegetation. As a result, overland flow would increase, and soil erosion would increase, with potentially high sediment loads. Water quality and riparian conditions would be adversely affected on a wide-scale basis (see Water and Riparian Resource Report), resulting in indirect adverse effects.

With Alternative 1, there would be no restoration of springs and riparian areas. These areas would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future (see Water and Riparian Resource Report), resulting in degradation of potential habitat for frogs.

Denser forest conditions produce lower values in understory biomass (pounds per acre). Under Alternative 1, understory biomass would continue to decline over the next 40 years. Limited cover around tanks and riparian areas, as well as the limited herbaceous understory across the project area, would continue to reduce the likelihood that frogs would successfully disperse and feed while traveling between waters. The limited cover would also leave frogs vulnerable to predation.

Cumulative Effects

The area analyzed for cumulative effects for northern leopard frogs is RU 5 within the project area and a 0.25-mile buffer outside of the project boundary, along RU 5 to include current and potential breeding sites. Cumulative effects include the effects from Alternative 1. This alternative would continue to result in indirect effects on Chiricahua leopard frogs. Degradation of habitat facilitated by this alternative would cumulatively combine with other forest activities, high-impact recreational use, livestock grazing, and habitat loss and degradation on private lands. Synergistic effects from climate change would continue to fragment key aquatic and dispersal habitat.

Critical Habitat

Two critical habitat management area units are within the action area: the Ellison and Lewis Creek management area and the Crouch, Gentry, Cherry Creeks, and Parallel Canyon management area. No change is expected to occur in these management area units under the no action alternative.

Determination of Effect

Alternative 1 may **affect** and is likely to adversely affect the Chiricahua leopard frog and designated critical habitat.

Effects Common to All Action Alternatives

Alternatives 2 and 3 would allow discharge from springs to resume flow through their historic spheres of discharge. Restoration implementation would increase riparian vegetation increasing availability of food and reproductive sites for this species over the long term, resulting in direct beneficial effects on habitat. Restoration would improve cover and water flow that provides escape from predators and prevents water loss for migrating leopard frogs.

Alternative 2 – Modified Proposed Action

Direct and Indirect Effects

Leopard frogs dispersing overland could be directly affected if they are inadvertently run over by mechanical equipment or if they could not find refugia during prescribed fire activities. All suitable habitat would be surveyed prior to restoration activities. Design features (see below and Appendix 5 of the wildlife specialist report) would reduce the likelihood of direct effects on frogs from mechanical thinning, temporary road construction, spring and riparian restoration, road decommissioning, and prescribed fire.

Under the modified proposed action, dense forest conditions and surface fuel loading in RU 5 would be reduced. The likelihood of large crown wildfires adversely affecting potential habitat by destroying understory and overstory vegetation would be reduced from 327,867 acres (59 percent) of all ponderosa pine to 129,762 acres (23 percent). Fire hazard index in grasslands would also be greatly reduced, from 5,000 acres to 138 acres). As a result, overland flow would be stable, and soil erosion would not have the high sediment loading potential. Water quality would not be adversely affected on a wide scale, resulting in indirect beneficial effects.

Under Alternative 2, spring and riparian restoration is proposed only in unoccupied habitat or with consultation with USFW. An important consideration for restoration of springs is to restore discharge from the spring source except where prescribed by existing adjudicated water rights. Alternative 2 would allow discharge from springs to resume flow through their historic spheres of discharge. Restoration implementation would increase riparian vegetation increasing availability of food and reproductive sites for this species over the long term, resulting in direct beneficial effects on habitat. Restoration would improve cover and water flow that provides escape from predators and prevents water loss for migrating leopard frogs.

Decommissioning unauthorized roads in RU 5 would improve the quality of the habitat in those areas where the roads are decommissioned. While the physical structure and features of the habitat may not measurably change along the former road alignment, eliminating disturbance along the roadway would be expected to improve the quality of habitat and reduce the potential for frogs to be crushed by vehicles using these roads. With each mile of road affecting approximately three acres of habitat, many acres of forested habitat may be improved within Chiricahua leopard frog breeding and dispersal habitat. Long-term effects would include habitat improvements over current conditions.

Constructing temporary roads would disturb vegetation and reduce habitat quality for leopard frogs. These effects may affect individuals but are expected to be short term, occurring only during project implementation. Temporary roads would be decommissioned to eliminate use and vegetation would be restored over the long term.

Implementation of the proposed action could increase the risk of spread of chytrid fungus across the project area. Machinery and equipment used during implementation could transfer chytrid fungus between waterbodies, increasing the occurrence of the pathogen in leopard frog habitats across the project area. Potential effects from chytrid fungus that is spread by machinery and equipment would be minimized by requiring decontamination procedures to be followed when activities take place within wetted areas or the moist perimeter of a tank or ephemeral stream and then immediately moving to another wetted area (see design features in Appendix C). Therefore, minimal potential for spread would exist.

Under the proposed action, surface disturbance within proximity of suitable habitats would increase. The use of heavy machinery and increased levels of human activity and traffic are likely to increase sedimentation in the earthen livestock tanks in the vicinity, especially in those located downslope from treatment areas. Effects from sedimentation on leopard frog habitats are extensive and varied. They include alterations in water quality and vegetation structure that ultimately have detrimental effects on leopard frogs by decreasing rate of development, increasing vulnerability to predators, and reducing food availability.

Additional meadow and grassland treatments are scattered throughout the project area and would occur in most of the area, increasing the likelihood that frogs would successfully forage around and migrate between available habitats due to decreased risk of predation.

Prescribed burning direct impacts are not likely, as most often, short term indirect impacts could occur due to sedimentation and increased ash flow. Prescribed burns where the majority of critical breeding sites occur would be coordinated with a wildlife biologist to insure protections for migrating frogs. In coordination with AZGFD, occupied, critical breeding, and potential breeding sites have been identified and mapped and would be included in the individual task order map with a protected water designation. Project design features (see below and Appendix 5 of the Wildlife Specialist Report) have been developed to reduce the potential effects on these important breeding sites and frogs using and moving between these sites. Implementation of best management practices would curtail soil erosion and minimize the potential for inflow into potential Chiricahua leopard frog habitat.

Critical Habitat

Effects on the primary constituent elements (PCE) of critical habitat are similar to the effects on suitable Chiricahua leopard frog habitat as described above. No long-term changes are expected to occur to any primary element from implementing the proposed action. Short-term effects on primary elements are possible related to water quality if precipitation follows directly after a burn, but these effects would be temporary and characteristics would return to pre-burn conditions. The proposed action would not significantly alter any of the characteristics of critical habitat primary constituent elements for the Chiricahua leopard frog.

PCE 1 – Aquatic breeding habitat and immediately adjacent uplands: Thinning and prescribed fire would not remove or reduce standing bodies of water within the action area. In the unlikely event that water is needed for fire abatement, it would not be drawn from any suitable or designated critical habitat but instead taken from an external source. Treatments under controlled conditions would reduce future sedimentation potential. Temporary roads needed to access areas for thinning would follow design features to mitigate soil and watershed damage. Prescribed fire would be managed to ensure lower-severity fire behavior, allowing for fuel reduction without soil damage. These actions would reduce the potential for sedimentation, ash accumulation, and the influx of pollutants that may degrade the water quality of important aquatic sites. It is unlikely for emergent or aquatic vegetation to be completely removed by back-burning fire because of moisture levels in riparian plants, burning techniques (back-burning), and the time in which prescribed burning would take place around frog populations. Some upland vegetation could be removed but this disturbance is expected to be short term and rebound during the following growing season.

Any effects that may occur as a result of the proposed action are anticipated to be insignificant given design features to reduce effects from implementation have been added to the proposed action (see Appendix C). These measures are in place to ensure that the proposed action would not contribute to the spread of nonnative predators and chytridiomycosis.

PCE 2 – Dispersal and nonbreeding habitat: Thinning and prescribed fire would only occur in riparian areas or near important aquatic habitat with consultation with a wildlife biologist. The proposed action would have no effect on CLF movement. Most structural features within dispersal habitat would be maintained (boulders, rocks, large downed logs, small mammal burrows); however, short-term effects on organic debris and leaf litter would occur. Overall, thinning, prescribed fire, and aquatic restoration implementation would have long-term beneficial effects by restoring habitat and protecting designated critical habitat from stand-replacing wildfires.

Cumulative Effects

The area analyzed for cumulative effects for Chiricahua leopard frogs is RU 5 within the Rim Country project area and a 0.25-mile buffer outside of the project boundary along RU 5 to include current and potential breeding sites. The temporal boundary is 25 years, to allow for 20 years of treatment plus an additional 5 years where effects would be ongoing. Restoration of aquatic habitats facilitated by this alternative would slow the combined cumulative effects from other forest activities, high-impact recreational use, livestock grazing, and habitat loss and degradation on private lands. Restoration implementation of key aquatic and dispersal habitat would cumulatively link, rather than fragment, these habitats allowing for the needs of breeding and dispersing leopard frogs.

Determination of Effect

Implementation of Alternative 2 may **affect** and is likely to adversely affect the Chiricahua leopard frog and designated critical habitat.

Alternative 3 – Focused Alternative

Direct and Indirect Effects

Direct and indirect effects from Alternative 3 would be similar to Alternative 2. Alternative 3 includes the same miles and acres of riparian restoration, while reducing the total number of acres thinned and treated with prescribed burning. Potential effects from chytrid fungus that is spread by machinery and equipment would be minimized by requiring decontamination procedures to be followed when activities take place within wetted areas or the moist perimeter of a tank or ephemeral stream. Therefore, minimal potential for spread would exist.

Alternative 3 treats fewer forested acres in Rim Country. Project design features have been developed (see Appendix C) to reduce the potential of effects on important breeding sites and the frogs using and moving between these sites.

Critical Habitat
Same as Alternative 2.

Cumulative Effects

Same as Alternative 2.

Determination of Effect

Implementation of Alternative 3 may **affect** and is likely to adversely affect the Chiricahua leopard frog and designated critical habitat**.**

Mexican Spotted Owl (Threatened)

Alternative 1 – No Action

This alternative proposes no restoration treatments, but habitat variables are modeled the same as for Alternatives 2 and 3 (Table 67, Table 68, Table 69). See Alternatives 2 and 3 Habitat Restoration in MSO Habitat below.

The no action alternative includes no new mechanical treatments or prescribed fire in Rim Country in any habitat, including ponderosa pine, pine-oak, aspen, meadows, springs, riparian areas, and streams. No road construction, maintenance, or decommissioning would occur within the project area. None of the associated wildlife habitats would be restored or moved toward restoration.

Alternative 1 Protected Habitat

Forest Structure

Under Alternative 1, large trees in PACs would not be replaced due to the stagnant growth rates. FVS modeling in PACs for Alternative 1 shows trees per acre would only slightly decrease, from the existing 1,291 MC and 1,276 P-O to 1,170 MC and 1,130 P-O in 2029 and 1,057 MC and 990 P-O in 2039. Quadratic mean diameter would only increase by one inch over 20 years (from six to seven inches), indicating a system that would not be growing large trees greater than 12 inches in diameter. The average of all basal areas, from the sapling Size Class 1 to old growth Size Class 6 shows that intermediate-sized trees (Size Class 3 with a basal area of 5 to12 inches and Size Class 4 with a basal area of 12 to 18 inches) would be predominant on the landscape and vastly departed from the natural range of variation and would not be lowered to the desired condition, a result of no treatments through 2039.

Snags

With no action, PACs would show an increase in coarse woody debris and snags greater than 12 inches in diameter (Table 68**Error! Reference source not found.**). While creation of large snags would continue, the decreasing numbers of large trees through time would maintain a deficit of large snags beyond the year 2039. Pulses of large snag creation may occur at any time as a result of fire, insects, and disease. Increases in large snags as an outcome of stochastic events would result in decreases of large trees.

Coarse Woody Debris and Understory

Small mammal habitat would be maintained through time in terms of logs and coarse woody debris (cover for prey species) under this alternative. However, accumulated coarse woody debris could decrease MSO habitat effectiveness (Roberts et al. 2010). Herbaceous biomass in tons per acre (food for prey species) and shrub biomass in tons per acre (cover for prey species) would not change in both the short term and long term under Alternative 1 (Table 68). However, canopy development combined with a lack of fire and increased needle accumulation would cause a continued decline in understory through time. The continued loss and fragmentation of understory vegetation would limit invertebrate populations, including pollinators. If this pattern continued over time, a cascading effect could occur as arthropod species richness and abundance declines, increasing the rate of decline in understory biomass and potentially causing an additive effect to MSO prey species. Combined decreases in understory vegetation and associated arthropod communities could affect MSO directly (lack of flying insects as prey) and indirectly (food availability for prey species such as mice, voles, birds, and bats). Understory vegetation would remain at low levels of productivity and would continue to decrease through time, except in areas where fire, insect, or disease opened the canopy.

Fire Effects

Maintaining the current trajectory for forest conditions would maintain the increasing risk of uncharacteristic fire. Ponderosa pine ecosystems would become increasingly departed from desired conditions under Alternative 1, increasing risks to ecosystem structure, pattern, composition, and function. Fire hazard index and risk of crown fire (modeling shown in the existing condition section) are greatly increased in the No Action Alternative compared to the action alternatives.

Surface fuel loading in protected habitat, including litter, duff, and coarse woody debris greater than three inches, would be high under Alternative 1, moving from an existing condition of 18.7 tons per acre to 27.04 tons per acre in 2049. Fire Hazard Index Modeled in MSO Habitat Types). Crown fire would be more likely if surface fuel build-up continues, leading to increased flame lengths. High surface fuel loadings can negatively affect MSO prey populations by altering the understory vegetation response, negatively affecting food resources for prey species.

Fire Hazard Index high and extreme need for treatment categories are increased under Alternative 1 from 49,889 acres (41 percent of the PACs in the project area in need of treatment) in existing condition to 57,191 acres (47 percent) of all PACs in the project area are expected to experience high-severity wildfire. In Recovery Nest/Roost habitat 4,175 acres (41 percent) of Nest/Roost Recovery habitat in the project area) with high and extreme need for treatment in the existing condition goes to 4,991 acres (49 percent) in Alternative 1. Foraging/Non-breeding Recovery habitat goes from 10,717 acres (26 percent) with high and extreme need for treatment in the existing condition to 14,337 acres (34 percent) in Alternative 1 (see Table 61 and Table 62).

Table 61. Fire Hazard Index modeled in MSO habitat types for the Existing Condition

MSO Habitat Type	Very Low Need For Treatment in Acres	%	Moderate Need for Treatment in Acres	%	Low Need for Treatment in Acres	%	High Need for Treatment in Acres	%	Extreme Need for Treatment in Acres	%
Protected PAC 120,970 Acres Modeled	29,277	24	19,049	16	22,761	19	32,865	27	17,024	14
Recovery Nest/Roost 10,288 Acres Modeled	2,678	26	2,054	20	1,381	13	2,112	21	2,063	20
Recovery Foraging/Non-Breeding 41,879 Acres Modeled	16,931	41	7,828	19	6,402	15	7,237	17	3,480	08

Table 62. Fire Hazard Index modeled in MSO habitat types for Alternative 1

MSO Habitat Type	Very Low Need For Treatment in Acres	%	Moderate Need for Treatment in Acres	%	Low Need for Treatment in Acres	%	High Need for Treatment in Acres	%	Extreme Need for Treatment in Acres	%
Protected PAC 120,970 Acres Modeled	22,027	18	16,920	14	24,830	21	35,358	29	21,833	18
Recovery Nest/Roost 10,288 Acres Modeled	1,522	15	1,598	15	2,175	21	2,643	26	2,348	23
Recovery Foraging/Non-Breeding 41,879 Acres Modeled	10,966	26	5,483	13	11,093	27	10,378	25	3,959	9

The potential for active and conditional crown fire would be increased in the No Action Alternative compared to the existing condition, from 58,243 acres (48 percent of the PACs in the project area) to 61,606 acres (51 percent) that would experience high-severity crown fire in Alternative 1. Both types of recovery habitat would also have increased risk of crown fire from the existing condition with Alternative 1 (Table 63).

Table 63. Potential for Crown Fire Modeled in MSO Habitat Types for Alternative 1

MSO Habitat Type	Active Crown Fire Acres	%	Conditional Crown Fire Acres	%	Passive Crown Fire Acres	%	Surface Fire Acres	%
Protected PAC	42,151	52	1,404	2	26,744	34	11,396	14
Recovery Nest/Roost	5,414	53	92	1	3,712	36	1,078	10
Recovery Foraging-Non-Breeding	18,102	43	358	1	19,130	46	4,262	10

Maintaining current forest conditions would maintain a high fire hazard index (83 percent at risk of stand-replacing fire conditions and increased risk of crown fire). Over 73 percent of MSO PACs would likely burn with crown fire under Alternative 1. The likelihood of high-severity fire and the size of wildfires producing undesirable effects would continue to increase. Alternative 1 would not follow Recovery Plan guidance for retaining management flexibility for abating the risk of high-severity fire in PACs (USDI FWS 2012b).

Alternative 1 does not meet the purpose and need for the Rim Country Project. Forest structure and health in MSO habitat would continue to degrade over time. Development of the large tree component would continue to be compromised by density-dependent competition and mortality. Understory development would be maintained at uncharacteristically low levels and continue to decline. Other specialty habitats important to prey species such as riparian areas, meadows, aspen, springs, and stream channels would continue to degrade or be lost entirely over the long term. MSO habitats would be on a trajectory moving away from desired conditions as described in the Coconino, Tonto and Apache-Sitgreaves Forest Plans.

Alternative 1 Nest/Roost Recovery Habitat

Forest Structure

Under Alternative 1, No Action, FVS modeling (see Alternatives 2 and 3 Habitat Restoration in MSO Habitat below.

In MSO Nest/Roost Recovery Habitat shows that over time trees per acre are reduced, but not to within the natural range of variation. Trees per acre in the existing condition (1,100 mixed conifer, 1,280 pine-oak, and 1,351 modeled recovery habitat on the Tonto) would change to 873 mixed conifer, 1,052 pine-oak and 1,134 modeled recovery habitat on the Tonto in 2039). Stand density index would remain high, from 420 mixed conifer, 369 pine-oak, and 441 modeled recovery habitat on the Tonto in the existing condition, to 438 mixed conifer, 380 pine-oak, and 445 modeled recovery habitat in 2039. The quadratic mean diameter would only increase two inches in mixed conifer and one inch in pine-oak over 20 years. The FVS Modeled Effects on Key Habitat Variables in Recovery Nest/Roost Habitat from No Action Alternative can be seen in table 13 in the section on effects mechanical thinning and prescribed burning for alternatives 2 and 3.

Snags

Snags greater than 12 inches in diameter show no change in any cover type under Alternative 1 (table 13). While creation of large snags would be maintained, the decreasing numbers of large trees through time could maintain a deficit of large snags beyond the year 2039.

Coarse Woody Debris and Understory

Downed logs and course woody debris (cover for prey species) would increase over time as a result of no action. Herbaceous biomass in tons per acre (food for prey species) would not change under Alternative 1 over the 20 years modeled (0.21 tons per acre existing condition in mixed conifer and pine-oak cover types, and 0.20 in modeled recovery habitat acres on the Tonto, is maintained through 2039). Shrub biomass in tons per acre (cover for prey species) would decrease in mixed conifer and would be maintained in pine-oak under Alternative 1, moving from 0.4 tons per acre in mixed conifer to 0.3 tons per acre in 2039 (Table 68).

Fire Effects

Surface fuel loading in MSO Nest/Roost Recovery habitat, including litter, duff, and coarse woody debris greater than three inches, would be high under Alternative 1, moving from an existing condition of 30 tons per acre in mixed conifer, 19 in pine-oak to 37 tons per acre in mixed conifer, 26 in pine-oak in 2039 (Table 68).

Fire Hazard Index would be increased from 8,035 acres (78 percent of the Nest/Roost Recovery habitat in the project area in need of treatment) to 9,150 acres (89 percent). The highest and greatest hazard categories of Fire Hazard Index in Nest/Roost Recovery habitat total 5,594 acres (50 percent) of all Nest/Roost Recovery habitat in the project area and are expected to experience high-severity wildfire.

Potential for crown fire is expected to increase in the No Action Alternative, from 8,290 acres (81 percent) to 9,218 acres (90 percent). Active crown fire in Nest/Roost Recovery habitat totals 5,414 acres (53 percent) of this habitat type in the project area that would experience high-severity crown fire.

Alternative 1 Foraging/Non-Breeding Recovery Habitat

Forest Structure

Under Alternative 1, No Action, FVS modeling shows that trees per acre in Foraging/Non-Breeding MSO Recovery Habitat would be reduced, but not to within the natural range of variability (from 1,398 in mixed conifer, 1,192 in pine-oak, and 1,443 modeled recovery habitat on the Tonto National Forest, to

1,101 in mixed conifer, 952 in pine-oak, and 1,196 modeled recovery habitat on the Tonto National Forest in 2039). Stand density index would remain high, from 376 in mixed conifer, 329 in pine-oak, and 407 modeled recovery habitat on the Tonto National Forest, to 182 in mixed conifer, 158 in pine-oak, and182 modeled recovery habitat on the Tonto National Forest in 2039. The quadratic mean diameter would only increase by one inch over 20 years.

Snags

Foraging/Non-Breeding Recovery Habitat under Alternative 1 would have an increase in coarse woody debris and snags greater than 12 inches in diameter (see Table 69). While creation of large snags would continue, the decreasing numbers of large trees through time could maintain a deficit of large snags beyond the year 2039.

Coarse Woody Debris and Understory

Downed logs and coarse woody debris (cover for prey species) would increase over time as a result of no action. Herbaceous biomass in tons per acre (food for prey species) would not change under Alternative 1 over the 20 years modeled (0.21 tons per acre in mixed conifer and pine-oak maintained through 2039). Shrub biomass in tons per acre (cover for prey species) would show little change in both the short term and long term under Alternative 1, moving from an average 0.25 tons per acre to 0.28 tons per acre in 2039.

Fire Effects

Surface fuel loading in MSO Foraging/Non-Breeding Recovery Habitat, including litter, duff, and coarse woody debris greater than three inches, would be high under Alternative 1, moving from an existing as high as 24 tons per acre to 32 tons per acre in 2049.

Fire Hazard Index is expected to increase from 10,717 acres (26 percent of the Foraging-Other Recovery habitat modeled as in need of treatment) to 14,337 acres (34 percent). The potential for crown fire would be increased with no action, from 15,090 acres (36 percent) to 16,302 acres (39 percent).

Other Habitat Effects

Springs, Riparian and Stream Habitat, Grasslands, Savannas, Meadows, and Aspen. No springs or riparian habitat would be restored. One hundred eighty-four (184) springs and associated prey habitat would remain in degraded condition within the project area, with many included in PACs. Similarly, wildlife habitat associated with almost 171 miles of riparian stream channels would remain in degraded condition within MSO habitat. The grasses, forbs, and shrubs that could potentially occupy these sites would remain absent or limited in both species richness and abundance.

No grassland, savanna, or meadow treatments would occur, resulting in nearly 350 acres in PACs and over 60,390 acres of this important habitat continuing to degrade as a result of pine tree encroachment in MSO habitat. This would represent a decline in the quantity and quality of habitat for grassland associated species, including obligate migratory and sensitive avian species. As food and cover decline for small mammals, potential source populations of important MSO prey species would be expected to decline in the long term. Overall, the landscape would move toward homogeneity as ponderosa pine continued to compromise or eliminate these key sources of heterogeneity.

Unique wildlife habitat features associated with 1,230 acres of aspen would decline or vanish as losses continued. Conifer trees would gradually succeed aspen trees through competition for space, light, and water, which is a major cause of aspen decline (Johnson 2010). Associated declines in regional avifauna would occur as a result of habitat loss (Griffis-Kyle and Beier 2003). The rate of avian decline could increase as habitat changes favored nest predators (Johnson 2010). Understory biomass, which provides the food and cover to support MSO prey species (for example, small mammals, birds, and arthropods), would decrease exponentially as conifer cover increased (Stam et al. 2008).

The effects of these microhabitats are greater than their combined total acres. This is particularly relevant when these patches of heterogeneity occur in PACs where MSOs disproportionately forage during the nesting season.

Roads. Under the no action alternative, no new restoration activities would take place and no additional use of existing roads would occur. Current rates of public and administrative use would continue. Maintenance to provide public and administrative access would continue, contingent upon funding. No increase in road maintenance to accommodate restoration activities would occur. No temporary roads would be constructed, but also no road decommissioning, unless they are analyzed under separate NEPA analysis.

Alternative 1 Direct and Indirect Effects

With no treatments occurring, there would be no direct increase or decrease in habitat quality of MSO protected, recovery, or critical habitat in the short term. In the long term, MSO habitat quality would decrease as a result of declines in forest health and resiliency.

The lack of mechanical thinning and low-severity prescribed fire would allow the current forest trajectory to continue. Dense forests would maintain closed canopy conditions but continue to exhibit reduced growth rates. The abundance of young and mid-aged forest would continue to dominate the landscape because of stagnating growth rates and competition-induced mortality of large trees. Gambel oak, aspen, and meadows would decline as pine encroachment continued. Spring function would decline as would reaches of riparian habitat channels. Competition for limited water and nutrients would continue and would increase in time as snow pack decreased with developing climate change.

This alternative would not reduce the threat of high-severity fire, which is a primary concern for the recovery of this species. Surface fuels would continue to increase and understory vegetation decrease or remain the same. Alternative 1 would not contribute to improving forest health or vegetation diversity and composition, sustaining old forest structure over time, or moving forest structure toward the desired conditions.

No additional disturbance from noise, smoke, or other aspects of implementation activities would occur under this alternative.

Cumulative Effects

Because of the size of the 4FRI Rim Country project area and the large portion of the western Upper Gila Mountain Recovery Unit and a portion of the Basin and Range Recovery Unit that it occupies, the project area itself was considered adequate for assessing habitat effects on PACs. Due to the potential for disturbance to owls, the cumulative effects analysis boundary was extended 0.5 mile beyond the project area periphery to account for the spatial component of this analysis. Cumulative effects include the effects of Alternative 1. With this additional 0.5-mile buffer, there are 209 PACs in the cumulative effects analysis area Table 64. The temporal component in this analysis was defined as 10 years for short-term effects and 30 years for long-term effects.

Table 64. MSO PACs Within or in Close Proximity to the Rim Country Project Area

PAC Location	Number of MSO PACs
Within Areas of Proposed Mechanical and Fire Treatments[1]	156
Within the Rim Country Project Area[2]	196
Within 0.5 mile of the Project Area Boundary	209

1. The area where treatments are proposed in the Rim Country project area, a subset of the total project area.
2. Total area including all vegetation cover-types and all projects managed by the Forest Service within the 4FRI boundary

The effects from projects before 2000 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-2000 projects also had heavy selection pressure for preferred tree genetics to provide healthy trees with good form. This latter effect resulted from harvested areas being regenerated from planting stock or from the selected reserve trees left in seed tree harvest units (Higgins, personal communications 2006). Wildlife habitat in the form of nesting, feeding, and loafing sites was reduced by selecting for disease-free trees with symmetric shapes, eliminating fork-top trees, trees with unusual branching patterns, and replanting with selected genetic stock from nurseries.

Cumulative Effects Alternative 1 – No Action

Alternative 1 would not contribute to the improvement of either forest structure or prey habitat within MSO habitat. The contributions of past, ongoing, and reasonably foreseeable actions would affect habitat for MSO and their prey, but no cumulative effects would result from 4FRI Rim Country (such as, no change would occur either spatially and temporally to alter these effects of other actions on the landscape).

Maintaining existing conditions would extend the current deficit of trees greater than 24 inches in diameter. Current numbers of trees per acre greater than or equal to 18 inches in diameter, already below forest plan and Recovery Plan direction, would likely be maintained due to increases in mortality rates resulting from competition. Slow to stagnating tree growth rates would prolong the time required for mid-aged trees to grow into mature trees. Replacement of mid-aged trees by younger trees would occur at low rates because of current deficits in small size classes, delaying, limiting, or preventing the long-term attainment of desired conditions for mature and old-growth forest. Ponderosa pine is not a shade-adapted species. Therefore, consistently dense canopy cover would delay or prevent development of multi-storied and uneven-aged forest structure in the long term. Growth could be further suppressed and mortality rates increased if climate patterns continue toward hotter and drier growing conditions. Within-stand mortality resulting from competition for rooting space, water, and nutrient availability, vulnerability to insects and disease, and fire could lead to patches of more open conditions. This could reduce potential nesting and roosting habitat even in locations where individual trees might benefit and eventually grow into larger size classes.

Pine-oak habitat would remain outside the natural range of variation in terms of tree densities and age-class distribution under Alternative 1. Loss of large diameter oak would continue, as would the suppression of young oak by competing pine trees. Total basal area in oak may decline over time and would likely remain below desired conditions. Dense forest structure could increase the risk of insect and disease outbreaks occurring and increase the scale at which they occur. Stochastic events outside the natural range of variation could continue to slow or prevent development of new MSO nesting and roosting habitat.

Limited road closures would allow continued access to most of the existing roads footprint and 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 risk of high-severity fire through time. By not treating outside of 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.

Determination of Effect

Based on the above analysis, Alternative 1 of the 4FRI Rim Country Project **may affect, is likely to adversely affect the Mexican spotted-owl.**

Effects Common to Both Action Alternatives

Environmental consequences are described by MSO habitat type (for example, protected and recovery) and designated critical habitat. Proposed treatments are similar across MSO habitat types, although the degree to which they are implemented would vary depending on specific stand conditions. Modeled results are based on stand-specific outputs and represent the variability in treatment implementation. The objectives of the treatments are to increase tree growth rates, retain large pine and oak trees, and increase forest resiliency. Recovery nest/roost habitat would be managed to maintain or achieve nest/roost conditions sooner than if they were not treated. Forest conditions in nest/roost habitat would remain at or above nest/roost values after treatments as shown in Table C.3 of the Recovery Plan.

The objective of the Rim Country treatments in MSO habitat is to improve forest structure for owls as defined in the Recovery Plan per the Flexible Toolbox Approach for Mechanical Treatments (Appendix 2). This is different from an emphasis on fuels reduction. Large trees would be retained, and targeting mid-aged trees would improve the health, growth rates, and sustainability of large trees. Certain habitat and stand structures warrant additional consideration. For example, some MSO habitat and certain stand conditions require consideration of additional management constraints before prescribing treatments. PACs exhibit a variety of topographic and forest conditions and occupied PACs can already be considered successful nesting habitat. Mechanical treatments in PACs would be designed to maintain or improve the characteristics that make each PAC effective at providing habitat while also making them resilient to disturbance. Consideration should be given to:

- increasing the number of large trees
- creating additional foraging habitat for MSO
- the fire hazard index in the PAC and whether it is in wildland-urban interface (WUI)
- restoration and protection of other resource values nearby, such as perennial water
- protecting other values at risk

Treating areas near PACs should be considered in order to improve resiliency in the PACs themselves. PACs should be treated with consideration of the larger landscape and not just separate entities. Specific treatments in PACs would be determined prior to implementation and in consultation with U.S. Fish and Wildlife Service (FWS) personnel. In nest/roost recovery habitat, the Flexible Toolbox Approach for Mechanical Treatments (Appendix D) states that, though recovery nest/roost habitat is distinct from PACs, their management objectives are similar. Any treatment proposed in MSO nest/roost recovery habitat should be designed specifically to maintain or accelerate the trajectory of these stands towards desired habitat conditions in the foreseeable future. Achieving management objectives within MSO foraging or other recovery habitat can be addressed with the flexible toolbox approach. Stands in recovery habitat would be assigned a treatment using the decision matrices; however, additional management direction would be applied such as maintaining increased basal area (40-110 BA for pine-oak and 40-135 BA for mixed conifer). This additional guidance is included in the project design features to ensure resource protection (see Appendix C).

Alternatives 2 and 3 Habitat Restoration in MSO Habitat

A total of 196 PACs (110,890 acres) occur in the Rim Country project area. An additional 39,748 acres either fall outside of the Rim Country boundary area (11,269 acres) or occur in other project areas (28,479 acres). These 39,748 acres would be treated as those projects planned and consulted with FWS. Twenty-nine PACs would have some other type of restoration (riparian, wet meadow, grassland, aspen, etc. see Actions common to Alternatives 2 and 3 below). In the 4FRI Rim Country project area, up to 82,411 acres of protected MSO habitat are proposed for thinning and/or burning, or other habitat restoration with Alternatives 2 and 3. Various restoration activities could occur under Alternatives 2 and 3 in MSO habitat. These activities include grassland and meadow restoration, spring restoration, riparian stream and stream channel restoration, stream habitat restoration, and aspen restoration. Acres and miles for other restoration activities were calculated for PACs (Table 65). Recommended design features to minimize effects on wildlife for all restoration activities proposed in PACs were reviewed and would not result in additional effects that are not already disclosed (Appendix 5). These activities would be implemented in recovery habitat types under both Alternatives 2 and 3: however, design features intended to improve stand and habitat quality would also be applied to achieve restoration success (see Appendix C). The restoration of these habitat types within recovery habitat would contribute to the mosaic treatment effect desired in the MSO Recovery and Forest Plans.

Table 65. Acres of restoration treatments proposed in MSO PACs

Treatment	PAC Acres
Mechanical Vegetation Treatments Total	24,873
Aspen Restoration	28
Facilitative Operations	298
PAC – Mechanical	18,371
Severe Disturbance Area Treatments	3,609
Grasslands Restoration	72
Riparian Restoration	2,142
Riparian/Wet Meadow Restoration (Overlap)	98
Wet Meadow Restoration	256
Prescribed Fire Total	82,411
Prescribed Fire Only	49,066
Facilitative Operations Prescribed Fire Only	7,875
Mechanical and Prescribed Fire Treatment	24,873
Riparian Restoration within Core Areas	610
Riparian/Wet Meadow Restoration (Overlap) within Core Areas	31
Wet Meadow Restoration within Core Areas	33
Stream Restoration (in miles)	171*

*Note that the stream restoration is measured in miles.

Aspen Restoration

All aspen restoration activities in PACs would happen outside of the breeding season. Recommended design features for aspen restoration are included so that aspen restoration activities would not result in additional effects that are not already disclosed. Currently, one PAC on the Coconino National Forest was identified for aspen restoration treatment (28 acres), the Schell Spring PAC.

Facilitative Operations

Facilitative operations may be needed in non-target cover types (such as pinyon-juniper) to support treatments in target cover types (ponderosa pine types). Within four PACs, approximately 300 acres could receive mechanical facilitative operations. Within 71 PACs, about 7,880 acres could be treated using prescribed fire facilitative operations. Design features have been added to mitigate disturbance to MSO from these activities.

Severe Disturbance Areas

Restoration treatments in severe disturbance areas would include combinations of reforestation, prescribed fire, lopping/scattering, mastication, and other mechanical methods, with the objective of identifying treatments that would be effective in restoring the fuel structure that produces the types of fire to which ponderosa pine is adapted. Thirty-three PACs (about 10,070 acres) could have severe disturbance restoration activities associated with them. Twelve PACs would have grassland restoration activities on approximately 72 acres. Twenty-seven PACs would have wet meadow restoration on approximately 420 acres. Design features (see Appendix 5, Appendix C) have been included to mitigate disturbances to MSO from these activities.

Grassland and Wet Meadow Restoration

Twelve PACs would have grassland restoration activities on approximately 72 acres. Twenty-seven PACs would have wet meadow restoration on approximately 420 acres. Design features (see Appendix 5, Appendix C) have been included to mitigate disturbances to MSO from these activities.

Stream and Riparian Restoration

A total of nearly 171 miles of stream restoration, with approximately 2,880 acres of riparian restoration, could occur in 127 PACs in the Rim Country project area. All restoration activities in PACs would happen outside of the breeding season. Spring and riparian stream channel and habitat restoration would also occur in MSO recovery habitat across the project area. See the Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities for a complete description of restoration activities proposed (Appendix 3). Design features have been included to minimize effects on MSO, to promote primary constituent elements in MSO habitat, and to avoid disturbance to MSO from implementation.

Skid Trails, Excaline, and or Tracked Harvesters

Skid trails could be needed in PACs and recovery habitats in order to accomplish thinning treatments; however, all would be rehabilitated after harvesting. Ground disturbance from skid trails can cause indirect effects from the loss of vegetation through compaction and rutting and exposure of bare mineral soil. Harvest activities with skid trails could adversely affect the prey base on a short-term basis by affecting individuals of prey species due to disturbance of prey species' habitat. As analyzed by the Rim Country soil scientist,

"Mechanical thinning of the ponderosa pine forests of Arizona has been occurring since the 1980s mainly through whole tree harvesting on slopes less than 40 percent. Typical equipment used for such harvesting includes rubber-tired feller bunchers and rubber-tired skidders with tracked dozers used for piling of slash. The amount of disturbance as a percentage of a typical harvest unit (such as, area included in a thinning contract) affected by compaction, rutting, and/or exposure of bare mineral soil from this type of harvesting has been estimated to be roughly 15 percent associated with feller-buncher and skidding operations, three percent associated with machine piling of slash, three percent associated with landings, and three percent associated with temporary roads (MacDonald 2013).”

Design features have been incorporated to minimize disturbance from heavy machinery operations, and thus would generally minimize compaction, rutting, and/or exposure of bare mineral soil in these areas.

Of the 24,873 acres of ground-based harvest methods in MSO PAC habitat, 5,223 acres (21 percent) could be affected by compaction, rutting, and/or exposure of bare mineral soil from mechanical thinning operations. No temporary roads are needed if skid trail lengths are increased as described in the roads section below, adding an additional 10 acres. This represents four percent of the total PAC acres (122,158 acres) in the 4FRI Rim Country project area. Effects are short term, dispersed across the landscape, with rehabilitation efforts incorporated through best management practices to reduce effects to MSO habitat.

Roads

Alternative 2 and 3 are the same in terms of roads proposed to haul material. The main difference is that in Alternative 3 temporary roads would be reduced from 330 to 170 miles. It is assumed that nearly all, if not all system roads within the project area could be utilized at some point in time to carry out restoration activities.

Road Maintenance- Roads that would be utilized for restoration work and hauling of forest products would likely see pre-haul maintenance if needed to make the roads passable to truck traffic, as well as maintenance during hauling and post haul maintenance. This maintenance would be in additional to a forest’s regular schedule of maintenance.

Road Decommissioning- Under this alternative up to 200 miles of system road on the Coconino and Apache-Sitgreaves National Forests could be decommissioned. The Tonto National Forest Travel Management EIS has identified approximately 290 miles of road within the Rim Country project area for decommissioning. In addition to system road decommissioning, up to 800 miles of unauthorized roads on all three forests may be decommissioned under this alternative.

Temporary Roads - Under Alternative 2 up to 330 miles of temporary road could be utilized to facilitate harvest activities. Under Alternative 3 up to 170 miles of temporary road could be utilized to facilitate harvest activities. These temporary roads may be new construction or also utilize existing unauthorized roads. Temporary roads would be decommissioned when harvesting and related restoration work is completed in the area that they access.

On June 11 2018, the Forest Operation Specialist met with the 4FRI Wildlife Biologist and GIS Specialist to conduct analysis of the need for temporary roads to mechanically treat proposed acres in PACs. Of the 150 PACs in the 4FRI Rim Country project area, 111 of these have areas greater than 1,250 feet from an existing road. Twenty (20) of these (see wildlife specialist report) have greater than 20 acres of habitat proposed for thinning. It was determined that, due to topography, ecological concerns (for the MSO, soils, and hydrology), and a small number of acres receiving treatment, these limited treatments would merit increased skidding lengths instead of temporary road construction. Therefore it was determined that no new temporary roads would be created in PACs in the 4FRI Rim Country project area.

Increased skid trail lengths for these acres were calculated with the hydrologist’s recommendation to determine the acreage of these longer skid trails. These increased skid trail lengths would affect an additional 10 acres of MSO Protected habitat.

Smoke from Prescribed Fire

Smoke from broadcast and pile-burning could temporarily disturb MSOs. Pile burning occurs during the winter and would not be expected to have direct effects on nesting owls. Burning would be managed to minimize the accumulation of smoke in PACs during the breeding season. Short-term effects from smoke would be reduced by coordinating the timing and type of burning with wind direction, topography, time of year, and distance to PACs. Initial entry burning would not occur in nest cores during the breeding season and burning would be restricted during the breeding season in areas that may create smoke effects on occupied PACs. Prevailing southwest winds and the topography of the area typically act to lift smoke, carrying it away from ignitions sites. Areas selected to protect PACs by thinning and burning outside of the PAC were developed in conjunction with the 4FRI Rim Country team and with the USFWS. With this information in mind, along with the concept that the species presumably adapted and evolved with smoke from wildland fire, smoke-related effects from maintenance burning would not be substantial.

The use of prescribed fire brings inherent uncertainty. While this would be minimized through the use of ignition and control techniques, the sheer number of acres and discrete applications of fire (such as, all or parts of 156 different PACs) increases the risk of fire burning out of prescription. While individual trees or pockets of torching could improve habitat conditions by adding diversity in dense, relatively homogeneous stands of pine-oak, the same action in other stands or larger areas of torching could create long-term adverse effects on MSO habitat. Adverse effects would only happen if burning exceeded prescription, therefore the degree of risk is unknown, unquantifiable, but remains a risk.

Smoke may have an adverse effect if predicted weather conditions change during burn operations. Smoke tends to settle into low-lying areas, including canyons which serve as owl habitat. Lung damage could occur if smoke settles into PACs with incubating adult or nestling MSOs for continuous days and nights. Lung damage could result from continuous exposure to high smoke levels. MSOs could be forced to alter foraging behavior as a result of extended smoke. Altered foraging behavior could leave owls vulnerable to predators. Under these circumstances, smoke settling into PACs could cause adverse effects. The risk of this is low due to the design features specifically developed to minimize this threat. However, some risk remains although it is considered low and is unquantifiable.

Wildfire

Fire hazard index and crown fire assessment was modeled for MSO and wildlife habitat types proposed for treatments. Fire modeling includes one treatment and two prescribed burns through the year 2029. After this period, maintenance burning is expected to maintain desired conditions across the project area or until further planning is needed. Fire hazard index and risk of crown fire was modeled for 120,975 acres in PACs, 10,288 acres in Nest/Roost recovery habitat, and 41,878 acres in foraging/non-breeding MSO recovery habitat. Table 66 shows the amount of each habitat type with risk ratings of Low, High, and Extreme by alternative. The existing condition shows that 49,889 acres, or 41 percent of all PACs within the project area, are at risk of high-severity wildfire. Alternative 2 reduces this risk to 29 percent of PACs, six percent of Nest/Roost recovery habitat, and one percent of Foraging/non-breeding habitat.

Table 66. Acres of MSO Habitat with High and Extreme Fire Risk by Alternative with Percentages of Total Habitat Modeled in the Project

Fire Hazard Index	Existing	Alternative 1	Alternative 2	Alternative 3
PAC	49,889 (41%)	57,191 (47%)	33,410 (28%)	33,105 (30%)
Nest/Roost Recovery	4,175 (41%)	4,992 (49%)	588 (06%)	778 (08%)
Foraging-other Recovery	10,717 (26%)	14,337 (34%)	372 (01%)	1,845 (04%)

The modeled potential for active and conditional crown fire (with percentages of each habitat type in the project area that could experience these categories of crown fire) is shown in Table 11 above. The action alternatives greatly reduce these risk categories of crown fire across MSO habitat types. For example the risk of active and conditional crown fire in PACs is reduced to 28 percent in Alternative 2 from 50 percent in Alternative 1. Risk of active and conditional crown fire in Nest/Roost recovery habitat is reduced to just 407 acres (four percent) in Alternative 2, from 16,032 acres (50 percent) in Alternative 1. The risk of crown fire in Foraging/Non-breeding recovery habitat is reduced to 350 acres (one percent) in Alternative 2.

Table 67. Active and Conditional Crown Fire Assessment Comparison of Alternatives in Wildlife Habitat (with Percentages of Total habitat Modeled in the Project Area)

MSO Habitat Type	Existing	Alternative 1	Alternative 2	Alternative 3
PAC	58,243 (48%)	61,608 (50%)	34,068 (28%)	33,044 (30%)
Nest/Roost Recovery	4,802 (47%)	5,183 (50%)	407 (04%)	685 (07%)
Foraging-other Recovery	15,090 (36%)	16,302 (39%)	350 (01%)	2,317 (06%)

Mechanical Thinning and Prescribed Burning

Alternatives 2 and 3 would follow forest plan direction, including implementing guidelines from the revised MSO Recovery Plan (USDI FWS 2012). Cover types may have all or some of the direction for MSO habitats, depending on location and stand structure. The objective of Rim Country treatments in MSO habitat is to improve forest structure for owls as defined in the Recovery Plan and in the Flexible Toolbox Approach for Mechanical Treatments (Appendix 2).

In MSO PACs: Potentially thin and burn to improve structure, maintain and develop large trees, and reduce risk of high-severity fire in PACs. No mechanical treatments, but fire may be implemented, in 100-acre core areas. Outside core areas, trees may be thinned and/or prescribed fire implemented where feasible to improve forest structure and minimize undesirable fire effects. Promote irregular tree spacing to create canopy gaps more conducive to treatment with prescribed fire, retain old growth attributes, protect large oaks, and ensure snags and coarse woody debris post-fire. Develop treatments in consultation with FWS.

In MSO Recovery Habitat: Follow Table C3 in revised MSO Recovery Plan for potential future nest/roost habitat and provide for owl daily movements, dispersal, and foraging habitat.

In MSO Recovery Habitat outside of potential future Nest/Roost: follow forest plan guidance. Intent is to continue to develop replacement Nest/Roost where possible, otherwise treat to develop a diverse mix of heterogeneous stand structures and densities to provide for owl dispersal and foraging. Design Features have been added to mitigate disturbance to the MSO from these activities (Appendix C).

Because of planning and timing restrictions, noise disturbance to owls is not expected in PAC habitat where the majority of foraging is done by nesting owls. Owls foraging outside PACs during nesting season could potentially be displaced by thinning activities and increased truck traffic. Owls could also be displaced by harvest activities and increased truck traffic outside the nesting season. Displaced owls could be more vulnerable to predation.

Vehicular traffic would not simultaneously increase across the entire implementation area, but harvest-related traffic increases would occur in localized areas somewhere on the landscape for every year of implementation. Most traffic is expected to occur during diurnal hours when MSO activity would be minimal. However, hauling of materials from harvest locations to highways could occur at night when owls are active. Once harvest activities are complete, traffic is expected to return to pre-harvest levels.

The amount of traffic increases the risk of collisions between owls and trucks. There have been documented instances of spotted owls being hit by vehicles on paved and unpaved roads. Although little information is available on the frequency or conditions related to the risk of collisions, the assumption is being made that, because of the scale of increase in truck traffic, the risk of collisions with owls would increase. The threat of collisions would be reduced below existing conditions in the long-term as a result of road decommissioning.

Treatments in MSO habitat were modeled using FVS (see Vegetation Report). Table 68 display the habitat variables important to the MSO and the modeled effects on them in protected habitat in 2019, 2029, and 2039.

MSO Protected Habitat

Table 68. FVS Modeled Effects on Key Habitat Variables in MSO Protected Habitat

PACs MC = 16,481 Acres Modeled PO = 56,180 Acres Modeled	Existing	No Action 2029	No Action 2039	Alt 2 2029	Alt 2 2039	Alt 3 2029	Alt 3 2039
Average of tpa MC	1291	1170	1057	392	227	531	379
Average of tpa PO	1276	1130	990	369	232	496	368
Average of BA MC	173	185	196	131	127	131	130
Average of BA PO	144	155	163	110	106	117	117
Average of SDI MC	398	414	425	253	218	262	235
Average of SDI PO	339	353	362	215	191	237	223
Average of QMD MC	6	6	7	9	12	9	12
Average of QMD PO	6	6	7	9	11	9	10
Average of SNAG 12-18” MC	4	3	3	8	5	7	5
Average of SNAG12-18” PO	2	3	3	5	5	5	4
Average of SNAG18-24” MC	2	1	1	3	2	2	2
Average of SNAG18-24” PO	1	1	1	1	1	1	1
Average of SNAG $\geq$ 24” MC	1	1	1	1	1	1	1
Average of SNAG $\geq$ 24” PO	0	0	0	1	1	1	1

PACs MC = 16,481 Acres Modeled PO = 56,180 Acres Modeled	Existing	No Action 2029	No Action 2039	Alt 2 2029	Alt 2 2039	Alt 3 2029	Alt 3 2039
Average of CANCOV-BA Regression MC	74	76	78	67	66	67	67
Average of CANCOV-BA Regression PO	69	71	73	62	61	64	64
Average of Surface Fuel TPA MC	29	33	35	28	27	27	27
Average of Surface Fuel TPA PO	20	23	25	18	19	19	20
Average of CWD 3”+ TPA MC	10	12	14	12	13	12	12
Average of CWD 3”+ TPA PO	8	9	10	8	9	9	9
Average of Surface Herb TPA MC	0.21	0.21	0.20	0.24	0.26	0.24	0.24
Average of Surface Herb TPA PO	0.21	0.21	0.21	0.23	0.23	0.22	0.22
Average of Surface Shrub TPA MC	0.40	0.37	0.34	0.63	0.73	0.55	0.65
Average of Surface Shrub TPA PO	0.23	0.23	0.23	0.24	0.24	0.24	0.25
Average of ALL_BA1 MC	1	1	1	0	0	0	0
Average of ALL_BA1 PO	1	1	1	0	0	0	0
Average of ALL_BA2 MC	15	15	14	7	3	8	5
Average of ALL_BA2 PO	13	16	18	5	3	8	7
Average of ALL_BA3 MC	49	51	52	28	23	31	26
Average of ALL_BA3 PO	47	47	47	27	22	30	27
Average of ALL_BA4 MC	51	52	56	37	36	36	37
Average of ALL_BA4 PO	42	46	48	35	35	37	37
Average of ALL_BA5 MC	30	38	43	31	33	30	33
Average of ALL_BA5 PO	22	25	28	23	25	23	25
Average of ALL_BA6 MC	26	29	32	28	31	26	29
Average of ALL_BA6 PO	18	20	22	19	21	19	21

In PACs, modelling shows that Trees per Acre is reduced in the action alternatives (2 and 3) as larger trees occupy more of this habitat type through time. The stand density index is also reduced as competition is lowered by treatments in PACs. A linear regression from basal area was used to estimate canopy cover. These estimates indicate that treatments would align with MSO Recovery Plan recommendations in mixed conifer with canopy cover higher than 60 percent and in pine oak, with canopy cover much higher than the recommended 40 percent, measuring above 60 percent in the action alternatives. The overall effect of treatments in PACs would be to increase large trees, as the quadratic mean diameter in inches is increased in Alternatives 2 and 3. Further, the current condition is maintained for the basal area average of all trees greater than 18 to 24 inches in diameter and the average of all trees greater than 24 inches in diameter in Alternatives 2 and 3. Shrub and herbaceous biomass would also be maintained or increase in Alternatives 2 and 3. Maintaining the current condition in PACS, while reducing risk of crown fire and the fire hazard index (decreasing fuel loading), and increasing coarse woody debris, downed logs, and snags of all size classes, are desired effects from treatments on MSO protected habitat.

Nest/Roost Recovery Habitat

Though these areas are distinct from PACs, their management objectives are similar. Any treatment proposed within MSO nest/roost recovery habitat should be designed specifically to maintain or accelerate the trajectory of these stands towards desired habitat conditions in the foreseeable future. Achieving management objectives within MSO recovery habitat can be addressed with the flexible toolbox approach. Stands in recovery habitat would be assigned a treatment using the decision matrices in the Flexible Toolbox Approach for Mechanical Treatments and with associated design features (Appendix C).

Table 69 shows the modeled effects from vegetation treatments by alternative to key MSO habitat variables in MSO Nest/Roost Recovery Habitat. As within PACs, the results of the action alternatives in MSO Nest/Roost Recovery habitat are that, while slightly reducing some variables in PACs, the treatments would maintain or increase most variables while treating and ultimately conserving these conditions over time.

Preserving MSO habitat by using thinning and burning treatments, while promoting large trees and reducing risk of fire hazard index and crown fire, is one of the main objectives of the action alternatives in Rim Country (returning resiliency to the forested ecosystem). Reducing trees per acre and the stand density index would greatly reduce competition in stands which, in conjunction with silvicultural prescriptions, would promote growth of large trees. These estimates indicate that treatments would align with MSO Recovery Plan recommendations, staying above 60 percent canopy cover in mixed conifer and well above 40 percent in pine oak. As with PACs, reducing the overall basal area average and canopy cover is not a desired outcome of treatment; however, reducing trees per acre and the stand density index would greatly reduce competition in stands which, in conjunction with silvicultural prescriptions, would promote growth of large trees. The quadratic mean diameter in inches would increase with the action alternatives, showing that this trend toward larger trees would be achieved. Increases in snags of all size classes and increases in shrub and herbaceous biomass are desired outcomes from treatments. Reductions in surface fuel and creation of interspaces and uneven-aged management would conserve MSO Nest/Roost Recovery habitat over time. Fire hazard index and risk of crown fire would be greatly reduced as a result of treatment (see Fire Ecology section for effects from the action alternatives).

Table 69. FVS Modeled Effects on Key Habitat Variables in MSO Nest/Roost Recovery Habitat

NR Recovery MC = 11,065 Acres Modeled PO = 13,539 Acres Modeled GM = 3,940 Acres Modeled on Tonto NF	Existing	No Action 2029	No Action 2039	Alt 2 2029	Alt 2 2039	Alt 3 2029	Alt 3 2039
Avg of Trees per Acre MC	1100	982	873	167	116	204	155
Avg of Trees per Acre PO	1280	1167	1052	217	137	521	432
Avg of Trees per Acre GM	1351	1231	1134	161	109	231	176
Avg of Basal Area MC	188	199	209	126	127	122	124
Avg of Basal Area PO	164	172	178	114	112	127	127
Avg of Basal Area GM	190	196	199	107	102	109	106
Avg of Stand Density Index MC	420	431	438	208	197	208	199
Avg of Stand Density Index PO	369	377	380	200	183	243	231
Avg of Stand Density Index GM	441	444	445	182	164	195	179
Avg of Quadratic Mean Diameter in Inches MC	6	7	8	14	16	13	15
Avg of Quadratic Mean Diameter in Inches PO	7	7	8	12	14	11	13

NR Recovery MC = 11,065 Acres Modeled PO = 13,539 Acres Modeled GM = 3,940 Acres Modeled on Tonto NF	Existing	No Action 2029	No Action 2039	Alt 2 2029	Alt 2 2039	Alt 3 2029	Alt 3 2039
Avg of Quadratic Mean Diameter in Inches GM	6	6	6	12	14	12	6
Average of SNAG 12-18” MC	4	4	4	5	3	5	3
Average of SNAG 12-18” PO	3	4	4	5	4	5	4
Average of SNAG 12-18” GM	3	4	3	6	4	6	4
Average of SNAG 18-24” MC	1	1	2	2	2	2	2
Average of SNAG 18-24” PO	1	1	1	2	2	1	2
Average of SNAG 18-24” GM	1	1	1	2	1	1	1
Average of SNAG ≥ 24” MC	1	1	1	1	1	1	1
Average of SNAG ≥ 24” PO	0	0	0	1	1	1	1
Average of SNAG ≥ 24” GM	0	0	0	1	1	1	1
Percent CANCOV Regression from BA MC	76	78	79	66	66	65	65
Percent CANCOV Regression from BA PO	73	74	76	64	62	66	66
Percent CANCOV Regression from BA GM	77	77	78	61	60	62	61
Avg of Surface Fuel tons per acre MC	30	34	37	24	23	23	22
Avg of Surface Fuel tons per acre PO	19	23	26	17	18	19	19
Avg of Surface Fuel tons per acre GM	23	27	29	19	18	20	19
Avg of Coarse Woody Debris 3”+ tons per acre MC	10	12	14	10	10	10	10
Avg of Coarse Woody Debris 3”+ tons per acre PO	6	8	9	8	8	8	8
Avg of Coarse Woody Debris 3”+ tons per acre GM	10	12	13	11	11	11	11
Avg of Herbaceous tons per acre MC	0.21	0.20	0.20	0.26	0.26	0.25	0.26
Avg of Herbaceous tons per acre PO	0.21	0.21	0.21	0.24	0.24	0.23	0.23
Avg of Herbaceous tons per acre GM	0.20	0.20	0.20	0.25	0.23	0.25	0.23
Average of Shrubs tons per acre MC	0.40	0.37	0.34	0.74	0.78	0.70	0.73
Average of Shrubs tons per acre PO	0.22	0.22	0.22	0.19	0.19	0.21	0.20
Average of Shrubs tons per acre GM	0.25	0.24	0.25	0.30	0.30	0.31	0.30
Avg of ALL BA1 0-1” MC	1	1	0	0	0	0	0
Avg of ALL BA1 0-1” PO	1	1	0	0	0	0	0

NR Recovery MC = 11,065 Acres Modeled PO = 13,539 Acres Modeled GM = 3,940 Acres Modeled on Tonto NF	Existing	No Action 2029	No Action 2039	Alt 2 2029	Alt 2 2039	Alt 3 2029	Alt 3 2039
Avg of ALL BA1 0-1" GM	1	1	1	0	0	0	0
Avg of ALL BA2 1-5" MC	12	12	13	1	1	2	2
Avg of ALL BA2 1-5" PO	10	11	13	2	1	3	3
Avg of ALL BA2 1-5" GM	14	15	16	1	1	2	2
Avg of ALL BA3 5-12" MC	39	40	39	13	10	15	12
Avg of ALL BA3 5-12" PO	41	40	38	16	12	22	19
Avg of ALL BA3 5-12" GM	54	53	51	14	11	17	14
Avg of ALL BA4 12-18" MC	61	59	58	32	29	33	30
Avg of ALL BA4 12-18" PO	54	54	54	34	32	38	35
Avg of ALL BA4 12-18" GM	61	62	63	31	27	33	29
Avg of ALL BA5 18-24" MC	43	52	57	44	45	42	43
Avg of ALL BA5 18-24" PO	37	44	47	39	41	41	42
Avg of ALL BA5 18-24" GM	31	36	38	33	31	31	31
Avg of ALL BA6 24" + MC	32	36	42	35	42	31	37
Avg of ALL BA6 24" + PO	21	23	25	23	27	23	27
Avg of ALL BA6 24" + GM	28	29	31	27	33	26	30

Foraging/Non-breeding Recovery Habitat

Design features (Appendix C) are included in both action alternatives, to use the following guidelines from the most current Mexican Spotted Owl Recovery Plan in Mexican spotted owl recovery foraging/non-breeding habitat:

- Crown spacing between tree groups (interspace) would average 25 to 60 feet distance, providing for forest health, prey habitat development, and to move toward or facilitate stand conditions more conducive to low-severity fire.
- Tree thinning in pine-oak would target 40 to 110 basal area; thinning in mixed conifer would target 40 to 135 basal area. The goal is to manage for a sustainable range of density and structural characteristics.
- No trees greater than 24 inches in diameter would be cut and trees greater than 18 inches would be retained, unless overriding management situations require their removal.

Table 70 shows the modeled effects from vegetation treatments by alternative to key MSO habitat variables in pine-oak, mixed conifer, and modeled recovery habitat on the Tonto National Forest in MSO Foraging/Non-breeding Recovery Habitat.

Table 70. FVS Modeled Effects on Key Habitat Variables in MSO Foraging/Non-breeding Recovery Habitat

Foraging/Non-breeding Recovery MC = 21,220 Acres Modeled PO = 85,458 Acres Modeled GM = 31,659 Acres Modeled on Tonto NF	Existing	No Action 2029	No Action 2039	Alt 2 2029	Alt 2 2039	Alt 3 2029	Alt 3 2039
Average of tpa MC	1398	1242	1101	154	97	377	304
Average of tpa PO	1192	1067	952	153	81	479	394
Average of tpa GM	1443	1308	1196	107	73	289	244
Average of BA MC	157	170	182	76	75	89	91
Average of BA PO	140	150	158	68	66	96	98
Average of BA GM	170	177	182	63	59	84	82
Average of SDI MC	376	394	406	133	121	172	165
Average of SDI PO	329	343	351	123	108	198	192
Average of SDI GM	407	414	416	108	95	162	151
Average of QMD MC	5	6	6	12	14	11	13
Average of QMD PO	6	6	7	11	14	10	12
Average of QMD GM	5	6	6	12	14	11	13
Average of SNAG 12-18” MC	3	3	3	4	3	4	3
Average of SNAG 12-18” PO	2	2	3	4	3	3	3
Average of SNAG 12-18” GM	2	2	2	5	3	5	3
Average of SNAG 18-24” MC	1	1	1	2	2	2	2
Average of SNAG 18-24” PO	1	1	1	1	1	1	1
Average of SNAG 18-24” GM	1	0	0	2	2	1	1
Average of SNAG ≥ 24” MC	1	1	0	1	1	1	1
Average of SNAG ≥ 24” PO	0	0	0	0	0	0	0
Average of SNAG ≥ 24” GM	0	0	0	1	1	1	1
Percent CANCOV Regression from BA MC	71	74	75	51	51	56	57
Percent CANCOV Regression from BA PO	69	70	72	48	47	59	59
Percent CANCOV Regression from BA GM	74	75	76	46	45	54	53
Average of Surface Fuel TPA MC	24	28	32	17	15	19	18
Average of Surface Fuel TPA PO	16	20	22	12	12	15	15
Average of Surface Fuel TPA GM	19	22	24	13	12	15	14
Average of CWD 3”+ TPA MC	8	10	12	9	8	9	8
Average of CWD 3”+ TPA PO	5	6	8	6	6	6	6
Average of CWD 3”+ TPA GM	6	7	9	8	7	7	7
Average of Surface Herb TPA MC	0.21	0.20	0.20	0.27	0.27	0.26	0.26
Average of Surface Herb TPA PO	0.21	0.21	0.21	0.26	0.25	0.24	0.24
Average of Surface Herb TPA GM	0.19	0.19	0.19	0.26	0.26	0.25	0.25
Average of Surface Shrub TPA MC	0.29	0.28	0.26	0.68	0.71	0.62	0.65

Foraging/Non-breeding Recovery MC = 21,220 Acres Modeled PO = 85,458 Acres Modeled GM = 31,659 Acres Modeled on Tonto NF	Existing	No Action 2029	No Action 2039	Alt 2 2029	Alt 2 2039	Alt 3 2029	Alt 3 2039
Average of Surface Shrub TPA PO	0.22	0.23	0.23	0.20	0.17	0.22	0.21
Average of Surface Shrub TPA GM	0.27	0.26	0.26	0.35	0.34	0.33	0.31
Average of ALL_BA1 MC	1	1	1	0	0	0	0
Average of ALL_BA1 PO	1	1	1	0	0	0	0
Average of ALL_BA1 GM	1	1	1	0	0	0	0
Average of ALL_BA2 MC	15	18	19	2	1	4	4
Average of ALL_BA2 PO	11	13	14	1	1	5	5
Average of ALL_BA2 GM	16	17	18	1	0	4	4
Average of ALL_BA3 MC	47	46	45	10	7	16	13
Average of ALL_BA3 PO	48	47	46	11	7	24	21
Average of ALL_BA3 GM	64	64	62	8	5	19	16
Average of ALL_BA4 MC	48	51	54	20	18	24	23
Average of ALL_BA4 PO	44	49	50	21	19	30	30
Average of ALL_BA4 GM	49	52	54	19	16	25	23
Average of ALL_BA5 MC	28	34	39	26	26	26	27
Average of ALL_BA5 PO	22	26	30	21	22	22	24
Average of ALL_BA5 GM	22	24	27	20	21	21	22
Average of ALL_BA6 MC	17	20	23	19	23	19	23
Average of ALL_BA6 PO	13	15	16	15	17	15	17
Average of ALL_BA6 GM	17	19	20	16	16	16	17

In MSO Foraging/Non-breeding Recovery habitat, treatments would maintain or increase most habitat variables beneficial to the MSO, its critical habitat, and its prey species, while conserving these conditions over time Table 70. These treatments would preserve Foraging/Non-Breeding Recovery habitat by thinning and burning while promoting large trees and reducing the fire hazard index and the risk of crown fire. A linear regression from basal area was used to estimate canopy cover. These estimates indicate that treatments would align with MSO Recovery Plan recommendations. The quadratic mean diameter in inches would increase with the action alternatives, showing that this trend toward larger trees would be achieved. Increases in snags of all size classes and increases in shrub and herbaceous biomass are desired outcomes from treatment. Reductions in surface fuel and creation of interspaces and uneven aged management would conserve MSO Foraging/Non-Breeding Recovery habitat over time. Fuel loads, the fire hazard index, and the risk of crown fire would be greatly reduced as a result of treatments (see Fire Ecology section for effects from the action alternatives).

Alternative 2 – Proposed Action

Under Alternative 2, mechanical treatments would occur in portions of all MSO habitats, except for core areas which would be only be burned (Table 71). Total treatments in MSO habitat include 241,585 acres of mechanical thinning and low-severity prescribed fire (about 71 percent of the total MSO habitat in the project area). This represents the largest number of MSO habitat acres ever treated with prescribed fire. The minimum post-treatment basal area for nesting and roosting habitat would be 110 square feet per acre. Adjustments would be made during implementation to retain a basal area of at least 110 square feet per acre wherever possible. Low-severity prescribed fire would be applied to all MSO habitats. No trees greater than 24 inches in diameter would be cut in MSO habitat. Trees up to 18 inches in diameter could be thinned in PACs. Treatments in recovery nest/roost habitat would be designed to move forests toward nest/roost habitat conditions. Treatments in nest/roost habitat would not lower forest structure values below the minimum nest/roost levels described in the forest plans and in Table C.3 of the Revised Recovery Plan (USDI FWS 2012b). It is assumed that mechanical treatments and two low-severity fires would be implemented during the project's lifespan (2019-2049).

Mechanical thinning and low-severity prescribed fire would take place at different times in different locations. MSO habitat could be affected by mechanical treatments in one area while prescribed fire occurs in another area in the same period of time. It is anticipated that implementation of all proposed treatments would require 20 or more years to complete.

Table 71. Alternative 2 thinning and burning treatments in MSO habitat

Treatment Type	Protected Habitat	Nest/roost Recovery	Foraging/Non-Breeding Recovery	Total Acres
Prescribed Fire Only[1]	49,066	None	None	49,066
Thinning+ Prescribed Fire	24,873	28,235	138,801	191,909
Prescribed Burns in Core Areas	610	N/A	N/A	610
Total	74,549	28,235	138,801	241,585
No Proposed Treatments	7,075	None	None	7,075
Total Analysis Acres	81,624	28,235	138,801	248,660

1. A single prescribed fire may include burning piles and a follow-up broadcast burn. Prescribed fire would be implemented as indicated by monitoring data to augment wildfire acres, with the expectation that desired conditions would require a fire return interval of about 10 years.
2. These areas would be treated as planned through other NEPA decisions for other project areas

Table 72. Acres of Treatments in MSO Habitat Types, Alternative 2

MSO Habitat Type	Cover Type	Aspen	Grass land or Meadow	Madrean Pinyon Oak	M/C with Aspen	Mixed Conifer Frequent Fire	Other	PJ	Ponderosa Pine	Ponderosa Pine/Evergreen Oak	Riparian	Total
Protected	PAC	169	123	945	324	11,265	622	4,468	41,741	6,260	1,699	67,617
PAC Core	PAC - Core Area	64	18	339	145	3,961	16	758	6,281	1,452	434	13,469
Recovery Replacement Nest/Roost	Recovery Replacement Nest/Roost	0	278	246	613	9,327	0	56	13,318	3,317	1,079	28,235
Recovery Replacement Nest/Roost	Modeled recovery habitat (Tonto NF)	0	0	246	0	0	0	56	1,796	1,653	265	4,017
Recovery Replacement Nest/Roost	Mixed Conifer	0	86	0	613	9,327	0	0	376	0	372	10,774
Recovery Replacement Nest/Roost	Pine-Oak	0	192	0	0	0	0	0	11,146	1,664	442	13,444
Recovery Foraging/Non-Breeding	Recovery Foraging/Non-Breeding	0	459	2,176	1,424	17,391	486	1,017	79,328	34,031	2,490	138,801
Recovery Replacement Nest/Roost	Modeled recovery habitat (Tonto NF)	0	0	2,176	0	0	486	904	8,461	18,597	1160	31,786
Recovery Replacement Nest/Roost	Mixed Conifer	0	159	0	1,424	17,391	0	0	1,095	777	573	21,418
Recovery Replacement Nest/Roost	Pine-Oak	0	299	0	0	0	0	113	69,772	14,657	757	85,598
Grand Total	**Grand Total**	**233**	**878**	**3,707**	**2,506**	**41,943**	**1,125**	**6,299**	**140,668**	**45,061**	**5,703**	**248,123**

Protected Habitat

There are 196 PACs (110,890 acres) within the project area. Approximately 7,075 acres occur in other project areas that overlap with the Rim Country project area but would be treated as those projects were planned and consulted on with the FWS. Approximately 17, 500 acres that also occur in other overlapping project areas would have some other type of restoration (riparian, wet meadow, grassland, aspen). Under Alternative 2, 81,624 acres (73 percent) of protected MSO habitat are proposed for thinning and/or burning or other restoration activities. Therefore, most of the protected habitat of the PACs in the Rim Country project area not associated with other projects would have some type of vegetation treatment. Most vegetation treatments (greater than 60 percent) would be prescribed fire only. Little change would occur in forest structure and MSO prey habitat from low-severity fire treatments.

In PACs, Alternative 2 would allow cutting trees up to 18 inches in diameter. All stands identified for mechanical thinning would be marked by hand and marking would be coordinated with the FWS. No mechanical treatments would occur in core areas. Design features (Appendix C) were included to minimize effects on owls and to promote Primary Constituent Habitat Elements recommended by the MSO Recovery Plan and the forest plans. Mechanical treatments in PACs are summarized in the Effects Common to Both Action Alternatives section. The Mechanical Treatments Flexible Toolbox Approach contains the following language for treatments in PACs:

PACs exhibit a variety of topographic and forest conditions and occupied PACs can already be considered successful nesting habitat. Mechanical treatments in PACs should be designed to maintain or improve the characteristics that make each PAC effective at providing habitat while also making them resilient to disturbance. Consideration should be given to 1) increasing the number of large trees; 2) creating additional foraging habitat for MSO; 3) the fire hazard index in the PAC and whether it is in wildland-urban interface (WUI); 4) restoration/protection of other resource values nearby, such as perennial water; and 5) protecting other values at risk. Treating areas near PACs should be considered in order in improve resiliency in the PACs themselves. PACs should be treated with consideration of the larger landscape and not just separate entities. Specific treatments in PACs would be determined prior to implementation and in consultation with U.S. Fish and Wildlife Service (FWS) personnel.

Table 73. Summary of treatments in PACs, Alternative 2

Proposed Treatment	- Alternative 2 - Modified Proposed Action Acres
PAC - Aspen Restoration	28
PAC - Facilitative Operations Mechanical	301
PAC - Facilitative Operations Prescribed Fire Only	6,882
PAC - Grassland Prescribed Fire Only	41
PAC - Grassland Restoration	23
PAC – Mechanical	17,464
PAC - Prescribed Fire Only	50,832
PAC - Riparian Prescribed Fire Only	911
PAC - Riparian Restoration	1,775
PAC - Severe Disturbance Area Treatment	3,606
PAC - Wet Meadow & Riparian Prescribed Fire Only	32
PAC - Wet Meadow & Riparian Restoration	98
PAC - Wet Meadow Prescribed Fire Only	33
PAC - Wet Meadow Restoration	254
Total	**82,279**

Forest Structure

Under Alternative 2, the FVS modeling of treatments over the next 30 years indicates that most forest structure, as it pertains to habitat variables important to the MSO in PACs, is preserved through time. Trees per acre would be reduced from the existing 1,291 in mixed conifer and 1,276 in pine-oak, to 227 in mixed conifer and 232 in pine-oak in 2039 (Table 68). Reducing trees per acre closer to NRV protects PACs and restores conditions for MSO by managing for less dense and encroached forested conditions. Openings created by bringing tree size classes to desired condition would provide habitat for a variety of prey species and would slow or reduce fire severity by breaking the continuity of dense tree canopies and ladder fuels.

The average of all basal areas from saplings (Size Class 1) to old growth or large trees (Size Class 6) show that intermediate-sized trees (Size 3 with BA 5 to 12 inches and Size 4 with BA 12 to 18 inches are currently predominant on the landscape and vastly departed from NRV) would be lowered closer to desired condition as a result of treatments through 2049. The basal area average would be decreased from the existing 173 in mixed conifer and 144 in pine-oak, to 127 in mixed conifer and 106 in pine-oak in 2039. Increase in basal area size classes for older trees and reducing medium-aged over-abundant size classes to NRV would benefit the MSO through reduction of over-encroached forest conditions. Further, this would increase vertical and horizontal habitat heterogeneity providing roosting options, thermal and hiding cover for the MSO and habitat for a variety of prey species.

The percent average canopy cover would be reduced from an existing 74 percent in mixed conifer and 69 percent in pine-oak, to 66 percent in mixed conifer and 61 percent in pine-oak in 2039. Retaining canopy cover allows for a thermal environment needed for nesting and roosting conditions for the MSO while allowing for prey base and for species that require interlocking crown habitat. Design features (Appendix C) would preserve the recommended habitat conditions in PACs wherever possible, while protecting this habitat from severe fire intensity or stand-replacing effects from crown fire (see the Fire Effects section for Alternative 2 below).

Promotion of large tree growth would be achieved from proposed treatments in Alternative 2 as stand density index would change from the existing 398 in mixed conifer and 339 in pine-oak, to 218 in mixed conifer and 191 in pine-oak in 2039.

A reduction in SDI competition would increase the quadratic mean diameter from the existing 6 inches in both mixed conifer and pine-oak, to 12 inches in mixed conifer and 11 inches in pine-oak in 2039. By emphasizing large trees, this should also provide for MSO life history needs (nesting and roosting) and provide for large snags and logs (Gainey et al. 2003).in 2049.

Alternative 2 Snags

In PACs, standing snags, coarse woody debris, and downed logs over 12 inches would all increase or be maintained as a result of treatments under Alternative 2 (Table 68). These Primary Constituent Element habitat variables important to the MSO and MSO prey species would be preserved over time under this action alternative.

Snags 12 to 18 inches in diameter would increase from four per acre in mixed conifer and two per acre in pine-oak to five per acre in both cover types in 2039. Snags 24 inches in diameter and greater would increase from one per acre in mixed conifer and 0 in pine-oak (existing) to one per acre in both cover types over 20 years. Retaining/increasing key habitat elements for the MSO such as snags of various sizes to provide for nesting and roosting and for prey habitat follows guidance from the MSO Revised Recovery Plan (2012). This is a long-term benefit to the MSO as a result of treatments in Alternative 2.

Alternative 2 Coarse Woody Debris and Understory

In PACs, large downed logs 12 or more inches in size would increase from one to four tons per acre as a result of treatments over 30 years. Coarse woody debris would increase from the existing 5.68 tons per acre to 7.61 tons per acre in 2049.

Herbaceous biomass in tons per acre would increase slightly over 20 years. The existing 0.2 tons per acre in both mixed conifer and pine-oak cover types would increase to 0.26 tons per acre in mixed conifer and 0.23 tons per acre in pine-oak in 2039. Treatments would move the existing shrub biomass from 0.40 tons per acre in mixed conifer to 0.73 in 2039. Increasing these habitat variables important to prey base for the MSO would be an added benefit from treatments in PACs in this alternative.

Alternative 2 Fire Effects

Surface fuel loading in MSO Protected Habitat would be reduced under Alternative 2, moving from an existing 29 tons per acre in mixed conifer and 20 tons per acre in pine-oak, to 27 tons per acre in mixed conifer and 19 in pine-oak in 2039.

Fire modeling in PACs for Alternative 2 shows the least benefit from treatment compared to other habitat types, as the objective in PACs is to provide interlocking crowns with larger proportions of woody debris and snags which can serve as ladder fuels. This complicates quantifying effects from treatments showing fewer acres of protected habitat benefiting from treatment than in surrounding habitats (see Recovery Habitat analyses below). Further, by analyzing the highest hazard categories for Fire Hazard Index and potential for active crown fire, treatment in PACs shows greater differences/benefits for preserving existing protected habitat while treating surrounding habitats at a higher level.

Fire Hazard Index would decrease from Alternative 2 from 91,697 acres (76 percent of the PACs in the project area in need of treatment) in existing condition to 83,832 acres (69 percent). The highest and extreme need for treatment categories of Fire Hazard Index from Alternative 2 in PACs would be 33,410 acres (27 percent) of all PACs in the project area expected to experience high-severity wildfire. This is decreased from 49,888 acres (41 percent) of all PACs in the existing condition. Reductions of this magnitude should preserve existing MSO habitat while encouraging conditions to create more over time through recovery habitats.

The potential for active and conditional crown fire would be decreased in Alternative 2 from 58,243 acres (48 percent) to 34,068 acres (28 percent) of this habitat type modelled that would experience high-severity crown fire as a result of treatment (Table 67).

Alternative 2 Nest/Roost Recovery

There are 39,461 acres of Nest/Roost Recovery Habitat in the Rim Country project area. Many of these acres (28,554 acres or 72 percent) could receive thinning and fire treatments under Alternative 2. The Mechanical Treatments Flexible Toolbox Approach (Appendix D) states the following for Nest/Roost Recovery Habitat:

Though these areas are distinct from PACs, their management objectives are similar. Any treatment proposed within MSO nest/roost recovery habitat should be designed specifically to maintain or accelerate the trajectory of these stands towards desired habitat conditions in the foreseeable future.

Table 74. Mechanical and Fire Treatments in MSO Nest/Roost Recovery Habitat, Alternative 2

Proposed Treatment	Alternative 2 - Modified Proposed Action Acres
Mixed Conifer Recovery NR	11,065
Facilitative Operations Mechanical	577
Facilitative Operations Prescribed Fire Only	38
MSO Recovery - Replacement Nest/Roost	9,579
Prescribed Fire Only	165
Riparian Prescribed Fire Only	21
Riparian Restoration	510
Wet Meadow & Riparian Restoration	33
Wet Meadow Restoration	143
Pine-Oak Recovery NR	13,539
Grassland Restoration	71
MSO Recovery - Replacement Nest/Roost	12,328
Prescribed Fire Only	270
Riparian Prescribed Fire Only	69
Riparian Restoration	596
Wet Meadow & Riparian Prescribed Fire Only	148
Wet Meadow & Riparian Restoration	4
Wet Meadow Restoration	53
Modeled Recovery NR (Tonto NF)	3,940
Facilitative Operations Mechanical	303
MSO Recovery - Replacement Nest/Roost	3,324
Riparian Restoration	313
Grand Total	28,554

Alternative 2 Forest Structure

Under Alternative 2, the FVS modeling from treatments over the next 30 years indicate that most forest structure, as it pertains to habitat variables important to the MSO in MSO Nest/Roost Recovery habitat, would be preserved through time. Trees per acre would be reduced from the existing 1,100 in mixed conifer, 1,280 in pine-oak, and 1,351 using the modeled recovery habitat on the Tonto, to 116 in mixed conifer, 137 in pine-oak, and 109 using the modeled recovery habitat on the Tonto. Reducing trees per acre closer to NRV would protect Nest/Roost Recovery habitat and restore conditions for the MSO by managing for less dense and encroached forested conditions. Openings created by bringing these size classes into desired condition would provide habitat for a variety of prey species and would slow or reduce fire severity by breaking the continuity of dense tree canopies and ladder fuels.

The average of all basal areas from saplings (Size Class 1) to old growth (Size Class 6) show that intermediate-sized trees (Size 3 with BA 5-12 inches and Size 4 with BA 12-18 inches are currently predominant on the landscape and vastly departed from NRV) would be lowered closer to desired condition as a result of treatments through 2039. Increasing basal area Size classes for older trees and reducing medium-aged over-abundant size classes to NRV benefits the MSO through the reduction of over-encroached forest conditions. Further, this would increase vertical and horizontal habitat heterogeneity providing roosting options, and thermal and hiding cover for the MSO and habitat for a variety of prey species.

The basal area average would decrease from the existing 188 in mixed conifer, 164 in pine-oak, and 190 in modeled recovery habitat on the Tonto, to 127 in mixed conifer, 112 in pine-oak, and 102 in modeled recovery habitat on the Tonto in 2029. The percent average canopy cover would be reduced from the existing 76 percent in mixed conifer, 73 percent in pine-oak, and 77 percent in modeled recovery habitat on the Tonto, to 66 percent in mixed conifer, 62 percent in pine-oak, and 60 percent in modeled recovery habitat on the Tonto in 2029. Design features for the project would preserve the recommended habitat conditions in Recovery Habitat wherever possible, while protecting this habitat from severe fire intensity or stand-replacing effects from crown fire.

Retaining canopy cover allows for a thermal environment needed for nesting and roosting conditions for the MSO while allowing for prey base and for species that require interlocking crown habitat. Promotion of large tree growth would be achieved in Alternative 2 from proposed treatments as stand density index would change from 420 in mixed conifer, 369 in pine-oak, and 441 in modeled recovery habitat on the Tonto, to 197, 183, and 164, respectively, in 2029. Reduction in stand density index competition would increase the quadratic mean diameter from the existing six inches in mixed conifer, seven in pine-oak, and six in modeled recovery habitat on the Tonto, to 16 inches in mixed conifer, and 14 inches in both pine-oak and the modeled recovery habitat on the Tonto in 2029. By emphasizing for large trees, this should also provide for MSO life history needs (nesting and roosting) and provide large snags and logs (Gainey et al. 2003).

Alternative 2 Snags

In Nest/Roost Recovery Habitat, snags would generally increase or be maintained as a result of treatments under Alternative 2 (Table 69). These Primary Constituent Element habitat variables important to the MSO and MSO prey species would be preserved over time under this action alternative. Retaining/increasing key habitat elements for the MSO, such as snags of various sizes to provide for nesting and roosting and for prey habitat, follows guidance from the MSO Revised Recovery Plan (2012). This is a long-term benefit to the MSO as a result of treatments under Alternative 2.

Alternative 2 Coarse Woody Debris and Understory

Coarse woody debris greater than three inches would be maintained at 10 tons per acre in mixed conifer and increases in pine-oak from six trees per acre to eight trees per acre in 2029. Using the modeled recovery habitat on the Tonto, coarse woody debris would increase from 10 trees per acre to 11 trees per acre in 2029. Herbaceous biomass would increase over the 20 years modeled in mixed conifer and in the modeled recovery habitat on the Tonto. The existing condition of 0.21 tons per acre in mixed conifer and 0.20 in modeled recovery habitat on the Tonto would increase to 0.26 in mixed conifer and 0.23 in modeled recovery habitat on the Tonto in 2039. More pronounced is the effect of treatments on the shrub biomass, which would change from 0.40 tons per acre in mixed conifer to 0.78 in 2029. In acres identified using the modeled recovery habitat on the Tonto, shrub biomass would increase from 0.25 tons per acre to 0.30 tons per acre in 2029. Increasing these habitat variables important to prey base for the MSO would be an added benefit to treatments in Nest/Roost Recovery habitat under this alternative.

Alternative 2 Fire Effects

Surface fuel loading in MSO Nest/Roost Recovery habitat would be reduced under Alternative 2, moving from 30 tons per acre in mixed conifer, 19 in pine-oak, and 23 in modeled recovery habitat on the Tonto, to 23 tons per acre in mixed conifer and 18 tons per acre in pine-oak and modeled recovery habitat on the Tonto in 2029 (Table 69).

Fire Hazard Index would be decreased from 4,175 acres (41 percent of the Nest/Roost Recovery habitat in high or extreme need of treatment) to 588 acres (six percent). Reductions of this magnitude should preserve existing MSO habitat while encouraging conditions to create more over time through recovery habitats.

The potential for active and conditional crown fire would be decreased under Alternative 2 from 4,802 acres (47 percent) to 407 acres (four percent). Reducing active crown fires by this magnitude is a benefit to MSO and its critical habitat that would preserve Nest/Roost Recovery habitat over time.

Alternative 2 Other Habitat Effects

Understory vegetation development is related to the amount of solar radiation reaching the ground. This creates a direct and inverse relationship between canopy closure and herbaceous cover. The uncharacteristic forest structure existing in the ponderosa pine forests of northern Arizona restricts herbaceous growth well below pre-settlement conditions. Ponderosa pine forests in Arizona are relatively homogeneous and the site-specific habitat variability that springs, streams, meadows, grasslands, savannas, and aspen represent are important to a wide array of wildlife, including MSO prey species. These distinct vegetation types support understory vegetation that is typically denser, more continuous, and more diverse because of the soil types supporting them and the increased solar radiation and moisture availability compared to ground conditions in the general forest. Understory vegetation provides the food and cover that supports an array of wildlife, including many small mammals, birds, bats, and a variety of arthropods that serve as food for vertebrate species and pollinators to help maintain herbaceous diversity. These microhabitats directly and indirectly support MSO prey species. Improvements to springs, riparian areas, stream channels, meadows, and aspen can benefit MSOs in ways greater than simple area estimates indicate.

Springs, Riparian and Stream Habitat, Grasslands, Savannas, Meadows, and Aspen

Springs, riparian areas, and stream channel restoration would be the same for both action alternatives and are described above in the Effects Common to Both Action Alternatives section. Grassland, savanna, and meadow treatments would include mechanical tree removal and prescribed burning within PACs under both Alternatives 2 and 3.

Cumulative Effects Alternative 2 – Modified Proposed Action

Treatments in these areas would reduce the fire threat for MSO habitat within the respective project area, as well as reducing the threat of high-severity fire starting in these areas and burning habitat outside the project areas. Given the diameter limits employed and the generally low intensity of the treatments in MSO habitat, decreases in the risk of high-severity fire and improvements to understory vegetation and prey habitat are expected to be short term, before canopies expand and intercept light, rain, and snow, thereby reducing understory response in the long term.

Cumulative effects from reasonably foreseeable projects could include disturbance from noise and potentially from smoke. Implementation of the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim), could cumulatively degrade but retain MSO habitat, including PACs and recovery habitat, in the short and long terms. However, the risk of high-severity fire eliminating MSO habitat would be reduced in the short and long terms.

Although smoke and noise can cross project boundaries, both largely disperse with distance. However, some areas where smoke settles could be at further risk of effects on owls where these projects share boundaries. All or most PAC treatments would have timing restrictions, cumulatively preventing treatments during the breeding season. The most common PAC treatment would be prescribed fire.

Given the various stages of planning and implementation, most project effects would be dispersed both spatially and temporally. Projects in MSO habitat are typically designed to improve habitat, or to reduce fuel loading and risk of crown fire while retaining habitat function, resulting in a decrease in risk of high-severity fire. Cumulatively there could be increased disturbance to individual MSOs from noise or smoke in the short term. Given restoration project objectives, the scale of the cumulative effects area, the distribution of MSO habitat across the project area, and the length of time over which treatments would be implemented (20 years of implementation and ten more years of obtained benefits through reduction of wildfire risk), cumulatively alternative 2 is not expected to negatively affect MSO population in the long term. Cumulatively, treatments in MSO habitat should move forest conditions toward desired conditions and decrease the risk of habitat loss to large-scale high-severity fire.

Determination of Effect

Based on the above analysis, Alternative 2 of the 4FRI Rim Country Project **may affect, is likely to adversely affect the Mexican spotted owl.**

Alternative 3 – Focused Alternative

Protected Habitat

Approximately 61,695 acres are proposed for treatment in PACs under Alternative 3. Mechanical treatments could occur in 18,887 acres and are summarized below in Table 75.

Table 75. Treatments in MSO Protected Habitat, Alternative 3

Proposed Treatment	Alternative 3 Focused Alternative Acres
PAC - Aspen Restoration	28
PAC - Facilitative Operations Mechanical	301
PAC - Facilitative Operations Prescribed Fire Only	3,065
PAC - Grassland Prescribed Fire Only	41
PAC - Grassland Restoration	23
PAC – Mechanical	15,754
PAC - Prescribed Fire Only	37,964
PAC - Riparian Prescribed Fire Only	911
PAC - Riparian Restoration	1,775
PAC - Severe Disturbance Area Treatment	1,416
PAC - Wet Meadow & Riparian Prescribed Fire Only	32
PAC - Wet Meadow & Riparian Restoration	98
PAC - Wet Meadow Prescribed Fire Only	33
PAC - Wet Meadow Restoration	254
Grand Total	**61,695**

Alternative 3 Forest Structure

Under Alternative 3, the FVS modeling of treatments over the next 30 years indicates that most forest structure, as it pertains to habitat variables important to the MSO in PACs, is preserved through time. Trees per acre would be reduced from the existing 1,291 in mixed conifer and 1,276 in pine-oak, to 379 in mixed conifer and 368 in pine-oak in 2029 (Table 68). Reducing trees per acre closer to NRV protects PACs and restores conditions for MSO by managing for less dense and encroached forested conditions. Openings created by bringing tree size classes to desired condition would provide habitat for a variety of prey species and would slow or reduce fire severity by breaking the continuity of dense tree canopies and ladder fuels.

The average of all basal areas from saplings (Size Class 1) to old growth or large trees (Size Class 6) show that intermediate-sized trees (Size 3 with BA 5-12 inches and Size 4 with BA 12-18 inches are currently predominant on the landscape and vastly departed from NRV) would be lowered, but not to desired conditions, as a result of treatments through 2039. The basal area average would be decreased from the existing 173 in mixed conifer and 144 in pine-oak, to 130 in mixed conifer and 117 in pine-oak in 2039. These modeled results would align with the MSO Recovery Plan recommendations. Design features would preserve the recommended habitat conditions in PACs wherever possible, while protecting this habitat from severe fire intensity or stand-replacing effects from crown fire.

Promotion of large tree growth would be achieved in Alternative 3 as stand density index would change from the existing 398 in mixed conifer and 339 in pine-oak, to 235 in mixed conifer and 223 in pine-oak in 2039. A reduction in SDI competition would increase the quadratic mean diameter from the existing six inches in both mixed conifer and pine-oak, to 12 inches in mixed conifer and 10 inches in pine-oak in 2039.

Alternative 3 Snags

In PACs, standing snags, coarse woody debris, and downed logs over 12 inches would all be maintained or increase as a result of treatments under Alternative 3 (Table 68). These Primary Constituent Element habitat variables important to the MSO and MSO prey species would be preserved over time under this action alternative. Snags 12 to 18 inches in diameter would increase from two per acre to four per acre in 2039. The number of snags per acre, snags 24 inches in diameter and greater would be maintained in PACs over the 20 years modeled. Retaining/increasing key habitat elements for the MSO such as snags of various sizes to provide for nesting and roosting and for prey habitat follows guidance from the MSO Revised Recovery Plan (2012). This is a long-term benefit to the MSO as a result of treatments in Alternative 3.

Alternative 3 Coarse Woody Debris and Understory

In PACs, coarse woody debris three inches or greater would increase from 10 to 12 tons per acre in mixed conifer and from eight to nine tons per acre in pine-oak as a result of treatments over the 20 years modeled. Herbaceous biomass in tons per acre would increase slightly over 20 years. Proposed treatments would change the amount of shrub biomass from the existing 0.4 tons per acre in mixed conifer to 0.65 in 2039. Shrub biomass would slightly increase in pine-oak as a result of treatments over the 20 years modeled.

Alternative 3 Fire Effects

Surface fuel loading in MSO Protected Habitat would be slightly reduced under Alternative 3, moving from an existing 29 tons per acre in mixed conifer to 27 tons per acre in 2039.

Fire Hazard Index would decrease from 49,889 acres (41 percent of the PACs in the project area in need of treatment) to 33,105 acres (30 percent). Reductions of this magnitude should preserve existing MSO habitat while encouraging conditions to create more over time through recovery habitats. Active crown fire in PACs in Alternative 3 total 33,044 acres (30 percent) compared to the existing 58,243 (48 percent) that would experience high-severity crown fire as a result of treatments.

Alternative 3 Nest/Roost Recovery

Forest Structure

Under Alternative 3, the FVS modeling from treatments over the next 30 years indicate that most forest structure, as it pertains to habitat variables important to the MSO in MSO Nest/Roost Recovery habitat, would be preserved through time. Trees per acre would be reduced from the existing 1,100 in mixed conifer, 1,280 in pine-oak, and 1,351 using the modeled recovery habitat on the Tonto, to 155 in mixed conifer, 432 in pine-oak, and 176 using the modeled recovery habitat on the Tonto in 2039. Reducing trees per acre closer to NRV would protect Nest/Roost Recovery habitat and restore conditions for the MSO by managing for less dense and encroached forested conditions. Openings created by bringing these size classes into desired condition would provide habitat for a variety of prey species and would slow or reduce fire severity by breaking the continuity of dense tree canopies and ladder fuels.

Table 76. Treatments in MSO Nest/Roost Recovery Habitat, Alternative 3

Proposed Treatment	Alternative 3 Focused Alternative Acres
Mixed Conifer Recovery NR	10,458
Facilitative Operations Mechanical	577
Facilitative Operations Prescribed Fire Only	38
MSO Recovery - Replacement Nest/Roost	8,972
Prescribed Fire Only	165
Riparian Prescribed Fire Only	21
Riparian Restoration	510
Wet Meadow & Riparian Restoration	33
Wet Meadow Restoration	143
Pine-Oak Recovery NR	8,844
Grassland Restoration	71
MSO Recovery - Replacement Nest/Roost	7,643
Prescribed Fire Only	260
Riparian Prescribed Fire Only	69
Riparian Restoration	596
Wet Meadow & Riparian Prescribed Fire Only	148
Wet Meadow & Riparian Restoration	4
Wet Meadow Restoration	53
Modeled Recovery NR (Tonto NF)	3,531
Facilitative Operations Mechanical	302
MSO Recovery - Replacement Nest/Roost	2,916
Riparian Restoration	313
Grand Total	22,833

The average of all basal areas from saplings (Size Class 1) to old growth (Size Class 6) show that intermediate-sized trees (Size 3 with BA 5 to 12 inches and Size 4 with BA 12 to 18 inches are currently predominant on the landscape and vastly departed from NRV) would be lowered as a result of treatments through 2039. The basal area average would decrease from the existing 188 in mixed conifer, 164 in pine-oak, and 190 in modeled recovery habitat on the Tonto, to 124 in mixed conifer, 127 in pine-oak, and 106 in modeled recovery habitat on the Tonto in 2029. The percent average canopy cover would be reduced from the existing 76 percent in mixed conifer, 73 percent in pine-oak, and 77 percent in modeled recovery habitat on the Tonto, to 65 percent in mixed conifer, 66 percent in pine-oak, and 61 percent in modeled recovery habitat on the Tonto in 2039. Design features for the project would preserve the recommended habitat conditions in Recovery Habitat wherever possible, while protecting this habitat from severe fire intensity or stand-replacing effects from crown fire.

Promotion of large tree growth would be achieved in Alternative 3 as the stand density index changes from 420 in mixed conifer, 369 in pine-oak, and 441 in modeled recovery habitat on the Tonto, to 199, 231, and 179, respectively, in 2039. Reduction in stand density index competition would increase the quadratic mean diameter from the existing six inches in mixed conifer, seven in pine-oak, and six in modeled recovery habitat on the Tonto, to 15 inches in mixed conifer, and 13 inches in pine-oak, and 16 inches in modeled recovery habitat on the Tonto in 2039.

Alternative 3 Snags

In Nest/Roost Recovery Habitat, snags would be maintained or increase as a result of treatments under Alternative 3 (Table 69). These Primary Constituent Element habitat variables important to the MSO and MSO prey species would be preserved over time under the focused alternative.

Alternative 3 Coarse Woody Debris and Understory

In Nest/Roost Recovery habitat, coarse woody debris greater than three inches would increase as a result of treatments through 2039. Herbaceous biomass would increase over the 20 years under Alternative 3. The existing 0.21 tons per acre in mixed conifer and pine-oak and the 0.20 tons per acre in modeled recovery habitat on the Tonto would slightly increase. Shrub biomass would change from 0.40 tons per acre to 0.73 tons per acres in mixed conifer by 2039.Increasing these habitat variables important to prey base for the MSO would be an added benefit to treatments in Nest/Roost Recovery habitat under this alternative.

Alternative 3 Fire Effects

Surface fuel loading in MSO Nest/Roost Recovery habitat would be reduced under Alternative 3, moving from 30 tons per acre in mixed conifer, 19 in pine-oak, and 23 in modeled recovery habitat on the Tonto, to 22 tons per acre in mixed conifer, 19 in pine-oak, and 23 modeled recovery habitat on the Tonto, to 22 in mixed conifer, 19 in pine-oak, and 19 modeled recovery habitat on the Tonto in 2039 (Table 69).

Fire Hazard Index would be decreased from 4,175 acres (41 percent of the Nest/Roost Recovery habitat in high or extreme need of treatment) to 588 acres (six percent). Reductions of this magnitude should preserve existing MSO habitat while encouraging conditions to create more over time through recovery habitats.

The potential for crown fire would be decreased under Alternative 3 from 4,802 acres (47 percent) to 407 acres (four percent). Reducing active crown fires by this magnitude is a benefit to MSO and its critical habitat that would preserve Nest/Roost Recovery habitat over time.

Alternative 3 Other Habitat Effects

Understory vegetation development is related to the amount of solar radiation reaching the ground. This creates a direct and inverse relationship between canopy closure and herbaceous cover. The uncharacteristic forest structure existing in the ponderosa pine forests of northern Arizona restricts herbaceous growth well below pre-settlement conditions. Ponderosa pine forests in Arizona are relatively homogeneous and the site-specific habitat variability that springs, streams, meadows, grasslands, savannas, and aspen represent are important to a wide array of wildlife, including MSO prey species. These distinct vegetation types support understory vegetation that is typically denser, more continuous, and more diverse because of the soil types supporting them and the increased solar radiation and moisture availability compared to ground conditions in the general forest. Understory vegetation provides the food and cover that supports an array of wildlife, including many small mammals, birds, bats, and a variety of arthropods that serve as food for vertebrate species and pollinators to help maintain herbaceous diversity. These microhabitats directly and indirectly support MSO prey species. Improvements to springs, riparian areas, stream channels, meadows, and aspen can benefit MSOs in ways greater than simple area estimates indicate.

Alternative 3 Springs, Riparian and Stream Habitat, Grasslands, Savannas, Meadows, and Aspen

Springs, riparian areas, and stream channel restoration would be the same for both action alternatives and are described above in the Effects Common to Both Action Alternatives section. Grassland, savanna, and meadow treatments would include mechanical tree removal and prescribed burning within PACs under both Alternatives 2 and 3

Cumulative Effects Alternative 3 – Focused Alternative

Cumulatively, when added to other projects in the cumulative effects boundaries in MSO habitat, the areas not assigned treatments using the decision matrix would be 218,670 less in Alternative 3 than in Alternative 2. In PACs, 14,640 fewer acres would be thinned and burned. In Recovery Nest/Roost habitat, 5,820 fewer acres would be treated in Alternative 3. Cumulatively, savannah treatments in Alternative 3 would be reduced by 15,190 acres, providing less restoration to benefit the MSO prey base. While short-term effects from disturbance would be lessened slightly across the cumulatively effects area in Alternative 3, the long-term effects and risk of habitat degradation from stand-altering wildfire or insect infestations would be greater than under alternative 2 and when added to treatments in MSO habitat would improve fewer acres.

Determination of Effect

Based on the above analysis, Alternative 3 **may affect, is likely to adversely affect the Mexican spotted owl.**

Western Yellow-billed Cuckoo

Alternative 1 – No Action Direct and Indirect Effects

Under Alternative 1, habitat conditions for wildlife would largely remain in their current condition. Thinning and prescribed fire would still occur as a result of current and reasonably foreseeable projects. However, the landscape would continue to move away from desired conditions (see Affected Environment above and in the Silviculture and Fire Specialist reports). Alternative 1 would have no direct effect on the Yellow-billed Cuckoo; however there would be substantial indirect effects. Dense forest conditions would still occur and the high fire hazard potential would persist. Large crown-wildfires could adversely affect potential habitat by destroying understory and overstory vegetation. As a result overland flow would increase, and soil erosion would increase with potentially high sediment loads. Water quality and riparian conditions would be adversely affected on a wide-scale basis (See Hydrology Report), resulting in indirect adverse effects.

Under Alternative 1, there would be no restoration of springs and riparian areas. These areas would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future (See Hydrology Report), resulting in degradation of potential habitat for cuckoos.

Denser forest conditions produce lower values in understory biomass (pounds per acre). Under Alternative 1, understory biomass would continue to decline over the next 40 years. Limited cover around tanks and riparian areas as well as the limited herbaceous understory across the project area, would continue to reduce the likelihood that cuckoos would successfully locate and nest in these areas.

Determination of Effect

Alternative 1 **may affect and is likely to adversely affect** the western yellow-billed cuckoo and its proposed critical habitat.

Alternative 2 – Modified Proposed Action

Prescribed fire and mechanical thinning projects have occurred and are expected to continue in habitat used by western yellow-billed cuckoo on national forests where cuckoos occur. Therefore, proposed fire and non-fire treatments may directly and indirectly affect cuckoos by removing suitable habitat and displacing breeding or foraging birds, and/or by disturbing cuckoos where suitable habitat is not displaced, but within the vicinity of project activities.

These kinds of projects could have short-term adverse effects on western yellow-billed cuckoo habitat by reducing cover, affecting water quality, and reducing prey abundance. Implementation of proposed activities and associated fire and smoke can alter cuckoo behavior by creating visual, noise, and physiological disturbance. Yellow-billed cuckoos may exhibit avoidance, ranging from less than a day where visual and noise disturbance is temporary to more than one breeding season where breeding and foraging habitat have been removed. If cuckoos are present at the time of thinning or prescribed burning activities, individuals could abandon their roosting and nesting sites.

If nests are abandoned, young or eggs would be lost. Any individuals present in or adjacent to treated areas could also experience effects from the loss of prey availability, fire, and visual, noise, and smoke disturbance. The effects could range from habitat use changes, activity pattern changes, increased stress responses, decreased foraging efficiency and success, reduced reproductive success, increased predation risk, and intraspecific diminished communication (NoiseQuest n.d. [2012]; Pater et al. 2009). These responses could vary depending on the nature of the disturbance, but would be expected to decrease as the distance from the activity increases.

Although design features are included in this alternative to mitigate effects from treatments, adverse effects on cuckoos and habitat are still likely to occur during migration and the early part of the breeding season. Prescribed burning just prior to arrival would reduce the available foraging habitat and prey species to cuckoos. Cuckoo home ranges are large, usually at least 50 acres in size. As such, effects on cuckoos and habitat from thinning and prescribed fire might occur within cuckoo riparian breeding habitat and adjacent foraging habitat up to 0.5 mile away.

Prescribed fire, and to a lesser extent mechanical thinning, would also benefit cuckoos by maintaining long-term ecosystem function on these fire-adapted landscapes. Thinning and fire would promote seral stage diversity and reduce fuel build-up that might otherwise result in a stand-replacing, high-severity fire. The regenerating and resprouting trees, shrubs, and herbaceous vegetation resulting from fire would increase the insect production needed by cuckoos to raise young.

Prescribed burning would occasionally use riparian drainages as control lines where no natural physical barriers, roads, trails, or openings can be used. Design features described above would ensure that effects on riparian habitat would be spread across the landscape and temporally separated. In this way, there would never be a case over the lifespan of the project that a single riparian drainage would be treated along its entire length.

Cumulative Effects from Alternative 2

The area analyzed for cumulative effects for Yellow-billed Cuckoo is within the project area’s riparian corridors and a 0.5-mile buffer. The temporal boundary is 30 years, including 20 years of implementation and 10 years of riparian system benefits from those treatments. Watershed health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves National Forests), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating cuckoo habitat in Rim Country would be reduced in the short and long terms.

All riparian treatments in cuckoo habitat would coordinate with wildlife biologists to determine timing restrictions, and mitigations cumulatively preventing treatments during the breeding season.

Given the various stages of planning and implementation, most project effects would be dispersed both spatially and temporally. Projects in riparian habitat are typically designed to improve habitat, or to reduce fuel loading and risk of crown fire while retaining habitat function, resulting in a decrease in risk of high-severity fire. Cumulatively there could be increased disturbance to individual cuckoos from noise or smoke in the short term. Given restoration project objectives, the scale of the cumulative effects area and the length of time over which treatments would be implemented (20 years of implementation and ten more years of obtained benefits through reduction of wildfire risk), cumulatively alternative 2 is not expected to negatively affect the cuckoo population in the long term. Cumulatively, treatments in riparian habitat should move forest conditions toward desired conditions and decrease the risk of habitat loss to large-scale high-severity fire.

Climate change, in combination with drought cycles, is likely to exacerbate existing threats to the western yellow-billed cuckoo's habitat in the southwestern United States, now and into the foreseeable future. Implementation of restoration projects such as Rim Country should cumulatively mitigate some of the long-term effects from climate change on western yellow-billed cuckoo habitat.

Determination of Effect

Implementation of Alternative 2 **May affect, is Likely to Adversely Affect** the Yellow-billed Cuckoo and its proposed Critical Habitat.

Alternative 3 – Focused Alternative

Direct and indirect effects for Alternative 3 would be the same as with Alternative 2. Alternative 3 includes the same number of miles and acres of riparian restoration, while reducing the total number of forested acres thinned and treated with prescribed burning. Alternative 3 would treat fewer acres in Rim Country. Project design features have been developed (included in Alternative 2 analysis for the Western yellow-billed cuckoo above) to reduce the potential of effects on nesting and foraging cuckoo habitat.

Cumulative Effects

Same as Alternative 2. Alternative 3 would treat less acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which would result in less watershed restoration.

Determination of Effect

Implementation of Alternative 3 **May affect, is Likely to Adversely Affect** the Yellow-billed Cuckoo and its proposed Critical Habitat.

Mexican Grey Wolf

Alternative 1 – No Action

Under Alternative 1, habitat conditions for wildlife would largely remain in their current condition. Thinning and prescribed fire would still occur as a result of current and reasonably foreseeable projects. However, the landscape would continue to move away from desired conditions (see Affected Environment above and in the Silviculture and Fire Ecology and Air Quality Reports). Alternative 1 would have no direct effect on Mexican wolves. Dense forest conditions would still occur and the high fire hazard potential would persist. Large crown fires could adversely affect potential habitat by destroying understory and overstory vegetation.

Under Alternative 1, there would be no restoration of springs and riparian areas. These areas would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future (see Water and Riparian Resource Report), resulting in degradation of conditions for potential prey species.

Determination of Effect

Alternative 1 would have **No Effect** to the Mexican wolf.

Alternative 2 – Modified Proposed Action

The 4FRI Rim Country Project lies within the Blue Range Wolf Recovery Area where Mexican wolf denning has not occurred. The Mexican wolf has not been reported denning in or near the Rim Country project area, though dispersing adults have moved through the area and could potentially den in the project area in the future.

If conflicts occur, the Forest Service would work with the Mexican Wolf Field Team to arrive at a solution. Actions taken on the other Ranger Districts where wolves occur included placing temporary restrictions around a wolf den site.

Dispersing reintroduced Mexican wolves might be disturbed during implementation of thinning and prescribed fire. Due to the mobility of the species, reintroduced wolves are likely able to avoid areas receiving treatment. Direct effects from thinning operations would not be expected to affect denning wolves because of the added design feature to limit disturbance.

Thinning and management-ignited fire alters prey species habitat to various degrees. Especially in areas that sustain low to moderate-intensity burns, there would be an eventual, relatively short-term increase in forage and browse used by some prey species.

Cumulative Effects

The cumulative effects analysis area for the wolf is the project area and a 10-mile buffer outside of the project boundary to include dispersing animals. The temporal boundary is 25 years to include 20 years of implementation, and 5 years of effects following treatments. Watershed and forest health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating wolf habitat in Rim Country would be reduced in the short and long terms.

Determination of Effect

Potential effects on the Mexican wolf reintroduction project from the Rim Country Project have been analyzed and found to be insignificant and discountable. Wolves have long endured in fire-adapted ecosystems and the implementation of this alternative would not adversely affect the reintroduction effort. Communication with the Interagency Field Team would allow project managers to avoid treatment in close proximity to dens, or during the wolf denning season.

By definition, a non-essential experimental population is not crucial to the continued existence of the species. Therefore, no management activities associated with the Rim Country Project would affect this 10(j) population so designated that could lead to a jeopardy determination for the entire species. The management activities associated with the Rim Country Project in the 10(j) area with Mexican wolves are **not likely to jeopardize the continued existence of the Mexican wolf.**

Alternative 3 – Focused Alternative

The direct and indirect effects from Alternative 3 would be similar to those from Alternative 2. Alternative 3 includes the same number of miles and acres of riparian restoration, while reducing the total number of acres thinned and treated with prescribed burning. Alternative 3 treat fewer acres in the Rim Country project area. A design feature was included (see Alternative 2 analysis above) to reduce the potential of effects on denning wolves.

Cumulative Effects

Same as Alternative 2. Alternative 3 would treat less acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which would result in less forest restoration and providing less risk of severe wildfire effects.

Determination of Effect

Implementation of Alternative 3 is **not likely to jeopardize the continued existence of the Mexican wolf.**

Forest Service Sensitive Species

Northern Goshawk

Alternative 1 – No Action

Vegetation Changes

Under the no action alternative, most of the overall landscape would move toward desired conditions more slowly than the other alternatives, while some areas may not move toward desired conditions at all (Table 77). Post-fledging family areas (PFAs and lands outside PFAs (LOPFAs) would have less age-class diversity than either of the action alternatives.

Table 77. Habitat variables in PFAs by alternative by decade

PFAs	Existing Condition	No Action 2029	No Action 2049	Alt2 2029	Alt 2 2049	Alt 3 2029	Alt3 2049
Avg of Trees per Acre	1062.52	958.87	778.86	450.22	162.39	620.50	379.60
Avg of Basal Area	130.53	137.53	145.49	70.36	57.96	94.55	92.65
Avg of Stand Density Index	303.15	311.01	313.76	154.85	106.20	209.68	185.61
Avg of Quadratic Mean Diameter in Inches	6.01	6.51	7.37	6.55	10.82	6.62	9.74
Avg of SNAG 12-18	1.75	3.08	4.70	6.53	4.09	4.75	3.95
Avg of SNAG 18-24	0.65	0.96	1.54	2.04	1.80	1.51	1.60
Avg of SNAG ≥ 24	0.35	0.38	0.56	1.06	1.07	0.78	0.83
Avg of Canopy Cover %	43.82	45.76	47.56	23.79	18.35	32.17	30.32
Avg of Surface Fuel tons per acre	14.83	16.88	22.06	9.87	9.77	11.95	13.40
Avg of Coarse Woody Debris	4.38	5.06	8.21	4.17	5.15	4.37	5.73
Avg of Downed Logs ≥12"	0.78	1.09	2.47	1.69	2.94	1.44	2.57
Avg of Herbaceous tons per acre	0.21	0.20	0.20	0.25	0.26	0.23	0.23
Average of Shrubs tons per acre	0.31	0.31	0.31	0.37	0.31	0.35	0.31
Avg of ALL BA1 0-1"	0.76	0.61	0.43	0.44	0.09	0.47	0.18
Avg of ALL BA2 1-5"	12.05	13.55	15.17	3.49	2.62	7.24	7.52
Avg of ALL BA3 5-12"	43.09	42.56	41.89	16.35	8.82	26.37	22.63
Avg of ALL BA4 12-18"	39.35	41.76	42.65	21.82	16.10	29.02	26.83
Avg of ALL BA5 18-24"	19.82	22.39	26.31	15.24	15.77	17.51	19.46
Avg of ALL BA6 24" +	15.45	16.67	19.02	13.02	14.55	13.94	16.03

Specifically, it would have the lowest proportion in grass-forb-shrubs, seedlings, and saplings; the highest proportion in mid-aged forest; and the lowest proportion in the older age classes.

Post-fledging Family Areas (PFAs)
In PFAs the FVS modeling of the effects of treatments on northern goshawk by alternative shows that the average trees per acre would remain high under Alternative 1, from the existing 1,062 to 958 in 2029 and 778 in 2049. The average of all basal area and canopy cover would continue to increase slightly, while the stand density index would remain high, from the existing 303 to 313 after 30 years. High competition for resources would keep the quadratic mean diameter low, from the current six inches to seven inches after 30 years. Mid-aged forest (BA3, 5-12 inches, and BA4, 12-18 inches) would continue to dominate the landscape and represent a huge shift in the NRV for the forested ecosystem.

Snags of all size classes important to prey species would continue to increase very slightly. Coarse woody debris and downed logs important to prey species would increase over 30 years. Herbaceous and shrub layers would show no improvement over time under Alternative 1.

Fuel loads in average of tons per acre would increase from 15 tons per acre in the existing condition to 22 tons per acre after 40 years under Alternative 1. The fire hazard index was modeled in PFAs under existing conditions (Table 79). Of the 39,478 acres modeled, Alternative 1 would result in 31,877acres (81 percent) of the PFAs that could potentially experience high-severity wildfire (Table 79).

The risk of crown fire was modeled in PFAs based on the existing condition. Alternative 1 would result in 34,730 acres (88 percent) of PFAs in the Rim Country project area experiencing crown fire (Table 80).

Lands outside of PFAs (LOPFAs)
The three forest plans have guidance to manage toward uneven-age stand conditions. In LOPFAs, Alternative 1 would have the slowest progress of all alternatives toward having age classes in uneven-aged (desired) condition.

In LOPFAs, FVS modeling of effects on Northern Goshawk by alternative shows that the average trees per acre would remain high under Alternative 1, from the current 1,062 to 964 in 2029 and 783 in 2049. The average of all basal area and canopy cover would continue to increase slightly, while the stand density index would remain high, from 303 to 313 after 30 years. High competition for resources would keep the quadratic mean diameter low, from the existing six inches to seven inches after 30 years. Mid-aged forest (BA3, 5-12 inches, and BA4, 12-18 inches) would continue to dominate the landscape and represent a huge shift in the Natural Range of Variation of the forested ecosystem.

Snags of all size classes important to prey species would continue to increase very slightly. Coarse woody debris and downed logs important to prey species would increase over 30 years. Herbaceous and shrub layers would show no improvement over time under Alternative 1. Wildfire modeling in the ponderosa pine habitat type by alternative show that of the 553,137 acres of ponderosa pine habitat type, 407,189 acres (81 percent) have the potential to experience high-severity wildfire under Alternative 1. Crown fire potential in ponderosa pine habitat from Alternative 1 could occur in 480,996 acres (87 percent) of this habitat type.

Determination of Effect
Alternative 1 may affect individual goshawks, but is not likely to cause a trend toward federal listing or loss of viability.

Effects Common to Both Action Alternatives

Gambel oak, juniper and pinyon species greater than five inches in diameter at the root collar (diameter root collar) may be considered as residual trees in the target group spacing and stocking.

Manage for large oaks (10 inch diameter at the root collar or larger) by removing ponderosa pine up to 18 inches in diameter that do not meet the “old tree” definition and do not have interlocking crown with oaks and occur within 30 feet of base of oak 10 inches in diameter at the root collar or larger.

Mechanical Treatments

Habitat features that appear to be important to a variety of goshawk prey species would be retained or improved with Alternatives 2 and 3.These habitat features include snags, downed logs, large trees, openings and associated herbaceous and shrubby vegetation, interspersion, and canopy cover (Reynolds et al. 1992, USDI FWS 1998, Squires and Kennedy 2006).

Noise disturbance from logging trucks was monitored for nesting goshawks in a study on the Apache-Sitgreaves National Forests. The study was coordinated between the Apache-Sitgreaves National Forests, 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).

Disturbance from hauling would 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.

Road work and use of haul roads could increase the potential for goshawk collision with vehicles. Little information is available on how frequently collisions might occur and what conditions might increase or lessen the vulnerability of goshawks.

A speed limit of 25 miles per hour would be implemented for vehicles passing through PFAs to reduce the hazard of collisions. Given the adult goshawk’s natural agility in flight and the size and noise of the large trucks and chip vans, adult goshawks would be expected to avoid colliding with log trucks passing through the PFA. Newly fledged goshawks still developing their flight skills may have a slightly higher potential for colliding with a large truck, but the reduced speed of the trucks and natural agility of goshawks should minimize this potential. Birds migrating or dispersing through unfamiliar terrain may be at higher risk than resident birds.

Vehicle activity would alternate throughout the Rim Country landscape as different contracts are issued and would concentrate in particular areas while the work is being conducted. Activity would be expected to increase well above existing traffic levels for about two years until operations shift to other areas.

In summary, hauling of wood products or road gravel would be unlikely to cause noise disturbance to nesting goshawks or result in collisions, but there is the potential to disrupt reproduction and rearing of young by, at most, one or two pair of goshawks and might result in the injury or death of one or more young. This risk would be lowered with a lower speed limit.

Prescribed Fire

The forest plans allow for wildfire to occur within PFAs during and outside the breeding season, although human disturbance should be limited during the breeding season so that goshawk reproductive success is not affected by human activities. Low-intensity ground fires are allowed at any time, but high-intensity crown fires are not acceptable in PFAs or nest areas.

The effects from burning would be influenced by the life history of the goshawk at the time of the fire, as well as several fire-related factors including pre-fire fuel loading and structure, the season when the fire occurs, fire intensity, and fuel consumption.. Burning effects would also be related to how similar burning conditions are to the natural fire regime. Knapp et al (2009) provide a good overview of the ecological effects of prescribed fire season.

Goshawks and their prey could be directly affected by the heat, flames, and smoke of a fire or indirectly by habitat modification. Animals that live in fire-adapted ponderosa pine forests have presumably developed behavioral adaptations to escape fires or find refugia and allow populations to persist (Knapp et al 2009).

Incubating adults or young goshawks unable to fly could inhale smoke from prescribed fires. Smoke could result in an extended absence of the adults during brooding or when the chicks are very young. This could result in increased vulnerability to predators or to unfavorable weather, or reduced feeding. Smoke is likely to be worse during first-entry burning, under conditions where fuels have built up to unnatural levels due to years of fire suppression. Smoke would be expected to be more within the range of natural variation after a first-entry burn and to have less intensity or duration. There would be a low likelihood of loss of nest trees or goshawks due to the heat, flames, or smoke of a prescribed fire with the design features for this project.

Wildfire Modeling

Fire hazard index was modeled for one treatment and two prescribed burns in 39,488 acres of PFAs within the project area. Fire hazard index by alternative is in the Table 78 below. The highest and greatest hazard categories of fire hazard index were calculated with percentages of the total habitat type in the project area for further analysis by alternative. 553,120 acres of ponderosa pine habitat type was also modeled for wildfire effects.

Table 78. Fire hazard index in PFA habitat by alternative

Fire Hazard Index	Existing	Alternative 1	Alternative 2	Alternative 3
PFA	27,414 (69%)	31,877 (81%)	10,261 (26%)	18,075 (46%)
PFAs with the Highest and Greatest Hazard Categories	13,511 (34%)	16,056 (41%)	1,968 (05%)	5,106 (13%)
Ponderosa Pine Habitat Type FHI	327,867 (59%)	407,189 (74%)	129,762 (23%)	247,350 (45%)

The potential for crown fire was also modeled in PFAs and ponderosa pine habitat type in the project area by alternative with acres and percentages included in Table 79 below. For further analysis active crown fire was assessed as well in both habitat types.

Table 79. Crown fire assessment in PFAs by alternative

Fire Hazard Index	Existing	Alternative 1	Alternative 2	Alternative 3
PFA All Crown Fire	32,695 (83%)	34,730 (88%)	30,732 (78%)	31,771 (80%)
PFA Active Crown Fire	13,033 (33%)	15,626 (40%)	1,583 (04%)	4,584 (12%)
PP Habitat Type All Crown Fire	430,771 (78%)	480,996 (87%)	447,738 (81%)	471,447 (85%)
PP Active Crown Fire Potential	112,496 (20%)	160,879 (29%)	12,486 (2%)	45,680 (08%)

Alternative 2 – Modified Proposed Action

PFAs

Vegetation Changes

FVS Modeling of Alternative 2 treatments on 37,860 acres of PFAs in the project area would take trees per acre from 1,062 to 450 in 2029 and 162 in 2049. The stand density index would be greatly reduced, from the existing 303 to 106 after 30 years. The quadratic mean diameter would increase from six inches to 10.7 inches after 30 years. Mid-aged forest (BA3, 5 to 12 inches, and BA4, 12 to 18 inches) would be treated to attain the desired condition, reducing these size classes to better represent uneven-aged management. Snags of all size classes important to prey species would continue to increase. Coarse woody debris and downed logs important to prey species would increase over 30 years. Also important to goshawk prey species, herbaceous and shrub layers would increase over time under Alternative 2.

Lands Outside of PFAs (LOPFA)

In LOPFAs the FVS modeling on 902,064 acres of ponderosa pine habitat shows that the average trees per acre would be lowered from 1,069 to 783 in 2029 and 451 in 2049. The average of all basal area and canopy cover would decrease, but the stand density index would be most reduced under Alternative 2, from 303 to 106 after 30 years. Lower competition for resources would increase the quadratic mean diameter, from six inches to nearly 11 inches after 30 years. Mid-aged forest (BA3, 5 to 12 inches, and BA4, 12 to 18 inches) would be greatly reduced under Alternative 2, bringing the age class distribution to desired condition after 30 years.

Snags of all size classes important to prey species would continue to increase from existing conditions. Coarse woody debris and downed logs important to prey species would increase over 30 years modeled. Herbaceous and shrub layers, also important for prey species, would be increased or maintained under Alternative 2.

Fire Effects

In both PFAs and in ponderosa pine habitat fuel loads in average of tons per acre would increase from 15 tons per acre in the existing condition to less than 10 tons per acre after 30 years under Alternative 2.

Fire hazard index was modeled in PFAs for Alternative 2 (Table 78). Of the 39,488 acres modeled Alternative 2 would result in a reduction over the existing condition from 27,414 (69 percent) of all PFA acres in the project area to 10,261 acres (26 percent) that could experience high-severity wildfire.

Risk of crown fire was modeled in PFAs for Alternative 2 (Table 79). Alternative 2 would result in 30,732 acres (78 percent) of PFAs in the Rim Country project area with the potential to experience crown fire. Active crown fire is reduced from 15,626 acres (40 percent) in alternative 1 to 1,583 (4 percent) acres that would experience active crowning under Alternative 2.

Determination of Effect
Considering direct, indirect, and cumulative effects, implementation of Alternative 2 may affect individual goshawks, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 3 – Focused Alternative

PFA

Vegetation Changes
Alternative 3 would change trees per acre from the existing 1,062 to 620 in 2029 and 379 in 2049. The stand density index would be highly reduced, from 303 to 185 after 30 years. The quadratic mean diameter would increase, from six inches to nearly 10 inches after 30 years. Mid-aged forest (BA3, 5 to 12 inches, and BA4, 12 to 18 inches) would be lowered, though not to the desired conditions. Snags of all size classes important to prey species would continue to increase. Coarse woody debris and downed logs important to prey species would increase over 30 years. Herbaceous and shrub layers would be maintained over time under Alternative 3.

Lands Outside of PFAs (LOPFA)
In LOPFAs, FVS modeling shows that the average trees per acre would be lowered under Alternative 3, from the existing 1,069 to 384 in 2049. The average of all basal area and canopy cover would decrease, but the stand density index would be reduced from 303 to 186 after 30 years. Lower competition for resources would increase the quadratic mean diameter, from six inches to nearly 10 inches after 30 years. Mid-aged forest (BA3, 5 to 12 inches, and BA4, 12 to 18 inches) would be greatly reduced under Alternative 3, bringing these age classes closer to desired conditions after 30 years.

Snags of all size classes important to prey species would continue to increase. Coarse woody debris and downed logs important to prey species would increase over 30 years. Herbaceous and shrub layers, also important for prey species, would be increased or maintained under Alternative 3.

Fire Effects
In both PFAs and in ponderosa pine habitat fuel loads in average of tons per acre increase from 15 tons per acre in the existing condition to less than 13 tons per acre after 40 years under Alternative 3.

Fire hazard index was modeled in PFAs for Alternative 3 (Table 79 above). Of the 39,488 acres modeled Alternative 3 would result in a reduction over the existing condition from 27,414 (69 percent) of all PFA acres in the project area to 18,075 acres (46 percent) that could experience high-severity wildfire.

Risk of Crown Fire was modeled in PFAs for alternative 3 (Table 79 above). Alternative 3 would result in 31,771 acres (80 percent) of PFAs in the Rim Country project area with the potential to experience crown fire. Active crown fire is reduced from 15,626 acres (40 percent) in Alternative 1 to 4,584 acres (12 percent) that would experience active crowning under Alternative 3.

Determination of Effect
Considering direct, indirect, and cumulative effects, implementation of Alternative 3 may affect individual goshawks, but is not likely to cause a trend toward federal listing or loss of viability.

Cumulative Effects for alternatives 2 and 3
The cumulative effects analysis boundary is defined as the project area and a one-half mile buffer around the outside of the project boundary, and includes effects for a period of 25 years beginning with implementation of the Rim Country Project... The fire hazard would increase over time as vegetation would continue to grow, fuels continue to accumulate, and the effects from climate change persist.

For Alternatives 2 and 3, the majority of acreage identified as part of the cumulative effects analysis occurs in LOPFA habitat, and the majority of past, current, and foreseeable future treatment acres are prescribed fire only. Most of the proposed treatments in alternatives 2 and 3are mechanical thinning with prescribed fire with alternative 2 cumulatively treating more acres whereas Alternative 3 would have the fewer

Cumulatively, restoration treatments would contribute toward improving forest health, vegetation diversity, and vegetation composition in goshawk habitat under Alternatives 2 and 3. This would aid in sustaining old forest structure over time and moving forest structure toward desired conditions, although on more acres in alternative 2 than in alternative 3. Watershed and forest health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating wolf habitat in Rim Country would be reduced in the short and long terms.

The combination of thinning and burning with other projects should improve species richness in the herbaceous understory, increase plant abundance, and improve fruit and seed production.

Treating within current and reasonably foreseeable projects when added to treatments in Rim Country would reduce fire threat for goshawk habitat within the respective project area as well as reducing the threat of high-severity fire starting in these areas and burning habitat outside the areas. In addition, cumulative improvements to understory vegetation and prey habitat are expected to occur in goshawk habitat and be more persistent in the long term compared to more conservative treatments in MSO habitat that are employed because MSOs have different habitat requirements than goshawks.

Cumulative effects from reasonably foreseeable projects could include disturbance from noise and potentially from smoke but could collectively improve goshawk habitat, including PFAs, because the risk of high-severity fire eliminating goshawk habitat would be reduced in the short term and long term. Although smoke and noise can cross project boundaries, both largely disperse with distance. However, some areas where smoke settles could have longer duration short term effects. Other projects, such as the CC Cragin and Beaver Creek Watershed Protection and Fuels Reduction Projects could cumulatively increase effects on goshawks in PFAs adjacent to shared boundaries.

Many current and reasonably foreseeable projects would overlap temporally. It is conceivable that actions would be occurring in PFAs in multiple locations within the 4FRI boundary. However, all or most PFA mechanical treatments or activities would have timing restrictions, postponing treatments until after the breeding season. Wild fire could occur at any time. Adult goshawks would be expected to adapt to fire because it inhabits ponderosa pine, which is a fire-adapted vegetation type in the southwest.

Given the various stages of planning or implementation, most project effects would be dispersed both spatially and temporally. Projects in goshawk habitat are typically designed to improve habitat, or to degrade elements of habitat structure while retaining habitat function, resulting in a decrease in risk of high-severity fire. Cumulative effects would likely increase disturbance to individual goshawks from noise or smoke in the short term., and effects are not expected to affect fecundity because of timing restrictions. Given typical project objectives, the spatial scale of the cumulative effects area, the distribution of goshawk habitat across the project area, and the length of time over which treatments would be implemented (10 or more years), cumulative effects are not expected to negatively affect the goshawk population in the long term. Overall, treatments in goshawk habitat should move forest conditions in the cumulative effects area toward desired conditions and decrease the risk of habitat loss to large-scale high-severity fire.

Northern Leopard Frog

Alternative 1 – No Action

Under Alternative 1, habitat conditions for northern leopard frogs would largely remain in their current condition. Thinning and prescribed fire would still occur as a result of current and reasonably foreseeable projects. However, the landscape would continue to move away from desired conditions. Alternative 1 would have no direct effects on northern leopard frogs; however, there would be substantial indirect effects. Dense forest conditions would still occur and the high fire hazard potential would persist. Large crown wildfires could adversely affect potential habitat by destroying understory and overstory vegetation. As a result, overland flow would increase and soil erosion would increase, with the potential for high sediment loads. Water quality and riparian conditions would be adversely affected on a wide-scale basis, resulting in indirect adverse effects.

Under Alternative 1, there would be no restoration of springs and riparian areas. These areas would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future, resulting in degradation of potential habitat for frogs.

Denser forest conditions produce lower values in understory biomass (pounds per acre). Under Alternative 1, understory biomass would continue to decline over the next 40 years. Limited cover around tanks and riparian areas, as well as the limited herbaceous understory across the project area, would continue to reduce the likelihood that frogs would successfully disperse and feed while traveling between waters. The limited cover would also leave frogs vulnerable to predation.

Determination of Effect

Alternative 1 would have no effect on Northern leopard frogs.

Alternative 2 – Modified Proposed Action

Dispersing leopard frogs could be directly affected if they collide with mechanical equipment or if they could not find refugia during prescribed fire activities. All springs and riparian reaches would be surveyed prior to restoration activities. Design features would reduce the likelihood of direct effects on frogs from mechanical thinning, temporary road construction, spring and riparian restoration, road decommissioning, and prescribed fire.

Under the modified Proposed Action, dense forest conditions and surface fuel loading would be reduced. The likelihood of large crown wildfires adversely affecting potential habitat by destroying understory and overstory vegetation would be reduced from 327,867 acres (59 percent) of all ponderosa pine in the project area, to 129,762 acres (23 percent) from Alternative 2. Fire hazard index in grasslands would also be greatly reduced from treatments (from 5,000 acres in the existing condition to 138 acres in Alternative 2). As a result, overland flow would be stable, and soil erosion would not have the high sediment-loading potential. Water quality would be not adversely affected on a wide-scale basis, resulting in indirect beneficial effects.

Under Alternatives 2 and 3, springs, meadows, and aquatic habitat restoration would be implemented, benefiting NLFs. 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 one to three years. An important consideration for restoration of springs is to restore discharge from the spring source except where prescribed by existing water rights adjudicated. Alternatives 2 and 3 would allow discharge from springs to resume flow through their historic spheres of discharge. Spring and seep restoration would improve riparian vegetation increasing availability of food and reproductive sites for this species over the long term, resulting in direct beneficial effects on habitat. Restoration of aquatic habitats would improve cover and water flow that provides escape from predators and prevents water loss for migrating leopard frogs.

Reconstructing 40 miles of temporary roads along their original alignments would generally have limited effects on the physical habitat features along the roads. About 30 miles of road reconstruction would address safety concerns for hauling. The remaining miles (about 10) would relocate roads out of drainage bottoms. Relocated roads would include rehabilitation of the abandoned road segment. Disturbance associated with road traffic is not expected to change because this represents improvements to segments of existing road, not new road construction. If each mile affects approximately three acres of habitat, then about 120 acres of breeding and dispersal habitat would be affected by road reconstruction.

Constructing temporary roads would disturb vegetation and reduce habitat quality for leopard frogs. Use of these roads by machinery and equipment could crush animals moving across the road. These effects may affect individuals but are expected to be short-term, occurring only during project implementation. Temporary roads would be decommissioned to eliminate use and vegetation would be restored over the long term.

Decommissioning 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 may not measurably change along the former road alignment, eliminating disturbance along the roadway would be expected to improve the quality of habitat and reduce the potential for frogs to be crushed by vehicles using these roads.

Implementation of the modified proposed action could increase the risk of spread of chytrid fungus across the project area. Machinery and equipment used during implementation could transfer chytrid fungus between waterbodies, increasing the occurrence of the pathogen in leopard frog habitats across the project area. Potential effects from chytrid fungus that is spread by machinery and equipment would be minimized by requiring decontamination procedures to be followed when activities take place within wetted areas or moist perimeter of a tank or ephemeral stream (see design features). Therefore, minimal potential for spread would exist.

Under the modified proposed action, surface disturbance within proximity of suitable habitats would increase. Direct effects could result from crushing and trampling of migrating or basking individuals. The use of heavy machinery and increased levels of human activity and traffic are likely to increase sedimentation in the earthen livestock tanks in the vicinity, especially in those located downslope from treated areas. Effects from sedimentation on leopard frog habitats are extensive and varied. They include alterations in water quality and vegetation structure, that ultimately have detrimental effects on leopard frogs by decreasing rate of development, increasing vulnerability to predators, and reducing food availability.

Prescribed burning may result in mortality of leopard frogs. Early fall prescribed fire has the highest likelihood of affecting leopard frogs, as this is a time of year when they are migrating between suitable habitats. Leopard frogs may migrate en masse, and large numbers may therefore be susceptible to fire at one time. Prescribed burns would be coordinated with a wildlife biologist to insure protections for migrating frogs. In coordination with AZGFD, occupied and potential breeding sites have been identified and mapped and would be included in individual contract maps with a special water designation. Project design features have been developed to reduce the potential effects on these important breeding sites and frogs using and moving between these sites (see Appendix 5 in the Wildlife Specialist Report). Implementation of best management practices would curtail soil erosion and minimize the potential for inflow into potential northern leopard frog habitat.

Determination of Effect

Implementation of Alternative 2 may affect individual northern leopard frogs, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 3 – Focused Alternative

Alternative 3 treats fewer forest acres in Rim Country, but the direct and indirect effects would be similar to Alternative 2. Alternative 3 includes the same miles and acres of riparian and other habitat restoration, while reducing the total number of acres thinned and treated with prescribed burning. While short-term effects from disturbance would be slightly less in Alternative 3, the long-term effects on the risk of habitat degradation from stand-altering wildfire or insect infestations would be greater.

Determination of Effect

Implementation of Alternative 3 may affect individual northern leopard frogs, but is not likely to cause a trend toward federal listing or loss of viability.

Cumulative Effects for alternatives 2 and 3

The cumulative effects analysis area for northern leopard frogs is the project area and a 0.25-mile buffer outside of the project boundary to include current and potential breeding sites. The temporal boundary is 30 years to include the effects of 20 years of implementation with effects from treatments lasting 10 years of riparian benefits following implementation.

The restoration of aquatic habitats included in these alternatives when added to treatments from other projects would slow the combined effects from other forest activities, high-impact recreational use, livestock grazing, habitat loss and degradation on private lands. Implementing restoration of key aquatic and dispersal habitat would link, rather than fragment, these habitats, allowing for the needs of breeding and dispersing leopard frogs. Alternative 3 would treat less acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which would result in less overall watershed restoration and providing less risk of severe wildfire effects than alternative 2.

Bald Eagle

Alternative 1 – No Action

Under Alternative 1, current and reasonably foreseeable projects would still be implemented in the Rim Country project area. Wildfire modeling in the ponderosa pine habitat type by alternative show that of the 553,137 acres of ponderosa pine habitat type, 407,189 acres (81 percent) have the potential to experience high-severity wildfire under Alternative 1. Crown fire potential in ponderosa pine habitat from Alternative 1 could occur in 480,996 acres (87 percent) of this habitat type. Dense forest conditions would still occur across the project area, and the high fire hazard potential would continue to place potential bald eagle nesting, roosting, and foraging habitat at risk with respect to stand-replacing fire.

Tree densities would continue to be high, slowing or stagnating growth into larger diameter classes, thereby limiting the development of roosting and perching habitat. Meadows, grasslands, and savannas would continue to be encroached by trees, limiting potential foraging areas.

Determination of Effect

Because of the design features included for both action alternatives to mitigate disturbance to eagles, Alternative 1 **would not result in take** as defined in the Eagle Act for bald eagles Effects Common to Both Action Alternatives.

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 area. Under the action alternatives (the modified proposed action and the focused alternative), there would be no direct adverse effects on nesting eagles as project design features would eliminate disturbance near known nesting sites. No vegetation treatments would occur within 0.5 mile (2,500 feet), unless mitigated by topography, of an occupied bald eagle nest between March 1 and August 31. Drift smoke from prescribed fire would be expected. Concentrations of smoke that might settle in an area for more than one or two nights when a female is on the nest could have adverse effects on individuals. Prevailing southwest winds and the topography of the area typically act to lift smoke, carrying it away from ignition sites. Nests on cinder cones and other raised topographic features and in Sycamore and Oak Creek Canyons, or in canyons immediately adjacent to Sycamore and Oak Creek Canyons or the Mogollon Rim, are not expected to have smoke settle in them long enough to cause measurable effects on eagles because of the air movement in these landscape-scale features. Conversely, nests in small canyons or valleys might incur effects from dense smoke settling near nesting locations.

When smoke settles into low-lying areas it typically does not last more than one or two nights. Limited smoke at nest locations would be expected to expose adult eagles to negligible effects as this would repeat an aspect of their evolutionary environment (Horton and Mannan 1988, Prather et al. 2008). However, on occasion dense smoke may settle into specific nest locations. Dense smoke settling into nest areas early in the season (January through June) could disturb brooding females. If the female is flushed long enough to affect incubation, this could result in loss of viability of the eggs. Dense smoke settling for multiple consecutive nights could affect the developing lungs of nestlings. Unlike mammals, damaged avian lungs do not repair themselves through time (Rombout et al. 1991). Triggering a female to discontinue incubating eggs or affecting the lung development of nestlings would constitute long-term adverse effects. Outside of these examples, smoke settling in nest locations would typically be short-term and not likely to cause adverse effects.

Alternatives 2 and 3 would exclude mechanical thinning treatments within a 300-foot buffer around confirmed nest and roost sites. Additionally, timing restrictions during the winter roosting season would provide protection from disturbance to roosting eagles. Potential roost treatments would be designed to maintain and develop roost characteristics such as large trees and snags, while reducing surface fuel loading and crown fire potential within the roost, increasing roosting habitat for eagles in the project area.

There would be no effect on nesting or roosting eagles; however, short-term disturbance to foraging bald eagles would occur during mechanical treatments, prescribed burning, hauling of wood products, and other project activities that may cause visual or auditory disturbance. Prescribed burning and mechanical treatment would occur annually; however, these are short-term effects and would be minimized due to activities being temporally and spatially separated. Prescribed burning effects would dissipate over time as first-entry burns would consume accumulated surface fuels, raising crown bulk height and reducing crown bulk density. In maintenance or second-entry burns in ponderosa pine cover types, fuel loads would be significantly lower and produce low-severity effects with fewer emissions. Disturbances would be localized, of short duration, and might affect individual birds but would not affect the overall distribution or reproduction of the species.

Indirect effects on the bald eagle include effects on eagle habitat, eagle prey species, or prey species habitat. No adverse effects on prey species or prey species habitat are anticipated. Indirect effects on habitat would occur from treatments that modify the number of trees in a group of suitable roost trees, as eagles prefer to roost in large trees in close proximity to each other. However, thinning would improve old tree longevity, resulting in beneficial effects. In RUs with documented bald eagle use, snags would slightly increase after treatment (2020) and continue to increase in the long term. Ignition techniques and site preparation would reduce potential mortality in these components from burning activities.

The modified proposed action (Alternative 2) would develop older larger tree size classes which could be used as future winter roost sites for bald eagles.

Determination of Effect

Because of the design features included for both action alternatives to mitigate disturbance to eagles, Alternatives 2 and 3 **would not result in take** as defined in the Eagle Act for bald eagles.

Cumulative Effects

The cumulative effects analysis area for bald eagles is the ponderosa pine habitat within the project area and a 0.5-mile buffer outside the project boundary. The temporal boundary is 30 years to include the effects of 20 years of implementation with effects from treatments lasting 10 years of riparian benefits following implementation.

Short-term effects added to similar effects from nearby projects were considered. Watershed and forest health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating wolf habitat in Rim Country would be reduced in the short and long terms.

Implementation of other project activities could occur simultaneously; however, it is not anticipated that effects from those activities would combine with the effects from the Rim Country Project to produce negative effects. Both action alternatives would improve and develop quality potential nesting and roosting habitat by developing groups of large trees and snags that are more fire resistant. This positive effect would combine with similar effects from activities such as the Travel Management Rule efforts, which may decrease the frequency of disturbance on the majority of potential roost sites, and slightly counteract the effects from utility line and road construction and maintenance as well as short-term disturbances from vegetation management and prescribed fire.

Alternative 3 would treat less acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which would result in less overall watershed restoration and providing less risk of severe wildfire effects than alternative 2.

Golden Eagle

Alternative 1 – No Action

There would be no direct effects on golden eagles as no habitat-altering activities or disturbance associated with project implementation would occur. Alternative 1 would not treat meadows, savannahs, or grasslands within the project area and trees would continue to encroach, reducing potential habitat for small mammals and consequently golden eagles. Tree densities would continue to be high, slowing growth into larger diameter classes and thereby limiting the development of larger diameter (18 inches or larger) trees important for nesting, roosting, and perching. Habitat conditions would remain in their current condition, notwithstanding natural processes. Dense forest conditions would still occur and the high fire hazard potential would continue to place potential golden eagle breeding, nesting, and foraging habitat at risk with respect to stand-replacing fire.

Effects Common to Both Action Alternatives

Both action alternatives would have the same effects on eagles, with Alternative 2 thinning and treating more acres, but with the same potential effects from restoration activities. Direct effects would be from activities that cause disturbances (smoke, auditory, or visual) to golden eagles nesting or foraging within or adjacent to the project. Under the modified proposed action or focused alternative, there would be no direct adverse effects on nesting eagles as project design features would eliminate disturbance near known nesting sites. No vegetation treatments would occur within 0.5 mile (2,500 feet) of an occupied golden eagle nest (unless mitigated by topography) between March 1 and August 31. Drift smoke from prescribed fire would be expected in most places; concentrations of smoke that might settle in an area for more than one or two nights when a female is on the nest could have adverse effects on individuals. Prevailing southwest winds and the topography of the area typically act to lift smoke, carrying it away from ignition sites. Nests on cinder cones and other raised topographic features on the Mogollon Rim are not expected to have smoke settle in them long enough to cause measurable effects on eagles because of the air movement in these landscape-scaled features. Conversely, nests in areas occurring in small canyons or valleys may have dense smoke settle in nesting locations.

When smoke settles into low-lying areas, it typically does not last more than one or two nights. Limited smoke at nest locations would be expected to expose adult eagles to negligible effects as this would repeat an aspect of their evolutionary environment (Horton and Mannan 1988, Prather et al. 2008). However, on occasion dense smoke may settle into specific nest locations. Dense smoke settling into nest areas early in the season (March through June) could disturb brooding females. If the female is flushed long enough to affect incubation, this could result in loss of viability of the eggs. Dense smoke settling for multiple consecutive nights could affect the developing lungs of nestlings. Unlike mammals, damaged avian lungs do not repair themselves through time (Rombout et al. 1991). Causing the female to discontinue incubating eggs or affecting lung development of nestlings would result in long-term adverse effects. Outside of these examples, smoke settling in nest locations would typically be short-term and not likely to cause adverse effects.

Under the modified proposed action, mechanical treatments, prescribed burning, road construction and decommissioning, hauling of wood products, and other restoration activities may cause visual or auditory disturbance to foraging golden eagles. This disturbance would be localized, of short duration and low intensity, and would not be expected to substantially interfere with normal feeding behavior. Up to 40,000 acres of prescribed burning and 45,000 acres of mechanical treatment would occur annually; however, these would be short-term effects and would be minimized due to activities being spatially and temporally separated. Additionally, prescribed burning effects would dissipate over time, as first entry burns usually consume accumulated surface fuels, raising crown bulk height and reducing crown bulk density. In maintenance or second entry burns in ponderosa pine, fuel loads would be significantly lower and produce low-severity effects with fewer emissions.

Indirect effects on the golden eagle include effects on eagle habitat, eagle prey species, or prey species habitat. There are no anticipated adverse effects on prey species or their habitats. Opening the canopy would provide improved visibility of and access to prey by golden eagles. Grassland and savanna treatments would maintain and improve foraging habitat on 36,340 acres of grassland and 17,590 acres of savanna habitat, improving prey species habitat by increasing availability of food for small mammals and resulting in an indirect beneficial effect.

Determination of Effect

Because of the design features included for both action alternatives to mitigate disturbance to eagles, the proposed treatments and activities **would not result in take** as defined in the Eagle Act for golden eagles.

Cumulative Effects

The cumulative effects analysis boundary is defined as the project area and a one-half mile buffer around the outside of the project boundary, and includes effects for a period of 25 years beginning with implementation of the Rim Country Project. Watershed and forest health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating wolf habitat in Rim Country would be reduced in the short and long terms.

Other activities planned that may have similar effects include temporary disturbances caused by prescribed fire and thinning in adjacent projects, or effects on roosting habitat from utility infrastructure development and maintenance. These short-term effects added to similar effects from other activities were considered. Implementation of other fuel reduction and restoration activities could occur simultaneously; however, it is not anticipated that effects from those activities would combine with effects from the Rim Country Project to cause negative effects.

Alternative 3 would treat less acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which would result in less forest and watershed restoration and providing less risk of severe wildfire effects.

American Peregrine Falcon

Alternative 1 – No Action

In grasslands, savannas, and meadows, tree encroachment and surface litter accumulation would continue, continuing to negatively affect some prey habitats for peregrine falcons. Stability of key ecosystem components such as species composition, forest structure, soil characteristics, and hydrologic function would be at moderate to high risk of loss in the event of a disturbance such as a high-severity wildfire. This alternative would result in the most stress on meadow and grassland habitats and thus would have the greatest negative contribution to potential grassland habitat.

Determination of Effect

Under the No Action Alternative, there would be **no direct or indirect effects on peregrines**. There would be no change to the prey species base, and no change in falcon hunting patterns within associated forest structure.

Effects Common to Both Action Alternatives

Constructing and reconstructing roads along their original alignments, including temporary and relocated roads, would not have noticeable effects on the physical habitat features along the roads. Increased disturbance associated with the increased activity on the improved road conditions may decrease the habitat quality along the improved roads. Aquatic and other habitat restoration in Alternatives 2 and 3 would improve habitat. There would be short-term disturbance to vegetation during implementation of restoration projects. However, restored vegetation would be expected within one year following restoration activities.

Decommissioning of roads in Alternatives 2 and 3 would improve the quality of the habitat in those areas where roads are decommissioned. The physical structure and features of habitat for falcons and their prey would be improved along the former road alignment, and disturbance along the roadway would largely be eliminated, thereby improving the quality of habitat in the long term.

Constructing temporary roads would disturb vegetation and reduce available habitat for peregrine prey. This may affect individuals but is expected to be short term, occurring only during project implementation. Temporary roads would be obliterated to eliminate use and vegetation would be restored over the long term.

Alternative 2 – Modified Proposed Action

Under the modified proposed action, no direct effects from mechanical treatments, temporary road construction, prescribed burning, or spring, riparian habitat, and ephemeral stream restoration is expected. There are four peregrine eyries (nest locations) within the project area. All four are associated with one pair of peregrines. These eyries are located on cliff ledges in a rugged canyon. No thinning treatments are proposed in these areas though they often overlook woodlands, riparian areas, or other habitats supporting avian prey species in abundance, which describes most of the Mogollon Rim and Steeper canyons: a burn-only treatment is planned. Smoke from burning operations would be expected to drain away from the nest location, reducing the potential for birds to be exposed to heavy concentrations of smoke. This area is also designated as a Mexican spotted owl protected activity center; protection measures developed for the owl would also protect peregrines breeding in this area as their breeding season overlaps with the owl.

Mechanical treatments prescribed burning, hauling of wood products, and other project activities may cause visual or auditory disturbance to foraging peregrine falcons. Approximately 40,000 acres of prescribed burning and 45,000 acres of mechanical treatment would occur annually; 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.

While peregrines do not nest or forage in ponderosa pine forest, active management in portions of the pine forest could potentially affect prey base habitat such as meadows, grasslands, and savannas, which are commonly encroached by pine trees as a result of fire exclusion. Restoring these habitats toward historic conditions and increasing water yield across the forest to improve marsh, pond, or lake habitat could increase prey base for peregrine falcons, resulting in an indirect beneficial effect.

Determination of Effect

Alternative 2 may affect individual peregrine falcons, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 3 – Focused Alternative

Alternative 3 treats fewer forest acres in Rim Country. The direct and indirect effects would be similar to Alternative 2. Alternative 3 includes the same miles and acres of riparian and other habitat restoration, while reducing the total number of acres thinned and treated with prescribed burning. While short term effects from disturbance would be lessened slightly in Alternative 3, long term effects of risk of habitat degradation from stand-altering wildfire or insect infestations are greater.

Determination of Effect

Alternative 3 may affect individual peregrine falcons, but is not likely to cause a trend toward federal listing or loss of viability.

Cumulative Effects

The cumulative effects analysis area for peregrine falcons is grassland, savanna, and riparian habitat within the project area and within 0.5 mile outside the project boundary. The temporal boundary is 30 years to include the effects of 20 years of implementation with effects from treatments lasting 10 years of riparian benefits following implementation.

Under both action alternatives, there would be an additive indirect effect from activities that modify vegetation. Those projects where thinning and burning are implemented could affect the prey base on a short-term basis by affecting individuals of prey species, by disturbing or harming prey species' habitat with fire. However, projects would be implemented at different times and in different locations, cumulatively minimizing disturbances to the prey base.

Watershed and forest health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating wolf habitat in Rim Country would be reduced in the short and long terms.

Other past, present, and ongoing projects have implemented thinning and prescribed burning (39,000 acres) in grasslands, which would cumulatively improve habitats for peregrine prey species in the long term.

Western Burrowing Owl

There are no documented nesting burrowing owls on the project area; however, potential nesting habitat does exist.

Alternative 1 – No Action

Tree encroachment and canopy development of existing trees would largely continue under Alternative 1. Denser forest conditions would produce lower values in understory biomass (pounds per acre). Understory biomass would continue to decline over the next 40 years under Alternative 1. This in turn would lead to less available habitat for prairie dogs and, consequently, burrowing owls. Vegetation would continue to grow and fuel would continue to accumulate, continuing to have negative effects on prairie dog habitat and potential habitat for western burrowing owls. Acres of grassland in Fire Regime Condition Class 1 would decrease in the absence of any type of treatment, as woody species continue to encroach and species composition shifts in favor of less fire-adapted species. Grasslands in the project area are at high risk of losing key ecosystem components such as species composition, forest structure, soil characteristics, and hydrologic function in the event of high-severity fire. High fire severity potential would persist, and a large crown wildfire event would have the potential to affect many individuals.

This alternative would result in the most stress on meadow and grassland habitats and thus would have the greatest negative effects on potential western burrowing owl habitat.

Alternative 2 – Modified Proposed Action

Alternative 2 would restore about 54,000 acres of historic grassland and savannahs. Indirect effects on burrowing owls would include effects on owl habitat, owl prey species, or prey species habitat. Active management in some areas of ponderosa pine forest could potentially affect their habitat (for example, meadows and grasslands are commonly encroached by pine trees as a result of fire exclusion). Restoring these habitats toward historic conditions could increase potential nesting and foraging habitat for western burrowing owls.

Meadow restoration treatments would improve and increase available habitat for prairie dogs, which would subsequently provide nesting habitat for burrowing owls. The modified proposed action would increase available habitat for prairie dogs with 54,000 acres of grassland, meadow, and savanna restoration treatments. Grassland treatments would not lead to a change in the percent of area with the potential for crown fire. Prescribed burning 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 for insects and small mammals, increasing food sources and resulting in an indirect beneficial effect for burrowing owls.

Determination of Effect

Alternative 2 would have **no effect** on burrowing owls but would improve potential future habitat for the species. **It is not likely to cause a trend toward federal listing or loss of viability.**

Alternative 3 – Focused Alternative

Direct, indirect, and cumulative effects from Alternative 3 would be the same as those from Alternative 2.

Determination of Effect

Alternative 3 would have no effect to burrowing owls. It is not likely to cause a trend toward federal listing or loss of viability.

Cumulative Effects

The cumulative effects analysis area for burrowing owls encompasses the project area and the associated prairie dog complexes. The temporal boundary is 30 years to include 2o0 years of implementation and 10 years of benefits from treatments.

Watershed and forest health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating habitat in Rim Country would be reduced in the short and long terms.

Cumulative activities such as implementing the Travel Management Rule are likely to decrease motorized use in grasslands, thus decreasing effects on prairie dog populations. This, combined with forest thinning and prescribed burning activities, could open up more habitat and increase grassland habitat connectivity. Short-term and localized effects from mechanical thinning and prescribed burning would result in disturbance, and the potential for collapse of burrows and displacement of prairie dogs. This effect may be cumulative with short-term effects from localized dispersed camping, wildfire, and wildfire suppression activities to temporarily displace prairie dog populations (and potentially burrowing owls) in limited areas.

Thinning 36,340 acres of grassland would cumulatively add to treatment acres from this project to reduce tree densities in grasslands and connect open corridors across the project area, providing additional potential future habitat for burrowing owls. Alternative 3 would treat less acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which would result in less forest and watershed restoration and providing less risk of severe wildfire effects.

Navajo Mogollon Vole

Alternative 1 – No Action

In Alternative 1, grasslands, meadows, and savannahs would not be rehabilitated. At the landscape scale, there would be no benefits to vole habitat. Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure increases. Acres of grassland would decrease in the absence of any type of treatment, as woody species continue to encroach and species composition shifts in favor of less fire-adapted species. Acres of ponderosa pine with the likelihood of high-severity wildfire would continue to increase. Ponderosa pine in the project area would be at a high risk of losing key ecosystem components, should there be a disturbance event such as fire or extended drought (Fire Ecology and Air Quality Report). Ponderosa pine in the project area is at high risk of losing key ecosystem components such as species composition, forest structure, soil characteristics, and hydrologic function in the event of high-severity fire.

Wildfire modeling in the ponderosa pine habitat type by alternative show that of the 553,137 acres of ponderosa pine habitat type in the project area, 407,189 acres (81 percent) have the potential to experience high-severity wildfire under Alternative 1. Crown fire potential in ponderosa pine habitat from Alternative 1 could occur in 480,996 acres (87 percent) of this habitat type, affecting the surrounding grasslands, meadows, and savannahs.

Vegetation would continue to grow and fuel would continue to accumulate, continuing to have negative effects on vole habitat.

Determination of Effect

Alternative 1 would have no effect on the Navajo Mogollon voles, and is not likely to cause a trend toward federal listing or loss of viability.

Alternative 2 – Modified Proposed Action

Under the modified proposed action, thinning and prescribed burning activities might disturb individual voles, resulting in direct adverse effects. Prescribed burning 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 effects on this species. In addition, the effect would be short-term and would have no effect on the population viability of voles. However, fire exclusion has resulted in uncharacteristically dense forests and meadow and grassland encroachment. Forest treatments can indirectly affect potential vole habitat by restoring meadows and reducing uncharacteristic tree densities and patterns in ponderosa pine forest. Restoring meadows and creating openings in the forest would increase potential understory development, including bunch grasses and other plants with C3 photosynthetic pathways, providing preferred food sources for voles.

In addition to grassland, savannah, and meadow restoration treatments, Alternative 2 calls for a diverse range of mechanical treatments where canopy openness would vary from 10 to 90 percent, depending on localized site conditions. Opening the canopy would provide both habitat connectivity and habitat stepping stones, facilitating landscape movements of dispersing voles. Reducing stand density could potentially reverse the declining trend in C3 plants and increase habitat quality for Mogollon voles. Prescribed fire and mechanical treatments would improve the stability of key ecosystem elements such as species composition, forest structure, soils, and hydrologic function. Moving these habitats toward historic conditions could increase potential habitat quality and quantity and reduce the risk of uncharacteristic, high-severity wildfire. The reduction of ponderosa pine basal area, increased growth in the understory vegetation on the forest floor, and increases in snags would result in indirect beneficial effects on the vole.

Under Alternative 2, as many as 250 miles of closed roads could be decommissioned. Roads often encourage removal of snags as hazard trees and provide easy access for fuelwood cutting, potentially reducing snags along roadways. Ganey (personal communications 2012) found an inverse relationship between snags and roads, so the proposed decommissioning of roads means more snags would be available in the future within vole habitat.

Fence design would allow access to small mammals. In addition, about 10 miles of road segments would be moved out of drainage bottoms, further enhancing vole habitat.

Determination of Effects

Alternative 2 may affect the Navajo Mogollon vole, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 3 – Focused Alternative

The effects from this alternative would be similar to those from Alternative 2. The same grassland restoration acres are proposed. Fewer acres are proposed for thinning and burning and 15,000 fewer acres of savannah treatments are proposed.

Determination of Effects

Alternative 3 may affect the Navajo Mogollon vole, but is not likely to cause a trend toward federal listing or loss of viability.

Cumulative Effects

The cumulative effects analysis area for Navajo Mogollon voles is the project area. The temporal boundary is 30 years to include 20 years of implementation and 10 years of benefits from treatments.

Short-term effects added to similar effects from nearby projects were considered. Watershed and forest health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating habitat in Rim Country would be reduced in the short and long terms. Implementation of other project activities could occur simultaneously; however, it is not anticipated to cause cumulative negative effects. Both action alternatives would move these habitats toward historic conditions and could increase potential habitat quality and quantity, reducing the risk of uncharacteristic, high-severity wildfire. This positive effect, combined with similar effects from activities such as the Travel Management Rule efforts, may decrease the frequency of disturbance on the majority of potential breeding sites, slightly counteracting the effects from utility line and road construction and maintenance, and short-term disturbances from vegetation management and prescribed fire.

Livestock are managed in systems designed to allow forage a chance to recover from livestock grazing, reducing the potential for cumulative effects from their grazing. However, wild ungulates would continue to reduce vegetative understory and affect plant composition. Cumulative activities such as the Travel Management Rule are likely to decrease motorized use in grasslands and meadows, thus decreasing effects on vole habitat. This, combined with forest restoration activities, could open up more habitats or provide more contiguous swaths of grassland habitat key to supporting thriving vole populations.

Alternative 3 would treat less acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which would result in less forest and watershed restoration and providing less risk of severe wildfire effects. Western Red Bat

Alternative 1 – No Action

With no treatments for the Rim Country Project, habitat quality would deteriorate for this species as overtopping ponderosa pine would lead to a decline in Gambel oak roosting habitat. The high fire hazard potential would persist, and a large, uncharacteristically severe wildfire event would have the potential to affect individuals. Acres of grassland in Fire Regime Condition Class 1 would decrease in the absence of treatments beyond the 13,440 acres of grassland thinning and burning resulting from current and reasonably foreseeable projects (see cumulative effects to all species section). At the landscape scale, woody species would continue to encroach into openings and species composition would shift in favor of less fire-adapted species. Ponderosa pine cover types in the project area would be at a high risk of losing key ecosystem components, should there be a large-scale disturbance event. In the event of high-severity fire, these key ecosystem components include species composition, forest structure, soil characteristics, and hydrologic function. High fire severity potential would persist, and a large crown wildfire event would have the potential to affect many individuals.

Wildfire modeling in the ponderosa pine habitat type by alternative show that of the 553,137 acres of ponderosa pine habitat type in the project area, 407,189 acres (81 percent) have the potential to experience high-severity wildfire under Alternative 1. Crown fire potential in ponderosa pine habitat from Alternative 1 could occur in 480,996 acres (87 percent) of this habitat type, affecting the surrounding grasslands, meadows, and savannahs.

Although habitat would be provided for this species, most of the forested area within the project area is in a moderately closed or closed canopy condition. Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure increases, resulting in indirect adverse effects. Under Alternative 1, limited acres of grasslands and forest opening would be restored, thus reducing foraging habitat for red bats. Gambel oak would continue to be overtopped by pine. Loss of mid- to large-diameter classes of oak from competition and from crown fire could reduce day roosts for red bats.

Water quality and riparian conditions would be adversely affected on a wide-scale basis, resulting in indirect adverse effects. Under Alternative 1, there would no restoration of springs and no restoration of ephemeral channels. These areas would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future, resulting in degradation of potential habitat for western red bats.

Determination of Effect

Alternative 1 may affect western red bats, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 2 – Modified Proposed Action

Prescribed burning in riparian areas would be coordinated with wildlife biologists to determine presence of federally listed or sensitive species (plants or animals) as well as mitigations needed for rare or sensitive species in/near the work areas. Thinning and prescribed burning activities could potentially disturb red bats if they are roosting in trees and caves, or hibernating among leaf litter within the ponderosa pine treated area. Prescribed burning occurring when bats are rearing young (April–July) or in deep hibernation (mid-winter) could have negative effects on local populations. However, most prescribed burning would occur in the spring and fall, and burn plans within 0.5 mile of known roosts or hibernacula would be designed to limit smoke at critical times (April–July and mid-winter).

Prescribed burning might result in the loss of snags and Gambel oak which could affect roosting bats. However, mitigation including managing for retention of all snags 18 inches in diameter and ignition techniques would reduce the losses of these forest components. Recruitment snags would be provided by retaining trees 18 inches in diameter and greater with dead tops and lightning damage. Selective thinning designed to release oak from competition would help create and retain mid- to large-sized oak. The modified proposed action is 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.

Alternative 2 calls for a diverse range of mechanical treatments that would vary from 10 to 90 percent open depending on site conditions. Prescribed burning 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. The reduction of dense forest canopy and increased growth in the herbaceous vegetation on the forest floor would result in indirect beneficial effects on bats. Forest conditions after treatment would improve bat habitat within the project area by increasing diversity and the density of understory vegetation, which provides habitat for prey populations, as many invertebrates are tied to specific understory plant species. Indirect benefits could potentially result from restoring meadows encroached by pine trees, and reducing uncharacteristic tree densities and patterns in the ponderosa pine forest that resulted from fire exclusion. These efforts would aid in restoring openings and edge habitat within the forest and improving understory vegetation that would benefit western red bats and their prey. Moving these habitats toward historic conditions would also increase the resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire.

Under the modified proposed action, spring, seep, and ephemeral channel restoration would improve riparian vegetation, increasing availability of food for bats over the long term, resulting in indirect beneficial effects.

Determination of Effect

Alternative 2 may affect the western red bat, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 3 – Focused Alternative

The direct, indirect, and cumulative effects on the Western red bat from Alternative 3 would be the same as from Alternative 2.

Determination of Effect

Alternative 3 may affect the western red bat, but is not likely to cause a trend toward federal listing or loss of viability.

Cumulative Effects

The cumulative effects analysis area for western red bats is the project area. The temporal boundary is 30 years to include 20 years of implementation and 10 years of benefits from treatments.

Short-term disturbance to bats would occur during thinning, hauling, and prescribed burning activities and may cause disturbance in nearby areas for the duration of the activity. These short-term effects added to similar effects from other past, present, and reasonably foreseeable projects were considered. Implementation of other fuel reduction activities could occur simultaneously; however, it is not anticipated that effects from these projects would combine with effects from the Rim Country Project activities to cause a negative effect. Ungulate grazing within the project area would reduce understory vegetation, which would reduce plant availability to adult insects, a primary food source. Generally, grazing systems are managed on a rotation 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 in meadows and around waters.

Alternative 3 would treat less acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which would result in less forest and watershed restoration and providing less risk of severe wildfire effects. Pale Townsend's Big-eared bat.

Alternative 1 – No Action

With no treatments for the Rim Country Project, habitat quality would deteriorate for this species as overtopping ponderosa pine would lead to a decline in roosting habitat. As tree densities increase, there would be less edge habitat, thereby reducing foraging opportunities. Seeps and springs would not be restored, which would continue to reduce the availability of riparian-associated host plants for noctuid moths on which the bat preys. High fire severity potential would persist, and a large, uncharacteristically severe wildfire event would have the potential to affect many individuals. Wildfire modeling in the ponderosa pine habitat type by alternative show that of the 553,137 acres of ponderosa pine habitat type in the project area, 407,189 acres (81 percent) have the potential to experience high-severity wildfire under Alternative 1. Crown fire potential in ponderosa pine habitat from Alternative 1 could occur in 480,996 acres (87 percent) of this habitat type, affecting the surrounding grasslands, meadows, and savannahs.

Fire intensity would continue to increase over time as vegetation would continue to grow and fuel would continue to accumulate, continuing to have negative effects on bat habitat. Acres of grassland would decrease in the absence of any type of treatment, as woody species continue to encroach and species composition shifts in favor of less fire-adapted species. Ponderosa pine cover types in the project area would be at a high risk of losing key ecosystem components, should there be a disturbance event, such as fire or extended drought (Fire Ecology and Air Quality Report). Key ecosystem components such as species composition, forest structure, soil characteristics and hydrologic function would be at a high risk of loss in the event of high-severity fire. High fire severity potential would persist, and a large crown wildfire event would have the potential to affect many individuals. Thirty-nine percent of the ponderosa pine and 12 percent of grassland habitat would support a crown fire. Marginal foraging habitat would still exist for this species; however, the high fire hazard potential would persist, and a large crown wildfire event could have the potential to affect individuals, resulting in indirect adverse effects.

Determination of Effect

Alternative 1 may affect pale Townsend's big-eared bats, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 2 – Modified Proposed Action

Forest management treatments potentially benefiting bats and their prey include group selection (small groups of trees removed for regeneration of new age classes resulting in a mosaic of roosting habitat, and small to medium gaps for foraging) and single tree selection (individual trees of all size classes removed fairly uniformly). These treatments maintain diverse forest structure and roost trees, create gaps that enhance edge habitat, and provide diverse vegetation structure increasing herbaceous vegetation important for bats' insect prey (Taylor 2006).

There are caves within 300 feet of the project boundary. Coconino Forest Plan guidelines recommend a 300-foot buffer around cave entrances, sinkhole rims and drainages leading to these features. This is a design feature for all known caves within the project area for Alternatives 2 and 3. Design features were added to the project to reduce effects on bat roosts. This would eliminate the potential for damage to the cave from mechanized equipment or increased sedimentation and would eliminate disturbance to Townsend's bats if they are roosting in caves. This would eliminate the potential for damage to the cave from mechanized equipment or increased sedimentation, and would eliminate disturbance to Townsend's bats if they are roosting in caves.

Thinning and prescribed burning activities could potentially disturb Townsend's bats if they are roosting in trees within the ponderosa pine treated area. Prescribed burning occurring when bats are rearing young (April–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 burning within 0.5 mile of known roosts or hibernacula or unsurveyed caves and mine shafts would be designed to limit smoke at critical times (April–May and mid-winter). Prescribed burning could also result in the loss of individual snags/hollow logs, which could affect roosting bats; however, mitigation including managing for retention of all snags 18 inches diameter and greater prior to prescribed burning would reduce the effects. The modified proposed action would be expected to result in a slight short-term increase in snags followed by a continued increase over the long term.

Prescribed burning 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 burning. These activities would disturb or remove understory vegetation, subsequently reducing availability of insects. These effects would be short-term and would be minimized due to activities being temporally and spatially separated. In contrast, reducing canopy closure, removing trees in and at the edges of meadows, restoring meadows, and prescribed burning would encourage the development of understory vegetation, and increase the amount of edge which would increase availability of food for the bat over the long term. Increasing diversity and density of understory vegetation provides habitat for prey populations. Many invertebrates are tied to specific understory plant species (Capinera 2010). Indirect benefits could potentially result from both restoring meadows encroached by pine trees and reducing uncharacteristic tree densities and patterns in the ponderosa pine forest that resulted from fire exclusion. These efforts would aid in restoring openings and edge habitat within the forest and improving understory vegetation that would benefit pale Townsend's big-eared bats and their prey. Moving these habitats toward historic conditions would also increase the resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire.

Under Alternative 2 there are up to 250 miles of closed roads that could be decommissioned. Roads often encourage removal of snags as hazard trees and provide easy access for fuelwood cutting potentially reducing snags along roadways. Ganey (personal communications, 2012) found an inverse relationship between snags and roads, so 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.

Under the proposed action, spring, seep, and channel restoration would improve riparian vegetation, increasing availability of food for noctuids and therefore Townsend's big-eared bats over the long term, resulting in indirect beneficial effects.

Determination of Effect

Alternative 2 may affect pale Townsend's big-eared bats, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 3 – Focused Alternative

The effects of Alternative 3 would be the same as Alternative 2. One documented cave roost is located within an AZGFD research site; however, these treatments are designed to provide tree groups up to 15 acres and can be designed to buffer cave locations as needed. Buffers are designed to eliminate potential sedimentation into the cave or damage from heavy machinery working over shallow passages. Alternative 3 has the same number of acres of grassland restoration treatments, while reducing savannah treatments by 15,000 acres.

Determination of Effect

Alternative 3 may affect pale Townsend's big-eared bats, but is not likely to cause a trend toward federal listing or loss of viability.

Cumulative Effects

The cumulative effects analysis area for pale Townsend's big-eared bats is the project area. The temporal boundary is 30 years to include 20 years of implementation and 10 years of benefits from treatments.

Short-term disturbance to bats would occur during thinning, hauling, and prescribed burning activities and may cause disturbance in nearby areas for the duration of the activity. These short-term effects added to similar effects from other past, present, and reasonably foreseeable projects were considered. Watershed and forest health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating habitat in Rim Country would be reduced in the short and long terms.

Implementation of other fuel reduction project activities could occur simultaneously; however, they are not anticipated to combine with Rim Country activities 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 rotation 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 in meadows and around waters. Implementation of the Travel Management Rule has reduced the number of roads near Townsend's big-eared bat roost locations.

Alternative 3 would treat less acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which would result in less forest and watershed restoration and providing less risk of severe wildfire effects.

Allen's Lappet-browed Bat

Alternative 1 – No Action

Under Alternative 1, only current and reasonably foreseeable projects would continue. Habitat would still exist for this species; however, the high fire hazard potential would persist, and a large, uncharacteristically severe wildfire event could have the potential to affect individuals and long-term suitability of habitat. Most of the forested area within the project area is in a moderately closed or closed canopy condition. Under Alternative 1, grasslands and forest openings would not be restored, thus recruitment of large snags would not meet forest objectives in the long term. Large-diameter trees would not maintain the numbers and distribution that would support large-diameter snags distributed across forested areas. There would be reduced foraging habitat for Allen's lappet-browed bats as conifers encroach into meadows and canopy closure increases, resulting in indirect adverse effects. High basal area and trees per acre counts would decrease or stagnate growth of large trees. Active competition-induced mortality would increase, decreasing future recruitment of large snags and decreasing future maternity roost sites.

Determination of Effect

Alternative 1 may affect Allen's lappet-browed bats, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 2 – Modified Proposed Action

Forest management treatments potentially benefiting bats and their prey include group selection (small groups of trees removed for regeneration of new age classes, which results in a mosaic of roosting habitat, and small to medium gaps for foraging) and single tree selection (individual trees of all size classes removed fairly uniformly). This would ensure a consistent source of large-diameter snags by maintaining recruitment of trees into larger size classes. These treatments would maintain diverse forest structure, including snags and gaps that enhance edge habitat, create diverse vegetation structure, and increase herbaceous vegetation important for bats' insect prey (Taylor 2006).

Thinning and prescribed burning activities could potentially disturb Allen's lappet-browed bats if they are roosting in trees within the ponderosa pine and pinyon juniper treated areas. Prescribed burning occurring when bats are rearing young (April–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 burning within 0.5 mile of known roosts/hibernacula or unsurveyed caves and mine shafts would be designed to limit smoke at critical times (April–May and mid-winter).

Prescribed burning could 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 this effect. Recruitment snags would be provided by retaining and growing more trees 18 inches in diameter and greater. Selection of trees with dead tops and lightning damage would contribute to potential habitat. The modified proposed action is expected to result in a slight short-term increase in snags followed by a continuing increase over the long term, with incidental loss of snags greater than 18 inches in diameter.

Prescribed burning 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 effects on bats. Forest conditions after treatment would improve bat habitat within the project area. Increasing diversity and density of understory vegetation provides habitat for prey populations. Many invertebrates are tied to specific understory plant species (Capinera 2010). Indirect benefits could potentially result from restoring meadows encroached by pine trees, as well as 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 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.

Under Alternative 2 there are up to 250 miles of closed roads that could be decommissioned. Roads often encourage removal of snags as hazard trees and provide easy access for fuelwood cutting potentially reducing snags along roadways. Ganey (personal communications, 2012) found an inverse relationship between snags and roads, so the proposed decommissioning of roads means more snags would be available in the future within Allen's lappet-browed bat habitat providing more roosting structures.

Under the modified proposed action, spring, seep, and channel restoration would improve riparian vegetation, increasing availability of food for bats over the long term, resulting in indirect beneficial effects.

Determination of Effect

Alternative 2 may affect Allen's lappet-browed bats, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 3 – Focused Alternative

Alternative 3 treats fewer forest acres in Rim Country, but the direct and indirect effects would be similar to Alternative 2. Alternative 3 includes the same miles and acres of riparian and other habitat restoration, while reducing the total number of acres thinned and treated with prescribed burning. The same grassland restoration acres are proposed as in Alternative 2, but 15,000 fewer acres in forest openings such as meadows and savannahs are proposed. While short-term effects from disturbance would be slightly less to Allen's lappet-browed bats in Alternative 3, the long-term effects on the risk of habitat degradation from stand-altering wildfire or insect infestations would be greater.

Determination of Effect

Alternative 3 may affect Allen's lappet-browed bats, but is not likely to cause a trend toward federal listing or loss of viability.

Cumulative Effects

The cumulative effects analysis area for Allen's lappet-browed bats is the project area. The temporal boundary is 30 years to include 20 years of implementation and 10 years of benefits from treatments.

Watershed and forest health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating habitat in Rim Country would be reduced in the short and long terms.

. The alternatives would be expected to result in a slight short-term increase in snags (greater than 12 inches diameter) followed by a continued increase over the long term of large snags (greater than 18 inches diameter). These short-term effects added to similar effects from other past, present, and reasonably foreseeable projects were considered.

Implementation of other fuel reduction and restoration activities could occur simultaneously; however, it is not anticipated that these effects would be additive to cause negative effects. Other fuel reduction and restoration projects might result in decreased large snags (greater than 18 inches in diameter) into the future. However, decreasing the potential for large-scale wildfires, and designing projects to increase tree growth for more large trees and, consequently, more recruitment snags, would improve the ability of tree roosting bats to locate roost sites across the landscape.

Prescribed burning produces low-severity burns that would reduce surface fuels and cause periodic loss of snags. Other activities such as high-severity wildfire, construction and maintenance of utility corridors, management of snags along forest roads, and private land development would also reduce the number of snags available for roosting in the long term. Large snags would be preserved whenever possible and design features to maintain and, where possible, develop snags on the landscape are incorporated into all projects. Although individual trees may be lost, large snags would be maintained and developed across the landscape to provide roosting habitat for Allen's lappet-browed bats.

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 rotation 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 in meadows and around water.

Alternative 3 would treat less acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which would result in less forest and watershed restoration and providing less risk of severe wildfire effects.

Spotted Bat

Alternative 1 – No Action

Under Alternative 1, only current and reasonably foreseeable projects would continue, as discussed in the cumulative effects to all species section. However, the high fire hazard potential would persist, and a large, uncharacteristically severe wildfire event would have the potential to affect individuals. Ponderosa pine forest in the project area would be at a high risk of losing key ecosystem components, should there be a disturbance event such as fire or extended drought (Fire Ecology and Air Quality Report). Key ecosystem components in ponderosa pine forest include species composition, forest structure, soil characteristics, and hydrologic function. High fire severity potential would persist, and a large crown wildfire event would have the potential to affect many individuals. Although habitat would be provided for this species, most of the forested area within the project area is in a moderately closed or closed canopy condition. Under Alternative 1, grasslands and forest openings would not be restored, thus there would be no benefits to bats. Favorable habitat would decrease over time as conifers encroach into meadows and canopy closure increases, resulting in indirect adverse effects. Wildfire modeling in the ponderosa pine habitat type by alternative show that of the 553,137 acres of ponderosa pine habitat type, 407,189 acres (81 percent) have the potential to experience high-severity wildfire under Alternative 1. Crown fire potential in ponderosa pine habitat from Alternative 1 could occur in 480,996 acres (87 percent) of this habitat type.

Determination of Effect

Alternative 1 may affect spotted bats, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 2 – Modified Proposed Action

Forest management treatments potentially benefiting bats and their prey include group selection (small groups of trees removed for regeneration of new age classes resulting in a mosaic of roosting habitat, and small to medium gaps for foraging) and single tree selection (individual trees of all size classes removed fairly uniformly). These treatments maintain diverse forest structure and roost trees, create gaps that enhance edge habitat, and provide diverse vegetation structure increasing herbaceous vegetation important for bats' insect prey (Taylor 2006).

Under the modified proposed action, thinning and prescribed burning activities could potentially disturb spotted bats if they are roosting in rock crevices in the ponderosa pine treated area. Prescribed burning occurring when bats are rearing young (April–July) or in deep hibernation (mid-winter) could have negative effects on local populations. However, most prescribed burning would occur in the spring and fall and burning within 0.5 mile of caves, mines, or cliff habitats would be designed to limit smoke at critical times (April–May and mid-winter).

Prescribed burning 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 burning. 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. In contrast, reducing canopy closure, removing trees in meadows, restoring meadows, and prescribed burning would encourage the development of understory vegetation, increasing availability of food for the bat over the long term.

Increasing the diversity and density of understory vegetation provides habitat for prey populations. Many lepidopterans are tied to specific understory plant species (Waltz and Covington 2004). Indirect benefits could potentially result from restoring meadows encroached by pine trees and reducing uncharacteristic tree densities and patterns in the ponderosa pine forest, a result of fire exclusion. These efforts would aid in restoring openings and edge habitat within the forest and improving understory vegetation that would benefit spotted bats and their prey. Moving these habitats toward historic conditions would also increase the resilience of these habitats and decrease the risk of uncharacteristic, high-severity wildfire. Under the modified proposed action, spring, seep, and channel restoration would improve riparian vegetation, increasing availability of food for bats over the long term, resulting in indirect beneficial effects.

Determination of Effect

Alternative 2 may affect spotted bats, but is not likely to cause a trend toward federal listing or loss of viability.

Alternative 3 – Focused Alternative

Alternative 3 treats fewer forest acres in Rim Country, but the direct and indirect effects would be similar to Alternative 2. Alternative 3 includes the same miles and acres of riparian and other habitat restoration, while reducing the total number of acres thinned and treated with prescribed burning. The same grassland restoration acres are proposed as in Alternative 2, but 15,000 fewer acres in forest openings such as meadows and savannahs are proposed. While short-term effects from disturbance would be slightly less to spotted bats in Alternative 3, the long-term effects on the risk of habitat degradation from stand-altering wildfire or insect infestations would be greater.

Determination of Effect

Alternative 3 may affect spotted bats, but is not likely to cause a trend toward federal listing or loss of viability.

Cumulative Effects

The cumulative effects analysis area for spotted bat is the project area. The temporal boundary is 30 years to include 20 years of implementation and 10 years of benefits from treatments.

Watershed and forest health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating habitat in Rim Country would be reduced in the short and long terms.

There could be potential short-term disturbance to potential foraging and roosting habitat with long-term benefits from the action alternatives. Short-term disturbance to bats would occur during thinning, hauling, and prescribed burning activities and may cause disturbance in nearby areas for the duration of the activity. These short-term effects, added to similar effects from other past, present, and reasonably foreseeable mechanical vegetation management and fuels reduction projects were considered. Implementation of these projects could occur simultaneously; however, it is not anticipated to accumulate to cause negative effects. Ungulate grazing in the project area reduces understory vegetation, which reduces plant availability to adult insects, a primary food source. Generally grazing systems are managed on a rotation 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 in meadows and around water.

Alternative 3 would treat less acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which would result in less forest and watershed restoration and providing less risk of severe wildfire effects.

Forest Service Management Indicator Species

Tonto National Forest Management Indicator Species

Rocky Mountain Elk

The Tonto National Forest estimated 283,200 acres of habitat occur on that forest for Elk (Tonto National Forest, 2005). No treatment or limited treatments as per previous years of acres accomplished in this forest type would leave nearly 220,000 acres of this (77 percent) untreated. Alternative 1 would not result in an immediate change to the quantity or quality of habitat used by elk on national forests. Alternative 1 would continue to provide large patches of trees with higher basal area, canopy density, and interlocking crowns, thereby providing thermal and hiding cover for elk. However, forage production would be limited under the forest canopies. Pine encroachment into grassy openings and meadows would continue to limit foraging habitat for elk under Alternative 1. Under Alternative 1, the current unnatural stand densities would threaten the sustainability of elk habitat over time by limiting understory production and creating a higher risk for uncharacteristic, high-severity fire.

Alternatives 2 and 3 would not result in a type conversion of mixed conifer or Ponderosa pine habitat on the Tonto National Forest and therefore would have no effect to the population trend for elk. These alternatives would promote thinning trees and prescribed burning in ponderosa pine that would open the canopy and decrease fine fuels on the forest floor. The Tonto National Forest estimated 283,200 acres of habitat occur on that forest for Elk (Tonto National Forest, 2005). The action alternatives could treat up to approximately 226,416 of this habitat on the Tonto National Forest, maintaining or improving the habitat quality of 80 percent of the available habitat on the Tonto National Forest. The result would be increased growth of herbaceous and shrub-level vegetation on these treated acres, which would provide increased forage in the long term. Reducing tree densities and ladder fuels would reduce available thermal and hiding cover for elk. However, thermal protection for elk would continue to be available in areas maintained at higher BA and canopy density.

Merriam's Turkey

The Tonto National Forest estimated 283,200 acres of habitat occur on that forest for turkey (Tonto National Forest, 2005). No treatment or limited treatments as per previous years of acres accomplished in this forest type would leave nearly 220,000 acres of this (77 percent) untreated. Alternative 1 would not result in an immediate change to the quantity or quality of habitat used by turkey on the national forests in the project area. Alternative 1 would continue to provide large patches of trees with a higher basal area, higher canopy density, and more interlocking crowns, thereby providing thermal and hiding cover for turkey. However, overstory suppression of oak, grass, and forb diversity and productivity would continue to limit foraging habitat for turkey in Alternative 1. Tree encroachment into openings and meadows would also limit turkey foraging habitat. Late-seral ponderosa pine would continue to be threatened by unnatural stand densities, creating risk for uncharacteristic, high-severity fire.

Alternatives 2 and 3 would not result in a type conversion of mixed conifer or Ponderosa pine habitat on the Tonto National Forest and therefore would have no effect to the population trend for turkey. The Tonto National Forest estimated 283,200 acres of habitat occur on that forest for turkey (Tonto National Forest, 2005). The action alternatives could treat up to approximately 226,416 of this habitat on the Tonto National Forest, maintaining or improving the habitat quality of 80 percent of the available habitat on the Tonto National Forest. The proposed treatments in Alternatives 2 and 3 would protect nesting and roosting habitat. The proposed thinning and burning activities would create tree groups that are favored by turkeys and would also increase the understory production. Increasing the understory would also increase plant and invertebrate abundance.

Vegetation design features would protect most mast-producing Gambel oaks within the project area. Targeted removal of over-topping ponderosa pines would increase resiliency and persistence of large oaks. Design features also specifically address retaining medium to high canopy cover in stringers of large ponderosa pine trees in the pinyon-juniper transition zones. This is a habitat favored by roosting turkeys. Low- severity prescribed fire along ridges and slopes is expected to retain yellow pine and roosting cover above drainages in the pinyon- juniper transition zone. While turkeys are not grassland species, groups of large and old trees would be retained where they occur on mollic-integrade soils. The results of these treatments would be savanna conditions. This would add resilience to groups of large, old trees, potentially increasing turkey roost habitat. In addition, the open habitat conditions resulting from the grassland and savanna treatments would increase foraging habitat for adults and poults.

Abert's Squirrel

The Tonto National Forest estimated 283,200 acres of habitat occur on that forest for Abert's squirrels (Tonto National Forest, 2005). No treatment or limited treatments as per previous years of acres accomplished in this forest type would leave nearly 220,000 acres of this (77 percent) untreated. Alternative 1 would continue to provide large patches of trees with higher basal area, canopy density, and interlocking crowns, thereby providing wintering habitat for squirrels on national forests. However, Alternative 1 would threaten the long-term viability of squirrels. Under Alternative 1, the current unnatural stand densities would threaten the sustainability of squirrel habitat over time by reducing tree vigor and health, limiting pine cone production, and creating a risk for uncharacteristic, high-severity fire. Vigor and health of trees in the older age class categories are important for sustaining squirrel nesting habitat over time. Pine cone production is important for squirrel foraging and nutritional demands. Large-scale losses of squirrel habitat from uncharacteristically large, stand-replacing fire would affect squirrel populations across the project area.

Alternatives 2 and 3 would not result in a type conversion of mixed conifer or Ponderosa pine habitat on the Tonto National Forest and therefore would have no effect to the population trend for Abert's squirrels. The Tonto National Forest estimated 283,200 acres of habitat occur on that forest for Abert's squirrels (Tonto National Forest, 2005). The action alternatives could treat up to approximately 226,416 of this habitat on the Tonto National Forest, maintaining or improving the habitat quality of 80 percent of the available habitat on the Tonto National Forest. With rare exceptions, Alternatives 2 and 3 would not remove old growth trees, and there would be an emphasis on retention of large-diameter trees, which should benefit Abert's squirrels for nesting, winter cover, and cone production. Project design criteria include tree thinning using the goshawk guidelines. This should result in a mosaic of vegetation structural stages, interrupting canopy closure, and allowing more sunlight to reach the forest floor. The reduction in canopy connectedness would reduce safe travel routes for Abert's squirrels and expose them to higher rates of predation in treatments creating more higher degrees of openness,. These treatments would also expose more of the forest floor to direct sunlight which could remove the microsite habitat for mycorrhizal fungi production, thereby reducing an important food source for squirrels. However, Dodd et al. (2006) postulated that up to 75 percent of a forested landscape could be treated and still provide suitable squirrel habitat, if treatments were applied as a mosaic of patches and areas of optimal habitat were retained. The alternatives are also designed to provide closed-canopy corridors to provide connectivity for squirrels and other species.

Alternatives 2 and 3 call for a diverse range of mechanical treatments to maintain forest habitat. Forest habitats would vary from 10 to 70 percent open, outside of grassland and savanna habitat, with variable basal area, trees per acre, and stand density index depending on site-specific conditions. Areas that would likely maintain a basal area and canopy cover high enough to support Abert's squirrels include MSO protected and recovery habitat, northern goshawk nest stands, other raptor nest sites, bald eagle roosts, buffers around caves and sinkholes, a portion of the older age class tree groups intended to support higher tree densities of mixed-age trees, and areas excluded from mechanical treatment such as wilderness or areas with slopes greater than 40 percent. As such, the patches of forest within the mosaic proposed by Alternatives 2 and 3 would vary in terms of Abert's squirrel habitat quality. A ratio of optimal to suboptimal patches that is skewed toward a more open condition would be less desirable to the squirrel and could lead to a short-term reduction in current squirrel populations. However, in the long term, post-treatment conditions would include tree growth and increased canopy connectedness, which should have a positive effect onto squirrel populations when viewed over longer time horizons.

Despite the proposed overall reduction in dense forest conditions, alternatives 2 and 3 would also provide for sustainable forests that include large, cone-bearing trees either as individual legacy trees or in groups, and clumps of mature and old-growth trees interspersed with patches suitable for fungi production. Canopy connectivity would be retained, but would no longer occur across so much of the landscape. In the long term, this should provide for more sustainable squirrel habitat over time because the risk of high-severity fire, and therefore long-term degradation or loss of squirrel habitat, would be significantly reduced (USDA FS 2010a). Landscape connectivity would be retained for canopy-dependent species.

Arizona Gray Squirrel

Alternative 1, No action could lead to a decreased species trend if effects from high-severity wildfire is encountered in high elevation riparian habitat across the project area.

Alternatives 2 and 3 would not result in a type conversion of riparian habitat on the Tonto National Forest and therefore would have no effect to the population trend for Arizona gray squirrels. The action alternatives would emphasize maintenance and restoration of healthy riparian ecosystems through conformance with LRMP's riparian Desired Conditions. Management strategies should move degraded riparian vegetation toward good condition as soon as possible. Damage to riparian vegetation, stream banks, and channels should be prevented. Alternatives 2 and 3 would improve riparian habitat and would likely assist in keeping the population stable.

Common Black Hawk

Alternative 1, No action could lead to a decreased species trend if effects from high-severity wildfire is encountered by riparian and cottonwood-willow vegetation type habitats across the project area.

Alternatives 2 and 3 propose 14,560 acres of Riparian restoration. Improvement of stream function is proposed for 777 miles across the project area through the action alternatives. Black-hawks could be disturbed by restoration activities, however design features to protect raptor nests have been included in the project record. This should minimize disturbance to the Common Black-hawk, though it is possible that disturbance from thinning implementation and short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. The removal of any eggs or fledglings would not result in a measurable negative effect to the Common Black-hawk population from any of the two action alternatives as the implementation of these acres would occur intermittently over space and time over the next 10 years. Long-term effects to the Common Black-hawk population would be positive as a result of habitat restoration. Alternatives 2 and 3 would improve riparian and cottonwood-willow vegetation types habitats and would likely assist in keeping the population stable.

Ash-throated Flycatcher

Alternative 1 could lead to a decreased species trend if high-severity wildfire is encountered in the pinyon-juniper vegetation type habitat across the project area.

Both action alternatives would include various levels of restoration implementation within pinyon-juniper. The alternatives could mechanically thin and burn 114,753 acres of pinyon-juniper. Most large trees would not be removed and pinyon-juniper woodlands would be managed for late-seral habitat, benefiting foraging and nesting habitat. Long-term benefits would include increasing understory development, managing for snag retention, and increasing habitat heterogeneity. Areas with currently dense conditions would be more open, leading to mixed long-term results for some species of birds. Unintentional take is expected to be minimized through the application of breeding season timing restrictions in Goshawk PFAs, deferral areas, and other design features. Alternatives 2 and 3 would improve the pinyon-juniper vegetation type habitat and would likely keep the population stable.

Gray Vireo

Alternative 1 could lead to a decreased species trend if high-severity wildfire is encountered in the pinyon-juniper vegetation type habitat across the project area.

Both action alternatives would include various levels of restoration implementation within pinyon-juniper. The alternatives could mechanically thin and burn 114,753 acres of pinyon-juniper. Most large trees would not be removed and pinyon-juniper woodlands would be managed for late-seral habitat, benefiting foraging and nesting habitat. However, mechanical treatment and burning could destroy nests if these activities occur during breeding season. Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintentional take of eggs or nestlings would not result in a measurable negative effect to the Gray Vireo population from both of the action alternatives. Alternatives 2 and 3 would improve the pinyon-juniper vegetation type habitat and would likely assist in keeping the Gray Vireo population stable.

Juniper Titmouse

Alternative 1 could lead to a decreased species trend if high-severity wildfire is encountered in the pinyon-juniper vegetation type habitat across the project area.

Both action alternatives would include various levels of restoration implementation within pinyon-juniper. The alternatives could mechanically thin and burn 114,753 acres of pinyon-juniper. Most large trees would not be removed and pinyon-juniper woodlands would be managed for late-seral habitat, benefiting foraging and nesting habitat. However, mechanical treatment and burning could destroy nests if these activities occur during breeding season. Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintentional take of eggs or nestlings would not result in a measurable negative effect to the juniper titmouse population from either of the action alternatives.

Hairy Woodpecker

Alternative 1 would increase the amount of late-seral forests in the long term. The risk of a large-scale wildfire is high. While fires promote recruitment of large snags, a study conducted locally, documented 40 percent of fire-killed snags falling within 7 years (Chambers and Mast 2005). Over 80 percent of ponderosa pine snags created by high-severity fire fell within 10 -years after a fire (Chambers personal communications 2008, Mast personal communications 2008). In addition, patches that burn with high-severity in today’s stand-replacing fires can reach several hundred hectares in size. Hairy woodpeckers do not use interior portions of larger burned areas, restricting much of their foraging to the edge habitat. The uncharacteristically large fires of recent years are less valuable to hairy woodpeckers than the smaller overstory-removing fires that occurred historically (USDA FS 2010a).

Live conifer trees with the potential to provide nesting habitat cavities such as dead-top trees and lightning struck trees would also be favored for retention. Prescribed fires would be designed to maintain desired forest structure, tree densities, snag densities, and coarse woody debris levels. Using the goshawk guidelines to direct management activities should have a positive effect on the species, as these prescriptions would result in forest structure that more closely resembles historic forests than those present today, including large trees and an abundance of snags (USDA FS 2010a).

Northern Goshawk

In Alternative 1, the quality of the habitat would deteriorate as canopies close tree densities increase, and understory production decreases. Closed canopies associated with higher tree densities would not allow sunlight and water to reach the forest floor for understory vegetation to grow, or provide habitat for prey species including vegetative cover, nesting substrates, seeds and fruits, grasses, forbs, and shrubs, as evidenced by the declining index of biomass production. In the long term, understory species richness would decline, reducing food and cover for prey species. Increased tree densities would increase competition among trees. Tree growth would decrease or stagnate and tree health decline due to competition for limited resources and space. Meanwhile, the lack of fire disturbance has led to increased tree density and fuel loads that increase the risk of uncharacteristically intense wildfire and drought-related mortality. When fires occur under current conditions, they tend to cause high tree mortality rates, including the large and old trees. These trees take longer to replace, moving the forest further from desired conditions, and increasing the time it would take to return to desired conditions. Another result of increased tree density is increased risk of insect and/or disease outbreak. Mortality created by these outbreaks also contributes to increased fuel loads and associated increase in the risk of uncharacteristically intense wildfire.

In Alternatives 2 and 3, the large tree habitat structure required for goshawk nesting (for example, large, tall trees with large branches and adequate flight paths) would be more available across the landscape as the numbers of large trees increases, improving habitat for existing and future resident goshawks and potentially increasing recruitment into the population. Creating interspace between groups of trees would help support prey species. Trees used for nesting would be able to grow to larger size, retain more of their crowns, and live longer with less competition, thus providing higher quality habitat for nesting and foraging.

The quality of the late seral stage ponderosa pine habitat would be expected to improve as stand conditions move closer toward historic conditions with more open understories, less competition among trees, and healthier forest conditions. Increasing the understory response would improve the quality of goshawk foraging habitat by providing more food and cover for prey species. The improved development of understory could also increase the diversity and amount of prey species available to goshawks.

Alternatives 2 and 3 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 northern goshawks and their prey species as all elements move toward desired future conditions. Overall, Alternatives 2 and 3 increase habitat quantity and improve habitat quality for northern goshawk and its prey species.

Northern Flicker

Alternative 1 could lead to a decreased species trend if high-severity wildfire is encountered in the pinyon-juniper vegetation type habitat across the project area.

Both action alternatives would include various levels of restoration implementation within pinyon-juniper. The alternatives could mechanically thin and burn 114,753 acres of pinyon-juniper. Most large trees would not be removed and pinyon-juniper woodlands would be managed for late-seral habitat, benefiting foraging and nesting habitat. However, mechanical treatment and burning could destroy nests if these activities occur during breeding season. Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintentional take of eggs or nestlings would not result in a measurable negative effect to the Northern flicker population from both of the action alternatives. Alternatives 2 and 3 would improve the pinyon-juniper vegetation type habitat and would likely assist in keeping the Northern flicker population stable.

Townsend's Solitaire

Alternative 1 could lead to a decreased species trend if high-severity wildfire is encountered in the pinyon-juniper vegetation type habitat across the project area.

Both action alternatives would include various levels of restoration implementation within pinyon-juniper. The alternatives could mechanically thin and burn 114,753 acres of pinyon-juniper. Most large trees would not be removed and pinyon-juniper woodlands would be managed for late-seral habitat, benefiting foraging and nesting habitat. However, mechanical treatment and burning could destroy nests if these activities occur during breeding season. Short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. Not all treatments would occur during the breeding season. Unintentional take of eggs or nestlings would not result in a measurable negative effect to the Townsend's solitaire population from both of the action alternatives. Alternatives 2 and 3 would improve the pinyon-juniper vegetation type habitat and would likely assist in keeping the Townsend's solitaire population stable.

Violet-green Swallow

Alternative 1 would lead to a decreased species trend if high-severity wildfire is encountered in the ponderosa pine/snags vegetation type habitat across the project area.

Alternative 1 would not result in an immediate change to the quantity or quality of habitat used by Violet-green swallows. Late-seral ponderosa pine would continue to be threatened by unnatural stand densities, creating risk for uncharacteristic, high-severity fire.

The proposed treatments in Alternatives 2 and 3 would protect nesting habitat. The proposed thinning and burning activities would also create canopy openings, allowing sunlight to reach more tree boles and increasing the prey base for swallows. Thinning and burning treatments are designed to return forest structure and composition to within the natural range of variation, which should benefit native wildlife species (Kalies et al. 2010). The vegetation design features for Alternatives 2 and 3 require that snags be managed to meet or move toward forest plan requirements and to move toward desired conditions. Snags or hazard trees within a distance of twice their height from private land boundaries or along key roads may be felled. In all other areas, conifer snags greater than 12 inches in diameter would be maintained, with an emphasis on snags greater than 18 inches in diameter, except in cases of human health and safety. Live conifer trees with the potential to provide nesting habitat cavities, such as dead-top trees and lightning struck trees, would be favored for retention. Prescribed burns are designed to maintain desired forest structure, tree densities, snag densities, and coarse woody debris levels.

Western Bluebird

Alternative 1 would lead to a decreased species trend if high-severity wildfire is encountered in the ponderosa pine open vegetation type habitat across the project area.

Alternative 1 would not result in an immediate change to the quantity or quality of habitat used by Western bluebirds. Late-seral ponderosa pine would continue to be threatened by unnatural stand densities, creating risk for uncharacteristic, high-severity fire.

The proposed treatments in Alternatives 2 and 3 would protect nesting habitat. The proposed thinning and burning activities would also create canopy openings, allowing sunlight to reach more tree boles and increasing the prey base for bluebirds. Thinning and burning treatments are designed to return forest structure and composition to within the natural range of variation, which should benefit native wildlife species (Kalies et al. 2010). The vegetation design features for Alternatives 2 and 3 require that snags be managed to meet or move toward forest plan requirements and to move toward desired conditions. Snags or hazard trees within a distance of twice their height from private land boundaries or along key roads may be felled. In all other areas, conifer snags greater than 12 inches in diameter would be maintained, with an emphasis on snags greater than 18 inches in diameter, except in cases of human health and safety.

Live conifer trees with the potential to provide nesting habitat cavities, such as dead-top trees and lightning struck trees, would be favored for retention. Prescribed burns are designed to maintain desired forest structure, tree densities, snag densities, and coarse woody debris levels.

Western Wood Peewee

Alternative 1 would lead to a decreased species trend if effects from high-severity wildfire is encountered by forested areas adjacent to riparian vegetation type habitats across the project area.

Alternatives 2 and 3 propose 14,560 acres of riparian restoration. Improvement of stream function is proposed for 777 miles across the project area in both action alternatives. Restoration of approximately 900,000 acres of forested habitat could occur with Alternative 2 and approximately 474,000 acres in Alternative 3.

Western wood peewees could be disturbed by restoration activities, however design features to protect raptor nests have been included in the project record. This should minimize disturbance to the Western wood peewees, though it is possible that disturbance from thinning implementation and short-term noise and smoke disturbance is possible during thinning and broadcast burning operations, potentially leading to loss of egg viability or injury or death to nestlings. The removal of any eggs or fledglings would not result in a measurable negative effect to the Western wood peewee population from any of the two action alternatives as the implementation of these acres would occur intermittently over space and time over the next 10 years. Long-term effects to the peewee population would be positive as a result of habitat restoration. Alternatives 2 and 3 would improve areas adjacent to riparian vegetation habitats and would likely assist in keeping the population stable.

Cumulative Effects

Some MIS are much more mobile than others. Therefore it is important to recognize habitat outside the project area as the affected environment for some animals. The cumulative effects analysis area varies by species (Table 80). The analysis includes the combined effects from all activities within the area as evaluated for each alternative. For example, the Abert's squirrel typically does not travel far; they stay in ponderosa pine forest year-round instead of migrating to lower elevations for the winter. Therefore, its cumulative effects analysis area is the ponderosa pine habitat type within the project area. On the other hand, elk use much larger areas to mate, calve, graze, and overwinter, so the cumulative effects analysis area for elk includes habitat outside the project area.

Cumulative effects can be an integral part of the effects analysis for wildlife and are discussed for each species. The cumulative effects discussed have occurred since 2001 and are considered changes in existing condition. The temporal boundary is 30 years to include 20 years of implementation and 10 years of benefits from treatments.

Table 80. Cumulative effects analysis area by species

Cumulative Effects Analysis Area	Species	Reason for Selection
Within project area	Pygmy nuthatch, turkey, Abert's squirrel, hairy woodpecker, red-naped sapsucker, juniper titmouse, Grace's warbler, western bluebird	Abert's squirrel use is focused on the area around their nest trees. Birds may move to other areas, but their nesting habitat is the most limiting factor for these species.
Project area plus 0.25-mile buffer around project area	Goshawk	The 0.25-mile buffer takes into account potential disturbances from activities within the project area.
Game management unit	Elk, mule deer, pronghorn	These species have wider mobility; GMUs are designed to encompass herd movements.

Alternatives 2 and 3

The planned thinning and burning of ponderosa pine and mixed conifer 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 1, but when added to the additional treatments in the alternatives, would provide for improvement across the landscape. These treatments would affect the MSO, Northern goshawk, Pygmy nuthatch, Rocky Mountain elk, Merriam's turkey, Abert's squirrel, Violet-green swallow, Hairy woodpecker, Western bluebird, and Western wood peewee by improving their habitats in the long term. These species' forestwide habitat trends would be improved by thinning projects that retain and enhance the large tree component within the ponderosa pine forest and that help create and retain large snags.

The 36,340 acres of grassland restoration, 17,600 acres of ponderosa pine savanna treatments, and 6,760 acres of meadow treatments would benefit pronghorn and elk by creating forage and corridors for movement between areas.

Treatment is possible on up to 115,000 acres of pinyon-juniper habitat. Design features would preserve older trees in this habitat type so effects from treatments to these MIS populations (Ash-throated flycatcher, Gray vireo, Juniper titmouse, Northern flicker and Townsend's solitaire) are expected to be minimal.

Fuelwood gathering and travel management requirements together help determine where the public can legally collect fuelwood. Since off road travel is only allowed in fuelwood areas, this would limit how far the public can travel to collect fuelwood. This would likely leave more dead and down woody material in areas farther from roads. There would likely be less dead woody material available within fuelwood areas closer to roads. This could prevent achieving forest plan requirements for snags, logs, and dead and down woody material near some roads. This would also limit how much fuelwood is removed away from roads and increase fuelwood removal along roads. Proposed treatments should help limit the amount of area not meeting forest requirements. This would affect the Northern goshawk, Pygmy nuthatch, Hairy woodpecker, Violet-green swallow, Northern flicker, and Juniper titmouse by removing snags that are needed for nesting or prey species.

The effects on MIS from ongoing and foreseeable activities, along with the proposed activities in Alternatives 2 and 3, are as follows: For all of the MIS species, the cumulative effects from these projects **would not adversely change the predicted forestwide habitat and population trends**.

Migratory Birds and Important Bird Areas

In the Mogollon Rim Snowmelt Draw Important Bird Area, the Rim Country Project would affect approximately 45,673 acres of ponderosa pine, aspen, pinyon-juniper, grasslands and savannas, ephemeral streams, and spring habitats. Mexican spotted owl protected, recovery, and critical habitats occur in the Important Bird Area. All design features associated with these habitat types would be followed as discussed in previous sections of this report.

Effects of the Proposed Activities on Migratory Birds

Currently, many migratory birds depend on habitats or habitat elements related to canopy openings, snags, and early seral conditions. Existing closed canopy forests limit or eliminate many of the necessary habitat components needed by these species, such as understory development sufficient to support abundant seeds, arthropods, and cover. 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. The ability to grow and maintain large trees would provide consistent development of future snags.

Table 81. Long-term effects on migratory bird habitats from Alternatives 2 and 3

Species	Habitat Links	Long-Term Effect to Habitat
Northern Goshawk	Late-seral PIPO[1]/Prey Habitat	Improved
Flammulated Owl	PIPO/openings/insects/snags	Improved
Cordilleran Flycatcher	PIPO/insects/ oak/dense forest	Mixed
Grace’s Warbler	PIPO/openings/insects/	Improved
Olive Warbler	PIPO/openings/insects/	Improved
Lewis’s Woodpecker	PIPO/openings/insects/snags	Improved
Purple Martin	PIPO/openings/insects/snags	Improved
Cassin’s Finch	PIPO/openings/seeds	Improved
Common Nighthawk	PIPO/openings/insects/	Improved
Mexican Whip-poor-will	PIPO/openings/insects/	Improved
Olive-sided Flycatcher	MC/openings/insects/snags	Improved
Evening Grosbeak	MC/openings/seeds	Improved
Red-faced Warbler	MC/oak/willow/insects/	Improved
Band-tailed Pigeons	MC/oak/willow/seeds/	Improved
Red-naped sapsucker	Aspen	Improved
Black-chinned Sparrow	Interior Chaparral	Mixed
Gray Vireo	Pinyon-juniper	Improved
Pinyon Jay	Pinyon-juniper	Improved
Juniper titmouse	Pinyon-juniper	Mixed
Black-throated Gray Warbler	Pinyon-juniper	Improved
Gray Flycatcher	Pinyon-juniper	Improved
Swainson’s Hawk	Open/Grassland	Improved
Ferruginous Hawk	Open/Grassland	Improved
Burrowing Owl (western)	Open/Grassland	Improved
Grasshopper Sparrow	Open/Grassland	Improved
Bendire’s Thrasher	Open/Grassland	Improved
Chestnut-collared Longspur	Semidesert Grassland	Improved

Species	Habitat Links	Long-Term Effect to Habitat
Lark Bunting	Semidesert Grassland, Desert Communities	Improved
Common Black-Hawk	Cottonwood/willow/riparian forest.	Improved
Bell's Vireo	Cottonwood Willow Riparian Forest	Improved
Elf Owl	Cottonwood Willow Riparian Forest	Improved
Lucy’s Warbler	Cottonwood Willow Riparian Forest	Improved
Yellow Warbler	Cottonwood Willow Riparian Forest; Mixed Deciduous Riparian Forest	Improved
Lincoln's Sparrow	Montane Willow Riparian Forest (breeding)	Improved
MacGillivray's Warbler	Montane Willow Riparian Forest, Aspen and Maple, Mixed Conifer	Improved
Brewer’s Blackbird	Wetlands, Montane/Subalpine Grasslands, Montane Willow Riparian Forest	Improved
Wood Duck	Cottonwood Willow Riparian Forest	Improved
Phainopepla	Desert Communities	None
Savannah Sparrow	Open habitats project-wide	Improved

Important Bird Areas

Most of the major vegetation cover types within the Mogollon Rim Snowmelt Draw IBA would be affected by Alternatives 2 and 3. The habitat of this IBA includes Ponderosa pine, white fir, Douglas fir, southwestern white pine, quaking aspen, and Gambel oak. Young plants of these canopy trees, plus canyon maple and New Mexico locust dominate the understory woody species. While most of the acres treated are within ponderosa pine and dry mixed conifer habitats, treatments would also occur in savannah, meadows, aspen, and pinyon juniper habitats. In addition, 53 miles of road decommissioning, restoration of six springs, and 7.5 miles of ephemeral stream channel restoration activities are proposed within the IBA in Alternatives 2 and 3. Design features (Appendix 5) are included in the project to reduce effects on bird species.

Overall, treatment objectives are to help restore forests to their natural range of variation.

Project activities including road decommissioning and spring and stream channel restoration, would help restore the area to more natural conditions. This should improve habitat conditions for all bird species that use the project area. There could be some limited effects on the species due to activities that might occur during the breeding season. It is expected that the habitats for which the Important Bird Area was established would benefit from the proposed treatments.

Cumulative Effects on Migratory Birds

Because of their seasonal movement, the primary management concern for migratory birds is nesting habitat and, for bald eagles, winter roost sites and known nest sites. The cumulative effects analysis area for migratory birds is the project area. The effects from projects that have already 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 for all alternatives section. Cumulative effects discussed here include those that have occurred since 2001 and the effects of the Rim Country alternatives. The timeframe considered is approximately 20 years in the future, at which time the majority of the activities proposed would have been completed and the vegetation response to these actions would have occurred. For further analysis on cumulative effects to migratory birds see the wildlife specialist report.

The temporal boundary is 30 years to include 20 years of implementation and 10 years of benefits from treatments. Watershed and forest health would increase with the combination of other projects occurring in Rim Country such as the CC Cragin Watershed Restoration Project (on the Mogollon Rim Ranger District) and Flagstaff Watershed Protection Project (the San Francisco Peaks and Mormon Mountain), reopening or developing rock pits (Coconino and Apache-Sitgreaves), and other restoration work, such as in in the Beaver Creek Rim Lakes and Larsen projects (Mogollon Rim). Cumulatively the risk of high-severity fire eliminating habitat in Rim Country would be reduced in the short and long terms.

Alternative 3 would treat fewer acres overall proposing 529,060 acres of treatment (424,070) less than Alternative 2 which cumulatively would result in less forest and watershed restoration and providing less risk of severe wildfire effects.

Resulting forest structure from planned thinning and burning of 195,405 acres of ponderosa pine habitat outside of the Rim Country boundary would be habitat within the natural 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 (for example, bark gleaners, woodpeckers, and flycatchers), but may negatively affect foliage gleaners in the short term (Patton and Gordon 1995, George et al. 2005). For further information about the cumulative effects to migratory birds from alternatives 2 and 3 see the wildlife specialist report.

The proposed project would treat between 42,486 to 43,863 acres of habitat within the Important Bird Area. This would cumulatively improve habitat condition within a broader area of the Important Bird Area.

Seasonal restrictions would limit project implementation activities between March 1 and September 30 in goshawk nest areas and post-fledging family areas and within Mexican spotted owl protected activity centers, which would reduce the potential for loss of species in ponderosa pine habitat. Prescribed fire could also occur 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 on the migratory birds populations listed above.

Locally Important Species

Two locally important species that occur in the project area were identified by Forest Service and US Fish and Wildlife biologists. The Arizona toad and the Arizona Black Rattlesnake.

The project could affect individual animals. Snakes or toads could be hit by vehicles associated with project implementation. Activities related to implementation could disturb individuals or interfere with hunting or foraging. However, overall there would not be a measurable negative effect on these two species populations. Long-term habitat improvements would include improved habitat and a decrease in potential disturbance from road decommissioning.

Aquatics

The analysis of aquatic biota and habitat, as well as the endangered, threatened, and sensitive aquatic species and their occupied, critical, and recovery habitats, that occur within the Rim Country project area is part of the Aquatics Report (Coleman 2019), which is incorporated by reference.

Affected Environment

The following section described the affected environment and effects of alternatives relating to threatened, endangered, and Forest Service sensitive species that may occur or have habitat in the project area. The analysis presented is summarized from the following report which is incorporated by reference: Aquatic Specialist Report for Rim Country, by Stephanie Coleman, 2019.

The indicator for riparian/wetland vegetation was used as a surrogate for riparian condition. A more comprehensive analysis of Watershed Condition Framework scores for the Rim Country Project Area as they relate to aquatic species and habitats can be found in the Aquatic Specialist Report (Coleman 2019)

Riparian Condition

Riparian Condition by aquatic species was determined averaging the Watershed Classification and Assessment Tracking Tool (WCATT) scores for the riparian vegetation indicator for all subwatersheds within a species action area. This provides an overview of the riparian condition as it relates to each species and their associated habitat. Averages from 1 to 1.4 are considered Good, 1.5-2.4 is Fair, and 2.5-3.0 is Poor (Table 82).

Four species have riparian condition rated in good condition which equates to functioning properly. Proper functioning condition indicates adequate vegetation, landform, and/or large woody debris are present to:

- Dissipate stream energy associated with high waterflow, thereby reducing erosion and improving water quality.
- Capture sediment and aid floodplain development.
- Improve flood-water retention and ground-water recharge.
- Develop root masses that stabilize streambanks against erosion.
- Maintain channel characteristics.

These watersheds have native vegetation in proper functioning condition throughout the stream corridor or along wetlands and water bodies. Native plant communities are vigorous, healthy and diverse in age, structure, cover and composition on greater than 80 percent of the riparian/wetland areas in the watershed. Sufficient reproduction of native species is occurring to ensure sustainability. Mesic herbaceous plant communities occupy most of their site potential and vegetation is in a dynamic equilibrium appropriate to the system.

Six species have riparian condition rated in fair condition, which is considered Functioning at Risk. These riparian areas are in limited functioning condition; however, existing hydrologic, vegetative, or geomorphic attributes make them susceptible to impairment. Disturbance partially compromises proper functioning condition of native vegetation attributes along stream corridors, wetlands, or water bodies. Native vegetation demonstrates a moderate loss of vigor, reproduction and growth, or changes in composition; particularly in areas most susceptible to human impact. Areas displaying light to moderate impact to structure, composition and cover may occupy 25 to 80 percent of the overall riparian area with only a few areas displaying significant impacts. Up to 25 percent of species cover or composition occurs from early seral species, but the communities across the watershed are still dominated by mid to late seral stages. Xeric herbaceous communities exist where water relationships have been altered but are relatively small, localized, and do not dominate across the watershed.

Four species have riparian condition rated in poor condition, which are considered Impaired.   These riparian areas clearly are not providing adequate vegetation, landform, or woody material to dissipate stream energy associated with moderately high flows, and thus are not reducing erosion, improving water quality, etc. large percentage of native vegetation attributes along stream corridors, wetlands, and water bodies are not in proper functioning condition. Native vegetation is vigorous, healthy and diverse in age, structure, cover and composition on less than 75 percent of the riparian/wetland areas in the watershed. Native vegetation demonstrates a noticeable loss of vigor, reproduction and growth, and changes in composition as compared with site potential communities. In these areas, cover and composition are strongly reflective of early seral species dominance although there would be late and mid seral species present in pockets. Mesic dependent herbaceous vegetation is limited in extent with many lower terraces dominated by xeric species most commonly associated with uplands. Reproduction of mid and late seral species is very limited. For much of the area, the water table is disconnected from the riparian area and the vegetation reflects this loss of available soil water.

Table 82. Average riparian condition from WCATT for species analysis areas

Species	Riparian Condition	Associated Rating
Gila trout	2.3	Fair
Gila chub	2	Fair
Gila topminnow	1	Good
Little Colorado spinedace	2.3	Fair
Loach minnow	1	Good
Razorback sucker	1	Good
Spikedace	1	Good
Narrow-headed gartersnake	2.5	Poor
Northern Mexican gartersnake	2.7	Poor
Desert sucker	2.6	Poor
Sonoran sucker	2.7	Poor
Little Colorado sucker	2.3	Fair
Headwater chub	2.4	Fair
Roundtail chub	2	Fair

Federally-listed and Forest Service Sensitive Species lists for all three Forests were screened to determine species that occur or have suitable habitat with the project and action area. Eleven federally listed species and nineteen sensitive aquatic species occur within the three Forests. Of those, nine federally listed and 16 sensitive individual species will be analyzed in detail (Table 83 and Table 84). Two of the species (gartersnakes) are both federally listed and sensitive species.

Table 83. Federally-listed and Forest Service Sensitive Aquatic Species Expected in the Project Area

Species	Status	Occurrence	Notes
Gila trout (*Oncorhyncus gilae*)	Federally Threatened	Documented Occurrence	Occurs within the Project and Action areas

Species	Status	Occurrence	Notes
Little Colorado Spinedace (*Lepidomeda vittata*)	Federally Threatened, with designated Critical Habitat	Documented Occurrence	Occurs within the Project and Action areas
Gila chub (*Gila intermedia*)	Federally Endangered with designated Critical habitat	Documented Occurrence	Does not occur within the Project Area, but does occur in watersheds within the project boundary.
Gila topminnow (*Poeciliopsis occidentalis occidentalis*)	Federally Endangered	Documented Occurrence	Does not occur within the Project Area, but does occur in watersheds within the project boundary.
Razorback sucker (*Xyrauchen texanus*)	Federally Endangered with designated Critical habitat	Documented Occurrence	Does not occur within the Project Area, but does occur in watersheds within the project boundary.
Loach minnow (*Tiaroga cobitis*)	Federally Endangered with designated Critical habitat	Documented Occurrence	Does not occur within the Project Area, but does occur in watersheds within the project boundary.
Spikedace (*Meda fulgida*)	Federally Endangered with designated Critical habitat	Documented Occurrence	Does not occur within the Project Area, but does occur in watersheds within the project boundary.
Narrow-headed gatersnake (*Thamnophis rufipunctatus*)	Federally Threatened, with proposed Critical Habitat & Forest Service Sensitive	Documented Occurrence	Occurs within the Project Area
Northern Mexican gartersnake (*Thamnophis eques*)	Federally Threatened, with proposed Critical Habitat & Forest Service Sensitive	Documented Occurrence	Occurs within the Project Area
Desert sucker (*Catostomus clarki*)	Forest Service Sensitive	Documented Occurrence	Occurs within the Project Area
Sonoran sucker (*Catostomus insignis*)	Forest Service Sensitive	Documented Occurrence	Occurs within the Project Area
Little Colorado sucker (*Catostomus sp. 3*)	Forest Service Sensitive	Documented Occurrence	Occurs within the Project Area
Headwater chub (*Gila nigra*)	Forest Service Sensitive	Documented Occurrence	Occurs within the Project Area
Roundtail chub (*Gila robusta*)	Forest Service Sensitive	Documented Occurrence	Occurs within the Project Area
Netwing Midge (*Agathon arizonicus*)	Forest Service Sensitive	Documented Occurrence	Occurs within the Project Area.
A Mayfly (*Fallceon eatoni*)	Forest Service Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the Project Area.
A Stonefly (*Capnia caryi*)	Forest Service Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the Project Area.
Parker's cylloepus riffle beetle (*Cylloepus parkeri*)	Forest Service Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the Project Area.

Species	Status	Occurrence	Notes
A Mayfly (*Fallceon eatoni*)	Forest Service Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the Project Area.
A Mayfly (*Moribaetis mimbresaurus*)	Forest Service Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the Project Area.
A Caddisfly (*Lepidostoma apache*)	Forest Service Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the Project Area.
A Caddisfly (*Lepidostoma knulli*)	Forest Service Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the Project Area.
A Caddisfly (*Limnephillus granti*)	Forest Service Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat of springs in ponderosa pine exist.
A Caddisfly (*Wormaldia planae*)	Forest Service Sensitive	Documented Occurrence	Occurs within the Action area
Ferris' Copper (*Lycaena ferrisi*)	Forest Service Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat of herbaceous wetlands exist.
Nokomis Fritillary (aka Great Basin Silverspot) (*Speyeria nokomis nokomis*)	Forest Service Sensitive	Documented Occurrence	Little is known about the species, but suitable habitat of herbaceous wetlands and streams exist.
Fossil springsnail (*Pyrgulopsis simplex*)	Forest Service Sensitive	Documented Occurrence	Occurs within the Action area
California floater (*Anodonta californiensis*)	Forest Service Sensitive	Documented Occurrence	Occurs within the Project and Action areas

Table 84. Federally-listed and Forest Service Sensitive Aquatic Species not analyzed in detail

Species	Status	Occurrence	Notes
Apache trout (*Oncorhyncus gilae apache*)	Federally Threatened	No Documented Occurrence	Does not occur within the Project or Action Area
Colorado pikeminnow (*Ptychochelus lucius*)	Experimental-Nonessential Population	No Documented Occurrence	Does not occur within the Project or Action Area
A Caddisfly (*Wormaldia planae*)	Forest Service Sensitive	Not Suspected to Occur	Does not Occur in the Project Area, and elevation range is lower than that of the project.
Balmorhea Saddle-Case Caddisfly (*Protoptila balmorhea*)	Forest Service Sensitive	Not Suspected to Occur	Does not Occur in the Project or Action Area, associated ERU semidesert grassland does not occur.

Assumptions and Methodology

Assumptions

Species occurrence geospatial layers utilized for analysis contain up-to-date information as of July 2018 and represent species current occurrence as well as potential suitable habitat.

Species analysis areas represent the drainage network where direct and indirect effects could occur to species or habitat.

Watershed Condition Framework assessments utilized for existing condition accurately reflect indicators for aquatic species and habitats.

Analyzing mechanical vegetation and prescribed burning treatments across vegetation types will address the highest level of effects that may occur; therefore, effects less than that are inherently addressed.

Project implementation would include all applicable Design Features, Best Management Practices, and Conservation Measures which are expected to minimize effects throughout the analysis.

The Aquatic and Watershed Flexible Toolbox Approach is adaptive management and guidance within the document would be implemented, including circumstances on where treatments are applicable, which inherently minimize effects on aquatic species and habitats.

Projects lists and acreages provided for Cumulative Effects analysis accurately represent past, current, and future activities within the project area.

Methodology

This analysis is for a total of 28 endangered, threatened, proposed, candidate, and sensitive aquatic species and their habitats. The species analyzed include twelve fish species, two mollusks, two gartersnakes, and twelve invertebrates. For analysis and discussion purposes, some of the species were grouped together, where appropriate, as this facilitates the comparison of changes between alternatives. Analyses compared and summarized the resource indicators and measures identified below (see Table 85). For invertebrate species, more qualitative analyses were required, primarily due to the unknown distributions of most of these species, limited distribution of these species, or the limited effects on these species associated with the proposed actions. Analyses included the changes (such as, increase, decrease, or change from current conditions) for the indicators or measures, and how they can affect aquatic species and their habitats.

For the purposes of analysis, mechanical vegetation treatments were analyzed across vegetation type (Ecological Restoration Unit) within the project area. Intuitively, mechanical vegetation treatments in forested Ecological Restoration units (ERUs) would be more extensive to move towards desired conditions than treatments in savannas, grasslands, meadows, and riparian areas to reduce encroachment. Prescribed burning was similarly analyzed across the project area regardless of vegetation type (ERUs).

The transportation system (roads) needed to implement Rim Country were analyzed quantitatively and qualitatively. Quantitative analysis was completed based on existing Forest Service roads (existing condition) and the number of ML-1 roads opened (action alternatives). While the analysis assumes all ML-1 roads would be opened for use, intuitively not all the roads would be opened or used at the same time across the project area. Therefore, the analysis is over estimating the potential effects of the action alternatives. The miles of roads (ML-1 thru 5) to be used is the same for both action alternatives as was therefore analyzed only once. Road relocation, decommissioning, and temporary roads were analyzed qualitatively for the action alternatives as the location of these activities is unknown. Miles proposed for each were based on averages across the three Forests over a given time period. Therefore, a more accurate analysis by species was not feasible. Miles of proposed road relocation and decommissioning were the same for both action alternatives and therefore only analyzed once. Mileage of temporary roads differed between the action alternatives and was analyzed as part of those alternatives.

In-woods processing and storage sites, rock pits, and aquatic/watershed restoration activities do not differ in acreage or mileage between the action alternatives. For those reasons, these three portions of the action alternatives were analyzed only once as Effects Common to Both Action Alternatives. In-woods processing and storage sites were analyzed quantitatively for the Coconino and Tonto National Forests where exact locations and acreages of proposed sites were available. A qualitative analysis was completed for the Apache-Sitgreaves National Forests because the use of identified processing sites on those forests are not being proposed, only the in-woods drying of biomass as needed. The acres of rock pit use and expansion were analyzed quantitatively, as were miles of general and heavy mechanical stream restoration.

Spatial and Temporal Context for Effects Analysis

The spatial analysis area includes the entire Rim Country project Area and adjacent areas that could be affected by activities occurring downstream of the proposed project area, or adjacent lands. The analysis area will vary by the species present within and downstream of Rim Country subwatersheds, and the extent and location of proposed activities within the various alternatives. For GIS quantitative analyses, areas for most of the aquatic species were developed to include all potential effects. Species analysis area boundaries were determined by including all of the subwatersheds within the project area that drain into occupied or suitable habitat, designated or proposed critical habitat, and identified recovery habitat. Additional spatial boundaries within each species analysis areas were defined specifically to delineate direct and indirect effects; these are described below.

Miles of stream identified for general and heavy mechanical stream restoration were identified spatially using factors that promote successful treatments. Potential locations for general stream treatments were identified based on stream gradient. Stream gradient was mapped using LiDAR data and averaging within reaches. Reaches with low (0 to 2 percent) and moderate (2 to 4 percent) stream gradient were used for general stream treatment identification based on Rosgen stream types and gradients where stream restoration is the most successful. Heavy mechanical stream reaches are a subset of the general stream dataset that were then filtered by the ability of machinery to access locations. These were identified by removing reaches with canyon slopes greater than 25 percent and further than 0.25 miles from roads. The canyon slope was used to be in alignment with existing Design Features.

Direct/Indirect Effects Boundaries

A 250-foot buffer on fish species habitat was used for analyzing acreage of direct effects on habitat, as this includes the stream and the adjacent riparian and upland areas that directly influence aquatic habitat and species. For indirect effects, all the analysis area that drains into the fish species habitat was included, as this captures all the potential indirect effects that could occur from any upstream area or activity. For the two gartersnake species a 600-foot buffer was used for analyzing acreage of direct effects because this covers the width of the stream, the width of proposed critical habitat, and the extent of habitat used by the species. For indirect effects, all the analysis area that drains into gartersnake habitat was included, similar to fish species. Percentage of areas affected by direct or indirect effects were calculated using the species analysis areas and the acres or miles proposed within those.

The temporal boundaries for analyzing direct and indirect effects to aquatic species will be 10 to 15 years, given that habitat conditions and species occupancy can change over that timeframe. Direct effects to species are fairly immediate (for example, harm or harassment), while indirect effects occur over a longer period as a result Short-term effects to habitat occur over a timeframe of a year to include a monsoon season and spring flow event. This is based on the assumption that monsoonal rain events (by their nature) increase erosion and sedimentation to aquatic habitats, while spring runoff tends to mobilize sediment downstream. Long-term effects to habitat can last for multiple years or seasons.

Cumulative Effects Boundaries

The spatial boundaries for cumulative effects are the combined areas of direct and indirect effects as described above. Additionally, for some species and some activities it can include private lands within the forest boundaries and lands adjacent to, or upstream and downstream of the project area. Temporal boundaries went back 30 years in time to include any activity with geospatial data on for quantitative analysis. Past management activities that did not have geospatial data were described by general resource area along with potential last effects going back further in time.

Resource Indicators and Measures

Resource measures were identified for those components that could be spatially defined and carried through the analysis of alternatives. Quantitative analyses were conducting for the following resource measures: 1) acres of mechanical thinning, 2) acres of prescribed burning, 3) miles of open ML-1, 4) acres of In Woods Processing Sites, 5) acres of rock pits use and expansion, 6) miles of general stream restoration, and 7) miles of heavy mechanical stream restoration. For some species (for example, sensitive aquatic macroinvertebrates) quantitative evaluation is not possible, so the analyses will be more limited and/or qualitative for some species. Qualitative analyses were used for components that could not be spatially defined such as temporary roads, road relocation, and road decommissioning which are part of both action alternatives. Resource indicators will allow for the comparison between the existing condition and each alternative, and how they may directly or indirectly impact aquatic species and their habitats. Resource elements are larger in context and represented by the resource indicators for analysis. For example, riparian condition represents both aquatic habitat quality and quantity. Measures represent the amount effect to the resource indicators; therefore if acres or miles of measures increase then potential effects to resource indicators may increase. Impacts to indicators will be addressed on the temporal context described previously as well as by direct and indirect impacts. Additional information is provided later for each group of species (such as, fish, frogs, snakes, and invertebrates) analyzed within the effects sections. The resource indicators, elements, and measures are listed in Table 85 below.

Several of the aquatic invertebrate sensitive species were not quantitatively analyzed using the resource indicators and measures. This was not possible primarily due to the species limited or unknown distributions, or no or limited impacts that could result from the proposed actions. GIS maps were reviewed for both alternatives to qualitatively assess the impacts that could occur to these species from the proposed actions (such as, mechanical vegetation treatments and prescribed burning).

Table 85. Resource indicators and measures for assessing effects between alternatives.

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LMP S/G; law or policy, BMPs, etc.)?
Habitat Quality Habitat Quantity Impacts to Individuals	1. Riparian Condition -Short and Mid-term effects negative - Long Term effect neutral or positive 2. Modification of Gartersnake Behavior - Short and Mid-term effects negative - Long Term effect neutral or positive 3. Harm of Gartersnakes - Short term effects negative - Mid and Long Term Effects Neutral 4. Pollutants, Exotic Species and/or Disease - Short, Mid-, and Long Term effects negative	Acres of mechanical thinning treatments	Yes	LMP S/G, BMPs
Habitat Quality Habitat Quantity Impacts to Individuals	1. Riparian Condition - Short and Mid-term effects negative - Long Term effect neutral or positive 2. Modification of Gartersnake Behavior - Short and Mid-Term effects negative - Long Term effect neutral or positive 3. Harm of Gartersnakes - Short term effects negative - Mid and Long Term Effects Neutral 4. Pollutants, Exotic Species and/or Disease - Short, Mid-, and Long Term effects negative	Acres of Prescribed Burning	Yes	LMP S/G, BMPs
Habitat Quality Habitat Quantity	1. Riparian Condition - Short and Mid-Term effects negative - Long Term effect neutral or positive 2. Habitat Connectivity - Short and Mid-Term effects negative - Long Term effect neutral or positive 4. Pollutants, Invasive Species - Short, Mid-, and Long Term effects negative	Miles of Open ML-1 and Temporary Roads (Road Density and Location)	Yes	LMP S/G, BMPs

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LMP S/G; law or policy, BMPs, etc.)?
Habitat Quality Habitat Quantity	1. Riparian Condition - Short and Mid-term effects negative - Long Term effect neutral	Acres of In Woods Processing Sites (IWPS)	Yes	LMP S/G, BMPs
Habitat Quality Habitat Quantity	1. Riparian Condition - Short and Mid-term effects negative - Long Term effect neutral	Acres of Rock Pits	Yes	LMP S/G, BMPs
Habitat Quality Habitat Quantity	1. Riparian Condition - Short Term effect negative - Mid and Long Term effects neutral or positive	Miles of general stream restoration	Yes	LMP S/G, BMPs
Habitat Quality Habitat Quantity Impacts to Individuals	1. Riparian Condition - Short and Mid-term effects negative - Long Term effect neutral or positive 2. Instream Aquatic Habitat - Short effects negative - Mid and Long Term effects positive 3. Harm of Fish or Gartersnakes - Short effects negative - Mid and Long Term effect neutral or positive 4. Pollutants, Invasive Species - Short, Mid-, and Long Term effects negative	Miles of heavy mechanical stream restoration	Yes	LMP S/G, BMPs
Habitat Quality and Quantity for Invertebrates	1. Riparian Condition - Short or Mid-Term effects negative - Long Term effects neutral or positive	Qualitative change in sediment delivery or habitat impacts.	Yes	LMP S/G, BMPs

Riparian Condition

Riparian Condition is being used as a surrogate to indicate potential changes in multiple factors that directly influence aquatic and riparian habitat quality and quantity such as sediment load, streamside canopy cover and structure, large woody debris, stream temperature, and changes in peak flows. The current condition of riparian areas indicates their ability and resiliency to provide the ecosystem services listed above in regards to potential direct and indirect impacts. Therefore, riparian areas in good condition would ameliorate potential short term direct impacts to riparian and aquatic habitat whereas areas in poor condition potentially would not. Additionally, resource measures could lead to positive or negative impacts to riparian condition (and thus aquatic or riparian habitat) depending on the timeframe.

Effects on riparian condition will be assessed quantitatively by alternative by comparing predicted direct, indirect, and cumulative effects by major proposed activities within the project area.

Habitat quality and quantity analysis topics include:

- ♦ Changes in streamside vegetation cover and structure.
- ♦ Changes in sediment delivery to streams altering aquatic habitat and food base.
- ♦ Changes in recruitment of large woody debris from riparian areas to streams altering aquatic habitat.
- ♦ Changes to stream temperatures as a result of warm water runoff from upland sources or reduced streamside canopy cover.
- ♦ Changes to aquatic habitat as a consequence of increased flows caused by removal of upland vegetation resulting in increased storm water runoff.

Environmental Consequences

Alternative 1 – No Action

There would be no direct effects on resource indicators for aquatic species and habitats as a result of the no action alternative, however there would be indirect effects by not moving these resources towards desired conditions. Existing conditions for watersheds would remained degraded and associated loss of habitat would continue which could potentially lead to reductions in populations over time. Overstocked and dense stands within the project area would not be treated, leaving a less healthy, less vigorous, and under productive forest. Encroachment of conifers into riparian areas and wetlands would continue which could decrease shrub and herbaceous ground cover as well as soil hydrologic function (Brown 2019). Current riparian and watershed conditions of Fair or Poor would continue to limit the quality of aquatic habitat and therefore species occupancy. Consequently, Alternative 1 would not be beneficial for riparian condition, aquatic habitat quality or quantity.

Effects Common to Both Action Alternatives

Opening ML-1 Roads

For Alternatives 2 and 3, it is assumed that all 5,682 miles of existing Forest Service roads within the project area would be utilized to provide access for removal of forest projects generated from the proposed mechanical vegetation activities as well as for other activities (Table 86). This includes temporarily opening all existing closed roads (ML-1) to utilize them for the time period that they are needed to provide access. These roads shall be closed upon completion of work and returned to a closed status (ML-1). For further explanation see the transportation specialist report (Rich 2018).

Table 86. Change Miles Of Open Forest Service Roads Treatments For Alternatives 2 & 3 As Compared To Alternative 1 Within The Project Area.

Maintenance Level	Alternative 1 Total Open Road Miles	Alternative 2 & 3 Open Road Miles
1- Basic Custodial Care (closed)	0/ 0	2,076
2 - High Clearance	2,864	2,864
3 - Suitable for Passenger Vehicles	669	669
4 - Moderate Degree of User Comfort	71	71
5 - High Degree of User Comfort	2	2
Total System Roads	3,606	5,682

Opening of ML-1 roads has the potential for direct short and mid-term impacts to aquatic indicators. Direct impacts would result if these activities occur in a species habitat. Both Alternatives are proposing treatments in the habitats of nine fish species and both gartersnakes (Table 87). Increases in miles of open roads ranges from 21 percent to 127percent of the analysis area for direct effects for seven species. The five species that occur downstream of the project have no increases in open roads within their direct effect analysis areas. Increases in road mileage are related to opening ML-1 roads within the direct effects analysis area. Little Colorado spinedace and roundtail chub have the largest increases in mileage; while headwater chub has no change in mileage in relation to direct impacts. Therefore Alternatives 2 and 3 would result in more potential direct impacts by increasing road density than Alternative 1.

Opening ML-1 roads can cause negative short and mid-term impacts to riparian condition, habitat connectivity, individuals, and introduction of pollutants or aquatic invasive species that are similar to new road or trail construction. Direct impacts to riparian condition include reduced riparian vegetation cover or structure, and removal of vegetation. This would be a direct impact to gartersnake critical habitat as well as some aquatic macroinvertebrate species habitat. The number of stream crossings could also be increased causing a direct effect to fish as well as indirect impacts of increased sedimentation from streambank damage. Indirect impacts of increased stream temperature could also occur from reduction in canopy cover within riparian areas. Associated ground disturbance and increased sedimentation delivery to riparian areas and streams is expected to occur short to mid-term until the roads were closed.

Table 87. Change By Species in Miles of Open ML 1 Forest Service Roads for Alternative 2 &3 As Compared To Alternative 1. Percentages Reflect Changes In Acreages Within Species Direct Effects Analysis Areas.

Species*	Alternative 1: Miles of Open Forest Service Roads	Alternative 2 & 3: Miles of Open Forest Service Roads/ Percent Increase
Gila trout	7	9/ 26%
Little Colorado spinedace	18	41/ 121%
Narrow-headed gartersnake	7	9/ 29%
Northern Mexican gartersnake	4	5/ 25%
Desert Sucker	23	45/ 90%
Sonoran Sucker	6	7/ 21%
Little Colorado sucker	18	40/ 114%
Headwater chub	13	13/ 0%
Roundtail chub	5	12/ 127%

* Species with analysis areas that did not overlap with miles of open ML 1 Forest Service roads are not listed.

Indirect impacts to riparian condition and introduction of pollutants could occur from opening ML-1 roads in upper watersheds for all analyzed species (Table 88). Increases in miles of open roads range from 4 percent to 115 percent. Narrow-headed gartersnake and Sonoran sucker have the largest increases in road mileage. Gila chub and the four species in Fossil Creek (Gila topminnow, Loach minnow, Razorback sucker, and Spikedace) have the lowest increases in open road mileage since only a portion of those subwatersheds are within the project area. Alternatives 2 and 3 would have more direct impacts from opening ML-1 roads within species action areas than Alternative 1.

Table 88. Change By Species In Miles Of Open Forest Service Roads For Alternative 2 &3 As Compared To Alternative 1. Percentages Reflect Changes In Acreages Within Species Analysis Areas. These Are Considered Indirect Impacts.

Species	Alternative 1: Miles of Open Forest Service Roads	Alternative 2 & 3: Miles of Open Forest Service Roads/ Percent Increase
Gila trout	232	324/ 40%
Gila chub*	61	63/ 4%
Gila topminnow*	63	70/ 11%
Little Colorado spinedace	917	1768/ 93%
Loach minnow*	63	70/ 11%
Razorback sucker*	63	70/ 11%
Spikedace*	63	70/ 11%
Narrow-headed gartersnake	170	372/ 119%
Northern Mexican gartersnake	86	142/ 65%
Desert Sucker	1034	1439/ 39%
Sonoran Sucker	112	240/ 115%
Little Colorado sucker	796	1412/ 77%
Headwater chub	354	438/ 24%
Roundtail chub	475	907/ 91%

*While the percentage is high for these species action areas, less than half of entire watershed is within the project area.

Indirect impacts of opening ML-1 roads in the upper watershed could occur to riparian condition and by introduction of pollutants or invasive aquatic species. In general, roads compact soils and reduce infiltration of water leading to increased erosion and runoff. They increase the drainage network to riparian areas and streams and connect these areas to the uplands by altering surface water pathways. This converts dispersed surface runoff and sediment filtering through a riparian area to direct deliveries of accumulated runoff and sediment. Pollutants and aquatic invasive species can be transferred to aquatic systems from machinery or vehicles. Leaking fuels or lubricants can be transferred to aquatic systems from vehicles, machinery, or fuel storage areas. Aquatic invasive species can similarly be transferred from an infected water body to an uninfected waterbody through driving.

Roads not only impact perennial and intermittent streams where aquatic species and riparian areas are present, but influence these habitats where they are located adjacent to or cross ephemeral channels in the watershed. Ephemeral streams indirectly support aquatic populations by providing required nutrients and other materials to the perennial streams (Levick et al. 2008).

Potential indirect effects are expected to vary based on current riparian condition. Species with riparian conditions that are currently poor are expected to have a higher level of indirect effects from sedimentation and peak flows. They are currently not capturing or processing sediment, indicating more could potentially reach stream from direct delivery. Stream energy from increased peak flows and concentrated flows would not be dissipated potentially altering instream habitats. Riparian areas that are fair or good would be capable of processing some levels of sediment and peak flows; however, the concentrated delivery from roads would still have negative impacts over the mid-term timeframe until they were closed.

Opening ML-1 roads would also increase road density during the timeframe that proposed project activities are occurring. This would negatively impact the Roads and Trails indicator for Watershed

Condition Framework in the interim impacting one of the five factors associated with aquatic species and habitats.

Design features for roads are expected to reduce some of the potential impacts to aquatic species and habitats. Minimizing disturbance of existing vegetation in ditches and at stream crossings during maintenance. New cross drains would discharge to stable areas where the outflow would quickly infiltrate the soil and not develop a channel to a stream. Whenever possible, use existing stream crossings unless a new crossing would result in less resource damage.

In Woods Processing Sites (IWPS) and Biomass Storage

No direct effects to any aquatic indicators or species are expected to occur from IWPS (Table 89). None of the proposed IWPS occur within 0.4 mile of occupied or suitable habitat. In addition, they occur within conifer ERUs (Ponderosa Pine, Ponderosa Pine-Evergreen Oak, Mixed Conifer w/ Aspen, and Mixed Conifer) and not within any riparian areas.

Indirect impacts from IWPS have the potential to occur to seven of the species based on their action areas. Two species (Gila trout and Sonoran Sucker) would have no indirect impacts. Acreages of IWPS range from 3.1 to 57.4 acres for both gartersnakes and desert sucker, respectively). Negative indirect impacts to riparian condition in the form of sedimentation are possible, but limited based on less than 0.5 percent of any species action area being impacted. In Woods Processing Sites would also have limited negative impacts to aquatic macroinvertebrates based on the very low percentage of IWPS acreage in any of the subwatersheds. For California floater, only two watersheds have the potential for any indirect impacts, with a total of approximately 72 acres of IWPS within those watersheds. The other aquatic macroinvertebrates share similar stream and riparian habitats with fish and gartersnakes; therefore, overall acreages of IWPS are still below 1 percent combined.

The Apache-Sitgreaves National Forests do not have any of the identified IWPS listed above; instead they would allow biomass (needles, tree tops and branches up to 5 inches) waiting to be processed to remain on forest during mechanical operations for up to 90 days. The timeframe allowed may be shortened based on conditions such as fire risk preparedness levels.

Allowing biomass to stay on the Apache-Sitgreaves National Forests should not directly impact aquatic species or habitats, but could have indirect impacts. Piling of any kind is not allowed within Aquatic Management Zones; therefore this action should not have any direct effects. Indirect effects could include soil disturbance from machinery moving material to and from the piles as well as hauling. Soil disturbance can lead to erosion and contribute fine sediment to streams negatively impacting aquatic habitat, species, and water quality; particularly eggs and early life stages that occur on or within substrate and aquatic macroinvertebrate community structure. Habitat can be negatively impacted by filling of pools and spawning substrates which can lead to loss of habitat quality and reduced reproductive success. Excessive fine sediment can impact macroinvertebrate prey bases and other food sources such as algae.

Similarly, leaving biomass should not directly impact sensitive invertebrates, but could have indirect impacts. For aquatic invertebrate species, increased fine sedimentation can lead to physical effects as well as changes in habitat and food availability and quantity. Physical effects include abrasion, clogging of gills and filter-feeding apparatus, burial, and changes in substrate composition (Jones et al. 2012). Bivalve mollusks, such as California floater, are capable of expelling unwanted particles from their gulls but can also expend more energy doing so than is gain from feeding. Filter feeding caddisfly larvae are generally not present in streams receiving high inputs of fine sediment. Burial presents difficulties for sedentary animals, such as mollusks, but can affect motile invertebrates where rates of deposition are high.

When inputs of fine sediment are increased in watersheds, interstices between large particles become filled which reduces refugia from predators or high-flow events. Most aquatic invertebrates are strongly associated with substrate composition; therefore increased fine sediment can alter habitat availability. Increased sedimentation can also decrease the nutritional quality of periphyton (the film of attaches algae, fungi, bacteria, organic matter, and sedimented material found on the surface of stones). Some caddisflies, stoneflies, and mayflies are particularly impacted by sedimentation (Harrison et al. 2007).

Table 89. Change By Species In The Acres Of In Woods Processing Sites For Alternatives 2 & 3 as Compared To Alternative1. Percentages Reflect Changes In Acreages Within Species Analysis Areas. These Are Considered Indirect Impacts.

Species*	Alternative 1: Acres of In Woods Processing	Alternatives 2 & 3: Acre of In Woods Processing/ Percentage of Direct Effects Area
Little Colorado spinedace	0	25.7/ 0.01%
Narrow-headed gartersnake	0	3.1/ 0%
Northern Mexican gartersnake	0	3.1/ 0.01%
Desert Sucker	0	57.4/ 0.02%
Little Colorado sucker	0	25.7/ 0.01%
Headwater chub	0	8.5/ 0.01%
Roundtail chub	0	38.5/ 0.02%

* Species with analysis areas that did not overlap with In Woods Processing Sites are not listed.

In Woods Processing Sites could have negative short and mid-term indirect impacts to riparian condition. In general, soils can be compacted and water infiltration reduced leading to increased runoff and sediment delivery to riparian areas and streams. This can reduce riparian condition, aquatic habitat quality and quantity depending on its current condition.

Potential indirect effects are expected to vary based on current riparian condition. Riparian condition for both gartersnakes, desert sucker and Sonoran sucker are currently impaired, therefore indirect effects are expected to be higher. Vegetation in these systems is not adequate to capture or process sediment, indicating more would reach streams. These riparian areas are often disconnected from the water table and are more reflective of upland species; therefore unable to dissipate stream energy associated with increased peak flows. Riparian condition for five species is currently functioning at risk, therefore indirect effects are expected to be less. Vegetation in these systems has loss of vigor, growth, or changes in composition, but is present and able to process sediment and dissipate flows in a limited capacity. Riparian condition for the remaining four species in Upper Fossil Creek is functioning properly. While indirect effects could occur, these riparian areas are able to process sediment and dissipate flows. That particular watershed also has less than 5 percent of its overall area within the project area inherently decreasing overall effects.

For those species with impaired or functioning at risk riparian condition, elevated sedimentation could negatively impact aquatic habitat, species, and water quality; particularly fish eggs and early life history stages that occur on or within substrate as well as the aquatic macroinvertebrate community structure. Habitat is impacted by filling of pools and spawning substrates which can lead to loss of habitat quality and reduced reproductive success. Peak flows can be increased altering channel forming flows leading to bank erosion and loss of habitat complexity. Reduction in riparian vegetation can lead to decreased organic matter input to support aquatic macroinvertebrates and increases stream temperature.

Potential indirect impacts of IWPS and biomass storage could occur short and mid-term. However, given the low overall acreage within species action areas, indirect effects are considered to be minimal.

Rock Pit Development or Expansion

No direct effects to any aquatic species or habitats are expected to occur from Rock Pit use or expansion. None of the proposed rock pits occur within ½ mile of occupied or suitable habitat. In addition, they occur within conifer ERUs (Ponderosa Pine, Mixed Conifer with Aspen, and Mixed Conifer) which are not utilized by sensitive invertebrate species, therefore no direct impacts would occur.

Indirect impacts from rock pit use and expansion within the upper watershed have the potential to occur to six of the species. Three species (Gila trout, Sonoran Sucker, and Desert Sucker) would have no indirect impacts. Acreages of rock pits within species action areas range from 4.6 to 200.6 acres (Table 90). Little Colorado spinedace and sucker have higher acreages of Rock Pits versus all other species. Overall, potential negative impacts are limited based on less than 1 percent of any species action area being impacted.

Indirect impacts to aquatic macroinvertebrates could occur from Rock Pit use and expansion similar to fish and gartersnakes. For California floater, only Upper Clear Creek watershed has any rock pits, approximately 177 acres or less than 1 percent of that 5th Code watershed.

Negative indirect effects from rock pits could potentially occur to riparian condition. Expansion of the pits would result in removal of some additional vegetation and could lead to some increases in erosion and sedimentation. However, design features limiting vegetation removal, erosion control, and reclamation are expected to reduce the potential for any impacts to riparian condition.

Table 90. Change By Species In The Acres Of Existing Rock Pits Sites And Their Expansion For Alternatives 2 & 3 As Compared To Alternative 1. Percentages Reflect Changes In Acreages Within Species Analysis Areas. These Are Considered Indirect Impacts.

Species*	Alternative 1: Acres of Rock Pits	Alternative 2: Acre of Rock Pits/ Percentage of Action Area
Little Colorado spinedace	20	200/ 0.07%
Narrow-headed gartersnake	0	5/ 0.01%
Northern Mexican gartersnake	0	5/ 0.01%
Desert Sucker	0	5/ 0.00%
Little Colorado sucker	0	103/ 0.05%
Headwater chub	0	5/ 0%

* Species with analysis areas that did not overlap with Rock Pits are not listed.

Stream, Riparian, Wet Meadow, and Spring Restoration

Proposed stream restoration was categorized as either general stream treatments or heavy mechanical stream treatments based on the methods of implementation. General stream treatments are described as any methods in the AWFTA that do not involve heavy mechanical equipment in or near a stream. Examples would include methods such as: fencing, planting, tools for improving spring outflows, and Zuni bowls or one rock dams as described in the AWFTA. Heavy mechanical stream treatments are reflective of treatments such as, but not limited to, channel reconstruction, channel realignment, and floodplain reconnection. The majority of the heavy mechanical treatments are described in appendix C under the heading “Tools for improving the form and function of stream channels and floodplains”.

General stream treatments could have direct and indirect impacts to aquatic indicators. Miles of proposed treatments range from 5 miles for Sonoran sucker to 179 miles for Little Colorado spinedace (Table 91). No direct or indirect impacts are expected to occur for 7 species as no treatments are proposed within their habitats, this includes both gartersnakes. The proposed activities are intended to enhance riparian and aquatic conditions at the site scale. All of these actions may result in some degree of short and mid-term negative effects to aquatic species and their habitats.

Direct effects to riparian condition would include ground disturbance reducing riparian vegetation cover or structure short to mid-term. Ground disturbance would lead to indirect impacts increased sedimentation during project implementation. These impacts are considered short-term (a few weeks) and sediment should be moved downstream during the first high stream flow. Beneficial impacts of general stream treatments can be immediate and long-term. Stabilizing headcuts has an immediate impact of stabilizing a stream and improving fish passage upstream. Riparian planting increases bank stability, shade, and organic matter inputs to streams improving stream habitat.

Table 91. Change by Species in the Miles of General and Heavy Mechanical Stream Restoration for Alternatives 2 & 3 As Compared To Alternative 1. Percentages Reflect Changes In Acreages Within Species Analysis Areas. These Are Considered Direct And Indirect Impacts.

Species*	Alternative 1	Alternatives 2 & 3: General Stream Treatment Miles/ Percentage of Action Area.	Alternatives 2 & 3: Heavy Mechanical Stream Treatment Miles/ Percentage of Project Area
Gila trout	0	7/ 22%	4/ 13%
Little Colorado spinedace	0	179/ 96%	24/ 13%
Desert Sucker	0	51/ 48%	18/ 17%
Sonoran Sucker	0	5/ 37%	3/ 26%
Little Colorado sucker	0	123/ 84%	14/ 10%
Headwater chub	0	9/ 19%	7/ 14%
Roundtail chub	0	23/ 66%	3/ 10%

* Species with analysis areas that did not overlap with stream restoration are not listed.

Heavy mechanical stream treatments could have negative direct and indirect impacts to aquatic indicators. These treatments inherently include disturbance to streams, their floodplains, and associated riparian areas in order to improve form and function. Miles of proposed treatments range from 3 to 24 miles, which encompasses 10 percent to 26 percent of occupied habitats. No direct and indirect impacts are expected to occur for 7 species as no treatments and proposed within their habitats, this includes both gartersnakes. Sonoran sucker and Desert sucker have the highest percentage of occupied/suitable habitat within proposed heavy mechanical stream treatments.

Short-term direct impacts of heavy mechanical stream restoration could occur to individuals, while indirect impacts to riparian condition, introduction of contaminants, and spreading of aquatic invasive species or disease could occur during project implementation.

Direct impacts in the form of mortality could occur from heavy machinery in and around streams, springs and wetlands. These are considered short-term effects as they would only occur while heavy equipment was operating. Conservation measures to look for and move gartersnakes, remove and isolate fish from instream construction zones, and in water work periods are expected minimize the potential for direct impacts. In water, work periods would be determined on a project specific basis and jointly by Forest Service, U.S. Fish and Wildlife Service and Arizona Game and Fish Department due to the overlapping of federally listed and sensitive species.

Short-term negative impacts of temporarily restricting habitat or habitat access (displacement) could occur during project implementation. Coffer dams and bypass systems associated with heavy mechanical restoration activities may temporarily block (few weeks) fish movement up and/or downstream through the construction area. Up and downstream fish movement is provided by ditch bypass systems, downstream movement is provided with plastic-culvert bypass systems, and no fish movement is provided with pump bypass systems. Headcuts and existing structures to be repaired may serve as exiting fish-passage barriers; therefore, coffer dams and diversion structures may not be any more of a barrier than the pre-restoration baseline.

Riparian condition could be negatively impacted short-term inputs of increased sedimentation from instream structure placement, opening of side channels, road crossing treatments, and other projects inside or near the bankfull channel. The sediment plume from activities would be most concentrated in the immediate project vicinity and should dissipate throughout the stream channel within a few hours. The amount, extent, and duration of fine sediment inputs and turbidity relate to the following: the type and duration of heavy machinery used within or near a bankfull channel; soil type; the amount of soil disturbance; whether restoration is in or out of the wetted channel; the sensitivity of the channel banks to erosion and other disturbances; the amount of time it takes for disturbed areas to revegetate and stabilize; and the probability of precipitation events before disturbed areas are re-vegetated or stabilized.

The increased stream turbidity may deposit fine coats of sediment on channel substrate a short distance downstream, encourage fish and other aquatic species to move downstream, and alter fish behavior patterns for a short time. It is anticipated that all project related sediment would be flushed out during the first fall/winter/spring high flows after project completion, and site restoration conservation measures are expected to prevent future project related sediment inputs into the stream. Therefore, long-term negative impacts to substrate are not expected.

Contaminants and aquatic invasive species or diseases could be introduced into the stream from large equipment causing negative indirect impacts to aquatic species. Chemical transport could be direct into streams from equipment or from storm water runoff through or over soil. Pollutants alter soil chemistry, may be absorbed by plants, can affect stream ecosystems, where they are dispersed and diluted over considerable distances. Typical water-quality responses to pollutants include altered levels of heavy metals, salinity, turbidity, and dissolved oxygen. These water quality changes can be sporadic and localized due to fluctuations in water quantity. Aquatic invasive species or diseases could similarly be introduced to streams or waterbodies. Best management practices and conservation measures requiring cleaning equipment, checking for leaks, storage of fuels, and staging areas for equipment out of AMZs minimizes the likelihood of either occurring.

Benefits from heavy mechanical stream restoration can be immediate and long-term by improving or restoring riparian condition via one of the following: stream structure/complexity, stream sinuosity and length, bank stability, floodplain connectivity. Such results would promote conditions that maintain or decrease stream temperature, reduce turbidity (via stable banks, improved sediment retention through increased channel structure, riparian areas, and floodplains), and improved nutrient input (via increases riparian organic input sources) and retention (via increased channel structure, sinuosity, and floodplain areas). It is anticipated that the project related sediment would be flushed out during the first spring high flows after project completion, and site restoration conservation measures are expected to prevent future project related sediment inputs into the stream. Therefore, long-term sediment impacts to sediment and turbidity are not expected.

Human constructed or caused physical barriers within the stream channel such as culverts and headcuts can impair sediment and debris transport, migration routes, life history patterns, and population viability.

First and second order streams are the sources of water, nutrients, wood, and other vegetative material for streams inhabited by fish and other aquatic organisms. Fish Passage Culvert Projects, Headcut stabilization and Associated Fish Passage, and Legacy Structure Removal treatments would result in benefits such as uninhibited stream access for migrating and rearing fish, restored or improved continuous paths for wood, nutrients, sediments, and other vegetative material essential for quality fish habitat.

Upland soil restoration structures (for example, Zuni bowls or native rock check dams) may be used to address site specific erosion/channelization resource issues within project watersheds. The number that may be installed would vary based on watershed needs. These structures would have a long term benefit of reducing erosion and sedimentation to stream by holding and stabilizing soils in the uplands and improving hydrologic condition and function. Riparian and rare plant planting and enclosures to protect existing or planted areas could occur where site-specific needs are identified in riparian areas, wet meadows, springs, and uplands areas such as where aspen or big-toothed maple occur. Riparian planting and enclosures along streams can improve bank stability, stream shading and aquatic habitat.

Aquatic Macroinvertebrates

Stoneflies, caddisflies, mayflies, midges, and riffle beetles are strongly associated with streams and riparian areas. Based on the biology and ecology of these four groups of species, stream and watershed restoration in accordance with the AWFTA could have negative direct and indirect impacts. Direct impacts to individuals and their habitats could occur short-term during project implementation. General stream treatments would have a low potential for direct and indirect impacts to these sensitive species given the methods included (for example, fencing or planting). Heavy mechanical stream treatments have the potential for more direct effects as they include short-term habitat alteration in streams and riparian areas that could also impact individuals. Indirect effects of sedimentation from the AWFTA restoration treatments would last as long as the first few flushing flow events. Beneficial effects would occur from improved stream habitats and riparian vegetation long term.

Nokomis Fritillary is a sensitive species that utilizes meadows, seeps, and boggy streamside vegetation. General stream treatments would have a low potential for direct or indirect impacts to the species. Heavy mechanical stream treatments could have direct and indirect impacts. Short-term direct impacts to individuals and their habitat could occur during implementation. Indirect effects of habitat alteration would last until vegetation was restored or had regrown that supports the species. Beneficial effects would occur from improved stream-riparian interaction and riparian habitat.

For California Floater, general stream restoration treatments would have a low potential for direct or indirect impacts. Fencing across streams could directly impact the species, but is unlikely. Indirect impacts of sedimentation from these methods would also be considered negligible. Heavy mechanical stream treatments are proposed in Upper Clear Creek (49 miles) and West Clear Creek (2.9 miles) where the species historically or currently occurs. Short-term direct impacts would occur during implementation of instream treatments that could also impact individuals. Indirect impacts of sedimentation are expected to persist until first few flushing flows mobilize any sedimentation downstream. Beneficial effects would occur from improved stream habitats long term.

For all sensitive aquatic macroinvertebrates, streams and riparian areas could have short-term negative indirect impacts from proposed stream restoration as part of Alternatives 2 and 3. Short-term indirect effects of heavy mechanical stream restoration include increased sedimentation and turbidity, introduction of contaminants, and spreading of aquatic invasive species or disease during project implementation. Project level best management practices and mitigations would minimize the potential for introduction of contaminants or spread of aquatic invasive species or disease.

Road Relocation and Decommissioning

Road relocation and decommissioning include restoring a road surface to a more natural state. Short-term negative impacts to individuals and riparian condition would be similar to those discussed above for aquatic restoration. Direct impacts to individuals could occur for any work within species habitats. Riparian condition could be negatively impacted short to mid-term by increased sediment delivery until vegetation reestablished.

However, long term benefits of reducing road density have a cascade of effects: improved riparian condition from reduction in runoff and sedimentation, fewer roads crossings, and the ability for riparian vegetation to be restored, and decreased mortality or disturbance of species. Road density is a major factor in the current condition of most subwatersheds with aquatic species in the project area. Reducing road density by decommissioning roads could help improve that particular Watershed Condition Framework indicator. Relocating roads does not reduce overall road density, but can alleviate direct versus indirect impacts, particularly if move a road further from a stream or riparian area.

Design features for road relocation are expected to reduce some of the potential impacts. Relocated roads should be constructed in a manner that does not hydrologically connect them to streams to extent practicable. They would also have sufficient drainage features to maintain the integrity of the travel, thereby reducing erosion and sedimentation. New cross drains would discharge to stable areas where the outflow would quickly infiltrate the soil and not develop a channel to a stream. When feasible, relocate roads out of drainage bottoms to upland locations; if this is not possible rock armor outfall of drainage features to dissipate water energy. Contaminants and aquatic invasive species or diseases could be introduced into the stream from large equipment causing negative indirect impacts to aquatic species. Chemical transport could be direct into streams from equipment or from storm water runoff through or over soil. Pollutants alter soil chemistry, may be absorbed by plants, can affect stream ecosystems, where they are dispersed and diluted over considerable distances. Typical water-quality responses to pollutants include altered levels of heavy metals, salinity, turbidity, and dissolved oxygen. These water quality changes can be sporadic and localized due to fluctuations in water quantity. Aquatic invasive species or diseases could similarly be introduced to streams or waterbodies. Best management practices and conservation measures requiring cleaning equipment, checking for leaks, storage of fuels, and staging areas for equipment of AMZs minimizes or precludes the likelihood of either occurring.

Direct and Indirect Effects - Alternatives 2 and 3

Mechanical Vegetation Treatments

For Alternatives 2 and 3, acres of mechanical vegetation treatments has the potential for negative short and mid-term impacts to riparian condition and individuals. Direct negative short term impacts would result if these activities occur in a species habitat from actions such as yarding, skidding, or harm to gartersnakes during mechanical operations. Both alternatives are proposing treatments within the habitats of seven fish species and both gartersnakes. For Alternative 2, increases in acreages of treatments ranges from 203 to 3,891 acres which equates to 1 percent to 100 percent of the analysis area for direct effects for those species. Whereas, increased acreage of treatments ranges from 566 to 4,881 which equates to 19 percent to 100 percent of the direct effects analysis area for Alternative 3. Five fish species would not be directly impacted by mechanical vegetation treatments under Alternatives 2 and 3 because they do not occur within the project area. Table 92 displays this information for each species.

Table 92. Change by species in the acres of mechanical vegetation treatments for Alternative 2 and 3 as compared to Alternative 1. Percentages reflect increases in acreage within direct effects analysis areas for species.

Species*	Alternative 1: Acres of Mechanical Vegetation Treatment Acres	Alternative 2: Acre of Mechanical Vegetation Treatment Acres/ Percentage of Direct Effects Area	Alternative 3: Acre of Mechanical Vegetation Treatment Acres/ Percentage of Direct Effects Area
Gila trout	0	1,398/ 52%	1,319/ 49%
Little Colorado spinedace	0	5,133/38%	4,881/ 36%
Little Colorado spinedace CH	0	1,496/ 40%	1,496/ 40%
Narrow-headed gartersnake & CH	0	2,266/ 93%	2,040/ 92%
Northern Mexican gartersnake & CH	0	1,249/ 100%	1,196/ 100%
Desert Sucker	0	3,891/ 29%	3,744/ 28%
Sonoran Sucker	0	573/ 39%	566/ 38%
Little Colorado sucker	0	3,292/ 25%	2,986/ 23%
Headwater chub	0	1,939/ 55%	1,806/ 52%
Roundtail chub	0	1,581/ 26%	1,180/ 19%

* Species with analysis areas that did not overlap with mechanical vegetation treatments are not listed.

Mechanical vegetation treatments can negatively impact riparian condition short to mid-term when they occur within the direct effects analysis area. Direct impacts of reduced riparian vegetation cover or structure could occur by removal of trees or crushed by machinery. These are also direct impacts to gartersnake critical habitat as well as habitat for some aquatic macroinvertebrates species. Indirect impacts of increased stream temperature from loss of canopy cover could occur, but should be limited based on design features associated with providing for and protection of existing stream shade. Indirect impacts of ground disturbance and increased sediment delivery to streams is expected to occur short to mid-term until ground cover is reestablished. Stream banks can be also be damaged, which are primary constituent element for some fish, however design features for mechanical vegetation treatments including restrictions for skid trails and yarding within riparian areas as well as protecting stream banks would minimize potential impacts.

Riparian condition for both gartersnakes, desert sucker and Sonoran sucker are currently impaired, therefore direct and indirect effects are expected to be higher. Vegetation in these systems is not adequate to capture sediment, are often disconnected from the water table and are more reflective of upland species. Riparian condition for the remaining species is functioning at risk, therefore direct and indirect effects are expected to be less. Vegetation in these systems has loss of vigor, growth, or changes in composition, but is present and functioning at some level.

Impacts to individuals in the form of harm or modification of behavior could also occur short to mid-term. Mechanical vegetation treatments within gartersnake habitat could result in harm of individuals as a direct effect. Indirectly, gartersnakes may avoid or move out of these areas while work is occurring causing displacement or disruption of social and feeding behavior. These indirect effects have the potential to reduce the health or reproductive capability of individuals.

Long term, mechanical vegetation treatments could have a neutral or positive effect on aquatic indicators. Riparian condition could be improved by removing encroachment and restoring streamside vegetation. Conifers can impede the growth the riparian woody and herbaceous species; therefore it is expected they would increase in cover and structure. This would provide for large woody debris over time as well as decreasing sediment delivery and peak flows. Impacts to individuals would cease once activities were completed and therefore have a neutral effect long term.

For both action alternatives, increased acres of mechanical vegetation treatments also has the potential for indirect occur short to mid-term impacts riparian condition from treatments in the upper watershed as compared to Alternative 1. These are indirect impacts that can occur within a species action area (such as, project watershed area that drains into a species occupied habitat) by changes in the uplands and on tributaries and drainages. Increases in percent of action areas treated under Alternative 2 range from 54 percent to 94 percent and from 11 percent to 68 percent for Alternative 3. Table 93 displays these species habitats as compared to the existing condition (Alternative 1).

Under Alternative 3, five species have increases of 11 percent, but it is important to note the overall acreage is comparatively small due to approximately half of that watershed occurring within the project area.

Table 93. Change by species in acres of mechanical vegetation treatments for Alternative 2 and 3 as compared to Alternative 1. Percentages reflect increases in acreage within species analysis areas. These are considered indirect impacts.

Species	Alternative 1: Acres of Mechanical Vegetation Treatment Acres	Alternative 2: Mechanical Vegetation Treatment Acres/ Percentage of Action Area	Alternative 3: Mechanical Vegetation Treatment Acres/ Percentage of Action Area
Gila trout	0	89,699/ 81%	71,921/ 65%
Gila chub*	0	12,325/ 57%	2,489/ 11%
Gila topminnow*	0	11,628/ 94%	1,327/ 11%
Little Colorado spinedace	0	150,627/ 55%	121,836/ 44%
Little Colorado spinedace Critical Habitat	0	25,612/ 43%	19,210/ 32%
Loach minnow*	0	11,628/ 94%	1,327/ 11%
Razorback sucker*	0	11,628/ 94%	1,327/ 11%
Spikedace*	0	11,628/ 94%	1,327/ 11%
Narrow-headed gartersnake and Critical Habitat	0	65, 851/ 74%	41,711/ 47%
Northern Mexican gartersnake and Critical Habitat	0	38,171/ 79%	31,051/ 64%
Desert Sucker	0	207,340/ 65%	169,502/ 54%
Sonoran Sucker	0	37,108/ 71%	30,623/ 59%
Little Colorado sucker	0	121,732/ 54%	95,251/ 42%
Headwater chub	0	117,548/ 83%	97,295/ 68%
Roundtail chub	0	122,186/ 76%	82,835/ 52%

*While the percentage is high for these species action areas, less than half of entire watershed is within the project area.

Mechanical vegetation treatments in uplands can indirectly impact riparian condition short to mid-term from increased sediment delivery and peak flows via removal of vegetation and ground disturbance. Soils can be compacted and water infiltration reduced from landings and skid trails leading to increased overland flow and erosion. Yarding and skidding can redirect water onto areas more likely to erode than natural channels. In turn, increased sedimentation and peak flows can occur reducing riparian condition, aquatic habitat quality and quantity.

Riparian condition for both gartersnakes, desert sucker and Sonoran sucker are currently poor, therefore indirect effects are expected to be higher. Vegetation in these systems is not adequate to capture or process sediment, indicating more would reach streams. These riparian areas are often disconnected from the water table and are more reflective of upland species; therefore likely unable to dissipate stream energy associated with increased peak flows. Riparian condition for five species is currently fair, therefore indirect effects are expected to be less. Vegetation in these systems has loss of vigor, growth, or changes in composition, but is present and able to process sediment and dissipate flows in a limited capacity. Riparian condition for the remaining four species in Upper Fossil Creek is good. While indirect effects could occur, these riparian areas are able to process sediment and dissipate flows.

For those species with poor or fair riparian condition, elevated sedimentation could negatively impact aquatic habitat, species, and water quality; particularly fish eggs and early life history stages that occur on or within substrate as well as the aquatic macroinvertebrate community structure. Habitat is impacted by filling of pools and spawning substrates which can lead to loss of habitat quality and reduced reproductive success. Peak flows can be increased altering channel forming flows leading to bank erosion and loss of habitat complexity. Reduction in riparian vegetation can lead to decreased organic matter input to support aquatic macroinvertebrates and increases stream temperature.

Design features related to mechanical vegetation treatments are expected to minimize the potential effects described above. The project includes spreading treatments in time and space within a watershed as well as for skid trails, yarding, and landings are expected to reduce these impacts.

Pollutants in the form of fuels and lubricants have the potential to be introduced into aquatic systems from staging areas and equipment. Spills and leaks can introduce pollutants to soils and then to streams and riparian areas reducing riparian condition and habitat quality. Design features for storm water protections plans, staging areas, fuel storage and checking equipment for leaks minimizes the potential for introduction of pollutants.

Long term, mechanical vegetation treatments are expected to improve overall watershed condition as well as riparian condition. Moving forests towards desired conditions of more a healthy, resilient state would provide for improved watershed function over time. It would also reduce the risk of uncharacteristic wildfire which can greatly impact all resource indicators and reduce aquatic habitat quality, quantity and populations. Alternative 2 would have more long term improvements to riparian condition than Alternatives 1 and 3 due to the increased overall acreage.

Prescribed Burning

For the action alternative, acres of prescribed burning has the potential for negative short and mid-term impacts to riparian condition and harm to individuals. Direct short term impacts would result if these activities occur within species habitat from fire lines, removal or reduction of vegetation due to burning or harm to gartersnakes. Alternatives 2 and 3 are proposing treatments in the habitats of seven fish species and both gartersnakes (Table 94). For Alternative 2, increases in acreage of treatments ranges from 0 to 9,405 which equates to 0 percent to 100 percent of the analysis area for direct effects for those species. Whereas for Alternative 3, increased acreage of treatments ranges from 623 to 8,819 which equates to 24 percent to 100 percent of the analysis area for direct effects for those species. Five fish species would not be directly impacted by prescribed burning under Alternatives 2 and 3 because the stream does not occur within the project boundary.

Prescribed burning can negatively impact riparian condition short to mid-term when it occurs in the direct effects analysis area. Direct impacts of reduced riparian vegetation cover or structure and decreases in large wood recruitment could occur from burning. Decreases in willows and other shrubby species reduces hiding and thermal cover for gartersnakes. This would be a direct alteration of gartersnake critical habitat as well as potentially impacting some aquatic macroinvertebrate species. This reduction is only expected to occur until vegetation recovers. Reduction in canopy cover also reduces stream shading and can increase stream temperatures. It also reduces organic matter inputs to streams which can alter food webs and prey base for fish and gartersnakes. Indirect impacts of increased stream temperature from loss of canopy cover could also occur, but should be limited based on design features associated with limiting high burn severity (mortality) and ignitions within riparian areas.

As discussed for mechanical vegetation treatments, riparian condition for both gartersnakes, desert sucker and Sonoran sucker are currently poor, therefore direct and indirect effects are expected to be higher. Vegetation in these systems is not adequate to capture sediment, are often disconnected from the water table and are more reflective of upland species. They already lack adequate streamside cover and structure, therefore those factors could be more susceptible to impacts. Riparian condition for the remaining species is fair, therefore direct and indirect effects are expected to be less as they have more cover and structure. Vegetation in these systems has loss of vigor, growth, or changes in composition, but is present and functioning at some level. Species with good riparian condition are expected to have even less potential direct effects, particularly given design features for prescribed burning.

Long term effects of prescribed burning are expected to be positive for riparian condition. Reduced fuel loading would protect these areas from uncharacteristic wildfire in the future. Large woody debris recruitment and streamside cover or structure can also improve with prescribed fire. Fire plays an important role in maintaining heterogeneity in riparian and aquatic systems that has been excluded similar to surrounding uplands (Gresswell 1999); therefore, restoring the fire regime would have some benefits to riparian condition.

Impacts to individual gartersnakes in the form of mortality or modification of behavior could also occur short to mid-term. Mortality could occur during prescribed burning; however, gartersnakes are mobile and design features of no burn piles within their habitat is expected to reduce that potential. While gartersnakes are more susceptible to exposure during a prescribed fire, it is more likely that harm or displacement would occur until the burns were completed. Long term impacts to individuals would be neutral or potentially positive if habitat improved and similarly increased social or feeding behavior.

Table 94. Affected acres by species and the percent of change in the acres of prescribed burning for Alternative 2 and 3 as compared to Alternative 1. Percentages reflect changes in acreages within species direct effects analysis areas.

Species*	Alternative 1: Acres of Prescribed burning	Alternative 2: Acres of Prescribed Burning/ Percent of Direct Effect Area	Alternative 3: Acres of Prescribed Burning/ Percent of Direct Effect Area
Gila trout	0	1,541/ 57%	1,462/ 54%
Little Colorado spinedace	0	9,405/ 70%	8,819/ 65%
Little Colorado spinedace Critical Habitat		2,114/ 57%	2,114/ 57%
Narrow-headed gartersnake and proposed Critical Habitat	0	2,437/ 100%	2,211/ 100%
Northern Mexican gartersnake and proposed Critical Habitat	0	1,249/ 100%	1,196/ 100%
Desert Sucker	0	4,542/ 34%	4,395/ 33%
Sonoran Sucker	0	630/ 43%	623/ 42%
Little Colorado sucker	0	6,734/ 52%	6,244/ 48%
Headwater chub	0	2,090/ 60%	1,957/ 56%
Roundtail chub	0	1,900/ 31%	1,470/ 24%

* Species with analysis areas that did not overlap with prescribed burning are not listed.

Prescribed burning in uplands can indirectly impact riparian condition short to mid-term from increased sediment delivery and peak flows for all analyzed species. The increases in percentage of action areas treated range from 57 percent to 97 percent for Alternative 2 and from 11 percent to 75 percent for Alternative 3. Table 95 displays these species habitats as compared to the existing condition (Alternative 1). However, while the five species (denoted with an asterisk) show increases in acres treated, it is important to note the overall acreage is small. This is due to less than half of their overall watershed occurring within the project. Therefore, while the percent increase is large the overall potential acres of impacts are much smaller than all other species. Overall impacts would be highest for both Gila Trout and Headwater Chub as most of their action area is encompassed and lowest for Gila Chub and the four species that occur in Fossil Creek.

Prescribed burning can indirectly impact riparian condition short to mid-term from increased sediment delivery and peak flows. Loss of ground cover from burning can increase erosion and overland flow which leads to increased sedimentation and peak flows. This could reduce riparian condition, aquatic habitat quality and quantity. However, these impacts are only expected to occur until ground cover vegetation recovers and has the ability to dissipate flows and trap sediment. Design features for extent of high burn severity as well as spatial and temporal spacing of activities within a watershed are expected to minimize potential impacts.

Riparian condition for both gartersnakes, desert sucker and Sonoran sucker are currently poor, therefore indirect effects are expected to be higher. Vegetation in these systems is not adequate to capture or process sediment, indicating more could potentially reach streams. These riparian areas are often disconnected from the water table and are more reflective of upland species; therefore unable to dissipate stream energy associated with increased peak flows. Riparian condition for five species is currently fair, therefore indirect effects are expected to be less. Vegetation in these systems has loss of vigor, growth, or changes in composition, but is present and able to process sediment and dissipate flows in a limited capacity. Riparian condition for the remaining four species in Fossil Creek is good. While indirect effects could occur, these riparian areas are able to process sediment and dissipate flows. Overall acres of treatment for Gila chub, loach minnow, spikedace, razorback sucker, and Gila topminnow are less than half of the watersheds in which they occur further reducing potential indirect effects. Additionally, prescribed burning would only occur in the upper watershed within the project area further decreasing potential indirect impacts.

For those species with poor or fair riparian condition, elevated sedimentation could negatively impact aquatic habitat, species, and water quality; particularly fish eggs and early life history stages that occur on or within substrate as well as the aquatic macroinvertebrate community structure. Habitat is impacted by filling of pools and spawning substrates which can lead to loss of habitat quality and reduced reproductive success. Potential reductions in fish prey base could also indirectly impact gartersnakes. Peak flows can be increased altering channel forming flows leading to bank erosion and loss of habitat complexity. Reduction in riparian vegetation can lead to decreased organic matter input to support aquatic macroinvertebrates and increases stream temperature.

Long term effects of prescribed burning in the upper watersheds are expected to be positive for riparian condition. Reduced fuel loading would protect these areas from uncharacteristic wildfire in the future that can impact entire watersheds and have long lasting negative impacts on riparian condition, aquatic habitat quality and quantity, as well as populations of species.

Table 95. Change by species in the acres of prescribed burning for Alternative 2 and 3 as compared to Alternative 1. Percentages reflect changes in acreages within species analysis areas. These are considered indirect impacts.

Species	Alternative 1: Acres of Prescribed burning	Alternative 2: Acres of Prescribed Burning/ Percentage of Action Area	Alternative 3: Acres of Prescribed Burning/ Percentage of Action Area
Gila trout	0	97,258/ 88%	79,480/ 72%
Gila chub*	0	12,328/ 57%	2,492/ 12%
Gila topminnow*	0	11,990/ 97%	1,328/ 11%
Little Colorado spinedace	0	172,583/ 63%	140,659/ 51%
Little Colorado spinedace Critical Habitat	0	28, 944/ 49%	22,291/ 38%
Loach minnow*	0	11,990/ 97%	1,328/ 11%
Razorback sucker*	0	11,990/ 97%	1,328/ 11%
Spikedace*	0	11,990/ 97%	1,328/ 11%
Narrow-headed gartersnake and proposed Critical Habitat	0	73,184/ 82%	47/315/ 53%
Northern Mexican gartersnake and proposed Critical Habitat	0	41,628/ 86%	34,621/ 72%
Desert Sucker	0	230,200/ 73%	190,190/ 60%
Sonoran Sucker	0	41,398/ 79%	34,202/ 66%
Little Colorado sucker	0	141,334/ 63%	113,047/ 50%
Headwater chub	0	127,710/ 90%	106,923/ 75%
Roundtail chub	0	135,344/ 84%	94,401/ 59%

*While the percentage is high for these species action areas, less than half of entire watershed is within the project area.

Temporary Roads

Temporary roads can cause negative impacts to riparian condition, habitat connectivity, as well as potentially introduce pollutants and or aquatic invasive species. Under Alternative 2, up to 330 miles of temporary roads could be utilized to facilitate mechanical vegetation activities. While for Alternative 3, up to 170 miles roads could be utilized These may be new locations and/or non-system roads and they would be decommissioned when work is completed in the area that the access.

Temporary roads can have the potential for direct short and mid-term impacts to aquatic indicators, but both action alternatives do not allow temporary roads within AMZs thereby removing the potential for direct effects.

Indirect negative impacts of opening temporary roads in the upper watershed could also occur to riparian condition. In general, roads compact soils and reduce infiltration of water leading to increased erosion and runoff. They increase the drainage network to riparian areas and streams and connect these areas to the uplands by altering surface water pathways. This converts dispersed surface runoff and sediment filtering through a riparian area to direct deliveries of accumulated runoff and sediment. Decreases in riparian condition from increased in peak flows and sedimentation could occur, but would vary based on their current condition.

Pollutants and aquatic invasive species can be introduced directly or indirectly to aquatic systems from machinery or vehicles creating or using temporary roads. Pollutants in the form of fuels and lubricants have the potential to be introduced into aquatic systems from staging areas and equipment. Spills and leaks can introduce pollutants to soils and then to streams and riparian areas reducing riparian condition and habitat quality. Design features for storm water protections plans, staging areas, fuel storage and checking equipment for leaks minimizes the potential for introduction of pollutants. Aquatic invasive species can similarly be transferred from an infected water body to an uninfected waterbody through driving or placement of materials from an infected source. However, design features for decontamination of equipment and not transferring water are expected to minimize potential introduction or spread of invasive species.

Long term, potential direct and indirect negative impacts of temporary roads would cease as roads were decommissioned and revegetated. Therefore, long term effects are considered neutral to aquatic resource indicators. Overall, the potential short and mid-term negative impacts of temporary roads would be highest in Alternative 2 than Alternatives 1 and 3 based on mileage.

Sensitive Species not Covered by Resource Indicators and Measures

Aquatic Macroinvertebrates

Stoneflies, caddisflies, mayflies, midges, and riffle beetles are strongly associated with streams and riparian areas. Based on the biology and ecology of the sensitive aquatic macroinvertebrate species, streams and riparian areas could have negative direct and indirect impacts from Alternatives 2 and 3 as described for federally listed species previously, but more impacts are expected for Alternative 2 based on the higher number of acres being treated. Mechanical vegetation treatments, prescribed burning, and roads can increase erosion and sedimentation, alter riparian vegetation, and alter stream habitats leading to impacts as described for fish and gartersnake species above. Alternatives 2 and 3 would have long-term benefits from reducing the risk of uncharacteristic wildfire and road densities as well as improved riparian and stream habitat from aquatic restoration.

Nokomis Fritillary is a sensitive species that utilizes meadows, seeps, and boggy streamside vegetation. As described above, both action alternatives could have negative direct and indirect negative impacts to the species and its habitat. Alternative 3 would have less direct and indirect negative impacts to the species and its habitat, than Alternative 2 for mechanical vegetation treatments, prescribed burning and roads. Mechanical vegetation treatments, prescribed burning, and roads can increase erosion and sedimentation, alter riparian vegetation, and alter stream habitats as described for fish and gartersnake species above. Ground disturbance and removal of vegetation would also reduce the availability of the butterflies host plant (*Viola nephrophylla*) short-term. Acres of riparian, grassland, and meadow treatments are the same between Alternatives 2 and 3, therefore potential direct and indirect impacts would be the same. Both alternatives would potentially having long-term benefits from reducing encroachment into its habitat, reducing the risk of uncharacteristic wildfire and lowering road densities.

The California Floater was once present in Fossil Creek, West Clear Creek, and Upper Clear Creek and it is possible that it may still occur within Chevelon Creek below Chevelon Dam. Direct and indirect negative impacts could occur in Upper Clear Creek and West Clear Creek, while no direct impacts would occur in Chevelon Creek and Fossil Creek. Direct impacts would include physical alteration of habitat and harm or harassment of individuals. Indirect impacts would include increases in erosion and sedimentation, as well as alteration of flows and habitats as described for fish and gartersnake species above. Mechanical vegetation treatments prescribed burning, and temporary roads would only have indirect impacts as they would not occur within streams. Opening ML1 roads and road relocation/decommissioning would have both direct and indirect impacts. . Both alternatives would potentially having long-term benefits from reducing the risk of uncharacteristic wildfire and reduced road densities; however Alternative 2 would provide more long-term benefit from higher number of acres treated.

For all sensitive aquatic macroinvertebrates, streams and riparian areas could have negative direct and indirect impacts from Alternative 3, but less than Alternative 2 given the decrease in acres treated. Direct and indirect negative impacts for road use, relocation and decommissioning would be the same for both Alternative 2 and 3. Direct and indirect impacts from temporary roads would be less in Alternative 3 than Alternative 2 given the reduction in proposed miles. Mechanical vegetation treatments, prescribed burning, and roads can increase erosion and sedimentation, alter riparian vegetation, and alter stream habitats that negatively impact these sensitive species as described for fish and gartersnake species above. Alternative 3 would potentially having long-term benefits from reducing the risk of uncharacteristic wildfire and reduced road densities.

Cumulative Effects

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

The cumulative effects analysis geographic boundary is the Rim Country project area. The following list summarizes the past, present, and future activities that add to the cumulative effects.

Cumulative effects to aquatic species and habitats are those effects from past, other present, and reasonably foreseeable future projects that result in changes to vegetative cover, soil and stream flow conditions, and contaminants that affect riparian condition and habitat. Activities that could have a cumulative effect include recreation such as dispersed camping and illegal road and trail creation, OHV use, forest restoration projects, fuels reduction projects, wildfire, roads and trails, road closures, and climate change. Most activities would be expected to result in localized impacts short to mid-term.

All recent and planned forest restoration, fuels reduction, and road decommissioning were and would be designed with similar protection measures, design features, and best management practices that are expected to further reduce cumulative impacts to aquatic habitats and species such as, spreading treatments out in space and time within watersheds are part of both action alternatives. Conversely, improvement in habitats would be expected in those areas where off-road travel is limited, road densities are reduced and habitat connectivity increased under implementation of travel management regulations and restoration activities that improve forest resiliency and riparian condition and stream habitat. Aquatic restoration activities have been individual small efforts with localized and short-lived impacts of increased sedimentation and long term habitat improvement where they have occurred.

Cumulative Effects for Alternative 1

Under alternative 1, there would be no affect during implementation to species, riparian condition or habitat. However the ability to retain sustainable and resilient ecosystems would be further compromised by the impacts of climate change, vulnerability to high-severity fires and associated post-fire flooding. Conifer encroachment would continue into riparian areas reducing streamside vegetation cover and structure normally associated with streams and wetlands negatively impacting riparian condition and habitat. Alternative 1 does not provide for improved riparian condition, aquatic species, or habitat. Alternative 1, when added to past, present and reasonably foreseeable future actions, would continue to put aquatic species and their habitats at risk.

Cumulative Effects common to Alternatives 2 and 3

Timber Harvest and Vegetation Management

Past timber harvest activities have resulted in substantial negative impacts to watersheds, hydrologic conditions, riparian and aquatic habitat, and fish species across the proposed project area. This activity has resulted in most of the existing maintenance level 1 and 2 roads. More recent vegetation treatments such as Upper Beaver Creek, Rim Lakes, Larson, and CC Cragin likely have had less impacts due to spreading treatments across watersheds in time and space to reduce overall watershed and soils impacts. Fuelwood collecting and harvesting is also a very widespread activity occurring across the project area, but is generally dispersed across the landscape which limits any potential increased sedimentation or ground disturbance.

Cumulative effects of past timber harvest would combine with short to mid-term increases in sediment delivery and peak flows. These are expected to vary based on current riparian condition. Cumulative impacts for species such as gartersnakes, desert sucker, and Sonoran sucker with overall poor riparian condition are expected to be higher as compared to riparian conditions that are in good or fair condition (Table 82). Vegetation in poor riparian condition is not adequate to capture sediment, are often disconnected from the water table and are more reflective of upland species. Therefore, they have less ability to process additional sediment or stream flows. As described previously, riparian condition for all the other species is in good to fair riparian condition so they are able to process pulses of sediment and stream flow. To reduce the potential for cumulative impacts of sedimentation and peak flows, design features such as, spreading treatments out in space and time within watersheds are part of all recent and planned forest restoration projects such as CC Cragin, Rim Lakes, and East Clear Creek.

Recreation and Recreation Management

Recreational activities occur throughout the proposed project area, and are continuing to increase. Developed recreation sites, dispersed camping, hiking, fishing, hunting, OHV use, boating, wildlife viewing, and many other types of recreational activities occur across proposed project area. Riparian areas, lakes, and streams are very popular areas for recreational activities and dispersed camping; this can result in localized deteriorated resource conditions from the concentrated use (for example, loss of vegetation and soil compaction), and can also impact water quality from sedimentation. Recreational activities can also facilitate the spread of diseases, aquatic invasive species, and nonnative aquatic species which compete with and predate upon native federally listed and sensitive species.

Recreational activities would be expected to combine with Rim Country in localized impacts short to mid-term decreases in riparian condition, increased sedimentation, and increases in disease and aquatic invasive species. Implementation of travel management should decrease OHV impacts while state and federal educational programs continue to inform the public of how to reduce potential spread of aquatic diseases or invasive species. Rim Country would not have a cumulative effects on presence or spread of nonnative aquatic species.

Fire Suppression and Fire Management Projects

Fire suppression activities have been in place for decades, and have resulted in unnatural vegetative conditions and have altered ecological processes across most of the proposed project area. Suppression activities are ongoing and would continue well into the future, as vegetation structure and composition has been altered so that allowing it to burn would result in uncharacteristic and unacceptable resource impacts. Fire suppression activities can also impact water resources and species dependent upon them by removing water, which usually occurs during the driest part of the year. Prescribed fire and burns have been occurring for the last 10-20 years, and have increased considerably in their extent and impacts over the last 5 to 10 years. Large, uncharacteristic wildfires have occurred across the proposed project area in the last 20 to 25 years, such as Rodeo-Chediski Fire (2002).

Past fire management has resulted in the current condition in many watersheds from years of fire suppression leading to the uncharacteristic fires occurring recently. Wildfires can have both impacts that are both positive and negative as described previously and depend upon burn severities. Cumulatively these impacts would be dependent on the existing resource conditions and the future environmental conditions. Climate change is expected to result in increased temperature, frequency and intensity of drought, and wildfire risk; which could result in increased sedimentation and reduced riparian condition across large portions of the project area. The proposed action would limit this effect by making forest conditions more resilient to large-scale wildfire.

Livestock Grazing

Grazing livestock has likely occurred for over a century across the proposed project area. Historically unrestricted and unregulated resulted in overgrazing, especially within riparian areas, has likely contributed to the degraded riparian and aquatic habitat conditions that currently occur. Livestock grazing occurs over most of the proposed project area, although some areas are excluded for resource recovery reasons. Infrastructure development and maintenance associated with livestock grazing allotments is substantial and can include brushing or removal of vegetation as well as stock tank cleaning. Instream stock tanks occur throughout the proposed project area which decrease stream flow and alter stream habitat. Impacts to aquatic habitat and species, hydrologic conditions and processes, and riparian and upland conditions have occurred; and this would continue as long as livestock management and the associated infrastructure remains in place, and contributes cumulative effects to aquatic species and their habitats.

Cumulative effects of livestock grazing would combine with short-term impacts to riparian condition through loss of understory vegetation and increased sedimentation. Allotments in and around the project area should be managed on a grazing system designed to allow forage a chance to recovery from livestock grazing reducing the potential for cumulative impacts. Pastures may be rested or deferred after completion of ground disturbing activities (for example, thinning or burning) to minimize impacts to vegetation. This when combined with the effects of other past, present, and foreseeable future activities in area is not expected to result in a net cumulative effect of disturbance to aquatic species or habitats.

Road and Trail Construction, Maintenance, and Closure

As previously stated past timber activities and harvest primarily accounted for road development and placement, and this is still reflected in the existing transportation system. Approximately 5,682 miles of roads and almost many miles of hiking trails occur within Rim Country. User created roads and trails also occur on the landscape and further increase the overall mileage. While roads and trails are necessary for the use, enjoyment, and management, they also are responsible for considerable landscape scale changes to the functioning and maintaining of ecological processes and values. Maintenance activities for roads and trails are limited by available funding, and can result in both positive and negative benefits, depending on when it occurs and how often. These impacts would continue as long as the roads/trails are in place, and are a major contributor to cumulative effects. The Coconino National Forest has closed over 90 miles of roads as part of focused watershed restoration activities in the Little Colorado River watershed. Continued use and maintenance of roads and trails can increase sedimentation to streams and cause fish passage barriers.

Cumulative effects of roads and trails would combine with short to long-term increases in sediment delivery and peak flows from Rim Country. These are expected to vary based on current riparian condition as previously described under timber harvest. Conversely, improvement in habitats would be expected in those areas where road densities are reduced and habitat connectivity increased under implementation of travel management regulations and restoration activities that improve forest resiliency and riparian condition and stream habitat. All temporary roads for the project would be decommissioned, further reducing cumulative effects long-term.

Special Uses and Permits/Minerals Management/Land Exchanges

Hundreds of special uses permits have been issued across the proposed project area. These include permits for outfitter and guiding activities, fuelwood and Christmas tree cutting, road easements, plant and minerals collection, church and youth camps, gravel and cinder pits, ditch bill easements, communications sites, and other uses as well. All of these activities have contributed to current conditions, particularly ditch bill easements which can reduce the available water for aquatic habitat.

Cumulative effects of special uses, minerals, and land exchanges would combine with short term, localized increases in sedimentation and spread of aquatic invasive species or disease. The action alternatives limit these effects by keeping rock pits far away from aquatic habitats and reclaiming these areas when no longer needed. Design features associated with the action alternatives are expected to minimize or remove the potential for introduction or spread of aquatic invasive species or disease.

Dam and Reservoir Development/Water Diversions

These projects have resulted in considerable impacts to aquatic habitat and species both directly and indirectly. Dam and reservoir development began in the late 1800's and continued into the 1960's across the project area, altering stream habitat into lake habitat. Most of this activity was to provide for downstream (and off Forests) water use and irrigation as well as to provide for recreational opportunities. Blue Ridge Reservoir is part of an interbasin transfer to the Verde River from the Little Colorado River drainage to provide water downstream. Most dams and water diversions have detrimental impacts to aquatic species and habitats such as isolated or separated populations, loss of available habitat, and dewatered streams.

Cumulatively, these actions are part of the existing stream conditions. The action alternatives would improve remaining stream habitat and associated riparian areas. While there would be short-term increases in sedimentation from stream or riparian restoration; riparian and stream conditions would be improved long-term.

Fisheries and Wildlife

Fisheries habitat improvement work in streams began in the 1930s on the Apache-Sitgreaves National Forests. These efforts were in response to degraded habitat conditions (likely from grazing livestock) and were focused on higher elevation trout streams, and intended to stabilize streams and provide pool habitat that had been reduced. Later efforts did not occur until the1970s thru the 1980s, and these efforts were largely focused on areas that had been heavily impacted by past management activities and concentrated recreational use. The Coconino National Forest began improving streams, springs and watersheds in the 1960s thru the 1990's in response to the degraded conditions. This included instream rock structures and aspen and riparian enclosures. Spring and stream restoration efforts began in the early 2000's as part of watershed planning for West and East Clear Creek as well as Barbershop Canyon.

Cumulatively, aquatic restoration activities have been individual, small efforts with localized, short-lived impacts of increased sedimentation and long term habitat improvement where they have occurred. The action alternatives would improve riparian condition and aquatic habitats across the landscape.

In summary long term cumulative effects are expected to be positive for riparian condition for alternatives 2 and 3. Alternative 2 has the greatest potential to improve overall riparian condition as well as watershed condition due to highest acreage being treated. Alternative 3 would maintain or improve conditions, but at a smaller scale due to less acreage restored. Risk associated with dense forest conditions would be reduced and forest resiliency to large scale disturbance under drier and warmer conditions would be improved by implementing the proposed treatments under all action alternatives.

Aquatic Macroinvertebrates

Stoneflies, caddisflies, mayflies, midges, and riffle beetles are strongly associated with streams and riparian areas. Based on the biology and ecology of these four groups of species, streams and riparian areas could have negative cumulative impacts from Alternative 3, but less than Alternative 2 given the reduced mechanical vegetation treatments, prescribed burning, and temporary roads. Mechanical vegetation treatments, prescribed burning, and roads can negatively impact riparian condition, aquatic habitat quality and quantity utilized by these sensitive species. However, alternative 1 has the greatest potential long term risk to habitat for aquatic macroinvertebrates. By not making forests more resilient, the landscape remains susceptible to wildfires which have an even greater overall impact. Alternative 1 would also not reduce road density by decommissioning roads or reduce impacts to riparian condition by relocating roads. Alternatives 2 and 3 have the potential to improve riparian conditions by restoring form and function of streams, wet meadows and springs which are the primary habitat of these sensitive species.

Aquatic Threatened, Endangered, and Sensitive Species and Habitat Determinations

Table 96. Preliminary Determinations for Threatened, Endangered, and Candidate Species within Rim Country Analysis Area for Both Action Alternatives. MA= May Affect; MII = May Impact Individuals

Species Status	Status	Species Determination	Critical Habitat Determination
Gila trout	Threatened	Alternative 2: MA Alternative 3: MA	N/A
Gila chub	Endangered with Critical habitat	Alternative 2: MA Alternative 3: MA	Alternative 2: MA Alternative 3: MA
Gila topminnow	Endangered	Alternative 2: MA	N/A

Species Status	Status	Species Determination	Critical Habitat Determination
		Alternative 3: MA	
Little Colorado Spinedace	Threatened with Critical Habitat	Alternative 2: MA Alternative 3: MA	Alternative 2: MA Alternative 3: MA
Razorback sucker	Endangered with Critical Habitat	Alternative 2: MA Alternative 3: MA	Alternative 2: MA Alternative 3: MA
Loach minnow	Endangered with Critical Habitat	Alternative 2: MA Alternative 3: MA	Alternative 2: MA Alternative 3: MA
Spikedace	Endangered with Critical Habitat	Alternative 2: MA Alternative 3: MA	Alternative 2: MA Alternative 3: MA
Narrow-headed gartersnake	Threatened with proposed Critical Habitat	Alternative 2: MA Alternative 3: MA	Alternative 2: MA Alternative 3: MA
Northern Mexican gartersnake	Threatened with proposed Critical Habitat	Alternative 2: MA Alternative 3: MA	Alternative 2: MA Alternative 3: MA
Desert sucker	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
Sonoran sucker	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
Little Colorado sucker	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
Headwater chub	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
Roundtail chub	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
Netwing Midge	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
A Stonefly	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
Parker’s cylloepus riffle beetle	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
A Mayfly	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
A Mayfly	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
A Caddisfly	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
A Caddisfly	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
A Caddisfly	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
Ferris’ Copper	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
Nokomis Fritillary (aka Great Basin Silverspot)	Sensitive	Alternative 2: MII Alternative 3: MII	N/A
California floater	Sensitive	Alternative 2: MII Alternative 3: MII	N/A

Rare Plants

Affected Environment

This section details the affected environment and environmental consequences for the threatened, endangered and Southwestern Region Regional Forester's sensitive plants (hereafter Southwestern Region sensitive plants), within the project area. It establishes the baseline against which the decision maker and the public can compare the effects of the action alternatives.

This section also describes the direct, indirect, and cumulative effects of implementing each alternative on threatened, endangered and Southwestern Region sensitive plants. It presents the scientific and analytical basis for the comparison of the alternatives presented in Alternatives section. The information presented here is part of the Botany and Noxious Weeds specialist report (Crisp 2018), which is incorporated by reference.

Assumptions

The environmental effects disclosed for rare plants are based on the following assumptions:

- All relevant laws, regulations, manual guidance and Forest Service policy relating to management of the resources discussed within are followed during analysis and implementation.
- Management would follow the guidance of the Forest Plans.
- Silviculture and prescribed burning treatments would be implemented as written and addressed in the Silviculture and Fire Ecology and Air Quality specialist reports and not substantially modified without review of the effects of such activities.
- Management activities related to roads and transportation as well as spring and channel restoration would be implemented as addressed in their respective reports and not substantially modified without review of the effects of such activities.
- Prescribed fires would be of lower severity and intensity in any given area compared to large-scale wildfires in the same area so the amount of disturbance from prescribed burning is less than compared to wildfires.
- Fire effects to individual species vary depending on several factors including life cycle, time of burning and several biotic and abiotic factors (Pyke et al 2010). As a result, the responses of the plant species discussed in this report may vary in any given area or time. The effects of fire on these species would be mitigated through the burning prescription.
- Areas to be treated would be surveyed for Southwestern Region sensitive plants before and after treatments are implemented. These factors should be considered when identifying survey needs
- Target special features and microhabitat needed by the species of interest. This is generally only a small portion of the area, and is estimated to be 5 percent or less of any given area.
- Survey and mitigation would be based on the likelihood of any of the species addressed in this document occurring within the project area. Not all areas contain suitable habitat for a given species.
- The amount of disturbance predicted to occur during treatment. For example, surveys may not be needed in areas scheduled for prescribed burning if the treatments are scheduled to be of low intensity.

- Areas to be treated would be surveyed for noxious or invasive weeds before and after treatments are implemented. These factors should be considered when identifying survey needs
- Likelihood of any of the species addressed in this document occurring within the project area
- Amount of disturbance. For example, surveys may not be needed in areas scheduled for prescribed burning if the treatments are scheduled to be of low intensity.
- Application of the design features, BMPs, and mitigation and conservation measures discussed in the Rare Plants section of chapter 3 and in appendix C are included in analysis and project implementation.
- The acreage of potential disturbance in this project is much larger than generally analyzed in similar projects, necessitating more noxious or invasive weed treatments to control invasive species. This would lead to increases in personnel and budget to accomplish this need.

Questions to Answer through Analysis

How would proposed treatments affect Southwestern Region sensitive plant species? The indicators used to evaluate environmental consequences are: (1) a qualitative evaluation of whether populations are maintained or increased per FSM 2760. 5(19), (2) a qualitative evaluation of whether potential habitat is maintained or enhanced, (3) an evaluation of whether impacts to sensitive plants and their habitats are effectively minimized, and, (4) an evaluation on habitat and species resiliency to natural disturbances including fire and climate change.

A unit of measure for Southwestern Region sensitive plant species is to maintain or increase the populations within the project area. Additionally, potential habitat for these species should be maintained or enhanced.

How would project activities affect interactions between noxious or invasive weeds and Southwestern Region sensitive plants?

Indicators/Topics of Analysis

The indicators used to evaluate environmental consequences are:

13. A qualitative evaluation of whether populations are maintained or increased per FSM 2670.5(19)
14. A qualitative evaluation of whether potential habitat is maintained or enhanced
15. An evaluation of whether effects on sensitive plants and their habitats are effectively minimized
16. An evaluation on habitat and species resiliency to natural disturbances including fire and climate change.

Federally Listed Threatened or Endangered Plants

The Rim Country project area **does not include** any locations or potential habitat for Threatened or Endangered plant species so no threatened or endangered plant species will be analyzed for this project

Southwestern Region Regional Forester's Sensitive Plants

Table 97 displays the Southwestern Region sensitive plants occurring within the project area.

Table 97. Southwestern Region Regional Forester's Sensitive Plants found in the Project Area

Common name	Scientific Name	Forest	ERU/Habitat	Data source	Notes
Villous groundcover milkvetch	*Astragalus humistratus var. crispulus*	Apache Sitgreaves	Narrow-leaf cottonwood/shrub. These occurrences are in the Rodeo-Chediski Fire (2002) and are in severely disturbed sites.	HDMS Data SEINet	N/A
Arizona Bugbane	*Actaea* (*Cimicifuga*) *arizonica*	Coconino, Tonto	Ponderosa pine, Mixed Conifer with Aspen	HDMS, SEINet and Forest Service files.	Arizona bugbane occurs mostly in deep canyons.
Dane Thistle	*Cirsium parryi ssp. mogollonicum*	Coconino	Springs	Goodwin (2005)	Field notes prepared by Goodwin (2005) provide the most accurate location and condition description for this species.
Hairy Clematis (Arizona leatherflower)	*Clematis hirsutissima var. hirsutissima*	Coconino	Ponderosa pine	FS files	Generally on limestone soils,
Mogollon Fleabane	*Erigeron anchana*	Tonto	Ponderosa pine/willow, ponderosa pine/evergreen oak, mixed conifer frequent fire.	SEINet, HDMS	Rock crevices or ledges on boulders and vertical rock faces, usually in canyons, usually on granite (HDMS 2003)
Rock Fleabane	*Erigeron saxatilis*	Coconino	Ponderosa pine, Mixed Conifer Frequent Fire, narrow-leaf cottonwood/shrub, willow/alder, Mixed Conifer with Aspen	SEINet, HDMS, NRM/TESP	Cliffs or vertical rock faces, usually on Coconino sandstone
Arizona Sneezeweed	*Helenium arizonicum*	Coconino, Apache - Sitgreaves	Ponderosa pine Forest (wet meadows) Apache Sitgreaves Ponderosa pine, Montane subalpine grasslands	SEINet, FS files and local knowledge, NRM/TESP	N/A

Common name	Scientific Name	Forest	ERU/Habitat	Data source	Notes
Eastwood (Senator Mine) Alumroot	*Heuchera eastwoodiae*	All	Ponderosa Pine Evergreen Oak,(TNF) Mixed Conifer Frequent Fire (TNF) Mixed Conifer with Aspen (TNF, A-S) Cottonwood Shrub (TNF), Ponderosa Pine/Willow (TNF, A-S) and Ponderosa Pine (A-S)	SEINet and HDMS	Specimens for this species on the Coconino NF have been reclassified to another species (Folk and Alexander 2015)
Flagstaff beardtongue	*Penstemon nudiflorus*	Coconino	Ponderosa pine/Gambel oak	HDMS, NRM/TESP	N/A
Blumer's Dock	*Rumex orthoneurus*	All	Fremont cottonwood/shrub, herbaceous, Mixed conifer frequent fire, mixed conifer with aspen, narrow leaf cottonwood/shrub, ponderosa pine/evergreen oak, ponderosa pine/willow and ponderosa pine forest.	SEINet and HDMS	N/A
Bebb's Willow	*Salix bebbiana*	Coconino, Apache-Sitgreaves	Montane willow riparian forest.	SEINet	N/A

Environmental Consequences

Alternative 1 – No Action

Southwestern Region Regional Forester's Sensitive Plants

Direct and Indirect Effects common to all species

Alternative 1 is the no action alternative. This alternative would not address the purpose and need for the Rim Country Project and would provide any progress toward the improved conditions addressed in each of the three forest's Land Resource Management Plans (LMRPs).

Specifically portions of the purpose and need that would improve habitat for these species would not be addressed.

- There would be no increase in forest resiliency and sustainability
- The risk of uncharacteristic fire effects would not be reduced.
- Habitat for wildlife and aquatic species would not be improved
- Conditions and function of streams and springs would not improve
- There would be no opportunity to restore woody riparian species, including Bebb's willow.

There would be no tree cutting and no prescribed burning, so no reduction in , tree density and canopy would not be reduced Conditions associated with dense ponderosa pine stands result in physiologically stressful environments for understory plants. Stressors include increased shading, deep litter horizons, low soil moisture, low nutrient availability and contribute to a decline in species richness within the plant community. (Laughlin and others 2011). These factors affect all understory species including Region 3 sensitive plants. There would continue to be a reduction or loss of understory vegetation and therefore, a loss of understory services.

With no treatment, fire hazard would continue to increase therefore increasing the risk of severe wildfire in many parts of the project area (see Vegetation and Fire Reports for more information). Factors that contribute to fire hazard ratings that would be reduced through management actions such as canopy cover, trees per acre and dead and down fuel loading would not be reduced. The risk of wildfire transitioning to crown fires would increase in many areas of the project area resulting in the increased risk of severe wildfire and degradation of potential habitat. Severe wildfires often result in short and long-term effects, which include removal of tree canopy, loss of the understory plant community and alteration of soil structure and nutrients (Pyke and others 2010). These changes could adversely affect the habitat and populations of Region 3 sensitive plants by damaging soil, killing existing plants and by reducing or destroying the seed bank. Fire size may also increase, leading to largescale crown fires, which in turn may cause a permanent loss in understory diversity (Covington 2000). Primary fire effects such as loss of individual plants or groups may recover in a matter of a few years. However, secondary effects such as permanent changes in biotic and abiotic factors can result in permanent changes in the post fire plant community (see Pyke and others 2010).

There would be no opportunities to improve the condition and function of streams and springs so opportunities to improve habitat for such species as Arizona sneezeweed, Bebb's willow and Blumer's dock would not occur and areas that might have historically provided habitat for these species and would remain degraded and unsuitable for these and other plant species that require mesic conditions for their survival.

With no action, there would be no restoration of structure and function in the treatment areas, resulting in continued departure from the desired conditions for all resources in this project, including Region 3 sensitive plant species.

If Alternative 1 is selected management actions such as fuels reduction projects, prescribed fire, spring and channel restoration would be limited to those analyzed and implemented by the individual projects analyzed in other NEPA on each forest.

Determination of Effects

Alternative 1 of the Rim Country EIS would not impact individuals of any of the Region 3 sensitive plant species discussed in this analysis and is not likely to result in a trend toward federal listing or loss of viability. This is because no management actions would occur as a result of this project.

Effects Common to Alternatives 2 and 3

Villous groundcover milkvetch (Astragalus humistratus var. crispulus)

Villous groundcover milkvetch is a Region 3 sensitive species for Apache Sitgreaves. Its distribution is limited to southeastern Apache County in Arizona and in neighboring Catron County in New Mexico where it grows on sandy soils of volcanic origin in dry pine forests (Spellenberg 2007). The occurrences on the forest are in narrow-leaf cottonwood/shrub ERUs.

Direct and Indirect Effects

The known occurrences of villous ground cover milkvetch are in areas proposed for stream channel restoration on the Apache-Sitgreaves National Forests. The project activities would help move the treated areas toward the desired conditions as described in the Apache-Sitgreaves LRMP including mitigating the landscape scale disturbance that occurred as a result of the Rodeo-Chediski Fire in 2002.

The plant locations were documented in 2014 so are present despite the disturbance from the fire. No scientific data or publications were found that document the effects of fire on the plant. Villous groundcover milkvetch has been observed growing in roadbeds so is assumed to tolerate disturbance (Spellenberg 2007) so would likely tolerate the burning treatments proposed for these areas.

Management activities related to stream restoration could result in the damage or loss of individual plants or groups of plants at the two known locations. This can be mitigated by following the guidelines for wildlife and rare plants in the forest plans, stating that modifications, mitigations, or other measures should be incorporated to reduce negative impacts to plants, animals, and their habitats and to help provide for species needs, consistent with project or activity objectives.

The management activities needed to restore the stream channels would be guided by the Aquatic Toolbox which would also mitigate the loss of plants. It is anticipated that the tools for improving the form and function of stream channels and floodplains (see appendix D) and the tools for improving spring outflows would be used at these sites.

Cumulative effects

The timeframe for analysis of cumulative effects on villous groundcover milkvetch is from 2002 when the Rodeo-Chediski Fire burned through the area to 20 years in the future. The area of this analysis is the project boundary. The degraded channels in the area may be attributed at least in part to the effects of the Rodeo-Chediski Fire in the areas around the occurrences of villous groundcover milkvetch as well as in the watersheds above and attributed to the need for action to restore these channels.

The effects of recreation on the plants at Black Canyon Lake when added to the effects of implementing the activities proposed in the Rim country Project may attribute to the impacts to the villous groundcover milkvetch in the area.

Other documented occurrences of villous groundcover milkvetch are within the Heber Wild Horse Territory. Desired conditions for this area include grazing that is in balance with the available forage. It is not known if horses or other grazers in the area utilize villous groundcover milkvetch as forage so cumulative effects are also unknown.

Determination of Effect

Implementation of Alternative 2 or 3 of the Rim Country EIS may impact individuals of villous groundcover milkvetch (*Astragalus humistratus* var. *crispulus)* but is not likely to result in a trend toward federal listing or loss of viability.

Dane (Mogollon) thistle (Cirsium parryi subsp. mogollicum)

Dane thistle is a Region 3 sensitive species for Coconino National Forest. It is endemic to a few canyons on the Mogollon Rim Ranger District.

Direct and Indirect Effects

The known range of Dane thistle is a small portion of the overall project area. At least one occurrence of Dane thistle was protected with a small wire structure in the past but this area has not been revisited in several years so the fates of the plants and structure are unknown. Two occurrences of Dane thistle are within the Coyote Springs Mexican Spotted Owl (MSO) PAC and would be treated using the PAC Mechanical, a treatment designed to reduce the risk of uncharacteristic wildfire in MSO PACs. Trees removed from areas in this treatment are generally smaller in diameter than those removed in other treatments. Canopy cover after treatment is generally higher as compared to those prescribed for areas outside MSO habitat. The third occurrence in outside the Coyote Springs PAC in recovery habitat. The most significant effect to Dane thistle from this treatment is direct losses of individuals from management actions and these can be mitigated by using design features and mitigations.

Short-term effects of prescribed fire include loss of individual plants. The potential long-term effects include the loss of shade, increased risk of noxious or invasive weeds and an increased risk of erosion. This would be mitigated by burning at intensities in all entries low enough to limit mortality to trees.

The management activities would help move the treated areas toward the desired conditions. The effects of disturbance from vegetation treatments and prescribed fire include loss of individual plants.

Aquatic restoration includes site disturbing activities that would affect the occurrences of Dane thistle, especially the northernmost occurrence which is less than 1/10th mile from a proposed restoration site. Ground disturbing activities such as moving soil would increase the risk of disturbance to individual plants and their habitat. These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible.

There are no rock pits or in-woods processing areas near Dane thistle so effects from management activities associated with rock pits or in-woods processing sites would occur.

The locations of Dane thistle are not near any roads so there are no effects from management actions along roads.

Cumulative effects

The area of this cumulative effects analysis includes the known range of Dane thistle. The timeframe begins when Dane thistle was first described in 1990 to twenty years in the future.

There have been a variety of management activities in the uplands surrounding the known Dane thistle occurrences but few activities have occurred in the steep canyon areas. Grazing by cattle has occurred in the past but the allotment containing Dane thistle is not currently being used. Grazing by wildlife still occurs. A limited amount of recreational activities such as hiking may occur in the areas but there are no established trails in the canyon areas.

There is a large dispersed camping area in the uplands above one occurrence. A fence restricts vehicle travel and camping near the canyon edge. Hikers from the camping area may occasionally venture into the area. At the same site, there is an historical cabin and spring diversion upslope. Through another project there are plans to rehabilitate the spring, allowing it to be free-flowing but management actions from this action are not anticipated to have any effect on Dane thistle.

In addition to the management actions in this analysis, grazing by wildlife and recreation would continue in this area.

Cumulatively, the loss of individual plants may occur when added to the loss of plants as a result of grazing, creation and other prescribed fire or mechanical treatments implemented within the cumulative effects boundary.

Determination of Effect

Implementation of Alternative 2 or 3 of the Rim Country EIS may impact individuals of Dane thistle (*Cirsium parryi* ssp *mogollonicum*) but is not likely to result in a trend toward federal listing or loss of viability.

Mogollon fleabane (*Erigeron anchana*)

Mogollon fleabane is a Region 3 sensitive species for Tonto National Forest where it grows in cliff faces and rocky area.

Direct and Indirect Effects

Treatments in the area of known occurrences of Mogollon fleabane include mechanical and prescribed fire treatments (goshawk foraging; meadow restoration). The area is also near a stream channel proposed for aquatic restoration.

The vegetation and prescribed fire treatments would support the management emphasis for Mogollon fleabane, and he vegetation treatments would reduce the risk of uncharacteristic disturbances and would improve watershed condition. Prescribed fire would reduce the risk of uncharacteristic fire in the area surrounding this occurrence Mogollon fleabane and move toward allowing fire to resume its natural ecological role.

Aquatic restoration may include site disturbing activities that would affect this occurrence of Mogollon fleabane. Ground disturbing activities such as moving soil would increase the risk of disturbance to individual plants and their habitat. These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible.

The known occurrence of Mogollon fleabane is near the Bear Flat Campground near roadway so the species may be affected if construction, maintenance or reconstruction of the road occur, especially if the rocky areas favored by the species is affected. This can be mitigated by locating and avoiding the plants before activities occur.

There are no rock pits or in-woods processing areas near this occurrence of Mogollon fleabane so no effects would occur.

Cumulative effects

The timeframe of this discussion of cumulative effects on Mogollon fleabane is from 1990 to 20 years in the future. The area of this analysis is the project boundary. Many known locations of Mogollon fleabane are in wilderness or remote areas and would not be affected by management activities such as those proposed in this project.

Related to the known occurrence in the project area near the Bear Flat Campground, past and future impacts from recreational activities have occurred and would continue to occur near the site. Recreational activities such as rock climbing could also affect plants by crushing individuals and altering habitat.

Factors contributing to the degradation of Tonto Creek which flows through Bear Flat Campground could have impacted Mogollon fleabane so it is included in this analysis. Cumulatively aquatic habitat restoration activities, could conserve or improve the habitat of Mogollon fleabane in this area.

The past actions such as construction and maintenance of roads in the area could have contributed to the effects on habitat in this area, especially if rock formations were altered during construction and maintenance.

In addition to the management activities in this project, the foreseeable actions in area include recreation and occupancy of nearby land. Grazing by cattle and wildlife may occur in the area. Wildfire may also occur in the area. These may affect the habitat or plants occurring at this location but are not likely to affect the entire species.

Determination of Effect

Implementation of Alternative 2 or 3 of the Rim Country EIS may impact individuals of Mogollon fleabane (*Erigeron anchana*) but is not likely to result in a trend toward federal listing or loss of viability.

Rock (cliff) fleabane (*Erigeron saxatilis*)

Rock fleabane is a Region 3 sensitive species for Coconino National Forest. All known occurrences are limited to the Coconino National Forest.

Rock fleabane is a small daisy-like plant that tends to grow in erosion pockets on vertical cliff faces, most commonly Coconino sandstone. Generally, risks from management activities are confined to activities that would affect the cliff habitat on which it depends.

Direct and indirect effects

Two areas containing rock fleabane are slated for mechanical treatment (goshawk foraging). The effects of mechanical treatment include loss of individual plants or groups of plants. These effects would be mitigated by using the design features in appendix C.

Prescribed fire would occur throughout the project area but rock fleabane tends to occur in rocky areas that are sheltered from most fire activities so effects to the species from burning are anticipated to be minimal. Management activities such as fireline construction are not likely to occur in these areas. Short-term effects of prescribed fire include loss of individual plants. There are two occurrences of rock fleabane in aquatic restoration areas. The risk to rock fleabane from management actions include loss or damage of plants or loss of habitat. Ground disturbing activities such as moving soil would increase the risk of disturbance to individual plants and their habitat. These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible.

An indirect effect of management actions within the potential habitat of rock fleabane includes an increased risk of invasion from noxious or invasive weeds incorporation of the design features, in appendix C would mitigate the effects of increased disturbance from management activities, and help to control the spread and introduction of weeds within the habitat of rock fleabane.

Two occurrences of rock fleabane appears to be near roadways so may be affected if construction, maintenance or reconstruction of the road occurs, especially if the rocky areas favored by the species is affected.

Factors contributing to the degradation of aquatic habitats that led to the decision to include the areas in this analysis may have also affected the habitat of rock fleabane. Aquatic habitat restoration, depending on the actions taken could preserve or improve the habitat of rock fleabane in this area, depending on the actions taken by restoring the general area and reducing effects such as erosion in the long term.

There are no rock pits or in-woods processing areas near this occurrence of rock fleabane so no effects would occur.

These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible.

Cumulative effects

The timeframe considered is from 1990 to 20 years in the future. The area of this analysis is the project boundary.

Factors contributing to the degradation of areas scheduled for aquatic restoration that led to the decision to include it in this analysis may have also affected the habitat of rock fleabane. Aquatic habitat restoration, depending on the actions taken could preserve or improve the habitat of rock fleabane in this area.

The past actions such as construction and maintenance of roads in the area could have contributed to the effects on habitat in this area, especially if rock formations were altered during construction and maintenance.

In addition to the management actions in this analysis, grazing by cattle and wildlife may occur in the area. Wildfire may also occur in the area. These may affect the habitat or plants occurring at this location but are not likely to affect the entire species.

Determination of Effect

Implementation of Alternative 2 or 3 of the Rim Country EIS may impact individuals of rock fleabane (*Erigeron saxatilis*) but is not likely to result in a trend toward federal listing or loss of viability.

Eastwood (Senator Mine) Alumroot (Heuchera eastwoodiae)

Eastwood Alumroot is a Region 3 sensitive species for all three forests. Eastwood alumroot is endemic to central Arizona where it grows on moist shaded slopes in ponderosa pine forests and canyons. The typical substrate is crevices in basalt soil or basalt soil (Arizona Game and Fish Department 2005).

Direct and indirect effects
There is one occurrence of Eastwood alumroot in an area slated for mechanical treatment. The effects of mechanical treatment include loss of individual plants or groups of plants.

Prescribed fire would occur in the project area. Short-term effects of prescribed fire include loss of individual plants. The potential long-term effects include, increased risk of noxious or invasive weeds and an increased risk of erosion.

Hunter and Christopher Creeks are slated for riparian restoration. The risk to Eastwood alumroot from these actions include loss or damage of plants or loss of habitat. . Ground disturbing activities such as moving soil would increase the risk of disturbance to individual plants and their habitat. These effects can be mitigated through design features mitigate loss of sensitive plants by avoiding them as much as possible.

An indirect effect of management actions within the potential habitat of Eastwood alumroot includes an increased risk of invasion from noxious or invasive weeds Incorporation of the design Features, best management practices, mitigation and conservation measures in appendix C would mitigate these effects.

There are no rock pits or in-woods processing areas near this occurrence of Eastwood alumroot so no effects would occur.

Cumulative effects
The area of consideration for this discussion is the project area boundary. The timeframe includes 20 years past and future. Although this species occurs on all three forests within the project area, no data were found to document the effects of management on the species. Several of the areas where Eastwood alumroot occurs are in remote areas and/or in wilderness areas such as the Sierra Ancha, Red Rock Secret Mountain, and Mazatzal Mountains where no management activities would occur. Past impacts to basalt soils and crevices, especially in canyons and drainage areas may have affected individuals, groups or habitat for Eastwood alumroot. Dispersed recreation, especially activities such as canyoneering and rock climbing occur in potential habitat for Eastwood alumroot.

Determination of Effect
Implementation of Alternative 2 or 3 of the Rim Country EIS may impact individuals of Eastwood (Senator Mine) alumroot (*Heuchera eastwoodiae*) but is not likely to result in a trend toward federal listing or loss of viability.

Blumer's Dock (*Rumex orthoneurus*)
Blumer’s dock is a Region 3 sensitive species for all three forests. Blumer’s dock is a large, long-lived herbaceous perennial plant endemic to New Mexico and Arizona. Its range is from east-central to southeastern Arizona (depending on taxonomic interpretation). Habitat for Blumer’s dock includes mid- to high-elevation wetlands with moist, organic soil adjacent to perennial springs or streams in canyons or meadows (Arizona Game and Fish Department 2002.

Direct and indirect effects
Most of the occurrences of Blumer’s dock occur in areas scheduled for riparian restoration, with some in areas where wet meadow restoration is planned.

The risk to Blumer’s dock from management actions to restore aquatic habitats and stream channels include loss or damage of plants or loss of habitat.

Ground disturbing activities such as moving soil would increase the risk of disturbance to individual plants and their

These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible.

An indirect effect of management actions within the potential habitat of Blumer's dock includes an increased risk of invasion from noxious or invasive weeds.

Prescribed fire would occur in the project area. Short-term effects of prescribed fire include loss of individual plants but these can be mitigated by using design features.

There are no rock pits or in-woods processing areas near the occurrences of Blumer's dock so no effects would occur.

Blumer's dock may occur near roadways so may be affected if construction, maintenance or reconstruction of the road occurs and can be mitigated by locating and avoiding the plants before activities occur.

Cumulative effects

The area of consideration for this discussion includes the portion of the project area containing Blumer's dock plants and habitat, especially the drainages in the area. The timeframe is from 1993 to 20 years in the future. The 1993 timeframe was chosen to allow inclusion of introductions of Blumer's dock on the Apache-Sitgreaves and Tonto National Forests as documented in the Conservation Strategy. These introductions were implemented to supplement the numbers of plants and populations of this rare species. The fates of many of these introductions are unknown but are not thought to have persisted. This would affect the distribution of Blumer's dock in the project area and could affect the mitigations and management actions for restoring these areas. A series of exclosures on Apache-Sitgreaves National Forests protects some of these sites.

Several large fires have occurred in the project area. The largest of these is the Rodeo-Chediski (2002). It and other large fires have affected the terrestrial and aquatic habitats in the area containing Blumer's dock by destroying or altering vegetation communities, creating landscape scale disturbance, contributing to the risk of invasion of noxious or invasive weeds and contribution to erosion.

Grazing by livestock and wildlife has occurred and would continue to occur in the area. Blumer's dock is palatable to animals and small populations may be completely eaten in a single year. Activities such as dispersed recreation and firewood gathering have occurred and would continue to occur in the area.

Determination of effect

Implementation of Alternative 2 or 3 of the Rim Country EIS may impact individuals of Blumer's dock (*Rumex orthoneurus*) but is not likely to result in a trend toward federal listing or loss of viability.

Bebb's Willow (*Salix bebbiana*)

Bebb's willow is a Region 3 sensitive species for Coconino and Apache-Sitgreaves National Forests. It occurs in several areas containing riparian habitat within the project area.

Direct and indirect effects

Some of the areas containing Bebb's willow would receive vegetation treatments. The effects of mechanical treatment include loss of individual plants or groups of plants. These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible. .The risk to Bebb's willow from management actions to restore aquatic habitats and stream channels include loss or damage of plants or loss of habitat. These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible.

Ground disturbing activities such as moving soil would increase the risk of disturbance to individual plants and their habitat. These effects can be mitigated through design features and mitigations to minimize the loss sensitive plants by avoiding them as much as possible. .

Prescribed fire would occur in the project area. The effects of prescribed fire include loss of individual plants. These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible.

An indirect effect of management actions within the potential habitat of Bebb's willow includes an increased risk of invasion from noxious or invasive weeds Incorporation of the design Features, best management practices, mitigation and conservation measures in appendix C.

There are no rock pits or in-woods processing areas near the occurrences of Bebb's willow so no effects would occur.

Bebb's willow may occur near roadways so may be affected if construction, maintenance or reconstruction of the road occurs and can be mitigated by locating and avoiding the plants before activities occur.

Cumulative effects

The area of consideration for this discussion includes the portion of the project area containing Bebb's willow and its habitat, especially the drainages in the area. The timeframe is 20 years past and in the future.

There are a series of exclosures on the Apache-Sitgreaves National Forests and Coconino National Forests. Some of contain, or were designed to protect, Bebb's willows. The status of these is unknown.

Several large fires have occurred in the project area. The tops of Bebb's willow may be removed by fire but the species is able to regenerate through basal sprouting. However, regeneration is often targeted and eaten by domestic and wild grazers, leading to depletion of underground reserves ultimately leading to the loss of plants in areas of heavy grazing pressure.

Grazing by livestock and wildlife has occurred and would continue to occur in the area. Bebb's willow is palatable to animals and small populations may be completely eaten in a single year. Activities such as dispersed recreation and firewood gathering have occurred and would continue to occur in the area.

Determination of Effect

Implementation of Alternative 2 or 3 of the Rim Country EIS may impact individuals of Bebb's willow (*Salix bebbiana)* but is not likely to result in a trend toward federal listing or loss of viability.

Alternative 2 – Modified Proposed Action

Arizona Bugbane (Cimicifuga arizonica)

Arizona bugbane is a Region 3 sensitive species for Kaibab, Coconino and Tonto National Forests. In this analysis occurrences of Arizona bugbane are limited to the Coconino National Forest. There are no known occurrences of Arizona bugbane within the Project area for Tonto National Forest. Arizona bugbane is endemic to northern Arizona where it occurs in mesic habitats, typically along the bottoms and lower slopes of steep, narrow canyons. The overstory often includes a combination of coniferous and deciduous tree species. The habitat is similar to that favored by Mexican spotted owls.

Direct and Indirect Effects

The proposed management actions would help move the treated areas toward the desired conditions as described in the LRMP. The most significant effect to Arizona bugbane from management actions is direct losses of individuals from management actions but these would be mitigated through the design features in appendix C.

This occurrence of Arizona bugbane is within the Tom's Creek Mexican Spotted Owl (MSO) PAC and would be treated using the PAC Mechanical, a treatment designed to reduce the risk of uncharacteristic wildfire in MSO PACs.

Trees removed from areas in this treatment are generally smaller in diameter than those removed in other treatments. Canopy cover after treatment is generally higher as compared to those prescribed using the mechanical toolbox for areas outside MSO habitat. Shade for Arizona bugbane plants in this area may be affected but it would not be extensive. This could result in the loss of a few individuals but would not affect the entire population at this site.

Short-term effects of prescribed fire include loss of individual plants. The potential long-term effects include the loss of shade, increased risk of noxious or invasive weeds and an increased risk of erosion. This would be mitigated by burning at intensities in all entries low enough to limit mortality to trees. The current knowledge of fire effects on Arizona bugbane are based largely on observations on a local wildfire, the Fry Fire in 2003.

No hauling is proposed in the immediate area of Arizona bugbane populations. Indirect effects from road use would be limited to dust from road maintenance but these would be minimal and inconsequential.

An indirect effect of management actions within the potential habitat of Arizona bugbane includes an increased risk of invasion from noxious or invasive weeds. Incorporation of the design features would mitigate the effects of increased disturbance from management activities, and help to control the spread and introduction of weeds within the habitat of Arizona bugbane.

No locations of Arizona bugbane occur within sites for spring or channel restoration, so there are no effects to the species.

There are no rock pits or in-woods processing areas near this occurrence of Arizona bugbane so no effects would occur.

Cumulative effects

The following past actions have affected the abundance of Arizona bugbane and have established baseline current condition for Arizona bugbane; grazing, recreation, wildfire and natural disturbances such as flooding, drought, tornados and mortality in overstory trees. Grazing impacts were addressed in the Conservation Assessment and Strategy for the Coconino and Kaibab National Forests and include fencing and monitoring in certain populations which led to a reduction in these conflicts.

In addition to the management actions in this analysis, the foreseeable activities in area include recreation such as hiking, rock climbing and canyoneering. Grazing by cattle and wildlife would continue. Wildfires may also occur in the area. Singly, none of these activities would eliminate Arizona bugbane at the site.

Cumulatively, the effects from activities from this project when added to effects from other projects would also not eliminate bugbane at this site.

Determination of Effect

Implementation of Alternative 2 of the Rim Country EIS may impact individuals of Arizona bugbane (*Cimicifuga arizonica*) but is not likely to result in a trend toward federal listing or loss of viability.

Hairy Clematis (Arizona leatherflower) (Clematis hirsutissima var. hirsutissima) (syn. var. Arizonica)

Hairy clematis is a Region 3 sensitive species for Coconino National Forest where it occurs in ponderosa pine forests. There is one location of hairy clematis in a unit proposed for stream channel restoration.

Direct and Indirect Effects

The area containing hairy clematis is slated for mechanical treatment (goshawk foraging). The effects of mechanical treatment include loss of individual plants or groups of plants. These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible.

Short-term effects of prescribed fire include loss of individual plants. The potential long-term effects include the loss of shade, increased risk of noxious or invasive weeds and an increased risk of erosion. These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible.

Activities associated with roads and transportation in this project would be limited those needed to accomplish the management actions that would occur in the area Effects to plants can be mitigated by locating and avoiding them.

An indirect effect of management actions within the potential habitat of hairy clematis includes an increased risk of invasion from noxious or invasive weeds

There are no rock pits or in-woods processing areas near this occurrence of hairy clematis so effects from management activities associated with rock pits or in-woods processing sites would occur.

Cumulative effects

The area of this analysis is the project boundary. The time frame is from 2005 to 10 years in the future which is considered the length of the decision to be made by this analysis.

One occurrence was detected in 2005 during a survey for the Bald Mesa Fuels Reduction Project. Since then there has been at least one entry of prescribed fire in this area. The effects were mitigated by locating and constructing hand line around the plants. Other activities include grazing and dispersed recreation in the uplands.

In addition to the management actions in this analysis, the foreseeable actions within the habitat of hairy clematis include recreation such as hiking and dispersed camping. Wildfires may burn in the area. Grazing by cattle and wildlife would continue. Singly none of these actions would eliminate the hairy clematis at the site

Determination of Effect

Implementation of Alternative 2 of the Rim Country EIS may impact individuals of Arizona bugbane (*Cimicifuga arizonica*) but is not likely to result in a trend toward federal listing or loss of viability.

Arizona sneezeweed (Helenium arizonica)

Direct and indirect effects

Arizona sneezeweed occurs on all three forests included in this analysis and within several treatments.

Short-term effects of prescribed fire include loss of individual plants. The potential long-term effects include the loss or damage of plants, increased risk of noxious or invasive weeds and an increased risk of erosion.

An indirect effect of management actions within the potential habitat of Arizona sneezeweed includes an increased risk of invasion from noxious or invasive weeds Incorporation of the design features, best management practices, mitigation and conservation measures in appendix C would mitigate the effects of increased disturbance from management activities, and help to control the spread and introduction of weeds within the habitat of rock fleabane.

Arizona sneezeweed is known to occur in the following aquatic restoration units; Woods Canyon Creek, Chevelon Lake and Canyon Creek but may be in additional sites as well. Aquatic restoration may include site disturbing activities that would affect Arizona sneezeweed. Ground disturbing activities such as moving soil would increase the risk of disturbance to individual plants and their habitat. These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible.

Arizona sneezeweed near roadways may be affected if construction, maintenance or reconstruction of the road occurs, especially if the rocky areas favored by the species is affected. This can be mitigated by locating and avoiding the plants before activities occur.

There are no rock pits or in-woods processing areas near this occurrence of Arizona sneezeweed so effects from management activities associated with rock pits or in-woods processing sites would occur.

Arizona sneezeweed may occur near roadways so may be affected if construction, maintenance or reconstruction of the road occurs and can be mitigated by locating and avoiding the plants before activities occur.

Cumulative effects

The timeframe considered is from 1999 when Arizona sneezeweed was added to the sensitive species list to 20 years in the future. The area of this analysis is the project boundary.

On the Coconino National Forest, Arizona sneezeweed has been addressed in Upper Beaver Creek Watershed Fuel Reduction (2010), Clint's Well Forest Restoration (2013) and the Cragin Watershed Protection Project (2018), in which effects were mitigated through design features and mitigations similar to those proposed in this project. The finding of effect for all of these projects was "may effect". To date, none of these projects has been fully implemented. Therefore the effects of the projects on Arizona sneezeweed including those that would be beneficial to the species have not been fully realized.

Arizona sneezeweed tends to grow in drainages and open areas. These areas are also favored by dispersed recreationists who may crush plants and alter habitat during activities. Activities such as grazing and fuelwood gathering have occurred and would continue in these areas.

Factors contributing to the degradation of aquatic habitats that led to the decision to include the areas in this analysis may have also affected the habitat of Arizona sneezeweed. Aquatic habitat restoration, depending on the actions taken could preserve or improve the habitat of Arizona sneezeweed in this area, depending on the actions taken by restoring the general area and reducing effects such as erosion in the long term.

Determination of Effect

Implementation of Alternative 2 or 3 of the Rim Country EIS may impact individuals of Arizona sneezeweed (*Helenium arizonicum*) but is not likely to result in a trend toward federal listing or loss of viability.

Flagstaff beardtongue (Penstemon nudiflorus)

Flagstaff beardtongue is a Region 3 sensitive species for Coconino National Forest. Flagstaff beardtongue grows in dry pine forests, pine/oak, pine/oak/ juniper and pinyon juniper forests.

Direct and indirect effects

Most of the areas containing Flagstaff beardtongue receiving vegetation treatments areas are proposed for mechanical treatment (goshawk foraging). The effects of mechanical treatment include loss of individual plants or groups of plants.

Prescribed fire would occur across the project area. Short-term effects of prescribed fire include loss of individual plants. The potential long-term effects include the loss of shade, increased risk of noxious or invasive weeds and an increased risk of erosion.

An indirect effect of management actions within the potential habitat of Flagstaff beardtongue includes an increased risk of invasion from noxious or invasive weeds.

Activities associated with roads and transportation in this project would be limited to those needed to accomplish the management actions that would occur in the area.

These effects can be mitigated through design features to mitigate loss of sensitive plants by avoiding them as much as possible.

There are no rock pits or in-woods processing areas near the occurrences of Flagstaff beardtongue so there would be no effects from these management activities associated with rock pits or in-woods staging areas.

Cumulative effects

The area of consideration for this discussion includes the Coconino National Forest within the analysis area boundary. The timeframe includes 20 years past and future.

Flagstaff beardtongue occurs on several of past projects that addressed vegetation and prescribed fire treatments. These include Upper Beaver Creek Watershed Fuel Reduction (2011), Clint's Well Forest Restoration, Lake Mary Road ROW Clearing (ADOT) (2016) and the 1st 4FRI EIS. Effects to Flagstaff beardtongue were mitigated with similar measures as those proposed in this DEIS. None of these projects have been fully implemented so the effects to Flagstaff beardtongue, including those that could be beneficial are not fully realized.

Management activities such as grazing have occurred and would continue to occur in the area of consideration. Other activities such as utility corridors have impacted individual plants or groups but has not substantially affected the species as a whole. Activities such as dispersed recreation and fuel wood cutting occur in the area of consideration. Flagstaff beardtongue is showy and is cultivated and offered for sale by local and regional wildflower vendors. The effects of activities such as collection of seeds or plants on wild populations is not known.

Determination of Effect

Implementation of Alternative 2 of the Rim Country EIS may impact individuals of Flagstaff beardtongue (*Penstemon nudiflorus*) but is not likely to result in a trend toward federal listing or loss of viability.

Alternative 3 – Focused Alternative

Arizona Bugbane (Cimicifuga arizonica)

Under alternative 3, no mechanical treatments would take place in the area where Arizona bugbane is known to occur, so the effects of mechanical treatment described in alternative 2 above do not apply. The reduction of canopy closure and reduction of stand densities would not occur in this alternative. The effects on Arizona bugbane of all other management actions are similar to those described above in the discussion of effects of alternative 2.

Hairy Clematis (Arizona leatherflower) (Clematis hirsutissima var. hirsutissima) (syn. var. Arizonica)

In alternative 3, no mechanical or fire treatments are proposed in areas where hairy clematis is known to occur so the effects of those actions are similar to alternative 1, the no action alternative. The effects of transportation and channel restoration are the same as those discussed for alternative 2, above, including the threats of noxious or invasive weeds.

Rock (cliff) fleabane (Erigeron saxatilis)

One occurrence of rock fleabane (in the Barbershop MSO PAC) would not receive mechanical and prescribed fire treatments in this alternative and would not move as quickly toward desired condition as compared to the potential MSO PAC treatment in Alternative 2. Two occurrences that would be treated as MSO habitat in alternative 2 would receive different mechanical treatments in this alternative. One area would receive an individual tree removal and the other would be treated using an uneven age thinning treatment. Both would receive some form of prescribed burning. The effects of these treatments may result in different overstory composition and structure but the effects to rock fleabane and its habitat are expected to be similar.

Arizona sneezeweed (Helenium arizonicum)

Fewer areas containing Arizona sneezeweed would be treated as compared to alternative 2. As a result, alternative 3 would not fulfill the purpose and need of the project as well as alternative 2 and there would be less progress toward the desired conditions of the forest LMRPs, including those that apply to Region 3 sensitive plants such as Arizona sneezeweed.

Flagstaff beardtongue (Penstemon nudiflorus)

Under alternative 3 few acres containing Flagstaff beardtongue would receive vegetation treatments. Alternative 3 would not address the purpose and need to the extent that alternative 2 would. There would be less progress toward the desired conditions that affect Flagstaff beardtongue. Forest resilience and would be attained on fewer acres and the risk of undesirable fire effects would be reduced in fewer areas. Flagstaff beardtongue plants and habitat in these areas would remain at higher risk of loss or

Bebb's Willow (Salix bebbiana)

Fewer areas containing Bebb's willow would receive vegetation or prescribed fire treatments as compared to alternative 2. As a result, it would not fulfill the purpose and need of the project to the extent that alternative 2 would and there would be less progress toward the desired conditions including those that apply to Region 3 sensitive plants such as Bebb's willow.

Noxious and Invasive Weeds

The noxious and invasive weed analysis is part of the Botany and Weeds Report (Crisp 2018), which is incorporated by reference.

Assumptions and Methodology

Assumptions

This analysis is based on the following assumptions.

17. All management activities would occur as analyzed in the various specialists reports and described in the FEIS.
18. The mitigation measures, design features, and Best Management Practices would be incorporated into project design and implementation. See Appendix C for these features.
19. Areas to be treated would be surveyed for noxious or invasive weeds before treatments are implemented.
20. These factors should be considered when identifying survey needs:
    - Likelihood of any of the species addressed in the Botany and Weeds report occurring within the treatment area
    - Amount of disturbance. For example, surveys may not be needed in areas scheduled for prescribed burning if the treatments are scheduled to be of low intensity.
21. The acreage of potential disturbance in this project is much larger than generally analyzed in similar projects, necessitating more noxious or invasive weed treatments to control invasive species.

Affected Environment

Each of the three forests has separate noxious or invasive weed treatment analyses. As a result, the targeted species and treatment methods may differ across forests. The Coconino National Forest was the first of the three forests to complete a noxious or invasive weed treatment analysis the *Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds, Coconino, Kaibab, and Prescott National Forests*; (USDA Forest Service 2005), analyzing 29 species for treatment. The Apache-Sitgreaves National Forests completed the *Environmental Assessment for the A-SNFs Integrated Forest-Wide Noxious or Invasive Weed Management Program* (USDA Forest Service 2008). It analyzed 53 species and included a variety of treatments including chemical, cultural, mechanical/physical and biological control. . The Tonto National Forest completed the *Environmental Assessment for Integrated Treatment of Noxious or Invasive Plants* in 2012 and addressed 68 species. It includes manual, mechanical, prescribed burning, cultural, use of biological control agents, and use of herbicides.

Noxious or invasive weeds are present within all three forests in the project area.

Table 98. Noxious or invasive weeds within the project boundary and forest where each species occurs.

Scientific name	Common name	Forest
Acroptilon repens	Russian knapweed	Apache-Sitgreaves, Coconino, Tonto
Alhagi maurorum	camelthorn	Coconino, Tonto
Arundo donax	Giant reed	Tonto
Bothriochloa ischaemum	yellow bluestem	Coconino
Brassica tournefortii	Asian mustard	Tonto
Bromus arvensis (*B. japonicus*)	Japanese brome	Coconino, Tonto
Bromus rubens	Red brome	Tonto
Bromus tectorum	cheatgrass	Coconino, Tonto
Carduus nutans	musk thistle	Apache-Sitgreaves, Coconino, Tonto
Centaurea biebersteinii	spotted knapweed	Coconino
Centaurea diffusa	Diffuse knapweed	Coconino
Centaurea melitensis	Malta starthistle	Tonto
Centaurea solstitialis	yellow star-thistle	Apache-Sitgreaves, Coconino, Tonto
Convolvulus arvensis	Field bindweed	Tonto
Eragrostis curvula	Weeping lovegrass	Tonto
Eragrostis lehmanniana	Lehmann's lovegrass	Tonto
Cirsium vulgare	bull thistle	Apache-Sitgreaves, Coconino, Tonto
Eleagnus angustifolia	Russian olive	Coconino
Erysimum repandum	Spreading wallflower	Tonto
Euphorbia esula	Leafy spurge	Coconino
Linaria dalmatica	Dalmatian toadflax	Coconino, Tonto
Linaria vulgaris	butter and eggs	Apache-Sitgreaves
Onopordum acanthium	Scotch thistle	Coconino, Tonto
Tamarix ramosissima	salt cedar	Apache-Sitgreaves, Coconino, Tonto
Ulmus pumila	Siberian elm	Tonto

Environmental Consequences

Alternative 1 – No Action

There would be no effects to noxious or invasive weeds from management activities because none would occur. Alternative 1 would not increase forest resiliency and sustainability or reduce the risk of undesirable fire effects.

There would be no improvement in terrestrial or aquatic habitats. There would be no surveys for or treatments of noxious or invasive weeds. Survey and treatment would continue in other projects, as part of the forests' noxious weed program, and by other entities such as Arizona Department of Transportation.

Weed infestations that would have been detected and treated would go unnoticed and continue to expand unless detected by other surveys or independent observations. Treatments that would have been part of the mitigating actions not be accomplished. As a result, treatment of weed infestations would not occur unless the locations are included in another project area or are treated by a cooperating agency. For example, treatments along highways or roadways in coordination other agencies would continue but would not expand outside of highway right of ways.

The guidance of past analyses that would allow treatment of noxious or invasive weeds on the forests, specifically the Environmental *Assessment for the A-SNFs Integrated Forest-Wide Noxious or Invasive Weed Management Program,* the *Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds, Coconino, Kaibab, and Prescott National Forests* and *the Environmental Assessment for Integrated Treatment of Noxious or Invasive Plants* for Tonto National Forest would not apply.

The design features in appendix C would not be used. These design features provide an integrated approach to noxious or invasive weed management but would not be incorporated into management activities on the forests if the no action alternative is selected.

Effects Common to Alternatives 2 and 3

The purpose of the Rim Country Project is to reestablish and restore forest structure and pattern, forest health, and vegetation composition and diversity in ponderosa pine ecosystems to conditions within the natural range of variation. Preventing, controlling, and eradicating noxious or invasive weeds is complementary to the purpose and need and would improve native vegetation composition. Management of noxious or invasive weeds is consistent with the purpose and need because management of them would contribute to the vegetation composition and diversity of the native plant community in the project area.

The action alternatives would move toward the desired conditions for native plant communities and noxious or invasive weed control. Noxious or invasive weed management would be guided by each forest's weed management NEPA. Surveys for noxious or invasive weeds would be conducted before management activities areas and needed treatments would follow the guidance of each forest's noxious or invasive weed assessment. Post implementation monitoring and treatment would occur.

To prevent the introduction and spread of noxious or invasive weeds by vehicles used in management activities, vehicles and equipment would be washed to remove soil, seeds and other debris from them before entering the area or when moving from one area to the other. Ideally, this would occur before the equipment comes onto the forest but it can also be facilitated with the approval of the contracting officer or timber sale administrator.

The direct effects of management activities on noxious or invasive weeds include ground-disturbing activities that have the potential to increase the acreage and/or density of the existing infestations within the project area. Disturbance may contribute to the spread of weeds by eliminating competition from existing vegetation and creating bare ground that is more easily invaded than undisturbed areas. Severe disturbance removes competitive vegetation, alters nutrient composition, and creates bare soil making potential sites for the invasion or spread of noxious or invasive weeds. Examples of management activities that would create localized severe disturbance include burned areas from slash piles, creation of log decks, bare soil created through road reconstruction, decommissioning, temporary road construction, in woods processing areas and rock pits.

Tree removal indirectly affects noxious or invasive weeds by reducing tree canopy and stand density. Treatments that reduce the tree canopy and lower the stand density would affect all understory plants, including noxious or invasive weeds by allowing more sunlight, increasing available nutrients and temporarily decreasing competition. The increased availability of resources and decrease in competition can also provide favorable conditions for noxious or invasive weeds and could increase the size and density of existing populations, especially in areas where weed infestations already exist. These effects are reduced to a non-significant level by incorporating the mitigation measures and design features and by incorporating survey and treatment in the project. Design features which limit the amount of soil disturbance permitted during timber sales and regulate the depth of rutting by vehicles when soil conditions are wet, minimizing soil disturbance, would help reduce the amount of disturbance during operations, reducing the amount of bare ground for noxious or invasive weeds to occupy.

Burning can release nutrients, reduce plant competition, increase the amount of available sunlight and increase bare soil. Most prescribed burning would be of low severity with low soil heating, retention on most ground litter and little or no change in mineral soil. Prescribed or managed fires generally result in lower severity and result in lower levels of noxious or invasive weed invasion as compared to uncontrolled wildfire

Alternatives 2 and 3 would incorporate a series of design features and mitigations that would reduce the risk of increasing weed coverage or extent and decrease the risk of introduction of noxious or invasive weed species not known to exist within the project area. Design features provide for collaboration between resources before the implementation of a prescribed fire. Follow-up monitoring would be conducted in areas of heavy disturbance such as large slash piles. Design features provide direction to conduct prescribed fires under conditions that promote native plant communities, hinder weed species germination, aid with controlling existing weed infestations, and prevent the spread of existing weeds.

Direct and indirect effects of temporary road construction, road reconstruction and maintenance or road decommissioning include disturbance and increased risks of dispersal of existing weed species and populations and introduction of new species. These would be mitigated by following the design features in Appendix C.

Management activities associated with aquatic and channel restoration would increase disturbance in certain areas. These effects would be mitigated by following the design features in Appendix C.

A series of rock or gravel pits would be needed to provide materials for road maintenance in the project area. Appendix C provides a series of design features designed to minimize the risks of introduction and spread of noxious or invasive weeds within the project area.

Processing areas are likely to be locations where invasive weeds are established during their operation. These areas would be managed under the timber sale or special use permit. To minimize the potential for invasive species spread and transport, these would be treated as part of the reclamation once operations are complete. Implementation of the design features would reduce introduction and spread of noxious and invasive weeds. Thus, while these areas would result in localized weed populations, the spread is expected to be limited. Design features provides for rehabilitation of processing areas after they are no longer used including seeding of sites with native seed which would help re-establish native plant communities and reduce the risk if noxious or invasive weed infestations. Seed mixes of native species used for post-thinning erosion would be certified as weed-free in accordance with Region 3s guidance for weed-free materials (USDA 2018) with a minimum of five pounds of pure live seed per acre (USDA 2018).

Alternatives 2 and 3 are expected to limit the establishment and spread of invasive species within and adjacent to the project area over the next several decades by decreasing the risk of high severity wildfires which are generally sources of severe disturbance. By decreasing fire severity, these alternatives would result in increased understory abundance and diversity which would be more resistant to invasive species over the next 10 to 20 years.

Cumulative Effects

The cumulative effects analysis area for noxious or invasive weeds includes the project area plus surrounding major arteries of transportation and utility corridors that enter the project area.

Major roads and utility corridors were included because of their roles in providing corridors for dispersal of noxious or invasive weeds. The timeframe for cumulative effects on noxious or invasive weeds is twenty years prior and twenty years into the future.

The distribution of noxious or invasive weeds on the project has been shaped by past management activities and natural disturbances in the project area. Activities such as firewood cutting have occurred in the past and would continue into the future. Fuel wood cutters can introduce weeds into the area through their actions. These actions occur under permit but the forests have limited control over where these activities would occur.

Wildfires are sources of high levels of disturbance depending on fire severity. Severely disturbed areas can be more easily invaded by noxious or invasive weeds than less severely disturbed or undisturbed areas. Numerous wildfires have occurred in the project area (see cumulative effects document). Some of these, such as the Rodeo-Chediski (2002), Juniper (2016) and Pot Fire (1996) have covered large acreages. These have resulted in large acreages of severe fire effects such as almost complete removal of the plant communities and soil erosion, leaving large areas of disturbance prone to noxious or invasive weed invasions. Some remedial actions for large fires have resulted in large acreages of non-native species that are now problematic and would be challenging to restore to native plant communities.

Past fire exclusion has contributed to the risk of noxious or invasive weed invasion by promoting very dense forests with little or no resilient understory community that would normally compete with noxious or invasive weeds. Fire exclusion also increases the risk of severe stand replacing fires and its accompanying severe disturbance.

There are numerous grazing allotments in the project boundary. The past effects of grazing and the associated activities are not completely known but may include temporary reduction of the native plant community in certain areas (especially near water sources) which would allow for plants such as the noxious or invasive weeds to enter the plant community through feed or manure.

A wide variety of recreation activities occur within the boundary of the project area including hiking, camping, hunting and recreational driving. Users can introduce noxious or invasive weeds from other areas on vehicles and personal equipment. The effects of livestock such as horses or pack animals used in recreation are similar to those in grazing and include temporary reduction of the native plant community in localized areas where animals are allowed to graze and introduction of weeds through feed or manure. Trampling and compaction can also occur if the same campsites are used repeatedly.

In the past there were few restrictions on off-road motorized travel whether for recreational or other purposes but these actions are now regulated through implementation of the Travel Management Rule on the forests. This reduces the risk of introduction of noxious or invasive weeds and reduces vehicle damage to existing vegetation and habitat.

Major highways tend to be corridors for weed dispersal by providing a source to vector weeds into the area. Management activities associated with the highways create disturbance and spread existing weeds. Examples include past activities such as blading of road ditches where equipment passed through existing weed infestations, spreading them along the road corridor. In 2003, the Southwestern Region of the Forest Service completed the Environmental Assessment for Management of Noxious Weeds and

Hazardous Vegetation on Public Roads on National Forest System Lands in Arizona. The decision, which followed in 2004, allowing treatment of noxious or invasive weeds along state and federal highway rights-of-way through all National Forests in Arizona. Some treatments have occurred along state and federal highways as a result but the extent of these treatments are not known.

The Apache-Sitgreaves National Forests has surveyed and treated numerous infestations of noxious or invasive weeds within the project area since 2004. All of the treatments prior to the approval of the *Environmental Assessment for the A-SNFs Integrated Forest-Wide Noxious or Invasive Weed Management Program* (USDA Forest Service 2008) were mechanical treatments accomplished using hand tools. Herbicide use on the forest began in 2009 after the approval of the document.

The Coconino National Forest began weed survey and treatments in about 1995 and like the Apache-Sitgreaves, they relied on non-herbicide methods to control isolated occurrences using mechanical control and alternatives such as grazing. Using sheep to control leafy spurge was utilized before the approval of the *Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds, Coconino, Kaibab, and Prescott National Forests*; (USDA Forest Service 2005). The EIS allowed use of herbicide as well as biological control.

There are records of surveys along roadways on the Tonto National Forest beginning in 1999. These surveys were generally by Arizona Department of Transportation. The forest began surveying for weeds in 2003. Many of the treatment prior to the approval of the *Environmental Assessment for Integrated Treatment of Noxious or Invasive Plants* (2012) were done using hand tools.

The disturbance resulting from the management activities in this project would continue to be sources of disturbance that may contribute to the threat of noxious or invasive weed occurrences and would be additive to the activities discussed in this section of the report.

Recreation

A summary of the Recreation Report is presented here and the specialist report (Wright 2018) is incorporated by reference. The potential effects of the 4FRI Rim Country Project on recreational opportunities was not raised as a concern by the public.

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Affected Environment

Recreation Trends

The Apache-Sitgreaves, Coconino, and Tonto National Forests provide diverse outdoor recreation opportunities connecting people with nature in a variety of settings. Forest users can hike, bike, drive motorized vehicles, camp, fish, view wildlife and scenery, and explore historic and prehistoric places. They enjoy opportunities for year-round recreation activities from birding and wild flower observing in the spring, hiking in summer months, fall color viewing and hunting, to cross country skiing in the winter.

Forest users may occasionally experience short-term or temporary disruptions in their recreation activities as a result of other groups currently occupying a preferred site, forest management activities such as current thinning or prescribed fire projects, fire restrictions or fire closures due to hot, dry weather and extreme fire danger, as well as natural occurrences such as fallen trees blocking a roadway or trail, and so on. When asked how visitors would react to such disruptions in their plans, they reported in the National Visitor Use Monitoring survey (NVUM) using substitution behaviors such as coming back another time, going elsewhere for a different activity, going elsewhere for the same activity, going to work, some other substitution or staying at home (USDA 2016- 2017). The number one response for all three Rim Country forests was by far going elsewhere for the same activity.

Demographic shifts and lifestyle changes have affected the demand for recreation opportunities on national forests. Today about 80 percent of the population lives in urban settings and may not have the same values as rural residents who live closer to or may depend on natural resources for their livelihood (Forest Service 2010). Both of these trends have created challenges to Forest Service recreation managers to meet demands for an ever-increasing number of recreation users as well as a diverse number of desired recreation activities. Population growth is expected to continue into the future and will increasingly affect national forest management activities, as well as ability to provide satisfying recreation opportunities.

The NVUM data highlights that the Coconino National Forest is the most popular national forest in the southwestern region, but the data also shows that the forest serves an interesting niche. The Coconino National Forest is heavily used by non-local and international visitors; it is estimated that 60 percent of the 4.7 million visitors come a long distance (over 100 miles) to visit the national forest (USDA Forest Service, 2018). While the Apache-Sitgreaves National Forests serves a higher percentage of visitors coming from more than 100 miles with 70 percent, both forests are visited by about 30 percent of local visitors. The Tonto National Forest is mostly visited by locals, with about 74 percent of visits coming from less than 50 miles away. Large numbers of visitors come from areas (primarily the Phoenix metropolitan area) to visit the area largely for the change of scenery, ideal climate, and relief from extreme summer temperatures in nearby major metropolitan areas. The Rim Country project area covers a wide array of recreationists coming from different places within Arizona and from other states and countries. This reflects the desire of many recreationist to participate in the extensive possibilities of recreation activities in the area.

Recreation Activities within the Project Area

There are a number of Forest Service trails and developed recreation facilities within the Rim Country analysis area, including developed campgrounds. Most of the recreation facilities are located on the Apache-Sitgreaves National Forests.

There are 30 developed campgrounds in the Rim Country project area. Campgrounds generally operate from May to October depending on weather. These campgrounds see high use on weekends typically from mid-May to mid-September.

There is a total of 728 miles of trail identified in the project area. The Apache-Sitgreaves National Forests contain the most miles of trail, with more than double that of the Coconino and Tonto National Forests. In addition, the Apache-Sitgreaves is the only forest to have snow trails. The project includes part of the Arizona National Scenic Trail, the General George Crook National Recreation Trail, the Blue Ridge Recreation Trail and the Highline National Recreation Trail.

There are currently no designated segments of wild and scenic rivers in the Rim Country project area. There are however, currently 9 segments of eligible wild and scenic rivers on the Apache-Sitgreaves and Coconino National Forest in the project area. In addition, as part of its forest plan revision process, the Tonto National Forest is completing an updated eligibility report for wild and scenic rivers to replace the existing eligibility report from 1993. To ensure compliance with current forest plan direction, this analysis includes both the eligible rivers reported in the 1993 study, as well as those listed in the current draft eligibility report.

Dispersed recreation includes the full suite of outdoor non-motorized and motorized recreation opportunities available throughout the year. Dispersed camping requires no additional facilities other than road or trail access, though the relatively unconstrained nature of dispersed camping can cause resource impacts such as soil compaction and erosion, loss of vegetation, increased fire risk, displacement of wildlife, and accumulation of trash and human waste. The number of dispersed campers in the analysis area is also difficult to estimate.

As Arizona's population has grown, the state has also seen a dramatic increase in ownership and use of personal off-highway vehicles (OHVs). Arizona Trails 2010 reported a 623 percent increase in sales of off-highway motorcycles and all-terrain vehicles (ATVs) in Arizona between the years 1995 to 2006 (McVay et al. 2010).

The 2013 Arizona Statewide Comprehensive Outdoor Recreation Plan reports that based on the Arizona Trails 2010 Plan, OHV users represent almost 22 percent of the Arizona population, which includes residents who use motorized vehicles on trails for multiple purposes. Of that, 11 percent of Arizona residents reported that motorized trail use accounted for the majority of their use and are considered "core users." With Phoenix and surrounding communities being among the fastest growing populations in the state, adjacent forest areas can expect a large increase in visitation.

In November 2005, the Forest Service announced new federal regulations called the Travel Management Rule, requiring each national forest to establish a designated system of roads, trails, and areas by vehicle type and time of year. Designated roads, trails, and areas would then be identified on a Motor Vehicle Use Map, made available to the public for free (36 CFR 212.56).

The 4FRI Rim Country Project would adhere to the current Travel Management Rule decisions for the Coconino, Tonto, and Apache-Sitgreaves National Forests.

The Forest Service uses the Recreation Opportunity Spectrum (ROS) to provide a framework for defining classes of outdoor recreation environments, activities, and experience opportunities (USDA Forest Service, ROS Primer and Field Guide 2011). The ROS is a land classification system that categorizes national forest land into six classes, each class being defined by its setting and by the desired opportunities and characteristics the setting offers. The six ROS classes are Primitive (P), Semi-Primitive Non-Motorized (SPNM), Semi-Primitive Motorized (SPM), Roaded Natural (RN), Rural (R), and Urban (U). There are no wilderness or recommended designated wilderness area within the proposed project. Opportunities for experiences along the spectrum represent a range from very high probability of solitude, self-reliance, challenge and risk, to a very social experience where self-reliance, challenge and risk are relatively unimportant.

The purpose of the ROS is to identify desired conditions across the Forest so that different parts of the forest may facilitate different recreational experiences. The ROS represents management objectives, which may not always reflect actual user experiences. The large majority of the Rim Country project area falls into the SPM and RN classes. Approximately 418,680 acres or 35 percent of the project area is SPM. RN makes up 418,675 acres or 50 percent, and SPNM makes up 13 percent of the area. The recent revised forest plans for the Coconino and the Apache-Sitgreaves National Forests contain updated ROS maps that represent the desired conditions for ROS classes across the forests. Not all acres on the forests currently meet these desired conditions. The desired conditions are meant to guide project design, alternative development, and assessment of potential project effects. ROS classifications are also used to determine if project activities would help move toward desired conditions for recreation opportunities at the forest level.

All three national forests in the project area offer numerous developed recreation opportunities as illustrated in Figure 87. The Rim Country Project does not include restoration activities in developed recreation sites, special areas, or designated Wilderness. Outside of these areas, many forest users engage in dispersed recreation including hiking, dispersed camping, driving motorized vehicles, rock climbing, cross-country skiing, and snow play. There may be restoration activities in many places where dispersed recreation occurs.

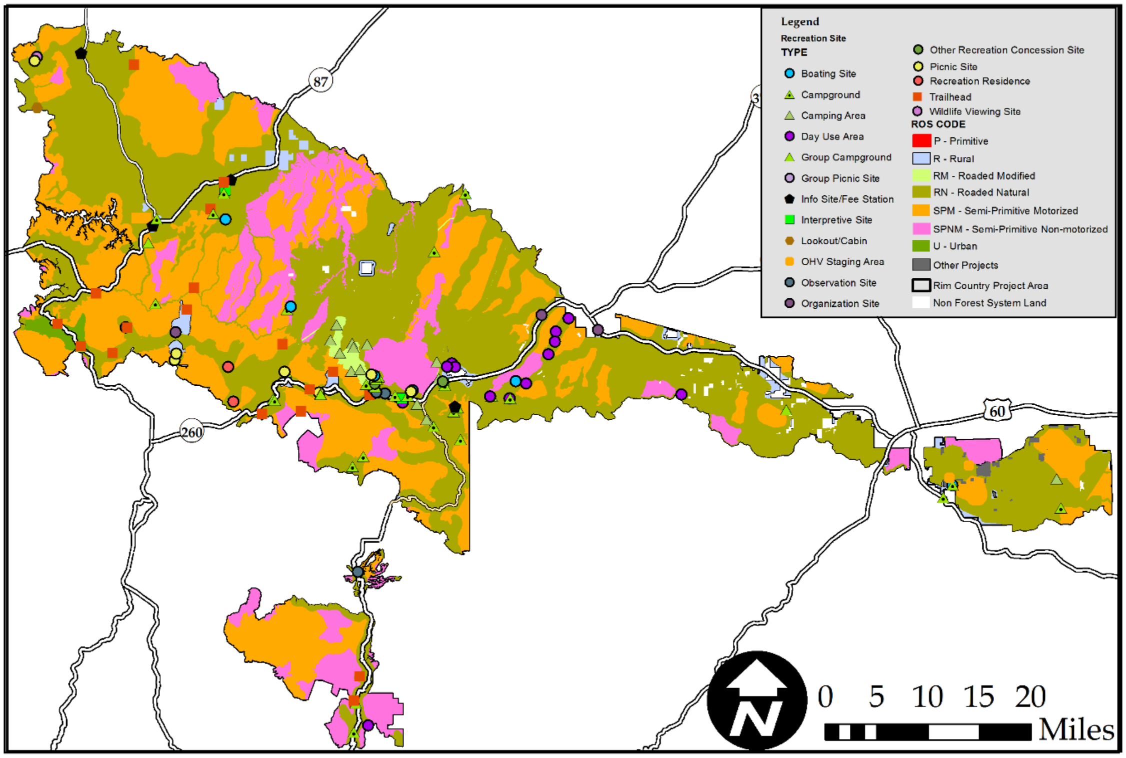

Figure 87. Rim Country developed recreation sites

A spectrum of high-quality outdoor recreation settings and opportunities would be made available in the project area.

Management activities on National Forest System lands are consistent with recreation setting objectives that provide opportunities for the public to engage in a variety of developed and dispersed recreational activities, in concert with other resource management and protection needs.

Assumptions and Methodology

This assessment includes use of the best available science, based on relevant peer-reviewed literature, published reports from regulatory and land management agencies, existing resource inventories, field visits, and the professional judgment of interdisciplinary and cooperating agency team members.

The Recreation Opportunity Spectrum (ROS) is the guiding system that forest plans direct be considered when planning projects to properly manage and balance recreation opportunities. The ROS provides a framework to assist managers in identifying different outdoor recreation environments, settings, activities, and experiences desired by the public, and deciding how to provide these different recreational opportunities over the landscape within the forest (USDA Forest Service, ROS Book, 1986). ROS classifications are identified to distinguish the desired conditions across the landscape. ROS classifications within the project area were referenced to determine if project activities would affect the potential for meeting or moving toward desired conditions identified in the ROS classifications.

The Special Uses Database System was used to generate a list of all recreation special use authorizations within the project area. This report was sorted by status. The authorizations were considered part of the existing condition if they had statuses of application accepted, pending signature, or issued.

Data and experiences from both the 4FRI first EIS and the Cragin Watershed Protection Project were used in this analysis because of proximity to the project area, probability that users would recreate in all these project areas, and the similarity of terrain and vegetation.

The timeframes for direct and indirect effects include the potential for up to 20 years of project implementation. The thinning treatments may take up to 20 years to complete, with each thinning contract generally completed within a three-year timeframe. Implementation may include prescribed burning over a 20-year period, with multiple burn intervals of two to 10 years across the project area. Any direct or indirect effects related to the recreationists' scenery perceptive are described in the scenery report.

Issues/Indicators/Analysis Topics

Analysis topics identified relative to recreation and lands management resources are based on Forest Plan desired conditions, management approaches, guidelines, and standards. There were very few public comments identifying issues or concerns related to recreation, except for potential effects from treatments on the Arizona National Scenic Trail and its users. Consequently, this resource area was determined to require cursory analysis. The primary issue of concern to recreation resources from the proposed activities is to minimize and mitigate impacts to recreation features (for example, developed campgrounds, signs, trails, and trailheads) and recreation activities (for example, driving for pleasure, dispersed camping, hiking, mountain biking, equestrian use, hunting, boating, special use events, and developed camping)..

Environmental Consequences

Alternative 1 – No Action

Under this alternative, recreation resources would be managed as they are currently without any effects from vegetation treatments and prescribed burning proposed in the Rim Country project area. Although electing the no action alternative would not result in impacts to these resources from prescribed burning or thinning, this alternative would not reduce the risk of uncharacteristic wildfire that could cause important resource damage, damage to recreation and lands infrastructure, and subsequent flooding. Wildfires ignited by lightening could be managed for resource benefit given conditions allow; however, the use of this strategy to decrease future crown-fire risk is unpredictable and unlikely to affect a majority of the project area. Alternative 1 is the point of reference for assessing action alternatives 2 and 3.

This alternative would contribute to the same risks identified as indirect effects. The increased risk of uncharacteristic wildfire resulting from this alternative would contribute to the issue of limited recreational access and opportunities on the national forests. Over the last several years, there have been a number of large high-intensity wildfires such as the Wallow Fire, General Fire, which have resulted in area closures and loss of temporary access and recreational use. Given an increasing likelihood of wildfire and a greater likelihood of high-intensity wildfire throughout the southwest under predicted climate change scenarios, the increased risk of wildfire, this alternative would result in a cumulative increase of these effects of risk to permitted infrastructure, limited recreational access, and loss of recreational opportunities and access in project area and surrounding areas. This alternative would also cumulatively combine with the increasing risk of high intensity fire from climate change and result in an elevated risk to lands and events managed under short-term or long-term special use permits.

Recreation Sites and Uses

Recreation Resources

The threat of uncharacteristically severe wildfire continues to increase with ongoing, unmanaged growth of vegetation. Uncharacteristic wildfire would severely influence recreation values and experiences in the analysis area. Research has demonstrated the negative effects wildfire can have on recreation activities. Vaux, et al. (1984) found that “intense fires may have detrimental effects on recreation values” (p.1).

During NVUM, visitors were asked what they would do if they were unable to visit this national forest due, for example, to closures related to wildfire damage and rehabilitation. The majority of visitors responded that they would have gone elsewhere for the same activity. This suggests that if the Rim Country project area was closed due to wildfire or related effects, visitors would seek alternative locations to enjoy the same recreation activities. This could lead to overcrowding in nearby areas, resulting in resource damage and undesirable recreational experiences.

Developed Recreation Facilities

Developed recreation facilities, such as campgrounds and group event sites, could be negatively affected if there is no action to reduce the risk of uncharacteristic wildfire. The changes to landscape character and visual quality following a severe fire would considerably diminish the quality of recreation experiences and activities in affected areas. Effects from severe wildfire on other recreation-related infrastructure such as restrooms, kiosks, bulletin boards, and trail signs would be substantial and would result in high costs to repair or replace damaged facilities. Historic sites such as lookout towers and guard stations could not be replaced if destroyed.

Trails

The Rim Country project area contains parts of four national trails: the Arizona National Scenic Trail (70 miles in the project area), the entire Blue Ridge National Recreation Trail (9.4 miles), the General Crook National Recreation Trail (95 miles in the project area), and the Highline National Recreation Trail (44 miles in the project area). Figure 89 illustrates the locations of the national trails in the project area. The Rim Country project area contains 728 miles of trail, ranging from most primitive to fully developed. Some trails in the Rim Country project area share characteristics with the trails that were damaged in the Schultz Fire. Wildfire or flood damage to segments of trails within the project area would require closures of affected sections until they could be properly repaired and determined safe for use. In the interim, potentially lengthy re-routes would have to be established for visitors wishing to hike any affected trails, especially for the state-wide Arizona National Scenic Trail.

While short-term effects of uncharacteristic wildfires on recreation are almost uniformly negative, longer-term effects may differentially impact certain user groups. Fire-damaged trees can take many years to fall, and it is likely that any affected trail system would experience increased numbers of downed trees across trails for many years, despite routine maintenance. Crossing downed logs on trails is more burdensome for mountain bikers, who must stop, dismount, and lift their bikes over fallen trees, than it is for hikers, who may be able to simply step over these obstacles. Hesseln, et al. (2003) found that the value of net benefits for hikers increased during the 40 years following crown fire, whereas the net benefits for mountain bikers declined over the same period. This demonstrates that different intensity fires may impact groups engaged in different recreation activities in different ways.

Overall trail users respond negatively and have a decreased return to forested areas that have experienced uncharacteristic wildfire. “The lack of mature trees and the large numbers of downed trees make the area unattractive to hikers and mountain bikers” (Starbuck et al. 2006, p. 63). So the no action alternative which has no vegetation management activities or prescribed burning treatments to reduce the risk of wildfire could have negative effects on trails and trail users if an uncharacteristic wildfire was to occur in the Rim Country project area.

Wild and Scenic River

There would be no effect on the Wild and Scenic Rivers as they would continue their management per the direction in the respective Forest Plans.

Dispersed Recreation

Following the Rodeo-Chediski Fire in 2002, dispersed camping in the burned area was prohibited for nearly seven years. The major reasons for this restriction was to protect visitors and property from damage due to falling trees and flooding, and to reduce recreation effects to fragile fire-damaged soils. The time it takes a fire-damaged tree to fall is unpredictable and depends on several factors including weather, topography, burn severity, and flooding. Trees that have been killed or damaged by fire may be unstable and parts or all of such trees can easily become dislodged and can fall onto forest visitors, vehicles, or camping equipment.

Dispersed camping is popular in the Rim Country project area and an uncharacteristic wildfire could result in closing a fire area to camping and other activities. This would impact thousands of visitors every summer that visit the project area to camp in the desirable summer temperatures. Should a wildfire result in large, long-term closures for safety or resource protection purposes, activities such as camping, hunting, and other recreational uses would be lost or severely degraded during both short-term (one to five years) and long-term (five years or more) timeframes.

Recreation Special Uses

Although the no action alternative would not produce any effects from vegetation management or prescribed burning on recreation special use activities, the risk of uncharacteristic wildfire would not be reduced. Uncharacteristic wildfire could impact recreation special uses because sites (recreation events) would likely be unsafe and less appealing for recreation special use activities after such a fire and would likely result in closures (short-term and long-term) depending on severity.

Effects on recreation residences at Diamond Point and Elison Creek, and organization camps including Camp Shadow Pines, Tall Timbers County Park, Arizona Cactus-Pine Girl Scout Camp, and Grand Canyon Council Boy Scout Camp could be extreme. In similar post-wildfire situations, such as after the 2005 Cave Creek Complex Fire on the Tonto National Forest, recreation residences were destroyed by wildfire. After five years of planning, 10 residences were approved for reconstruction and the permits for three residences were either revoked or expired without renewal. Thus, this alternative could result in a long-term decrease in recreational use and opportunity in the project area.

Motor Vehicle Use

Motorized Travel Management implementation in combination with the no action alternative is expected to have no effects on recreation settings. Present and future activities may result in degradation along heavily used camping corridors, but these would be small and localized.

Recreation Opportunity Spectrum

ROS would remain within forest plan guidelines unless stand-replacement wildfire affects a large portion of the analysis area. Locations and results of unplanned fire ignitions are impossible to predict; however, it is likely that an uncharacteristic wildfire would move conditions away from desired conditions for semi-primitive areas where the evidence of humans is meant to be limited (semi-primitive areas). Uncharacteristic wildfire would likely include a number of alterations to the forest environment such as cutting of dead roadside hazard trees, increased signage to warn of post-fire dangers, re-constructed roads, or recently constructed dozer or hand-built fire line. All of these would result in short and some long-term effects that would move conditions away from desired conditions identified for semi-primitive areas.

Effects Common to Both Action Alternatives

Developed Sites

Mechanical and prescribed fire treatments could negatively affect developed recreation sites. However, developed recreation sites would not be modified by any alternatives, as design features have been developed to protect the sites from possible negative effects from proposed treatments in Alternatives 2 and 3.

Recreation Special Use

None of the alternatives would have any effects from vegetation management or prescribed burning on Recreation Special Use activities. All permittees can execute their business as intended by their authorized special use permits.

Effects Unique to Each Action Alternative and Differences among Them

The Modified Proposed Action and the Focused Alternative, which include different amounts of thinning and prescribed burning, would reduce the risk of extensive crown fire and uncharacteristic wildfire. These alternatives would protect the developed campgrounds, lands infrastructure, trails, and dispersed recreation areas within the project area, maintaining open recreation areas and activities for users during and in the years following the project implementation. Shorter-term impacts would occur to uses during implementation, including the potential impacts from larger processing sites near residences, highways, and dispersed recreation areas.

In the long term, the Modified Proposed Action would support the health and safety of recreationalists and surrounding communities, as well as reduce potential effects on water supplies, utilities, and other infrastructure within and adjacent to the project area.

Trails

Overall, trail users respond negatively and have a decreased return to forested areas that have experienced uncharacteristic wildfire. Trail users would be minimally affected by the proposed treatments in both Alternatives 2 and 3 since design features are developed to mitigate any issues related to trails. Effects like visitor displacement and possible overcrowding of some areas where visitors choose to go instead of areas closed or disturbed by proposed treatments are difficult to estimate. However, all three alternatives present different possibilities of risks of uncharacteristic wildfires. Alternative 2 has the lowest risk because of its sizeable amount of acres treated. Alternative 3 would have lower risk than the no action alternative and higher risks than the Modified Proposed Action. The greatest effects on trails would result from uncharacteristic wildfires. This risk can be reduced with proposed treatments. Alternative 1 poses the greatest threat to the trail systems, followed by Alternative 3. The Modified Proposed Action

(Alternative 2) offers the best possible outcome for the current and future use of the trail systems, treating the most acres of forest.

Dispersed Recreation and Motor Vehicle Use

Dispersed recreation and motor vehicle use display the same effects from Alternatives 2 and 3, while. Alternatives 2 and 3 might result in some reduction of recreation opportunities during active forest thinning and prescribed burning, and potentially longer slash treatment duration. 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.

Alternatives 2 and 3 propose to decommission 200 miles of existing system and unauthorized roads on the Coconino and Apache-Sitgreaves National Forests and 290 miles on the Tonto National Forest. In addition, up to 800 miles of unauthorized roads on all three forests could be decommissioned under these alternatives. The Rim Country Project would adhere to the travel management decisions for the Coconino, Tonto, and Apache-Sitgreaves National Forests. Design features would address any issues related to the construction of temporary roads for haul access, insuring decommissioning of all temporary roads after treatments are completed. Hence, both alternatives would reduce access or ease of access to recreate in certain areas on the forests. However, decommissioning unauthorized roads could positively affect recreation resources by protecting resources and removing access to motorized recreation where unlawful.

Alternatives 2 and 3 would have similar effects, but would vary proportionally with treatment area size. Minor effects would be mitigated through design features.

Recreation Opportunity Spectrum

Alternatives 2 and 3 might cause temporary effects on recreation users at particular areas during implementation activities, mainly thinning operations and hauling. There would be longer term potential effects of increased traffic and noise near processing site locations. However, since most of the project area is located within Roaded Natural, Semi-Primitive Motorized, and to a lesser amount Semi-Primitive Non-Motorized ROS settings, these effects would be consistent with recreation opportunity objective settings for the majority of the project area.

Alternative 2 – Modified Proposed Action

Recreation Sites and Uses

Developed Sites

Any vegetation treatments or prescribed burning in developed recreation sites would generally occur in fall, winter, or spring, which are low-use recreational periods. All treatments in recreation sites would be designed to protect and enhance existing vegetative structure, while maintaining the character of the site. Proposed mechanical treatments and prescribed fire adjacent to developed recreation sites must be reviewed and approved by the district ranger. The district recreation staff may help determine boundaries or no treatment zones around constructed features that need to be protected in campgrounds. Treatments around the perimeter of campgrounds are encouraged. The timing of treatments must be worked out with districts. Treatments would generally avoid summer. Activity slash must be piled in agreed upon locations, and treated as soon as possible. If campgrounds remain open into fall and winter, provide information about upcoming closures and management activities on-site, at Forest Service offices, and on Forest Service websites (see recreation design features in Appendix C).

Facilities at developed sites and campgrounds in the project area would be protected from adverse effects from management activities, and such treatments would protect the developed sites from any short or long-term risk of uncharacteristic wildfire.

Trails

Trail use level is not expected to change. The Modified Proposed Action includes prescribed burning and thinning activities adjacent to the Arizona National Scenic Trail, Highline Recreation Trail, and General Crook National Recreation Trail. Trails within the project area may be temporarily closed during prescribed burning activities but, throughout project implementation, trails and trail infrastructure would be considered and protected, and effects on scenic qualities minimized to the extent practicable. Damage to trails or necessary trail maintenance resulting from prescribed burning or mechanical treatments in the area would be rehabilitated as soon as possible.

In the Modified Proposed Action, mechanical thinning activities would avoid national and forest system trails if possible. Coordination with district recreation planners, trails specialists, and local trail stewards would occur during prescription or burn plan development, layout, marking, thinning, and burning where any treatment would occur on, adjacent to, or near national and system trails. This is to ensure that trails and trail infrastructure are considered and protected and effects on scenic qualities are minimized to the extent practicable. If trails were temporarily closed due to thinning, trails would be returned to pre-treatment conditions (see recreation design features in Appendix C).

Skidding of felled trees would avoid national and forest system trails, if possible, except where motorized use is already authorized (trails located on open system and administrative roads). If it were determined necessary that a trail must be used as a skid trail crossing, perpendicular trail crossings would be used. Trail crossing locations, including those on the Arizona National Scenic Trail and the General Crook and Highline National Recreation Trails would be designated and flagged with input from district trails specialists, recreation planners, or archaeologists. Trails would be restored to Forest Service standards (pre-project condition) following treatment.

There would be no use of motorized equipment on national scenic and recreation trails, or other forest system trails. If these were used for control lines, the district recreation staff would help coordinate the implementation. Where new temporary roads intersect existing roads or trails, native materials such as logs, slash, and/or boulders would be placed along the temporary road to line-of-sight or first 300 feet, whichever is greater.

Road closures, one-way traffic, and area closure restrictions would be implemented as deemed necessary by forest officials for health and safety concerns during any operation. Signs would be placed at major intersections on hauling routes during periods of active hauling. If it is necessary to close forest roads or areas of the forest, notices and signs would be posted at key locations adjacent to and within the project area, such as along major Forest Service roads accessing the area or on kiosks at trailheads, bulletin boards, electronic sign boards. Closures due to operations would also be posted online and on social media as well as being publicized via news releases. Coordination is required with district recreation planners or trails specialists to ensure well-marked and publicized detour routes for the Arizona Trail, General Crook Trail, Highline Trail, and system trails during operational closures.

Dispersed Recreation

Vegetation treatments, prescribed burning, and fuel treatments, occurring over time and space, would have little effect on the recreating public. Alternative 2 would support the re-integration of low-intensity fire as a regulatory process on the landscape. Several cases show low-intensity wildland fires yielding virtually no effects on recreational value and in some instances imparting positive social impacts. Both Sanchez et al. (Sanchez, 2016) and Starbuck et al. (2006) show visitations in California and New Mexico increasing under low-intensity fire scenarios. The only anticipated effect that the Modified Proposed Action would have on dispersed recreation is when prescribed burning coincides with hunting seasons, especially in the fall of the year, or during brief closures of campsites, roads, or trails.

There may also be temporary area closures while prescribed burns are being implemented and, less often, closures for managed fire activities. Spring burning would affect fewer people using dispersed campsites. In total, the action alternatives are not expected to considerably affect dispersed recreation within the project area. Treatments would be planned to be staggered throughout the project area in both time and space, so that even during temporary closures from active treatments, there would be many other places to hunt, camp and recreate. Efforts would be taken to limit forest treatment activities within the project area during high-use weekends and holidays, such as Memorial Day, Independence Day, and Labor Day, especially in locations where concentrated use is expected to occur.

Temporary closures from treatments would result in the temporary loss of recreational access or opportunities and could result in decreased satisfaction of nearby recreational sites where there is overcrowding. This is most likely to occur during high-traffic weekends from Memorial Day through Labor Day, which often includes heavy use of dispersed camping sites within the project area. It can also occur during hunting season.

The transportation system proposed for use under Alternative 2 utilizes a combination of existing Forest Service system roads, improved existing non-system roads, and new temporary roads. No new permanent roads are proposed. Road use during the project for hauling and prescribed burning would affect dispersed recreational uses such as OHV riding where project activities occur on MVUM open roads. Dispersed camping areas along open roads that are being used for implementation may be affected by noise and dust.

There may be temporary road closures enacted during thinning operations or prescribed burning, but these closures would be short term for burning and mainly on Forest Service administrative use roads. The effects from disturbance and closure would be a minor effect on dispersed recreational uses, because they would be of limited duration and there would be many other open areas to camp and recreate during this time.

Spring restoration and improvements would improve the resilience of these areas and make them more attractive to dispersed recreationists. Water in the Southwest is a rare feature, and people are attracted to it for recreation activities including hiking, picnicking, camping, scenery, wildlife and wildflower viewing.

Recreation Special Uses

The Modified Proposed Action would reduce the risk of uncharacteristic wildfire in areas with recreation special uses activities. Coordinated efforts would be made with sponsors of recreational special-use events such as running or mountain biking races, to minimize the effects of such proceedings during Rim Country project implementation. Appropriate signage would be used to inform the public of thinning or prescribed burning activities. The Modified Proposed Action would allow for continued recreation special use activities at current levels throughout the project area during and beyond the timeframe of project implementation.

Wild and Scenic River

Proposed treatments would have no effect under alternative 2 on the Wild and Scenic Rivers. All possible effects would be addressed as per the design features, best management practices and mitigations per Appendix C (Design Features).

Motor Vehicle Use

There would be log truck and other activity-related traffic on the designated road system, although not all roads would be used as haul routes. Hauling would not occur on all roads at the same time. Recreationists could expect increased noise, dust, and traffic on some haul routes.

Approximately 150 miles of existing non-system roads would be reconstructed or improved as part of project implementation.

There would be short-term disturbance and temporary changes in ROS classes and roadside recreation settings during road improvement activities. Recreation visitors may be inconvenienced and have to wait during some activities, or roads may be temporarily closed causing displacement. Road relocation would result in a safer road to travel on. It would also result in short-term disturbances such as increased bare ground and decreased roadside visual quality in scattered locations. Long-term effects would be improved water quality at stream crossings, and safer and better-maintained roads for forest user enjoyment.

Road decommissioning would occur on approximately 200 miles of existing system roads on the Coconino and Apache-Sitgreaves National Forests and approximately 290 miles of roads on the Tonto National Forest. Up to 800 miles of unauthorized roads on all three forests could be decommissioned under this alternative.

Short-term effects of road decommissioning would include ground disturbance and sedimentation and noise disturbance to recreationists. Short-term effects would last from three to 10 years as the project activities rotate across the landscape. There would be a long-term improvement of recreation settings as vegetation is established, soil erosion is minimized, and there is decreased disturbance from motorized vehicles. Once recovered, these former routes are often not apparent to the casual user. Decommissioning 200 miles of roads would improve recreation settings over time and would improve ROS classes, especially in the semi-primitive non-motorized ROS class where all 85 miles of haul routes would be decommissioned.

About 330 miles of temporary roads for haul access would be constructed to support restoration activities. Construction may include tree removal, ground disturbance, and installation of drainage structures, road blading, and other disturbances. Following implementation, the temporary roads would be obliterated using techniques noted for road decommissioning. Temporary road construction would result in short-term disturbance. When possible, there would be relocation and reconstruction of existing open roads adversely affecting water quality and natural resources, or of concern to human safety. This would have long term-positive effects on water quality, natural resources, and human safety.

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 the use of Best Management Practices (BMPs) (see Appendix C).

Recreation Opportunity Spectrum

There may be temporary effects on recreation users at particular areas during implementation activities, mainly harvesting operations and hauling. There would be longer term potential effects from increased traffic and noise near processing site locations. However, since most of the project area is located within Roaded Natural and a small amount of Rural ROS settings, these effects would be consistent with recreation opportunity objective settings for the majority of the project area.

Construction of all new temporary roads would be similar to a primitive, native surface road that would be cleared and opened for short-term use during thinning and hauling operations. The construction and use would be consistent with the RN or SPM designations and, after use; the temporary road would be completely rehabilitated and would become naturalized within several years after use. The very slight encumbrance of the SPNM area would likely not result in long-term effects to the ability of the area to meet SPNM characteristics over the long term.

Mechanical treatments would primarily occur in RN (50 percent) and SPM (35 percent) areas, with a lesser amount occurring in SPNM (13 percent) in the project area. Mechanical treatments would be expected to result in short-term effects (one to two years after treatment) where the sights and sounds of humans are more noticeable on the landscape. However, after a short period of time and subsequent treatments such as prescribed fire, the evidence of treatments would fade and is not expected to affect ROS designations. As a result none of the mechanical treatments would prevent an area from meeting or moving toward ROS classifications over the long term (greater than one year).

Spring restoration and improvements would improve the resilience of these areas and make them more attractive to dispersed recreationists. The proposed improvements may cause short-term changes in the recreation settings, but would result in improvements in the setting characteristics and ROS classes over time. In both action alternatives, up to 184 springs would be improved. Mitigations to use native materials or natural-appearing materials appropriate to the ROS setting would result in natural-appearing improvements. The spring improvements would improve and meet ROS classes.

The 777 miles of channel restoration proposed would improve recreation settings over time. Mitigations to use native materials or natural-appearing materials appropriate to the ROS setting and consultation with a landscape architect regarding project design would result in natural-appearing improvements. The channel improvements would improve the settings and meet ROS classes.

Aspen treatments would take longer for recreation settings to be natural appearing in roaded natural and semi-primitive settings due to the need to fence or create barriers to ungulate grazing. Aspen groves are popular recreation settings for many users throughout the year, but especially for fall color viewing. The restoration activities would assure that aspen continue as a vital component within the ponderosa pine forest. There would be short to moderate term changes in ROS settings where aspen are treated. Aspen restoration requires that ungulates be kept out of sprouting trees until they are large enough to withstand the browsing pressure. Fencing and jackstraw piling are both proposed methods for keeping the ungulates out.

Up to 200 miles of protective barriers around springs, aspen, native willows, and big-tooth maples, as needed for restoration, would be constructed. This would cause temporary changes in the ROS class setting characteristics since the natural-appearing environment would be somewhat altered. More developed settings would appear altered for a shorter period since human alterations may be visible in these settings. Since the barriers must stay in place for many years, the primitive ROS settings would be altered for at least 20 years or until the trees can survive browsing. When the protective barriers are removed or begin to break up and decompose, treatment areas would meet ROS classes.

Alternative 3 – Focused Alternative

Recreation Sites and Uses

The effects from Alternative 3 would be the same as those described for Alternative 2 with the exception of the number of acres restored. The same design features would be applied for both Alternative 2 and Alternative 3. Alternative 3 would treat 47 percent fewer acres than Alternative 2. Approximately 39 percent fewer acres would receive mechanical and prescribed fire restoration treatments, about 26 percent fewer prescribed fire-only. Additionally, the Severe Disturbance Area Treatments would be 78 percent less in Alternative 3. Alternative 3 would have less potential to reduce the risk of large-scale, high-severity fires in the project area. It would have less of a positive effect than Alternative 2 on protecting and maintaining high quality recreation settings over time.

Developed Sites

Any vegetation treatments or prescribed burning in developed recreation sites would follow the same design features as in Alternative 2. Consequently, the effects from management activities on developed sites would protect the developed sites from any short or long-term risk of uncharacteristic wildfire similarly to Alternative 2. However, facilities at developed sites and campgrounds in the project area would be less protected from adverse short and long term effects from the risk of uncharacteristic wildfire because of the fewer area treated.

The effects explained in Alternative 2 would be the same for the following areas: dispersed recreation, trails, and recreation special use

Motor Vehicle Use

About 170 miles of temporary roads for haul access would be constructed to support restoration activities as compared to 330 miles in Alternative 2. As indicated in Alternative 2, following implementation, the temporary roads would be obliterated using techniques noted for road decommissioning. Temporary road construction would result in short-term disturbance. When possible, there would be relocation and reconstruction of existing open roads adversely affecting water quality and natural resources, or of concern to human safety. This would have long term-positive effects on water quality, natural resources, and human safety. The short-term disturbance would be less than Alternative 2 since there would be 50 percent less temporary roads built in this alternative. Additionally, there would be less 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.

Recreation Opportunity Spectrum

Alternative provides for the long-term protection of recreational settings and facilities on 483,160 acres where mechanical thinning and burning would occur, by improving stand conditions and reducing fuel loading, and would lower the risk of high-severity. Maintaining healthy, green forests and reducing the risk of large-scale, high-severity fires in the project area would have a positive effect on protecting and maintaining high quality recreation settings into the future. Effects from Alternative 3 would be similar to those from Alternative 2 although on an area almost half the size.

Mechanical treatments would primarily occur in RN (50 percent) and SPM (35 percent) areas, with a lesser amount occurring in SPNM (13 percent). Mechanical treatments are expected to result in short-term effects (one to two years after treatment) where the sights and sounds of humans are more noticeable on the landscape. However, after a short period of time and subsequent treatments such as prescribed fire, the evidence of treatments would fade and would not be expected to affect ROS designations. As a result, none of the mechanical treatments would prevent an area from meeting or moving toward ROS classifications over the long term (more than one year).

Effects from Rock Pit Use and Expansion

Effects Common to All Alternatives

All alternatives would increase the level of noise, dust, and traffic in the project area. All alternatives would cause a temporary loss of access to desired recreation areas when rock pits are being used to process roadbed material and mine. There would also be potential safety issues when recreationists are using roads that are haul routes for roadbed material.

There would be no direct or indirect effects on recreation special use permittees as they could continue their normal operations as directed in their permit. Motor vehicle use should not be affected, as these rock pits would not add any access restrictions or modifications affecting recreationists.

Most rock pits are located in ROS in forested areas making them difficult to view. Under both action alternatives, design features would help mitigate the impact to recreation from rock pits.

Alternative 1- No Action

General Effects to Dispersed Recreation, Recreation Special Uses, Developed Recreation Sites, Trails and Motor Vehicle Use

If Alternative 1 were to be implemented, there would be rock mining, processing, and hauling activities at the existing and currently operational rock pits.

Alternative 1 could cause a short-term disruption of recreation uses and displacement of recreation users at and near the existing and operational pits during times when aggregate materials are being hauled. This would have the effect of concentrating operations and hauling to a relatively small number of locations, and as a result this alternative would concentrate rock mining, processing, and hauling at currently operating pits or on main hauling routes (when aggregate material is purchased from private sources and hauled onto the forests), increasing the amount of time spent in each location since fewer pits would be used.

Alternative 1 would include dust and noise impacts to nearby trails and recreation areas. Portions of the trails and recreation areas in proximity to these rock pits would likely experience increased dust, noise, and perceptions of human activity when the pits are operational. These effects would be temporary and short term.

Recreational Opportunity Spectrum

Rock pits are located in Roaded Natural, Roaded Modified, and Semi-Motorized ROS setting. The pits developed in these settings would comply with the setting characteristics. Since the pits are located away from or not in the viewshed of primary (sensitive) travel corridors, these would comply with the setting characteristics.

Effects Common to Both Action Alternatives

General Effects to Dispersed Recreation, Recreation Special Uses, Developed Recreation Sites, Trails and Motor Vehicle Use

Effects from Alternative 2 would include dust and noise effects on these resources. Portions of the trails and recreation areas that are in proximity to these trails would likely experience increased dust, noise, and perceptions of human activity. However, the maximum values of estimated noise levels for most of the heavy equipment associated with pit development would be in the 40-50 dB range for locations 0.5 miles away, or comparable to a running computer or refrigerator.

Effects from Alternative 2 would include disruption of recreation use at and near pits where roadbed materials are being mined and processed, and along haul routes that provide recreational access. Access to desired recreation resources could be altered, requiring recreationists to use another route, or go to another recreation resource where access is not disrupted by hauling activities.

There could also be safety impacts if recreationists are using the same roads as those used for hauling. Potential safety impacts to recreationists would be reduced by placing signs at major intersections on hauling routes during periods of active hauling. The effects at, and in proximity to, active pits would be temporary and short term. With the application of recreation design features, effects on trails and recreation areas would be temporary, short-term, and therefore less than significant.

Recreational Opportunity Spectrum

Most of the rock pits are located in Roaded Natural settings. One rock pit is located in the Roaded Modified and two rock pits are located in Semi-Motorized ROS setting. The pits developed in Roaded Natural, Roaded Modified, and Semi-Motorized settings would comply with the setting characteristics. Since the pits are located away from or not in the viewshed of primary (sensitive) travel corridors, these would comply with the setting characteristics.

The pits are similar to a very small mechanical treatment area, which would generally be consistent with natural vegetation patterns. For example, rock pit development would occur at the scale of non-ponderosa pine inclusions such as aspen and meadows that naturally occur in northern Arizona forests. The development would meet the intent of the management direction in the Apache-Sitgreaves Forest Plan.

Effects from Use of In-woods Processing and Storage Sites

Most processing sites are located in forested areas making them difficult to view even from 300 feet to 0.5 miles.

Alternative 1 - No Action

Alternative 1 does not propose in-woods processing sites and storage sites and would not initiate human-caused changes to the recreation resources within the project area. Alternative 1 would meet the ROS in both the Coconino and Tonto National Forests.

Alternative 2 – Modified Proposed Action

The processing sites may be used as part of 4FRI Rim Country Project implementation. Following completion of use of processing sites and removal of all equipment and materials, site rehabilitation would have to be accomplished, including but not necessarily limited to removal of aggregate, restoration of pre-disturbance site grades, de-compaction of soil for seedbed preparation, and seeding and mulching of the site with native grasses and forbs. To hasten recovery and help eliminate unauthorized motorized and non-motorized use of skid trails and temporary roads, physical measures would be used such as recontouring, pulling slash and rocks across the line, placing cull logs perpendicular to the route, and disguising entrances.

Of the proposed 12 processing sites, nine are in Roaded Naturel ROS, 3 are in Semi-Primitive Motorized and one overlaps Semi-Primitive Motorized and Semi-Primitive Non-Motorized. Development and operation of the processing sites would not conflict with desired conditions for SPM and RN designations where there are occasional or regular sights and sounds of human influence. The processing sites could have a broader effect on ROS experience in the immediate area where operations can be heard and seen (0.14 to 2.4 miles around a site), but these would not be inconsistent with the RN, SPM, or SPNM settings. During use of a processing site, the appearance of the forest would change because most of any existing trees would be cleared on the site. The locations of the processing sites have been selected to limit the need for tree removal and would be designed so that there is visual screening from the main roads, thereby moderating the visual effects of the sites. In addition, during use there would be increased traffic and interaction between log trucks, chip vans, or other vehicles and equipment in use at the site and public use of the forest. The time of effects to ROS from the processing sites would be variable: smaller processing sites would be used over a shorter time (5 to 10 years) than the larger sites that could be in use from 10 to 20 years. After use, the areas would be completely rehabilitated and trees and vegetation would slowly be reestablished.

All of the sites are located 100 to 300 feet from forest system roads to provide for visual screening. Effects on dispersed recreational use from the processing sites includes noise disturbance from equipment and increased truck traffic entering and leaving the site. These effects would range from temporary, over a few months when the mechanical operation are active, to several years for the large sites (10 to 15 acres) that would service as focal points for in-woods processing of logs, etc.

There could be longer-term use of some processing site locations under the larger 4FRI implementation effort. Therefore, the authorization of these sites may combine with the effects from other projects occurring within or adjacent to the Rim Country project area, or in the 4FRI footprint, resulting in longer term effects from their use. Those effects would be related to noise and traffic near some processing sites.

Alternative 3 – Focused Alternative

Effects on recreation resources would be of the same type as described for Alternative 2, as all proposed in-woods processing sites could potentially be utilized.

Cumulative Effects

The cumulative effects analysis area is the Rim Country project area. The timeline for analysis is 20 years because most long-term effects of the alternatives are assessed out to a 20 year timeframe (with the exception of large-scale high-severity wildfire, which is more difficult to project).

The public experiences the cumulative effects of past management activities as the existing conditions.

Alternative 1 – No Action

Increasing population growth is also expected to drive increasing recreational demand, which would further result in decreasing recreational access and opportunity. By 2020, the Coconino National Forest is expected to experience an addition 338,000 national forest visits per year compared to current use (English and others 2014). Closures resulting from wildfires within or near the project area would combine to further reduce the available supply of recreation opportunities and access compared to demand, and would result in fewer visits to the national forests in some cases, increased crowding, and degradation of user experiences in surrounding areas that forest users travel to as a substitute recreational experience.

Alternative 2– Modified Proposed Action

Alternative 2 would restore the ponderosa pine forest health and sustainability on 889,340 acres; this combined with other restoration activities would decrease the risk of high-severity wildfire or large insect outbreaks. Increasing numbers of recreation users and demand for ponderosa pine recreation settings would 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, as well as similar vegetation and burning projects such as Upper Beaver Creek Forest Restoration, and Rim Lakes Forest Restoration, would be expected to result in cumulative retention of or improvement in the quality of recreation settings and an increase in the ability of the Apache-Sitgreaves, Coconino, and Tonto National Forests to meet recreation demands over the long term.

Past vegetation management activities resulted in an even-aged forest structure that is generally undesirable for recreation settings. It contributed to the scarcity of large, mature trees, and has not resulted in a forest with a more 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 all three forests, as well as opportunities for managed wildfire, would 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-severity fire and smaller scale insect infestation. The cumulative effects on desired recreation settings and ROS class characteristics forest users seek would be to maintain and improve them.

Alternative 2 is expected to have mostly positive effects on recreation settings due to the decommissioning of user-created routes and some existing forest roads. The quality of some recreation settings in ROS classes were declining due to unconfined motorized use. 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 because of these activities.

No new road construction is proposed now or in the future in cumulative effects projects. Motorized trails 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 re-established.

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-severity wildfires (Westerling 2006) (Marlon 2012)(CLIMAS. 2011). Unmanaged forests have shown increases in tree stress and mortality as a result of global warming, and old, mature trees are especially vulnerable(Ritchie and others 2008.; Van Mantgem 2009.; Williams 2010). When added to other restoration projects in the cumulative effects area alternative 2 may cumulatively result in improved forest structure, composition and diversity, more resilient forest conditions, decreased tree stress, and the potential for decreased mortality creating a more pleasant experience for visitors

Over time, effects would lessen and the crown fire risk predicted for the project area as a result of climate change would decrease. Recreation structures and environment would be made more resilient to wildfire effects by mechanical thinning and prescribed fire treatments. Since direct or indirect effects resulting from project activities would be mitigated by project design features, there would be no cumulative effects on trails, recreation sites, other structures related to recreation, and recreationists' experience.

Ongoing or planned projects of a similar nature to Rim Country within the project boundary include the Cragin Watershed Protection Project (64,430 acres), Upper Beaver (49,210 acres), Timber Mesa Vernon (41, 162 acres), Upper Rocky Arroyo (33,436acres), Larson (30,041 acres), Rim Lakes (33,770 acres) and Clint Wells (17,741 acres). These thinning and burning projects would have similar effects on recreation as Rim Country and resource impacts would be mitigated similarly. The Rim Country Project, in combination with ongoing and future projects, would not result in any detrimental cumulative effects to recreation.

Alternative 3– Focused Alternative

The focused alternative would have similar minor, short-term, and temporary negative direct and indirect effects on recreation sites and uses as Alternative 2. As noted, less area inside the project boundary would be affected by treatments. Consequently, the predicted crown fire risk because of climate change would menace more area in the project area than in Alternative 2. This would heighten the danger of disastrous consequence to recreation structures, sites, and recreation settings.

Rock Pit Use and Expansion

Alternative 1 – No Action

This analysis includes the potential cumulative effects to recreation during the 20-year implementation of this project. Numerous other projects would require the use of the same roads that are used to access recreational resources on the three national forests. Other restoration projects would still result in a cumulative increase in hauling by heavy machinery on main forest travel corridors and concentrated hauling for periods of several weeks in project areas.

The cumulative effects would be an increase in potential safety hazards such as dust and truck traffic to motorized recreation users, especially during duplicate hauling periods (which includes hauling associated with road maintenance and hauling associated with tree and slash removal). However, this cumulative effect is considered less than significant because of the long period and large area for implementation of the future foreseeable actions. If any activity from a particular project in combination with actions associated with existing rock pit activity were to affect recreational access, recreationists could find other areas on the three national forests with similar recreation opportunities.

The largest cumulative effect from this alternative would be the cumulative effect of hauling, causing traffic, noise, and dust in areas near recreation sites or on the main road system being used to access recreation opportunities. Under tis no action alternative, there would still be cumulative effects on the recreational experience for several thousand forest visitors over the next two decades.

Effects Common to Both Action Alternatives

The cumulative effects from both action alternatives (Alternatives 2 and 3) would be similar to those under Alternative 1, which include the effects of hauling, and causing traffic, noise, and dust in areas near recreation sites or on the main road system being used to access recreation opportunities. However, since more rock pits would be available for use, this would spread the effects to more areas while lessening the effects in areas where rock pits would be more intensively used without the addition of the new rock pits. The cumulative effects would be less for Alternative 3 since the treatment area is half the size of Alternative 2.

Scenery

A summary of the scenery report is presented here. The specialist report (Fargo 2019) is incorporated by reference. This analysis for the Rim Country Project is consistent with scenery-related Apache-Sitgreaves, Coconino, and Tonto Forest Plan direction, USFS policies, and applicable elements of Forest Service Scenery Management Systems.

Affected Environment

The 4FRI Rim Country Project area is important to many for its unique scenic qualities. These scenic qualities are admired from the panoramic views of the Mogollon Rim, four national trails, and the many developed recreation sites and scenic roads that wind through the project area. Due to the high concentration of visitors to the project area, the scenic resources of this area are critical to their experiences and perceptions.

The Apache-Sitgreaves, Coconino, and Tonto National Forests' natural, cultural, and historic resources provide diverse outdoor recreation opportunities that connect people with nature in a variety of settings. Forest users can hike, bike, drive motorized vehicles, camp, fish, view wildlife and scenery, and explore historic and prehistoric places. They enjoy opportunities for year-round recreation activities from birding and wild flower observing in the spring to hiking in summer months, fall color viewing and hunting, and cross country skiing in the winter. See the Recreation Report for more detail on developed recreation sites, the Recreation Opportunity Spectrum classifications, and other recreation information specific to the Rim Country project area.

In all three forests in the project area, the existing condition of scenic resources is a result of implementing the forest plans. The management of multiple resources has, to varying degrees, altered the natural landscape character. The most obvious effects on scenic resources within the project area are from vegetation and landform alterations. Resource management activities which have altered scenic resources include vegetation management, mineral extraction, utility corridors, roads and trails, development of recreation sites such as campgrounds and picnic grounds, improvements associated with special use permitted sites, livestock grazing, and fire management (suppression and prescribed burning).

The three Rim Country forests have developed a recreation niche setting to provide general context for the importance of inherent scenic qualities that contribute to the landscape character. These qualities include aesthetic, social, and biophysical features specific to Rim Country. The importance of scenic assets for recreation is described in greater detail, with supporting recreation niche maps in the scenic resource report.

Scenic Character Description

The project area is viewed at foreground, middleground, and background distances from sensitive roadways, trails, and recreation sites located inside and around the project boundary. These areas and routes, outlined in the scenic resource report, receive high use and the users have high concern for scenery. Figure 88 defines the landscape distance zones utilized in the analysis. (Forest Service 2000).

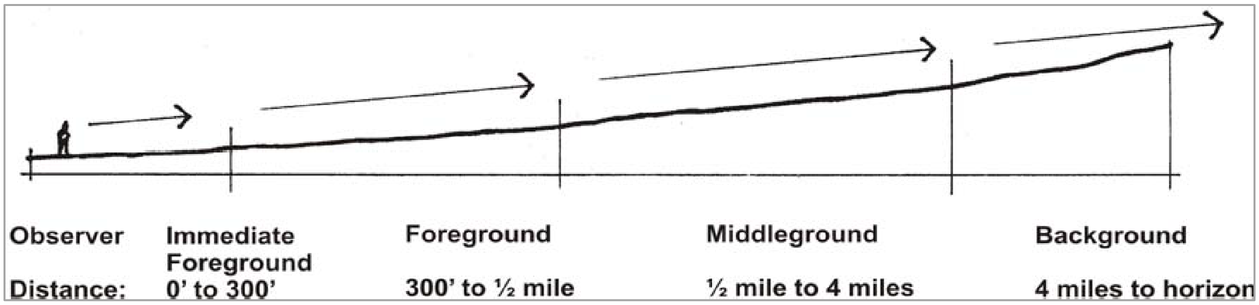

Figure 88. Landscape distance zones

The forested landscapes in the Rim Country project area are highly departed from desired conditions, lacking desired species composition, spatial arrangement, and structure, and are very dense as measured by basal area, trees per acre, and stand density index. Some of these areas are at high risk for disturbance from undesirable fire behavior, insects and disease, and climate change.

The exclusion of fire has resulted in high canopy cover and high tree density. Consequently, understory vegetation which includes aspen, oak, and other species of shrubs, grasses, and forbs is less diverse and more sparse. In the meadows and grasslands of the Rim Country project area, covering approximately 21,000 acres, conifers and junipers have encroached into these once open grassland habitats, decreasing the size and function of landscapes that were historically grasslands.

There are 728 miles of trails identified in the project area including four national trails (Figure 89). These trails offer unique recreational opportunities and an opportunity to experience the scenic quality of the project area. The following national trails are located within the project area:

- The General Crook National Recreation Trail is a 138-mile-long historic route. Portions of the trail are located on the Coconino and Apache-Sitgreaves National Forests. The trail follows the Mogollon Rim, one of the more striking geologic features in Arizona, offering spectacular views of the states central mountains and desert. Approximately 95 miles of this trail are located in the project area.
- The Arizona National Scenic Trail is a continuous, more than 800-mile diverse and scenic trail across Arizona from Mexico to Utah that crosses through the Coconino and Tonto National Forests. It links deserts, mountains, canyons, communities, and people. Approximately 70 miles of this trail are located in the project area. Approximately 30 miles of its segments overlap with other trails in the project area.
- The Blue Ridge National Recreation Trail is a 9.4-mile loop trail located on the Apache-Sitgreaves National Forests that follows Billy Creek and winds its way through ponderosa pine forest to the top of Blue Ridge Mountain. The entire trail is within the project area.
- The Highline National Recreation Trail offers beautiful vistas of rim canyons, brushy hills, distant mountains, unique rock formations, and wonderful stands of ponderosa pine. The Highline Trail runs essentially east to west below the Mogollon Rim and roughly following it. Approximately 44 miles of this trail are located in the project area.

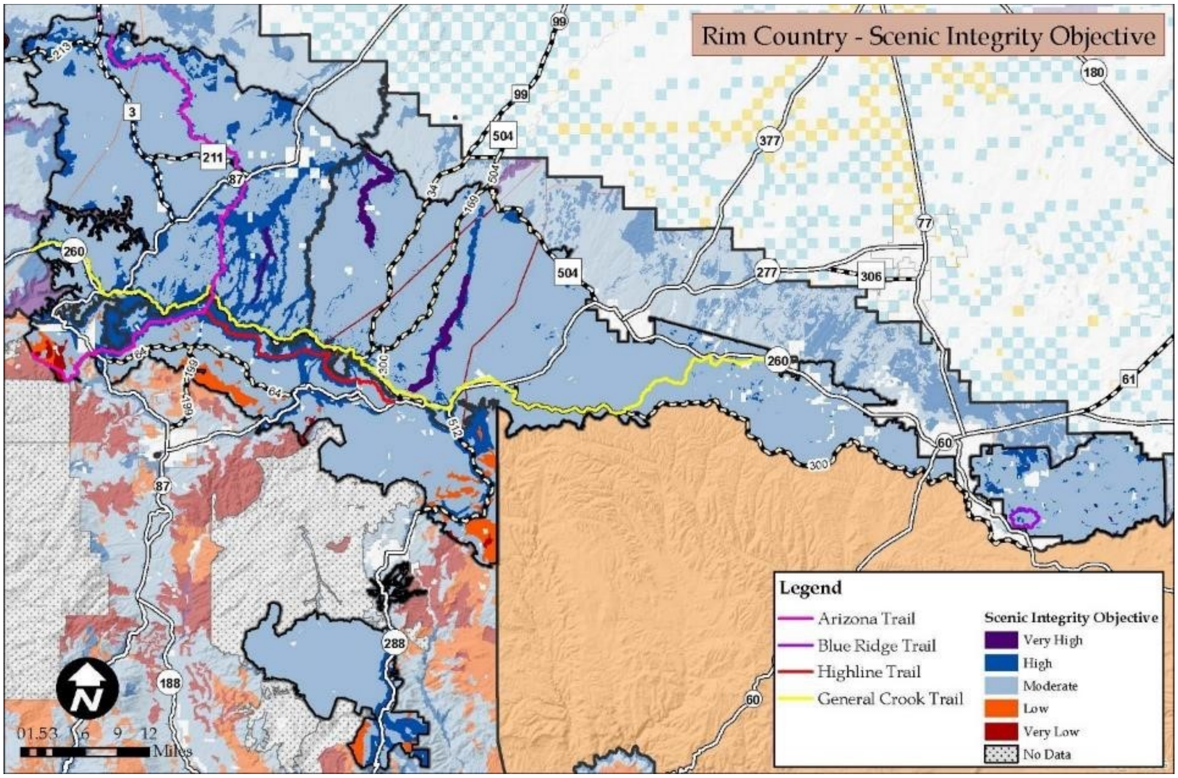

Figure 89. National trails in the Rim Country Project area

There are nine segments of eligible wild and scenic rivers on the Apache-Sitgreaves and Coconino National Forests that contribute to the scenic quality of the project area. Each system has a buffer of one-quarter mile where a High scenic integrity objective must be maintained per the forest plans. In addition, as part of its forest plan revision process, the Tonto National Forest is completing an updated eligibility report for wild and scenic rivers which would replace the existing eligibility report from 1993. To ensure compliance with current forest plan direction, this analysis includes both the eligible rivers reported in the 1993 study, as well as those listed in the current draft eligibility report. Figure 90 and Figure 91 display the locations of the eligible wild and scenic rivers on the Apache-Sitgreaves and Coconino National Forests relative to the project area, as well as the rivers from the 1993 eligibility report and the current eligibility study (ongoing) for the Tonto National Forest.

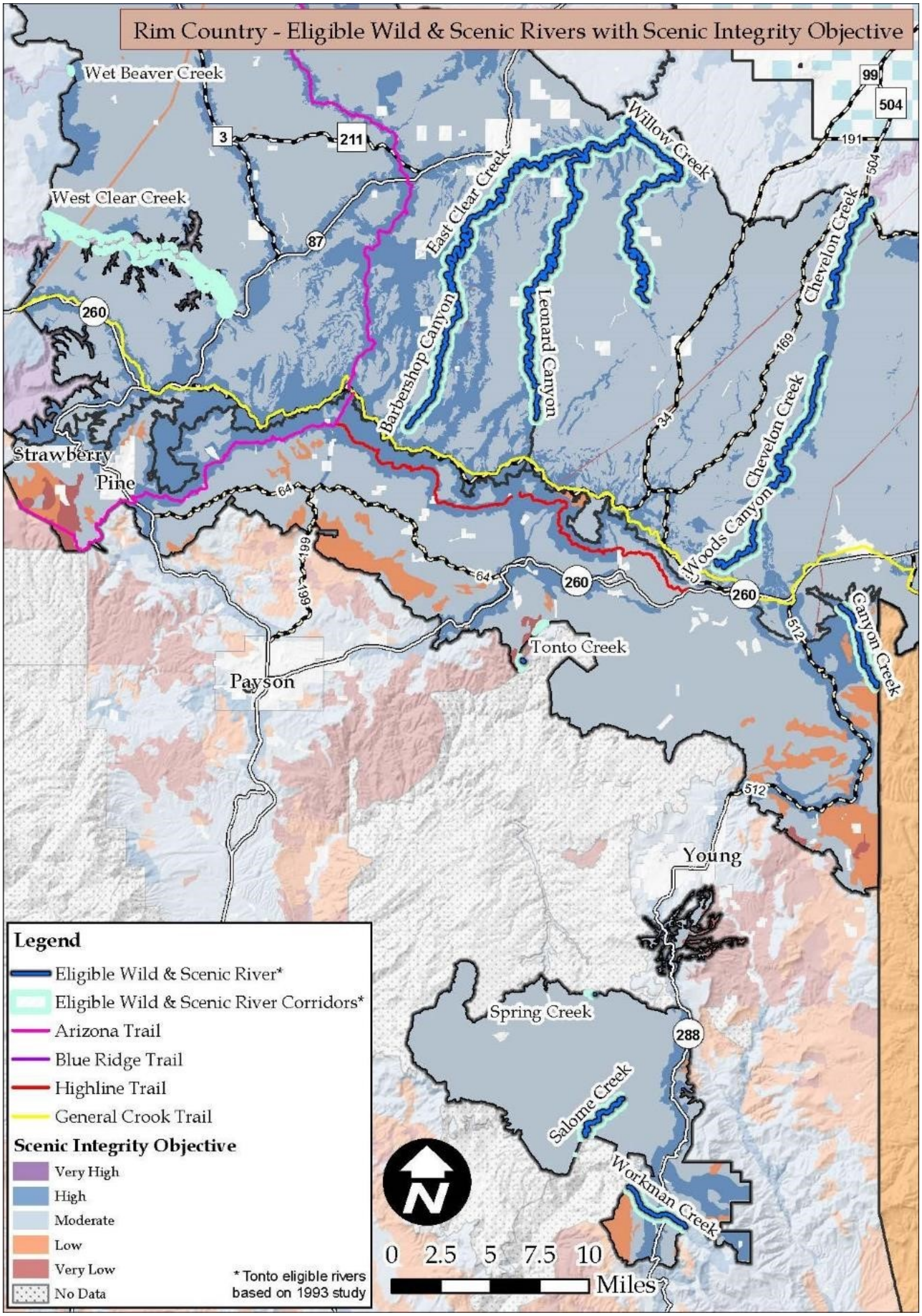

Figure 90. Eligible Wild and Scenic Rivers and Scenic Integrity Objectives (w/ 1993 Tonto National Forest)

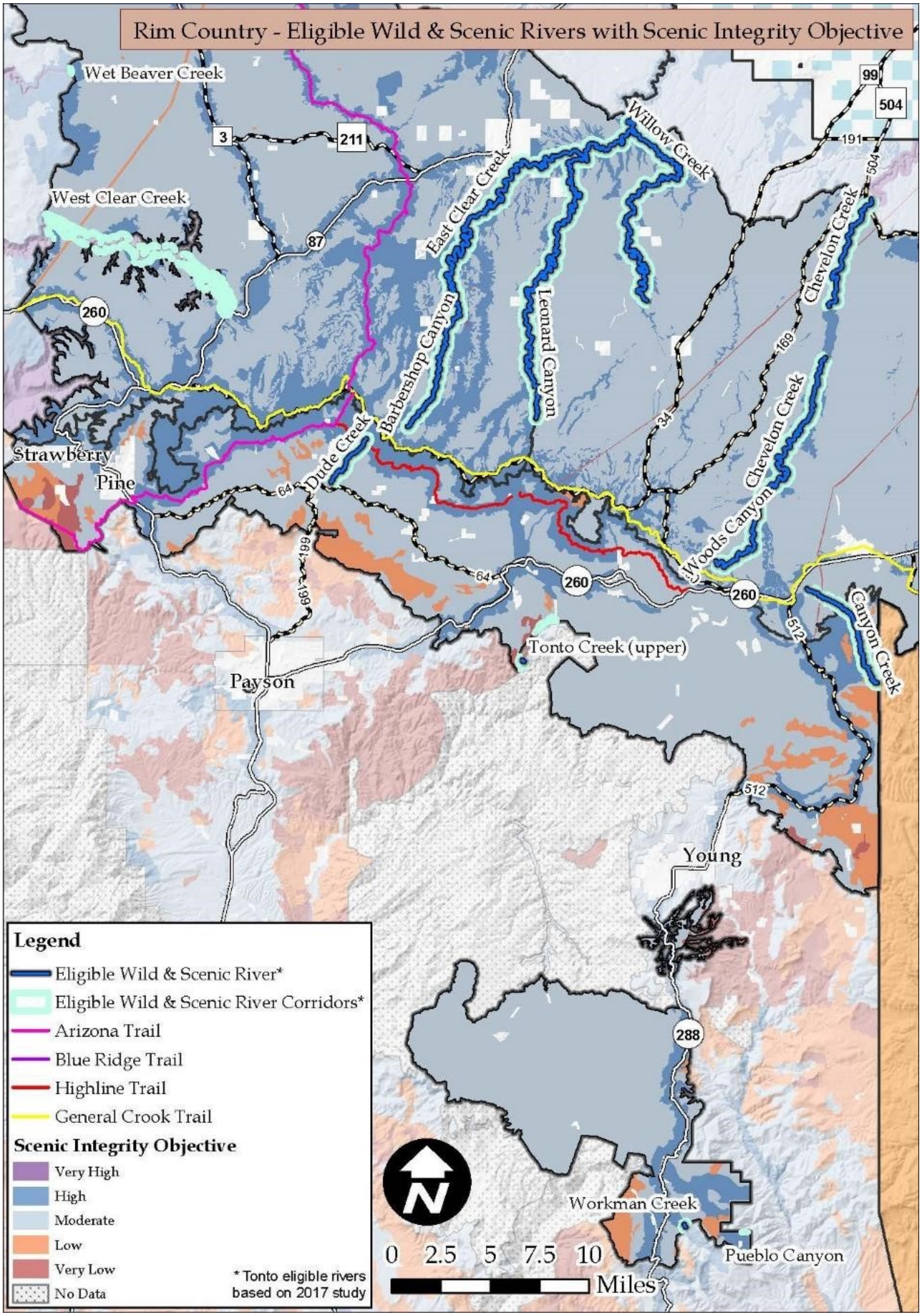

Figure 91. Eligible Wild and Scenic Rivers and Scenic Integrity Objectives (w/ Current Tonto National Forest)

Landscape visibility describes the portions of landscapes visible from travelways and use areas important to constituents for their scenic quality, aesthetic values, and landscape merits. Travelways and use areas have identified sensitivity levels for viewing scenery. Concern Level 1, the highest concern for scenery, is given to travelways or use areas that often lead to distinctive scenic features such as residential areas, resorts, and recreation areas, and attract a higher percentage of users having high concern for scenic quality, thus increasing the importance of those travelways for viewing natural-appearing scenery (Forest Service 2000). These areas most often have a High scenic integrity objective allocated to the foreground distance zone. Highway 87, Roads 3 and 512, and the From the Desert to Tall Pines Scenic Byway (288) are Concern Level 1 roads. The national trails are all examples of Concern Level 1 trails. Concern Level 2 is assigned to routes and places that are locally important, where people have a moderate to high concern for scenic quality. Forest Road 64 would be considered a Concern Level 2 route. The existing scenic integrity level ranges from Moderate to High along Concern Level 1 and 2 routes. All routes with a high scenic integrity objective adjacent to them would be considered Concern Level 1 routes.

Ecosystem Context

The vegetation is the dominant scenic attribute in the Rim Country project 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-severity fires are inconsistent with the desired scenic character and its sustainability.

- Currently, 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. Among the potential attributes are large mature trees; diverse species including aspen, evergreen oak, Gambel oak, and grasslands; as well as other understory shrubs, grasses, and forbs.
- Inter-tree spaces (interspaces) and openings have been filled with small and medium sized trees, where if these were opened up, sunlight would reach the forest floor, adding to the scenic quality as well as helping provide for greater understory vegetation composition and abundance.
- Fire has been suppressed for many years and this, in combination with overly dense forests, departs significantly from reference conditions. Currently there is a risk of large-scale, high-severity fire that could result in elimination of the vegetation scenic attributes that are desired. High frequency, low-severity fire helps to recycle nutrients, keep tree densities lower, and keep fuel accumulations lower.
- 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 forests, 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 these roads would restore characteristic forest landscape features.

Assumptions and Methodology

Assumptions

- Scenery Management System terminology will be used in the tables, maps, and environmental consequences section of this report to more uniformly describe effects.

- Treatment location, in relation to terrain and elevation and other vegetative screening, can affect the visibility of management activities. Vegetation treatments on steep slopes, when other landforms do not block the view, can dominate the landscape.
- The duration of view or speed of travel through an area (such as, walking or riding in a vehicle) determine how long a viewer has to study and pick out objects, forms, lines, colors, and patterns in the landscape.
- How well treatments transition from treated to untreated areas can also affect how evident a treatment is in all distance zones.
- Proposed activities, although they may have some short-term negative effects on scenery, also may begin to move the landscape toward the desired landscape character. Effects that would move the vegetation toward the desired landscape character are beneficial to scenic resources in the long term. These beneficial effects are often realized over a long period of time but lead to the lasting sustainability of valued scenery attributes. For example, tree thinning may have short-term effects of ground disturbance, stumps, and slash, but in the long term, if properly mitigated for scenery, may provide visual access into the forest and promote large tree growth and a smooth herbaceous ground cover. In the long-term, the removal of some trees, dependent upon scale and intensity of treatment, may be a beneficial effect for scenery.
- Desired landscape character often includes and is linked to preferred visual settings. Gobster (1994) summarizes visually-preferred settings as having four common attributes: large trees, smooth herbaceous ground cover, an open midstory canopy with high visual penetration, and vistas with distant views and high topographic relief.
- Visual access, or how far one can see into a forest, is also a preferred scenic setting (Ryan 2005). The degree of visual access varies throughout the project area, depending on the amount of understory vegetation present in the forest. Younger ponderosa pine forests may have dense vegetation, which allows very little visual access into the forest. In the long term, scenic resources would have higher scenic quality if visual access is achieved or enhanced.

Methodology

This analysis applies current National Forest Scenery Management methodology in conjunction with existing Apache-Sitgreaves, Coconino, and Tonto National Forest Plan direction. ArcMap and GIS data layers were used to analyze the proposed activities in regards to recreation use, sensitive travel corridor locations, areas potentially seen from sensitive travel corridors and use areas, and visual quality objectives and scenic integrity objectives assigned to the area. The potential effects on scenic resources from this project were determined based on a site visit to the project area with members of the interdisciplinary team, review of photos of the project area, use and interpretation of GIS data and aerial imagery, and review of research and analysis of similar projects including the 1st 4FRI project analysis and scenic resource report. Direct, indirect, and cumulative effects were considered in this analysis.

Scenery Management System (SMS)

The Scenery Management System places importance on identifying which scenic elements forest constituency most values, and developing management strategies to maintain or improve those elements. The Apache-Sitgreaves and Coconino Forest Plans currently use SMS. The Tonto National Forest will be transitioning from VMS to SMS at a later date. For consistency in this analysis, the SMS terminology will be used in tables, maps, and the environmental consequences section.

The Scenic Integrity Objectives (SIOs) are used in the Scenery Management System and are described in more detail in the scenic resources report. They range from Very High, meaning the landscape character is unaltered, to Very Low, meaning the landscape character is highly altered. Intermediate levels include High (landscape character appears unaltered), Moderate (landscape character is slightly altered), and Low (landscape character is moderately altered). Scenic integrity objectives can be applied in two ways: (1) to describe a degree of existing scenic integrity or disturbance, or (2) to describe a minimum objective for future integrity.

Figure 92 displays the scenic integrity objectives for the project area (the visual quality objectives for the Tonto National Forest have been converted to SIO). For the 4FRI Rim Country Project, these scenic integrity objectives represent the long term goals for the restoration activities proposed. The majority of the project area is mapped as Moderate where the landscape character "appears slightly altered." The areas designated as High or Very High are generally located along sensitive scenic areas such as scenic roadways or highly traveled routes, or along eligible Wild and Scenic Rivers. There is also a small amount of Low on the Tonto National Forest.

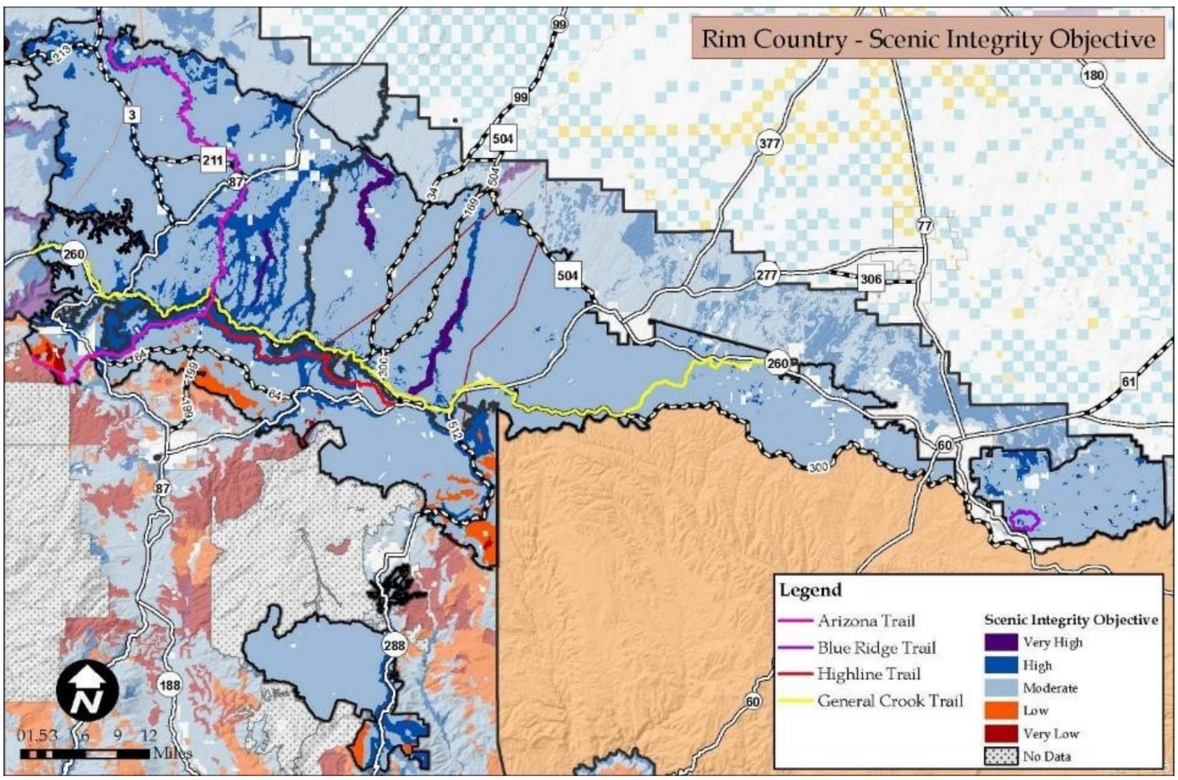

Figure 92. Scenic Integrity Objectives for the entire project area

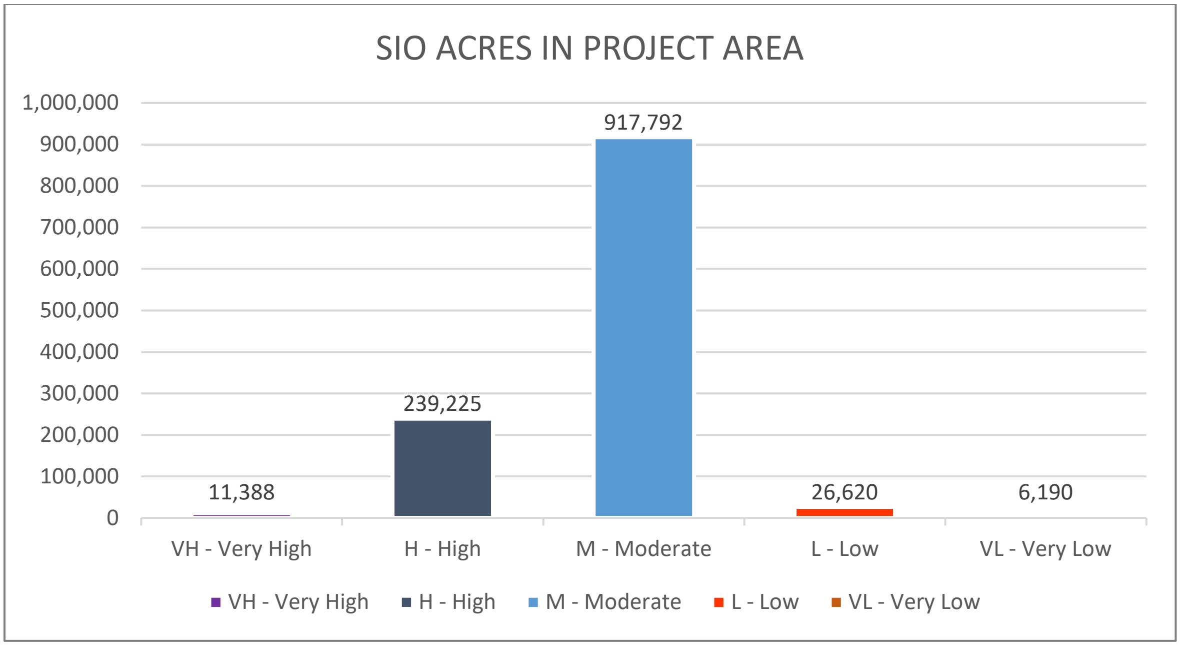

Figure 93. Acres of Scenic Integrity Objective

Spatial and Temporal Context for Effects Analysis

The spatial boundaries for analyzing the direct and indirect effects on scenery are National Forest System lands within the project area boundary since the proposed activities would only occur on National Forest System lands.

Short-term scenic effects from vegetation management are often the most noticeable until the growth of grasses, shrubs, and remaining trees begin to soften the effects of thinning operations. Short-term for this analysis refers to a three to five-year period after all vegetation treatments in an area are complete. Short-term effects are especially noticeable when the viewer has an up-close view of the treatment site, usually in the foreground viewing distance.

Long-term effects, which for this analysis is considered beyond five years, vary by the treatment and the method used.

Past harvest of forested slopes is generally noticeable for 15 to 30 years, depending upon the treatment prescription, soil type, aspect, and vegetative species composition. At the end of this time period, the regrowth of vegetation begins to develop closed canopy characteristics and the area no longer appears altered. The cumulative effects analysis area consists of all lands, including other ownerships inside the 4FRI Rim Country project boundary.

Environmental Consequences

Alternative 1 – No Action

Alternative 1 proposes no additional management activities in the project area and initiates no human caused changes to the scenic resources or visual quality objectives within the project area. In the short term, the scenic integrity would remain unchanged and the project area would continue to be mostly natural-appearing for several years. In the long term, important scenic attributes such as scattered groups of trees of all ages with grassy openings, evidence of frequent low-severity fire, large mature tree character, diverse understory, prominent Gambel oak and grasslands, functioning riparian systems and ephemeral channels that historically contributed to the attractiveness of the area would continue to decline along with scenic integrity.

There is the potential, if dense stands foster beetle outbreaks, more severe mistletoe infections, or other forest health concerns, that tree vitality would decline and there would be a reduction of scenic integrity. If stand-replacing wildfire were to occur, this would also result in the loss of valued scenic character and would continue to be of concern to the Coconino, Apache-Sitgreaves, and Tonto National Forests and residents of the surrounding communities. If a large fire or series of fires occur, views of a fire-altered landscape may begin to dominate. Effects on scenic quality include charred bark on standing trees and down logs, a blackened appearance to the ground plane, and burned understory plants. The visual effects would be reduced within two years, with the regeneration of ground cover plants and the deposition of forest litter over the burned sites. Charred bark, limbs, and other features may be visible for many years. The burned areas would likely regenerate in dense stands of shrubs and seedlings, particularly in moist sites at the bottom of drainages and where root stock and seed sources exist.

These changes would be visible throughout the project area in the foreground of forest roads and trails, and as middle ground and background views from communities within the project area, and developed recreation sites. If a wildfire were to occur near a recreation site, those who use the sites may choose to go elsewhere, if they are sensitive to the appearance of a fire-altered landscape.

Under this alternative there would be no opportunities to enhance and improve scenic resources or achieve the desired conditions, since there would be no thinning, prescribed fire, or other treatments related to restoration. The forests would continue to implement small-scale thinning and prescribed burning, but nothing on the scale of this project. As a result, very little progress would be made toward desired conditions.

The No Action Alternative would not meet forest plan desired conditions or forest plan direction. It 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. In addition, the No Action Alternative would continue the current condition outside of the natural range of variability.

The comparison of effects from the No Action alternative indicates that the only positive effect or trend would be the cumulative effect of Motorized Travel Management. All other ongoing or reasonably foreseen actions would result in a decline in the vegetation, water, and land form that create the landscape character of the area; decreased long-term scenic attractiveness as the unique natural and cultural elements that combine to form the scenic beauty of the area decline; and a downward trend in the scenic integrity objectives as deviations from the valued landscape character become more pronounced.

Effects Common to Both Action Alternatives

The effects on scenery from Alternative 2 would be the same as those from Alternative 3 with the exception of the difference in treatment acres where the effects would occur. Alternative 3 would treat 47 percent less area than Alternative 2, so the following effects can be expected to affect scenic resources in less of the project area with Alternative 3.

Aspen, Native Willows, Big-Tooth Maple, Seep/Spring Protective Barriers

Aspen, native willows, big-tooth maple, ephemeral drainage treatments and spring/seep areas require protective barriers to protect the areas from browsing. Both action alternatives require up to 200 miles of protective barriers. Barrier materials proposed include wire, wood and jackstrawing of trees. All would introduce unnatural linear features into the landscape that would not be natural appearing. Since these are isolated areas scattered around the over 1,000,000 acre project area, introduction of linear features would have minor effects.

Wood fencing materials would have the least effect since they would be in scale, and have texture and color that would look most natural in the seep/spring and aspen settings. Many times wooden fencing is viewed as an attractive cultural feature. 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. Design features would be used to introduce the fewest contrasting elements where wire fencing is used and effort would be made to locate the fencing where it is least noticeable. Wire fencing would have low effects and would meet the SIO.

Jackstrawing has been used to a limited extent on the Coconino National Forest in order to protect aspen restoration projects from ungulate browsing. It involves cutting and stacking high numbers of cut trees in an irregular manner to form a wide, tall barrier surrounding the aspen stand. While natural materials would be used to create the jackstraw, the shape and form created at this scale would not normally be found in the characteristic landscape. It would not be completely unnatural however, as it would be similar to large scale blow down events that may be caused by weather related events. Placement of jackstraw treatment would not meet the requirements for foregrounds of Concern Level 1 roads or the National Trails in high SIO areas. Even if foreground sites were allowed to drop one SIO level, they would still not meet the basic definition of moderate SIO that "noticeable deviations must remain visually subordinate to the landscape character being viewed" (Forest Service 2000). Beyond the foreground, jack-straw piling may be suitable, and would be mitigated by carefully locating these barriers. As noted, the short term effects timeline for jackstrawing around aspen would be longer than for conifers, up to 20 years. Design criteria would be implemented to avoid placement of jackstraw within the foreground of high concern level roads or National Trails. As jack-straw barrier begins to deteriorate, trees lose their brown needles, branches break off, and logs lose their bark and grey out, the jack-straw piles compress and become less noticeable. It is anticipated that the aspen would also be large enough to withstand ungulate browsing when the jack-stray piles deteriorate or are burned in follow up prescribed burning activities. These areas would improve over time to the mapped SIO.

Landings and In-woods Processing and Storage Sites

Landing sites, where logs are processed for removal, are a primary short term visual effect. These sites are cleared, and scraped and leveled. Slash, log decks, and equipment dominate the immediate foreground view, and may be evident from a foreground view. Ground disturbance occurs from trucks, loaders and skidders moving over the site. After harvest is complete and slash has been removed, the site disturbance may be evident for approximately five years following use of the site. Sometimes landing sites require additional tree clearing.

Trails

People are often more sensitive to changes in the landscape along trails, than along roads and recreation developments. This is because they travel at a slower pace, and are immersed in the environment, and tend to have an expectation for a natural appearing setting. Smaller details, such as stumps and slash, are more likely to be noticed.

As a result, a decrease in the sense of solitude and diminished scenic quality would likely occur while traveling the trails within the project area. Most viewers may perceive diminished scenic quality along area trails until slash is reduced, and the remaining trees have matured. Temporary roads and skid trails may potentially cross the trails. There may be a reduction in the natural appearance of the forest as viewed from the trail. There may be increased encounters with people and machinery until the project is completed. Many of the trails provide access to unmanaged areas; this negatively affects visitor's experience when they anticipated a more natural, unmanaged environment. This would be reduced over time, and should be a minimal effect over 10 to 15 years, once ground cover and understory are reestablished and the slash has been reduced.

The Scenic Integrity would likely be reduced in the foreground and middleground, because viewers would more likely be aware of details as treatments. A decrease in the sense of solitude could lead to displacement of trail users in the short term (1 to 5 years.) They may opt to visit other areas where they would have the experience of a landscape that appears unmanaged.

National Trails, specifically the Arizona, Highline and General Crook Trail would have similar short term effects on scenery as described above. However, additional design criteria specific to National Trails would help protect the scenic integrity, especially in the foreground of the trail, during project implementation. Ultimately, in the long term, the vegetation activities would move the vegetation adjacent to trails towards desired conditions outlined in the Forest Plan.

Developed Recreation Sites

Mechanical and prescribed fire treatments could negatively affect developed recreation sites. However, developed recreation sites would not be modified by any alternatives as design features have been developed to protect the sites from possible negative effects from proposed treatments in Alternatives 2 and 3.

For campsites, it is desirable to provide and retain privacy and screening, screen other constructed features such as restrooms, provide shade, retain unique character trees and so on. Per the design criteria for recreation campgrounds, these areas would be treated, but require coordination with the District Recreation Staff in order to determine places where no treatment would occur in order to protect constructed features. In addition prioritizing treatments, treatment timing and slash pile locations would be agreed upon. Immediate adjacent to the campgrounds (outside of fenced or otherwise delineated campground boundaries), prescribed burning or mechanical treatments and burning would be appropriate.

For other developed recreation sites, it is appropriate to include burning or mechanical treatments and burning outside of an established boundary that would protect the constructed features at these sites. Per the mitigations for recreation, these boundaries would be established in conjunction with the District Recreation Staff prior to treatment.

Effects of treatments in developed recreation sites would be similar to those analyzed for mechanical treatments and prescribed burning discussed in this report under Alternatives 2 and 3. There would be short term reductions in scenic quality as a result of treatments. In the long term, the treatments would help to reduce risks to scenic stability and would improve the overall scenic integrity.

Eligible Wild and Scenic Rivers

The overall objectives for management within the project area are to bring the landscape closer to the desired conditions outlined in the Forest Plan. Wild and scenic rivers are managed to protect the outstandingly remarkable values for which they were designated in the National Wild and Scenic River

Preservation System and to protect their free-flowing nature. Rivers determined to be eligible for the System are also managed to protect the outstandingly remarkable values for which they are eligible. There are currently 9 eligible wild and scenic rivers on the Apache-Sitgreaves and Coconino National Forest and additional segments on the Tonto National Forest from the 1993 eligibility study and the current eligibility study. A map illustrating the locations of the segments are in the Scenic Character Description in the scenery report. The tables below show the classifications of each eligible wild and scenic river segment (including the Tonto 1993 and current eligibility study) as well as the treatment type and acres affected for each alternative.

Table 99. Eligible Wild and Scenic Rivers on the Apache-Sitgreaves and Coconino National Forests for Alternative 2

River Name and Class	Mechanical & Prescribed Fire	Prescribed Fire Only	Total Acres
Barbershop Canyon	**2,601**	**1,140**	**3,741**
Wild	2,601	1,140	3,741
Chevelon Creek	**2,228**	**5,053**	**7,281**
Recreational	617	0	617
Scenic	1,611	0	1,611
Wild	0	5,053	5,053
East Clear Creek	**3,406**	**2,063**	**5,469**
Scenic	3,406	2,063	5,469
Leonard Canyon	**3,542**	**2,372**	**5,914**
Recreational	3,542	2,372	5,914
West Clear Creek	**1,194**	**551**	**1,745**
Wild	1,194	551	1,745
Wet Beaver Creek	**8**	**11**	**19**
Wild	8	11	19
Willow Creek	**0**	**4,806**	**4,806**
Wild	0	4,806	4,806
Grand Total	**12,979**	**15,996**	**28,976**

Table 100. Eligible Wild and Scenic Rivers on the Tonto National Forest for Alternative 2 Identified in the 1993 Eligibility Study

River Name and Class	Mechanical & Prescribed Fire	Prescribed Fire Only	Total Acres
Canyon Creek	**1,150**	**364**	**1,514**
Recreational	1,150	364	1,514
Salome Creek	**1,112**	**0**	**1,112**
Wild	1,112	0	1,112
Spring Creek	**34**	**0**	**34**
Recreational	34	0	34
Tonto Creek	**150**	**0**	**150**
Wild	150	0	150
Workman Creek	**1,159**	**0**	**1,159**
Recreational	1,159	0	1,159
Grand Total	**3,605**	**364**	**3,969**

Table 101. Eligible Wild and Scenic Rivers on the Tonto National Forest for Alternative 2 Identified in the Current Study

River Name and Class	Mechanical & Prescribed Fire	Prescribed Fire Only	Total Acres
Canyon Creek	**1,548**	**364**	**1,913**
Recreational	1,548	364	1,913
Dude Creek	**1,045**	**0**	**1,045**
Recreational	1,045	0	1,045
Pueblo Canyon	**0**	**9**	**9**
Wild	0	9	9
Tonto Creek (upper)	**211**	**0**	**211**
Scenic	211	0	211
Workman Creek	**82**	**0**	**82**
Recreational	82	0	82
Grand Total	**2,886**	**373**	**3,259**

Table 102. Eligible Wild and Scenic Rivers on the Apache-Sitgreaves and Coconino National Forest for Alternative 3

River Name and Class	Mechanical & Prescribed Fire	Prescribed Fire Only	Grand Total
Barbershop Canyon	**2,601**	**1,054**	**3,656**
Wild	2,601	1,054	3,656
Chevelon Creek	**235**	**3,441**	**3,676**
Recreational	66	0	66
Scenic	169	0	169
Wild	0	3,441	3,441
East Clear Creek	**2,581**	**1,718**	**4,299**
Scenic	2,581	1,718	4,299
Leonard Canyon	**3,542**	**2,372**	**5,914**
Recreational	3,542	2,372	5,914
West Clear Creek	**877**	**111**	**988**
Wild	877	111	988
Wet Beaver Creek	**8**	**0**	**8**
Wild	8	0	8
Willow Creek	**0**	**3,504**	**3,504**
Wild	0	3,504	3,504
Grand Total	**9,844**	**12,200**	**22,044**

Table 103. Eligible Wild and Scenic Rivers on the Tonto National Forest for Alternative 3 Identified in the 1993 Eligibility Study

River Name and Class	Mechanical & Prescribed Fire	Prescribed Fire Only	Grand Total
Canyon Creek	1,150	364	1,514
Recreational	1,150	364	1,514
Salome Creek	707	0	707
Wild	707	0	707
Spring Creek	0	0	0
Recreational	0	0	0
Tonto Creek	57	0	57
Wild	57	0	57
Workman Creek	820	0	820
Recreational	820	0	820
Grand Total	2,735	364	3,099

Table 104. Eligible Wild and Scenic Rivers on the Tonto National Forest for Alternative 3 Identified in the Current Study

River Name and Class	Mechanical & Prescribed Fire	Prescribed Fire Only	Grand Total
Canyon Creek	**1,548**	**364**	**1,913**
Recreational	1,548	364	1,913
Dude Creek	**1,045**	**0**	**1,045**
Recreational	1,045	0	1,045
Pueblo Canyon	**0**	**0**	**0**
Wild	0	0	0
Tonto Creek (upper)	**117**	**0**	**117**
Scenic	117	0	117
Workman Creek	**7**	**0**	**7**
Recreational	7	0	7
Grand Total	**2,717**	**364**	**3,081**

As noted in the Interagency Wild & Scenic Rivers Coordinating Council Technical Paper (IWSR Coordinating Council 2014) "Timber management activities on federal lands within WSR corridors must be designed to help achieve land-management objectives consistent with the protection and enhancement of the values that caused the river to be added to the National System. Management direction needed to protect and enhance the rivers values is developed through the river planning process. WSR designation is not likely to significantly affect timber management activities beyond existing measures to protect riparian zones, wetlands, and other resource values as guided by other federal requirements." In addition, "Timber management activities on federal lands outside the corridor are managed to protect and enhance the values that caused the river to be designated. Measures needed to protect and enhance the rivers values are developed through the river planning process and include management direction as necessary for lands adjacent to the corridor."

The treatment areas that overlap the proposed WSR boundary have specific design criteria for scenery, recreation and other resource protection. The design features have been included in Appendix C specifically for the purpose of adjusting proposed treatments in the future as eligibility and suitability are determined. Any management activities proposed in eligible wild and scenic river corridors in the Rim Country project area would have the purposes of restoring natural geomorphic and ecological processes and the specific outstandingly remarkable values (ORVs) of the river. These activities are proposed to move the vegetation within the corridor towards desired conditions outlined in the Forest Plan and according to the standards and guidelines for the river corridors. In addition, the proposed activities would help to protect potential scenic values of the eligible wild and scenic river from the effects of wild fire. For both Alternatives, there would be short term effects associated with mechanical treatment and prescribed fire within the eligible wild and scenic river corridors, but in the long term, the proposed vegetation treatments would increase diversity for scenery. Overall, the scenery outstandingly remarkable value would be maintained and enhanced.

Wilderness

There are no treatments proposed in wilderness therefore there would be no effects on wilderness areas. However, at the viewpoint toward or from the Wilderness, there would be a change in the texture between the forested area that would be treated outside the Wilderness, and the untreated forest within the wilderness. There would be increased areas of ground seen between the remaining trees, giving a more coarse appearance to the landscape and slopes. In the case where the Wilderness boundary crosses on a slope, it is possible that this boundary may be evident to observers because of the change in the forest texture. Because of the increased dominance, the scenic integrity may likely be reduced in the short term.

Large Mature Trees

The proposed actions would meet forest plan requirements for large mature trees across the landscape. Some allocated acres may not meet all old growth characteristics, but would move conditions toward requirements for large trees, downed woody debris, and snags. The more open, groupy character of the conifer forest would help make the trees more visible and as a result, more prominent. Use of the old tree strategy would help recruit and retain large trees. The treated areas would have more of the desired landscape characteristics and would make progress toward meeting SIO.

Proposed Activities for Mexican Spotted Owls

As a result of the treatments proposed under this alternative, stands throughout most of the project area would appear more to have the desired conditions of open, groups of trees of all ages and sizes. In some areas, treatments are modified for Mexican spotted owls. These changes are designed to meet other laws, regulations and policies.

MSO treatments proposed incorporate the need for "Improving habitat structure in addition to managing for fire risk abatement is consistent with the USFWS draft MSO recovery plan that focuses on desired conditions and provides for treating PACs to meet restoration and fuels reduction objectives. A key draft recovery objective is to maintain habitat conditions necessary to provide roosting and nesting habitat (pp. 84-85) (USDI 2012)". This treatment would result in stands appearing slightly more open and more diverse over time when compared to the existing condition, although the difference may not be noticeable to the casual forest visitor, particularly when driving along the roads. The treatments proposed for MSO would move the habitat toward desired conditions, but scenic attributes in these areas would continue to be at risk from ecological stressors.

Alternative 2 – Modified Proposed Action

Mechanical Treatment and Burning

Approximately 889,340 acres would be mechanically thinned or burned under this alternative. Mechanical treatments include but are not limited to the use of chainsaws or feller-bunchers to cut trees and lop slash, skidders to move material to landings, bulldozers to pile slash, and specialized equipment such as feller-bunchers or track-type hot saws, and tree shears to cut, chop, break, and lop fuel material.

Hand thinning usually has little or no short-term effects on scenery. Trees are cut down, then cut into segments that can be treated. Effects may include slash from limbing and topping trees. Project mitigations require slash to be treated.

Conventional mechanical treatments typically have moderate short-term effects on scenery. During implementation, in most cases whole trees are cut and moved to a "landing" near a haul road. At the landing, the limbs and tops are removed, and the clean logs are decked to be loaded and hauled away. After vegetation has been thinned, the slash is piled using bulldozers. Effects typically include trampling of vegetation where equipment is operating, creation of linear skid trails where vegetation is trampled or completely removed exposing bare soil, creation of linear log landings where vegetation has been removed and bare soil is exposed, and piles of cull logs not suitable for commercial uses. After logs or useable material is removed, slash would be treated as per mitigation measures. This may include bulldozers push slash into large piles (10to 20 foot wide piles, often 10 feet tall) which can trample vegetation and cause bare soil to be exposed, and hand piling. Design criteria would prioritize treatment of slash along high concern level roads (those in High SIO), require trails to be returned to pre-treatment conditions, and cull logs be removed from landings and potentially used to help close off entrances to decommissioned roads.

There would be a low to moderate effect on scenic quality during and immediately following mechanical treatments. Stumps are typically left no more than six inches high and are often cut flush with the ground unless prevented by rocks or other natural features. 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 design features are implemented. The effects in these areas would be short term (lasting one to five 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 one to three years after project completion, depending on how quickly the areas revegetate. Scraped trees would heal or scars would become less noticeable over time.

Prescribed burning would likely result in short-term, moderate reduction in scenic quality, but with ground vegetation recovery, can enhance scenic beauty within five years. Where prescribed fire is limited to slash reduction, isolated areas of burned piles would be evident. Once these piles have been scattered there may be some short-term evidence of darkened litter and soil that would be reduced within five years and generally only be noticeable within the immediate foreground. Greater visual effects would occur in areas where prescribed fire is used as a tool to regenerate aspen or reintroduce fire. This includes charred bark of standing trees and down logs, and a blackened appearance to the ground plane and burned understory plants. The visual effects would be reduced within two years, with the regeneration of ground cover plants and the deposition of forest litter over the burned sites. Charred bark, limbs, and other features could be visible for many years.

Smoke from prescribed burning 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.

The restoration treatment areas should be recovered and moving toward reference conditions after the first thinning and prescribed burning activities. These would be further improved after follow-up prescribed fire treatments. The restoration treatments would meet the purpose and need of the project and would help move the forest structure, pattern and composition toward reference conditions.

Road Reconstruction and Decommissioning

Approximately 150 miles of existing roads would be reconstructed with Alternative 2. There would be few to no effects from road improvements. Improvements may include, but are not limited to, drainage improvements, tree removal, slight realignments, and addition of surfacing materials. Potential effects include exposure of bare soil, tree stumps, and contrasting color and texture of surfacing materials. These effects are usually short term (one to five years) and become less noticeable as natural vegetation is re-established and the surfacing material begins to be incorporated into the soil horizon. Road relocation would have more noticeable effects on scenery. Effects of the newly constructed road bed would include newly exposed bare ground, damaged vegetation, tree stumps, root wads, and contrasting color and texture of surfacing. There would also be effects associated with the old road bed. It would appear newly disturbed as well if associated drainage features such as culverts are pulled, new drainage ditches established, the surface roughened to promote vegetation establishment, and slash, brush, boulders or other devices are used to close off the entrance. There would be a strong contrast between the existing forest floor and the new and old road beds that would detract from scenic quality. Design features, best management practices, and mitigation measures would be used during road reconstruction. The old roads would naturalize over time and become less noticeable to the casual observer.

Approximately 330 miles of temporary roads would be constructed for haul access. These would be decommissioned when treatments are finished. The new temporary roads would add new, unnatural linear features to 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 scenic integrity objectives. In High scenic integrity objective, the new temporary road construction would drop these areas one level to Moderate until the roads are decommissioned and begin to naturalize, about five years later. Design features and best management practices would be used to rehabilitate decommissioned roads and this would hasten their recovery.

Under this alternative up to 200 miles of system road on the Coconino and Apache-Sitgreaves National Forests could be decommissioned. The Tonto National Forest Travel Management EIS has identified approximately 290 miles of road within the Rim Country project area for decommissioning. In addition to system road decommissioning, up to 800 miles of unauthorized roads on all three forests could be decommissioned under this alternative. Following decommissioning, all roads would be allowed to naturalize. There would be short-term effects (up to five years) as the roads have drainage established, the surface area roughens, is seeded and mulched with pine needles and slash, and boulders and other devices are used to close off entrances to the roads. Design criteria and best management practices would be used to rehabilitate these roads. The existing closed roads would naturalize over time and become unnoticeable to the casual observer.

Alternative 3 – Focused Alternative

Mechanical Treatment and Burning

Alternative 3 treats 47 percent less area than Alternative 2. Approximately 39 percent fewer acres would receive mechanical and prescribed fire restoration treatments, about 26 percent less prescribed fire only. Additionally, the Severe Disturbance Area Treatment area is 78 percent less in Alternative 3 than in Alternative 2. Approximately 483,160 acres would be mechanically thinned or burned with prescribed fire under Alternative 3. For Alternative 3, there would be less prescribed burning activity that would likely result in less short-term, moderate reductions in scenic quality relative to Alternative 2. As a result, there would be fewer visual effects in the project area where prescribed fire is used as a tool to regenerate aspen or reintroduce fire, resulting in fewer areas of reduced visibility of the scenic landscape in the short term. However, Alternative 3 would treat significantly fewer acres of grasslands, savannah, and open canopy cover, resulting in fewer acres of improved understory species abundance and composition. Ultimately, this alternative would have less potential to reduce the risk of large-scale, high-severity fires in the project area. Since high-severity fire is a risk factor for most scenery attributes, the fewer proposed mechanical and prescribed fire treatments in Alternative 3 would result in fewer improvements to scenic quality in the long term.

Road Reconstruction and Decommissioning

Approximately 150 miles of existing roads would be reconstructed with Alternative 3. There would be little to no effects from road improvements. Improvements may include, but are not limited to, drainage improvements, tree removal, slight realignments and addition of surfacing materials. Potential effects would be the same as described under Alternative 2.

Approximately 170 miles of temporary roads would be constructed for haul access. These would be decommissioned when treatments are finished. Although the effects of temporary roads would be the same as in Alternative 2, this alternative proposes nearly 50 percent fewer temporary roads, resulting in fewer unnatural linear features in the landscape on a temporary basis. Similar to Alternative 2, this action would have moderate effects on the mapped scenic integrity objective. In High scenic integrity objective, the new temporary road construction would drop these areas one level to Moderate until the roads are decommissioned and begin to naturalize about five years later. Design criteria and best management practices would be used to rehabilitate decommissioned roads and this would hasten their recovery.

Under this alternative up to 200 miles of system road on the Coconino and Apache-Sitgreaves National Forests could be decommissioned. The Tonto National Forest Travel Management EIS has identified approximately 290 miles of road within the Rim Country project area for decommissioning. In addition to system road decommissioning, up to 800 miles of unauthorized roads on all three forests may be decommissioned under this alternative. Following decommissioning, all roads would be allowed to naturalize. Effects would be as described for Alternative 2. Design features and best management practices would be used to rehabilitate these roads. The existing closed roads would naturalize over time and become unnoticeable to the casual observer.

Cumulative Effects

The cumulative effects analysis area is the ponderosa pine forest on the Coconino, Apache-Sitgreaves and Tonto National Forests within the Rim Country project area. The timeline for analysis is 20 to 30 years because most long-term effects of the alternatives are assessed out to a 20-30 year timeframe (with the exception of large-scale high-severity wildfire which is more difficult to project). The following is a list of actions relating to scenic attributes, landscape character, and scenic integrity considered in the cumulative effects analysis for this project:

- Past activities that created the current conditions include grazing, the evolving forest management practices related to timber harvest and fire suppression, drought, disease and insect infestations, and dispersed recreational use.
- Present and future activities such as vegetation management, fire and fuels management, utility corridor clearing and new utility corridors, and other management activities (for example, noxious weeds treatments). These activities could occur on private lands as well.

The cumulative effects of past management activities are visible as the existing conditions. Vegetation management practices, fire suppression, and over grazing have resulted in the current overly dense forests, even-aged forest structure, and sparse understory trees, shrubs, grasses, and forbs.

Alternative 1 – No Action

The short-term cumulative effects (1 to 5 years) from the No Action Alternative, combined with similar current and future restoration treatments and prescribed burning projects, are expected to be negligible unless additional large-scale, high-severity wildfires occur in the ponderosa pine type in the project area. If wildfires burn large areas, the scenic quality would be decreased and there would be long-term negative changes 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 decline or not be present. The scenic effect of a high-severity wildfire would combine with scenic effects from adjacent land development, utility development and/or maintenance, and effects from dispersed recreation use to result in a cumulative effect so that scenic integrity is greatly diminished in areas burned 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 effect scenic attributes.

In the absence of large, high-severity wildfires, long-term cumulative effects of the No Action Alternative and present and future vegetation management activities would be relatively small and localized. In the absence of large-scale treatment, the scale of treatments that are currently accomplished would not result in improvement to scenic integrity. 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.

Alternative 2 – Modified Proposed Action

Vegetation management projects would alter the appearance of the landscape where ground-disturbing activities are conducted. Similar to the action alternatives, activities that are very close (300 feet or less) to scenic highways, major travelways, and recreation resources, would have temporary adverse effects on visually sensitive areas. This would increase the chance that people would be exposed to evidence of fire and mechanical thinning activities. Once slash and/or the evidence of fire are reduced, the forest would have a more managed appearance until understory shrubs and trees have provided a more varied appearance, which could be 30 to 40 years.

Individuals who are sensitive to the visual changes of vegetation management and fire-altered landscapes would likely perceive diminished scenic quality. There would be an increased visual presence of roads. When roads are obliterated, the prism would remain for many years. However, once vegetation grows in the road prism, especially trees, it would be less noticeable, and probably only noticed by people walking across or near the road bed. The length of time for recovery ranges from two or three years, to over 50 years, depending on the effectiveness of the decommissioning at deterring travel by off-highway vehicles.

Cumulative effects on scenery resources in the Rim Country project area are expected to meet the visual quality objectives of the forest plans in the short term. In High scenic integrity objective areas, it is expected that any human activities would not be visually evident. In Moderate scenic integrity objective areas, any deviations present would be expected to be subordinate to the characteristic landscape. In Low scenic integrity objective areas any deviations present may dominate the characteristic landscape but would utilize naturally established form, line, color, and texture, and appear natural or compatible to the natural surroundings.

Alternative 2, along with the other past, ongoing, and reasonably foreseeable projects and activities, may have cumulative effects on scenery resources. However, these cumulative effects are expected to meet the visual quality objectives of the forest plans in the short term; no long-term effects are anticipated if the scenery project design features are applied.

Alternative 3 – Focused Alternative

The cumulative effects from Alternative 3 would be similar to those from Alternative 2. There would be slightly fewer negative short-term cumulative effects in localized areas (areas with landings, temporary roads, ground-disturbing activities), since this alternative would mechanically treat and burn fewer acres and require fewer temporary roads. However, there would also be slightly fewer positive long-term cumulative effects in terms of, counteracting drought and insect damage likely to occur as a result of climate change, improved stand structure, and understory improvement, since there would be less mechanical treatment and burning to facilitate greater forest resiliency.

Effects from Rock Pit Use and Expansion

A total of 21 rock pits were identified for use and potential expansion up to 30 percent of their existing footprint. The material from the rock pits may be used for a variety of road maintenance activities, from general maintenance of primary roads to construction or rehabilitation of temporary roads. The proposed use and expansion of rock pits would include hauling of equipment and aggregate materials to and from the pits for use in road maintenance, road construction, and erosion control to aid in implementation of the 4FRI Rim Country project and other projects in the 4FRI footprint.

Effects Common to All Alternatives

Effects common to all alternatives include views of exposed soil at active rock pits locations, and removed vegetation. Active pits would also have processing and mining equipment, and trucks for hauling roadbed material to desired locations. In addition to space for processing equipment, pits requiring processing would also need space to store stockpiles of processed and partially processed materials. The space needed for processing equipment, stockpiling of materials, and loading is included in the footprint of each rock pit site.

Most rock pits are located in Moderate scenic integrity objective in forested areas making them difficult to view even from a foreground distance (300 feet to 0.5 miles). Under both action alternatives, design features would help mitigate the effect on scenery from rock pits.

Alternative 1 - No Action

Under Alternative 1, for implementation of other projects and activities, rock pit activities would continue to mine and process roadbed materials from active existing pits either for maintenance of Forest Service roads, temporary road construction, or through permitted use. Direct effects on visually sensitive areas would be views of exposed soil, removed vegetation, and of trucks and other equipment used to mine and process roadbed material. The magnitude of these direct effects would vary depending on the duration of activities at each existing pit, the number of viewers that are able to see the exposed soil, removed vegetation, and equipment, and the distance from which viewers can observe these project-related activities.

Indirect effects would include long–term views of the pits following mining activity and before re-vegetation efforts have been completed.

Mining and processing activities that occur at any of the pits within 0.5 miles of scenic routes or major travelways, or within 0.5 miles of recreation resource areas, could cause adverse, temporary effects. The importance of these effects can be evaluated in terms of their consistency with scenic integrity objectives. Actively mined pits are consistent with the scenic integrity objective of Moderate since the landscape may appear slightly altered and the pits are visually subordinate when viewed from distances of greater than 0.5 mile, which is the breakpoint between the foreground and middle-ground distances (USDA FS 1996).

Alternative 2 - Modified Proposed Action

Due to the relatively small footprint and locations of the proposed rock pits on the landscape, most direct and indirect visual effects would be very limited to where the pit can be seen from forest roads. Out of the proposed 21 pits, there are 8 pits that are located within 0.5 miles of major travelways or trails. Most of the pits that are located next to a major roadway, recreation site, or trail were initially used to provide material to construct these same roadways, recreation site, or trail. Often the rock pit was built very near the road or trail but in an area not visible to provide for a convenient material source without affecting the viewshed.

Mining and processing activities that occur at any of the pits within 0.5 miles of scenic routes or major travelways, or within 0.5 miles of recreation resource areas, could cause adverse, temporary effects. The importance of these effects can be evaluated in terms of their consistency with scenic integrity objectives. Actively mined pits are consistent with the a Moderate scenic integrity objective since the landscape may appear slightly altered and the pits are visually subordinate when viewed from distances of greater than 0.5 mile, which is the breakpoint between the foreground and middleground distances (USDA FS 1996). In situations where a proposal does not meet scenic integrity objectives or visual quality objectives, the Forest Plan allows for "one classification movement downward…"(USDA FS 1987, p. 60).

Alternative 3 – Focused Alternative

Effects on visually sensitive areas and consistency with scenic integrity objectives would be of the same type as described for Alternatives 1 and 2. As discussed for Alternative 2, these proposed activities would result in some adverse effects on scenic integrity objectives.

Effects from Use of In-woods Processing and Storage Sites

A total of 12 in-woods processing sites are proposed for consideration in this project. Tasks that would be carried out at processing sites include drying, debarking, chipping stems and bark, cutting logs, manufacturing and sorting logs to size, producing wood cants, scaling and weighing logs, and creating poles from suitably sized logs. Equipment types commonly used at processing sites include circular or band saws, various sizes and types of front-end loaders, log loaders, and chippers of several types, and may include processors, planers and mechanized cut to length systems, and associated conveyers and log sorting bunks for accumulation and storage of logs.

Eight processing sites were proposed and analyzed for environmental effects in the Cragin Watershed Protection Project. These sites are carried forward for potential use in implementing the Rim Country Project. An additional 12 processing sites are being analyzed that range in size from four to 21 acres. Most processing sites are located in forested areas making them difficult to view even from a foreground distance (300 feet to 0.5 miles).

Potential sites were screened so as to be located outside of meadows, where some of the most productive forest soils are found, and in relatively flat areas. Other sites are located in existing clearings and flat areas. The siting of processing sites in relatively flat areas would minimize the need for extensive site grading. Processing sites were located to provide for a buffer of 100 to 300 feet from forest roads and state highways to provide for visual screening from Concern Level 1 and 2 travelways. Site boundaries are approximate and may be further modified during implementation and layout.

Following completion of use of processing sites and removal of all equipment and materials, site rehabilitation would have to be accomplished, including removal of aggregate, restoration of pre-disturbance site grades, de-compaction of soil for seedbed preparation, and seeding and mulching of the site with native grasses and forbs.

Alternative 1 - No Action

Alternative 1 proposes no in-woods processing and storage sites and initiates no human-caused changes to the scenic quality within the project area. Alternative 1 would meet the adopted High, Moderate, and Low scenic integrity objectives throughout the project area as it does not create any unnaturally-appearing elements of form, line, color, or texture.

Alternative 2 - Modified Proposed Action

The scenic integrity objectives, adjacent scenic resources, and the visibility of the proposed processing sites were considered from foreground, middleground, and background perspectives. The highest level of detail would likely be perceived from the foreground perspective. However, due to the size and scale of the sites, particularly those of larger acreage, there is the potential for the proposed openings and associated infrastructure to be seen from a distance from sensitive viewing platforms. Thinning around the edges of the processing site boundaries would promote a more naturally-appearing landscape when these sites are seen from a distance.

Low interim scenic integrity objectives would be assigned to these locations during implementation. During implementation, the proposed processing sites would likely be noticeable to the casual observer and, depending on the perspective of the viewer, may dominate the view. Visitors would notice the lack of vegetation and the aggregate surface. Built structures such as fencing, sanitation facilities, office trailers, fuel storage containers, or other temporary structures would likely be noticeable to the casual observer. Heavy equipment, and associated conveyers and log sorting bunks for accumulation and storage of logs may be highly visible from sensitive viewing platforms. For safety, most of the equipment would likely be a yellow color to ensure visibility for the workers, which would create a notable contrast for visitors. The concentration of wood and slash for sorting and drying would be evident to visitors to the near vicinity. Design features would ensure that scenic integrity objectives are met post implementation and effects on scenery are minimized during implementation to the extent practicable. Due to the potential for the soils to be heavily compacted form the operations at these sites, recovery post-implementation may take up to 10 years, depending on the duration and extent of usage of the processing site. The scenic integrity objectives would be met after the sites have been reclaimed and restored to a naturally-appearing landscape character, likely 10 years post treatment.

Alternative 3 - Focused Alternative

Effects on visually sensitive areas and consistency with scenic integrity objectives for Alternative 3 would be similar to those for Alternative 2, as all proposed in-woods processing sites could potentially be utilized. As discussed for Alternative 2, proposed activities would result in some adverse effects on scenic integrity objectives.

Unavoidable Adverse Effects

Though both action alternatives (Alternatives 2 and 3) were designed to move resources toward desired conditions, implementation of either one would result in some unavoidable, short-term, adverse effects. At the same time, implementation of Alternative 1, the no action alternative, would also result in some unavoidable, short-term, adverse effects from forest management activities that are part of other projects and from wildfires that may occur within or near the Rim Country project area.

Adverse effects from implementation of either of the action alternatives would be limited in extent and duration by ensuring that management activities are consistent with standards and guidelines from the forest plans and proposed amendments. Project design features, found in Appendix C, along with mitigations and protocols in Appendix J of the Programmatic Agreement between the Southwestern Region of the Forest Service, the Arizona, New Mexico, Texas and Oklahoma State Historic Preservation Offices and the Advisory Council on Historic Preservation, would apply to both action alternatives and would provide additional means and mitigations to avoid or minimize adverse effects while still meeting the purpose and need of the project.

Implementation of activities in both action alternatives could result in some of the following unavoidable, short-term, adverse effects (further details can be found in the respective resource sections of this chapter):

1. Individuals of some threatened and endangered species, as well as some sensitive species, may be harmed. Habitat for certain species may be temporarily adversely affected.
2. Short-term disturbances to grasses, forbs, shrubs, and small trees may occur.
3. Air quality may temporarily decrease.
4. Erosion and soil compaction may temporarily increase.
5. Water quality may be temporarily affected.
6. Cultural artifacts, features, and sites may be disturbed or damaged.
7. Tribal access to Traditional Cultural Properties and forest products may be temporarily hindered during implementation of treatments.
8. Temporary decreases in access to recreation opportunities and deviations from scenic integrity objectives may occur.
9. Forage availability may decrease temporarily.
10. Noxious weed infestation may increase.

None of the alternatives has expected energy requirements or conservation potential (40 CFR 1502.16(e)).

Natural or depletable resource requirements and conservation potential of various alternatives and mitigation measures, as well as means to mitigate adverse environmental effects are discussed in the resource sections of this chapter and in Appendix C (40 CFR 1502.16(f)).

None of the alternatives would affect the design of the built environment. The effects of implementing the alternatives on urban quality and historic and cultural resources (40 CFR 1502.16(g)) are displayed in the Fire Ecology and Air Quality, Tribal Relations, and Heritage Resources Reports and the corresponding sections of this chapter.

There could be short-term, temporary effects on 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 effects 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 need by the permit holders. Such mitigation would minimize potential adverse effects on these resources.

Short-term Uses and Long-term Productivity

NEPA requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). As declared by the Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101). Consistent with the Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528-531), the Forest Service manages each national forest to sustain the multiple use of its renewable resources in perpetuity while maintaining the long-term health and productivity of the land. Land management plans (forest plans) guide sustainable, integrated management of the resources within the plan area in the context of the broader landscape, giving due consideration to the relative values of the various resources in particular areas (36 CFR 219.1(b)).

By ensuring that proposed treatment activities and design features in both action alternatives move resources towards desired conditions in a manner consistent with forest plan direction, the long-term productivity of the land would not be impaired by short-term uses associated with implementation of either action alternative. All potential short-term disturbances would be evaluated and mitigated at a site-specific level prior to implementation. This disclosure focuses on soils, water, and vegetation resources. More detailed discussions related to short-term uses and long-term productivity can be found in the effects analysis sections for the individual resources earlier in this chapter and in individual resource specialist reports.

Soils and Water

Implementation of Alternative 1, the no action alternative, would not directly affect soil and water productivity and quality, though it would result in continued loss of soil productivity on, and erosion from, roads that would be decommissioned by implementation of either of the action alternatives. It would do nothing to avoid or decrease undesirable effects on soils and water quality from future wildfires.

Restoration treatments and associated activities, including prescribed fire, in Alternatives 2 and 3 would result in some ground disturbance and would produce short-term, localized effects to soil productivity and water quality. Long-term benefits of treatments in both alternatives would include avoiding or decreasing undesirable effects on soils and water quality from future wildfires and improving overall soil retention and water quality in degraded watersheds. Because of the larger area over which mechanical thinning and prescribed fire treatments would be implemented in Alternative 2, both the short-term effects and long-term benefits to productivity would be greater than those from activities in Alternative 3. Both action alternatives would decommission equal mileages of forest system and unauthorized roads, leading to positive long-term benefits on soil productivity and water quality in the areas around those roads under either alternative.

Vegetation

Alternative 1 would not directly result in short-term effects on the productivity of vegetation. At the same time, it would not address the problems of stagnant tree growth and mortality, or susceptibility to fire and insect or disease outbreaks. Thus it would be expected to lead to declining productivity, if not outright losses of over- and understory species from stand-replacing wildfires and insect or disease outbreaks over the long term.

Implementation of either action alternative would lead to short-term effects on and mortality of vegetation from disturbances associated with implementing restoration treatments. However, restoration treatments would reduce inter-tree competition, improve growth and vigor of residual trees, and increase understory productivity and diversity, including of shade-intolerant species. These treatments would also improve resistance and resilience to wildfires, climate change, and insect and disease outbreaks, thus maintaining or enhancing the long-term productivity of restored ecosystems.

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be undone, 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, but are reversible, such as the temporary loss of canopy cover in forested areas that are kept clear for use as a power line right-of-way or road. See discussions of environmental consequences for individual resources earlier in this chapter for more detail.

A likely outcome of Alternative 1 would be one or more high-intensity, stand-replacing wildfires in the project area. Post-fire effects on resources that require decades or longer to recover would constitute irretrievable commitments of those resources in the short term and potentially the long term. For example, topsoil, which is critical to healthy surface vegetation, would take centuries to fully recover. Likewise, the loss of old and large trees would be irretrievable and would require many decades, if not centuries, to recover. Given uncertainties of the effects of climate change and the possibility of post-fire vegetation type conversions from forest to non-forest, the loss of entire stands to wildfires could represent an irreversible commitment of those resources. Cultural resources are non-renewable, and direct damage from high-intensity wildfires, such as spalling of rock art or cracking of artifacts, would represent an irreversible commitment of those resources. In addition, indirect effects of high-intensity wildfires on cultural resources, such as damage from bulldozers used during suppression operations, or exposure following post-fire erosion, can lead to irreversible degradation or losses of cultural resources.

Alternative 1 would not result in additional road decommissioning within the project area beyond what may occur as part of other projects or management activities. Relative to the action alternatives, both of which would include decommissioning of up to 490 miles of existing system roads and 800 miles of unauthorized roads, the lost soil and vegetation productivity associated with continued use of these roads in Alternative 1 would represent an irretrievable commitment of these resources.

Alternatives 2 and 3 include mechanical thinning and prescribed burning on approximately 953,130 and 529,060 acres, respectively. Potential cultural resource damage from thinning, burning, and related activities would represent an irreversible commitment of these resources. Design features and established mitigation measures and protocols would help avoid and minimize potential negative effects on cultural resources.

Alternatives 2 and 3 include the construction of up to 330 and 170 miles of temporary roads, respectively. Decreases in soil and vegetation productivity while these roads are used would represent irretrievable commitments of resources. Inadvertent damage to cultural resources from construction and use of temporary roads would be an irreversible commitment of these resources. Design features, along with established mitigation measures and protocols to protect cultural resources, would help avoid and minimize potential negative effects of construction and use of temporary roads. Temporary roads would be decommissioned when restoration work is completed in the areas to which they provide access.

Alternatives 2 and 3 include the proposed expansion of 11 existing rock pits to provide adequate sources of road surfacing material for project-related activities. The expansion of these pits would represent an irretrievable commitment of resources due to the removal of developed soils needed for vegetative growth on approximately 27 acres. The differences in soil productivity within the pit and in the surrounding area would be distinct and unavoidable, though effects on other resources would be mitigated by using design features. The loss of productive topsoil from rock pit expansion would be offset by decreases in soil erosion on and along roads from the proper maintenance of road surfaces to manage runoff.

Alternatives 2 and 3 include the potential for creation of up to 12 in-woods processing and storage sites to facilitate more utilization of forest resources, increase transportation efficiencies, and reduce implementation costs. The surface area for all 12 processing sites would be 127 acres, with individual sites ranging in size from four to 21 acres. Sites were chosen to minimize potential effects on soils and water quality, and design features were developed to further mitigate potential effects on these and other resources. Nonetheless, the clearing and preparation for use of any of these sites would result in irretrievable commitments of vegetation and soil productivity resources, since vegetation would be cleared and topsoil displaced and compacted if any of these sites are used.

The effects on lands and lands special uses would occur only during the implementation of this project. Once the project was complete, effects would cease. The long-term benefit to structures located on non-National Forest Service lands and those authorized by special use permits would be reduced risk of uncharacteristic fire behavior.

The effects on minerals would be permanent, as consumption of non-renewable mineral resources under this project would remove the availability of these resources in the future.

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."

1. Implementation of restoration activities, temporary road construction, and road decommissioning may require Section 404 permits from the U.S. Army Corps of Engineers and/or Section 401 permits from the Arizona Department of Environmental Quality (ADEQ) or tribes, as required by the Clean Water Act, if they involve dredging or discharging fill into waters of the U.S., or if they may result in discharges to state or tribal waters.
2. In-woods processing and storage sites would likely be regulated as industrial sites subject to permitting under ADEQ's Multi-Sector General Permit program. This permit program requires that certain industrial facilities implement control measures and develop site-specific stormwater pollution prevention plans to comply with Arizona Pollutant Discharge Elimination System (AZPDES) requirements.
3. All operators at rock pit sites must have or obtain coverage under an AZPDES permit and establish and implement a stormwater pollution prevention plan, if required, to comply with state water requirements based on the magnitude of the specific rock pit operation.
4. Permits for installation of aboveground storage tanks at in-woods processing sites, and for temporary fuel storage tanks used to implement restoration treatments would have to be obtained through the Arizona State Fire Marshall's Office.
5. Petroleum storage in aboveground containers with a total aggregate capacity of 1,320 gallons or more, would be subject to the Spill Prevention, Countermeasures, and Contingency (SPCC) Rule and an SPCC plan would be required (40 CFR Part 112).
6. Best management practices would be implemented and monitored for all activities with the potential to impair water quality in accordance with the intergovernmental agreement between ADEQ and the Forest Service Southwestern Regional Office to control and manage nonpoint source pollution.
7. All prescribed burning would be coordinated daily with ADEQ to comply with state and federal regulatory requirements and to ensure ADEQ is aware of potential smoke impacts to receptors. Burning would not take place without prior approval from ADEQ.
8. The U.S. Fish and Wildlife Service, in accordance with the Endangered Species Act regulations for projects with threatened or endangered species, provided informal project design input as the alternatives were developed. Formal consultation would begin after the official DEIS comment period.

9. Current denning/rendezvous site locations of Mexican gray wolves and any necessary changes to planned restoration activities due to proximity to those sites would be determined through coordination with the Mexican Wolf Interagency Field Team.
10. If cultural sites are found during pre-implementation surveys or during activity implementation, the Forest Service would follow guidance found at 36 CFR 800.12 and in the Programmatic Agreement between the Southwestern Region of the Forest Service, the Arizona, New Mexico, Texas and Oklahoma State Historic Preservation Offices and the Advisory Council on Historic Preservation. Implementation of this guidance is done in consultation with the AZ State Historic Preservation Office and tribes, if appropriate, and an effort is made to minimize effects to the discovery.
11. In accordance with the National Historic Preservation Act (NHPA), Executive Order 13175, the Programmatic Agreement, and other regulations and policies, the Tonto Tribal Liaison has begun government-to-government consultation for the Rim Country project. Consultation with Native American tribes on the Rim Country project was initiated on August 16, 2016 and would continue throughout the project’s 10- to 20-year life span.
12. Appendix J of the Programmatic Agreement is a protocol for large-scale fuels reduction, vegetation treatment, and habitat improvement projects developed in consultation with and signed by the Regional Forester, all four State Historic Preservation Offices, and the Advisory Council. Appendix J describes the methods to be used to achieve a No Adverse Effect determination for the Rim County analysis as a whole, while providing a strategy for a phased NHPA Section 106 evaluation for individual task orders.
13. Individual task orders, or undertakings, would be inventoried when each specific project area is identified. A NHPA Section 106 report would be produced for each proposed individual undertaking, and all consultation with the AZ State Historic Preservation Office and appropriate tribes would be completed prior to implementing the task order.

See the Law, Regulation, and Policy section earlier in this chapter for more information on applicable laws, regulations, and policies.

Chapter 4. List of Preparers and Consultants

The following personnel were involved in preparation of the draft environmental impact statement (DEIS).

Table 105. Rim Country DEIS preparers and contributors

Name	Title	DEIS Contribution	Education and Experience
Aaron Fargo	Landscape Architect, Enterprise Program	Scenery	M.L.A., University of Michigan, 2013. Years of Experience: 6
Annette Fredette	4FRI Planning Coordinator, Interdisciplinary Team (IDT) Leader	IDT Leadership, NEPA/Planning	B.S., Forest Management, Northern Arizona University, 1978. Years of Experience: 27
Bernadette Barthelenghi	(Former) Recreation Program Manager, Apache-Sitgreaves NFs	Recreation and Scenery	B.S., Environmental Planning & Design, Rutgers University, 1991. Years of Experience: 27
Bill Noble	(Former) 4FRI Wildlife Biologist	Wildlife	M.S., Wildlife Sciences and Forest Sciences, Oregon State University, 1994; B.S., Wildlife Biology, University of Montana, 1985. Years of Experience: 26
Brady VanDragt	Recreation Planner, Mogollon Rim Ranger District, Coconino NF	Recreation	B.S., Geography, Western Michigan University, 1996. Years of Experience: 21
Cary Thompson	Wildlife Biologist, Flagstaff Ranger District, Coconino NF	Wildlife	B.S., Biology (fish and wildlife emphasis), Northern Arizona University, 1995. Years of Experience: 22
Charlotte Minor	(Former) Landscape Architect, Coconino NF	Recreation and Scenery	M.L.A., University of Arizona; B.S., Forestry, Northern Arizona University. Years of Experience: 26
Christopher Nelson	(Former) Watershed Program Manager, Apache-Sitgreaves NFs	Hydrology and Riparian Resources, Air Quality	B.S., Watershed Management, University of Arizona. Years of Experience: 39
Christopher Welker	North Zone Recreation and Lands Staff, Tonto NF	Recreation and Lands	B.S., Forest Management and Spatial Information Management Systems, Colorado State University, 2002. Years of Experience: 15
Clint Dalton	Archeologist, Tonto NF	Heritage Resources	M.A., Cultural Resource Management, Adams State University, ongoing; B.A, Anthropology, Metropolitan State University of Denver, 2005. Years of Experience: 11
Craig Johnson	(Former) Forest Tribal Liaison, Coconino NF	Tribal Consultation	M.A., Applied Archeology, Northern Arizona University, 1998. Years of Experience: 18
Daniel Kipervaser	4FRI Monitoring Coordinator	Monitoring and Adaptive Management Plan	M.S., Ecology, Colorado State University, 2007; B.S., Biology and Environmental Policy, Colby College, 1998. Years of Experience: 15
Dave Dorum	Habitat, Evaluation, and Lands Program Manager, Region I, AGFD	Wildlife/Aquatics	B.S., Wildlife Biology, Arizona State University, 1990. Years of Experience: 28
David Bailey	GIS Specialist, Tonto NF	GIS, Data Analysis	*

Name	Title	DEIS Contribution	Education and Experience
Debra Crisp	Forest Botanist, Coconino NF	Botany	M.S., Forestry, Northern Arizona University, 2004. Years of Experience: 32
Deborah MacIvor	(Former) Forest Engineer, Apache-Sitgreaves NFs	Transportation	B.S., Civil Engineering, University of New Mexico. Years of Experience: 29
Delilah Jaworski	(Former) Social Scientist, Enterprise Program	Socioeconomics	M.S., Environment and Development, London School of Economics, 2008; B.A., Middle Eastern Studies, George Washington University, 2007. Years of Experience: 10
Denise Ryan	Archeologist, Payson Ranger District, Tonto NF	Heritage Resources	*
Dick Fleishman	4FRI Operations Coordinator	Operations	M.S., Public Administration, Northern Arizona University, 1990; B.S., Forest Management, Northern Arizona University, 1980. Years of Experience: 37
Esther Morgan	Forest Archaeologist and Tribal Liaison, Apache-Sitgreaves NFs	Heritage Resources	M.A., Bioarchaeology, Arizona State University, 1995; B.A., Anthropology, Humboldt State University, 1989. Years of Experience: 30
Gayle Richardson	Silviculturist, Black Mesa Ranger District, Apache-Sitgreaves NFs	Silviculture	B.S., Forestry, Northern Arizona University, 1981. Years of Experience: 36
Grant Loomis	Forest Hydrologist, Tonto NF	Watershed and Water Resources	M.S., Hydrology and Water Resources (all but thesis), University of Arizona, 1979. Years of Experience 39
Gregory Schuster	Recreation Program Manager, Tonto NF	Recreation	M.A., Parks, Recreation, and Tourism Management, North Carolina State University; B.S., Geology, University of North Carolina - Wilmington. Years of Experience: 22
Hannah Griscom	Habitat Specialist, AGFD	Wildlife/Aquatics	M.S., Rangeland Ecology and Watershed Management, University of Wyoming, 2007; B.S., Wildlife Biology, University of Arizona, 2000. Years of Experience: 15
Jami Clark	AGFD	Wildlife/Aquatics	*
Jeffery Thumm	Fire Management Specialist, Mogollon Rim Ranger District, Coconino NF	Fire and Fuels	B.S., Wildlife Ecology, Texas A&M University, 1993. Years of Experience 20
Jennifer Wright	Recreation Specialist, Enterprise Program	Recreation	M.S., Ecological Planning and Graduate Certificate in Ecological Economics, University of Vermont, 2011; B.S. Forest Management, Université Laval, Québec, 1999. Years of Experience: 18
Jeremy Human	(Former) Forest Fuels Specialist, Apache-Sitgreaves NFs	Fire and Fuels	Fire Ecology and Management Certificate, Northern Arizona University. Years of Experience: 26

Name	Title	DEIS Contribution	Education and Experience
Jessica Haas	(Former) Ecologist, Rocky Mountain Research Station	Fire Ecology and Air Quality	M.S., Natural Resource Management, University of Montana, 2010; B.A., Psychology and Anthropology, University of Albany, 2003. Years of Experience: 17
Jill Holderman	(Former) Forest Wildlife Biologist, Tonto NF	Wildlife	M.S., Land Use Planning, University of Nevada - Reno; B.S., Integrated Pest Management, University of Nevada - Reno. Years of Experience: 30
John Souther	4FRI NEPA Specialist	NEPA	M.S., Geography, University of Wisconsin - Madison, 2014; B.S., Geology, West Virginia University, 2003. Years of Experience: 3
John Wilcox	Wildlife Biologist, Payson Ranger District, Tonto NF	Wildlife	B.A., Wildlife and Range Management, Texas A&M University, 2001. Years of Experience: 12
Judy Adams	Forest Lands Team Leader, Coconino NF	Lands and Special Uses	B.S. Forestry, Michigan Technological University. Years of Experience: 31
Julie Rowe	Special Uses Program Manager, Coconino NF	Lands and Special Uses	B.A., University of California - Santa Cruz, 1992. Years of Experience: 25
Justin Schofer	4FRI Wildlife Biologist	Wildlife	M.S., Biological Science, Northern Arizona University, 2007; B.S., Wildlife and Fisheries Conservation, University of Massachusetts - Amherst, 1998. Years of Experience: 22
Katherine Sánchez Meador	Environmental Coordinator, Enterprise Program	NEPA	M.A., New Mexico State University, 1997. Years of Experience 16
Kathleen Sevy	Rangeland Management Specialist, Mogollon Rim and Red Rock Ranger Districts, Coconino NF	Range	B.S., Renewable Natural Resources, University of Arizona, 1985. Years of Experience: 30
Kelly Wolff	Habitat, Evaluation, and Lands Program Manager, AGFD	Wildlife/Aquatics	B.S., Environmental Resources with Wildlife Habitat focus, Arizona State University, 1999. Years of Experience: 19
Kendell Hughes	Rangeland Management Specialist, Black Mesa and Lakeside Ranger Districts, Apache-Sitgreaves NFs	Range	B.S., Agriculture, Lincoln University, 1992. Years of Experience: 27
Kimber Jones	(Former) Forest Landscape Architect, Tonto NF	Recreation and Scenery	B.S., Landscape Architecture, Iowa State University. Years of Experience: 26
Kit (Christopher) MacDonald	Soil and Watershed Program Manager, Coconino and Kaibab NFs	Soils	M.S., Forestry with soil science emphasis, Stephen F. Austin University, 1999. Completion of major course work toward Ph.D. in Forestry with soil science emphasis. Years of Experience: 23

Name	Title	DEIS Contribution	Education and Experience
Kristen Waltz	Economist, Enterprise Program	Socioeconomics	M.S., Resource Economics, University of Delaware, 2008; B.S., Natural Resource Management, University of Delaware, 2006. Years of Experience: 10
Margaret Hangan	Forest Archaeologist, Kaibab NF	Heritage Resources	M.A., Anthropology, California State University - Bakersfield, 2003; B.A., Anthropology, Pitzer College, 1989. Years of Experience: 30
Mark McEntarffer	Realty Specialist, Tonto NF	Lands and Lands Special Uses	B.S., Public Planning, Northern Arizona University, 1998. Years of Experience: 8
Mark Nigrelli	4FRI Geospatial Analyst	GIS, Data Analysis	GIS Graduate Certificate, University of Northern Arizona, 2011; B.S., Biology/Biopsychology and Cognitive Science, University of Michigan, 2004. Years of Experience: 11
Mary Lata	(Former) 4FRI Fire Ecologist	Fire Ecology, Air Quality	Ph.D., Geoscience, University of Iowa, 2006; M.S., Physical Geography, emphasis on fire and process geomorphology, University of Iowa, 1997; B.S., Interdisciplinary Studies, University of Iowa, 1995. Years of Experience: 20
Matthew Cole	(Former) 4FRI Wildlife Biologist	Wildlife	B.S., Wildlife, University of Minnesota, 1980. Years of Experience: 36
Matthew O’Neill	Forest Fisheries Biologist, Coconino NF	Aquatics	Ph.D., Biology, Northern Arizona University, 2012; M.S., Biology, Northern Arizona University, 2005; B.S., Biology, Florida Institute of Technology, 1999. Years of Experience: 8
Max Wahlberg	Fire Ecologist, Enterprise Program	Fire Ecology, Air Quality	B.A., Environmental Studies, Prescott College, 2004. Years of Experience: 16
Monica Boehning	(Former) Forest Silviculturist, Apache-Sitgreaves NFs	Silviculture	B.S., Forestry, Northern Arizona University. Years of Experience: 35
Nanebah Nez Lyndon	Tribal Relations Program Manager, Tonto NF	Tribal Relations	M.A., Anthropology, Arizona State University, 2013. Years of Experience: 9
Noah Bard	Forest Information Specialist (GIS), Coconino NF	GIS, Data Analysis	M.S., Applied Geospatial Sciences, Northern Arizona University, 2014; B.S. Parks and Recreation Management – Wildland Management, Northern Arizona University, 2004. Years of Experience: 9
Patricia Ringle	Silviculturist, Payson and Pleasant Valley Ranger Districts, Tonto NF	Silviculture	B.S., Forestry, Northern Arizona University, 2002; Years of Experience: 17
Patrick Moore	4FRI Silviculturist	Silviculture	USFS Certified Silviculturist, 2013 to Present; Ph.D., Forest Ecology, Utah State University, 2013; M.S., Forestry, Southern Illinois University, 2006; B.S., Biology, Maryville University, 1998. Years of Experience: 13

Name	Title	DEIS Contribution	Education and Experience
Patti (Mary) O'Connor	Forest GIS Coordinator, Tonto NF	GIS, Data Analysis	M.S., Forest Management, Northern Arizona University, 1990; B.S., Forest Management, Northern Arizona University, 1980. Years of Experience: 34
Paul Brown	Watershed Program Manager, Apache-Sitgreaves NFs	Hydrology and Riparian Resources	M.S., Hydrology, University of Idaho, 1998; B.S., Geology, University of North Dakota, 1993. Years of Experience: 19
Peter Pilles	Heritage Program Manager, Coconino NF	Heritage Resources	B.A., Anthropology, Arizona State University, 1967. Adjunct Professor at Northern Arizona University. Years of Experience: 51
Phillip Dobesh	(Former) Wildlife Biologist, Springerville Ranger District, Apache-Sitgreaves NFs	Wildlife	M.S., Wildlife Ecology, University of Nebraska – Lincoln, 2007; B.S., Fisheries and Wildlife, University of Nebraska – Lincoln, 2002. Years of Experience: 10
Randall Chavez	Recreation & Lands Staff, Sitgreaves Zone, Apache-Sitgreaves NFs	Recreation and Lands	B.S., Range Management, New Mexico State University, 1996. Years of Experience: 23
Randy (Lloyd) Fuller	(Former) 4FRI Silviculturist	Silviculture, Flexible Tool Box, Initial Modelling, Existing Conditions, No Action Alternative, Climate	Ph.D., Botany and Forest Pathology, Forest Entomology, and Mycology, Oregon State University, 1979; B.S., Forest Science, Northern Arizona University, 1974. Years of Experience: 35
Richard Gonzalez	Forest Silviculturist, Coconino & Kaibab NF	Draft Implementation Plan	USDA USFS Certified Silviculturist, 2011 to Present; B.A., Forestry Science with Ecological Restoration focus, Northern Arizona University, 2007. Years of Experience: 15
Rob Nelson	Habitat, Evaluation, and Lands Program Manager, Region II, AGFD	Wildlife/Aquatics	B.S., Wildlife Biology, Kansas State University, 2002. Years of Experience: 16
Robbin Redman	4FRI Planning Coordinator, Interdisciplinary Team (IDT) Leader	IDT Leadership, NEPA/Planning	BS- Forestry-University of Montana-1994; BS Paralegal Studies-Providence University-2000l NEPA Certificate from Utah State University-2003. Years of Experience: 28
Robert Madera	Forest Botanist, Tonto NF	Botany	M.S., Plant Biology and Conservation, Arizona State University, 2016; B.S., Conservation Biology, Arizona State University, 2013. Years of Experience: 6
Robert Rich	Southwestern Region, Forest Operations Specialist	Transportation	M.S., Forestry, University of Montana, 2012; B.S., Forestry, University of Montana, 1980. Years of Experience: 37
Roger Joos	Wildlife Biologist, Mogollon Rim Ranger District, Coconino NF	Wildlife	B.S., Wildlife Science, University of Arizona. Years of Experience: 19

Name	Title	DEIS Contribution	Education and Experience
Sharalyn (Shay) Peterson	Habitat, Evaluation, and Lands Specialist, AGFD	Wildlife/Aquatics	M.S., Forestry, Northern Arizona University, 2015; B.S., Commercial Photography/Anthropology, Northern Arizona University, 2009. Years of Experience: 10
Stephanie Coleman	Aquatics Program Manager, Apache-Sitgreaves NFs	Aquatics	M.S., Wildlife Biology (Aquatic Emphasis), New Mexico State University, 2007; B.S., Wildlife Conservation Biology (Aquatic and Terrestrial), Arizona State University, 1997. Years of Experience: 24
Steve Rosenstock	Statewide Coordinator, Habitat Enhancement, AGFD	Wildlife/Aquatics	B.S., Fishery and Wildlife Biology, Colorado State University, 1984; M.S., Fishery and Wildlife Biology, Colorado State University, 1988. Years of Experience: 30
Steven Johnson	(Former) Engineer, Sitgreaves Zone, Apache-Sitgreaves NFs	Transportation	B.S., Civil Engineering, University of Arizona, 1991. Years of Experience: 26
Suzanne DeRosier	Wildlife Biologist, Black Mesa Ranger District, Apache-Sitgreaves NFs	Wildlife	B.S., Zoology, University of Washington, 1985. Years of Experience: 28
Theresa Tanner	(Former) Aquatics Program Manager, Apache-Sitgreaves NFs	Aquatics	M.S., Fisheries Science, University of Alaska - Fairbanks, 2008; B.S., Wildlife Biology, University of Alaska - Fairbanks, 2004. Years of Experience: 19
Thomas Runyon	Hydrologist, Flagstaff and Mogollon Rim Ranger Districts, Coconino NF	Soils and Watershed	M.S., Environmental Engineering, University of Arizona, 1989; B.S., Geology, Northern Arizona University, 1985. Years of Experience: 30
Victor Morfin	Forest Fuels Specialist, Coconino NF	Fire Ecology and Air Quality	M.S., Forest Science, Northern Arizona University, 1998. Years of Experience: 29
William Dudley	North Zone Fuels Specialist, Tonto National Forest	Fire Ecology and Air Quality	Fire Ecology and Management Certificate, Northern Arizona University, 2018. Years of Experience: 4

* Biographical information unavailable

List of Contributors

Several other individuals contributed to development of the DEIS by providing data, attending internal planning meetings, or providing content review:

Angela Abel

Jeff Leonard

Orry Hatcher

Catherine Luna

John Manthal

Paula Coté

Chandler Mundy

Kenna Belsky

Rebecca Hoffman

Cheryl Prewitt

Kristina Hill

Shana Fitzpatrick

Christina Akins Mark Swift

Shane Baca

Christine Crawford

Mary Price

Shannon Houlette

Christopher Barrett

Matt Turner

Tammy Hoem-Neher

Christopher Miller

Melanie Lawrence

Thomas Greene

David Johnson

Michael Martinez

Timothy Gilloon

Dawnee Burson

Mike Dechter

Vernon Keller

Chapter 5. Distribution List

Introduction

This chapter lists tribes, agencies, organizations, and persons to whom the draft environmental impact statement (DEIS) was provided. Distribution methods include paper copies, CDs, and electronic documents posted on the 4FRI Web site: http://www.fs.usda.gov/4FRI.

Tribes and Tribal Chapters

As part of this project, the Forest Service consulted with following tribes and tribal chapters who have historic ties and interests in the Apache-Sitgreaves, Coconino, and Tonto National Forests: Fort McDowell Yavapai Nation, Gila River Indian Community, Havasupai Tribe, Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Navajo Nation, Mescalero Apache Tribe, Salt River Pima–Maricopa Indian Community, San Carlos Apache Tribe, San Juan Southern Paiute Tribe, Tonto Apache Tribe, White Mountain Apache Tribe, Yavapai–Apache Nation, Yavapai–Prescott Indian Tribe, Pueblo of Acoma, and Pueblo of Zuni. Eight Navajo Chapters in proximity to the project area – the Alamo, Bodaway/Gap, Cameron, Coalmine Canyon, Dilkon, Lechee, Leupp, Ramah, Tolani Lake, and To'Nanees'Dizi Chapters – and the Dine Medicine Man's Association are also included.

Federal, State, and Local Agencies and Representatives

Federal

Advisory Council on Historic Preservation, Washington, DC

National Oceanic and Atmospheric Administration, Office of Policy and Strategic Planning, Washington, DC

National Oceanic and Atmospheric Administration, Southwest Region Fisheries Habitat Conservation Division, Long Beach, CA

U.S. Army Corps of Engineers, South Pacific Division CESPD-CMP, San Francisco, CA

U.S. Coast Guard, Office of Environmental Management, Washington, DC

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, PPD/EAD, Riverdale, MD

U.S. Department of Agriculture, National Agricultural Library, Beltsville, MD

U.S. Department of Agriculture, Natural Resources Conservation Service, Washington, DC

U.S. Department of Energy, NEPA Policy & Compliance, Washington, DC

U.S. Department of the Interior, Fish and Wildlife Service, Phoenix, AZ

U.S. Department of the Interior, Office of Environmental Policy & Compliance, Washington, DC

U.S. Department of the Interior, National Park Service, Flagstaff, AZ

U.S. Environmental Protection Agency, Region 9, San Francisco, CA

U.S. Federal Aviation Administration, Western-Pacific Region, Lawndale, CA

U.S. Federal Highway Administration, Arizona Division, Phoenix, AZ

U.S. Navy, Energy and Environmental Readiness Division, Washington, DC

Western Area Power Administration, Lakewood, CO

State

Arizona Department of Environmental Quality, Phoenix, AZ

Arizona Department of Forestry and Fire, Flagstaff, AZ

Arizona Department of Transportation, Flagstaff, AZ

Arizona Game and Fish Department, Flagstaff, AZ – Cooperating Agency

Arizona State Historic Preservation Office, Phoenix, AZ

Arizona Junior Senator Martha McSally

Arizona Senior Senator Kyrsten Sinema

Arizona Congressman Tom O'Halleran, Congressional District 1

Arizona Congressman Paul Gosar, Congressional District 4

Local

Apache County, St. Johns, AZ

City of Camp Verde, Camp Verde, AZ

City of Clarkdale, Clarkdale, AZ

City of Cottonwood, Cottonwood, AZ

City of Flagstaff, Flagstaff, AZ

City of Payson, Payson, AZ

City of Sedona, Sedona, AZ

City of Show Low, Show Low, AZ

City of Tusayan, Tusayan, AZ

City of Williams, Williams, AZ

Clarkdale Fire Department, Clarkdale, AZ

Coconino County, Flagstaff, AZ

Eastern Arizona Counties Organization, Show Low, AZ

Gila County, Globe, AZ

Graham County, Safford, AZ

Greenlee County, Clifton, AZ

Mountainaire Community Council, Flagstaff, AZ

Navajo County, Holbrook, AZ

Williams Fire Department, Williams, AZ

Yavapai County, Prescott, AZ

List of Individuals and Organizations

The below individuals and organizations submitted comments during the Rim Country Project scoping period in 2016 and will receive the Rim Country DEIS. In addition to the individuals listed, 765 others on the project mailing list will receive the DEIS. The full list of people notified is contained in the Rim Country Project record.

- 4FRI Stakeholder Group
- Aaron Green, Arizona Department of Forestry and Fire
- Alicyn Gitlin, Sierra Club, Grand Canyon Chapter
- Arthur Firstenberg
- Bill Davis
- Bradley Powell, Arizona Wildlife Federation
- Bruce Fox
- Chad Hanson, John Muir Project
- Danny Smith, Graham County Board of Supervisors
- Dorothy Holasek
- Duke Grant
- Fred Gaudet, Arizona Trail Association
- Garrett Hanks, Trout Unlimited
- Gentry Smith, Desert Fly Casters
- Greg Dyson, Wild Earth Guardians
- Jan Boyer
- Jason Gerdes, Environmental Protection Agency
- Jason Whiting, Navajo County Board of Supervisors
- Jean Public
- Jim Strogen
- John Hamill, Theodore Roosevelt Conservation Partnership
- John Johnson, Flying H Ranch
- Joni Howard
- Joyce Francis, Arizona Game and Fish Department
- Judy Prosser, Bar-T-Bar Ranch
- Kathy Smith
- Leigh Kuwanwisiwma, Hopi Tribe
- Leslie Johnson, Flying H Ranch
- Lynn Krigbaum
- Mark Perkins
- Marsha Honn
- Mary Fish
- Melinda Honn
- Nate Reisner, Arizona Department of Transportation
- Pascal Berlioux, Eastern Arizona Counties Organization
- Peter Steere, Tohono O’odham Nation
- Rob Marshall, The Nature Conservancy
- Rob Nelson, Arizona Game and Fish Department
- Stephen Clark, Arizona Elk Society
- Todd Schulke, Center for Biological Diversity
- Tom Mackin, Coconino Sportsmen
- Tommie Martin, Gila County Board of Supervisors
- Travis Bruner, Grand Canyon Trust
- William Baker
- Woody Cline

Appendix A – Maps

Note: If you obtained a paper copy of the DEIS, it includes five 11x17-inch maps for alternatives 2 and 3. Viewers of the electronic version of the DEIS can find the five maps listed under Appendix A – Map Packet on the Rim Country Project page of the 4FRI Planning website at this address: https://www.fs.usda.gov/detail/4fri/planning/?cid=stelprd3837085.

Appendix B – Forest Plan Amendments

Three project-specific amendments for the Tonto NF are evaluated in the Rim Country DEIS. The forest plan amendments are authorized via 36 CFR 219, the Forest Service Planning Rule. Each amendment is a specific, one-time variance in the current Tonto Forest Plan direction for the Rim Country Project. The amendments would not apply to any other projects or areas outside of the Rim Country project area and any associated changes in forest plan language or direction would cease to be in effect upon completion of this project.

Both of the action alternatives (alternatives 2 and 3) would require these proposed amendments.

The purpose of Amendment 1 is to bring alternatives 2 and 3 into alignment with the revised Mexican Spotted Owl Recovery Plan and defer monitoring to the FWS biological opinion that is specific to this project. Amendment 2 clarifies existing direction related to managing canopy cover and interspace in the Forest Plan. The purpose of Amendment 2 is to bring the project into alignment with the best available science (Reynolds et al. 2013) that provides desired conditions for restoring fire-adapted ponderosa pine in the Southwest. Amendment 3 removes the restrictive language related to 40 percent slopes and the language identifying slopes above 40 percent as inoperable, to allow mechanical treatments with new methods and equipment on slopes greater than 40 percent without adverse environmental effects.

Amendment 1. Ponderosa pine vegetation/forest cover types

There is a need for the 4FRI Rim Country analysis to be in alignment with the Apache-Sitgreaves and Coconino NF revised forest plan management direction. The revised forest plans reflect a change in conditions since the 1980s including acknowledgement that vegetation conditions (structure, composition, and function) are divergent from reference conditions and forest conditions indicate a substantial departure from the natural fire regime. The revised plans use the latest best available science and information. Because a final Tonto National Forest (hereafter referred to as Tonto NF) revised forest plan is not expected until at least 2020, an amendment is needed to:

- Replace forest plan standards and guidelines for ponderosa pine/bunchgrass, ponderosa pine/Gambel oak, ponderosa pine/evergreen oak, dry mixed conifer and old growth with desired conditions and guidelines
- Add a desired condition for the percentage of interspaces within uneven-aged stands to facilitate restoration.
- Add the desired interspaces distance between tree groups.
- Add a definition to the forest plan glossary for the terms interspaces and openings.
- For the purposes of this amendment, the following definitions apply:

Interspaces as defined by RMRS-GTR-310 (Reynolds et al. 2013) are areas within a stand that are not currently under the vertical projection of the outermost perimeter of tree canopies (drip-line). They are generally composed of grass-forb-shrub cover but could also be areas with scattered rock or exposed mineral soil. As spaces between trees, tree groups and tree clumps, interspaces contribute to the "open canopy" character of frequent-fire forests. They often connect with other interspaces and thus are variably shaped and sized. Also see "openings". Interspaces and tree group locations are dynamic and shift over time.

Openings may result from different causes. They may be defined as generally persistent treeless areas having a fairly distinct shape or size, occurring naturally due to differences in soil types as compared to sites that support forests or woodlands. Openings include meadows, grasslands, rock outcroppings, and wetlands. They may also result from disturbances like severe fire or windthrow, or management activities to intentionally create space for new tree regeneration. Natural and created openings are not the same as interspaces found in the frequent-fire forests or woodlands. See "interspaces."

Uneven-aged forests are forests that comprise three or more distinct age classes of trees, either intermixed or in small groups.

Uneven-aged management is the application of combined actions needed to simultaneously maintain continuous forest cover, and support the recurring regeneration of desirable species and the orderly growth and development of trees through a range of diameter or age classes to provide a sustained yield of forest products. Cutting is usually regulated by specifying the number or proportion of trees of particular sizes to retain within each area, thereby maintaining a planned distribution of size-classes. Cutting methods that develop and maintain uneven-aged stands are single-tree selection and group selection. An uneven-aged, regulated forest is one which has a balanced progression of three or more age/size-classes, such that each younger/smaller class is advancing to replace the class above it on approximately the same acreage, until it is mature for harvest or other resource objectives. A regulated forest reaches sustained yield when the volume cut periodically equals the amount of net volume growth for that same period.

Amendment 2. Mexican spotted owl component

In 2012, the Mexican Spotted Owl Recovery Plan, First Revision, was published (USDI FWS 2012). There is a need for the 4FRI Rim Country analysis to be in alignment with the management direction provided in the revised Recovery Plan and the other forest plans that are part of this landscape EIS. A project-specific plan amendment is needed because the 1985 Tonto National Forest Plan, as amended, includes direction from the former (1995) recovery plan.

The plan amendment would:

- Update definitions and direction for protected (protected activity centers (PACs)), recovery habitat, and other forest and woodland types to be in alignment with the current recovery plan.
- Update language and direction related to prescribed cutting and fire treatments in PACs to be consistent with the current recovery plan.
- Add forest structure guidelines for recovery habitat.
- Update survey information and remove population and habitat monitoring direction. The MSO monitoring plan from Coconino and Kaibab NF 4FRI decision would serve as a starting point for continuing monitoring across MSO habitat on Tonto NF, in consultation with the USFWS.
- Remove the direction for treating habitat in incremental percentages. The MSO monitoring plan for the Coconino and Kaibab NF 4FRI decision would serve as a starting point for continuing monitoring across MSO habitat on Tonto NF, in consultation with the USFWS. The monitoring plan includes a phased implementation and monitoring strategy.

Background

At the request of the 4FRI planning team, Dr. Joseph Ganey and other Mexican spotted owl experts published the "Status and ecology of Mexican spotted owls in the Upper Gila Mountains Recovery Unit, Arizona and New Mexico" in 2011 (RMRS GTR-256). The intent of this report was to aid planners in evaluating potential benefits or impacts of management actions for Mexican spotted owls and their habitat.

Each stand within PACs on the Tonto NF would be modeled to identify silvicultural and prescribed fire treatments that would yield the best existing and future Mexican spotted owl habitat conditions. Selecting trees for removal would prioritize the release of large and old trees including oak. The goal for PAC treatments would be to move existing owl habitat toward the desired conditions described in the 2012 Mexican spotted owl Recovery Plan, First Revision (USDI FWS 2012). Whether nesting and roosting habitat would benefit from selectively cutting trees greater than 9 inches diameter at breast height would be determined with the USFWS. Treatments up to 9 inches diameter at breast height are consistent with the current Tonto NF forest plan. The proposal would be in alignment with the revised Mexican spotted owl Recovery Plan (USDI FWS 2012).

Prescribed fire is an appropriate and effective tool for improving habitat conditions within most PACs, including core areas. Excluding PACs and/or core areas from prescribed fire is either done by drawing burn units that do not include the PAC/core area. This can result in thousands of additional acres outside of the PAC being excluded from prescribed fire. The other way PACs are excluded is by creating firelines. Firelines can range from a ~3 foot wide hand line to a ~12+ foot wide dozer line. The number of acres of potential ground disturbance needed to exclude PACs from burning could range from about ½ acre (hand line) to about 2.5 acres (dozer line), and would also include limbing, thinning, cutting, as needed along the lines, depending on site specific burning conditions (weather, fuel, topography). Additionally, burning off of firelines built through heavy fuels increases the risk to fire managers implementing proposed actions.

There is concern that constructed firelines could encourage recreation use in areas of spotted owl nesting and roosting, and increased human disturbance could lead to indirect effects, including removal of snags and logs inside PACs by firewood cutters and campers.

Burning in Mexican spotted owl PACs is difficult as there is a need to address the high fuel loadings while maintaining many of the habitat elements that contribute to fuel loading. There is often a short burn window available in order to avoid the breeding season (i.e., the nonbreeding season – September 1 to February 28). Lining numerous core areas greater than or equal to 100 acres would be expensive in terms of time, money, and other resource commitments. In many projects, PAC treatments have been eliminated for these reasons. Applying low-severity prescribed fire within the 100-acre core areas may eliminate the need for fireline construction and will potentially minimize impacts to protected habitat.

A geographic layer for recovery habitat across the 4FRI Rim Country project area will be developed and will merge all available pine-oak and mixed conifer data. A landscape-scale approach would meet the goal of providing continuous replacement nesting and roosting habitat over time at a landscape scale, as described in the revised Recovery Plan.

Recovery habitat would be managed to meet a 110 square feet basal area or greater for Mexican spotted owl nest and roost habitat as recommended in the revised Recovery Plan. The purpose is to allow more of the uncharacteristically dense in-growth in most diameter size classes in the Rim Country Project area to be removed while retaining nesting and roosting habitat components. The purpose is to improve forest health while retaining large trees and increasing large tree growth rates as described in the revised recovery plan. Based on a cursory review of existing condition data there will likely be a need to increase forest spatial heterogeneity and improve MSO prey habitat. Increasing the basal area range would provide opportunities to mimic canopy gap processes which produce horizontal variation in stand structure. These changes would both increase and retain nesting and roosting structure and increase understory cover.

Research suggests that small mammal biomass (including voles and mice) drives spotted owl reproductive output. Thinning smaller trees would also improve sub-canopy flight zone, thereby increasing Mexican spotted owl foraging effectiveness.

Monitoring assesses the effectiveness of management actions and provides the adaptive framework for more successful management guidelines. Monitoring habitat allows for modeling future forest conditions to determine if there will be adequate habitat to support Mexican spotted owl populations. Occupancy, reproduction and habitat monitoring and final project design for all activities in all Mexican spotted owl habitat was developed for the first 4FRI analysis in consultation with the U.S. Fish and Wildlife Service. While the monitoring plan from the first 4FRI analysis will be reviewed, a new monitoring plan that is specific to this landscape will be developed in coordination with the USFWS. The USFWS identifies the minimum monitoring requirements as part of their biological opinion. Adaptive management would also allow modifying Rim Country MSO treatments with the monitoring results from the first 4FRI.

Amendment 3. Mechanical treatments on steep slopes

The current Forest Plan restricts the use of mechanical equipment to slopes less than 40 percent. Amendment 3 would remove the restrictive language related to 40 percent slopes and also the language identifying slopes above 40 percent as inoperable in order to allow mechanical harvesting on slopes greater than 40 percent within the project area.

It would be necessary to allow for use of specialized mechanical equipment to cut and remove trees and also to mechanically treat other vegetation on steep slopes, in order to carry out restoration treatments in portions of the Rim Country project area on the Tonto Forest. Since the Tonto Forest Plan was written and amended, the design of mechanized ground-based equipment has progressed to allow operations on steep slopes more effectively and without adverse effects on soil resources. This forest plan amendment is needed in order to be able to utilize such equipment on slopes greater than 40 percent, to meet the purpose and need of the Rim Project, and to move toward desired conditions on these steeper slopes in the project area.

Current Tonto Forest Plan Direction

Chapter 4 Replacement Page 40-2:

> *Allow no timber harvest except for fire risk abatement in mixed conifer and pine-oak forests on slopes greater than 40% where timber harvest has not occurred in the last 20 years.*

Chapter 4_4A Replacement Page 135:

> *Restrict tractor skidding to those areas that have sustained slopes of 40% or less.*

Chapter4_5A Page 158:

> *Restrict tractor skidding to those areas that have sustained slopes of 40% or less.*

Proposed Language for Tonto Forest Plan Amendment

Within the Rim Country project area, mechanical treatments are allowed on slopes greater than 40% where mechanical treatments are not otherwise restricted and the use of mechanized ground-based equipment would not result in adverse effects on soil and water resources. Mechanical restoration treatments on slopes greater than 40% will adhere to the Rim Country Project design features and Best Management Practices (BMPs) designed to protect soils and water quality.

Appendix C – Design Features, Best Management Practices, Mitigation, and Conservation Measures

Table 106 lists design features, best management practices, and mitigation and conservation measures (collectively referred to as design features) that are designed to minimize or avoid effects common to all action alternatives. They are integral parts of the action alternatives that help align proposed activities with forest plan objectives, desired conditions, standards, and guidelines. As such, they have been included in the analysis presented in this DEIS. Design features in the table are organized by resource.

Table 106. Design features, best management practices, mitigation, and conservation measures

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ001	Any equipment or personnel for activities in and around streams, natural or constructed waters, springs, or wetlands of any kind will use decontamination procedures to prevent the spread of disease (e.g., Chytrid fungus) and aquatic invasive species. Personnel entering the water following Appendix G in the 2007 Chiricahua Leopard frog Recovery Plan and the Stop Aquatic Hitchhikers Clean, Drain, Dry procedure http://stopaquatichitchhikers.org/prevention/#clean-drain-dry.	To minimize potential for spreading aquatic diseases or invasive species.	Forest plan compliance
AQ002	Porous boulder structures and vane restoration treatments: • Full channel spanning boulder structures are to be installed only in highly uniform, incised, bedrock-dominated channels to enhance or provide fish habitat in stream reaches where log placements are not practicable due to channel conditions (not feasible to place logs of sufficient length, bedrock dominated channels, deeply incised channels, artificially constrained reached, etc.), where damage to infrastructure on public or private lands is of concern. • Install boulder structures low in relation to channel dimensions so that they are completely overtopped during channel-forming flow events (approximately a 1.5 flow event). • Boulder step structures are to be placed diagonally across the channel or in more traditional upstream pointing “V” or “U” configurations with the apex oriented upstream. • Boulder step structures are to be constructed to allow upstream and downstream passage of all native fish species and life stages that occur in the stream. Plunges shall be kept to less than 6 inches in height. • The use of gabions, cable, or other means to prevent the movement of individual boulder in a boulder step structure is not allowed. • Rock for boulder step structures shall be durable and of suitable quality to assure long-term stability in the climate in which it is to be used. Rock sizing depends on the size of the stream, maximum depth of low, planform, entrenchment, and ice and debris loading. • The project designer or an inspector experienced in these structures should be present during installation. • Full spanning boulder step structure placement should be coupled with measures to improve habitat complexity and protection of riparian areas to provide long-term inputs of large wood.	To guide porous boulder structures and vane restoration treatments for aquatic and watershed restoration.	Specialist recommendation
AQ003	When using pressure treated lumber for fence posts, complete all cutting/drilling offsite of the designated AMZ (to the extent possible) so that treated wood chips and debris do not enter water or flood prone areas.	To prevent detrimental effects of chemicals from entering aquatic habitats.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ004	Set-back or removal of existing berms: • Design actions to restore floodplain characteristics-elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type. • Remove drain pipes, fences, and other capital projects to the extent possible. • To the extent possible, remove nonnative fill material from the floodplain to an upland site. • Where it is not possible to remove or set-back all portions of berms, or in areas where existing berms support abundant riparian vegetation, openings will be created with breaches. Breaches shall be equal to or greater than the active channel width to reduce the potential for channel avulsion during flood events. In addition to other breaches, the berm, dike, or levee shall always be breached at the downstream end of the project or at the lowest elevation of the floodplain to ensure the flows will natural recede back into the main channel thus minimizing fish entrapment.	To guide set-back or removal of existing berms, dikes, and levees to reconnect stream channels with floodplains as a means to increase habitat diversity and complexity, moderate flow disturbances, and provide refuge for fish during high flows.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ005	Channel Reconstruction/Relocation Treatments: • Construct geomorphically appropriate stream channels and floodplains within a watershed, valley, and reach context. • Design actions to restore floodplain characteristics – elevation, width, gradient, length, and roughness-in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type. • To the greatest degree possible, remove nonnative fill material from the channel and floodplain to an upland site. • When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain where appropriate to support the project goals and objectives. • Structural elements shall fit within the geomorphic context of the stream system. For bed stabilization and hydraulic control structures, constructed riffles shall be preferentially used in pool-riffle stream types, while roughened channels and boulder step structures shall be preferentially used in step-pool and cascade stream types. • Material selections (large wood, rock, gravel) shall also mimic natural stream system materials. • Construction of the stream bed should be based on Stream Simulation Design principles as described in section 6.2 of Stream Simulation: An Ecological Approach to Providing Passage of Aquatic Organisms at Road-Stream Crossings or other appropriate design guidance documents (USDA-Forest Service 2008).	To guide stream, floodplain, and other stream/watershed restoration treatments to minimize detrimental effects to aquatic habitats.	Forest plan compliance and specialist recommendation
AQ006	All stream crossings must be approved in advance of use to minimize the number and length of stream crossings. Such crossings will be at right angles and avoid potential spawning or breeding areas to the greatest extent possible. Stream crossings shall not increase the risk of channel re-routing at low and high water conditions. After project completion, temporary stream crossing will be restored.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	Forest plan compliance and specialist recommendation
AQ007	For recreation relocation projects—such as campgrounds, horse corrals, off-road vehicle trails—move current facilities out of the riparian area or as far away from the stream as possible.	To reduce recreation effects on aquatic habitats.	Forest plan compliance
AQ008	To the extent feasible, heavy equipment will work from the top of the bank, unless working from within the stream bed would result in less damage to the aquatic ecosystem, as determined by a biologist.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ009	Any fence placement must allow for lateral movement of a stream and to allow establishment of riparian plant species. To the extent possible, fences will be placed outside the channel migration zone. Fences that cross the channel migration and the stream channel proper should include breakaway portions that will not collect debris on the fence and cause potential breach of the debris jam.	To maximize success of riparian planting and reduce maintenance on fencing.	Specialist recommendation
AQ010	When building riparian exclosure fences, minimize vegetation removal, especially potential large wood recruitment sources, when constructing fence lines.	To reduce detrimental effects to riparian species (flora and fauna) and floodplains.	Specialist recommendation
AQ011	Where appropriate, include hazard tree removal (amount and type) in project design. Fell hazard trees when they pose a safety risk. If possible, fell hazard trees within riparian stream systems areas towards a stream. Keep felled trees on site when needed to meet coarse large wood objective or to be used as part of restoration treatments.	Improve aquatic habitat complexity while meeting safety objectives.	Specialist recommendation
AQ012	Leave sufficient numbers of cut trees (large woody debris) onsite for needed surface flow grade control in systems where large woody debris is appropriate. Fisheries, wildlife, or watershed personnel will identify locations for large woody debris before works starts and/or inspect large woody debris placement work done by the timber sale administrator or contracting officer representative prior to unit closeout.	To minimize impacts to streams and soils in meadows from tree thinning operations.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ013	Streambank Restoration Treatments: Without changing the location of the bank toe, restore damaged streambanks to a natural slope and profile suitable for establishment of riparian vegetation. This may include sloping of unconsolidated bank material to a stable angle of repose or the use of benches in consolidated, cohesive soils. • Complete all soil reinforcement earthwork and excavation when soils are sufficiently dry to prevent excessive rutting. When necessary, use soil layers or lifts that are strengthened with biodegradable fabrics and penetrable by plant roots. • Include large wood to the extent it would naturally occur for streambank restoration. If possible, large wood should have untrimmed root wads to provide functional refugia habitat for fish. Wood that is already within the stream or suspended over the stream may be repositioned to allow for greater interaction with the stream. • Rock will not be used for streambank restoration, except as ballast to stabilize large wood. • Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous. Vegetation, such as willow, sedge, and rush mats, may be gathered from abandoned floodplains, stream channels, etc. • Do not apply surface fertilizer within the AMZ of any stream channel. • Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons. • Conduct post-construction monitoring and treatment or removal of invasive plants until native plant species are well established.	To guide streambank and channel restoration/resilience treatments.	Forest plan compliance and specialist recommendation
AQ014	Minimize removal of desirable vegetation around springs, streams and wetlands.	To reduce detrimental effects to sensitive habitats.	Forest plan compliance and specialist recommendation
AQ015	When removing a culvert from a first or second order, non-fish bearing stream roads managers, biologists, and watershed personnel shall determine if culvert removal should include stream isolation and rerouting in project design. Culvert removal on fish bearing streams shall adhere to the measures described in Fish Passage Restoration.	To reduce impacts to fish passage.	Specialist recommendation
AQ016	For culvert removal projects, restore natural drainage patterns and channel morphology. Evaluate channel incision risk and construct in-channel grade control structures when necessary.	To reduce detrimental effects to floodplains, riparian areas, stream channels and aquatic habitat.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ017	Structural erosion control measures will not include materials that can trap reptiles or amphibians in their habitat. Structural erosion control measures not made of biodegradable material (e.g., silt fences) will be removed and material contoured in or removed once the site is stabilized to prevent them from causing resource issues and decomposing on site.	To minimize detrimental effects to federally listed, sensitive, or other reptiles and amphibians.	Forest plan compliance and specialist recommendation
AQ018	• Given the potential for multiple aquatic species to occur in a given location, FS, FWS, and AGFD biologists will cooperatively prioritize aquatic species of concern on a site specific basis regarding timing restrictions for instream and riparian restoration activities. • Work will occur during base-flow conditions, and on dry or frozen riparian soil conditions where possible.	To minimize direct effects to critical habitat (e.g. spawning and breeding) for federally listed and forest sensitive species.	Forest plan compliance and specialist recommendation
AQ019	Biologists will be consulted during pre-planning for all treatments that will occur in springs, streams, and riparian areas, as well as fens or bogs where histic soils are present, to determine presence of federally listed or sensitives species (plants or animals), as well as mitigations needed for rare or sensitive species in/near the work areas.	To minimize effects to rare/sensitive aquatic species during project implementation.	Forest plan compliance and specialist recommendation
AQ020	Garter snakes: • Aquatic Management Zones in Narrow-headed and Northern Mexican Garter snake proposed critical habitat will be 600 ft. on either side of the stream. • No mechanical or hand piling will occur within the Garter snake AMZs to minimize effects during controlled burns or pile burning. • Any Narrow-headed and Northern Mexican garter snakes found will be relocated for the project types listed above following the Instream Construction Zone Isolation for Aquatic Species design features. Per the protocol, biologists will pre-identify areas where snakes would be moved in coordination with Arizona Game and Fish Department and U.S. Fish and Wildlife Service. • Disturbance of rock/boulder piles and large woody debris in narrow-headed or northern Mexican garter snake habitat or proposed critical habitat will be avoided to the greatest extent practical during their hibernation period. • Do not build temporary roads in narrow-headed or northern Mexican garter snake habitat or proposed critical habitat during their hibernation period.	To minimize detrimental effects to federally listed garter snakes.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ021	A qualified, permitted biologist will be on site during heavy equipment construction activities to attempt to protect narrow-headed or northern Mexican garter snakes and/or key habitat features during construction. If this is a contract, the biologist will need to work with the COR to discuss activities related to the contract to avoid potentials for claims. This will occur within proposed critical habitat for construction zones in the following project types: • Fish Passage Restoration • Large Wood, Boulder, and Gravel Placement • Legacy structure removal or maintenance • Channel Reconstruction/Relocation • Off- and Side-Channel Habitat Restoration • Streambank Restoration • Set-back or Removal of existing berms for aquatic restoration • Beaver Habitat Restoration	To minimize direct effects to spawning and breeding grounds for federally listed and forest sensitive species.	Specialist recommendation
AQ022	Garter snakes: Any Narrow-headed and Northern Mexican garter snakes found will be relocated for the project types listed above following the Instream Construction Zone Isolation for Aquatic Species design features. Per the protocol, biologists will pre-identify areas where snakes would be moved in coordination with Arizona Game and Fish Department and U.S. Fish and Wildlife Service.	To minimize direct effects to spawning and breeding grounds for federally-listed and forest sensitive species.	Specialist recommendation
AQ023	Instream Construction Zone Isolation from Aquatic Species: Isolate Capture Area within the construction zone • Install block nets at up and downstream locations outside of the construction zone to exclude fish from entering the project area. Leave nets secured to the stream channel bed and banks until construction activities within the stream channel are complete. If block nets or traps remain in place for more than one day, monitor the nets or traps at least on a daily basis to ensure they are secured to the banks and free of organic accumulation and to minimize fish predation or inadvertent capture of other aquatic species in the trap.	To minimize sedimentation and detrimental effects to aquatic species and habitat during aquatic and watershed restoration projects.	Specialist recommendation

<table>
<tr><th>DF/BMP/M&CM Number</th><th>Description</th><th>Primary Purpose</th><th>Basis</th></tr>
<tr><td>AQ023 Continued</td><td>Capture and release of species within the construction zone
• Species trapped within the isolate work area will be captured and released as prudent to minimize risk of injury, then released at a safe release site, preferably upstream of the isolated reach, for fish in a pool or other area that provided cover and flow refuge. Collect fish in the best manner to minimize potential stranding and stress by seine or dip nets as the area is slowly dewatered, baited minnow traps placed overnight, or electrofishing (if other options are ineffective). Fish must be handled with extreme care and kept in water the maximum extent possible during transfer procedures. A healthy environment for the stressed fish shall be provided – large buckets (five-gallon minimum to prevent overcrowding) and minimal handling of fish. Place large fish in buckets separate from smaller prey-sized fish. Monitor water temperature in buckets and well-being of captured fish. If buckets are not being immediately transported, use aerators to maintain water quality. As rapidly as possible, but after fish have recovered, release fish. In cases where the stream is intermittent upstream, release fish in downstream areas and away from the influence of construction. Capture and release will be supervised by a fishery biologist experienced with work area isolation and safe handling of all fish.
Dewatering construction site
• When dewatering is necessary, ensure diversion passes flows and aquatic species to minimize detrimental effects. Return flow to downstream channel so they are not dewatered. Coffer dams should be built with non-erosive materials or covered in a manner that minimizes erosion and sedimentation as well as decreases in water quality.
Diversion sandbags can be filled with material mined from the floodplain as long as such material is replaced at the end of project. Small amounts of instream material can be moved to help seal and secure diversion structures. Dissipate flow energy at the bypass outflow to prevent damage to riparian vegetation or stream channel. If diversion allows for downstream fish passage, place diversion outlet in a location to promote safe reentry of fish into the stream channel, preferably into pool habitat with cover. Pump seepage water from the de-watered work area to a temporary storage and treatment site or into upland areas and allow water to filter through vegetation prior to reentering the stream channel.
Surface Water Withdrawals:
• Surface water may be diverted to meet construction needs, but only if developed sources are unavailable or inadequate. If aquatic species are or may be present (e.g. fish, tadpoles, mollusks), diversions may not exceed 10% of the available flow and fish screen(s) will be installed, operated, and maintained.</td><td>To minimize sedimentation and detrimental effects to aquatic species and habitat during aquatic and watershed restoration projects.</td><td>Specialist recommendation</td></tr>
</table>

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ023 Continued	Stream re-watering: • Upon project completing, slowly re-water the construction site to prevent loss of surface water downstream as the construction site streambed absorbs water and to prevent a sudden release of suspended sediment. Monitor downstream during re-watering to prevent stranding of aquatic organisms below the construction site.	To minimize sedimentation and detrimental effects to aquatic species and habitat during aquatic and watershed restoration projects.	Specialist recommendation
AQ024	Avoid water withdrawals from streams bearing aquatic species whenever possible. Water drafting must take no more than 10% of the stream flow and must not dewater the channel to the point of isolating species. Pump intakes shall have fish screens of 3/32 inch mesh or less and will have an intake flow of less than 1 foot/second to prevent entraining fish. Implement decontamination procedures as outlined in AQ001 when drafting from waterbodies and streams. Biologists must be consulted in all situations when pumping water from streams or other natural waterbodies.	To avoid, or minimize detrimental effects to native or desirable aquatic species and habitats.	Forest plan compliance
AQ025	Avoiding discharging water from one source into a different body of water, such as dumping unused water from a water tender in or near a water body other than the water body from which it was acquired.	To avoid spread of invasives, disease, and contaminants.	Forest plan compliance
AQ026	Restoring fish passage during headcut and grade stabilization treatments: • In streams with current or historic fish presence, provide fish passage over stabilized headcut through constructed riffles for pool/riffle streams or series of log or rock structures for step/pool channels. If large wood and boulder placement will be used for headcut and grade stabilization, refer to Large Wood, Boulder, and Gravel Placement. • Armor headcut with sufficiently sized and amounts of material to prevent continued up-stream migration of the headcut. Materials can include both rock and organic materials which are native to the area. Material shall not contain gabion baskets, sheet pile, concrete, articulated concrete block, and cable anchors. • Focus stabilization efforts in the plunge pool, the headcut, as well as a short distance of stream above the headcut. • Minimize lateral migration of channel around headcut (“flanking”) by placing rocks and organic material at a lower elevation in the center of the channel cross section to direct flows to the middle of the channel. • Short-term headcut stabilization may occur without associated fish passage measures. However, fish passage must be incorporated into the final headcut stabilization action and be completed during the first subsequent in-water work period. • In streams without current or historic fish presence, it is recommended to construct a series of downstream log or rock structures to expedite channel aggradation.	To minimize loss of fish passage during headcut and channel grade stabilization treatments.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ026 Continued	• Construct structures in a 'V' or 'U' shape, oriented with the apex upstream, and lower in the center to direct flows to the middle of the channel. • Key structures into the stream bed to minimize structure undermining due to scour, preferably at least 2.5x their exposure height. The structures should also be keyed into both banks – if feasible greater than 8 ft. • If several structures will be used in a series, space them at the appropriate distances to promote fish passage of all life stages of native fish. Incorporate jump height, pool depth, etc. in the design of step structures. Recommended spacing should be no closer than the net drop divided by the channel slope (for example, a one-foot high step structure in a stream with a two-percent gradient will have a minimum spacing of 50-feet. • Include gradated (cobble to fine) material in the rock structure material mix to help seal the structure/channel bed, thereby preventing subsurface flow and ensuring fish passage immediately following construction if natural flows are sufficient. • If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work session, remove the most upstream barrier first if possible.	To minimize loss of fish passage during headcut and channel grade stabilization treatments.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ027	Large Wood, Boulder, and Gravel Placement Treatments: • Place large wood and boulders in areas where they would naturally occur and in a manner that closely mimic natural accumulations for that particular stream type. For example, boulder placement may not be appropriate in low gradient meadow streams. • Structure types shall simulate disturbance events to the greatest degree possible and if appropriate, could include, but are not limited to, log jams, debris flows, windthrow, and tree breakage. • No limits are to be placed on the size and shape of structures as long as such structures are within the range of natural variability of a given location and do not block fish passage. • Projects can include grade control and bank stabilization structures, while size and configuration of such structures will be commensurate with scale of project site and hydraulic forces. • The partial burial of large wood and boulders is permitted. This applies to all stream systems but more so for larger stream systems where use of adjacent riparian trees or channel features is not feasible or does not provide the full stability desired. • Large wood includes whole conifer and hardwood trees, lobs, and root wads. Large wood size (diameter and length) should account for bankfull width and stream discharge rates. When available, trees with root wads should be a minimum of 1.5x bankfull channel width, while logs without root wads should be a minimum of 2.0x bankfull width. • Structures may partially or completely span stream channels or be positioned along stream banks. • Stabilizing or key pieces of large wood must be intact, hard, with little decay, and if possible have root wads (untrimmed) to provide functional refugia habitat for fish. Consider orienting key pieces such that the hydraulic forces upon the large wood increases stability. • Anchoring large wood – Anchoring alternatives may be used in preferential order: 1) Use of adequate sized wood sufficient for stability. 2) Orient and place wood in such a way that movement is limited. 3) Ballast (gravel or rock) to increase the mass of the structure to resist movement. 4) Use of large boulders as anchor points for large wood. 5) Pin large wood with rebar to large rock to increase its weight. For stream that are entrenched (Rosgen F, G, A, and potentially B) or for other streams with very low width to depth ratios (<12) and additional 60% ballast weight may be necessary due to greater flow depths and higher velocities.	To guide successful large wood and boulder stream restoration treatments.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ028	Engineered Logjams: • Engineered log jams will be patterned, to the greatest degree possible, after stable natural log jams. • Grade control engineered log jams are design to arrest channel down-cutting or incision by providing a grade control that retains sediment, lowers stream energy, and increases water elevations to reconnect floodplain habitat and diffuse downstream flood peaks. • Stabilizing or key pieces of large wood that will be relied on to provide streambank stability or redirect flows must be intact, solid (little decay). If possible, acquire large wood with untrimmed root wads to provide functional refugia habitat for fish. • When available, trees with root wads should be a minimum of 1.5x bankfull channel width, while logs without root wads should be a minimum of 2.0x bankfull width. • The partial burial of large wood and boulders may constitute the dominant means of placement, and key boulders (footings) or large wood can be buried into the stream bank or channel. • Angle and Offset – The large wood portions of engineered log jam structures should be oriented such that the force of water upon the large wood increases stability. If a root wad is left exposed to the flow, the bole placed into the stream bank should be oriented downstream parallel to the flow direction so the pressure on the root wad pushes the bole into the streambank and bed. Wood members that are oriented parallel to flow are more stable than members oriented at 45 or 90 degrees to the flow. • If large wood anchoring is required, a variety of methods may be used. These include buttressing the wood between riparian trees, the use of manila, sisal or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, such as rebar pinning or bolted connections, may be used. Rock may be used for ballast but it limited to that needed to anchor the large wood. • There is no DBH (diameter at breast height) restriction for large wood, but consider the following before removing and placing trees.	To guide engineered log jam stream treatments	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ028 Continued	Diameter This key to establishing a logjam is utilizing larger diameter wood that resists decay. These pieces of wood are often called "key pieces," and serve as the anchors for the logjam structure. Wood can improve fish habitat only if the wood is large enough to stay, influence flow patterns, and sediment sorting. Larger diameter wood retains its size longer as abrasion and decay occurs over the years. Larger diameter wood is more effective in creating pools and complex channels that improve fish populations. The minimum diameter required for a key piece of wood depends on bankfull width of the stream is found in the following table. Bankfull widths and minimum diameter of logs to be considered key pieces. Bankfull Width* - Feet Minimum Diameter* - Inches 0 to 10 10 10 to 20 16 20 to 30 18 Over 30 22 * This table was taken from '1995 Guide to Placement of Large Wood in Streams'. Length • The length of the wood is also important to stability. To be considered a key piece a log with a rootwad still attached should be at least one and one-half times (1.5X) the bankfull or a log without a rootwad should be twice (2X) the length of the stream's bankfull width. As the best fish habitat is formed around jams composed of 3 to 7 logs, at least 2 key pieces should be used at each structure. • Mimic natural accumulations of large woody debris based on stream type, valley setting, and community type and ensure future large woody debris recruitment. • Tailholds as part of tree tipping operations are permitted across perennial, intermittent, and ephemeral streams but the use of protective straps will be required to prevent tree damage.	To guide engineered log jam stream treatments	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ029	Gravel Augmentation Stream Restoration Treatments: • Gravel can be placed directly into the stream channel, at tributary junctions, or other areas in a manner that mimics natural debris flows and erosion. • Augmentation will only occur in areas where the natural supply has been eliminated, significantly reduced through anthropogenic disruptions, or used to initiate gravel accumulations in conjunction with other projects, such as simulated log jams and debris flows. • Gravel to be placed in streams shall be a properly sized gradation for that stream, clean, and non-angular. When possible use gravel of the same lithology as found in the watershed. Reference the Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings (USDA-Forest Service 2008) to determine gravel sizes appropriate for the stream. • Gravel can be mined from the floodplain at elevations above bankfull, but not in a manner that would cause stranding during future flood events. Crushed rock is not permitted. • After gravel placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material. • Do not place gravel directly on bars and riffles that are known spawning areas, which may cause fish to spawn on the unsorted and unstable gravel, thus potentially resulting in red destruction.	To guide gravel augmentation treatments for aquatic and watershed restoration.	Forest plan compliance and specialist recommendation
AQ030	Imported gravel for use in or around aquatic systems must be free of invasive species, non-native seeds, and aquatic diseases. If necessary, wash gravel prior to placement and allow it to completely dry for a minimum of 2 days to prevent spread of chytrid fungus. More time for drying may be needed depending on the amount of gravel.	To prevent spread or introduction of invasive species and aquatic diseases in stream habitat.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ031	Off and Side Channel Stream Habitat Restoration: • When a proposed side channel will contain >20% of the bankfull flow, the Action Agencies will ensure that the action is reviewed by the Forest or Regional Fisheries Biologist and the Forest or Regional Engineer. • Data requirements and analysis for off- and side-channel habitat restoration include evidence of historical channel location, such as land use surveys, historical photographs, topographic maps, remote sensing information, or personal observation. • Allowable excavation – • Off- and side channel improvements can include minor excavation (<10% of volume) of naturally accumulated sediment within historic channels. There is no limit as to the amount of excavation of anthropogenic fill within historic side channels as long as such channels can be clearly identified through field or aerial photographs. Excavation depth will not exceed the maximum thalweg depth in the main channel. Excavated material removed from off- or side-channels shall be hauled to an upland site or spread across the adjacent floodplain in a manner that does not restrict floodplain capacity.	To reconnect historic side-channels with floodplains by removing off-channel fill and plugs. Furthermore, new side-channels and alcoves can be constructed in geomorphic settings that will accommodate such features.	Forest plan compliance and specialist recommendation
AQ032	Ensure that an experienced engineer, fisheries biologist, hydrologist and/or geomorphologist are involved in the design of all aquatic restoration projects as needed. Their experience should be commensurate with the technical requirements of the project being undertaken.	To ensure technical skills and planning requirements for all aquatic and watershed restoration treatments.	Specialist recommendation
AQ033	Replant each area requiring revegetation prior to or at the beginning of the first growing season following instream or riparian restoration activities. Achieve reestablishment of vegetation in disturbed areas to at least 70% of pre-project levels within three years. Barriers will be installed as necessary to prevent access to revegetated sites by ungulates or unauthorized persons.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	Forest plan compliance
AQ034	During all implementation within AMZ's, maintain shade, bank stability, and large woody material recruitment potential.	Minimize detrimental disturbance of desirable riparian/aquatic conditions to the greatest extent practical.	Forest plan compliance
AQ035	Live conifers and other trees can be felled or pulled/pushed over for in-channel large wood placement in streams only when conifers and trees are fully stocked by silvicultural standards. Tree felling shall not create excessive stream bank erosion or increase the likelihood of channel avulsion during high flows.	To maintain forest structure and facilitate riparian restoration activities	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ036	Within the primary shade zone for streams, springs and wet meadows retain 100% of the over-story canopy closure with the exception of hardwood treatments, unless other exceptions listed below are met. Source trees being extracted (either by tipping and/or felling) for stream restoration will not be cut from within the primary shade zone. Hill Slope — Primary Shade Zone Width (slope distance) <30% — 50 ft. 30-60% — 55 ft. >60% — 60 ft. Exceptions: The distances listed above may be reduced (but not less than 25 ft.) if any of the following conditions apply: • The trees are located on a south facing slope and therefore do not provide stream shade; • An appropriate level of analysis is completed and documents, such as shade modeling with LiDAR, using site-specific characteristics to determine the primary shade tree width; and/or • Field monitoring or measurements are completed to determine the width where Optimum Angular Canopy Density (65% or greater) is achieved. • If trees are being felled for safety reasons they can be felled towards the stream.	To maintain or improve the primary shade zone surrounding aquatic habitats.	Specialist recommendation
BT001	During layout, protect Southwestern Region sensitive plants where practical by including the plants within tree groups and using areas not occupied by the plants as interspaces.	Provide protection and shade needed by the sensitive plants while allowing for the least effect on clump/group/interspace design and layout during implementation and help mitigate effects on Southwestern Region sensitive plants and forest plan analysis species.	Specialist recommendation
BT002	Survey springs and channels for Bebb's willow before implementation and identify locations. Inform the forest botanist or district wildlife biologist if new locations are found and mitigate effects to plants and populations. Mitigations include avoiding plants, altering designs, or including plants in enclosures. Identify opportunities to enhance Bebb's willow where plants are decadent or dying. Manual grubbing of grasses may be used to increase the likelihood of planting success.	Protects populations and habitat of Bebb's willow. Bebb's willow stands would be enhanced by using cuttings, planting locally cultivated plants, and fencing existing or newly planted willows.	Forest plan compliance
BT003	Prescribed fires are conducted under conditions that promote native plant communities, hinder weed species germination, aid with controlling existing weed infestations, and prevent the spread of existing weeds.	Promote healthy native plant communities and reduces the risk of noxious or invasive weed invasions.	Forest plan compliance

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
BT004	Review various sites such as spring restoration for opportunities to introduce and restore Bebb's willow to supplement existing locations on the forest and introduce young plants into areas where plants are decadent and dying. Bebb's willow stands would be enhanced by using cuttings, planting locally cultivated plants, and using barriers as needed to protect existing or newly planted willows from browsing. Manual grubbing of grasses may be used to increase the likelihood of planting success. Where needed, fire lines would be placed around Bebb's willows and/or fuels would be removed from the vicinity of willow clumps to ensure there is only low to very low burn severity (fire effects to soil) and low to very low severity (fire effects to vegetation) in and around willow clumps.	Aids in restoring Bebb's willow which is a Southwestern Region sensitive species for the A-S and Coconino NF and a rare species on the landscape for both forests.	Specialist recommendation
BT005	When planning for implementation, identify species of concern (such as Southwestern Region sensitive plants), and determine potential habitat based on past occurrences and the known ranges of the species. If there are no documented surveys, the appropriate specialist (e.g., forest botanist, wildlife biologist) should be consulted to determine the need for, and extent of, new surveys. If the appropriate specialist is unavailable, the area to be treated should be surveyed prior to implementation and implementation plans should be adjusted if/as needed, based on survey results. Surveys should focus on areas most likely to contain plants or potential habitat for the targeted species, based on conditions such as soil or vegetation type, rather than covering the entire area. Habitat modeling, or the use of habitat descriptions of species from past documentation, etc. will be used to help define survey areas. Narrow endemics should receive more attention than more widespread species because the loss of individuals would have greater impact on the overall population of the species than in more widely distributed species.	Complies with FSM direction 2670. Manual direction (FSM 2670.5(19)) emphasizes that management actions should avoid or minimize effects on sensitive species.	Forest plan compliance
BT006	Monitor the effects of treatment on Southwestern Region sensitive plants after treatments are completed.	Provides opportunities to obtain knowledge on local species that are often poorly understood. Allows for adaptive management in future treatments.	Forest plan compliance
BT007	Mitigate loss of individuals and groups of Southwestern Region sensitive plants during management activities by avoiding plants as much as possible while achieving management objectives. Preserve plants and habitat during implementation of management activities, while realizing there may be some short-term losses of individuals or groups and short-term effects to habitat while moving toward desired conditions.	Complies with FSM direction, minimizes effects on Southwestern Region sensitive plants.	Forest plan compliance

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
BT008	Landings, machine slash piles and other ground disturbing activities (e.g., firelines, parking areas, etc.) and other ground-disturbing activities (such as temporary road construction and reconstruction, tracked vehicles, and pits) should not occur directly on Southwestern Region sensitive plant populations.	Mitigates effects of disturbance, loss of plants, and severe burning effects on soils. Reduces loss of native seed bank and limits extent of severe disturbances.	Forest plan compliance and specialist recommendation
CK001	A buffer to restrict mechanical treatment within a radius of 300 feet should be used to restrict activities that can negatively alter the resources, functions, and associated features of caves or karst features unless site-specific adjustments are made in coordination with the appropriate specialist(s), based on the characteristics and importance of the cave or karst features and the expected impact of the proposed activity. Thinning or other vegetation treatments with chainsaws or other light equipment, as needed to implement mechanical treatments or prescribed fire, may be used up to cave openings or edges of the sinkholes/pits if specialists determine that there is some risk to the cave/karst environment if nothing is done. Directional felling should be used to fell trees away from karst features. If felled trees must be removed from within the buffer, avoid yarding over or through karst features.	Minimize alteration of the chemical, physical, and biological conditions of karst features, to protect human health and safety, and to reduce potential disturbance to roosting bats. To protect cave ecosystems from negative fire effects and to minimize alteration of the chemical, physical, and biological conditions of karst features.	Forest plan compliance and specialist recommendation
CT001	All activities will comply with the NHPA for all ground-disturbing undertakings as appropriate. Effects on cultural resources would be determined in consultation with the SHPO and other consulting parties. Potential effects would be addressed through site avoidance strategies and implementing the site protection measures listed in Appendix J of the Southwestern Region Programmatic Agreement (PA) and in the 4FRI heritage strategy and section 106 clearance report.	Regulatory requirement. Compliance with NHPA and Southwestern Region PA with AZ SHPO.	Forest plan compliance and specialist recommendation
CT002	Consult with Native Americans, particularly when projects and activities are planned in sites or areas of known religious or cultural significance.	Regulatory requirement. Compliance with NHPA, AIRFA, Southwestern Region PA with AZ SHPO, EO 13007, EO 13175, and other applicable Executive Orders and legislation.	Forest plan compliance
CT003	Eligible, or potentially eligible, cultural resources would be managed to achieve a “no effect” or “no adverse effect” determination whenever possible, in consultation with the SHPO and ACHP (36 CFR 800).	Regulatory requirement. Compliance with NHPA and Southwestern Region PA with AZ SHPO.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
CT004	Monitoring during and after project implementation shall occur to document site protection and condition.	Compliance with Southwestern Region PA (Appendix J) with AZ SHPO.	Forest plan compliance and specialist recommendation
CT005	Proposed treatment activities and schedules would accommodate tribal traditional and ceremonial use.	Compliance with the Food, Conservation, and Energy Act of 2008 (Public Law 110-234)	Forest plan compliance and specialist recommendation
CT006	In accordance with regulations (43 CFR 10) governing application of the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), if human remains, funerary objects, sacred objects, or objects of cultural patrimony are inadvertently encountered, operations in the area must immediately cease and the Forest Archaeologist must be notified. The Forest will work to initiate consultation with the affected tribe (s) to implement any requirements listed in NAGPRA and the PA and to develop a plan to mitigate for the effects on the find.	Regulatory requirement. Compliance with NAGPRA, NHPA and Southwestern Region PA with AZ SHPO.	Forest plan compliance and specialist recommendation
CT007	Should any previously unidentified cultural materials be discovered during project implementation, work must cease immediately and the Forest Archaeologist must be contacted to initiate the consultation process as outlined in the Advisory Council on Historic Preservation Regulations (36 CFR Part 800.13).	Regulatory requirement. Compliance with NHPA and Southwestern Region PA with AZ SHPO.	Forest plan compliance and specialist recommendation
CT008	Contracts, permits, or leases that have the potential to affect cultural resources shall include appropriate clauses specifying site protection responsibilities and liabilities for damage.	To insure that mitigations measures identified during the analysis phase to protect cultural sites from being adversely effected are addressed during the implementation portion of the project.	Forest plan compliance and specialist recommendation
CT009	Fines, etc., for the costs of restoration and repair resulting from breaches of contracts, permits, or leases that cause inadvertent or intentional damages to cultural or tribal resources shall be strictly enforced.	ARPA, Site protection	Forest plan compliance and specialist recommendation
CT010	Locate, record, and evaluate the General Crook and other significant historic trails within the project area well before implementation. Maintain historic and scenic integrity of National Register-eligible historic roads, including the preservation of associated historic features, tread width, curve radii, and other features that contribute to the National Register eligibility of the historic roads.	Regulatory requirement. Compliance with NHPA and Southwestern Region PA with AZ SHPO. Site protection, ARPA (prevention of looting)	Forest plan compliance and specialist recommendation
CT011	Plate over National Register-eligible and unevaluated sites located within roads that will be maintained or reconstructed	NHPA compliance, 4FRI Rim Country Site Plating protocol	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
CT012	Coordinate with forest cultural resource specialists to design and implement projects (or don't implement projects) located in areas of very high site density.	Site protection, ARPA (prevention of looting)	Forest plan compliance and specialist recommendation
CT013	Culturally modified trees such as blazed trees, lookout trees, phone line trees, arborglyphs, peeled trees, etc.) will be avoided. Protection measures may include removing ladder fuels around the trees by hand, establishing buffer zones to keep equipment from damaging trees or affecting root systems, etc.	Regulatory requirement. Compliance with NHPA and Southwestern Region PA with AZ SHPO.	Forest plan compliance and specialist recommendation
CT014	Roads to National Register-eligible and unevaluated sites identified to be closed post implementation will be closed after identified treatments are completed.	Regulatory requirement. Compliance with NHPA and Southwestern Region PA with AZ SHPO.	Forest plan compliance and specialist recommendation
CT015	All rock pit locations will be surveyed for cultural resources. All identified cultural resources that are considered eligible for the purposes of Section 106 of the National Register of Historic Places within or adjacent to the rock pit boundary shall be flagged prior to implementation. Flagged cultural resources shall be fully avoided. In addition to flagging, rock pit extraction areas shall include fencing along the pit boundary to minimize the potential for indirect effects on cultural resources outside of the pit boundary where applicable.	Reduces disturbance footprint, protects cultural and historic sites, and retains seed sources for eventual reestablishment of residual plant cover, potentially enhancing fruit, seed, and plant production.	Forest plan compliance and specialist recommendation
CT016	During layout and implementation, identify traditionally used plants, including Emory oak, that are at risk or have been identified as culturally, medicinally, or economically important to tribal communities. Design and apply management prescriptions and activities to protect and enhance specified plant populations. Provide opportunities for tribal members to harvest plants before implementation in areas where important species are known to exist.	To protect and enhance populations of plants used traditionally by tribes and to improve tribal access to harvest those plants prior to implementation of restoration treatments	Specialist recommendation
FE001	Prescribed fire will be implemented in such a way that, whenever possible, damage to fencing and other infrastructure used for managing livestock will be minimized. Any damage incurred to fences or other infrastructure associated with grazing management resulting from prescribed fire will be the responsibility of fire to fix as soon as possible following the burn, or on a timeline agreed on with range managers that would not affect planned grazing management.	To minimize damage to grazing infrastructure. Fire can easily damage grazing infrastructure, particularly fences, gates, and their supporting structure. Fencing can be costly, and is critical to the effective implementation of grazing management strategies.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
FE002	Burn unit size, as well as strategic placement, would be a consideration in designing units and implementation prioritization.	Fire effects & behavior: Large treatment areas arranged across a landscape are generally more effective at reducing fire behavior than arrangements of small treatment areas are. The arrangement of treatment units, regardless of size, can also make a significant difference in the effectiveness of treatments. Air Quality: Larger burn blocks, can mitigate some air quality impacts by increasing the number of acres that could be burned in a single burn window.	Specialist recommendation
FE003	As burn plans and burn units are developed, ensure consideration is given to the spatial and temporal effects of broadcast burning in the upper levels of a watershed.	To mitigate the cumulative effects to aquatic habitats and riparian areas of broadcast burning multiple adjacent levels within a watershed. Such effects include, but are not limited to sedimentation and ash delivery to aquatic habitat.	Forest plan compliance and specialist recommendation
FE004	When practicable, damage or mortality to old trees and large trees would be mitigated by implementing prescription parameters, ignition techniques, raking, wetting, thinning, compressing slash, or otherwise mitigating fire effects to the degree necessary to meet burn objectives and minimize fire effects and behavior that could threaten old trees. Trees identified as being of particular concern (e.g., trees with known nests or roosts for herons, eagles, osprey, or other raptors, occupied nest cores, or critical areas in Mexican spotted owl protected activity centers (PACs) would be managed in accordance with wildlife design features (see Wildlife). Prepare old trees 1 year or more before a burn if possible.	Old trees are rare components and are under-represented across much of the project area. Implementing mitigation measures when possible is a critical component of restoration on a landscape scale. Large trees that are not old are not as susceptible to damage from fire as old trees. Mitigation measures that can be implemented a year or more before a burn, such as thinning or raking, may improve the response of the effectiveness of the mitigation measures.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
FE005	Fire personnel should confer with the appropriate district or forest personnel to identify noxious or invasive weeds within the perimeter of the prescribed burn unit, and areas that will be utilized as part of the implementation (such as staging areas), before burning is implemented. Jointly they shall identify the necessary mitigations as identified in the applicable forest weed management document. Mitigations may include, but are not limited to, avoiding noxious weeds while implementing and/or pretreatment of weeds before implementation. Follow-up monitoring should be conducted, especially in areas of severe disturbance. Large slash pile sites should be monitored after burning, and noxious or invasive weeds should be controlled according to the applicable forest weed management document.	Detect new weed infestations before they spread. Controls weeds, reduces risk of invasion and reduces risk to native species by reducing weed competition.	Specialist recommendation
FE006	Burning within narrow-headed garter snake occupied habitat or proposed critical habitat will not occur during the hibernation period (December - February) when garter snakes are more likely to be hibernating in wood piles, debris jams, etc., unless cleared by the district biologist.	To avoid, improve, or minimize effects on the narrow-headed garter snake.	Forest plan compliance and specialist recommendation
FE007	Ignitions will not occur within any AMZ, unless approved by a watershed specialist and/or a biologist.	To prevent the introduction of chemicals, such as drip torch fuel, into soils and water.	Forest plan compliance and specialist recommendation
FE008	Firelines would be used to facilitate prescribed fire operations as needed to balance fire management and other resource protection objectives: (1) Firelines may consist of natural barriers, roads and trails, or may be constructed, if necessary, in coordination with other resource specialists. (2) Fireline width would be determined as adjacent fuels and expected fire behavior dictate, assuming compliance with the requirements of cultural, wildlife, and other resource areas. (3) Constructed firelines would be rehabilitated when they are no longer needed, using methods appropriate to the site.	To provide for activities needed to implement prescribed fire while minimizing disturbance to all resources.	Specialist recommendation
FE009	Burn plans will incorporate Emission Reduction Techniques (ERTs) when they can effectively minimize air quality impacts, and when feasible (subject to economic and technical constraints, safety criteria, and land management objectives). Decision documents will identify smoke-sensitive receptors (or specify that there are none), and include objectives and courses of action to minimize and mitigate effects on those receptors as feasible.	Emission reduction techniques are recommended by the ADEQ as techniques that can be effective for minimizing air quality impacts.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
FE010	Mitigation and design features for smoke effects include: 1) Reducing emissions produced for a given area treated 2) Redistributing/diluting emissions through meteorological scheduling and by coordinating with other burners in the airshed. Dilution involves controlling the rate of emissions (from multiple fires) or scheduling for dispersion to assure tolerable concentrations of smoke in designated areas 3) Avoidance uses meteorological conditions when scheduling burning in order to avoid incursions of wildland fire smoke into smoke sensitive areas. 4) no direct ignition of stumps to reduce smolder residence time	Minimize air quality impacts	Forest plan compliance and specialist recommendation
FE011	Concerned/interested public will be given as much warning as possible in advance of prescribed burns via notices, press releases, email lists, public announcements, phone lists, or other notification methods as appropriate.	To provide advanced notice for publics concerned about potential effects from emissions resulting from prescribed fires.	Forest plan compliance and specialist recommendation
FE012	Prescribed fires may be conducted before or after mechanical treatments. The sequencing of prescribed fires and mechanical treatments would be decided on a site-specific basis, depending on the site, burn windows, available resources, thinning schedules, etc.	Increase the flexibility for implementing both prescribed fire and mechanical treatments.	Specialist recommendation
FE013	Mechanical treatments following broadcast burns would occur after surface vegetation has recovered sufficiently to minimize soil disturbance from the mechanical treatments. Prescribed fire treatments following mechanical treatments would occur after there has been adequate surface vegetation recovery that fuel loads are sufficient to meet the objectives of a prescribed burn.	Minimize effects from the combined effects from mechanical treatments and prescribed fire on vegetation and soil. To maintain soil condition and productivity, and to ensure that prescribed fire objectives can be met.	Specialist recommendation
NW001	Survey for noxious or invasive weeds in treatment areas prior to treatment and follow appropriate guidance based on location: Apache-Sitgreaves NFs: Follow the guidance in Appendix A of the Environmental Assessment for the ASNFs Integrated Forest-Wide Noxious Or Invasive Weed Management Program Coconino NF: Follow the guidance in appendix B of the "Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds, Coconino, Kaibab, and Prescott NFs within Coconino, Gila, Mojave, and Yavapai Counties, Arizona" Tonto NF: Follow the guidance in Appendix C of the Tonto NF Weed Treatment EA when operating on the Tonto NF.	Provides guidance and mitigation for noxious or invasive weeds.	Forest plan compliance

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
NW002	Prevent spread of potential and existing noxious or invasive weeds by vehicles and equipment used in management activities by washing vehicles and equipment to remove seeds, soil, vegetative matter, and other debris that could contain or hold seeds prior to entering the project area and when moving from one treatment unit to another. For example, see timber sale contract provision 2400-6/6T B/BT6.35.	Reduces the potential for introduction of noxious weeds into NFS lands and mitigates effects of management actions on existing and potential noxious or invasive weed infestations; Forest Plan direction is complementary to Timber Sale Contract Clause 2400-6/BT B6.35, and Stewardship Contract G/GT.3.5 and watershed best management practices.	Forest plan compliance and specialist recommendation
NW003	If contractor desires to clean off-road equipment on national forest land, such as at the end of a project or prior to moving to, or through an area that is free of invasive species of concern, contractor shall obtain prior approval from contracting officer or timber sale administrator as to the location for such cleaning and measures, if any, for controlling impacts.	This measure is designed to prevent the spread of noxious weeds from one treatment unit to another.	Forest plan compliance and specialist recommendation
NW004	If noxious or invasive weeds are identified during or post-implementation, treat the weeds and monitor for a minimum of three growing seasons.	This measure is designed to eliminate noxious or invasive weeds identified within a treatment area and provide assurance that the treatments were successful.	Forest plan compliance and specialist recommendation
NW005	Timing of prescribed fire and herbicide application in areas with leafy spurge will be determined on a site-specific basis by the District Fuels Specialist and District Weeds Coordinator at the time of implementation. Herbicide treatments in the fall are most effective, though spring herbicide treatments following fall burns may be necessary to facilitate control.	Allows prescribed fire to occur in our near existing populations of leafy spurge while providing for control of it. Allows on the ground, site-specific assessment and coordination of the prescribed fire and control of leafy spurge on a site-specific basis.	Specialist recommendation
NW006	Before ground disturbing activities begin, inspect material sources on site annually (or before disturbance for new sites) to ensure they are weed- free before use and transport. Treat weed-infested sources for eradication, and strip, stockpile, and treat contaminated materials before using pit materials.	Prevent establishment and spread of invasive weed populations	Forest plan compliance and specialist recommendation
NW007	If weed treatments are not successful or not possible, operators would be informed of locations of noxious or invasive weed populations and ground disturbance associated with rock pit sites would be located away from noxious or invasive weed populations.	Prevent establishment and spread of invasive weed populations	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
NW008	Equipment operators shall maximize that recovery and proper disposal of all fuels, fluids, lubricants, empty containers, and replacement parts.	Prevent establishment and spread of invasive weed populations	Specialist recommendation
NW009	Monitor and treat noxious or invasive weed populations following project implementation annually for at least three years to ensure that any weeds transported to the site are detected and controlled.	Prevent establishment and spread of invasive weed populations	Specialist recommendation
NW010	Maintain stockpiled, uninfested material in a weed-free condition.	Prevent establishment and spread of invasive weed populations	Forest plan compliance
RM001	Historic range monitoring sites including witness trees/posts, 1inch angle iron stakes, and any other site location markers would be protected. These sites would not be excluded from treatment but care needs to be taken to avoid loss of these site markers and damage to the areas and shown as a protected improvement on the sale/contract/agreement area map. These sites would not be used as locations for temporary access roads, skid trails, landing areas, or large slash piles. District range and timber personnel will coordinate on these locations during presale packaging and prior to implementation.	Avoid monitoring site damage.	Specialist recommendation
RM002	The sale administrator would work closely with the district range staff to determine pasture use during thinning activities.	Avoid infrastructure damage, and retain allotment and pasture fences within a thinning treatment area. Provides for coordination of different activities within the same areas	Specialist recommendation
RM003	All fences and shown as a protected improvement on the sale/contract/agreement area map in the cutting area would be protected from thinning activities. Skid trail layout would attempt to keep equipment on one side of the fence to avoid having to cut fences. If fences need to be cut, a gate or temporary cattleguard may need to be constructed/installed with appropriate bracing; these areas shall be coordinated with district range personnel prior to cutting. If the fence is cut or damaged it shall be repaired to conditions equal to or better than existed (to Forest Service Standards). Temporary cattle guards would be installed on all haul roads where gates exist within active grazed pastures. All cattle guards on haul roads would be maintained throughout hauling activities and cleaned, if necessary upon completion of a sale. Damage to other range improvements, such as tanks, drainage into tanks, spillways, drinkers, pipelines, corrals, etc., shall be repaired or cleaned to a condition that was as good as or better than existed. Skid trails, roads, landings, etc. should not be placed next to these range improvements.	Protect infrastructure.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
RM004	Rest or deferment of a pasture by livestock may occur after the completion of ground disturbing activities, such as burning and mechanical thinning. Range management personnel will evaluate conditions to determine when adjustment to livestock management, such as rest of deferment of a pasture is needed. Several factors may be used to assist in these determinations, such as plant recovery, plant vigor, and size of the disturbed area in relation to the pasture size. Plants that are well rooted, have multiple leaves or branches, and/or are producing seed head or flowers provide evidence of plant recovery, vigor, and reproductive ability.	Post ground-disturbing treatment assessment.	Specialist recommendation
RM005	The removal or exclusion of livestock water would be mitigated with alternative water sources, providing lanes to the water, or piping water to a livestock drinker.	Provide alternate water sources.	Specialist recommendation
RM006	Prior to the construction of any exclosure fences or barriers, which exclude forage and/or water, or the removal of a water source, such as earthen tanks or trough, there needs to be a review by the District Ranger, Range Management personnel and other specialist to evaluate the extent and amounts that may be excluded on an allotment/pasture. If a pasture/allotment has a considerable amount or extent of fencing or water exclusion, which could change livestock management such as numbers, season of use, distribution, etc., then these proposals should be analyzed during the Allotment Management Planning process. During this process, livestock management on the allotment can be evaluated along with the resource concern that would have initiated the fence and other possible solutions may arise.	To ensure that changes to an allotment/ pastures will not hinder permittees' operations without coordination with local specialist expertise. This will also allow a review of water rights, if applicable.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
RM007	Range and fire managers will coordinate burning and grazing schedules to minimize disruption of grazing while maximizing the implementation of prescribed fires. Each allotment will have specific management needs to be considered as management actions are planned and implemented. Past and future burns, projected rest/deferment are examples of things that should be considered when burn plans are being written and prior to implementation of prescribed fire. Grazing options, such as swing pastures, may be utilized to increase flexibility for range and fire managers. Long-term and annual prescribed fire plans should be developed and adjusted to minimize burning in multiple pastures of an allotment, unless recognized and approved.	The process of planning and implementing prescribed fire is long and complex. The effects are beneficial to most resources, though there are a myriad of restrictions on where and when prescribed fire can be implemented. The USFS issues Term Grazing Permits, Allotment Management Plans, and/or Annual Operating Instructions describing numbers, season of use, pasture rotations, etc. that permittees follow. Coordination will help maintain good working relationships and will minimize hardships to the permittees, while managing for ecosystem health. Coordinating the management of these programs for minimal disruption to both is desirable.	Specialist recommendation
RM008	Range readiness monitoring will be included in the appendix D implementation plan checklist. Annual monitoring typically includes measures for forage production, precipitation, forage utilization, livestock numbers, and livestock season of use. Condition and trend monitoring every 5 to 10 years measures plant canopy cover, plant frequency, and ground cover. By requiring inclusion of all design features and mitigation, appendix E, the biophysical and social monitoring and adaptive management plan, includes grazing-related monitoring.	To ensure range readiness is part of the annual compliance process.	Specialist recommendation
RS001	Coordination with the District Recreation Planner, District Trails Specialist, and local trail stewards will occur during prescription or burn plan development, layout, marking, thinning, and burning where any treatment will occur on, adjacent or near National and system trails. This is to ensure that trails and trail infrastructure are considered and protected and effects to scenic qualities are minimized to the extent practicable.	Resource protection	Forest plan compliance and specialist recommendation
RS002	Historic trails, roads and trail markers in the project area will be protected during project implementation in all contract types and force account work. Additionally, the General Crook Trail, the Arizona Trail, the Highline Trail, and other historic trails, roads and National Recreation Trails will maintain historic and scenic integrity during project implementation.	Regulatory requirement. Compliance with NHPA and Southwestern Region PA with AZ SHPO, National Recreational Trails compliance, National Historic Trails compliance.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
RS003	Efforts would be taken to limit forest treatment activities and hauling from rock pits within the project area during high-use weekends and holidays (e.g., Memorial Day, 4th of July, Labor Day, etc.); especially in locations where recreation-based activities (e.g., trails, trailheads, etc.) occur.	Protect public safety, decrease noise, reduce dust and minimize visibility issues on roads during high-use periods	Forest plan compliance and specialist recommendation
RS004	Fire Control Lines: (a) Fire holding lines would be constructed, where ever possible, to reduce the contrast so that they are not noticeable in the middle and background views. Generally restore control lines to a near undisturbed condition in the foregrounds (within 300 feet) of sensitive roads, trails, developed recreation sites and private property. Avoid constructing fire holding lines within the AZT unless no other viable alternatives exist, and follow all requirements for areas with high scenic integrity objectives. If the Arizona Trail must be used as a holding line, both sides of the trail would be treated- a lateral distance to be determined by a scenery specialist. (b) Rehabilitate containment lines by rolling back the soil berm formed during line construction and constructing drainage features as necessary to prevent concentration of runoff. Disguise containment lines to line of sight or first 300 feet, whichever is greater; (c) To hasten recovery and help eliminate unauthorized motorized and nonmotorized use of control lines in these areas, use measures such as recontouring, pulling slash and rocks across the line, and disguising entrances, and (d) Do not use motorized equipment on national scenic, historic and recreation trails, or other forest system trails if these are used for control lines. Control lines however should be avoided on these trails under any circumstances unless the trails are co-located on roads. Coordinate with the district recreation staff regarding use of national trails as control lines.	Resource protection	Forest plan compliance and specialist recommendation
RS005	Where new temporary roads intersect existing roads or trails, native materials such as logs, slash, and/or boulders would be placed along temporary road to line-of-sight.	Reduce unauthorized use	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
RS006	Unit Marking: (a) Avoid using trails as boundaries. (b) Avoid abrupt changes between treatment units. (c) Where feasible strive to have the minimal marking of trees within the Arizona Trail, General Crook Trail, and Highline Trail corridors. (d) Utilize species designation where appropriate to minimize the amount of necessary marking. (e) Unit boundaries will be marked with water based paint and on the side of truck not seen from trails, roads or sensitive travel ways. When possible, utilize discernible boundaries that do not require paint. (f) Use the below techniques suggested for edges of treatment units. Edges of Individual Units: (a) Ensure that forest stand composition changes are textural, with small, natural openings and not symmetrical in shape. Avoid straight lines and right angles. Ensure that openings resemble the form, line, and texture of those found in the surrounding natural landscape with edges feathered to avoid a shadowing effect. (b) Where treatment unit is adjacent to denser forest (treated or untreated), the percent of thinning within the transition zone (150–250 feet) would be progressively reduced toward denser edges of the unit. (c) Where treatment unit interfaces with an opening (including savanna and grassland treatments, and natural openings) the transition zone would progressively increase toward open edges of the unit. (d) Soften edges by thinning adjacent to the existing unit boundaries. Treat up to edges; do not leave a screen of trees. Favor groups of trees complying with prescribed treatments that visually connect with the unit’s edge to avoid an abrupt and noticeable change. When feasible, treat both sides of open system roads and trails to avoid contrast. (e) Treatment boundaries should extend up and over ridgelines to avoid “Mohawk” look. (f) The ridgeline silhouette should have a textural effect of small, natural-appearing openings rather than large, thinned areas and unnatural-appearing breaks. (g) Minimize mechanical treatments within 1/4 mile of the Arizona Trail, General Crook Trail, and Highline Trail corridors. Where mechanized treatments are authorized, restore visual evidence of mechanized treatment activity with 1/4 mile of the trails in order to promote a naturally appearing setting.	Scenic integrity	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
RS006 Continued	(h) Implementation will comply with the nature and purpose of the Arizona National Scenic Trail. The Forest Service will meet annually with the Arizona Trail Assoc. to discuss and document monitoring activities; (i) ensure a landscape architect or recreation specialist with knowledge of scenery management is involved in implementation planning, initial layout strategy and mechanical treatment design.	Scenic integrity	Forest plan compliance and specialist recommendation
RS007	'When possible, new fuelwood piles, and fuelwood skid trails should be located out of view in areas of High Scenic Integrity to avoid observation of bare mineral soil. Rehabilitate fuelwood skid trails, fuelwood piles, or other disturbed areas by restoring original contours, fine grading, and seeding with native seed mix. Skidding activities would avoid National and forest system trails, if possible, except where motorized use is already authorized (trails located on open system and administrative roads). If it is determined necessary that a trail must be used as a skid trail crossing, make perpendicular trail crossings. Trails needing protective measures and skid trail approval will be identified on the sale contract/or agreement map. Trail crossing locations, including those on the Arizona National Scenic Trail and the General Crook and Highline National Recreation Trails would be designated and flagged with input from the District Trails Specialist, Recreation Planner or Archaeologist. The trail would be restored to USFS standards (pre-project condition) following treatment.	Avoid degrading recreation setting and resource protection	Forest plan compliance and specialist recommendation
RS008	Mechanical thinning operations shall not damage cairns or markers that are displayed as protected improvements on the sale, contract or agreement map.	Resource protection and scenic integrity and avoid substantial interference with the nature and purpose of the trail (in compliance with Section 7(c).	Forest plan compliance and specialist recommendation
RS009	If trails are temporarily closed due to thinning, trails shall be returned to pre-treatment conditions. The public will be notified of the closure and the closure duration should be as short as feasible.	Resource protection	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
RS010	Temporary Road, Skid Trail, Landing, and In-Woods Processing Site Construction: (a) Utilize dust abatement methods for hauling during the season when dust is likely and funding is available. Coordinate with the appropriate county on the application and timing of application of dust abatement on road segments that have county maintenance responsibilities. (b) Blend temporary roads and skid trails into the characteristic landscape of the surrounding area. Create cut and fill banks to be sloped to accommodate natural revegetation and to reduce sharp contrasts viewed from any distance. Where new temporary roads and skid trails meet a primary travel route, they should intersect at a right angle and, where practicable, curve after the junction, to minimize the length of route seem from the primary travel route. (c) Shape and/or feather the edges of log landings and in-woods processing sites to avoid abrupt changes between treated and untreated areas. Standing trees and shrubs around in-woods processing sites and landings shall be left in strategic locations to serve as screening in sensitive viewsheds. (d) When possible, in-woods processing sites, landings, temporary roads, and skid trails should be located out of view of CL1 and CL2 travel routes and wild and scenic rivers, to avoid observation of management activities. Do not locate perpendicular to roads or trails, rather set off at an angle whenever possible. When avoiding these locations is not possible, the evidence of management activities should be restored in a timely manner per (f). (e) In woods processing sites, landings, temporary roads, and skid trails should be minimized within sensitive viewsheds, such as those within eligible or suitable wild and scenic river corridors or next to developed recreation sites, private homes, or communities, and along paved and passenger car level roads and trails; Stump heights shall be cut low with a 8" height above ground (uphill side) within wild and scenic river corridors; in the immediate foreground (300 feet) of CL1 and CL2 travel ways; and in the foreground of recreation sites, private lands, and trails. (f) Highest emphasis for slash treatment, temporary road closures and road decommissioning will be placed on eligible or suitable wild and scenic river corridors; foreground (up to 300 feet) of developed recreation sites, private homes or communities; and Concern Level 1 roads (paved roads and passenger car roads) and trails, especially those designated as national scenic, historic, or recreation trails. (g) All constructed features including but not limited to fencing, office trailers, sanitation facilities, fuel storage containers, or temporary structures shall be designed to blend with the surrounding environment. Color of proposed above-ground features shall be non-reflective and treated to be Forest Service brown or for a rusty appearance, or as approved by a FS landscape architect or other FS official.	Resource protection and scenic integrity and avoid substantial interference with the nature and purpose of the trail (in compliance with Section 7(c).	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
RS010	(h) In-woods processing sites, landings, skid trails, and temporary roads will be rehabilitated, including restoring proper drainage and reseeding as needed with native species. (i) To hasten recovery and help eliminate unauthorized motorized and non-motorized use of skid trails and temporary roads, use physical measures such as re-contouring, pulling slash and rocks across the line, and disguising entrances;. (j) National Scenic, Historic, and Recreation Trails as well as forest system trails (motorized and non-motorized) will not be used for temporary roads or skid trails. It is acceptable to make perpendicular trail crossings. The locations of crossings will be designated. Trail crossings will be restored to pre-project condition after use. (l) Crossing of the Arizona Trail will be done sparingly and only if no other alternative exists. These crossing locations will be coordinated with District Recreation Staff and the national trail administrator.	Resource protection and scenic integrity and avoid substantial interference with the nature and purpose of the trail (in compliance with Section 7(c).	Forest plan compliance and specialist recommendation
RS011	Cull Logs, Stump Heights, and Slash Treatments: (a) Cull logs would not be abandoned on landings. Use cull logs for closing temporary roads and decommissioning roads. Cull logs may also be suitable to use as down woody material, but must be scattered away from the landings. (b) Stump heights should be cut as low as possible. Flush cut or low cut stumps horizontally to 6" (on the uphill side) within immediate foreground (300 feet) of roads, trails, developed recreation sites and private property. Flush cut or low cut to 8" in other distance zones where topography and operational safety allows, with 12" heights as the exception and rarely occurring.	Resource protection and avoid substantial interference with the nature and purpose of the trail. (in compliance with Section 7©	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
RS011 Continued	(c) Slash must be treated or removed in the immediate foreground of sensitive places (e.g., in corridors of eligible or suitable wild and scenic rivers; within 300 feet of the centerline of Concern Level 1 roads, or national trails and sensitive trails; or 300 feet from the boundary of a recreation site or private land/communities). Where whole tree thinning occurs, machine piling may occur toward the back of landings. Prioritize slash burning in these locations within one year or as soon as possible after treatment. If conventional thinning practices are used and trees are delimbed and topped in the forest, machine-piled slash should be placed outside of eligible or suitable wild and scenic river corridors and at least 300 feet away from the centerline of roads, national trails, and sensitive trails; developed recreation sites; or private land/communities. In these instances, piles should be burned as soon as possible or within 1 - 3 years. After burning is complete, burn sites that are visible from roads, trails, developed sites, or private dwellings will be covered with natural duff to a minimum of 3 inches to minimize visibility of the burned area. In areas where burning will not occur until after 2 growing seasons: Remove slash within 300 feet from sensitive areas. If scattering is required, scatter slash to 18" or less in depth. Root wads and other debris in sensitive foreground areas and in wild and scenic river corridors would be removed, burned, or chipped. Outside of these areas, it is acceptable to scatter root wads and debris or use them to help close temporary roads or skid trails. If slash is not removed in grassland treatment areas, it is acceptable to create machine piles 300 feet away from the centerline of sensitive roads and trails, developed recreation sites, and private land/communities. Within eligible or suitable wild and scenic river corridors, slash should be removed, burned, or otherwise treated to return the area to its pre-implementation condition.	Resource protection and avoid substantial interference with the nature and purpose of the trail. (in compliance with Section 7©	Forest plan compliance and specialist recommendation
RS012	Coordinate with designated Forest Service representative prior to implementing jackstraw, spring, and road restoration treatments. Do not implement jackstraw treatments within 1,000 feet of National Trails.	Maintain scenic integrity.	Forest plan compliance and specialist recommendation
RS013	In semi-primitive non-motorized recreation opportunity spectrum classes specifically (occurring on about 13 percent of the project area), in eligible or suitable wild and scenic river corridors, and in inventoried roadless areas (IRAs) : (a) Temporary roads should not generally be built (also see RS024). If they are used, they would be restored to pre-treatment conditions when projects are completed; (b) Strive to make stump heights 8 inches above ground (uphill side) or lower, with 12-inch heights the exception and rarely occurring; (c) Slash must be treated or removed in these areas; and (d) Use existing barriers (roads) and natural barriers as control lines whenever possible.	Protection of visitor experience	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
RS014	Recreation Sites: (a) Proposed mechanical treatments and prescribed fire adjacent to developed recreation sites must be reviewed and approved by the district ranger. Work with the district recreation staff to determine boundaries or no treatment zones around constructed features that need to be protected in campgrounds. Treatments around the perimeter of campgrounds are encouraged. The timing of treatments must be worked out with districts. Treatments would generally avoid summer. Activity slash must be treated either through removal, lop and scatter, chipping or piling. If piled, slash must be piled in agreed upon locations, and treated as soon as possible. If campgrounds remain open into fall and winter, provide information about upcoming closures and management activities onsite, at FS offices, and on FS Web sites.	Protection of visitor experience	Forest plan compliance and specialist recommendation
RS015	Implement road closures, one-way traffic, and area closure restrictions as deemed necessary by forest officials for health and safety concerns during any operation. Signs would be placed at major intersections on hauling routes during periods of active hauling. If it is necessary to close forest roads or areas of the forest, notices and signs would be posted at key locations adjacent to and within the project area, such as along major FS roads accessing the area or on kiosks at trailheads, bulletin boards, electronic sign boards, etc. Closures due to operations would also be posted online and on social media as well as being publicized via news releases. Coordinate with the District Recreation Planner or trails specialist to ensure well marked and publicized detour routes for the Arizona Trail, General Crook Trail, and Highline Trail, and system trails during operational closures within the project. Any closures should be done for as short a time as possible.	Public safety	Forest plan compliance and specialist recommendation
RS016	When mechanical treatment and/or burning are occurring along open trails that are not National Recreation Trails, slash will be pulled back immediately within 100 feet of the centerline of the trail corridor within specified timeframes (coordinate with recreation specialist).	Maintain scenic integrity.	Forest plan compliance and specialist recommendation
RS017	Retain heathy, large diameter, or character trees that have unique shape or form along all trails in a manner that results in stable, wind -firm residuals that are seen within 1/4 mile of the trail. Avoid lines of trees; strive to achieve a grouped appearance where appropriate to avoid abrupt changes in the landscape character along the trail corridor.	Protect visitor experience	Forest plan compliance and specialist recommendation
RS018	(a) Prior to blasting activities, nearby landowners or other permitted Forest users near the blasting location would be notified. (b) Standing trees and shrubs would be left in strategic locations along the perimeter of active rock pits to serve as screening to sensitive viewsheds.	To improve public safety by increasing awareness of blasting activities and to minimize impacts to scenic resources	Forest plan compliance and specialist recommendation
RS019	Trucks hauling materials would be limited to no more than 25 miles per hour on all forest roads, and 10 miles per hour within 0.25 miles of all signed campgrounds and trailheads. The speed restriction near campgrounds will be outlined on contract area maps.	Reduces noise and dust during hauling	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
RS020	Entrances to active rock pit sites would be gated to prevent inappropriate motor vehicle use, dumping, or other activities.	Decrease noise, protect public safety and minimize impacts to forest resource in and around rock pit sites	Forest plan compliance and specialist recommendation
RS021	Material extraction activities should not be permitted in designated or recommended special areas or Chevelon Canyon.	To protect the unique character of these areas.	Forest plan compliance
RS022	All restoration activities within eligible or suitable wild and scenic river corridors will be designed to protect or enhance the free-flowing character and outstandingly remarkable values (ORVs) of rivers, and to maintain the rivers' current inventoried classifications (wild, scenic, or recreational), unless a suitability study is completed that recommends management for a less restrictive classification.	To protect eligible and suitable wild and scenic rivers	Forest plan compliance
RS023	Restoration activities within the corridors of eligible or suitable wild river segments on the Apache-Sitgreaves National Forests will not include any tree cutting.	To protect the primitive character of eligible or suitable rivers classified as wild	Forest plan compliance
RS024	Temporary roads will not be constructed within inventoried roadless areas (IRAs) or within the corridors of eligible or suitable river segments classified as wild. Within corridors of eligible or suitable river segments classified as scenic, avoid constructing long stretches of conspicuous temporary roads paralleling the riverbank. Maps will be provided as needed.	To ensure that wild river segments and IRAs maintain their primitive characteristics and to protect the largely undeveloped character of scenic river segments	Forest plan compliance
SI001	Non-commercial tree thinning is allowed only as required to adjust fuel loads to implement a low- to moderate-severity burn to promote growth of deciduous trees and shrubs, such as aspen, cottonwood, willow, other deciduous species, and associated meadows.	To provide desired fire behavior and desired vegetation composition	Specialist recommendation
SI002	A phased approach can be used to complete light thinning with lop/scatter so slash does not have to be piled or disposed of mechanically.	To facilitate desired fuel conditions for broadcast burning	Specialist recommendation
SI003	All snags will be maintained within the AMZ unless deemed a hazard tree that could be made available for stream restoration activities.	To provide habitat for snag-dependent wildlife and future coarse woody debris.	Specialist recommendation
SI004	To protect old growth trees, thinning from below is allowed, If conifers are even-aged pole, sapling, or mid-seral with no old growth trees, thin existing trees to the degree necessary to promote a low- to moderate-severity burn.	To facilitate desired fuel conditions for broadcast burning	Specialist recommendation
SI005	Where livestock or wildlife grazing could be a threat to restoration of riparian deciduous vegetation and an immediate moderate-severity burn would consume large amounts of felled trees, consider delaying the burn and leaving felled trees in place to create grazing barriers to help assure plant growth.	To create grazing barriers and assure desirable vegetation response	Specialist recommendation
SI006	If in an existing grazing allotment, projects in this category shall be accompanied by livestock grazing practices that promote the attainment of moderate-severity burn objectives.	To facilitate desired fuel conditions for broadcast burning	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SI007	Exclosure fencing to prevent utilization of plantings by deer, elk, and livestock is permitted.	To provide desired vegetation composition in riparian areas	Specialist recommendation
SI008	Source trees for placement in stream restoration should come from but are not limited to: over or fully stocked upland and riparian stands that are adjacent to the site, hazard trees, trees that have fallen naturally and are still suitable, trees generated from administrative sites (maintenance, expansion, or new construction), and hardwood restoration.	To maintain forest structure and facilitate riparian restoration activities	Specialist recommendation
SI009	Danger trees, hazard trees, and trees killed through fire, insects, disease, blow-down and other means can be felled and used for in-channel placement regardless of live-tree stocking levels.	To facilitate riparian restoration activities	Specialist recommendation
SI010	Identified wildlife trees shall not be felled.	To maintain nest/roost habitat.	Specialist recommendation
SI011	Trees may be stockpiled for future instream restoration projects.	To facilitate riparian restoration activities	Specialist recommendation
SI012	Remove juniper to natural stocking levels where Forest Service determines that juniper trees are expanding into neighboring plant communities to the detriment of other native riparian vegetation, soil, or streamflow.	To maintain desired vegetation composition in riparian areas and wetlands	Specialist recommendation
SI013	For each area evaluated for juniper treatments, interdisciplinary teams would discuss the following questions in order to identify the attributed of an area and select the appropriate treatments: • What kind of site (potential natural vegetation, soils)? • Successional state of site? • Components that need to be restored? • How units may fit into the overall landscape mosaic? • Long-term goals and objectives?	To maintain desired vegetation composition in riparian areas and wetlands	Forest Plan Compliance
SI014	Do not cut old-growth juniper, which typically has several of the following features: sparse limbs, dead limbed or spiked-tops, deeply furrowed and fibrous bark, branches covered with bright-green arboreal lichens, noticeable decay of cambium layer at base of tree, and limited terminal leader growth in upper branches.	To provide future snag and coarse woody debris habitat.	Forest plan compliance
SI015	Felled trees may be left in place, lower limbs may be cut and scattered, or all or part of trees may be used for streambank or wetland restoration in order to provide surface roughness and bank stabilization or as necessary to protect riparian or wetland shrubs from grazing by livestock or wildlife (e.g. jackstraw barriers)	To facilitate riparian restoration	Specialist recommendation
SI016	Felled trees may be placed into stream channels and floodplains to promote channel aggradation as long as such actions do not negatively impact use of spawning gravels or increase width to depth ratios.	To facilitate riparian restoration	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SI017	On steep or south-facing slopes, where ground vegetation is sparse, leave felled juniper in sufficient quantities to promote reestablishment of vegetation and prevent erosion.	To provide soil resource protection in wetlands and riparian areas	Specialist recommendation
SI018	If seeding is a part of the action, consider whether seeding would be most appropriate before or after juniper treatment.		Specialist recommendation
SI019	Certified silviculturists and experienced botanists, ecologists, soil and water specialists or associated technicians shall be involved in designing riparian vegetation treatments.	To provide desired vegetation composition in riparian areas and wetlands	Specialist recommendation
SI020	Species to be planted will be of the same species that naturally occur in the project area. Acquire native seed or plant sources as close to the watershed as possible	To improve planting success.	Specialist recommendation
SI021	Tree and shrub species, willow cuttings, as well as sedge and rush mats to be used as transplant material shall come from outside the bankfull width, typically in terraces (abandoned floodplains), or where such plants are abundant.	To provide desired vegetation composition in riparian areas	Specialist recommendation
SI022	Sedge and rush mats should be sized to prevent their movement during high flow events.	To minimize streambank erosion	Specialist recommendation
SI023	Concentrate plantings above the bankfull elevation.	To provide desired vegetation composition in riparian areas	Specialist recommendation
SI024	Removal of native and non-native vegetation that will compete with plantings is permitted.	To provide desired vegetation composition in riparian areas	Specialist recommendation
SU001	Notify the affected landowners, permit holders, and Forest Service permit administrators whenever project activities are planned in areas having special use authorizations or non-NFS inholdings.	To ensure that land owners and permit holders are aware of planned activities well in advance, and to provide them opportunity to discuss concerns and potential mitigations to protect their sites.	Specialist recommendation
SU002	All National Forest System property boundary lines adjoining private, State, and public trust lands, such as Indian Reservations, shall be located, monumented, marked, and posted to prescribed Forest Service standards prior to undertaking land management activities that will occur near or adjacent to the property line.	To ensure that project activities occur only on NFS lands.	Complies with policy in FSM 7152.03
SU003	Evaluate potential haul routes that may be needed through non-federal land and ensure easements are in place or obtained prior to use.	To prevent illegal trespass across lands with other ownership.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SU004	Coordinate management activities with permit holders for any utility corridors (powerlines, pipelines, etc.) to determine how to protect facilities and improvements. Provide notification of activities during planning/layout and prior to implementation. Include pre-work safety meetings between utility holders and contractors.	To protect permit holders' facilities and improvements and ensure that management activities do not interfere with the operation of utility corridors.	Specialist recommendation
SU005	Place project-generated slash outside of permitted utility line and pipeline rights-of-way; do not interfere with utility corridor management.	Ensure that activities do not interfere with the operation of utility corridors	Specialist recommendation
SU006	Vegetation treatments adjacent to power line corridors will be designed to reduce linear edges and create a more irregular natural appearance outside of the right-of-ways.	Maintain natural appearance of landscape	Specialist recommendation
SU007	Implement a 100 foot buffer zone around weather stations and other meteorological facilities. No road construction or thinning is to occur within the buffer. Routine management activities (such as hazard tree removal) may still occur within the buffer zone.	To ensure that project activities do not interfere with meteorological data gathering.	Forest plan compliance and specialist recommendation
SU008	Protect highway ROW infrastructure from damage by management activities. Include facilities to be protected on contract area maps.	To ensure ROW infrastructure remains functional for its intended purposes	Specialist recommendation
SU009	Coordinate planned activities with ADOT and/or the appropriate county to ensure safe operation of roads and highways during project implementation.	To protect public safety on the affected roadways during operations	Specialist recommendation
SU010	Remove thinning slash from highway ROWs. If approved by the FS, chipped slash may be left onsite at a maximum depth of two inches, otherwise it must be removed completely. Any decking or tree processing within ROW needs prior approval. The maximum duration that logs and biomass can be left in the ROW is 30 days.	To ensure slash does not interfere with ROW access as potentially needed by ADOT or county	Specialist recommendation
SU011	Processing sites would be authorized under the terms of the timber contract or through a special use authorization depending on who would be the operator. Fees may be associated with special use authorizations.	Ensure proper authorization and permitting of in-woods processing sites	Forest plan compliance

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SU012	Through the Arizona Department of Environmental Quality (ADEQ), the operator of a processing site would obtain coverage under a Multi-Sector General Permit (MSGP) for storm water discharges associated with non-mining industrial facilities such as timber products http://www.azdeq.gov/node/525 and http://www.azdeq.gov/permits-needed-timber-products-sector. Coverage under this permit would entail preparation and implementation of a storm water pollution prevention plan (SWPPP) as well as periodic inspections of the facility consistent with requirements of the permit.	Ensure proper authorization and permitting of in-woods processing sites	Forest plan compliance
SU013	Support operations and facilities on processing sites that would be allowed include: office trailers, sanitation facilities and fuel products storage containers or temporary structures. Fencing would be allowed to provide security for equipment and products. Camping or living trailers would not be allowed in the processing sites. Operators would provide their own water and water storage facilities and trash pickup. Connections to nearby powerlines and phones lines would be permitted. Operations on site would comply with fire restrictions and forest closures as applicable. Processing sites located in the interior of the project area would operate when the roads are open and passable and may be closed during the winter months if road and in-woods conditions are such that resource damage will occur, typically mid-December to April. Sites located near state highways or other paved roads may operate year-round.	Ensure proper design and construction of in-woods processing sites	Forest plan compliance and specialist recommendation
SU014	The design, construction and operation of processing sites shall utilize practicable procedures for control of surface water runoff from facilities.	Ensure proper design and construction of in-woods processing sites	Forest plan compliance
SU015	Processing site equipment and vehicles shall be operated and maintained to minimize petroleum and lubricating products from entering soil or surface/ground waters.	Ensure proper design and construction of in-woods processing sites	Forest plan compliance
SU016	The contractor or permittee operating the processing site shall maintain the authorized facility and site in good condition and in accordance with approved contract or operating plans and specifications. When the contractor or permittee completes the authorized activity, they must rehabilitate by removing all facilities and structures, removing all wastes with disposal at an approved facility, restoring the pre-disturbance site gradient, preparing the site for reseeding by scarifying the site, and application of a native seed mix as specified and approved by the Forest Service.	Ensure proper reclamation and rehabilitation of in-woods processing sites.	Forest plan compliance

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW001	All stream channels and riparian areas will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream and or riparian areas (wet meadows, springs, wetlands etc.). AMZ widths should be based on Forest Plan direction or other guidance documents. Where AMZ widths are not customized to site conditions and don't occur in Narrow-headed or Northern Mexican Garter Snake proposed critical habitat (see AQ021), the default minimum width for ground-based mechanical and prescribed burning treatments for perennial, intermittent, and ephemeral streams are 150, 75, and 50 feet, respectively. Lakes and reservoirs should follow the same default AMZ widths (150 feet) as those for perennial waters. AMZ's around other riparian features will be on a case-by-case basis and outlined in the projects plan-in-hand. See SW004 for acceptable activities within AMZ's)	To insure adequate protection of surface water quality during ground-based mechanical vegetation treatments and to provide consistency in how AMZ widths are measured and identified on the ground.	Specialist recommendation
SW002	Unless prescribed by forest plan direction AMZs can be customized by an ID team of qualified specialists prior to project implementation based on desired conditions along the stream reach and the nature of resource values at risk (such as the presence of aquatic ESA species or its potential introduction), special concerns for water quality degradation, erosion hazard, existing vegetative ground cover conditions, stream bank and riparian conditions, natural geologic features, and flow regime. The IDT will determine appropriate AMZ widths and treatment limitations within these zones. These changes should be reflected in the plan-in-hand documents and included in the task order or contract maps.	To allow the greatest flexibility in designing AMZ prescription to meet resource benefits while protecting the values at risk.	Specialist recommendation
SW003	Stream channels to be protected with a prescribed aquatic management zone (AMZ) will be shown on the project task order, contract or agreement maps, or burn plan maps. AMZ widths will be clearly labeled or described.	Allows for a reduction in ground disturbance by limiting the number of passes required to extract material and turning of equipment. BMP ultimately aims to reduce the amount of disturbed area affected during operation and to retain as much as possible the filtering effect of the undisturbed ground.	Specialist recommendation
SW004	Accepted activities within AMZs include mechanical and conventional tree felling, yarding, skidding, backing fire, and stream and springs restoration projects. When completing mechanical vegetation treatments within an AMZ, minimize the area of equipment usage in the AMZ. Vehicular operations including travel should not occur longitudinally through AMZ. Turning machines and skidding within AMZs should be minimized to the greatest extent possible. Landings, decking areas, machine or hand piles, temporary road installation and skidding across streams or wetlands are to occur outside of AMZs unless otherwise specified. Skidding across ephemeral or intermittent streams may occur at designated crossing under no-flow conditions. Minimize disturbance and removal of riparian vegetation within AMZ's.	To avoid, improve, or minimize effects to soils, water quality, and aquatic species and habitat.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW005	Mechanical vegetation treatments within AMZs will minimize the amount of thinning debris deposited in stream channels and remove excess debris by hand or end-lining with one end suspension except where coarse woody debris is needed for stream health as identified by fisheries or watershed specialists. Remove thinning debris less than six inches in diameter and less than six feet long and place it above the ordinary high water mark.	To minimize the potential for stream or culvert blockage.	Specialist recommendation
SW006	Mechanical vegetation treatments within AMZs will fell trees outside the stream channel unless otherwise specified as a stream treatment.	To minimize disturbance to stream morphology as much as possible and reduce the amount of fine woody debris entering the stream system.	Specialist recommendation
SW007	If completing mechanical vegetation treatments within an AMZ, do not designate trees for removal where the root system is important in maintaining channel morphology without first consulting with a watershed specialist.	To provide for bank stability and minimize erosion and bank instability to streams or other aquatic habitats.	Forest plan compliance and specialist recommendation
SW008	Site-specific criteria whereby either fire is allowed to burn in AMZs will be solely driven by the need to maintain or improve riparian and stream habitat (with the exception of WUI areas, see SW015 below). A site-specific evaluation will be conducted by a specialist as a part of the burn plan for each unit where fire is proposed.	Proper maintenance of prescribed burning activities adjacent to and/or within AMZs should help maintain the sediment filtering capacity of drainage way and reduce potential erosion in these locations.	Specialist recommendation
SW009	Fire control lines shall only be constructed within AMZs if mutually agreed upon by the authorized FS officer, fuels specialist, watershed specialist, and biologist. Only the following are allowed in AMZs: Raking, brushing (less than 3 feet wide), leaf-blower, or other techniques that limit disturbance to soils. Any fireline in AMZ's need to be rehabilitated by removing any berms and raking removed material back across the fireline as soon as possible to prevent sediment movement.	To minimize the disturbance of riparian vegetation and minimize sediment.	Specialist recommendation
SW010	The following direction should be incorporated in developing the burn plan and project implementation: High soil burn severity should not occur on greater than 5 percent areal extent of the uplands or an AMZ in each burn unit unless to meet specific IDT treatment objectives. High severity should be patchy rather than concentrated. No more than 5 percent mortality is allowed in the mature forest canopy along a streamside in each burn unit, with this mortality occurring as discontinuous patches. Variance in these parameters would need to be approved by appropriate specialist(s).	Maintaining low / moderate burn intensities and limiting the areal extent of high intensity burning will reduce the potential for severe soil burning which ultimately helps retain long-term soil stability/productivity and minimizes detrimental effects to soil, aquatic species, aquatic habitat, and desirable riparian species (flora and fauna) in AMZs.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW011	Apply the following direction if AMZ is within ½ mile of private land boundary or designated WUI: Treatment measures necessary to reduce the risk of wildfire encroachment on adjacent private lands may take priority over other considerations in these AMZs. Entry and treatments in these reaches will be considered on a case-by-case basis by ID teams.	To ensure that the fire management objectives and water quality objectives for these reaches are appropriately balanced.	Specialist recommendation
SW012	As part of seeding or other revegetation activities, do not apply surface fertilizer within an AMZ.	To protect water quality	Forest plan compliance and specialist recommendation
SW013	Domestic livestock grazing within an AMZ affected by prescribed fire may be deferred until ground cover is adequately re-established as per guidance outlined in RM004.	Promote recovery and establishment of riparian species, protect floodplain function, and provide for resilient stream systems.	Specialist recommendation
SW014	During project implementation use existing system travel courses and stream crossings whenever possible, unless new construction would result in less resource disturbance. Minimize the number of temporary access roads and travel paths to lessen soil disturbance, compaction, and impacts to vegetation. Temporary roads will not be built on slopes where grade, soil, or other features suggest a likelihood of excessive erosion or failure. Temporary roads areas will be restored to natural, preconstruction conditions as much as possible.	To minimize soil disturbance and reduce sedimentation and erosion in aquatic habitats.	Forest plan compliance and specialist recommendation
SW015	When altering spring developments or splitting flow, place troughs far enough away from groundwater-dependent ecosystems (GDEs), wetlands, and other sensitive or unique habitats to prevent erosion, compaction, or degradation to sensitive soils and vegetation due to livestock or wildlife congregations.	To maintain or improve the integrity of springs and other groundwater-dependent ecosystems (GDE) and minimize effects on these sensitive systems.	Specialist recommendation
SW016	All vehicle staging, fueling of vehicles, and storage of petroleum products would be done on a designated protected, upland site at least 150 feet outside of AMZs or from natural water bodies and wetlands. If more than 1,320 of gallons of petroleum products are to be stored onsite above ground or if a single container exceeds 660 gallons, then a spill prevention control and countermeasures plan (SPCC) would be prepared as per 40 CFR 112. All herbicides and pesticides servicing and storage will be on designated, approved, upland sites.	To protect soil/water resources and aquatic species from petroleum, herbicide and pesticide contamination.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW017	Contractor shall take all reasonable precautions to prevent pollution of air, soil, and water by Contractor's Operations. If facilities for employees are established on a Project Area, they shall be operated in a sanitary manner. In the event that Contractor's Operations or servicing of equipment result in pollution to soil or water, Contractor shall conduct cleanup and restoration of the polluted site to the satisfaction of Forest Service. Contractor shall maintain all equipment operating on Sale Area in good repair and free of abnormal leakage of lubricants, fuel, coolants, and hydraulic fluid. Contractor shall not service tractors, trucks, or other equipment on National Forest lands where servicing is likely to result in pollution to soil or water. Contractor shall furnish oil-absorbing mats for use under all stationary equipment or equipment being serviced to prevent leaking or spilled petroleum-based products from contaminating soil and water resources. Contractor shall remove from National Forest lands all contaminated soil, vegetation, debris, vehicle oil filters (drained of free-flowing oil), batteries, oily rags, and waste oil resulting from use, servicing, repair, or abandonment of equipment.	To protect soil/water resources and aquatic species from petroleum contamination.	Forest plan compliance
SW018	No temporary roads, storage areas, camp sites, landings, machine piles and/or skidding will occur on dry or wet meadows in a project area. Skidding in meadows may occur for the sole purpose of removing meadow encroaching trees. All meadow locations identified during the layout phase of a project sale will be clearly labeled on contract maps for protection.	To minimize impacts to meadow systems and improve implementation.	Specialist recommendation
SW019	Heavy equipment, vehicle operation, road construction, staging areas, stockpile areas, piling of slash, fence construction, fire lines, and other operational activities shall not be allowed in springs, seeps, or any other Groundwater-dependent Ecosystem (GDE), unless it is for the benefit or protection of the GDE or development of the springs.	To maintain or improve the integrity of springs and other GDEs and minimize effects on these sensitive systems.	Forest plan compliance and specialist recommendation
SW020	At spring development restoration sites, place watering troughs far enough from a steam or surround with a protective surface to prevent sediment delivery to the stream. Avoid steep slopes and areas where compaction or damage could occur to sensitive soils, slopes or vegetation due to congregating livestock or wildlife.	To reduce sediment delivery to aquatic habitats.	Specialist recommendation
SW021	Spring developments should not disturb the spring orifice (point where water emerges). Spring head boxes should be places in a location that will cause the least amount of disturbance to the soils and vegetation of the GDE. Preferable locations for spring head boxes should be in an established channel downstream from the orifice or a locations where flowing water becomes subsurface.	To maintain or improve the integrity of springs and other GDE's and minimize effects on these sensitive systems	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW022	Formerly used skid trails should be utilized where properly located. The designation of new skid trails should be oriented to the contour of the slope as much as operationally feasible. Skid trail design should minimize concentrated runoff and sediment delivery by avoiding long, straight skid trails and providing breaks in grade. Designated skid trails and log landings would be required within the tree removal contracts (BMP 24.18 in FSH 2509.22) on all cutting units. Location of new skid trails and overall skid trail placement should be designed to minimize the overall disturbance footprint across the treatment unit while still meeting the objectives of the stand treatment.	Utilization of existing skid trails, designation of new skid trails, and proper skidding design should reduce the overall heavy disturbance footprint across the treatment unit. Skid trail placement that follows the contour of the slope as much as operationally feasible will help lessen the potential for accelerated erosion downslope.	Specialist recommendation
SW023	Closed skid trails and roads must have adequate runoff and erosion control features. Slash is the preferred method for diverting water if of sufficient quantity and size is available to maintain complete contact with the ground. Berms should be removed to allow water off of skid trails and roads in to restore the natural grade of the slope as much as possible. Otherwise construct water bars and lead out ditches. Waterbars should not be more than 2 feet deep and need at least a 10-foot lead-out. Waterbars are only to be implemented with equipment with an articulating blade (no skidders), or by hand to remove berms, seeded, mulched, and cross-ripped. All berms and depressions (i.e., ruts) created along the skid trail or road will be filled in to restore the natural grade of the slope as much as possible.	Minimize the concentration of run-off and sediment delivery into stream channels.	Forest plan compliance and specialist recommendation
SW024	Erosion control structures and measure must be in place prior to an erosive event. The timber sale and/or stewardship contract, and or agreement outlines the timing and application of erosion control methods to minimize soil loss and sedimentation of stream courses.	Minimize the concentration of run-off and sediment delivery into stream channels.	Forest plan compliance and specialist recommendation
SW025	Scarification or ripping of landings should be conducted in a manner as not to mix the surface soil and subsoils to the point where subsoil becomes inverted and exposed at the surface.	Mixing of surface soil and subsoil is generally not conducive to obtaining desirable herbaceous revegetation.	Specialist recommendation
SW026	During machine piling of slash, rough piling is encouraged. This involves piling only large concentrations of slash, leaving areas of low concentration undisturbed. Also, where feasible, rack and pile. All piling equipment must be equipped with a brush rake to minimize disturbance to the soil surface.	Rough piling minimizes disturbance to existing ground cover and the surface soil.	Specialist recommendation
SW027	Slash can be placed on skid trail and travel corridors to drive on to reduce rutting and soil disturbance from mechanized equipment.	To reduce potential for rutting and compaction along mechanical equipment travel courses.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW028	Seed mixes for erosion control on site disturbed locations can include any of the following certified weed-free native species at a minimum of 5 pounds per acre pure live seed. Potential vegetation for individual sites should utilize the Apache-Sitgreaves, Coconino, and Tonto NFs' Terrestrial Ecosystem Surveys (TES) to identify species to be utilized. Where appropriate and feasible, protect site with a variety of methods (e.g., ungulate proof fencing, spreading slash etc.)	Minimize soil loss and sedimentation of stream courses from skidding operations. Minimize noxious weed spread and reestablish native vegetation. Minimize effects on severe erosion soils.	Forest plan compliance
SW029	Mechanical crushing of lopped slash can only occur on 0–25 percent slopes.	Incorporate slash into the soil to promote long term soil productivity.	Forest plan compliance
SW030	Slash and/or chips can be scattered on landings to help minimize the formation of rills and gullies.	Minimize the concentration of run-off and sediment delivery into stream channels.	Specialist recommendation
SW031	Skid trail stream crossings will not be allowed unless pre-approved by the authorized FS officer with consultation from a watershed specialist for perennial and intermittent streams. Ephemeral streams crossings will be authorized by the FS officer. Crossings will be at right angles to channel and drainage banks. The number of designated crossings should be minimized.	A qualified person should designate stream crossings in order to protect stream banks and stream morphology.	Specialist recommendation
SW032	Felling to the lead would be required within the timber sale and/or stewardship contract, and or agreement to minimize ground disturbance from skidding operations.	Felling of timber should be done to minimize ground disturbance from skidding operations and to minimize effects on severe erosion soils.	Forest plan compliance
SW033	Temporary roads are not allowed to cross perennial or ephemeral streams. Culverts, temporary bridges, low-water crossings, or log-fords will be required on all skid crossings on all streams that will have flowing water during the life of the temporary crossing. Skid trail crossings will be removed and restored when no longer needed. Any fill material will be removed and the channel and stream banks restored to a pre-project condition.	Protect stream morphology from damage from crossings while avoid damming or impounding free-flowing waters to provide streamflows needed for aquatic and riparian-dependent species.	Forest plan compliance and specialist recommendation
SW034	During thinning, operators shall avoid excavating skid trails whenever practical, locate skid trails where the need for sidecasting is minimized, and avoid adverse skidding to the greatest extent possible unless specialized equipment capable of adverse skidding without creating adverse soil impacts is utilized.	To prevent soil displacement	Specialist recommendation
SW035	Slash should be distributed throughout skid trails, forwarder trails and cable corridors wherever mineral soils are exposed.	To provide surface roughness and prevent concentrated runoff that could cause accelerated erosion.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW036	During cable thinning operation, operators shall limit cable thinning to uphill yarding whenever practical. When downhill cable yarding is necessary, operators shall layout the cutting system in a manner which minimizes soil displacement. The numbers and widths of yarding corridors shall be minimized.	To prevent soil displacement from cable yarding operations.	Specialist recommendation
SW037	Operators shall minimize the yarding of logs across streams or wetlands. Yarding across ephemeral streams shall be performed in ways that minimize soil and bank disturbances. Where it is necessary to yard across intermittent or perennial streams or wetlands, it shall be done by swinging the yarded material free from the ground to the greatest extent practicable (i.e. full suspension).	To prevent adverse effects to water quality	Specialist recommendation
SW038	During cable thinning, operators shall install effective cross ditches that drain onto undisturbed forest floor or spread slash on all skid trails and cable corridors located on steep or erosion-prone slopes	To prevent erosion and sediment delivery to stream courses and other waterbodies.	Specialist recommendation
SW039	Landings and decks should be clearly designated on the timber sale project plan.	To aid in implementation of project.	Specialist recommendation
SW040	Sizing, spacing, and placement of landings should be designed to minimize the overall ground disturbance footprint across the treatment unit while still meeting the objectives of the stand treatment.	Limit the overall amount and extent of heavy ground disturbance that implicates soil stability/ productivity as well as the filtering capacity of upland areas.	Forest plan compliance and specialist recommendation
SW041	Heavy ground disturbance activity areas (landings, major skid trails, unsurfaced haul roads, etc.) and excessive ground disturbance in any location (i.e., exceeding the rutting guidelines) should aim to not exceed 15 percent -areal extent of a treatment unit within a timber sale area.	To meet soil condition thresholds for management concern and to reduce the overall heavy ground disturbance footprint across a treatment unit.	Forest plan compliance and specialist recommendation
SW042	Skid trails, landings, and temporary roads are to be closed and have erosion control measures implemented as outlined in SW033 post-treatment and landings are to be scarified and seeded with a certified weed-free mix of primarily native, perennial grasses. The Coconino NF does not require scarification unless compaction is present.	Scarification and seeding of heavily disturbed areas will help break up soil compaction and reintroduction of native, perennial grass species will aid in mitigating the over-establishment of exotic or noxious weeds. Water-barring, restoring the natural grade or the slope, and utilizing slash for additional erosion control mitigation will dissipate the run-off energy, reducing sediment delivery, as well as aiding in long-term site stability/productivity.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW043	In meadow and grassland restoration sites where trees are being removed, designate skid trails in order to limit disturbance from skidding. Where material is not being removed, do not skid logs in meadows or grasslands, lop and scatter or manually remove slash from meadow; these are the preferred methods of treating slash. Do not machine pile within meadows or grasslands.	To minimize impacts to streams and soils in meadows from tree thinning operations.	Forest plan compliance
SW044	When thinning trees, no skidding is allowed across wetlands or springs and their outflows. This restriction needs to be displayed on contract or agreement area maps.	To minimize impacts to streams and soils in meadows from tree thinning operations.	Forest plan compliance
SW045	The authorized FS contract team member AND a watershed specialist will verify that the contractor has properly implemented the project watershed BMPs and erosion control measures prior to the closure of the project contract. In evaluating acceptance the following definition will be used by the FS: “Acceptable” erosion control means only minor deviation from the established standards and guidelines, providing no major or lasting impact is caused to soil and water resources. Include Biology staff where units are adjacent to federally listed and sensitive aquatic species habitat. Certified Timber Sales Administrators or CORs will not accept erosion control measures that fail to meet these criteria.	It is necessary to have a watershed specialist present during closeout to ensure that project watershed BMPs were implemented correctly as they were the original designer of the conservation practice. To minimize sediment delivery to T&E and sensitive species aquatic habitat	Specialist recommendation
SW046	Wet Meadows, springs, seeps or other wet features where mechanized equipment is to be excluded will be designated as “protected areas” be clearly labeled on task order, contract, or agreement maps and marked on the ground. Any features discovered during the layout phase of a project will also be included on task order or contract maps and boundaries shall be delineated on the ground during layout.	Soils and vegetation in wet meadows, dry meadows, springs, seeps or other sources where the presence of water is indicated will be protected from disturbance which could cause adverse effects on water quality, quantity, wildlife and aquatic habitat.	Specialist recommendation
SW047	Tree falling methods in designated protected areas and other sensitive areas such wet meadows, or around springs, seeps, should have the minimal impact to soils as possible. Methods for removal and end-lining will be determined on a case-by-case by the authorized FS officer after consultation with a watershed specialist.	Wet meadows, springs, seeps, and other wet areas have soil types with low soil weight-bearing strength due to permanently or seasonally high moisture contents and inherent soil characteristics which make them highly prone to detrimental soil compaction and topsoil displacement.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW048	Vegetation treatment in dry meadows will be treated in a site-specific manner to be determined by a watershed specialist in consultation with the project ID team.	Dry meadow soil types have low soil weight-bearing strength due to seasonally high moisture contents and inherent soil characteristics which make them highly prone to detrimental soil compaction and topsoil displacement.	Specialist recommendation
SW049	Whether identified pre-implementation and on a task order/contract area map OR during the implementation phase, locations above 25 percent slope gradient on sensitive soil types (e.g., cinder cones) will include a “protected area” designation that is clearly marked to exclude the use of mechanized thinning equipment. Hand-felling methods only will be permitted in these locations, unless use of specialized equipment may allow operations on steeper slopes. Viability and authorization of specialized equipment use above these slope gradients will be determined during the layout phase of a sale by the pre-sale forester AND a watershed specialist. This specification of desired equipment must be specified in the contract.	To protect highly erodible/sensitive soils on steep slopes by preventing traffic by heavy machinery on soils that are susceptible to destabilization and erosion.	Specialist recommendation
SW050	All ground disturbing activities using heavy equipment must be done under conditions which maintain soil condition (i.e. avoiding excess rutting, compaction, and displacement).	Insure that mechanical operations do not take place when ground conditions are such that detrimental soil compaction and topsoil displacement can occur.	Specialist recommendation
SW051	Skid Trails: Allow up 6 inches of rutting over no more than 15 percent areal extent along a skid trail (two or more drags being considered a skid trail). Depth of rut is a measurement from the bottom to the top of a berm. Slope gradients of 20 percent or more will be considered on a case-by-case basis. Any rutting that occurs must be rehabilitated at the soonest time practical.	Excessive ground disturbance and rutting causes detrimental soil compaction and topsoil displacement. Compaction effects to the surface soil and inverted, exposed subsoil is not conducive to obtaining desirable long-term herbaceous revegetation. Excessive ground disturbance hinders long-term soil stability and productivity through increased erosion and establishment of exotic or invasive species that out-compete native, perennial grasses and forbs.	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW052	At landings and within 75 feet of landings, rutting depths greater than 10 inches will not be allowed. Skidders shall not be turned on roads. Landings on slopes will be minimized to the greatest extent practicable and soil and watershed mitigation measures will be applied on a case by case basis to ensure that unacceptable soil loss does not occur.	Prevents detrimental soil disturbance to depths that are difficult to adequately ameliorate and that could lead to broken tree roots resulting in drought stress of remaining trees.	Forest plan compliance and specialist recommendation
SW053	Rutting on an unsurfaced road (generally maintenance Level 1, 2 and temporary roads) will not exceed 8 inches depth for more than 75 linear feet or 10% of road length, whichever is shorter. Rutting in excess of 3 inches depth will not be permitted on surfaced collector or arterial roads (generally some maintenance level 2 and all maintenance level 3 and 4 roads).	Prevents rutting of the road traveled way that could lead to concentrated runoff, erosion and adverse effects to surface water quality.	Forest plan compliance and specialist recommendation
SW054	For any other locations (e.g., interior locations other than skid trails) within a sale area, if wheel tracks or depressions consistently exceed 2 inches then conditions are too wet to operate in these areas.	To prevent detrimental soil disturbance and compaction that would make it difficult for vegetation to become reestablished.	Forest plan compliance and specialist recommendation
SW055	No prescribed fire control lines should be constructed using mechanized equipment on slopes greater than 40 percent or greater than 25 percent on identified fragile or sensitive soil types.	Restriction of fire control line construction and burning activities to these slope breaks will help mitigate accelerated overland flow and erosion typically associated with these settings.	Specialist recommendation
SW056	If fire control lines are constructed, rehabilitate lines after use by either rolling berm back over the entire fire line, spreading slash across the fire line, or water barring the fire line. If water barring only, vary spacing dependent on slope and disguise the first 400 feet of line to discourage use as a trail.	To prevent erosion and sediment delivery from firelines to stream courses. Also prevents firelines from being used as trails, thereby hastening recovery.	Specialist recommendation
SW057	Coarse woody debris will be managed to achieve forest plan direction and specialist recommendations. These recommended levels may be lower in WUI areas. Ponderosa Pine Forest: 3 to 10 tons/acre (For Tonto NF: Refer to Forest Plan) Dry Mixed Conifer: 5 to 15 tons/acre (For Tonto NF: Refer to Forest Plan) For facilitative operations or other activities that may occur in non-target vegetation types (E.g., Pinyon-Juniper, Wet Mixed Conifer), refer to the applicable forest plan to find appropriate fuel loading levels.	Maintain long term soil productivity. To provide levels of surface fuels (fine and coarse woody debris) to address the need for habitat (cover), soils (organic material and limited areas of high burn severity), and fire (to limit areas of high burn severity and a high resistance to control).	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW058	Burn plans will be designed to minimize fire intensity in riparian areas that have a PFC rating of Nonfunctional or Functional-at-Risk with a downward trend.	These systems may lack the vegetation to adequately dissipate energy and protect stream banks, therefore retaining the vegetative cover is necessary.	Specialist recommendation
SW059	Limit the areal extent of mechanical treatment which may occur in a subwatershed (HUC12) to 25% in a given year and 40% over 5 years of that subwatershed. For prescribed burning the percentages can be doubled. This is for subwatersheds that have not experienced a relatively recent large scale disturbance such as a fire and/or in a nonfunctioning condition. If exceeding these percentages by either treatment type or in combination, perform a cumulative watershed effects evaluation using a procedure such as the Equivalent Disturbed Area Analysis or other appropriate methodology. If it is determined that potential cumulative effects may be adverse to watershed function and condition, treatments should be spread out spatially and temporally.	Reduce potential cumulative effects which may adversely affect subwatershed scale (HUC12) condition or function.	Specialist recommendation
SW060	When restoring floodplains, mimic to the extent possible, the elevation, width, gradient, length, and roughness that would occur naturally for that stream reach and associated valley type.	To improve hydrologic function and connectivity and reduce detrimental effects to channel morphology and aquatic habitat. Reconnecting floodplains to their historic stream channels will improve soil hydrologic function, increase wetted area, and provide for improved stream morphology.	Specialist recommendation
SW061	Without changing the location of the bank toe, restore damaged streambanks to a natural slope and profile suitable for establishment of riparian vegetation. This may include sloping of unconsolidated bank material to a stable angle of repose or the use of benches in consolidated, cohesive soils.	To guide streambank restoration treatments.	Specialist recommendation
SW062	Road erosion control, such as lead-out ditches or water bars, shall be constructed to hydrologically disconnect road surface runoff from stream channels.	Minimize the concentration of run-off and sediment delivery into stream channels.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW063	Road drainage is controlled by a variety of methods including rolling the grade, insloping, outsloping, crowning, water spreading ditches, and contour trenching. Sediment loads at drainage structures can be reduced by installing sediment filters, rock and vegetative energy dissipaters, and settling ponds. Design of roads is included in the transportation plan of the forest product removal contract or agreement and T- specs. Road maintenance through the integrated resource service contract forest product removal contracts/agreements should require pre-haul and post-haul maintenance on all roads to be used for haul.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	Forest plan compliance and specialist recommendation
SW064	Relocated trails or roads will be constructed in a manner that does not hydrologically connect them to stream courses to the extent practical. Relocated roads and trails will have sufficient drainage features to maintain the integrity of the traveled way. New cross drains shall discharge to stable areas where the outflow will quickly infiltrate the soil and not develop a channel to a stream.	To provide for stable and serviceable roads and trails that do not adversely affect soils, surface water quality or aquatic habitats.	Specialist recommendation
SW065	Site rehabilitation on riparian sites for stream channel and road reconstruction projects where ground disturbance occurs: seed at 5 pounds per acre or other appropriate rate with certified weed-free native seed mix to rehabilitate the site and minimize effects of noxious weeds.	To comply with State and Federal water quality standards by minimizing soil erosion through the stabilizing influence of vegetation ground cover.	Forest plan compliance and specialist recommendation
SW066	Site rehabilitation on disturbed sites and stream channel shaping on decommissioned roads consists of several revegetation methods, such as, but not limited to: (1) Storing sod removed from the initial ground disturbance and replace the sod from the top of the bank on the disturbed site; (2) Use appropriate mix of species that will achieve vegetation establishment and erosion control objectives at the site. (3) Protect site with slash spread across the disturbed area to create microclimates and protect from grazing ungulates. Slash placement should be limited to the upper two-thirds of the bank to limit transport downstream of woody material;(4) Consider the use of mycorrhizal inoculum on severely disturbed sites where no topsoil is left; and (5) install erosion mat.(6) Protect site with herptile-friendly barriers until the site has reestablished (see AQ018). Temporary erosion control should be installed before land or channel disturbing activities commence and will be inspected for adequacy/effectiveness at sufficient intervals to minimize adverse effects to soils or surface water quality.	Comply with State and Federal water quality standards by minimizing soil erosion through the stabilizing influence of vegetation ground cover. To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW067	All potential seeding areas as part of restoration treatment to re-establish native, perennial grass abundance and vigor will be evaluated on a site-specific, case-by-case basis by the project interdisciplinary team (IDT). Seeding product for potential treatment areas will contain a mixture of certified weed-free native grasses which will contain a composition and ratio to be determined by the IDT.	For locations that do not have a viable enough seed bank to be propagated by prescribed fire activities alone, seeding may be necessary to help sites rejuvenate a more abundant and diverse herbaceous cover component that is aligned with the natural vegetative potential of the site.	Specialist recommendation
SW068	De-compact soil by scarifying the soil surface of roads and paths, stream crossings, staging, and stockpile areas so that seeds and plantings can root.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects on species.	Forest plan compliance
SW069	For road, trail, aquatic, and watershed treatments: dispose of slide and waste material in stable sites out of the flood-prone area. Use native materials to restore natural or near-natural contours.	To protect water quality and aquatic habitat	Specialist recommendation
SW070	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash or other certified weed free mulch material.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	Specialist recommendation
SW071	Prior to construction/ site preparation, critical riparian vegetation areas, wetlands, and other sensitive sites will be clearly delineated to minimize ground disturbance, erosion, and sedimentation to aquatic habitats. Project specific BMP's will be implemented prior to construction when specified.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	Specialist recommendation
SW072	Minimize clearing and grubbing activities when preparing staging, project, and or stockpile areas. Any large wood, topsoil, and native channel material displaced by construction will be stockpiled for use during restoration if applicable. Materials used for implementation of aquatic and watershed restoration categories (e.g., large wood, boulders, fencing material) should be staged out of the 100-year floodplain.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW073	Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork as quickly as possible-when ground conditions are driest. During excavation, stockpile native streambed materials above the bankfull elevation, where it cannot reenter the stream, for later use.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	Forest plan compliance and specialist recommendation
SW074	Disturbance to streambank vegetation should be minimized in all project activities.	To protect riparian vegetation and stream channel stability.	Specialist recommendation
SW075	Do not borrow road fill or embankment materials from the stream channel or meadow surface on road maintenance projects. End-load all material hauled onsite and compact fill.	Minimize disturbance in drainage systems and minimize sediment production within channel.	Specialist recommendation
SW076	Heavy equipment will be commensurate with the project and operated in a manner that minimizes adverse effects to the environment (e.g., minimally-sized, low pressure tires, minimal hard turn paths for tracked vehicle, temporary mats or plates within wet areas or sensitive soils.)	To minimize impacts to streams and wetlands as well as aquatic habitats from heavy equipment use to implement restoration treatments.	Forest plan compliance and specialist recommendation
SW077	Placement of lop / scatter material or piling for burning will occur outside of fragile or sensitive soil types.	Minimize disturbance of sensitive soil.	Specialist recommendation
SW078	In rock pit areas, soil and vegetation disturbance would be avoided to the extent practicable. Clear only the area needed for expansion of the pit.	Prevents impacts to soil, vegetation, and wildlife.	Specialist recommendation
SW079	All erosion control work to be constructed related to ground disturbing activities would be in place or maintained prior to potential damaging runoff events	To avoid and minimize impacts to water quality and watershed integrity.	Forest plan compliance and specialist recommendation
SW080	One 50-gallon spill kit (or two 30-gallon spill kits) must be located on-site during use of all heavy equipment.	To avoid impacts to water quality and wildlife.	Specialist recommendation
SW081	No permanent structures would be constructed as part of any rock pit; although at least one self-contained portable toilet is required to be on-site during all operations.	To protect water quality and prevent unnecessary impacts to vegetation and wildlife.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
SW082	Where there is topsoil that is first removed to access the aggregate material source, this soil shall be stockpiled for reclamation. Soil would be stockpiled instratum and replaced so that the “A” horizon is back on the surface.	To facilitate reclamation efforts.	Specialist recommendation
SW083	In rock pits, stockpiled material should be placed and shaped to prevent water from ponding and to direct water to a drainage system. Mine pit areas would be designed to be internally draining, keeping sediment on-site of rock pits using settling ponds, check dams, or sediment barriers; and monitor and inspect the site frequently and correct problems promptly. Ponds should be cleaned out before they are more than 1/3 full of sediment.	To protect water quality.	Specialist recommendation
SW084	Replace topsoil, revegetate, and reclaim mined areas pit as soon as possible once pit use is discontinued.	To protect soil and water resources.	Specialist recommendation
TR001	Avoid locating temporary roads on soils with severe erosion hazard.	The completion of a total maximum daily load assessment may result in developing additional water quality improvement strategies and mitigation of effects within associated watersheds	Specialist recommendation
TR002	On areas to be prescribed burned, if decommissioned roads are used as fire lines, return decommissioned roads to their pre-burn condition. Rehabilitation of the surface should refer to the soil and water BMPs for rehabilitation of fire lines and disturbed areas.	Discourage use on previously decommissioned roads and maintain a safe and economic road system.	Specialist recommendation
TR003	Where temporary road construction is unavoidable, provide soil protection through implementation of any of the following methods to control sediment and protect water quality. Methods may include, but are not limited to: properly locating the temporary road in and upland position, road drainage (waterbars/rolling dips), and outsloped roads. For activities adjacent to the road to control runoff include tactics such as wattling, hydro-mulching, straw or wood-shred mulching, spread slash, erosion mats, terraces, blankets, mats, silt fences, riprapping, tackifiers, soil seals, seeding and side drains.	To protect long-term soil productivity	Specialist recommendation
TR004	Utilize road safety signage with any project road activities that are related to project implementation.	Provide for user safety.	Specialist recommendation
TR005	Utilize the closest material source that has the specified material type for all road maintenance/reconstruction/relocation projects.	Minimize energy use for road maintenance/reconstruction/relocation activities.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
TR006	Road maintenance through the timber sale contract or stewardship contract should require pre-haul and post-haul maintenance on all roads to be used for haul.	Provide for a safe travel surface and provide for access to the project area.	Specialist recommendation
TR007	Decommissioned roads should have the roadbed removed and natural contours and gradients restored as much as possible. Slash or other suitable erosion material (mats, wattles, jute, silt fence, etc.) should be used where necessary and disturbed areas should be seeded with a suitable erosion control see mix consisting primarily of native grass species. Roads that are in closed status should be either lightly scarified and seeded or stabilized with erosion control features (e.g., rolling the grade, waterbars, etc.). Road entrances should be blocked to prevent access and signed as closed. Camouflaging of road entrances with large rocks and woody debris may prevent unauthorized access and improve stability. Road drainage features such as lead-out ditches or waterbars should not be hydrologically connected to stream channels on active or closed roads.	To protect long-term soil stability/productivity and water quality by reducing overland flow and sediment delivery originating from these locations.	Specialist recommendation
TR008	As a condition of approval for use of a temporary road under any contract involving mechanical thinning, temporary roads will be decommissioned, using any one or combination of appropriate methods, by the purchaser/contractor when mechanical treatments are finished.	To protect long-term soil productivity and water quality and ensure that temp roads do not become de facto new roads.	Specialist recommendation
TR009	If trees need to be removed for temporary road construction, avoid old trees unless necessary to prevent additional habitat degradation. Avoid removal of large trees, as well as oaks and aspens where feasible.	To minimize adverse effects on forest structure and habitat, and to minimize road disturbance from temporary roads and need for fills in stump holes.	Specialist recommendation
TR010	Roads causing damage to hydrological resources, cultural resources or threatened endangered, and sensitive species habitat are a priority for decommissioning.	To reduce effects to aquatic habitats from roads.	Specialist recommendation
TR011	Do not borrow road fill or embankment materials from the stream channel or meadow surface on road maintenance or stream crossing projects. Compact (compress) the fill dirt.	to minimize disturbance in drainage systems, sediment production within channels, and changes to channel morphology that will alter aquatic habitats	Specialist recommendation
TR012	Where feasible, relocate roads out of drainage bottoms to an upland location. If this is not feasible, rock armor outfall of drainage features as an energy dissipater.	To minimize sediment delivery into and disturbance to drainage systems, and minimize sediment production within channels.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
TR013	Avoid road rehabilitation and maintenance during periods of sustained or heavy rainfall.	To minimize erosion and negative effects from sediment and other contaminants on water bodies and aquatic and associated habitats and cave/karst systems.	Specialist recommendation
TR014	When deemed necessary in order to prevent potential damage to buried utilities, the Forest Service shall coordinate any hauling activity which will cross buried utilities with the owner of the line. Care shall be taken to prevent damage to buried utilities which may include mitigation measures such as gravel padding or other suitable measures.	Prevent damage to water pipelines	Specialist recommendation
TR015	While a rock pit is in operation, appropriate dust abatement measures will be taken on roads and pit areas where trucks are operating if necessary.	Reduce dust and minimize visibility issues on roads.	Specialist recommendation
WL001	Trees greater than 24 inches in diameter would not be cut in Mexican spotted owl recovery and protected habitat except in overriding management situations such as for human safety.	to minimize adverse effects on Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and to comply with ESA and direction in the 2012 MSO Recovery Plan, pp. 268-269	Forest plan compliance and specialist recommendation
WL002	Mexican spotted owl protected activity centers (PACs) and recovery nest/roost habitat will be managed to meet basal area, trees per acre, and canopy cover requirements as specified in the most current MSO Recovery Plan	To minimize adverse effects on Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and to comply with ESA and direction in the 2012 MSO Recovery Plan, tables C.1, C.2, and C.3	Forest plan compliance and specialist recommendation
WL003	Coordinate and implement management activities within Mexican spotted owl protected activity centers (PACs) to reduce potential disturbance and minimize the frequency and duration of operations within and immediately adjacent to these areas.	to minimize adverse effects on Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and to comply with ESA	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
WL004	In Mexican spotted owl recovery foraging/non-breeding habitat, follow the most current Mexican spotted owl Recovery Plan and incorporate the following guidelines: • Crown spacing between tree groups (interspace) would average 25 to 60 feet distance, providing for forest health, prey habitat development, and to move toward or facilitate stand conditions more conducive to low severity fire. • Tree thinning in pine-oak would target 40 to 110 BA; thinning in mixed conifer would target 40 to 135 BA. The goal is manage for a sustainable range of density and structural characteristics. • No trees greater than 24 inches in diameter would be cut and trees greater than 18 inches would be retained, unless overriding management situations require their removal.	To minimize adverse effects to Mexican spotted owls and contribute towards the recovery of the owl while restoring Mexican spotted owl habitat.	Forest plan compliance and specialist recommendation
WL005	In Mexican spotted owl protected activity centers (PACs), springs, riparian and stream restoration, temporary road construction, obliteration, relocation, and maintenance, would not occur during the breeding season (March 1 to August 31), if occupied.	To minimize adverse effects on Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and to comply with ESA	Forest plan compliance and specialist recommendation
WL006	In occupied Mexican spotted owl protected activity centers (PACs) with currently nesting owls, no mechanical or prescribed fire treatments or road or trail maintenance would occur during the breeding season (March 1 to August 31).	To minimize adverse effects to Mexican spotted owls and comply with ESA and the 2012 MSO Recovery Plan, table C.1 while restoring Mexican spotted owl	Forest plan compliance and specialist recommendation
WL007	Hauling would generally avoid Mexican spotted owl protected activity centers (PACs) during the breeding season (March 1 to August 31) unless specific analysis has documented that this would not lead to adverse effects. Thinning equipment would remain greater than or equal to 0.25 miles from PAC boundaries during breeding season unless topographic features would limit noise; trucks would drive less than or equal to 25 miles per hour in PACs.	To minimize adverse effects on Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and to comply with ESA	Forest plan compliance and specialist recommendation
WL008	In Mexican spotted owl protected activity centers (PACs), no new wire fencing would be constructed in PACs to minimize the risk of owls colliding with new fences. Other alternatives would be used for aspen, sensitive plants, springs, and ephemeral channel restoration exclosures.	To minimize adverse effects to Mexican spotted owls and contribute towards the recovery of the owl while restoring Mexican spotted owl habitat.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
WL009	In Mexican spotted owl protected activity centers (PACs), road maintenance would not occur during the nesting season (Effective March 1 to August 31), if occupied.	To minimize adverse effects on Mexican spotted owls while restoring Mexican spotted owl habitat , contribute towards the recovery of the owl, and comply with ESA	Forest plan compliance and specialist recommendation
WL010	All stands included in the proposed mechanical treatments for Mexican spotted owl protected activity centers (PACs) would be hand-marked for thinning, and prescriptions and marking would be coordinated with the US Fish and Wildlife Service.	To improve site specificity of treatments to retain trees with the greatest habitat value and continue coordination with the U.S. Fish and Wildlife Service during implementation.	Specialist recommendation
WL011	Fireline associated with preventing fire from entering Mexican spotted owl protected activity centers (PACs) and/or core areas would be constructed outside the nesting season.	To minimize adverse effects to Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and comply with ESA.	Forest plan compliance and specialist recommendation
WL012	In Mexican spotted owl protected activity centers (PACs) nest trees would be protected in the design and implementation of prescribed fires.	To minimize adverse effects to Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and comply with ESA.	Forest plan compliance and specialist recommendation
WL013	Survey all potential spotted owl areas including protected, recovery nest/roost, and other forest and woodland types within the implementation area plus the area ½-mile beyond the perimeter of the proposed treatment area. Surveys should be conducted for two years, with the second-year survey either the year before or the year of (but prior to) project implementation.	To minimize adverse effects to Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and comply with ESA.	Forest plan compliance and specialist recommendation
WL014	Coordinate burning spatially and temporally to limit smoke effects on nesting Mexican spotted owls, particularly for protected activity centers (PACs) with nests in low-lying areas (Effective March 1 to August 31).	To minimize the effects to Mexican spotted owls and comply with ESA	Forest plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
WL015	In Mexican spotted owl protected activity centers (PACs), recovery nest/roost, goshawk post-fledging family areas, no old trees of any species would be cut during the creation of temporary roads.	To protect and retain old trees and maintain or develop key habitat components	Specialist recommendation
WL016	In northern goshawk nest stands, burn plans covering areas with nesting goshawks and/or known nest trees would include mitigations to minimize smoke effects on nesting birds and nest trees would be protected	To minimize disturbance to goshawks while restoring goshawk habitat.	Forest plan compliance and specialist recommendation
WL017	Fuels in goshawk nesting areas would be evaluated and, if necessary, would be manipulated outside of the breeding period (March 1 to September 30) to ensure low severity fire effects from prescribed fire.	To minimize disturbance to goshawks while restoring goshawk habitat.	Forest plan compliance and specialist recommendation
WL018	In northern goshawk post-fledging family areas (PFAs), thinning activities would not occur in occupied PFAs during the breeding season unless the district biologist can document that effects would not trend to listing or loss of viability.	To minimize disturbance to goshawks while restoring goshawk habitat.	Specialist recommendation
WL019	Hauling will not occur within post-fledging family areas (PFAs) during the breeding season (March 1 through September 30) unless monitoring determines the PFA is not occupied, or the nest is 1/4 mile away, topographically isolated, or as determined by a wildlife biologist.	To minimize disturbance to goshawks	Specialist recommendation
WL020	In northern goshawk post-fledging family areas (PFAs), spring, riparian and stream restoration projects would not occur during the breeding season (March 1 to September 30) if occupied. However, work could potentially occur on an individual basis through coordination with the District biologist if specific analysis has documented that effects will not trend to listing or loss of viability.	To minimize disturbance to goshawks while restoring goshawk habitat.	Forest plan compliance and specialist recommendation
WL021	In northern goshawk post-fledging family areas (PFAs) road construction, obliteration, relocation, and maintenance would not occur during the breeding season (March 1 to September 30) if occupied, or as determined by a wildlife biologist.	To minimize disturbance to goshawks while restoring goshawk habitat.	Forest plan compliance and specialist recommendation
WL022	In bald and golden eagle nest sites, mechanical treatments within 300-yards of bald or golden eagle nest trees would only occur outside of the breeding season (January 1st to August 31st) or if the nest is inactive.	To minimize disturbance to eagles while restoring forest habitat.	Specialist recommendation
WL023	In bald and golden eagle nest sites, burn plans would be coordinated with the district wildlife biologist to ensure nesting eagles would not be adversely affected from smoke.	To minimize disturbance to eagles while restoring forest habitat.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
WL024	No project activities would occur within 500 feet of confirmed bald eagle communal roost sites from October 15 – April 15.	To minimize disturbance to eagles while restoring forest habitat.	Specialist recommendation
WL025	If new Mexican spotted owl protected activity centers (PACs) are established in areas with planned or ongoing 4FRI activities then existing design features related to MSO protection would apply to management activities.	To minimize adverse effects to Mexican spotted owls while restoring Mexican spotted owl habitat	Forest plan compliance and specialist recommendation
WL026	In turkey foraging and roosting cover, mechanical thinning will retain mostly medium, with some areas of high canopy cover in ponderosa pine stringers in the pinyon-juniper transition zone. Thinning activities will retain all large and old trees along ridges and slopes above the pine and pinyon-juniper transition zone and will be implemented to contribute to development/recruitment of groups and clumps of large and old trees.	To minimize disturbance to turkeys while restoring forest habitat.	Forest plan compliance and specialist recommendation
WL027	Manage prescribed fire to retain ponderosa pine and roosting cover for turkeys.	To minimize disturbance to turkeys while restoring forest habitat.	Forest plan compliance and specialist recommendation
WL028	No mechanical treatment would occur within 300 yards of an active great blue heron rookery between April 1 and June 30. Burn plan development would include consultation with the local biologist as well as the implementation of prescribed fire to minimize adverse impacts of smoke on nesting herons.	To minimize disturbance to rookeries while restoring forest habitat.	Specialist recommendation
WL029	No dominant or co-dominant trees would be cut in great blue heron rookeries. Nest trees would be prepped prior to implementing prescribed fire and ignition mitigations would apply. Timing would avoid mechanical thinning while birds are in the nest. Activities would be coordinated with the local biologist.	To minimize disturbance to rookeries while restoring forest habitat.	Specialist recommendation
WL030	Protect active raptor nest sites from disturbance by project-related activities by restricting activities during nesting season as specified in the applicable forest plan, or as determined by a local wildlife biologist. Known nest trees for any raptor species will be prepped, as needed, to avoid negative impacts to survival or successful reproduction, prior to implementing management activities, including prescribed fire.	To minimize disturbance to raptors while restoring forest habitat.	Forest plan compliance and specialist recommendation
WL031	All non-Forest Service personnel involved in thinning and burning activities, transportation of equipment and forest products, research, or restoration activities would be briefed on the Mexican spotted owl, know to report sightings and to whom, avoid harassment of the owl, and are informed as to whom to contact and what to do if an owl is incidentally injured, killed, or found injured or dead.	To minimize adverse effects to Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and comply with ESA.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
WL032	A 300-foot buffer for mechanical treatment with heavy equipment should be designated around known bat colonies (use AGFD HDMS database). For treatments around cave entrances, sink hole rims and other karst features that are to occur during the maternity season (April 15-August 31) or during monsoon season, coordination should occur with a wildlife biologist regardless of whether HDMS data indicates the occurrence of bat colonies or not.	To minimize disturbance to bats and their habitat, including detrimental effects to the cave/karst microclimate and hydrology, and to prevent collapse and sedimentation	Specialist recommendation
WL033	Only low intensity fire will occur in Chiricahua Leopard Frog occupied habitats or suitable habitat within reasonable dispersal distance from occupied sites as defined in the species recovery plan.	Minimize disturbance while restoring forest conditions.	Forest plan compliance and specialist recommendation
WL034	In native leopard frog occupied sites (streams, tanks, etc.), frog dispersal distances should be considered when establishing an appropriate AMZ. In general, a 650-foot or designated along logical topographic breaks no-treatment buffer (no thinning, no direct ignition) is reasonable for leopard frog dispersal. Designated skid trail crossings through the buffer zone are allowed. Mechanical equipment may reach into the AMZ with coordination between the TSA/COR and biologist to meet objectives. In leopard frog dispersal habitat, a 200-foot protection zone (100 feet either side of the stream) would be established around designated stream courses. There would be no thinning and no direct ignition within the protection zones. Designated skid trail crossings through the buffer zone are allowed. Fall burning and burn plans should be coordinated with district wildlife biologists.	Minimize disturbance while restoring forest conditions.	Forest plan compliance and specialist recommendation
WL035	In springs identified for restoration, springs would be surveyed for leopard frogs prior to implementation of restoration activities.	Minimize disturbance while restoring springs and spring habitat.	Forest plan compliance and specialist recommendation
WL036	Do not use tanks for water sources that are known to have populations of northern, lowland, and/or Chiricahua leopard frogs as water sources for prescribed fire activities. Activities in and around natural or constructed waters would use decontamination procedures to prevent the spread of Chytrid (Bd) fungus and other invasive aquatic species, unless an evaluation by a forest biologist determines it unnecessary.	Minimize disturbance while managing fire.	Forest plan compliance and specialist recommendation
WL037	Where cover exists near dependable waters, consult with a wildlife biologist to determine where and if hiding areas, openings, and interspaces should be created.	Maintain hiding cover where wildlife congregates while restoring forest structure.	Specialist recommendation
WL038	Snags and Logs: Protect snags and logs wherever possible by placing landings in existing openings or in areas where snags and/or logs, and old trees would be minimally affected.	Maintain key but limited wildlife habitat components while restoring forest structure.	Forest plan compliance

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
WL039	Snags and Logs: In ponderosa pine, protect/provide snags and logs wherever possible through site prep, implementation planning, green tree selection, and ignition techniques to retain 1-2 snags per acre greater than or equal to 18 inches in diameter, and greater than or equal to 3 logs greater than or equal to 8 feet long and greater than or equal to 12 inches mid-point diameter, and 3-10 tons of coarse woody debris (greater than 3 inches in diameter) per acre in pine and pine-oak habitat.	Maintain key but limited wildlife habitat components while restoring forest structure.	Forest plan compliance
WL040	Snags: Retain trees greater than or equal to 18 inches in diameter with dead tops, cavities, and lightning strikes wherever possible to provide cavity nesting/foraging habitat (i.e., the living dead) in ponderosa pine habitat.	Maintain key but limited wildlife habitat components while restoring forest structure.	Specialist recommendation
WL041	In pinyon-juniper cover type, snags 8 inches and greater in diameter at root collar would be managed for an average of 5 per acres, while snags 18 inches and greater in diameter would be managed for 1 per acre, and coarse woody debris would be managed for a post-treatment average of 2-5 tons per acre.	Maintain key wildlife habitat components while restoring forest structure.	Forest plan compliance and specialist recommendation
WL042	Snags: Emphasize retention of snags exhibiting loose bark to provide habitat for roosting bats.	Maintain key but limited wildlife habitat components while restoring forest structure.	Forest plan compliance and specialist recommendation
WL043	For wildlife cover and stand heterogeneity in ponderosa pine cover type: Gambel oak, juniper and pinyon species would not be cut with the following exceptions: seedling/sapling, young and mid- aged pinyon and juniper up to 11 inch diameter at the root collar may be cut within a 50 foot radius of individual or groups of old ponderosa pine (as defined in the old tree implementation strategy); and when there is no other option to facilitate thinning operations (skid trail and landing locations). Gambel oak, juniper and pinyon species greater than 5 inch diameter at the root collar (diameter root collar) may be considered as residual trees in the target group spacing and stocking. Manage for large oaks (10 inch diameter at the root collar or larger) by removing ponderosa pine up to 18 inches in diameter that do not meet the “old tree” definition and do not have interlocking crown with oaks and occur within 30 feet of base of oak 10 inches in diameter at the root collar or larger. In areas of savanna restoration and wildland-urban interface pinyon-juniper mechanical treatment, seedling/sapling, young and mid-aged pinyon and juniper may be cut.	Maintain a range of structure conditions (i.e., wildlife habitat heterogeneity) while restoring forest conditions.	Specialist recommendation
WL044	Burn Plans and Ignition Techniques: Apply fire prescriptions to maintain forest plan levels of coarse woody debris.	Maintain a range of structure conditions (i.e., wildlife habitat heterogeneity) while restoring forest conditions.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
WL045	Burn Plans: Ensure that the potential cumulative effects of multiple fires burning in a given area do not produce negative effects to local wildlife; coordinate burning between administrative units and between wildlife and fire management to minimize potential disturbance.	Minimize disturbance to wildlife while conducting restoration activities.	Specialist recommendation
WL046	Defer thinning in a ¼ mile radius around known black bear den sites from April 15 to June 30 maps would be provided to those implementing the activities.	Minimize potential for disturbance.	Specialist recommendation
WL047	In-channel structures: Consist of porous channel-spanning structures comprised of biodegradable vertical posts (beaver dam support structures) approximately 0.5 to 1 meter apart and a height intended to act as the crest elevation of an active beaver dam. Variation of this restoration treatment may include post lines only, post lines with wicker weaves, construction of starter dams, reinforcement of existing active beaver dams, and reinforcement of abandoned beaver dams (Pollock et al. 2012).	To maintain or provide for future beaver (and associated species) habitat.	Forest plan compliance and specialist recommendation
WL048	Place beaver dam support structures in areas conducive to dam construction as determined by stream gradient or historical beaver use.	To maintain or provide for future beaver (and associated species) habitat.	Forest plan compliance and specialist recommendation
WL049	Place beaver dam support structures in areas with sufficient deciduous shrub and trees to promote sustained beaver occupancy.	To maintain or provide for future beaver (and associated species) habitat.	Forest plan compliance and specialist recommendation
WL050	Beaver habitat restoration activities may include planting riparian hardwoods (species such as willow and alder) and building exclosures (such as temporary fences) to protect and enhance existing or planted riparian hardwoods until they are established.	To maintain or provide for future beaver (and associated species) habitat.	Forest plan compliance and specialist recommendation
WL051	Temporarily restrict human access and disturbance-causing land-use activities within a 1-mile radius around active Mexican gray wolf dens between April 1 and July 31, and around active rendezvous sites between June 1 and September 30. Exceptions include any authorized specific land use that was active and ongoing at the time Mexican wolves chose to locate a den or rendezvous site nearby. Coordinate with the Interagency Field Team (IFT) to determine current denning/rendezvous site locations.	To avoid adverse effects to reproductive success, natural behavior, or persistence of Mexican wolves. To prevent loss of IFT equipment (cameras, etc.) on Forest.	Forest plan compliance and specialist recommendation
WL052	Rock pits within ½ mile of MSO recovery and protected habitat would be surveyed to protocol to determine occupancy by owls before operations are initiated, unless a wildlife biologist determines this restriction is unnecessary.	To avoid or minimize potential impacts to MSOs.	Forest plan compliance and specialist recommendation
WL053	No ground disturbance from rock pit development or operation would occur in known protected activity centers (PACs), or within 1/4 miles of nests and roosts	To avoid or minimize potential impacts to MSOs.	Forest plan compliance and

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
	during the nesting season, unless a wildlife biologist determines this restriction is unnecessary.		specialist recommendation
WL054	Material hauling from rock pits in or within ¼ miles of occupied PACs would occur outside of the Mexican spotted owl nesting season unless a wildlife biologist determines this restriction is unnecessary.	To avoid or minimize potential impacts to MSOs.	Forest plan compliance and specialist recommendation
WL055	Pit development and operation within occupied northern goshawk PFAs may occur when surveys have indicated there are no active nests. If surveys identified an occupied nest, all operational activities and hauling would be avoided March 1 – September 30th unless a wildlife biologist determines this restriction is unnecessary.	To minimize impacts to Northern goshawk	Forest plan compliance and specialist recommendation
WL056	If a Northern goshawk is detected at a rock pit location at any time, the local district biologist would be contacted prior to any additional activity to confirm goshawk activity in the area and determine additional mitigations, if necessary, to limit impacts to nesting goshawks.	To avoid or minimize potential impacts to nesting Northern goshawk	specialist recommendation
WL057	Prior to reinitiating operations in rock pits where standing water is pooled, a wildlife biologist will determine if aquatic surveys for sensitive or threatened species should occur.	To avoid or minimize potential impacts to threatened or sensitive aquatic species	Forest plan compliance and specialist recommendation

Appendix D – Alternatives 2 and 3 Implementation Plan

The environmental impact statement (EIS) for the Rim Country Project describes the purpose and need, alternatives, and the potential maximum effects from the activities in those alternatives. This implementation plan is designed to be integral to the selected alternative and record of decision (ROD). The process described in this appendix describes the link from the EIS to the project-specific work without the need for additional NEPA analysis. It should be considered in conjunction with Appendix C that provides the design features, best management practices, and mitigation and conservation measures. Tables D-1 contain checklists designed to support implementation compliance.

Essentially, if the quantity of treatments in Tables D-1 are within the bounds of the treatments analyzed in Chapter 3 of the EIS and the specialist reports, the program of work is considered to be consistent with that effects analysis. Tables D-1 shows the compliance evaluation and documentation requirements to demonstrate this compliance. ***Sections A through E provide direction that would be used by implementers to ensure that implementation meets the purpose and need and forest plan standards and guidelines. Silvicultural prescriptions will document the stand level desired conditions and objectives which is consistent with this analysis, incorporate design features (Appendix C), and provide the course of action needed to move toward the project desired conditions.

Description of Plan Components

Section A Implementation Checklist: The checklist is designed to track compliance with the NEPA decision and ensure activities are consistent and compliant with the analysis and decision (correct location, appropriate number of acres by treatment type). The checklist is designed to be used by the implementation team leader. Sources of data to populate row three are found in Chapter 3 and the specialists reports.

Section B Management Direction, Desired Conditions and Treatment Design: This section includes existing forest plan management direction, desired conditions, and treatment-specific silvicultural design. It is designed to be used by the district implementation team.

Section C Old Tree Implementation Plan: This section provides the Old Tree Implementation Plan, including old tree descriptions, illustrations, and guidance.

Section D Large Tree Implementation Plan: Section D includes guidance and the Large Tree Implementation Plan. This guidance is designed to be reviewed by the district implementation team and silviculturist during the development of site-specific prescriptions and during implementation.

Section E Density Management and the Relationship between Treatment Intensity, Tree Group Density, and Overall Average Density

Section F Flexible Toolbox Approach: Two flexible toolbox approaches being used in the Rim Country Project. Mechanical Treatments Flexible Toolbox Approach uses decision matrices based on vegetation or stand conditions for flexibility in prescribed treatments. It is designed to be used during the planning process and implementation. The Flexible Toolbox Approach for Aquatics and Watershed Restoration Activities uses a different type of decision matrix for implementation of and prioritizing restoration projects.

Section A – Implementation Checklist

Table 107. Implementation Plan Checklist

Implementation Plan Checklist	Yes	No	Not Applicable
Is the treatment on a line officer approved 5 year plan?			
For burning, is the treatment burn plan completed and signed? • Objectives have been developed in interdisciplinary manner and are clearly delineated? • Objectives are consistent with management direction? • Are burn plans reviewed and signed off by district interdisciplinary team? • All burning and burn plan check lists completed?			
For timber operations, are timber sale prep checklist, timber sale folder check list, timber sale package checklist completed? • Are timber sales reviewed through a plan-in-hand process and signed off by district interdisciplinary team?			
Are treatment silviculture prescriptions completed and signed? • Objectives have been developed in interdisciplinary manner and are clearly delineated? • Objectives are consistent with management direction? • Have silviculturist signed off on desired forest conditions in burn plans?			
Is treatment consistent with design features?			
Are wildlife and botanical surveys, if necessary, complete? In threatened and endangered species habitat, are the actions consistent with the FWS biological opinion?			
Are heritage surveys complete? Is the action consistent with the letter of concurrence from AZ SHPO?			
Are rights-of-way and land line locations in place (if applicable)?			
Are treatments consistent with desired conditions and implantation strategies in the Implementation Plan?			
Has implementation monitoring and adaptive management strategies been documented and used/planned for higher quality outcome?			
Are Road Packages completed for timber sales?			

Section B – Management Direction, Desired Conditions, and Treatment Design

Mexican Spotted Owl Habitat (MSO) Habitat

Protected Activity Center (PAC)

Vegetation Management Direction: Retain key forest species such as Gambel oak; retain key habitat components such as snags and large down logs; generally harvest conifers less than 18 inches in diameter only within those PACs treated to abate fire risk and implement burn only treatments in 100-acre nest cores as described in the MSO recovery plan.

Desired Conditions: Table C.2 (USDI 2012) lists guidance for minimum desired structural elements within PACs. Other key habitat components includes snags greater than 18 inches, down logs greater than 12 inch midpoint diameter, hardwoods, and an understory vegetation layer that includes shrubs and herbaceous species.

Strive for a diversity of patch sizes with minimum contiguous patch size of 2.5 ac with larger patches near activity center; mix of sizes towards periphery. Forest type may dictate patch size (i.e., mixed conifer forests have larger and fewer patches than pine-oak forest). Strive for between patch heterogeneity. Horizontal and vertical habitat heterogeneity within patches, including tree species composition. Patches are contiguous and consist of trees of all sizes, unevenly spaced, with interlocking crowns and high canopy cover. Tree species diversity, especially with a mixture of hardwoods and shade-tolerant species. Diverse composition of vigorous native herbaceous and shrub species.

Opening sizes between 0.1 - 2.5 ac. Openings within a forest are different than natural meadows. Small canopy gaps within forested patches provide for prey habitat diversity. Openings should be small in nest/roost patches, may be larger in rest of PAC. Minimum canopy cover of 40 percent in pine-oak and 60 percent in mixed conifer. Measure canopy cover within stands.

Diversity of tree sizes with goal of having trees ≥16” DBH contributing ≥50 percent of the stand BA.

PAC Mechanical Thin and Burn Treatment Design

Each PAC has 100-acre burn only area, called the core, around the known nest or roost sites.

Outside the 100-acre core burn only area, trees may be thinned and/or prescribed burns may be used to protect habitat, treat fuels and mitigate fuel hazards where feasible.

Prescribed Burning Objectives and Tactics

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired MSO PAC habitat forest structure, tree densities, snag densities, and course woody debris levels.

- Course woody debris would be managed for 3 to 10 tons per acre, and downed logs greater than 12 inch midpoint diameter would be managed for three per acre ≥12 inches. Averages are at the landscape scale;
- 100-acre burn only area around the known nest or roost sites managed for low intensity fire and low forest severity to forest canopy

- Outside the 100-acre core burn only area, treat fuels and mitigate fuel hazards with low intensity fire and moderate to low severity to forest canopy;
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;
- Prescribed burning includes following concurrence and consultation advice from FWS;

Mechanical Thinning Objectives and Tactics

Use mechanize equipment to reduce and remove hazardous live and dead fuel loading;

Design tree thinning treatments to meet desired conditions. Retain and promote large hardwoods such as Gambel oak; other species may be felled to meet desired conditions;

Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff;

Snags greater than 18 inches would be managed for two per acre in ponderosa pine and three per acre in mixed conifer. Averages are at the landscape scale;

Recovery Nesting/Roosting Habitat

Vegetation Management Direction: MSO recovery habitat is defined by the recovery plan and established through FWS consultation. Decision of Rim Country EIS determines where MSO recovery habitat stratification in the project area. Two types of forested recovery nesting/roosting habitat exist it the project: mixed-conifer and pine-oak. 25 percent of mixed-conifer recovery habitat is managed for recovery nesting/roosting habitat. 10 percent of pine-oak recovery habitat is managed for recovery nesting/roosting habitat. Where possible, retain key forest species such as oak, snags and large down logs. Refrain from falling trees 24.1 inches DBH and greater.

Desired Conditions: Table C.2 & C.3 (USDI 2012) lists guidance for minimum desired structural elements within recovery nesting/roosting habitat. Other key habitat components includes snags greater than 18 inches, down logs >12- inch midpoint diameter, hardwoods, and an understory vegetation layer that includes shrubs and herbaceous species. The following represents additional desired conditions from Table C.3 (USDI 2012):

- Basal area for pine-oak recovery nesting/roosting habitat at least 110 ft2 basal area per acre;
- Basal area for mixed-conifer recovery nesting/roosting habitat at least 120 ft2 basal area per acre;
- Basal area by the following size classes: at least 30 percent of the basal area in trees 12-18 in DBH and at least 30 percent of the basal area in trees 18 in DBH or greater;
- Density of 12 trees per acre of trees greater than or equal to 18 inches DBH;

Recovery Nesting/Roosting Habitat Mechanical Thin and Burn Treatment Design

Prescribed Burning Objectives and Tactics:

Prescribed burns will be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired recovery nesting/roosting habitat forest structure, tree densities, snag densities, and course woody debris levels.

- Course woody debris would be managed for 3-10 tons per acre, and downed logs greater than 12 inch midpoint diameter would be managed for three per acre ≥12 inches. Averages are at the landscape scale;
- Prescribed burning management to meet desired condition with low intensity and low to moderate severity to forest canopy;
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;
- Prescribed burning includes following concurrence and consultation advice from FWS;

Mechanical Thinning Objectives and Tactics:

- Use mechanized equipment to reduce and remove hazardous live and dead fuel loading;
- Design tree thinning treatments to meet desired conditions. Retain Gambel oak; remaining species may be felled to meet desired conditions;
- Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff;
- Where possible, manage for the sustainability of large oaks by removing ladder fuels and overtopping trees;
- Snags greater than 18 inches would be managed for two per acre in ponderosa pine and three per acre in mixed conifer. Averages are at the landscape scale;
- Retain trees greater than 24 inches DBH;
- Stands of recovery nesting/roosting habitat that are currently simultaneously meeting conditions in Table C3 of the MSO recovery plan should not go below identified levels.

Recovery Foraging/Non-breeding Habitat

Vegetation Management Direction: MSO recovery habitat is defined by the recovery plan and established through FWS consultation. Decision of Rim Country EIS determines where MSO recovery habitat stratification in the project area. Two types of forested recovery foraging/non-breeding habitat exist it the project: mixed-conifer and pine-oak. These areas are mixed-conifer and pine-oak stands that are outside of PACs and recovery nesting/roosting habitat. MSO habitat management overrides other habitat management such as with goshawk habitat overlap. Manage to desired conditions appendix C in the revised MSO recovery plan (USDI 2012).

Desired Conditions: Sustainable uneven aged stand structure. Improved forest health by an immediate reduction of risk of bark beetle attacks and/or reduction of dwarf mistletoe stand severity and landscape intensity to historical levels. Sustainable horizontal and vertical stand structure diversity. Sustainable amount of key habitat components such as snags greater than 18 inches, down logs greater than 12-inch midpoint diameter, shade, old age trees and hardwoods.

Recovery Foraging/Non-breeding Habitat Mechanical Thin and Burn Treatment Design

Prescriptions should strive to maintain conditions for key habitat components (snags, logs, shade, and old trees) while achieving management objectives such as fuels reduction and ecosystem sustainability.

Prescribed Burning Objectives and Tactics:

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired recovery foraging/non-breeding habitat forest structure, tree densities, snag densities, and course woody debris levels.

- Course woody debris would be managed for 3 to 10 tons per acre, and downed logs greater than 12 inch midpoint diameter would be managed for three per acre ≥12 inches. Averages are at the landscape scale;
- Prescribed burning management for low to moderate intensity fire with low to moderate severity to forest canopy;
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;
- Prescribed burning includes following concurrence and consultation advice from FWS;

Mechanical Thinning Objectives and Tactics:

Design tree thinning treatments to meet desired conditions. Retain Gambel oak; other tree species may be felled to meet desired conditions;

Silviculture objectives include improve and maintain forest health conditions, maintain and increase tree species diversity, improve understory grass/forb diversity, create and maintain a sustainable uneven aged forest environment and reduce tree densities to facilitate low fire intensities that could occur during severe fire weather conditions.

Use mechanize equipment to reduce and remove hazardous live and dead fuel loading;

Manage for tree groups of dominate age classes stratified by young, mid-aged, and old-aged tree groups. Retain groups of dominate and codominant trees. Where age or size class diversity is not present, management activities should strive to encourage horizontal and vertical diversity.

In general, manage for tree groups with grassy interspaces or random tree spacing. Site level determination based on soil types, habitat type and regeneration rates shall confirm the proper determination to create or not create grassy interspaces. Stand level target basal area of 40 to 70 ft2 BA/acre in recovery foraging/non-breeding habitat for ecosystem resiliency; pine-oak stands could have group basal areas represent 40 to 110 ft2 BA/acre; mixed conifer stands could have group basal areas represent 40 to 135 ft2 BA/acre. Gambel oak, juniper, and pinyon species greater than 5-inch DRC may be considered as residual trees in the target group spacing and stocking. The objective is to manage for a sustainable range of density and structural characteristics.

Silviculture cutting systems include uneven aged thinning, intermediate thinning or stand improvement thinning. Soil types, current condition and historical reference conditions guide the type of silviculture cutting system.

In moderate and heavy dwarf mistletoe infection centers prescribe an intermediate thinning (IT) treatment that retains full stocking densities of trees. Retain the dominant and codominant trees with the least amount of mistletoe. Reduce the amount of release to the residual stand where mistletoe exist.

Activity and residual slash may be removed, lopped and scattered or piled to burn in place;

Where possible, manage for the sustainability of large oaks by removing ladder fuels and overtopping trees;

Snags greater than 18 inches would be managed for two per acre in ponderosa pine and three per acre in mixed conifer. Averages are at the landscape scale;

Retain all trees greater than 24 inches DBH unless the tree is considered a hazard to public safety

Northern Goshawk Habitat

Post-Fledging Family Area (PFA)

Vegetation Management Direction: Northern Goshawk (goshawk) habitat is stratified into nesting areas, post- fledging family areas and foraging areas. Goshawk foraging areas are managed in the general Ponderosa Pine and other forest desired conditions and do not pertain to this section. Nest areas are within post- fledging family areas. Goshawk post- fledging family areas, approximately 420 acres in size, and nest areas, 30 acres in size. These habitats are determined by historical nesting locations and are analyzed in the Rim Country EIS. Goshawk post- fledging family areas and nest areas could be identified in future surveys.

Management for goshawk post-fledging family areas are similar to the general Ponderosa Pine forest conditions, except post-family fledging areas generally are managed to contain 10 to 20 percent higher basal area in mid-aged to old tree groups. Nest area management needs to have dense canopies of mid-age and old trees. Prescribed fire treatments are low intensity and low severity fire to tree canopies. Other treatment to meet stand level objectives and desired conditions include silviculture management systems with the use of mechanize equipment and hand thinning.

Desired Conditions: Goshawk post-fledging family areas may contain 10 to 20 percent higher basal area in mid-aged to old tree groups or random tree spacing than goshawk foraging areas and the surrounding forest. Goshawk nest areas have forest conditions that are multi-aged and dominated by large trees with relatively denser canopies than the surrounding forest.

Goshawk Post Fledging Family Area Mechanical Thin and Burn Treatment Design

Prescribed Burning Objectives and Tactics:
Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired goshawk nest habitat forest structure, tree densities, snag densities, and course woody debris levels.

- Course woody debris would be managed for 3-10 tons per acre, and downed logs greater than 12 inch midpoint diameter would be managed for three per acre ≥12 inches. Averages are at the landscape scale;
- 30 acre nesting area around the known nest or roost sites are managed for low intensity fire and low severity to forest canopy;
- Outside the 30 acre nesting area within the 420 acre post-fledging family area, treat fuels and mitigate fuel hazards with low intensity fire and moderate to low severity to forest canopy;
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;

Mechanical Thinning Objectives and Tactics:
Design tree cutting treatments to meet desired conditions. Retain Gambel oak; all other species may be felled to meet desired conditions;

- Silviculture objectives in goshawk post-fledging family areas include improve and maintain forest health conditions, maintain and increase tree species diversity, improve understory grass/forb diversity, create and maintain a sustainable uneven aged forest environment and reduce tree densities to facilitate low fire intensities that could occur during severe fire weather conditions. Maintain higher densities within mid aged and old aged trees;
- In general, nest stands will receive a low thinning treatment. Use mechanize equipment to reduce and remove hazardous live and dead fuel loading;
- Manage for uneven aged structure, stratified by young, mid-aged, and old-aged trees (grouped or random). Retain groups of dominant and codominant trees. Where age or size class diversity is not present, management activities should strive to encourage vertical diversity;
- In general, tree group density would be managed at higher group densities within mid-aged and old aged tree groups when group selection treatments are implemented. Young tree groups are managed to maintain tree stocking necessary to provide for desired future mid age and old age group densities;
- When group selection treatments are implemented, residual tree groups, on average, would range in size from 0.1 to 1 acre. Group size would vary within this range depending on site quality, existing stand structure, and pre-settlement tree evidence. Abiotic factors such as aspect, drainages and slope are other field determinations made for prescribing tree group sizes;
- When group selection treatments are implemented, manage for tree groups with grassy interspaces. Site level determination based on soil types, habitat type and regeneration rates shall confirm the proper determination to create or not create grassy interspaces. Gambel oak, juniper, and pinyon species greater than 5-inch DRC may be considered as residual trees in the target group spacing and stocking. The objective is to manage for a sustainable range of density and structural characteristics;
- Silviculture cutting systems include group selection with intermediate treatments, intermediate treatments only or individual tree selection. Even aged cutting systems may be used to improve forest health while meeting desired conditions. Soil types, current condition and historical reference conditions guide the type of silviculture cutting system;
- In moderate and heavy dwarf mistletoe infection centers, prescribe an intermediate thinning (IT) treatment that retains full stocking densities of trees. Retain the dominant and codominant trees with the least amount of mistletoe. Reduce the amount of release to the residual stand where mistletoe exist.
- Mistletoe free trees within the dominant and codominant crown position would have priority for retention. Where age class diversity is not present, 1 to 10 suppressed and intermediate trees per group could be retained for vertical diversity.
- Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff;
- Where possible, manage for the sustainability of large oaks by removing ladder fuels and overtopping trees;

- Snags greater than 18 inches would be managed for two per acre in ponderosa pine. Snag creation is not necessary. Select slow dying top killed trees that are greater than 18 inches DBH for retention to promote snag recruitment. Averages are at the landscape scale;

Goshawk Post Fledging Family Area Mechanical Thin Silviculture Prescription

Prescriptions are developed based on silviculture systems and management schemes. Uneven aged (UEA), Intermediate Treatment (IT) and Stand Improvement (SI). The prescriptions abbreviated for goshawk post fledging family areas (PFA) are the following: PFA UEA40-55, PFA UEA25-40 and PFA UEA10-25. The numbers next to the abbreviated prescription represent the intensity of interspace and openness created from the prescription.

PFA UEA40-55, PFA UEA25-40, PFA and UEA10-25 represent uneven-age silviculture systems (group selection and individual tree selection). These stand level prescriptions would be used to establish grass forb interspace between tree groups, thin tree groups, and establish regeneration areas. Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 108.

Table 108. Desired Condition of tree groups and interspaces for PFA UEA treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
UEA40	45–60%	40–55%	55'–70'	60-80 ft^2
UEA25	60–75%	25–40%	40'–55'	65-85 ft^2
UEA10	75–90%	10–25%	25'–40'	70-90 ft^2

Approximate interspace width between tree groups would average from 25 to 70 feet with a maximum width of 200 feet. Table D-2 Displays average interspace width depending on prescription.

Regeneration openings (group selection) account for 10 to 20 percent of tree groups. They would average 0.25 to 1 acre and would be no larger than 2 acres. Regeneration openings are irregular shape and size. They would only be established by removing most abundant tree size classes and/or where tree health compromised by bark beetles or dwarf mistletoe. Avoid retaining dwarf mistletoe infected trees in or around regeneration areas.

Priority for regeneration openings would surround healthy vigorous advanced regeneration. Regeneration openings would be created adjacent to tree groups and would not be surrounded by interspace. Regeneration areas need to be large enough and placed appropriately to be resilient to low severity fires. In general, ponderosa pines are resilient to low severity fires after approximately 10 years of age. Where advanced regeneration is not present, retain seed trees arranged in groups in openings greater than an acre in size.

Treatments would strive to attain an overall average density of 70 to 80 square feet of BA per acre outside of regeneration areas.

PFA IT 40 PFA IT 25 and PFA IT10 represent intermediate treatments. These treatments would be used to establish interspace between individual trees and tree groups and thin tree groups within post family fledging areas with moderate and high dwarf mistletoe infection Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 109.

Table 109. Desired condition of tree groups and interspaces for PFA IT Treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
IT40	45–60%	40–55%	60'–80'	60-80 ft^2
IT25	60–75%	25–40%	40'–60'	65-85 ft^2
IT10	75–90%	10–25%	25'–40'	70-90 ft^2

Approximate interspace width between tree groups would average from 25 to 80 feet with a maximum width of 200 feet. Table 109 Displays average interspace width depending on prescription.

Treatments would strive to attain an overall average density of 70 to 90 square feet of BA per acre outside of regeneration areas.

PFA SI40 PFA SI25 and PFA SI10 represent thinning for stand improvement. These treatments would be used to establish interspace between tree groups and thin tree groups within PFA even-age sites and/or stand dominated by young aged trees. Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 110.

Table 110. Desired condition of tree groups and interspaces for PFA SI treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
SI40	45–60%	40–55%	60'–80'	60-80 ft^2
SI25	60–75%	25–40%	40'–60'	65-85 ft^2
SI10	75–90%	10–25%	25'–40'	70-90 ft^2

Interspace width between tree groups would average from 25 to 80 feet with a maximum width of 200 feet. Table D-4 Displays average interspace width depending on prescription. Some stands, desired conditions for SI treatments can be achieved through non-commercial thinning and spacing guidelines. The main objective would be to create resiliency to fire while growing the stand to meet desired conditions into the future. Other objectives include reducing individual tree competition and selecting quality formed trees for retention.

Ponderosa Pine Forests

Outside of Mexican Spotted Owl Habitat and Landscapes outside of Goshawk PFAs

Vegetation Management Direction: Ponderosa pine forest pertaining to this section is stratified outside of MSO habitat and goshawk PFAs. Please refer to previous sections for MSO habitat and goshawk PFA for direction. Some goshawk foraging areas are managed in the general Ponderosa Pine.

Ponderosa Pine forest are managed for uneven-aged forest conditions. Uneven aged forest conditions include young, mid-aged and old aged trees. Prescribed fire treatments are low intensity and low severity fire to tree canopies. Other treatment to meet stand level objectives and desired conditions include silviculture management systems with the use of mechanize equipment including hand thinning.

Desired Conditions

Landscape Scale

- The ponderosa pine forest is a mosaic of structural states ranging from young to old trees. Forest structure is variable but uneven-aged and open in appearance. Sporadic areas of even-aged structure may be present on 10 percent or less of the landscape to provide structural diversity.
- The forest arrangement consists of individual trees, small clumps, and groups of trees with variably-sized interspaces of grasses, forbs, and shrubs. Vegetation associations are similar to reference conditions. The size, shape, and number of trees per group and the number of groups per area vary across the landscape. Tree density may be greater in some locations, such as north-facing slopes and canyon bottoms.
- The ponderosa pine forest is composed predominantly of vigorous trees, but declining, top-killed, lightning-scarred, and fire-scarred trees provide snags and coarse woody debris. Snags and coarse woody debris are well distributed throughout the landscape. Ponderosa pine snags are typically 18 inches or greater in diameter and average 1 to 2 per acre.
- Coarse woody debris, including logs, ranges from 3 to 10 tons per acre. Logs average 3 per acre within the forested area of the landscape.
- Where it naturally occurs, Gambel oak is present with all age classes represented. It is reproducing to maintain or expand its presence on capable sites across the landscape. Large Gambel oak snags are typically 10 inches or larger in diameter and are well distributed.
- Grasses, forbs, shrubs, needles, leaves, and small trees support the natural fire regime.
- Old growth occurs throughout the landscape, in small, discontinuous areas consisting of clumps of old trees, or occasionally individual old trees. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).
- Frequent, low to mixed severity fires, occurring approximately every 2 to 17 years.

Midscale

- Ponderosa pine forest is characterized by variation in the size and number of tree groups depending on elevation, soil type, aspect, and site productivity. The more biologically productive sites contain more trees per group and more groups per area, resulting in less space between groups. Interspaces typically range from 10 percent in more biologically productive sites to 70 percent in the less productive sites. Tree density within forested areas ranges from 20 to 80 square feet basal area per acre.
- The tree group mosaic composes an uneven-aged forest with all age classes, size classes, and structural stages present. Occasionally, patches of even-aged forest structure are present (less than 50 acres). Disturbances sustain the overall age and structural distribution.
- Fires burn primarily on the forest floor and do not spread between tree groups as crown fire.
- Forest structure in the wildland-urban interface (WUI) may have smaller, more widely spaced groups of trees than in the non-WUI areas.

Fine scale

- Trees typically occur in irregularly-shaped groups and are variably spaced with some tight clumps. Tree crowns in the mid- to old-aged groups are interlocking or nearly interlocking.
- Interspaces surrounding tree groups are variably shaped and composed of a grass, forb, and shrub mix. Some may contain individual trees or snags.

- Trees within groups are of similar or variable ages and may contain species other than ponderosa pine. Tree groups are typically less than 1 acre and average ½ acre. Mid- to old-aged tree groups consist of approximately 2 to 40 trees with interlocking canopies.
- Where Gambel oak occurs, the majority are single trunk trees over 8 inches in diameter with full crowns.

Ponderosa Pine Forest Mechanical Thin and Burn Treatment Design

Prescribed Burning Objectives and Tactics:

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired forest structure, tree densities, snag densities, and course woody debris levels.

- A mix of prescribed fire intensities and severities to forest crowns would be used to meet desired conditions.
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;

Mechanical Thinning Objectives and Tactics:

Design tree cutting treatments to meet desired conditions. Retain Gambel oak; other tree species may be felled to meet desired conditions;

- Silviculture objectives include improve and maintain forest health conditions, maintain and increase tree species diversity, improve understory grass/forb diversity, create and maintain a sustainable uneven aged forest environment and reduce tree densities to facilitate low fire intensities that could occur during severe fire weather conditions. Maintain higher densities within mid aged and old aged tree groups;
- Use mechanize equipment to reduce and remove hazardous live and dead fuel loading in coordination with fire/fuels staff to see if the amount and arrangement of fuel loading left behind is appropriate for prescribed burning as well as does not present a safety concern for wildfire;
- Manage for uneven-aged structure stratified by young, mid-aged, and old-aged tree (grouped or random). Retain groups of dominate and codominant trees. Where age or size class diversity is not present, management activities should strive to encourage vertical diversity;
- In general, tree group density would be managed at higher group densities within mid-aged and old aged tree groups when group selection treatments are implemented. Young tree groups are managed to maintain tree stocking necessary to provide for desired future mid age and old age group densities;
- When group selection treatments are implemented, residual tree groups, on average, would range in size from 0.1 to 1 acre. Group size would vary within this range depending on site quality, existing stand structure, and pre-settlement tree evidence. Abiotic factors such as aspect, drainages and slope are other field determinations made for prescribing tree group sizes;
- When group selection treatments are implemented, manage for tree groups with grassy interspaces. Site level determination based on soil types, habitat type and regeneration rates shall confirm the proper determination to create or not create grassy interspaces. Gambel oak, juniper, and pinyon

species greater than 5-inch DRC may be considered as residual trees in the target group spacing and stocking. The objective is to manage for a sustainable range of density and structural characteristics;

- Silviculture cutting systems include group selection with intermediate treatments, intermediate treatments only or individual tree selection. Even aged cutting systems may be used to improve forest health while meeting desired conditions. Soil types, current condition and historical reference conditions guide the type of silviculture cutting system;
- In moderate and heavy dwarf mistletoe infection centers where regeneration areas would not meet the desired conditions, prescribe an intermediate thinning (IT) treatment. Retain the dominant and codominant trees with the least amount of mistletoe. Mistletoe free trees within the dominant and codominant crown position would have priority for retention. Where age class diversity is not present, 1 to 10 suppressed and intermediate trees per group would be retained for vertical diversity.
- Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff;
- Where possible, manage for the sustainability of large oaks by removing ladder fuels and overtopping trees;
- Snags greater than 18 inches would be managed for two per acre in ponderosa pine. Snag creation is not necessary. Select slow dying top killed trees that are greater than 18 inches DBH for retention to promote snag recruitment. Averages are at the landscape scale;
- Savanna prescriptions are scattered within ponderosa pine forest. These prescriptions would restore pre-settlement tree density and pattern using pre-settlement evidence as guidance. Generally, these areas are open with a reference condition of 10 to 30 percent of tree canopy;
- Savanna prescriptions would retain all pre-settlement trees and the largest post-settlement trees that most closely resemble old trees in size and form as replacement trees adjacent to pre-settlement tree evidences at a 1:1 ratio. Some younger trees would also be retained to maintain uneven-aged structure.
- Generally, savanna prescriptions manage for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individuals. Amount of interspace would vary within this range depending on reference conditions. Juniper and pinyon species in the seedling/sapling, young, and mid-aged stages would generally be removed except where needed as replacements for pre-settlement trees.

Ponderosa Pine Forest Mechanical Thin Silviculture Prescription

Prescriptions are developed based on silviculture systems and management schemes. Uneven aged (UEA), Intermediate Treatment (IT) and Stand Improvement (SI). The prescriptions abbreviated are for ponderosa pine forest are the following: UEA 40-55, UEA 25-40 and UEA 10-25. The numbers next to the abbreviated prescription represent the intensity of interspace and openness created from the prescription. Same principles apply to some dry mixed conifer stands.

UEA 40-55, UEA 25-40 and UEA 10-25 represent uneven-age silviculture systems (group selection and individual tree selection). These stand-level prescriptions would be used to establish grass forb interspace between tree groups, thin tree groups, and establish regeneration areas. Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 111.

Table 111. Desired condition of tree groups and interspaces for UEA treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
UEA40-55	45–60%	40–55%	60’-100’	40-60 ft^2
UEA25-40	60–75%	25–40%	40’-60’	45-65 ft^2
UEA10-25	75–90%	10–25%	25’-40’	50-70 ft^2

Approximate interspace width between tree groups would average from 25 to 120 feet with a maximum width of 200 feet. Table D-5 Displays average interspace width depending on prescription.

Regeneration openings (group selection) account for 10 to 20 percent of tree groups. They would average 0.25 to 1 acre and would be no larger than 2 acres. Regeneration openings are irregular shape and size. They would only be established by removing most abundant tree size classes and/or where tree health compromised by bark beetles or dwarf mistletoe. Avoid retaining dwarf mistletoe infected trees in or around regeneration areas.

Priority for regeneration openings would surround healthy vigorous advanced regeneration. Regeneration openings would be created adjacent to tree groups and would not be surrounded by interspace. Regeneration areas need to be large enough and placed appropriately to be resilient to low severity fires. In general, ponderosa pines are resilient to low severity fires after approximately 10 years of age. Where advanced regeneration is not present, retain seed trees arranged in groups in openings greater than an acre in size.

Treatments would strive to attain an overall average density of 40 to 70 square feet of BA per acre outside of regeneration areas.

IT 40, IT 25 and IT 10 represent intermediate treatments. These treatments would be used to establish interspace between individual trees and tree groups and thin tree groups within post family fledging areas with moderate to high dwarf mistletoe infection Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 112.

Table 112. Desired condition of tree groups and interspaces for IT treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
IT40	45–60%	40–55%	60'–80'	40-60 ft^2
IT25	60–75%	25–40%	40'–60'	45-65 ft^2
IT10	75–90%	10–25%	25'–40'	50-70 ft^2

Approximate interspace width between tree groups would average from 25 to 80 feet with a maximum width of 200 feet. Table 112 Displays average interspace width depending on prescription.

Treatments would strive to attain an overall average density of 40 to 70 square feet of BA per acre outside of regeneration areas.

SI40, SI25 and SI10 represent thinning for stand improvement. These treatments would be used to establish interspace between tree groups and thin tree groups within even-age sites and/or stand dominated by young aged trees. Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 113.

Table 113. Desired condition of tree groups and interspaces for SI treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
SI40	45–60%	40–55%	60'–80'	40-60 ft^2
SI25	60–75%	25–40%	40'–60'	45-65 ft^2
SI10	75–90%	10–25%	25'–40'	50-70 ft^2

Interspace width between tree groups would average from 25 to 80 feet with a maximum width of 200 feet. Table D-7 Displays average interspace width depending on prescription. Some stands, desired conditions for SI treatments can be achieved through non-commercial thinning and spacing guidelines. The main objective would be to create resiliency to fire while growing the stand to meet desired conditions into the future. Other objectives include reducing individual tree competition and selecting quality formed trees for retention.

Aspen Stands or Inclusions in Mixed Conifer Forests

Vegetation Management Direction: Management activities that kill or stress overstory trees may be used since they mimic natural disturbances and enhance aspen regeneration. Aspen restoration efforts may include removing conifer competition and fencing to exclude ungulates.

Desired Conditions: Aspen is successfully regenerating and recruiting into older and larger size classes. Size classes have a natural distribution, with the greatest number of stems in the smallest classes. Coniferous species comprise less than 10 percent of the overstory.

Landscape Scale

- Areas of aspen occur and shift across the forested landscape. They are successfully regenerating and being recruited into older and larger size classes. Size classes have a natural distribution, with the greatest number of stems in the smaller size classes.

Mid-scale

- Aspen may compose 10 to 100 percent of the area depending on disturbance (e.g., fire, insects, silvicultural treatments) in multistoried patches.
- As an early seral species, aspen reproduction and recruitment benefit from low severity surface fires.

Aspen Mechanical Thin and Burn Treatment Design

Inclusions of aspen remnants within portions of other forested areas would be regenerated by removing all post-settlement conifers from within 100 feet of the aspen clone. Some removal of aspen within the clone as well as ground-disturbing activity or burning may occur to stimulate suckering.

Treatments for aspen clones would meet desired conditions. Silvicultural cutting treatments include weeding other coniferous trees to reduce competition and protection of regeneration through jackstraw, fencing, and coppice cutting and planting.

Each clone would be evaluated as to need for fencing or creation of other barriers to reduce ungulate browsing of regenerating aspen.

Prescribed burns may be used where and when feasible to treat fuels, mitigate fuel hazards, and to produce effects that stimulate aspen suckering and regeneration, and growth of native herbaceous vegetation. Inclusions of aspen remnants within portions of ponderosa pine stands could be regenerated by prescribed burning to stimulate suckering.

Prescribed burns are designed to reduce post-settlement conifer stocking within 100 feet of the aspen clone and disturb the site with sufficient intensity to encourage aspen regeneration.

Piñon-juniper Woodlands

Vegetation Management Direction: Manage for uneven-age conditions to sustain a mosaic of vegetation densities (overstory and understory), age classes, and species composition well distributed across the landscape. Provide for reserve trees, snags, and down woody debris.

Desired Conditions: Mosaic of young and mature, species diverse patches of trees interspersed with interspace across the landscape to promote the growth grasses and herbaceous understory species. Mature patches would be structurally diverse, containing large live and dead standing trees as well as trees with dead or broken tops, gnarls, and burls. The structure and composition reflects the natural range of variation.

Landscape Scale

- A mix of desired species, ages, heights, and groupings of trees create a mosaic across the landscape.
- In persistent PJ woodlands, tree canopy cover is closed (greater than 30 percent), shrubs are sparse to moderate, and herbaceous cover is patchy.
- PJ savanna is open in appearance with trees occurring as individuals or in small groups and ranging from young to old. Overall, tree canopy cover is 10 to 15 percent, but may range up to 30 percent.
- Snags, averaging one to two per acre, and older trees with dead limbs and tops are scattered across the landscape. Coarse woody debris averages 2 to 5 tons per acre.
- Old growth includes old trees, dead trees (snags), downed wood (coarse woody debris), and/or structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).
- Fire is less frequent and more variable than in the savanna due to patchiness of ground cover. The fires that do occur are mixed to high severity.

Mid-scale

- Grass and forb cover is maximized, based on site capability, to protect and enrich soils.

Piñon-juniper Woodland Mechanical Thin and Burn Treatment Design

Prescribed Burning Objectives and Tactics:

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired forest structure, tree densities, snag densities, and course woody debris levels.

- Prescribed fire intensity and severity to forest crowns would be used to meet desired conditions.
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;

Mechanical Thinning Objectives and Tactics:
Design tree thinning treatments to meet desired conditions. All tree species may be felled to meet desired conditions;

- Silviculture objectives include creating woodland conditions to facilitate future prescribed fire desired conditions. Other objectives would improve and maintain forest health conditions, maintain and increase tree species diversity, improve vigor in pinyon pine species and improve understory grass/forb diversity;
- Use mechanize equipment and fuelwood activities to reduce and remove hazardous live and dead fuel loading;
- In general, manage for tree groups with grassy interspaces to meet desired conditions.
- Silviculture cutting systems may include group selection with intermediate treatments, intermediate treatments only or individual tree selection. Even aged cutting systems may be used to improve forest health while meeting desired conditions. Soil types, current condition and historical reference conditions guide the type of silviculture cutting system;
- Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff.
- Savanna prescriptions within woodland the landscape would restore pre-settlement tree density and pattern using pre-settlement evidence as guidance. Generally, these areas are open with a reference condition of 10 to 30 percent of tree canopy;
- Savanna prescriptions would retain all pre-settlement trees and the largest post-settlement trees that most closely resemble old trees in size and form as replacement trees adjacent to pre-settlement tree evidences at a 1:1 ratio. Some younger trees would also be retained to maintain uneven-aged structure.
- Generally, savanna prescriptions manage for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individuals. Amount of interspace would vary within this range depending on reference conditions. Juniper and pinyon species in the seedling/sapling, young, and mid-aged stages would generally be removed except where needed as replacements for pre-settlement trees.

Grasslands

Vegetation Management Direction: Reduce conifer encroachment within grasslands as identified by mollisol soils.

Desired Conditions: Restore historic grassland/forest edge as indicated by existing pre- settlement conifers and evidence of pre-settlement conifers.

Landscape

- Perennial herbaceous species dominate and include native grasses, grass-like plants (sedges and rushes), and forbs, and in some locations, a diversity of shrubs.

- Herbaceous vegetation and litter provide for and maintain the natural fire regime.
- In montane/subalpine grasslands it ranges from approximately 2 to 400 years, depending on the adjacent forested Forest type.
- Landscapes associated with montane/subalpine grasslands vary from natural appearing where human activities do not stand out (high scenic integrity) to unaltered where only natural ecological changes occur (very high scenic integrity).

Mid-scale

- Woody (tree and shrub) canopy cover is less than 10 percent.

Prescribed Burning Objectives and Tactics:

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing reducing tree densities to desired conditions. Prescribed fires are designed to maintain and enhance grassland conditions.

- Prescribed fire intensity and severity to tree crowns would be used to meet desired conditions.
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;

Mechanical Thinning Objectives and Tactics:

Design tree thinning treatments to meet desired conditions. All tree species may be felled to meet desired conditions;

- Silviculture objectives include creating woodland conditions to facilitate future prescribed fire desired conditions. Other objectives would improve and maintain forest health conditions, maintain and increase tree species diversity, improve vigor in pinyon pine species and improve understory grass/forb diversity;
- Use mechanized equipment and fuelwood activities to reduce and remove hazardous live and dead fuel loading;
- In general, manage for tree groups with grassy interspaces to meet desired conditions.
- Silviculture cutting systems may include group selection with intermediate treatments, intermediate treatments only or individual tree selection. Even aged cutting systems may be used to improve forest health while meeting desired conditions. Soil types, current condition and historical reference conditions guide the type of silviculture cutting system;
- Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff.
- Treatments are designed to promote and reestablish the historic meadow edge as defined by pre-settlement trees and evidences and the current forest structure of young trees encroaching on the edge of the grassland.
- Tree group arrangement, size, and density are a function of existing pre-settlement trees and evidence. Retain all pre-settlement trees and the largest post-settlement trees that most closely resemble old trees in size and form as replacement trees adjacent to pre-settlement tree evidences at a 1:1 ratio.

Section C – Old Tree Implementation Plan

Old Tree Descriptions and Illustrations

Old trees would be retained, with few exceptions, regardless of their diameter, within the Rim Country analysis area. Removal of old trees would be rare. Exceptions would be made for threats to human health and safety, and those rare circumstances where the removal of an old tree is necessary in order to prevent additional habitat degradation. Old trees would not be cut for forest health reasons or to balance age or size class distributions.

Threats to human health and safety would include hazard trees as defined by Forest Service Manual and Forest service Handbook Direction (currently FSM 2332.1, FSM 2332.11, and FSH 7709.59). A hazard tree is defined as a tree that has both a structural defect that increases the chance of a tree or its parts to fail and a target (people, buildings, cars, etc.) would be hit when the tree fails.

One example of a situation where the removal of an old tree is necessary in order to prevent additional habitat degradation is in the rare case of an old tree growing on the side of an existing curve in a road. Hauling equipment may require a wider turning radius. The options are to relocate the road or cut the old tree and widen the curve to accommodate the larger turning radius. Relocating the road would result in a larger area of the forest being permanently disturbed, versus the large tree and widening the curves radius. This is an example where cutting the old tree would result in less habitat degradation then relocating a road.

This old tree implementation plan will be applied to the Rim Country Environmental Impact Statement Record of Decision and may not apply to subsequent decisions on the same project area or on other areas within Region 3. Subsequent decisions may include an old tree implementation plan that reflects project specific current conditions and the purpose and needs of subsequent projects.

Old Tree Descriptions and Illustrations - Old trees will be determined by the following characteristics described in Figure D-1:

- Age –Established prior to 1870, predating Euro-American settlement.
- D.B.H. – Site dependent. Old trees on higher productivity sites would likely have larger diameters than old trees on lower productivity sites
- Bark – Ranging from reddish brown, shading to black in the top with moderately large plates between the fissures to reddish brown to yellow, with very wide, long, and smooth plates.
- Tops – Ranging from pyramidal or rounded (occasionally pointed) to flat (making no further height growth).
- Branching – Ranging from upturned in upper third of the crown, horizontal in the middle third, and drooping in the lower third of the crown to mostly large, drooping, gnarled, or crooked. Branch whorls range from incomplete and indistinct except at the top to completely indistinct and incomplete.

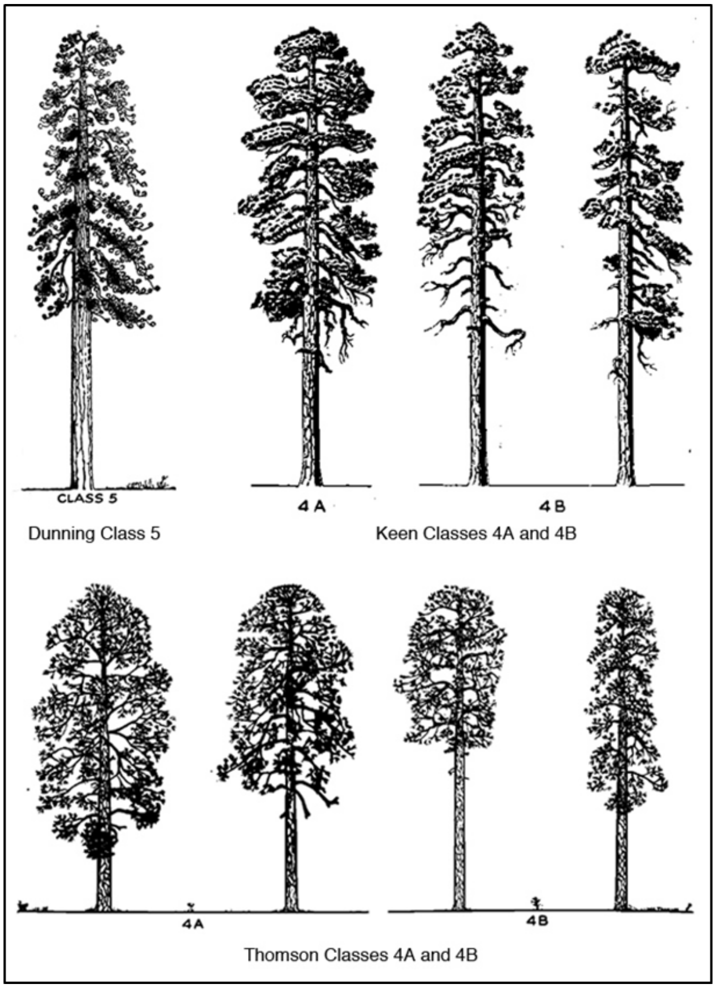

Figure 94. Illustrations of mature size classes derived from Dunning (1928), Keen (1943), and Thompson (1940)

Ponderosa Pine Age Class Descriptions

Dunning (1928) Age Class 5: Overmature; usually largest trees in stand; bark light yellow with wide, long and smooth plates; tops flat with terminals rarely discernable; nearly all branches are drooping, gnarled, and crooked.

Keen (1943) Age Class 4: Overmature; making no further height growth; diameter growth very slow; bark light yellow, uniform for entire bole (except in extreme top), with wide, long and smooth plates and often shallow fissures; tops usually flat or occasionally rounded or irregular; branches large, heavy, and often gnarled or crooked and mostly drooping except in extreme top.

Thomson (1940) Age Class 4: Mature-overmature; trees usually large; bark reddish-brown to yellow with wide, long and smooth plates; tops usually flat and making no further height growth; branches mostly large and drooping, gnarled or crooked.

Thompson (1940) Age Class 3: Intermediate-mature; bark reddish brown shading to black in the top with moderately large plates between the fissures; tops usually pyramidal or rounded, occasionally pointed; branches upturned in top third of crown, those in the middle horizontal and drooping in the lower third

Section D – Large Tree Implementation Plan

The large tree implementation plan is designed to inform implementation. The plan's ecological objectives are consistent with the desired conditions found in the three Rim Country forest plans as well as the enacting language of the Collaborative Forest Landscape Restoration Program "maximizing the retention of large trees, as appropriate for the forest type, to the extent that the trees promote fire-resilient stands." (Omnibus Public Land Management Act of 2009).

For the purpose of this document, large post-settlement trees, as defined by the socio-political process, are those that are 16-inch DBH or larger. Groups of trees greater than or equal to 18-inch DBH represent the largest and (sometimes) oldest trees. These size classes best correspond with the successional stage classification system that was developed to address the forest dynamics of southwestern ponderosa pine.

This plan may not include every instance where large post-settlement trees may be removed. There may be additional areas and/or circumstances where large post-settlement trees need to be removed in order to achieve restoration objectives. During implementation (prescription development), if there is a condition where forest plan desired conditions conflict with the exception condition categories listed below, no large trees would be felled until the NEPA decision is reviewed by the District. The District would decide whether the action is consistent with the analysis and the decision made. The exception categories for falling large trees are listed below.

Seeps and Springs

Seeps are locations where surface-emergent groundwater causes ephemeral or perennial moist soil or bedrock. Standing or running water is infrequent or absent. Vegetation and other biological diversity are adapted to mesic habitat with moist, adequate soil moisture. Springs are small areas where surface-emergent groundwater causes ephemeral or perennial standing or running water and wet or moist soils. Vegetation and other biological diversity are adapted to mesic habitat or aquatic environments (Feth and Hem 1963).

Seeps and springs exhibit unique, often isolated biophysical conditions that can sustain unique, mesic-adapted biological diversity, and can facilitate endemism and speciation. Springs also provide water and other habitat to terrestrial wildlife. In the late 1800s, unsustainable livestock grazing practices significantly reduced herbaceous cover, reducing competition pressure on pine seedlings. Coupled with the onset of fire suppression in the early 1900s, pine trees rapidly encroached and recruited into native grasslands (e.g., Moore and Huffman 2004, Coop and Givnish 2007). This cause and effect relationship allowed for an increase in pine tree development. Due to the absence of frequent fires and the presence of livestock grazing, the establishment of large post-settlement trees may reduce available soil moisture (Simonin et al. 2007) and block the sunlight necessary to support the unique biophysical conditions associated with seeps and springs.

Removal of trees that have encroached upon seeps and springs may constitute a relatively small part of an overall seep and spring restoration effort, when compared to fully addressing root causes of overall degradation. Thinning alone, without addressing other sources of degradation, is unlikely to fully restore seeps and springs (Thompson et al. 2002). However, it is a necessary step leading to the restoration of these ecologically important areas.

Ecological Objectives

- The biophysical conditions in seeps and springs upon which terrestrial, mesic-adapted, and aquatic native biological diversity depend are conserved and restored.

- The integrity of the spring's unique biophysical attributes is not compromised by tree rooting and shading.
- Mesic habitats associated with a seep or spring are not encroached upon by conifers.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.

Riparian

Riparian areas occur along ephemeral or perennial streams or are located downgradient of seeps or springs. These areas exhibit riparian vegetation, mesic soils, and/or aquatic environments.

Riparian areas exhibit unique biophysical conditions that can sustain unique, mesic-adapted, or aquatic biological diversity. Riparian areas and the streams, springs, and seeps connected to them often harbor imperiled species that can be sources of endemism. Riparian areas also provide water and other habitat to terrestrial and aquatic wildlife. In the absence of frequent fires and in the presence of other competing factors, large post-settlement trees may have become established and grown within riparian areas to the point that they compromise available soil moisture or light that support the unique biophysical conditions that are associated with the riparian areas. Conifer trees encroaching into riparian zones of any size may need to be removed to retain or improve riparian vegetation and condition

Ecological Objectives

- The biophysical conditions in riparian habitat upon which terrestrial and aquatic native biological diversity depends are conserved and restored.
- The use of soil and water best management practices (BMPs) minimize the impacts of removing trees within riparian areas.
- Removal of trees constitutes a relatively small part of an overall riparian area restoration effort, when compared to the fundamental causes of overall degradation. Riparian areas are fully restored by using an array of tools that address all sources of degradation.
- Available soil moisture or light that support that area's unique biophysical conditions is not compromised by growing (rooted) trees.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.
- Post-treatment snags and logs that include large trees are available onsite.

Wet Meadows

High elevation streamside or spring-fed meadows occur in numerous locations throughout the Southwest. However, less than 1 percent of the landscape in the region is characterized as wetland (Dahl 1990), and wet meadows are just one of several wetland types that occur. Patton and Judd (1970) reported that approximately 17,700 hectares of wet meadows occur on national forests in Arizona and New Mexico.

Wet meadows may be referred to as riparian meadows, montane (or high elevation) riparian meadows, sedge meadows, or simply as wet meadows. Wet meadows are usually located in valleys or swales, but may occasionally be found in isolated depressions, such as along the fringes of ponds and lakes with no outlets. Where wet meadows have not been excessively altered, sedges (Carex spp.), rushes (Juncus spp.), and spikerush (Eleocharis spp.) are common species (Patton and Judd 1970, Hendrickson and Minckley 1984, Muldavin et al. 2000). Willow (Salix) and alder (Alnus spp.) often occur in or adjacent to these meadows (Long 2000, Long 2002, Maschinski 2001, Medina and Steed 2002). High elevation wet meadows frequently occur along a gradient that includes aquatic vegetation at the lower end and mesic meadows, dry meadows, and ponderosa pine or mixed conifer forest at the upper end. These vegetation gradients are closely associated with differences in flooding, depth to water table, and soil characteristics (Judd 1972, Castelli et al. 2000, Dwire et al. 2006). While relatively rare, wet meadows are believed to be of disproportionate value because of their use by wildlife and the range of other ecosystem services they provide. Wet meadows perform many of the same ecosystem functions associated with other wetland types, such as water quality improvement, reduction of flood peaks, and carbon sequestration.

Wet meadows are one of the most heavily altered ecosystems. They have been used extensively for grazing livestock, have become the site of many small dams and stock tanks, have had roads built through them, and have experienced other types of hydrologic alterations. Most notably, the lowering of their water tables due to stream down thinning, surface water diversions, or groundwater withdrawal (Neary and Medina 1996) has occurred. Due to the presence of livestock grazing and hydrologic changes, large post-settlement trees may have established and grown within wet meadows such that they compromise available soil moisture or light creating unique biophysical conditions.

Ecological Objectives

- The biophysical conditions of wet meadows upon which terrestrial native biological diversity depend are conserved and restored.
- Wet meadow function is not impaired by growing (rooted) trees.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.
- Removal of large trees constitutes a relatively small part of an overall riparian area restoration effort, when compared to the fundamental causes of overall degradation. Wet meadows are fully restored by using an array of tools that address all sources of degradation.

Encroached Grasslands

Encroached grasslands are herbaceous ecosystems that have infrequent to no evidence of pine trees growing prior to settlement. The two prevalent grassland categories in the 4FRI landscape are montane (includes subalpine) grasslands and Colorado Plateau (a subset of Great Basin) grasslands, with montane grasslands being most common (Finch 2004). A key indicator of grasslands is the presence of mollisol soils. Mollisol soils are typically deeper with higher rates of accumulation and decomposition of soil organic matter relative to soils in the surrounding landscape. Grasslands in this region evolved during the Miocene and Pliocene periods, and the dark, rich soils observed in grasslands today have taken more than 3 million years to produce. In addition to their association with mollic soils, grasslands in this region are maintained by a combination of climate, fire, wind desiccation, and, to a lesser extent, by animal herbivory (Finch 2004).

Typical montane grasslands in this region are characterized by Arizona fescue (Festuca arizonica) meadows on elevated plains of basaltic and sandstone residual soils. Montane grasslands generally occur in small (<100 acres) to medium sized (100 to 1,000 acres) patches. Historic maintenance of the herbaceous condition in these grasslands is subject to some debate though appears to be primarily driven by periodic fire. The cool-season growth of Arizona fescue also plays a large role in maintenance of parks and openings by directly competing with ponderosa pine seedlings. Identification of grasslands in this region should use a combination of the threatened, endangered, and sensitive (TES), Southwest Regional GAP Analysis, and Brown and Lowe Vegetation Classification (Brown and Lowe 1982, TNC GIS Layer 2006), TEU data, EAU, among other existing vegetation and soils data.

Prior to European settlement, conifer trees were rarely established in grasslands because they were either suppressed by production of cool-season grasses or killed by frequent fire (Finch 2004). In the late 1800s, unsustainable livestock grazing practices significantly reduced herbaceous cover, reducing competition pressure on conifer seedlings. Coupled with the onset of fire suppression in the early 1900s, pine trees rapidly encroached and recruited into native grasslands (e.g., Moore and Huffman 2004, Coop and Givnish 2007). Plant diversity is particularly important in grassland ecosystems. Grassland plots with greater species diversity have been found to be more resistant to drought and to recover more quickly than less diverse plots (Tilman and Downing 1994). This resilience will become even more important in a warming climate. Conifer tree removal, restoration of fire, and appropriate livestock numbers are all necessary to restore structure and function of native grasslands.

Ecological Objectives

- Grasslands are enhanced, maintained, and function with potential natural vegetation (as defined by vegetative mapping units).
- Grasslands function with a natural fire regime.
- Existing grasslands are not encroached upon by conifers.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.

Aspen Stands and Patches

Quaking aspen (*Populus tremuloides*) generally occurs within mixed conifer forests. It is ecologically important due to the high concentration of biodiversity that depends on aspen for habitat (Tew 1970, DeByle 1985, Finch and Reynolds 1987, Griffis-Kyle and Beier 2003). Aspen is currently declining at an alarming rate (Fairweather et al. 2008).

Aspen occurs in small patches throughout the Rim Country project area. Bartos (2001) refers to three broad categories of aspen: (1) stable and regenerating (stable), (2) converting to conifers (seral), and (3) decadent and deteriorating. All of the aspen occurring within conifer forests of the Rim Country project area is seral aspen, which usually regenerates after disturbance through root sprouting.

The lack of fire as a natural disturbance regime in southwestern ponderosa pine forests since European settlement has caused much of the aspen dominated lands to cede to conifers (Bartos 2001). Other factors contributing to gradual aspen decline over the past 140 years include reduced regeneration from browsing ungulates (Pearson 1914, Larson 1959, Martin 1965, Jones 1975, Shepperd and Fairweather 1994, Martin 2007). More recently, aerial and ground surveys indicate more rapid decline of aspen, with very high mortality occurring in low and mid-elevation aspen sites. Major factors thought to be causing this rapid decline of aspen include frost events, severe drought, and a host of insects and pathogens (Fairweather et al. 2008) that have served as the “final straws” for already compromised stands.

Favorable soil and moisture conditions maintain stable aspen over time. Aspen stands have been mapped across the entire Rim Country area and map layers are available from existing databases.

Ecological Objectives

- Aspen stands and patches are conserved and restored to their appropriate fire regime.
- Aspen is effectively being regenerated or maintained, and regeneration, saplings, and juvenile trees are protected from browsing.
- There is decreased competition from conifers. Post-settlement conifer tree numbers do not exceed residual targets that have been identified using pre- settlement conifer tree evidences, site visitations, and collected data.
- Removal of large trees constitutes a relatively small part of the aspen restoration effort, when compared to the fundamental causes of overall degradation. Aspen forests and woodlands are fully restored by using an array of tools that address all sources of degradation.

Ponderosa Pine/Gambel Oak Forest (Pine-Oak)

A number of habitat types exist in the southwestern United States that could be described as pine-oak. Ponderosa pine forests are interspersed with Gambel oak (*Quercus gambelii*) trees in locations throughout the Rim Country project area in a habitat association referred to as PIPO/QUGA (USFS 1997, USDI 1995).

In southwestern ponderosa pine forests, Gambel oak has several growth forms distinguished by stem sizes and the density and spacing of stems within clumps. These include shrubby thickets of small stems, clumps of intermediate-sized stems, and large, mature trees that are influenced by age, disturbance history, and site conditions (Kruse 1992, Rosenstock 1998, Abella and Springer 2008, Abella 2008a). Different growth forms provide important habitat for a large number and variety of wildlife species (Neff et al. 1979, Kruse 1992). These include hiding cover in a landscape with limited woody shrub cover, cavity substrate for birds and bats, roost potential for bats, nest sites for birds, and bark characteristics used by invertebrates. Whether as saplings, shrubby thickets, or larger sized trees, oak adds a high value for wildlife in ponderosa pine forests.

Gambel oak provides high quality wildlife habitat in its various growth forms and is a desirable component of ponderosa pine forests (Neff et al. 1979, Kruse 1992, Bernardos et al. 2004).

Gambel oak enhances soils (Klemmedson 1987), wildlife habitat (Kruse 1992, Rosenstock 1998, USDI 1995, Bernardos et al. 2004), and understory community composition (Abella and Springer 2008). Large oak trees are particularly valuable since they typically provide more natural cavities and pockets of decay that allow excavation and use by cavity nesters than conifers. In addition to its important ecological role, Gambel oak has high value to humans as it is a popular firewood that possesses superior heat-producing qualities compared to other tree species (Wagstaff 1984).

Gambel oak densities appear to have increased in many areas with fire exclusion, especially in the small and medium diameter stems (<8-inch DBH, Abella and Fulé (2008)). Chambers (2002) found that Gambel oak on the Kaibab and Coconino NFs was distributed in an uneven-aged distribution, dominated by smaller size classes (<5 centimeter DBH) and few large diameter oak trees. Because of Gambel oak's slow growth rate, there may be little opportunity for these small Gambel oak trees to attain large diameters (>85 centimeters) (Chambers 2002).

Pine competition with oak has been identified as an issue in slowing oak growth, particularly for older oaks (Onkonburi 1999). Onkonburi (1999) also found that for northern Arizona forests, pine thinning increased oak incremental growth more than oak thinning and prescribed fire. Fulé (2005) found that oak diameter growth tended to be greater in areas where pine was thinned relative to burn only treatments and controls. Thinning of competing pine trees may promote large oaks with vigorous crowns and enhanced acorn production (Abella 2008b), and may increase oak seedling establishment (Ffolliott and Gottfried 1991).

Ecological Objectives

All Gambel Oak

- Small oak trees develop into larger size classes.
- Fire treatments retain small and shrubby oak in numbers and distribution.
- All growth forms of Gambel oak are present and larger, older oak trees are enhanced and maintained.
- Large, post-settlement trees are not restricting oak development.
- Frequent, low intensity surface fire occurs in ponderosa pine-Gambel oak forests.
- Brushy thicket, pole, and dispersed clump growth forms of Gambel oak are present and maintained by allowing natural self-thinning, thinning dense clumps, and/or burning.
- Gambel oak growth forms are protected from damage during restoration treatments including thinning and post-thinning slash burning.

In MSO Recovery Habitat

- Within MSO habitat and designated critical habitat, the recovery plan for the MSO improves key habitat components and primary biological factors, which includes Gambel oak.
- Within 30 feet of oak 10- inch DRC or larger, post-settlement mixed conifer trees up to 18-inch DBH (that do not have interlocking crowns with oak) are not restricting oak development.

Outside MSO Recovery Habitat

- Large post-settlement trees' drip lines or roots do not overlap with those of Gambel oak trees exhibiting greater than 8 inch DRC

Within-stand Openings (Interspaces)

Within-stand openings are small openings (generally 0.05 to 1.0 acres) that were occupied by grasses and wildflowers before settlement (Pearson 1942, White 1985, Covington and Sackett 1992, Sánchez Meador et al. 2009). For the purposes of this strategy, within-stand openings are equivalent to interspaces. The within-stand opening management approach described below is distinct from, and should not be considered as guidance relating to regeneration openings.

Pre-settlement openings can be identified by the lack of stumps, stump holes, or other evidence of pre-settlement tree occupancy (Covington et al. 1997). Current openings include fine-scaled canopy gaps. It is not necessary to have desired within-stand openings and groups located in the same location that they were in before settlement (the site fidelity assumption). Trees might be retained in areas that were openings before settlement, and openings might be established in areas which had previously supported pre-settlement trees.

Within-stand openings appear to have been self-perpetuating before overgrazing and fire exclusion (Pearson 1942, Sánchez Meador et al. 2009). Fully occupied by the roots of grasses and wildflowers as well as those of neighboring groups of trees, these openings had low water and nutrient availability because of intense root competition (Kaye et al. 1999). Heavy surface fuel loads insured that tree seedlings were killed by frequent surface fires, reinforcing the competitive exclusion of tree seedlings (Fulé et al. 1997).

These natural openings appear to have been very important for some species of butterflies, birds, and mammals (Waltz and Covington 2004). Often the largest post-settlement trees, typically a single tree, became established in these natural within-stand openings as soon as herbaceous vegetation was removed by overgrazing (Sánchez Meador et al. 2009). Contemporary within- stand openings or areas dominated by smaller post-settlement trees should be the starting point for restoring more natural within-stand heterogeneity.

Ecological Objectives

- The pattern of openings within stands that provide natural spatial heterogeneity for biological diversity are conserved, created, or enhanced.
- Openings break up fuel continuity to reduce the probability of torching and crowning and restore natural heterogeneity within stands.
- Openings promote snowpack accumulation and retention which benefits groundwater recharge and watershed processes at the fine (1 to 10 acres) scale.
- The presence of large trees does not prevent the reestablishment of sufficient within- stand openings to emulate natural vegetation patterns based on current stand conditions, pre-settlement evidences, desired conditions, or other restoration objectives.
- Groups of trees typically range in size from 0.1 acre to 1 acre. Canopy gaps and interspaces between tree groups or individuals are based on site productivity and soil type and range from 10 percent on highly productive sites to as high as 90 percent on those soil types that have an open reference condition.
- Suitable openings for successful natural regeneration in this project would range in size from 3/10 to 8/10 of an acre.

Heavily-Stocked Stands (with High Basal Area) Generated by a Preponderance of Large, Young Trees

In some areas, the increase in post-settlement trees has been so rapid that current stand structure is characterized by high density and high basal area in large, young trees. These stands or groups of stands exhibit continuous canopy which promotes unnaturally severe fire effects under severe fire weather conditions. At the fine scale, the management approach would apply on a case-by-case basis. The removal of large trees may be necessary to meet site-specific ecological objectives as listed below. For example, the removal of large trees may be necessary in order to reduce the potential for crown fire to spread into communities or important habitats that include MSO and/or goshawk nest stands.

In stands where pre-settlement evidences, restoration objectives, community protection, or other ecological restoration objectives indicate much lower tree density and basal area would be desirable, large post-settlement conifers may need to be removed to achieve post-treatment conditions consistent with a desired restoration trajectory. Where evidence indicates higher tree density and basal area would have occurred pre-settlement, only a few large conifers may need to be removed. Many of these areas would support crown fire and, thus, require structural modification to reduce crown fire potential and restore understory vegetation that supports surface fire.

Ecological Objectives

- Natural heterogeneity of forest, savanna, and grasslands occurs at the landscape scale and within stands.
- Groups are restored by retaining the largest trees on the landscape to reestablish old growth structure in the shortest timeframe possible.
- Decreased shading and interception from the canopy, decreased needle litter and duff, and surface fire restore and maintain a mosaic of natural vegetative communities.
- Decreased shading and interception from the canopy fuels allow the growth of continuous herbaceous surface fuels to carry surface fire.
- Reduced horizontal and vertical canopy fuels reduce the potential for crown fire.
- Fire may be used with other methods to maintain forest structure over time.
- Regeneration openings and interspaces contribute to the ecological objective of natural heterogeneity of historical forest structure, age class diversity, and open space.

Section E – Density Management and the Relationship between Treatment Intensity, Tree Group Density, and Overall Average Density

Table 114. Treatment intensity

Treatment Intensity	% Area in Interspace	Total % Treed Area	% Treed Area in Groups and Individuals	% Treed Area in Regeneration Openings	Average Group BA to Achieve Overall BA of 40	Average Group BA to Achieve Overall BA of 50	Average Group BA to Achieve Overall BA of 60	Average Group BA to Achieve Overall BA of 70	Average Group BA to Achieve Overall BA of 80	Average Group BA to Achieve Overall BA of 90
10-25	10	90	90	0	44	56	67	78	89	100
10-25	10	90	85	5	47	59	71	82	94	106
10-25	10	90	80	0	50	63	75	88	100	113
10-25	10	90	75	15	53	67	80	93	107	120
10-25	10	90	70	20	57	71	86	100	114	129
10-25	15	85	85	0	47	59	71	82	94	106
10-25	15	85	80	5	50	63	75	88	100	113
10-25	15	85	75	10	53	67	80	93	107	120
10-25	15	85	70	15	57	71	86	100	114	129
10-25	15	85	65	20	62	77	92	108	123	138
10-25	20	80	80	0	50	63	75	88	100	113
10-25	20	80	75	5	53	67	80	93	107	120
10-25	20	80	70	10	57	71	86	100	114	129
10-25	20	80	65	15	62	77	92	108	123	138
10-25	20	80	60	20	67	83	100	117	133	150
25-40	25	75	75	0	53	67	80	93	107	120
25-40	25	75	70	5	57	71	86	100	114	129
25-40	25	75	65	10	62	77	92	108	123	138
25-40	25	75	60	15	67	83	100	117	133	150
25-40	25	75	55	20	73	91	109	127	145	164
25-40	30	70	70	0	57	71	86	100	114	129

Treatment Intensity	% Area in Interspace	Total % Treed Area	% Treed Area in Groups and Individuals	% Treed Area in Regeneration Openings	Average Group BA to Achieve Overall BA of 40	Average Group BA to Achieve Overall BA of 50	Average Group BA to Achieve Overall BA of 60	Average Group BA to Achieve Overall BA of 70	Average Group BA to Achieve Overall BA of 80	Average Group BA to Achieve Overall BA of 90
25-40	30	70	65	5	62	77	92	108	123	138
25-40	30	70	60	10	67	83	100	117	133	150
25-40	30	70	55	15	73	91	109	127	145	164
25-40	30	70	50	20	80	100	120	140	160	180
25-40	35	65	65	0	62	77	92	108	123	138
25-40	35	65	60	5	67	83	100	117	133	150
25-40	35	65	55	10	73	91	109	127	145	164
25-40	35	65	50	15	80	100	120	140	160	180
25-40	35	65	45	20	89	111	133	156	178	200
40-55	40	60	60	0	67	83	100	117	133	150
40-55	40	60	55	5	73	91	109	127	145	164
40-55	40	60	50	10	80	100	120	140	160	180
40-55	40	60	45	15	89	111	133	156	178	200
40-55	40	60	40	20	100	125	150	175	200	225
40-55	45	55	55	0	73	91	109	127	145	164
40-55	45	55	50	5	80	100	120	140	160	180
40-55	45	55	45	10	89	111	133	156	178	200
40-55	45	55	40	15	100	125	150	175	200	225
40-55	45	55	35	20	114	143	171	200	229	257
40-55	50	50	50	0	80	100	120	140	160	180
40-55	50	50	45	5	89	111	133	156	178	200
40-55	50	50	40	10	100	125	150	175	200	225
40-55	50	50	35	15	114	143	171	200	229	257
40-55	50	50	30	20	133	167	200	233	267	300

Treatment Intensity	% Area in Interspace	Total % Treed Area	% Treed Area in Groups and Individuals	% Treed Area in Regeneration Openings	Average Group BA to Achieve Overall BA of 40	Average Group BA to Achieve Overall BA of 50	Average Group BA to Achieve Overall BA of 60	Average Group BA to Achieve Overall BA of 70	Average Group BA to Achieve Overall BA of 80	Average Group BA to Achieve Overall BA of 90
55–70	55	45	45	0	89	111	133	156	178	200
55–70	55	45	40	5	100	125	150	175	200	225
55–70	55	45	35	10	114	143	171	200	229	257
55–70	55	45	30	15	133	167	200	233	267	300
55–70	55	45	25	20	160	200	240	280	320	360
55–70	60	40	40	0	100	125	150	175	200	225
55–70	60	40	35	5	114	143	171	200	229	257
55–70	60	40	30	10	133	167	200	233	267	300
55–70	60	40	25	15	160	200	240	280	320	360
55–70	60	40	20	20	200	250	300	350	400	450
55–70	65	35	35	0	114	143	171	200	229	257
55–70	65	35	30	5	133	167	200	233	267	300
55–70	65	35	25	10	160	200	240	280	320	360
55–70	65	35	20	15	200	250	300	350	400	450
55–70	65	35	15	20	267	333	400	467	533	600

Note: Red fill indicates high residual within group basal areas, yellow fill indicates moderate within group basal area and green indicates low within-group basal area

Table 115. Trees per Acre by Quadratic Mean Diameter and Basal Area

Group Quadratic Mean Diameter	55 BA^2	60 BA^2	65 BA^2	70 BA^2	75 BA^2	80 BA^2	85 BA^2	90 BA^2	95 BA^2	100 BA^2	105 BA^2	110 BA^2	115 BA^2	120 BA^2	125 BA^2	130 BA^2	135 BA^2	140 BA^2	145 BA^2	150 BA^2	155 BA^2	160 BA^2	165 BA^2	170 BA^2	175 BA^2	180 BA^2	185 BA^2	190 BA^2	195 BA^2
8	158	172	186	200	215	229	243	258	272	286	301	315	329	344	358	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	125	136	147	158	169	181	192	204	215	226	238	249	260	272	283	294	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	101	110	119	128	138	147	156	165	174	183	193	202	211	220	229	238	248	257	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11	83	91	99	106	114	121	129	136	144	152	159	167	174	182	189	197	205	212	220	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	70	76	83	89	96	102	108	115	121	127	134	140	146	153	159	166	172	178	185	191	NA	NA	NA	NA	NA	NA	NA	NA	NA
13	60	65	71	76	81	87	92	98	103	109	114	119	125	130	136	141	147	152	157	163	168	NA	NA	NA	NA	NA	NA	NA	NA
14	51	56	61	66	70	75	80	84	89	94	98	103	108	112	117	122	126	131	136	140	145	150	NA	NA	NA	NA	NA	NA	NA
15	45	49	53	57	61	65	69	73	77	81	86	90	94	98	102	106	110	114	118	122	126	130	NA	NA	NA	NA	NA	NA	NA
16	39	43	47	50	54	57	61	65	68	72	75	79	82	86	90	93	97	100	104	107	111	115	118	NA	NA	NA	NA	NA	NA
17	35	38	41	44	48	51	54	57	60	63	67	70	73	76	79	83	86	89	92	95	98	102	105	108	NA	NA	NA	NA	NA
18	31	34	37	40	42	45	48	51	54	57	59	62	65	68	71	74	76	79	82	85	88	91	93	96	99	NA	NA	NA	NA
19	28	31	33	36	38	41	43	46	48	51	53	56	58	61	63	66	69	71	74	76	79	81	84	86	89	91	NA	NA	NA
20	25	28	30	32	34	37	39	41	43	46	48	50	53	55	57	60	62	64	67	69	71	73	76	78	80	83	NA	NA	NA
21	23	25	27	29	31	33	35	37	40	42	44	46	48	50	52	54	56	58	60	62	64	67	69	71	73	75	77	NA	NA
22	21	23	25	27	28	30	32	34	36	38	40	42	44	46	47	49	51	53	55	57	59	61	63	64	66	68	70	72	NA
23	19	21	23	34	26	28	30	31	33	35	36	38	40	42	43	45	47	49	50	52	54	56	57	59	61	62	64	66	NA
24	18	19	21	22	24	26	27	29	30	32	33	35	37	38	40	41	43	45	46	48	49	51	53	54	56	57	59	61	62

Note: SDI "zones" are explained in the silviculture report.

Color Coding Key: Green = SDI zones 1 and 2 (15 to 35% of maximum SDI). This is considered the lower range of stocking.

Yellow = SDI zone 3 (36 to 45% of maximum SDI). This is considered the middle range of stocking.

Orange = SDI zone 3 (46 to 55% of maximum SDI). This is considered the upper range of stocking.

Red = SDI zone 4 (56%+ of maximum SDI). Tree groups will not be managed within this zone.

Section F – Flexible Tool Box Approach

Mechanical Treatments Flexible Toolbox Approach

Rim Country Project provides the implementation resource specialists flexibility to apply a higher quality treatment that best meets project desired conditions and stand level prescription objectives. The need for this approach is derived from applying adaptive management considerations and lessons learned from past related projects.

The project decision and analysis used a site specific treatment assigned at the stand level based on biotic and abiotic factors such as known habitat, soil types. The analysis used the best information and tools at the time to model a site specific decision. Field verification could drive change to the baseline prescription for a higher quality of implementation. Baseline prescriptions is a place for field verification to start. This toolbox approach would be used to identify and analyze prescription options when discrepancies occur upon field verification. This approach describes a series of current conditions and then identify a prescription that could stands toward desired conditions. We will use decision matrices with a set of “if…then” determination points, based on conditions at the time of implementation, which would lead to the desired condition. Figure 95 demonstrates the toolbox process using cover and habitat cover types, a decision matrix and modifiers.

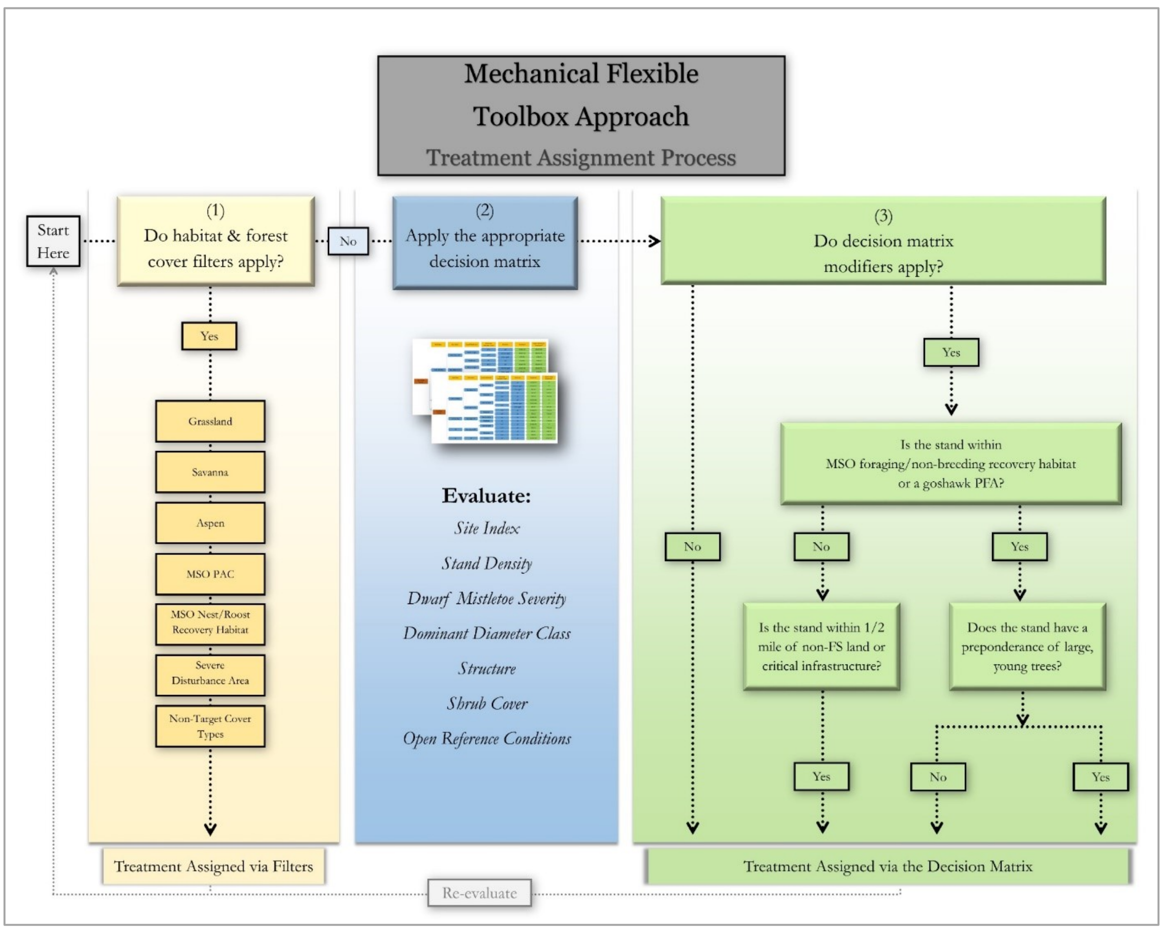

Figure 95. Mechanical Flexible Toolbox Process

Habitat and Ecosystem Cover Filters

Certain habitats are managed to specific treatment objectives and tactics outlined in Section B Management Direction, desired Conditions and Treatment Design. Habitat and ecosystem cover filters include Mexican spotted owl protected activity centers, Mexican spotted owl nest roost recovery, aspen stands, savanna areas, grassland areas, severe disturbance areas and non-targeted cover types for facilitating operations. Stands or areas within these filters would be treated with the objectives and tactics outlined in Section B. Treatments will not be determined as a result of the flexible toolbox decision matrix.

Mexican Spotted Owl Protected Activity Centers and Recovery Nesting and Roosting Habitat

These areas have been consulted on with Fish and Wildlife Service.

Aspen

These stands have been identified as those having the majority of live basal area in aspen. Aspen restoration treatments may include conifer removal from within stands, and barriers to reduce browsing pressure on regeneration. Inclusion of aspen stands not identified in the analysis may be treated as aspen upon field verification.

Grassland

Areas or portions of stands that overlap with a grassland terrestrial ecosystem unit were identified as grassland. Grassland-specific restoration includes a mechanical treatment that removes post-settlement conifers and manages for at least 90% of the treatment area as grass/forb, using pre-settlement tree evidence as guidance. Inclusion of grasslands based on soils that are not identified in the analysis may be treated as grassland upon field verification.

Savanna

Stands or portions of stands that overlap with a savanna terrestrial ecological unit and are adjacent to stands identified for a grassland treatment are classified as savanna. Also, those stands or portions of stands that overlap with a savanna terrestrial ecological unit and with an existing condition of less than 25 percent max SDI were identified as savanna. Savanna restoration includes a mechanical treatment that restores pre-settlement tree density and pattern, and manages for a range of 70 to 90 percent interspace between groups or individual trees, using pre-settlement evidence as guidance. Inclusion of savanna based on soils that are not identified in the analysis may be treated as savanna upon field verification

Severe Disturbance Areas

Severe disturbance areas are those where the spatial extent and/or the pattern of high severity effects is not within Desired Conditions, likely as a result of high-severity wildfire or insect outbreak. In some places this has resulted in aggressively sprouting species, such as alligator juniper and various species of oak dominating the vegetative response, making it difficult or impossible for ponderosa pine to establish or thrive. In other areas, extensive, overly dense patches of ponderosa pine regeneration have put stands on a trajectory toward stagnation, density-related mortality, or additional severe disturbance. In these areas of extensive, pure ponderosa pine regeneration, the decision matrices would be applied.

Restoration treatments in severe disturbance areas will include combinations of reforestation, prescribed fire, lopping/scattering, mastication, and other mechanical methods with the objective of identifying treatments that would be effective in restoring the fuel structure that produces the types of fire to which ponderosa pine is adapted.

Non-target Cover Types (Facilitative Operations)

Facilitative operations (FO) are treatments implemented in non-target cover types as needed to support the use of prescribed fire in target cover types. FO would be used in non-target cover types that lie between target cover types and existing features appropriate to use as prescribed fire boundaries, or that are surrounded by target cover types. FO treatments would either move these areas towards desired conditions as described in the forest plans or maintain the current condition. The inclusion of FO in burn units would be designed to improve safety, improve treatment effectiveness, expand burn windows, and minimize disturbance.

DECISION MATRICES

The following decision matrices have been built to incorporate discrete attributes that can be used to segregate stands for different treatments and build diversity across the landscape. There are two matrices: one for the Apache-Sitgreaves and Coconino NFs and one for the Tonto NF.

The Tonto matrix was developed separately because of the large amount of the ponderosa pine/evergreen oak cover type on the Tonto.

If the goal of a flexible toolbox is to prescribe the right treatment on the right acre, then vegetation condition should guide management decisions. One way to do this is to describe the stand structure, for example if it is even-aged or uneven-aged. We may want to thin even-aged stands differently than uneven-aged stands to move them toward the desired condition of uneven-aged stand structure. An even-aged stand would be treated to develop more openings, to encourage new cohorts and a more uneven-aged structure, and to develop one or two more age classes (additional age classes could be developed in later entries). An uneven-aged stand would be thinned to develop larger groups, in all diameter ranges, to maintain or enhance the current uneven-aged structure.

Another way to provide more flexibility is to consider the variety of site classes that occur across the project area. Stands with a higher site class may be able to be managed at a higher residual basal area and with less interspace. Additionally, the level of dwarf mistletoe infection should be considered in prescribing treatments in order to most effectively improve resilience without releasing or stimulating the infection. Refer to Section B Management Direction, desired Conditions and Treatment Design for specific treatment descriptions. Figure D-3 and Figure D-4 are decision matrices used during field verifications.

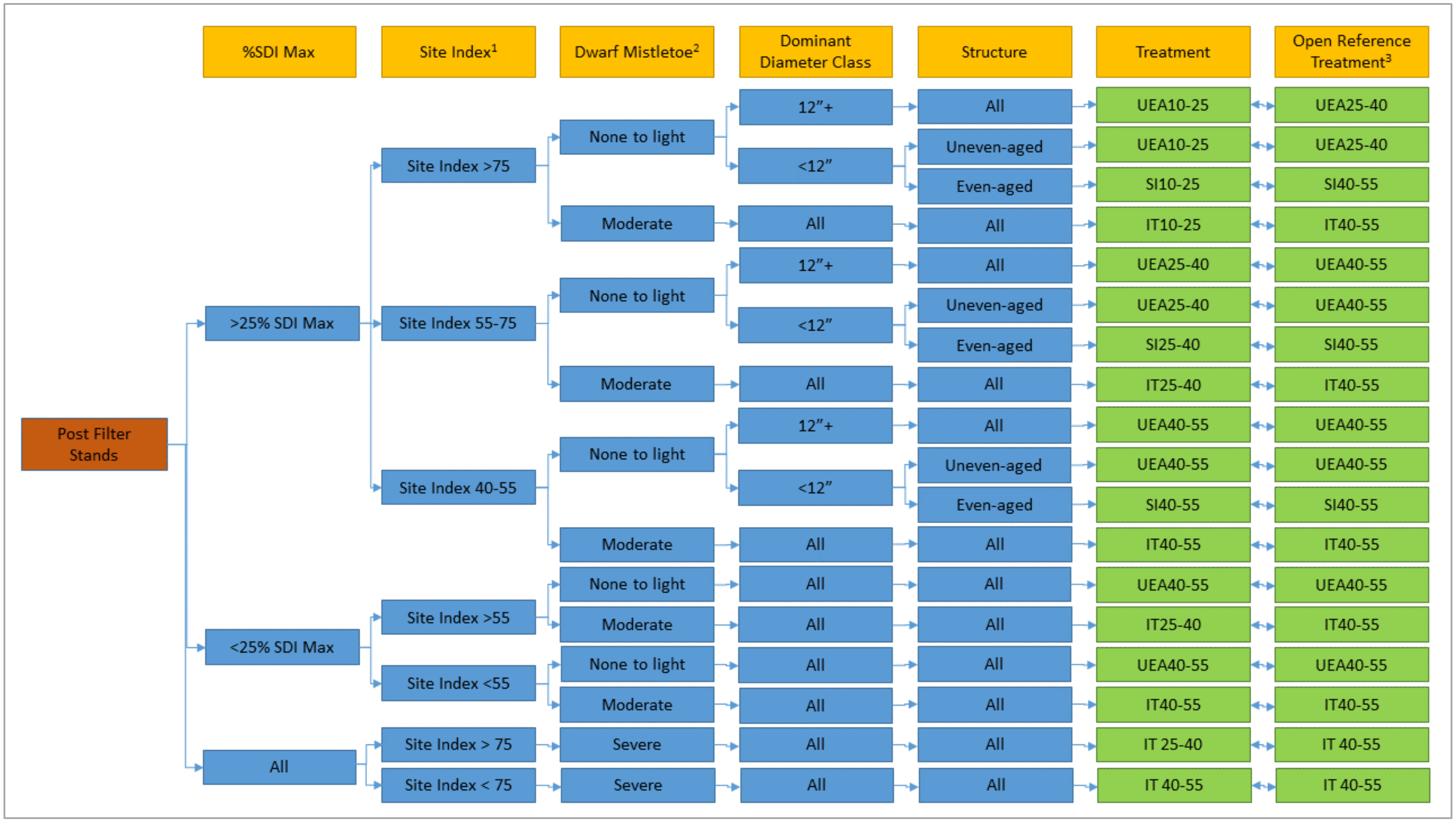

Figure 96. Decision matrix for the Coconino National Forest and Apache-Sitgreaves National Forest

[1]Stands with a Site Index less than 40 are confined to woodland sites.

[2]Dwarf Mistletoe Infection:

Light: < 20% Susceptible TPA infected. Moderate: 20-80% Susceptible TPA infected. Severe: > 80% Susceptible TPA infected

[3]Open Reference Treatment: Alternative treatment applied to those stands or parts of stands that occur on mollic intergrade soils where we have not proposed a savanna treatment as described in the savanna section of the flexible toolbox.

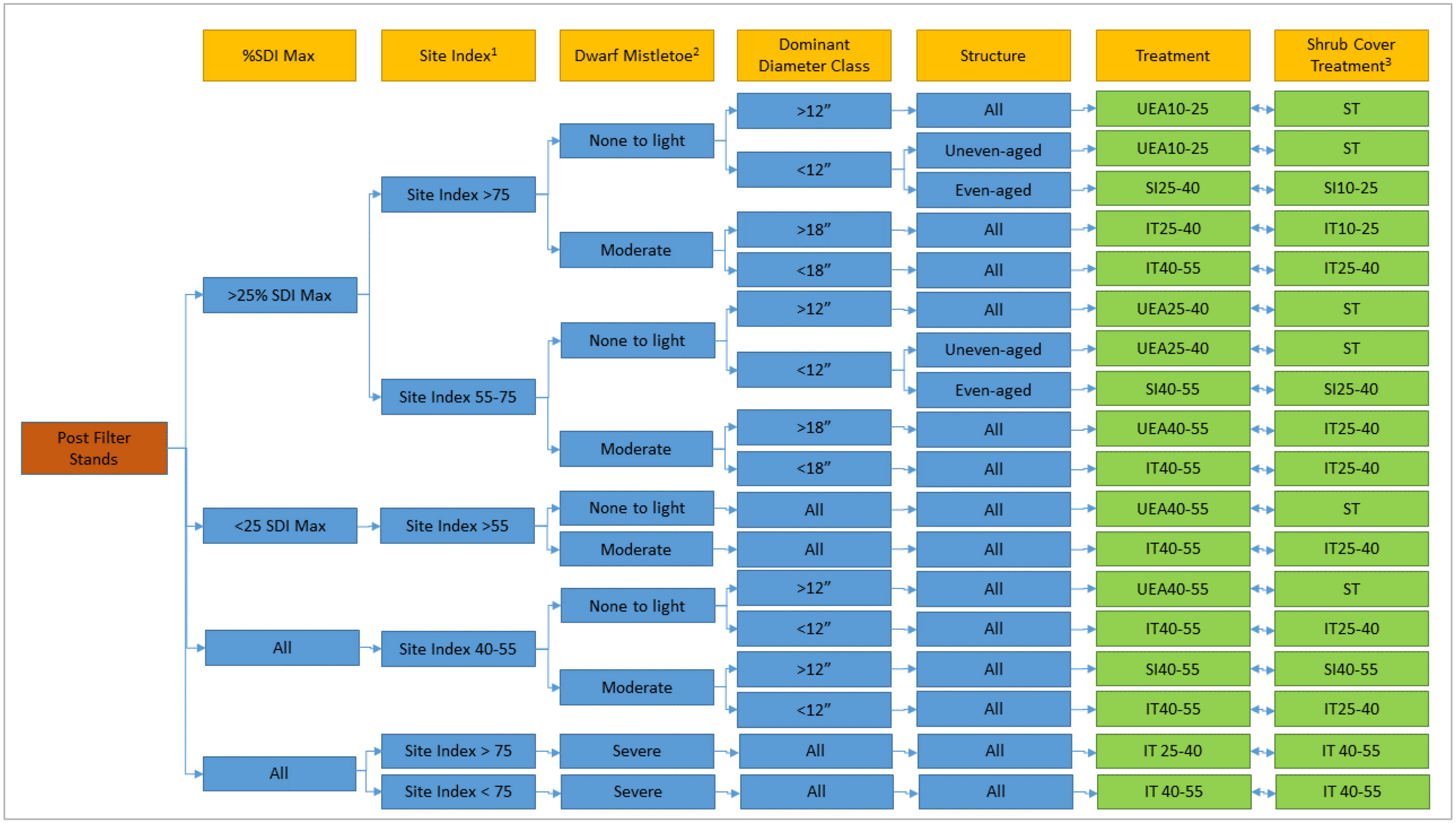

Figure 97. Decision Matrix for the Tonto National Forest

[1]Stands with a site index less than 40 are confined to woodland sites.

[2]Dwarf Mistletoe Infection:

Light: < 20% Susceptible TPA infected. Moderate: 20-80% Susceptible TPA infected. Severe: > 80% Susceptible TPA infected

[3]Shrub Treatment: Alternative treatment designed for when evergreen oak or shrub exceeds 40% of existing cover or when habitat type indicates that an undesirable shrub response would be likely.

The advantage of using this type of matrix is that we are looking at "conditions" and not necessarily "stands." Some of the stand delineations are potentially dated and there is a chance that the conditions that set the stand boundaries have changed, or that conditions within a stand are now changed (partial burns, partial thinning). This flexible approach prescribes treatments according to expected conditions and not necessarily by previously defined stands, so that stand boundaries can be re-delineated based on current conditions. This is particularly important where there is a patchy condition in a stand, such as that caused by dwarf mistletoe or a group of large young trees. If it is necessary to have two or more distinct treatment prescriptions in one stand to accommodate intra-stand variability, then the silviculturist should delineate new stand boundaries.

This approach also allows for a broad range of densities within the individual treatments identified in the decision matrices. This approach helps give fine-, mid-, and landscape-scale perspectives across the project area, in order to determine if proposed treatments are moving toward desired conditions at multiple scales. Stand-level data can be aggregated up to the mid- and landscape-scales for the Rim Country analysis.

Stands Infected with Dwarf Mistletoe

While the overall incidence (distribution and percent of landscape affected) of dwarf mistletoe is thought to have increased only modestly compared to historic conditions, the overall intensity and abundance of mistletoe is thought to have increased considerably (Conklin and Fairweather 2010). In order to meet the purpose of increasing the resilience and sustainability of ponderosa pine ecosystems within the Rim Country project area, restoration-based treatments that would assist in reducing the abundance and intensity of dwarf mistletoe infection in stands are included.

In lightly (0 to 20 percent infection) and moderately (20 to 80 percent infection) infected stands, the restoration treatments in the modified proposed action will address dwarf mistletoe. In stands with light infections, to the proposed action allows for removal of infected trees as part of the uneven-aged thinning, single-tree selection, stand improvement treatments. Pockets of mistletoe infection would be addressed through the reduction of basal area as well as the creation of openings and interspaces as part of these treatments.

In moderately-infected stands, the intermediate thin treatment would be particularly effective at addressing dwarf mistletoe, especially at the lower part of the moderate range (20 to 50 percent). Towards the higher end of the moderate range (50 to 80 percent infection), mistletoe would remain as a component of the stand, while remaining basal area, providing for full stocking, would reduce the stimulation of mistletoe in the remaining trees. Pockets of dwarf mistletoe infection could be addressed through the reduction of basal area as well as the creation of small openings and interspaces.

Heavily infected stands (80 percent or more of the target species in the stand are infected) would be assigned an intermediate thin (IT) treatment. In order to be ecologically responsive, treatment intensities would be applied with respect to site quality, with stands with higher site qualities being prescribed less intense treatments (see Figure 96 and Figure 97). As it has been shown that restoration-based treatments applied at the lowest intensity level are less effective than those implemented at higher intensity levels (Kralicek and Mathiasen, unpublished data), the lowest intensity level (IT 10-25) would be omitted from the treatment assignment process. While the effects were analyzed assuming implementation at the highest intensity within the assigned treatment, this still allows for the application of other restoration-based treatments to be applied to these stands, including a less intense treatment, deferment of mechanical treatment, or use of prescribed fire only. Because of the patchy nature of dwarf mistletoe infections, it is recommended that the district silviculturist consider re-delineating a stand with high mistletoe infection and treating the healthy and infected portions with separate prescriptions.

WUI (non-FS lands and critical infrastructure)

For the purposes of the Rim Country Project, what is commonly referred to as Wildland-Urban Interface, or WUI, will consist of those areas within ½ mile of non-FS lands with structures or critical infrastructure (communication sites, high value recreation sites, transmission lines, FS building complexes). In these areas, in order to protect values at risk, the flexibility is given for more open treatments that will result in up to 70 percent interspace.

Stands or parts of stands within these buffers that are identified as habitat and cover type filters or modifiers (as described in this flexible toolbox approach) will not be considered for these types of increased-intensity treatments, but will be considered for the appropriate treatments per their descriptions in this flexible toolbox approach.

These treatments to protect values at risk will be prioritized with site-specific considerations identified with Community Wildfire Protection Plans and local FS ranger districts, including:

- Susceptibility to wildfire
- Current conditions
- Prevailing winds
- Topography

The current condition of each of these areas will be field-reviewed prior to implementation by an interdisciplinary team of resource specialists, to determine what type and level of mechanical treatment is needed to protect the values at risk.

Habitat and Forest Cover Modifiers

Some habitat and stand structures will make use of the decision matrices but with specific design features to ensure resource protection. For example, while MSO PACs may require certain types of treatment apart from the decision matrices, treatments in northern goshawk (NOGO) Post-Family Fledgling Areas (PFAs) or in Stands with a Preponderance of Large Young Trees (SPLYT) may only require certain design features in addition to decision matrix treatments to provide adequate resource protection. Habitat and forest cover types that will require additional considerations or modifiers in addition to application of the decision matrices are described here.

MSO Foraging/Non-breeding Recovery Habitat

Achieving management objectives within MSO recovery habitat can be addressed with the flexible toolbox approach. Stands in recovery habitat would be assigned a treatment using the decision matrices; however, additional management direction would be applied such as maintaining increased basal area (40-110 BA for pine-oak and 40-135 BA for mixed conifer). This additional direction will be included in the project design features to ensure resource protection.

NOGO Nest Stands

Achieving management objectives for northern goshawk nest stands can be addressed with the flexible toolbox approach. NOGO nest stands would be assigned a treatment using the decision matrices. However, additional direction would be included in project design features, such as maintaining increased basal area within nest areas, to maintain or improve habitat and ensure forest plan compliance.

NOGO Post-Fledging Areas (PFAs)

Management objectives in NOGO PFAs are similar to those in NOGO nest stands and can be addressed with the flexible toolbox approach. NOGO PFA stands would be assigned a treatment using the decision matrices; however, additional direction would be included in project design features, such as maintaining increased basal area within PFAs, to maintain or improve habitat and ensure forest plan compliance.

Stands with a Preponderance of Large Young Trees (SPLYT)

The iterative spatial analysis and field validation effort undertaken by the Forest Service and stakeholders yielded an initial filter for SPLYT located outside of MSO PACs, MSO recovery habitat, and wildland urban interface (WUI). For ponderosa pine SPLYT, criteria are that: a) the Quadratic Mean Diameter (QMD) of the top 20 percent of trees is greater than 15 inches diameter at breast height (DBH), and b) there is more than 50 square feet/acre of basal area (BA) in trees greater than 16 inches DBH. All stands would be field-verified prior to mechanical thinning. Stands (or portions thereof) meeting SPLYT criteria, including those not captured by the data filter, would be treated at the lowest range of intensity within the identified silvicultural prescription. For example, a stand identified by the decision matrices to receive an uneven-aged treatment leaving 10 to 25 percent interspace (UEA 10-25), would be treated to 10 percent interspace and to the upper end of its natural range of variation (NRV) for trees per acre (TPA) and BA in order to maintain large tree dominance and conditions favorable to canopy-dependent species. Stands (or portions thereof) that are identified by the SPLYT criteria data filter but, upon field verification, are determined not to meet the SPLYT criteria, will be treated within the range of intensities applied to other non-SPLYT stands.

Wild and Scenic River Corridors

There are currently no designated wild segments of wild and scenic rivers in the Rim Country project area. However, as part of its forest plan revision process, the Tonto NF is completing an updated eligibility report for wild and scenic rivers to replace the existing eligibility report from 1993. To ensure compliance with current forest plan direction, the Rim Country EIS includes both the eligible rivers reported in the 1993 study, as well as those listed in the current draft eligibility report. Design features have been included in Appendix C specifically for the purpose of adjusting proposed treatments in the future as eligibility and suitability are determined. Any mechanical treatments proposed in eligible wild and scenic river corridors in the Rim Country project area will be modified to meet the purposes of restoring natural geomorphic and ecological processes and the specific outstandingly remarkable values (ORVs) of the river (such as fish and wildlife habitat).

Mechanical Treatment Flexible Toolbox Approach Summary

The objective mechanical treatment flexible toolbox approach is to provide a higher quality treatment by accurately assessing forest stands in fine detail with professional walkthrough assessments. Figure 97 demonstrated the mechanical treatment flexible toolbox approach in more detail. Tables imbedded into this section would be used by field personnel upon prescription writing.

Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities

The Rim Country project area encompasses over 1.2 million acres ranging in elevation from around 4,300 to 8,850 feet and includes 11 target vegetation cover types. This project area includes stream types ranging from high gradient headwater streams, meandering meadow reaches, and low gradient depositional valleys. There are approximately 4,000 miles of stream channels, including perennial, intermittent, and ephemeral. Wetlands such as wet meadows and springs also occur, providing unique aquatic and riparian habitats. There are 411 known springs on the three national forests that are either developed or undeveloped, and occur in meadow or riparian settings. It is estimated there are up to 10 times the number of unmapped springs that are not developed in the Rim Country project area. Riparian areas include vegetation types such as herbaceous sedge/rush, willow/alder, and cottonwood/sycamore vegetation.

Conditions within these watershed and aquatic systems range from relatively pristine to highly impacted. There are legacy impacts from timber management, channel modification, water developments such as springs and stock tanks, unregulated grazing, as well as more contemporary impacts from roads, non-native species, wildfires, recreation, and off-highway vehicle use. Some of these impacts are irreversible; however, in many systems there is potential for a new functional equilibrium. In other systems, there is the opportunity for either full restoration or preventing further degradation.

In general, desired conditions are functional soil, vegetation, and water resources, consistent with their flood regime and flood potential, which provide for diverse habitats. Stream channels have functioning floodplains and dissipate flood energy, as well as support connected riparian areas.

The toolbox addresses the effects of roads on watershed and aquatic systems, such as unauthorized routes and trails and stream crossings. The miles of unauthorized routes (roads or trails) within the project area are unknown, but their effects on these systems can easily be generalized. Based on current mapping, it is estimated that there are over 800 road and stream crossings in the project area. It is assumed that road crossings are generally stable on maintenance level 3 thru 5 roads (suitable for passenger cars to high degree of user comfort), and range from stable to unstable on maintenance level 1 and 2 roads (basic custodial care, i.e., closed, to open to high clearance vehicles). Existing maintenance level 1 and 2 roads which are potentially causing resource damage are addressed in the toolbox as well as maintenance level 3-5 roads which may be destabilizing streams.

Due to the size and complexity of the 1.24-million-acre Rim Country project area, and the variety and scope of the proposed activities, site-specific identification and analysis of all areas of need, or the possible combinations of restoration activities needed for each is not feasible within the necessary timeframe for Rim Country analysis. Complete baseline information on the condition of every acre is not currently available. However, there are a few categories of watershed and aquatic impairments that are common throughout the project area that may be appropriately addressed with a suite of restoration treatments, referred to as ”tools”, with predictable effects that can be analyzed in this project.

There is a wealth of information available to help make informed decisions on what kinds of restoration tools would be appropriate for certain site conditions. Altered or degraded riparian and aquatic habitat conditions generally occur across similar landscape features. To ensure the proper tools are available to help design specific watershed and aquatic restoration treatments for a variety of existing conditions, we propose to use a flexible toolbox approach so that local prescriptive treatments can be customized to current site-specific conditions. Landscape features that affect watershed and aquatic systems and how they function include: valley width, gradient, upland and riparian cover types, slope, access, soil types, hydrology (stream or spring flow), and substrate size. These features would be considered in determining site specific restoration treatments and the appropriate tools.

Having a suite of tools available for restoration helps account for imperfect information and adjust treatments in a variety of existing conditions, enabling project implementers to find the best solutions for a site-specific problem. Tools that might be appropriate in one area (e.g., stream type) may not be the right tool somewhere else. This flexible toolbox approach provides the ability to adapt treatments to unanticipated conditions or adapt treatments if monitoring indicates the effects of the project will differ from what was predicted in the analysis. Treatments that may cause effects potentially beyond the sideboards or limitations described in the original NEPA analysis would require subsequent NEPA analysis. Whenever possible, restoration treatments should be coordinated with other activities in the same area to create efficiencies. Restoration treatments could be incorporated into mechanical thinning contracts or stewardship agreements, or could be stand-alone projects specifically developed to address high-priority needs for comprehensive restoration.

This flexible toolbox approach applies to all action alternatives. Before carrying out aquatics and watershed restoration treatments, project leaders, specialists, and partners would look at a specific area to be treated and select the appropriate restoration tool(s). Some of the factors to be considered when designing these projects are: the extent and cause of the degraded resources, water quality issues, threatened and endangered species habitat, scenic sensitivity levels, and effects on non-forest lands. Design criteria, best management practices, and mitigation and conservation measures developed for the Rim Country Project would be applied to the flexible toolbox.

Implementation Decision Matrix

To guide implementation of aquatics and watershed restoration treatments and assist with their prioritization, a decision matrix was developed to be included in the flexible toolbox approach. The matrix gives guidance on the types of information to collect to identify the need for restoration treatments, identify potential restoration options and constraints, and prioritize projects for implementation.

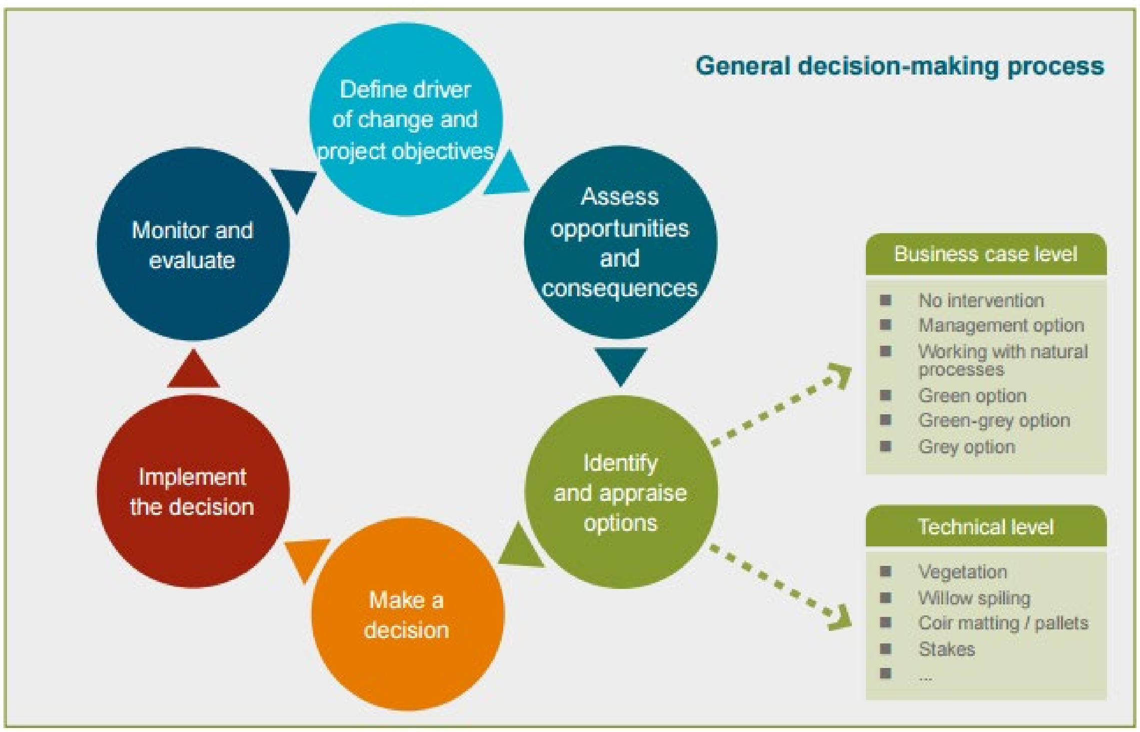

Figure 98. General decision-making process (Roca, et al. 2017)

Define driver of change and project objectives: The first step is identifying potential sites where restoration activities may be needed. Once sites are determined, information is needed to determine the existing baseline conditions and to understand any underlying causes of degradation. A baseline will need to be identified for the activity site using existing conditions and potentially reference sites if the activity site is degraded. The baseline for the site is what all restoration options should be assessed against to provide a basis for comparison. Understanding the drivers of change or causes of degradation is necessary to define the best approach and reach the most appropriate solution.   The baseline should account for existing condition and drivers of change. In turn, objectives for the restoration activities in relation to improving the baseline condition should be determined.

Key Information that may be needed:

- Site reconnaissance: IDT, partners, stakeholders walk the potential project area to identify areas of concern and potential causes.
    - ♦ Landforms (valley type (transport vs. depositional reaches), relic channels, floodplains, very old trees, distinct reach breaks.
    - ♦ Occurrence of excess erosion or deposition, loss or change in species composition or density (plant or animal).
    - ♦ Signs of manipulation (berms, ditches, skid roads, landings, unusually flat surfaces, hummocks, old or unauthorized roads, infrastructure, etc.….)
- Research the history of an area.
    - ♦ Historic aerial photos
    - ♦ USFS photo archives, local historical societies, universities
    - ♦ Prior reports and local knowledge
    - ♦ Try to piece together what happened to cause the degradation.
- Characterize the past, current, and likely future trajectory of the area (e.g. SEM or Rosgen stream type, spring type, riparian successional stage, or Proper Functioning Condition.
- Assessment and inventory:
    - ♦ Valley and channel types (valley and channel gradients, entrenchment ratio, width to depth ration, sinuosity)
    - ♦ Hydrology (flood, low flow, bankfull, regional curves, channel bed material, roughness).
    - ♦ Sediment inputs (roads, fires, other land ownership, banks)
    - ♦ Riparian habitat and condition (existing, potential, and function)
    - ♦ Habitat connectivity (aquatic, terrestrial)
    - ♦ Forest resources (terrestrial and aquatic species, rare plants, weeds, etc.…)
    - ♦ Springs Ecosystem Assessment Protocol (SEAP) evaluation (Springs Stewardship Institute).
- Determine potential cause(s) of the problem (I.e. human activity, animals, past management, or natural processes). Whenever feasible, manage the cause of the problem rather than its symptoms.
- Determine the baseline of the system to adequately assess all restoration treatments.
- Identify any drivers likely to impact the system over its lifetime (e.g. growth, climate change).

Assess opportunities, consequences, and constraints: Identifying potential consequences of current condition (e.g. bank or bed erosion) and the opportunities to improve site conditions should be assessed to inform the identification of measures and their prioritization. Constraints of a potential project also need to be identified such as accessibility, nearby land ownership, and roads that cannot be moved are beneficial to determining restoration opportunities, prioritization, and potential treatments to be used.

Potential short and long-term consequences of potential treatments should also be identified. Finally, the scope of the potential activity needs to be evaluated to determine if the fit within the constraints of the NEPA.

- Promote resilient ecological functions of the system being assessed.
- Integrate approaches to seek solutions that deliver multiple benefits whilst increasing resilience.
- All feasible options should be clearly set out and described in relation to the baseline.
- Describe and assess key impacts to all stakeholders, both positive and negative for each restoration treatment.
- Determine restoration projects scope
    - ♦ Start big and whittle down based on process drivers.
    - ♦ Find a downstream vertical grade control (start of a canyon reach, natural nick point, etc.)
- For springs (Springs Stewardship Institute): Evaluate condition and need for spring function and species use. Develop specific goals for restoration
    - ♦ Restore the site to as nearly natural and ecologically functioning a condition as possible OR restore specific resources, characteristics or populations as desired by the manager OR restore other desired future condition of the site
    - ♦ Consider: Minimizing maintenance costs and activities
- For developed springs
    - ♦ Evaluate the water use needs and costs, irrigation schedule, and maintenance
    - ♦ Identify features to preserve in situ
    - ♦ Identify features to remove – old pipes, concrete, fencing, roads/trails, etc.
- Consider the following questions from Beechie et al. 2008:

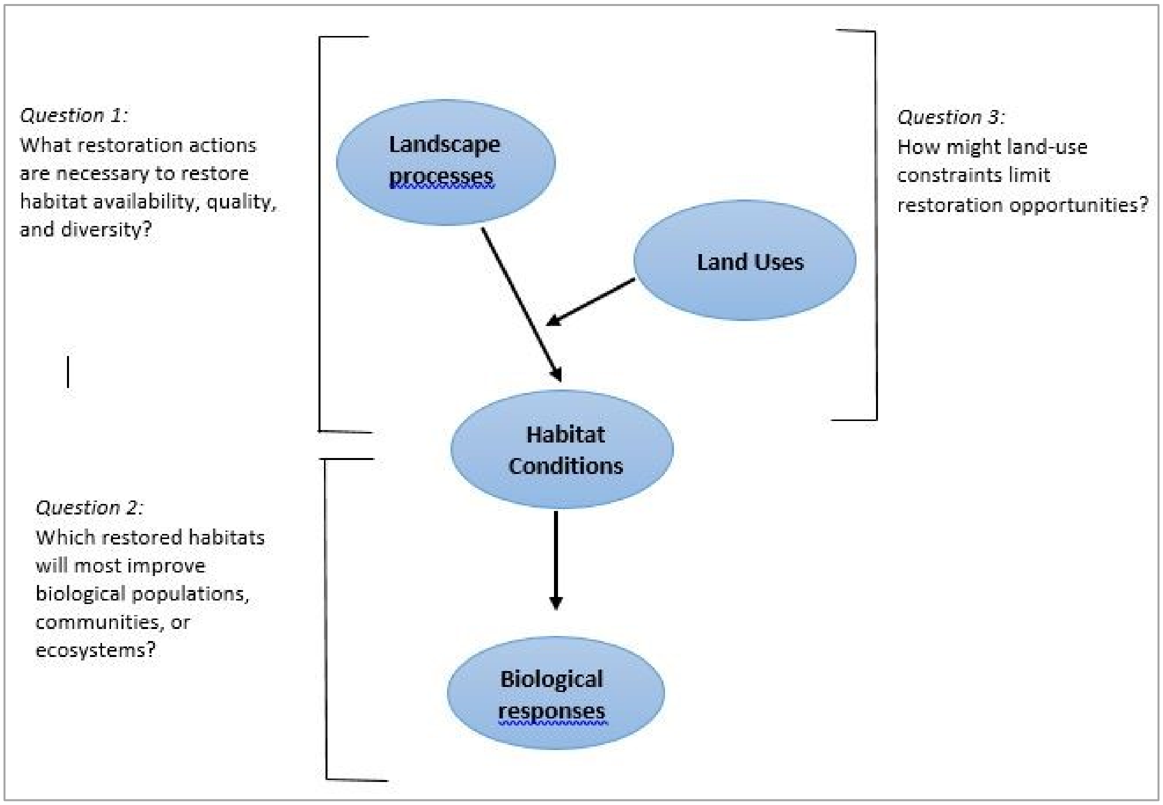

Figure 99. Diagram of conceptual linkages and questions to be addressed in assessments used to identify and prioritize restoration actions (Beechie et al. 2008).

Identify and appraise options: A number of potential options should be considered and appraised in order to provide a robust basis upon which to make a decision on how to move forward. All feasible options and flexible tools should be assessed and clearly described in relation to the baseline (no action) to provide decision makers and partners all the necessary information to base their decisions.

In addition, impacts of all options should be described and assessed. This includes impacts on all stakeholders, both positive and negative. Impacts should be screened for relevance and significance and can be assessed qualitatively or quantitatively where enough information is available to support the assessment.

In summarizing the results of the options, costs and benefits should be aggregated across relevant categories to provide a consistence basis for assessment. Comparisons should be consistent and any uncertainties should also be described and addressed.

- Can the restoration treatment meet and fulfill the objectives for the project?
- What are the chances of success?
- Does it address the causes rather than the symptoms?
- Consider the consequences of taking no action, assess the risks, costs, and benefits of implementing each option.

No Treatment: allows the natural adjustment of a system and therefore is the most sustainable. Should be applied when natural processes are likely to constitute a natural solution to the problem and the system has the ability to adjust (all processes functioning and no anthropogenic constraints).

Management Option(s)/Restoration Activities: Based on addressing the causes of the problem. This option involves restoration treatments to improve existing conditions.

Restoration activities should be developed and prioritized at the forest and district level in collaboration with partners.

Prioritization

Four primary considerations could be used to prioritize locations and timing of aquatic and watershed restoration activities: watershed condition framework, corresponding vegetation restoration activities, partner interest, and presence of federally-listed or candidate species.

Activities that may be identified within a proposed vegetation treatment area include, but are not limited to: thinning conifers along and within riparian areas, restoring incised channels, riparian planting, removing/obliterating unauthorized routes, and/or putting in drainage and closing level 1 system roads after all treatments are completed.

Prioritization of aquatic and watershed restoration projects will depend upon multiple site specific factors. Therefore, we list considerations when prioritizing activities rather than requirements.

Table 116. Considerations for prioritizing where and when treatments are implemented

Factors to Consider	Details and Guidance
Watershed Condition Framework and priority watersheds.	Areas or activities within existing Watershed Restoration Action Plans can increase opportunities to move watersheds into a higher condition class. Maintaining or improving watershed condition where feasible should be taken into consideration. Projects in priority watersheds should be considered.
Projects that improved impaired waters	Projects that improve water quality in ADEQ TMDL (water quality improvement plan) or 303b listed streams.
Vegetation restoration activities within the area.	Incorporating aquatic and watershed restoration activities in an area with other restoration treatments whenever possible is one way to create efficiencies with heavy equipment and personnel.
Partner Interest	Projects that already have partners or interested partners, particularly if funding is available, should be considered.
Presence of federally listed or candidate species	The presence of these species and improving their habitat could increase the prioritization of a project over a site that had none present.
Wet meadows, cienegas, and other similar habitats.	These habitat types store water in upper watersheds and maintain baseflow to other aquatic habitats. They also cool water and can provide for lower stream water temperatures. Maintaining and improving these areas can have great downstream beneficial impacts.
Upper watershed vs. lower	Restoration in upper portions of watersheds can have beneficial impacts downstream such as reduced sedimentation, maintaining baseflow, and cooling stream temperatures. They will have a larger range of beneficial impacts than projects lower in a watershed.
Issues that are new, easily treated, or could quickly spread.	Newer issues have not yet caused that much damage; restoration treatments of these are more cost and time effective as well as preventing more degradation. Projects such as these are 'low-hanging fruit' when compared to larger or more widespread issues. In addition, new infestations of noxious weeds or aquatic invasive plants are easier to treat early rather than after they spread.
Force account, contracted, and partner implementation	All three categories have merit, but may have differing financial or oversight costs. These should be considered differently amongst options and assessed. Prioritization may depend upon which category a project occurs in when weighed against work load, capacity, and financial considerations.
Process versus form-based projects	Projects that enhance site conditions, but do not restore the processes that create habitat or site conditions are considered form-based. These types of projects can require more maintenance than projects that restore the processes that create and maintain habitat. Projects that restore processes may be more of a priority than those that address a specific issue rather than the larger problem.

Implementation of the treatment:

Consultation and Implementation:

Pre-implementation surveys will be conducted for Endangered Species Act and sensitive species, rare plants, invasive species, and cultural resources. If federally-listed, rare, or sensitive species, or cultural sites, are found during pre-implementation surveys or during activity implementation, the appropriate mitigation will be incorporated into activity design. Any cultural resource findings will be coordinated with the State Historical Preservation Office.

Validation and Collaboration Period:
Activities will include written specific activity descriptions and associated design criteria. The Implementation Checklist (Appendix D of the EIS, and stand-alone Implementation Plan) will be used to ensure each activity is consistent with the Rim Country analysis and within the scope of the decision.

Pre-project notification will be reported to all required regulatory agencies at least 60 days prior to implementation of the activity.

Monitor and evaluate: The impacts are monitored in order to appraise them against initial objectives of the project. The information should be used to ensure the project is consistent with the assumptions, analysis and biological opinion for the project. It should also be used to inform future restoration treatment decisions on maintenance and adaptive management.

Restoration treatments in the flexible toolbox:

The first set of tables below describe existing conditions and resource concerns for general types of aquatic systems in the toolbox. The second set of tables list the restoration tools grouped by the general set of resource concerns they address.

Table 117. Springs

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Surface flow impacted by hydrological drought, alteration of the source or outflow, springbox, diversion or piping.	Reduced surface and subsurface flows from human created diversions, piping and alterations reduce habitat for aquatic, wetland and riparian obligate species; plants and animals.	Improving spring outflows
Channeling or degraded outflow channels are degraded leading to reduced surface and/or subsurface flow.	Reduced surface and subsurface flows reduce habitat for aquatic, wetland and riparian obligate species; plants and animals.	Improving spring outflows and/or form and function of stream channels and floodplains
Invasive or noxious plants are present and competing with native vegetation.	Native plants are outcompeted or overtaken, habitat degraded, loss or decline of native species.	Improving native riparian or aquatic vegetation
Developed spring is splitting flow from a failing springbox, diversion or piping.	Diversion of flow is dewatering the outflow and associated wetlands.	Improving spring outflows
Riparian or aquatic vegetation and proper soil function is impacted by recreation or overgrazing by livestock or elk.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Plant composition has low similarity compared to historic range of variability. Reduction or loss of habitat.	Improving native riparian or aquatic vegetation
User created trails or roads are impacting wetland and associated vegetation.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Loss or decline of vegetative ground cover and increases in bare soil exposure. Soil compaction and subsequent accelerated erosion causing degradation of proper soil function and site productivity. Potentially leading to altered surface or subsurface flows. Reduction or loss of habitat.	Improving road or trail interactions
Spring is being encroached by upland species or undesirable native species.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Reduction or loss of spring habitat.	Improving native riparian or aquatic vegetation

Table 118. Wetlands (marshes, potholes, wet meadows, and natural ponds)

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Wetland is impacted by invasive plant species	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Plant composition has low similarity compared to historic range of variability. Reduction or loss of habitat.	Improving native riparian or aquatic vegetation
Encroachment by upland species or undesirable native species.	Encroachment is identified as an indicator of lowered water table, loss or decline of native and/or rare wetland, riparian, and aquatic plant species.	Improving native riparian or aquatic vegetation
Vegetation and soils may be impacted by excessive livestock or elk herbivory, unauthorized routes, etc.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Loss or decline of vegetative ground cover and increases in bare soil exposure. Soil compaction and subsequent accelerated erosion causing degradation of proper soil function and site productivity. Potentially leading to altered surface or subsurface flows. Reduction or loss of habitat.	Improving native riparian or aquatic vegetation.
Evidence of incision, slumping, excessive soil erosion/sedimentation or other such issues that are draining the wetland.	Reduced surface and subsurface flows draining the wetlands, narrowing or loss of wetland, riparian, and aquatic plant species. Reduction or loss of habitat.	Improving form and function of stream channels and floodplains
Poorly located or user created roads and trails causing degradation to soil function and site productivity.	Streams or wetlands have increased sedimentation, increased erosion, accelerated peak flows and loss or degraded vegetation from user created roads or trails.	Improving road or trail interactions

Table 119. Montane Meadows

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Native vegetation is impacted by invasive plant species.	Loss or decline of native plant species. Plant composition has low similarity compared to historic range of variability. Reduction or loss of habitat.	Improving native riparian or aquatic vegetation
Encroachment by upland species or undesirable native species.	Encroachment is an indicator of lowered water table, loss or decline of native plant species.	Improving native riparian or aquatic vegetation
Vegetation and soils may be impacted by excessive livestock or elk herbivory, unauthorized routes, OHV use, camping, etc.	Loss or decline of vegetation and ground cover, increases in bare soil exposure. Soil compaction and subsequent accelerated erosion causing degradation of proper soil function and site productivity. Potentially leading to altered surface or subsurface flows. Reduction or loss of habitat.	Improving native riparian or aquatic vegetation
Evidence of incision, slumping, excessive soil erosion/sedimentation or other such issues that are draining the meadow.	Reduced surface and subsurface flows draining the meadows. Reduction or loss of habitat.	Improving form and function of stream channels and floodplains
Poorly located or user created roads and trails causing degradation to soil function and site productivity.	Increased sedimentation, erosion, and accelerated peak flows from user created roads or trails.	Improving road or trail interactions

Table 120. Unneeded Roads and Unauthorized Routes and Trails

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Poorly located or user created roads and trails causing excessive soil disturbance, erosion and soil compaction.	Soil compaction and erosion. Soil compaction and subsequent erosion causing increased sedimentation if road networks are connected to stream channels.	Improving road or trail interactions
Stream or wetland damage due to poorly located or user created roads within the floodplain, wet meadow, spring outflow, or other such wetland habitats.	Confinement of stream channel, degradation of wetlands, erosion into aquatic habitats, draining of wetlands, channel widening.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Need for frequent maintenance that impacts aquatic and watershed resources.	Concentration of flows that were originally spread across a wide area via drainage capture by ditching or berms. Potential changes in peak flows.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Need for frequent maintenance that impacts aquatic and watershed resources.	Impacts to active channel or flood plain dimension that alters function (energy dissipation or sediment transport).	Improving road or trail interactions and/or form and function of stream channels and floodplains

Table 121. Roads and Stream or Wetland Crossing

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Road crossings are increasing sedimentation to streams, springs, wet meadows, and other wetlands. Road crossings are causing excessive soil erosion/sedimentation that may be impacting nearby downstream vegetation stability/productivity.	Increased sedimentation to aquatic systems degrading spawning habitat, reducing macroinvertebrate and algae food base. Loss or decline of native wetland vegetation and proper soil stability/productivity downstream from road crossing.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Roads and associated stream crossings are changing the character of flow across the landscape, such as concentrating flows into a culvert.	Alteration of flows/hydrology within a stream valley is causing channel incision.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Road crossings are causing geomorphic changes to stream channels such as stream widening.	Roads may cause widening of channels which can cause increased stream temperatures, alterations to the channel, and degraded stream habitat. Undersize culverts may cause an increase in stream velocity causing scour and downcutting.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Road crossing geometry is impairing sediment transport capacity and competency.	Alteration of sediment transport is causing long-term aggradation/degradation of the stream channel.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Aquatic organism passage (where it is meant to exist) is completely or partially impeded due to lack of stream flow, perched culverts, degraded culverts or other such issues.	Aquatic organisms cannot pass part or all of the time impeding migration, genetic flow, distribution, and access to refuge habitats.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Roads are impacting stream and wetland plant communities through physical disturbance and soil compaction.	Roads may cause vegetation trampling, soil cover loss and soil compaction that can lead to decreased diversity of native species, loss of ground cover, and invasion of exotic species.	Improving road or trail interactions and/or form and improving native and riparian vegetation.

Table 122. Streams (channels, floodplains, and riparian)

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Stream habitat complexity is lacking, where it should exist, in relation to all aquatic species life stages (e.g. rearing and juvenile habitat).	Aquatic species need a variety of habitats to complete their life cycle.	Improving form and function of stream channels and floodplains
Most stream habitat is riffles or runs with little to no pool habitat and pool cover. Pool to riffle ratio is low.	Pool habitat is critical for resting habitat and thermal refugia for many species of fish.	Improving form and function of stream channels and floodplains
Large woody debris and recruitment is not present to create instream habitat complexity and cover.	Lack of large woody debris contributes to poor stream habitat diversity.	Improving form and function of stream channels and floodplains
Spawning habitat for various species (i.e. clean gravel bars, clean sand) are lacking.	Spawning habitat is essential to maintaining fish populations.	Improving form and function of stream channels and floodplains
Stream substrate is compacted or becoming cemented (i.e., tightly packed). Stream substrate is covered in fine sediment above natural levels.	Cemented substrate affects habitat availability for small bodied fish, macroinvertebrate habitat, and spawning habitat. Decreased pool depth and cover.	Improving form and function of stream channels and floodplains
Stream temperatures are high or reaching thermal tolerance of aquatic species.	Many aquatic species in the southwest are living at the edge of their thermal tolerance, drought conditions or warming temperatures may make habitats unsuitable.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation
Stream has or is currently incising and no longer connects with its floodplain or historic channels. Streambanks are incised or laterally unstable, and/or historic channels are abandoned.	Floodplain connection is critical for maintaining stream geomorphic function, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Laterally unstable banks are causing high erosion and sedimentation rates that alter aquatic and riparian habitat quality. Sediment transport is also affected. Historic channels provide habitat for varying ages classes of species, dissipate flood flows, provide riparian and aquatic habitat.	Improving form and function of stream channels and floodplains
Stream is confined; it has been straightened or confined.	Artificially confined streams may not function properly. Confinement may cause incision or other issues due to changes in stream power and sediment transport. These areas often have issues during flood flows.	Improving form and function of stream channels and floodplains

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Stream width and depth ratio is inappropriate for stream type.	Overly wide streams may lack pools and habitat diversity and have higher stream temperatures than streams with a lower width depth ratio. Conversely, artificially confined streams may be not be able to dissipate stream energy.	Improving form and function of stream channels and floodplains
Hydrologic cycles are altered leading to reduced flood flows, or increased frequency of high flows (e.g. post fire flooding).	Aquatic and riparian species are adapted to certain hydrologic cycles which can be important to their life cycles. Flood flows are essential for maintaining properly functioning stream channels, floodplains and substrate distribution.	Improving form and function of stream channels and floodplains
Streams and associated floodplains are not dissipating flood water energy causing damage to streambanks. Meander pattern altered.	Altered channel roughness or meander pattern is causing excessive erosion, limiting energy dissipation from high flows, changes to channel morphology, altering stream habitat and floodplains.	Improving form and function of stream channels and floodplains
Water quality is poor due to turbidity, sedimentation, or other factors other than temperature.	Poor water quality can cause a shift in macroinvertebrate and fish assemblages to more disturbance tolerant species. It can also alter primary or secondary productivity leading to changes in food availability.	Improving form and function of stream channels and floodplains
Large woody debris is not present in channels or wetlands to reduce stream energy, provide cover, and create complex habitat.	Lack of large woody debris recruitment to streams reduces roughness, cover, and habitat complexity.	Improving form and function of stream channels and floodplains
Riparian communities are not functioning at potential to support geomorphic and biotic needs of the aquatic community.	Riparian communities (both woody and herbaceous) are essential to the health of instream aquatic systems.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation
Leaf litter from riparian vegetation (allochthonous material) is lacking.	Organic matter (leaves) provide nutrients and food source for macroinvertebrates, prey species for fish.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation
Existing riparian woody vegetation is lacking or out competed by conifers.	Loss or decline of riparian vegetation, stream shade, and bank stability.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation
Floodplain vegetation has converted to upland species.	Riparian vegetation aids in flood resilience, dissipation of flows (roughness), large woody debris and bank stability for stream systems.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Riparian area is narrowing.	Narrowing riparian area could indicate reduced water table, disconnected floodplain, or other constraints leading to loss of bank stability, shade, large woody debris, and possibly reduced flows.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation
Soil compaction and accelerated soil erosion/sedimentation and bank instability.	Decreased soil function leading to stream bank soil instability and reduced site productivity of desirable native, riparian vegetation.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation

Flexible Toolbox: Tools described by general type of resource issues or concerns they may address.

Table 123. Tools for Improving native Riparian or Aquatic Vegetation

Tools	Resource Issues or Concerns Addressed
Removing tree(s), tree canopy, or shrub encroachment of upland species with hand thinning, mechanical thinning or prescribed fire.	Loss or decline of wetland, riparian, or aquatic plant species. Indicators of drying that can be associated with past land management practices
Remove and manage noxious or invasive plants using hand methods or herbicides as described in forest weed management plans.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Protection or restoration of existing native biodiversity, erosion control, wildlife forage and habitat.
Plant native aquatic or riparian plant species by hand or mechanically, including seeding.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species, increased bank stability and leaf litter. Loss of site diversity and proper soil function.
Protect and promote existing native aquatic or riparian plant species. Site protection or fencing, which could be for seasonal restrictions, temporary restrictions, or year round. Install fencing, remove/relocate roads or trails, create defined trails for recreation management using manual or mechanical tools.	Promote plant growth and vigor, reduce erosion and sediment inputs to aquatic systems, removal of riparian or aquatic stressors. Reduce ungulate grazing, excessive soil disturbance, OHV impacts, created trails, and dispersed camping causing resource damage. Reduce erosion, bank instability
Prescribed burning.	Natural disturbance leading to regeneration of riparian plant species, reduction in fuel loading and fuel corridors.

Table 124. Tools for Improving Spring Outflows

Tools	Resource Issues or Concerns Addressed
Improve or remove boxes or other infrastructure, using excavation, shovels, trackhoes, jackhammers, concrete saw to restore natural spring function. Remove unneeded channels to consolidate spring outflow and increase habitat.	Spring developed for irrigation or livestock that is no longer needed and is compatible with existing water rights. Restoring natural spring function and flow
Split flow in developed springs to allow water above existing water rights to be released to spring outflows. Hand methods for fixing springboxes, piping, or diversions to split spring flow.	Drying of spring outflow, reduced aquatic and riparian vegetation, reduced habitat, reduced soil function, spring not functioning properly
Protect spring emergence zone and/or springbrook from direct ungulate disturbance through fencing.	Loss and/or degradation of wetland and riparian species from concentrated ungulate use of spring emergence zone and/or springbrook

Table 125. Tools for improving road or trail interactions with stream courses, springs, or other wetlands

Tools	Resource Issues or Concerns Addressed
Obliterate roads restoring natural contours and vegetation using mechanical roads treatments.	For existing roads causing resource damage such as confining a stream, draining wetlands, loss or degradation of riparian or aquatic vegetation and habitat, and loss or degradation to proper soil function.
Close and restore unauthorized roads, trails, and dispersed camping areas using mechanical roads treatments.	For unauthorized roads, trails or recreational impacts causing resource damage such as confining a stream, draining wetlands, loss or degradation of riparian or aquatic vegetation and habitat, and loss or degradation to proper soil function.
Return ML 1 roads to closed status after use for restoration treatments by removal of drainage infrastructure (e.g., culverts), reestablishment of road drainage through lead-out ditches, water bars, rolling dips, and other means, removal of unstable fill, , and placement of slash using mechanical roads treatments.	Erosion, sedimentation, degradation or loss of vegetation from ML 1 roads.
Armor downstream culvert outlets using mechanical roads treatments.	Increased erosion and scouring downstream of culverts, bank instability, and channel downcutting.
Upsizing culverts using mechanical roads treatments.	Streams scouring around culverts and over roads, increased erosion to streams or wetlands, reduced aquatic organism passage from road culverts. Potential impacts to channel soil stability and site productivity.
Installing or adding culverts or culvert arrays using mechanical roads treatments.	Loss of stream connectivity, channel width, erosion and sedimentation to streams, channelization and increased channel width due to roads. Potential impacts to channel soil stability and site productivity.

Tools	Resource Issues or Concerns Addressed
Maintaining Aquatic Organism Passage where it exists if road work needed. – Install bridge, replace culvert, or remove crossing using mechanical roads treatments.	Decreased fish passage, habitat access, passage of high flows and bedload, and decreased channel complexity from road culverts.
Install hardened low water crossings or fords (rock, concrete slab, concrete planks, concrete blocks, geocell fords, and vented fords on existing ML1 and ML2 roads needed for mechanical offerings using mechanical roads treatments.	Loss or degradation of riparian vegetation or soil function, channel widening, increased erosion, sedimentation to aquatic habitats, increased bank instability from roads crossing streams or wetlands.
Install and replace bridges on ML1 and ML2 roads needed for mechanical offerings using mechanical roads treatments.	Decreased aquatic and wildlife passage through culverts or under exiting bridges, deposition of stream bedload upstream of culverts, high flows are scouring channel and floodplain upstream, log jams are forming upstream of culverts or bridges.
Raise culverts where invert elevations have resulted in stream incision.	Restore natural flow paths and connection of flow to floodplain areas.
Install raised permeable roadbeds with or without culverts where roads cross areas of seasonal or perennial water inundation.	Restore natural flow paths.
Restore channels affected by road crossings using mechanical roads treatments.	Channel widening, erosion and sedimentation upstream or downstream of a road crossing. Loss or degradation of riparian vegetation and soil function.
Decommission or relocate ML1 and ML2 roads needed for mechanical offerings causing resource damage to springs, wetlands or streams using mechanical roads treatments.	Reduce sedimentation and erosion, improve vegetation and soil condition, restore stream banks, restore and improve aquatic and terrestrial habitat.
Developing footpath(s) on existing trails to prevent further erosion using hand or mechanical treatments.	Streams, springs, or wetlands have increased sedimentation, increased erosion, and loss or degraded vegetation and soil condition from user created trails.

Table 126. Tools for improving the form and function of stream channels and floodplains

Tools	Resource Issues or Concerns Addressed
Large woody debris, log Structures, log jams, yarding trees. Tree falling, transport and placement of trees and root wads from somewhere else, yarding over trees, helicopter wood, mechanical installation.	Floodplain connection is critical for maintaining stream geomorphic function, soil stability, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Sediment transport is also affected. Lack of large woody debris recruitment to streams for reduces roughness, cover, and habitat complexity.
Weirs and Beaver Dam Analogs (BDAs) installed by hand or mechanical methods.	Floodplain connection is critical for maintaining stream geomorphic function, soil stability, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Sediment transport is also affected.
Wicker, log and rock wires, vanes, or baffles, brush bundles and root wads using various methods and installed by hand or mechanically.	Lack of channel roughness or meanders is causing excessive erosion, changes to channel morphology, altering stream habitat and floodplains.
Boulder and log deflectors using mechanized installation.	Lack of channel roughness or meanders is causing excessive erosion, changes to channel morphology, altering stream habitat and floodplains. Lack of pool habitat or instream cover.
Hand girdling trees to provide for future large woody debris stream input.	Lack of large woody debris recruitment to streams for reduces roughness, cover, and habitat complexity.
Restoring meanders or adding stream length by induced meandering, recontouring the channel, plug and pond, other similar methods mechanically.	Artificially confined streams may not function properly. Confinement may cause incision or other issues due to increased stream power and sediment transport. These areas often have issues during flood flows.
Channel reconstruction, realignment or floodplain reconnection using mechanical treatments.	Floodplain connection is critical for maintaining stream geomorphic function, soil stability, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Sediment transport is also affected.
Flood plain creation, widening, or laying back incised stream banks using mechanical treatments.	Floodplain connection is critical for maintaining stream geomorphic function, soil stability, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Sediment transport is also affected
Removing instream stock tanks and replacing with guzzlers, drinkers, etc. in the uplands using mechanical treatments	Restore channel width, sediment, flow, and water source for downstream areas.
Zuni bowls, one rock dams or other similar methods using mechanical or hand treatments.	Slow overland flow or stream flow in small channels, reduce erosion and sedimentation.
Reconnection of historic side channels that should be functioning using mechanical treatments.	Floodplain connection is critical for maintaining stream geomorphic function, soil stability, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Sediment transport is also affected.
Maintenance of existing structures using manual or mechanical treatments.	Structures that stabilize banks, create instream cover and channel roughness, etc. from the CCC era forward currently exist on the landscape.
Removing existing erosion control structures	Removing poorly placed or nonfunctional structures can improve channel form and function.

The tools listed above for aquatic and watershed restoration activities would not be used universally across the project area. In general, the tools all have circumstances where they would be more successful in moving the restoration project toward desired condition. Some tools have circumstances where they would not generally apply as they would be ineffective, not needed, or potentially cause degradation rather than improving conditions. Listed below are the general circumstances under which each tool would apply or conversely, where they would not apply. Table 127 is intended to provide general implementation guidance for the tools as well as to better define where these proposed activities could occur for Rim Country.

Characteristics that could be mapped such as stream gradient and road maintenance levels were used to greatest extent possible. However, some characteristics such as presence of ungulate impacts or presence of noxious or invasive plants cannot be defined using remote sensing techniques and will still need to be determined on site Applicability based on stream gradient was determined using Rosgen stream types as well as literature on specific tools.

Table 127. Generalized circumstances for when or where tools would not apply

Treatments/Tools	Circumstances where treatments would apply	Circumstances where treatments would not apply
Removing tree(s), tree canopy, or shrub encroachment of upland species with hand thinning, mechanical thinning or prescribed fire.	N/A see Mechanical toolbox and Design Criteria	N/A see Mechanical treatments flexible toolbox and Design Features in Appendix C
Remove and manage noxious or invasive plants using hand methods or herbicides as described in forest weed management plans.	Anywhere that noxious or invasive plants are impacting native riparian or aquatic vegetation.	Anywhere noxious or invasive plants do not occur
Plant native aquatic or riparian plant species by hand or mechanically, including seeding.	In low and medium gradient stream reaches and all other wetland types where wetland, riparian, or aquatic plant species should be present.	High gradient stream reaches
Protect and promote existing native aquatic or riparian plant species. Site protection or fencing, which could be for seasonal restrictions, temporary restrictions, or year round. Install fencing, jack straw, remove/relocate roads or trails, create defined trails for recreation management using manual or mechanical tools.	In low and medium gradient stream reaches where wetland, riparian, or aquatic plant species should be present. Areas would also have to be reasonably close to road system for access and maintenance.	High gradient stream reaches, narrow or confined valleys
Improve or remove spring boxes and other infrastructure, using excavation, shovels, trackhoes, jackhammers, concrete saws to restore natural spring function. Removing unneeded channels to consolidate spring outflow and increase habitat.	Low to moderate gradient stream reaches	High gradient stream reaches, narrow or confined valleys
Split flow in developed springs to allow water above existing water rights to be released to spring outflows. Hand methods for fixing springboxes, piping, or diversions to split spring flow.	Low to moderate gradient stream reaches	N/A

Treatments/Tools	Circumstances where treatments would apply	Circumstances where treatments would not apply
Protect spring emergence zone and/or springbrook from direct ungulate disturbance through fencing.	In areas where ungulate disturbance is impacting springs.	Where ungulate disturbance is not a causative factor.
Obliterate roads restoring natural contours and vegetation using mechanical roads treatments.	Where existing roads causing resource damage such as confining a stream, draining wetlands, loss or degradation of riparian or aquatic vegetation and habitat, and loss or degradation to proper soil function.	N/A
Close and restore unauthorized roads, trails, and dispersed camping areas using mechanical roads treatments.	For unauthorized roads, trails or recreational impacts causing resource damage such as confining a stream, draining wetlands, loss or degradation of riparian or aquatic vegetation and habitat, and loss or degradation to proper soil function.	N/A
Return ML 1 roads to closed status after use for restoration treatments by removal of drainage infrastructure (e.g., culverts), reestablishment of road drainage through lead-out ditches, water bars, rolling dips, and other means, removal of unstable fill, and placement of slash using mechanical roads treatments.	Anywhere that ML1 roads are opened for use within Rim Country.	N/A
Armor downstream culvert outlets using mechanical roads treatments.	ML 2-4 roads where erosion is occurring from culverts.	N/A
Upsizing culverts using mechanical roads treatments.	ML 2-4 roads in areas where stream or overland flow had increased above the capacity of existing infrastructure.	N/A
Installing or adding culverts or culvert arrays using mechanical roads treatments.	ML 2-4 roads in areas where stream or overland flow had increased above the capacity of existing infrastructure.	N/A
Maintaining Aquatic Organism Passage where it exists if road crossing work needed. – Install bridge, replace culvert, or remove crossing using mechanical roads treatments.	Where roads and streams intersect on ML 2-4 roads	ML 1 and ML 5 road/stream crossings or intersections.
Install hardened low water crossings or fords (rock, concrete slab, concrete planks, concrete blocks, geocell fords, and vented fords on existing ML1 and ML2 roads needed for mechanical offerings using mechanical roads treatments.	Where ML 1-2 roads intersect with streams	ML 3-5 road and stream intersections
Install and replace bridges on ML1 and ML2 roads needed for mechanical offerings using mechanical roads treatments.	Where ML 1-2 roads intersect with streams	ML 3-5 road and stream intersections

Treatments/Tools	Circumstances where treatments would apply	Circumstances where treatments would not apply
Developing footpath(s) or tread on existing trails to prevent further erosion using hand or mechanical treatments	Where trails are within 250 feet from streams	Trails beyond 250 feet from streams.
Large woody debris, log structures, log jams, yarding trees. Tree falling, transport and placement of trees and root wads from somewhere else, yarding over trees, helicopter wood, mechanical installation.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches
Weirs and Beaver Dam Analogs (BDAs) installed by hand or mechanical methods.	Low to moderate gradient stream reaches and valleys (most viable at stream slopes of 0-3%), with wide to narrow floodplains.	High gradient stream reaches. BDAs are less viable at stream slopes of >3%.
Wicker, log and rock wires, vanes, or baffles, brush bundles and root wads using various methods and installed by hand or mechanically.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches.
Boulder and log deflectors using mechanized installation.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches
Hand girdling trees to provide for future large woody debris stream input.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches
Restoring meanders or adding stream length by induced meandering, recontouring the channel, plug and pond, other similar methods mechanically.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains. Wetlands and wet meadows.	High gradient stream reaches
Channel reconstruction, realignment or floodplain reconnection using mechanical treatments.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches
Flood plain creation, widening, or laying back incised stream banks using mechanical treatments.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches
Removing instream stock tanks and replacing with guzzlers, drinkers, etc. in the uplands using mechanical treatments	Low to moderate gradient stream reaches and valleys.	High gradient stream reaches
Zuni bowls, one rock dams or other similar methods using mechanical or hand treatments.	Low to moderate gradient stream reaches and valleys.	High gradient stream reaches
Reconnection of historic side channels that should be functioning using mechanical treatments.	Low to moderate gradient stream reaches and valleys.	High gradient stream reaches
Maintenance of existing structures using manual or mechanical treatments.	Generally found in low to moderate gradient stream reaches and valley slopes.	High gradient stream reaches
Removing existing erosion control structures	Generally found in low to moderate gradient stream reaches and valley slopes.	High gradient stream reaches

References

The following is a partial reference list useful for ideas and designs of potential treatments:

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Appendix E – Monitoring and Adaptive Management Plan

Introduction

The pace and scale of 4FRI is likely to affect many aspects of the ponderosa pine ecosystems of northern Arizona. The anticipated effects of our treatments are disclosed in the 4FRI Rim Country Project Environmental Impact Statement (EIS). Monitoring will help determine if the intended effects are achieved, recognizing that our management should improve as monitoring information is collected and applied.

This section is intended to: 1) clarify the process for both monitoring and adaptive management in the Rim Country project area, 2) clarify the requirements for monitoring, and 3) describe the collaboratively-developed monitoring and adaptive management plan that is the foundation of the multi-party monitoring framework. The 4FRI Stakeholder Group (stakeholders) and the U.S. Forest Service (USFS) coordinated on the design of this monitoring and adaptive management plan, with the intent of integrating it into the EIS and implementing it within the 4FRI landscape. The 4FRI Stakeholder Group will also create a Multi-party Monitoring Board (Monitoring Board) which will work with the USFS to oversee monitoring prioritization, implementation, data storage, and assessment. All monitoring results, including positive progress toward desired conditions and unexpected benefits or challenges, will be used for stakeholder learning and developed into outreach material for broader dissemination.

The selected indicators are based on the desired conditions derived from the forest plans and integrated into the Rim Country Project. The emphasis of this project is the restoration of a fire-adapted ecosystem. Restoration is defined as "the process of assisting the recovery of resilience and adaptive capacity of ecosystems that have been degraded, damaged, or destroyed. Restoration focuses on establishing the composition, structure, pattern and ecological process necessary to make terrestrial and aquatic ecosystems sustainable, resilient and healthy under current and future conditions" (FSM 2020.5). This monitoring and adaptive management plan outlines how we will use a multi-scaled suite of indicators and sampling strategies to assess the changes that result from management activities and determine the degree to which they meet the purpose and need and move toward desired conditions. Monitoring is intended to determine whether management activities positively affect the ecological processes within the project area and across the greater landscape.

While the four forest initiative area as a whole encompasses a 2.4-million acre landscape, this Rim Country project area only represents approximately one-half of that area, 1.24 million acres. This monitoring and adaptive management plan details the framework and process for monitoring within this project area; however, we intend to apply it across the entire initiative area.

Adaptive Management Process

The 4FRI Rim Country Project, like the 1st 4FRI EIS, is a long-term forest restoration effort that is unprecedented in scale in the southwest region. Implementation of the entire project is anticipated to take more than 20 years. Coupled with this size and scope, the project is occurring as the southwest is experiencing increased climatic changes, such as periods of extended drought and increased temperatures—the effects of which are unknown or, at a minimum, untested. The uncertainties inherent in a project of this magnitude mandate that management activities be flexible to accommodate needed modifications. This adaptive management plan is intended to provide information that can help the USFS respond to changing conditions and new knowledge. Adaptive management refers to a "rigorous approach for learning through deliberately designing and applying management actions as experiments" (Murray and Marmorek 2003). Monitoring of alternative management actions provides the data for the adaptive management process. When used in an adaptive management framework, monitoring should link landscape management with learning, and ultimately allow for improved efficiency in planning and implementation.

The USFS and Stakeholder Group have collaboratively developed the monitoring and adaptive management plan by taking the desired conditions, and selecting a suite of indicators and metrics that best measure trends toward those desired conditions. To assure that adequate metrics are used to assess trends, the indicators were selected based on attributes that can be easily measured, are precise, are sensitive to changes over time, and that satisfy multiple objectives of the monitoring process (Eagan and Estrada-Bustillo 2011, Moote 2011, Derr et al. 2005). Once the indicators were selected, triggers (sometimes described by thresholds) were identified that signify a movement towards an undesired outcome; triggers can help indicate whether or not a change in management is advisable. In some cases, the most current scientific knowledge still does not provide sufficient information to identify quantitative triggers; when this occurs, monitoring data will be analyzed to help develop triggers for future management.

To assure success of the monitoring program, a clear link describing how monitoring information will be utilized in future decision-making is essential (Noon 2003, Williams 2009). In the past, this has been achieved administratively (Mulder et al. 1999, Sitko and Hurteau 2010), legally via the NEPA process (Buckley et al. 2001, CERP 2009), or through collaborative agreements (Gori and Schussman 2005, Greater Flagstaff Forest Partnership 2005). When there is sufficient information to develop a threshold that suggests a trend away from the desired conditions, this plan goes on to describe and outline the potential adaptive management actions. Initially, when a trigger or threshold is reached, the monitoring framework focuses on the need to assess if or how management actions have contributed to the outcomes. The USFS and the Multi-party Monitoring Board will collaboratively evaluate the monitoring data and other relevant data to establish causal relationships. Based on the evaluation, follow-up actions will be developed. These may include, for example, continued monitoring, collecting more refined data, implementing the existing adaptive management action, or developing a new adaptive management action. The 4FRI Stakeholder Group may choose to recommend adaptive management actions to the USFS. USFS staff may also develop new adaptive management actions internally. This is a collaborative process; however, ultimately, the deciding official determines what management actions will be implemented.

As the project matures and baseline data is collected, thresholds can be refined to describe specific quantitative ranges that will trigger adaptive management actions. Stakeholders and the USFS are committed to a strong adaptive management process. Concerned stakeholders are more likely to support management actions if they are confident that the results from those actions are not only carefully monitored, but are also used to modify future actions (Rural Voice for Conservation Coalition 2011). As such, we expect that the Stakeholders will continue to work closely with the USFS and recommend adaptive management actions.

This monitoring and adaptive management plan is intentionally designed as a living document. There is an expectation that indicators, metrics, methods, thresholds, adaptive management actions, and monitoring priorities will change (adapt) over the course of the project as information is gained and new questions are revealed. The USFS will collaborate with the 4FRI Stakeholder Group as we make changes and assess monitoring priorities throughout the life of this document.

However, adaptive management activities and their anticipated effects must fall within the scope of those analyzed within the FEIS. If management activities or effects are anticipated to exceed that scope, additional NEPA analysis may be required.

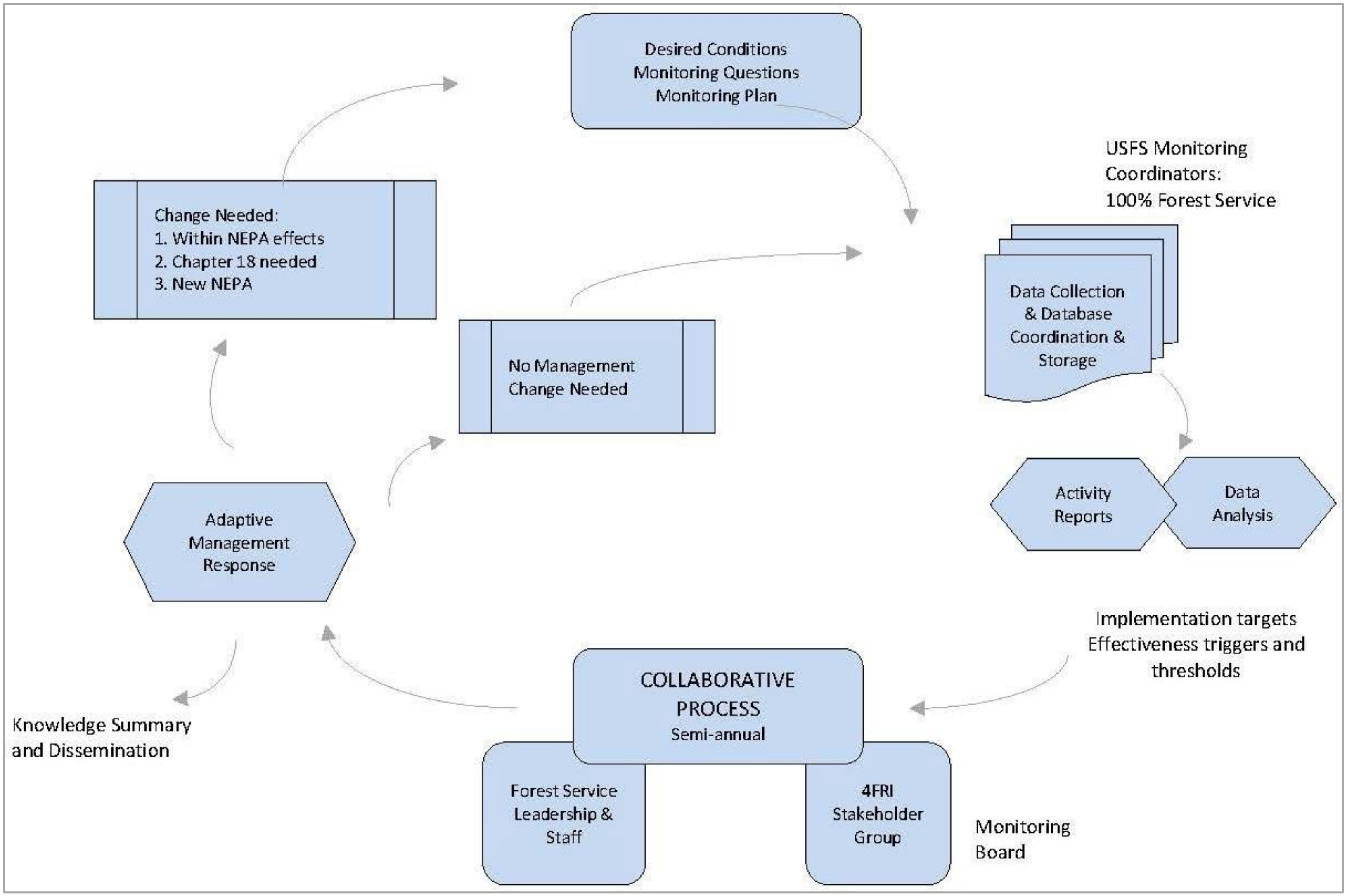

Figure 100. 4FRI Adaptive Management Process

Monitoring

Requirements for Monitoring

4FRI is supported by multiple federal mandates, regulations, and funding programs. As such, there are different monitoring requirements for each of these programs.

Collaborative Forest Landscape Program

In 2010, 4FRI was selected for funding under the Collaborative Forest Landscape Program. The purpose of the Collaborative Forest Landscape Program is to encourage the collaborative, science-based ecosystem restoration of priority forest landscapes through a process that: 1) encourages ecological, economic, and social sustainability; 2) leverages local resources with national and private resources; 3) facilitates the reduction of wildfire management costs, including through reestablishing natural fire regimes and reducing the risk of uncharacteristic wildfire; and 4) demonstrates the degree to which various ecological restoration techniques achieve ecological and watershed health objectives and affect wildfire activity and management cost; and where the use of forest restoration byproducts can offset treatment costs while benefitting local rural economies and improving forest health (U.S. Congress 2009).

Section g-3 of the Act specifies annual reporting on the accomplishments of each selected project. Annual reporting includes: 1) a description of all acres treated and restored through projects implementing the strategy; 2) an evaluation of progress, including performance measures and how prior year evaluations have contributed to improved project performance; 3) a description of community benefits achieved, including any local economic benefits; 4) the results of multi-party monitoring, evaluation, and an accountability process. Items 1-3 are compiled locally and sent to the USFS Washington Office for annual reporting. The multi-party monitoring (Item 4) focuses on effectiveness monitoring, and reporting timeframes are dependent on the variables or measures but will be included in the 5, 10, and 15-year Collaborative Forest Landscape Restoration Act reporting. Multi-party indicator monitoring is accomplished through a partnership of the USFS and partner funding and staff.

The Collaborative Forest Landscape Restoration Program requires multi-party monitoring and reports at 5, 10, and 15 years post the authorizing Act (2009). These include national indicators to assess project goals. Each year, the Four Forest Restoration Initiative receives congressionally appropriated funds under the CFLN budget line item. The amount varies annually; however, the USFS agrees to dedicate 10 percent of the annual CFLN funds to monitoring activities.

Monitoring activities covered by this 10 percent allocation are expected to include some of the pre-treatment monitoring, post-treatment effectiveness monitoring and TES species monitoring; however, it will not typically cover implementation monitoring which is funded through the operational budget. More details are provided below.

As the first acres of task orders or contracts within the 4FRI Rim Country project area are implemented, monitoring activities will test the assumptions within this document, verify that activities are moving toward the desired conditions, and help refine the adaptive management process. The USFS may use funding sources other than CFLN to support monitoring; however, collaborative partners are expected to support monitoring efforts by soliciting and contributing both in-kind and monetary funds from other sources. National forests may complete project-level implementation and compliance monitoring with funding from stewardship retained receipts (see Stewardship Contracting below), as outlined in FSM 2409.19 Section 67.2, when there is interest and support from local collaborative partners. Retained receipts may defray some of the direct costs of local multi-party monitoring and support the collaborative monitoring process by paying for facilitation, meeting rooms, travel, incidental expenses, data collection, and dissemination of monitoring findings to the public.

Stewardship Contracting

Stewardship contracting is only one of several administrative tools that can be used for project implementation. While the use of stewardship contracts is beyond the scope of this NEPA analysis, there are monitoring requirements associated with stewardship that have been included in this collaboratively-developed monitoring and adaptive management plan. Currently, the authorizing language for stewardship contracting only requires programmatic process monitoring of: 1) the status of development, execution, and administration of stewardship contracts or agreements; 2) the specific accomplishments that have resulted; and 3) the role of local communities in development of agreements or contract plans.

Types of Monitoring

Ecological (also referred to as environmental) monitoring is generally undertaken to determine whether the current state of the biophysical system matches or is trending toward some desired condition (Noon 2003). When conducted systematically, monitoring can provide valuable feedback regarding the effects of land management on resource conditions (Palmer and Mulder 1999, Lindenmayer and Likens 2010).

Social monitoring is done to assess society's perceptions on an issue or groups of issues. Changes in these perceptions are assessed through time as issues change in scope or context.

Economic monitoring is done to assess the economic impact of the 4FRI Rim Country Project. Monitoring activities related to land management can be further classified into three categories: implementation, effectiveness, and validation (Busch and Trexler 2003).

Implementation monitoring is designed to determine the extent to which a management activity was carried out as designed (did we do what we said we were going to do?). Implementation monitoring is closely associated with process monitoring as described above.

Effectiveness monitoring tracks the extent to which the management activity achieved its ultimate objective. Effectiveness monitoring refers to an assessment of treatment effects, considered alongside other factors that may affect outcomes (including grazing history, variations in annual precipitation, etc.), rather than to measuring whether they were applied as intended or whether they validate a pre-existing concept.

Validation monitoring assesses the degree to which underlying assumptions about ecosystem relationships are supported (Block et al. 2001, Busch and Trexler 2003). Validation monitoring is often closely associated with research and is not integrated in this monitoring plan.

Monitoring: Desired Conditions, Indicators, Thresholds, and Triggers

Should probably insert a statement in here about methods (to the effect that proposed methods represent examples of how monitoring could be accomplished rather than something set in stone).

A vital component of a successful adaptive management and monitoring program is an explicit statement of desired conditions. As proposed activities are implemented, monitoring efforts use indicators to determine what progress is being made in moving toward desired conditions. Thresholds and triggers can be considered as benchmarks that inform management direction (i.e., maintain or modify) (Ringold et al. 1999, Lindenmayer and Likens 2010). These desired conditions should provide information that results in timely adjustment of management activities to better meet objectives and support informed decision making (Noon et al. 1999, Noon 2003).

In the 4FRI monitoring program, the monitoring indicators are organized by desired conditions that guide the project strategy. The desired conditions are derived from forest plans and integrated into the Rim Country project. The desired conditions and the associated monitoring indicators, thresholds, and triggers are presented in Table E-3. Quantitative standards have been used wherever possible, but many of the desired conditions are qualitative and generalized. Indicator ranges have been described where possible for both desirable as well as undesirable conditions. Triggers and thresholds were developed through literature reviews, expert input, and social values.

Prioritization: Monitoring Tiers

Financial resources (both USFS and Stakeholder contributions) will be dedicated to monitoring. However, it is well understood that there will be insufficient funds to monitor all the indicators over the entire treatment area. A Multi-party Monitoring Board will meet periodically to, among other things, prioritize indicator monitoring and identify geographic locations to be monitored. Budgetary limitations will dictate how much and what type of monitoring can be accomplished.

Implementation/compliance monitoring will meet legal and regulatory requirements (Table E-3) and will be completed annually by the Forest Service using the operational budget. Effectiveness monitoring is also a priority and a key component in meeting our adaptive management goals; however, only a subset of the Rim Country treatment areas will be monitored and, at any one location, only some of the monitoring indicators will be assessed. To help the Multi-party Monitoring Board determine what effectiveness monitoring will be accomplished with available funds, this plan provides a tiered system for monitoring.

Prioritization of the indicators within each tier is expected. All of the Tier 1 indicators need not be monitored before those in Tier 2. Monitoring activities described in the Mexican Spotted Owl sections will take priority over all other monitoring activities since the biological opinion provided by the U.S. Fish and Wildlife Service is contingent upon that monitoring. Indicators associated with socioeconomic monitoring are considered Tier 1 and will be prioritized along with all of the biophysical indicators.

As new information becomes available and new questions are raised, the indicators or their order of priority may change. Research which is a part of validation monitoring is independent of implementation and effectiveness monitoring and will be funded strictly by external entities. The results of relevant research should inform future monitoring prioritization and adaptive management decisions. Table E-1 displays the effectiveness monitoring tiers and how they will be prioritized.

Table 128. Effectiveness monitoring tiers and prioritization

Monitoring Tier	Priority for Completion	Who Will Complete	Type of Monitoring	Type of Funding
Tier 1	1	Multiparty USFS Stakeholders Agency Partners	Effectiveness	Appropriated, Partner
Tier 2 (includes research)	2	Multiparty USFS Stakeholders Agency Partners Research Advocate	Effectiveness, Research, Validation	Appropriated, Partner, Research Advocate

Monitoring Scale

The 4FRI Rim Country Project will implement management activities at scales beyond those typically used in the management of the national forests. As such, it is helpful to provide clarification of the scales described in this document. The Forest Service and the Stakeholders sometimes use different terms to describe the same scales. For example, the Forest Service, at times, uses the term watershed to represent areas ranging in size from 10,000 acres to 100,000 acres. However, stakeholders consider some of the sizes within that range to be a treatment area and some to be a firescape. Table E-2 provides a crosswalk of the terminology used by the Forest Service and the Stakeholders to describe various spatial scales. For ease of understanding, all terms have been simplified and grouped as “fine” or “broad” scale indicators. In some cases, it is appropriate to measure an indicator at both scales. However, this does not preclude monitoring efforts that may make finer distinctions; for example, some monitoring can occur at both, or either, the “group” and “site” scale, depending on the questions and information needed to make informed decisions.

Table 129. Scale Terms Used by Stakeholders and USFS*

Size in Acres	Stakeholders: 4FRI Landscape Strategy	USFS: 4FRI Rim Country EIS	Desired Conditions and Monitoring Indicators used in the Monitoring Plan
< 1	Group		Fine
1-1,000	Site	Stand	Fine
1,000-10,000	Treatment Area	Treatment Area	Broad
10,000-100,000	Treatment Area / Firescape	Watershed	Broad
100,000-1,000,000+	Firescape, Analysis Area, Landscape	Project Area	Broad

*These terms aren’t really being used in the new analysis. Summary statistics are being calculated primarily at HUC5 watersheds which are more or less at the range of restoration units. There isn’t really a treatment area level (except in the contracting sense)

Implementation Monitoring Plan

Introduction: Implementation monitoring is designed to determine the extent to which a management activity was carried out as designed. Not only is this a regulatory requirement, but also a means by which the Forest Service is able to demonstrate measureable progress toward the desired conditions derived from the forest plans and integrated into the Rim Country Project. Appendix C describes the design features, best management practices (BMPs), and mitigation and conservation measures that are common to all action alternatives. (Need to update reference to the most current location) Appendix D contains the Rim Country Implementation Plan. The direction in these appendices are the foundation for all management activities.

Indicator: We employ two indicators to monitor implementation. The first is a quantitative measure of area, volume, or distance treated for each natural resource. The second measure is compliance: either the activities were completed in full compliance with all design features, best management practices, and mitigations, or they were not.

Scale: As these indicators are related to implementation, they are evaluated at a spatial scale of either the treatment unit area or full task order area.

Method: Compliance with the design features, BMPs, mitigations and conservation measures, and the implementation plan will be evaluated at multiple stages. Initial field visits will validate the predicted ground conditions. Based on the information gathered during these visits, the silviculturist will use both, the guidance found in Appendix C and Appendix D, and the site-specific conditions based decision framework (flexible toolbox) to develop appropriate treatment prescriptions for each stand. The relevant direction will be brought forward as needed into contract documents. The contract administrators will monitor day-to-day activities of the contractors as they implement the treatments to ensure compliance. After the task order or contract is completed, resource specialists will also evaluate the finished product to ensure that there is full compliance.

Quantitative implementation monitoring ensures compliance through annual reporting requirements.

Data Source: The data sources for compliance indicators are typically sale administrators who monitor the day-to-day execution of each task order, agreement, or contract; or resource specialists who conduct post-project inspections. The data sources for quantitative indicators are the Forest Service databases of record.

Cost: The cumulative cost associated with ensuring compliance and proper reporting across all the resource areas is expected to range from $500,000 – $700,000 annually. The costs cover contract administration, inspection, data recording and resource specialist reviews.

Trigger/Threshold: The trigger for adaptive management is a compliance failure or failure to report land management activities.

Adaptive Management: In the event of a compliance issue, the adaptive management action will be to re-evaluate the implementation process to determine the source of the failure and, if necessary, develop additional compliance monitoring protocols. In the event of a reporting failure, the reports will be corrected to properly reflect the relevant land management activities.

The reporting process will be re-evaluated and additional assurance measures may be put in place.

Table 130. Implementation monitoring questions and indicators

Monitoring Questions Derived from Desired Condition	Monitoring Indicator	Assessment Method	Frequency of Measurement
Are ponderosa pine restoration treatments occurring within the project area?	Acres thinned /green tons removed, acres prescribed burned	Database Records	Reported annually
If mechanical treatments occurred, were they implemented in accordance with design features, BMPs, mitigation measures and the silvicultural implementation guide?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did treatments designed to naturalize non-system roads occur?	Miles of road effectively closed to motor vehicle traffic	Database Records	Reported annually
If roads were closed to motor vehicle traffic, were the treatments implemented in accordance with design features, BMPs, and mitigation measures? When appropriate, were adaptive actions employed as described in chapter 2, Table 19?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
If roads were used, were they maintained or rehabilitated after use in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
If roads were used, were undesired impacts to surrounding resources minimized or mitigated in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
If temporary roads were created, were they decommissioned prior to the close of the associated task order as required in the Collaborative Forest Landscape Restoration Act?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did management activities minimize or mitigate undesired impacts to scenery, recreation resources and recreation opportunities in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did management activities minimize or mitigate undesired impacts to soil and water in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did management activities maintain or promote long-term soil productivity in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did channel restoration treatments occur?	Miles and acres of channel restored	Database Records	Reported annually

Monitoring Questions Derived from Desired Condition	Monitoring Indicator	Assessment Method	Frequency of Measurement
If channel restoration treatments occurred, were they implemented appropriately using the aquatic toolbox and in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did management activities minimize impacts to water resources in a manner that adheres to the Clean Water Act, State and Federal Water Quality Standards, and the intergovernmental agreement between the Southwestern Region and the ADEQ	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did management activities occur in Mexican spotted owl habitat?	Acres of vegetation treated/green tons removed, acres prescribed burned, acres burned in managed fire	Database Records	Reported annually
If management activities occurred in Mexican spotted owl habitat, were they implemented in accordance with design features, BMPs, mitigation measures, and the project biological opinion?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Were design features, BMPs, mitigation measures and forest plan requirements met for not only threatened, endangered, sensitive species, but also the other wildlife species listed in Appendix C?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did treatments designed to reduce or manage noxious weeds and invasive species occur?	Acres treated	Database Records	Reported annually
Did management activities minimize or mitigate the spread of noxious weeds, invasive species or non-native species in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did management activities minimize or mitigate undesired impacts to sensitive plants and preserve special areas in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did management activities adequately protect Bebb’s willow from fire and ungulates in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did management activities prevent, minimize or mitigate damage to grazing range sites and infrastructure in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review

Monitoring Questions Derived from Desired Condition	Monitoring Indicator	Assessment Method	Frequency of Measurement
Did management activities limit disruption to grazing activities and ensure post-fire range readiness in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did range, silviculture, and fire managers ensure that sufficient surface fuels were present in accordance with design features, BMPs, and mitigation measures prior to implementing planned prescribed fires?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did range managers ensure range readiness in accordance with design features, BMPs, and mitigation measures prior to resuming livestock grazing after a management activity or fire?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Were planned prescribed fires coordinated with neighboring forests and other affected agencies and communities?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did prescribed fires occur in accordance with ADEQ requirements and did they minimize or mitigate undesired impacts to wildlife, soil, water, vegetation and air quality in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did management activities minimize old and large tree mortality?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did management activities result in reduced potential for uncharacteristic wildfires effects?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did the Forest Service consult with the SHPO, ACHP and tribes as required and comply with the requirements of the NHPA and the Southwestern Region PA with the AZ SHPO?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Did management activities prevent, minimize or mitigate undesired impacts to cultural resources in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review
Was the public provided information and notification related to vegetation treatments and prescribed fires in accordance with design features, BMPs, and mitigation measures?	Compliance	Contract inspection and specialist review	Ongoing and at post-project review

Biophysical Monitoring Plan

Biophysical Monitoring for Structure and Pattern

The USFS distinguishes between desired conditions related to pattern versus those related to structure. Structure relates to the age distribution and the vertical spatial arrangement of the overstory of the forest, while pattern refers to the horizontal distribution of vegetation across a stand or a landscape.

Relevant Desired Conditions

Conservation of Biological Diversity:

a. Ponderosa pine ecosystems provide the necessary … structure, abundance, distribution… that contributes to the diversity of native plant and animal species…
b. Where fire use is not possible, mechanical treatments are designed to restore and/or maintain forest structure over time.
c. Ponderosa pine ecosystems are composed of all age and size classes within the analysis area and are distributed in patterns more consistent with reference conditions.
d. Ponderosa pine ecosystems are heterogeneous in structure and distribution at the analysis area scale. Openings and densities vary within the analysis area to maintain a mosaic appropriate to support resilience of individual trees and groups of trees.

Ecosystem Resilience:

a. Ponderosa pine ecosystems are restored to more natural tree densities in order to maintain availability of moisture and nutrients to support adaptation to climate change without rapid, large-scale type shifts.

Conservation and maintenance of soil, water, and air resources:

a. Forest structure supports a variety of natural resource values and processes, including hydrologic function, which meets ecological and human needs.
b. Forest openings are designed to improve snow accumulation and subsequent soil moisture and surface water yield.

Description and Justification

Many of the desired conditions related to structural components of ponderosa pine forests specify a need for heterogeneous forests that more closely approximate reference conditions.

Investigations of historical ponderosa pine conditions indicate that forests were generally open in structure wherein trees occurred in multi-aged clumps of differing size among abundant understory plant communities (Mast et al. 1999, Waltz et al. 2003, Sánchez Meador et al. 2011). It has been suggested that restoration treatments that focus on creating this structure of uneven-aged tree groups interspersed with openings of various sizes will provide the greatest benefit in terms of biological diversity and ecosystem function (Sabo et al. 2009, Kalies et al. 2010).

Determining the extent to which restoration treatments benefit and affect native plant and animal diversity will require a multi-scaled approach to characterizing several aspects of structural diversity. Wildlife and plants respond to their environment across multiple spatial and temporal scales (Wiens 1989). Indeed, management that creates or maintains structural complexity at the stand or patch scale while preserving a diverse assemblage of stands (or patches) that differ in size and spatial arrangement at broader scales has been identified as a necessary component of managing forested systems for diversity (Lindenmayer et al. 2006). Understanding the contribution of forest structure and composition to biodiversity is further complicated by the potential existence of "domains of scale" (i.e., areas where a process may behave predictably, but beyond which the process may change in an unpredictable and non-linear way) and that any single scale of measurement is likely to be arbitrary with respect to the process of interest (Wiens 1989).

Forest structure is a multi-dimensional attribute that is not assessed adequately by any single measure. Similarly, heterogeneity in forest structure occurs at multiple scales requiring multiple indicators (Cushman et al. 2008). Thus, two distinct sets of indicators will be used to assess changes in forest structure that result from 4FRI-implemented treatments.

Fine-scale Assessment

Tier 1 Suggested Indicators: Age Structure, spatial aggregation

- Age Structure (Diameter Distribution): While collecting this information pre-treatment and post-treatment will likely require a fairly intensive field effort, it will allow us to measure structural complexity in terms of age (size) structure and will also provide information for calculating changes in density and basal area that result from treatment.
    - ♦ Assessment: Field sampling of tree diameter (both pre- and post-treatment) of treated sites
    - ♦ Frequency: Immediately post-treatment (either mechanical or prescribed fire); every 10 years thereafter.
    - ♦ Threshold/Trigger: No threshold determined for this indicator. Also see implementation plan which includes if and how the Large Tree Implementation Plan will be used for specific task orders.
    - ♦ Adaptive Management: Evaluate reasoning for implementing large tree removal. If needed, appropriate adaptive management actions will be developed.
- Spatial Aggregation (Ripley's K and/or Getis Ord): Measures of spatial aggregation can be used to determine "patchiness". Statistical tests such as Ripley's K and Getis Ord can be used to describe spatial properties such as the distribution and clustering of trees as well as canopy cover. These properties can be compared to those of "restored" areas to measure our progress towards historic conditions.
    - ♦ Assessment: Freely available pre- and post-treatment aerial photography of stands identified for treatment
    - ♦ Frequency: Immediately post-treatment (either mechanical or prescribed fire) or as soon as appropriate aerial photography becomes available; every 10 years thereafter.
    - ♦ Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
    - ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.

Broad-Scale Assessment

Tier 1 Suggested Indicators: Canopy openness, patch size, patch configuration, patch diversity, and patch evenness.

- Canopy Openness (Percent and Characteristics of Openings): Because many of the treatment types being applied within 4FRI are designed explicitly to achieve a particular post- treatment percentage of canopy openness, we will measure the pre- and post-treatment percentage of canopy cover. This indicator in conjunction with the spatial aggregation statistics can help describe the degree to which 4FRI treatments are achieving "patchiness" and the degree to which those patches vary. Also, tracking the size and orientation of forest openings is important to determine their impacts on snowpack accumulation and retention that affect soil moisture, plant- available soil water and system resilience to climate variability.
  - ♦ Assessment: Multiple tools, including some developed by the Remote Sensing and Application Center (RSAC) to process input images (NAIP, LiDAR, etc.) into canopy/ non canopy patches and assess for spatial pattern (Landscape Indices, FRAGSTATS) or field methods where appropriate.
  - ♦ Frequency: Immediately post-treatment (either mechanical or prescribed fire) or as soon as appropriate aerial photography becomes available; every 3-10 years thereafter.
  - ♦ Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available. TBD
  - ♦ Adaptive Management: Assess potential sources of deviation, including prescription and implementation; increase monitoring efforts in future task orders.
- Patch Size (Patch area, Patch density, Patch Size Distribution): Patch area is a fundamental quantity for understanding landscape composition that can be used both to calculate a variety of other indicators as well as model species richness, occupancy, and distribution in conjunction with field data. Patch density can be used as an index for spatial heterogeneity across a landscape, but has the added utility of being comparable across areas of differing size (e.g., comparisons between treatment areas or watersheds) (McGarigal and Marks 1995). Distribution of patch size provides information on the variability of patch sizes within a particular class (e.g., groups, openings, etc.). These data, in conjunction with mean patch size, can provide information on key aspects of landscape heterogeneity and composition, particularly as patch size changes as a result of restoration treatments. These indicators can provide an indication of the ability of restoration treatments to achieve heterogeneity (and diversity) at spatial extents beyond the stand-level and can be calculated within the freely available FRAGSTATS program (McGarigal et al. 2002).
  - ♦ Assessment: Categorical maps (e.g., groups, openings, etc.) based on satellite imagery and/or aerial photography
  - ♦ Frequency: Annually to track broad-scale change or when suitable imagery becomes available.
  - ♦ Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
  - ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.
- Patch Configuration (Nearest neighbor distance distribution and Contagion): These two indicators provide information on landscape configuration (i.e., the spatial arrangement of patches, treatment

areas, etc.). Nearest neighbor distances that are narrowly distributed (i.e., little variation) tend to indicate a fairly even distribution of patches across the landscape. Contagion measures both the intermixing of different patch types as well as their spatial distribution. These two indicators provide a characterization of heterogeneity in terms of landscape configuration (i.e., spatial relationships among differing patch types) and has been used to characterize a variety of different landscapes (McGarigal and Marks 1995, Cushman et al. 2008). These indicators are also available within FRAGSTATS (McGarigal and Marks 1995, McGarigal et al. 2002).

- ♦ Assessment: Categorical maps (e.g., groups, openings, etc.) based on satellite imagery and/or aerial photography
- ♦ Frequency: Annually to track broad-scale change or when suitable imagery becomes available.
- ♦ Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
- ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.

- Diversity and Evenness (Simpson's Diversity and Evenness Indices): These measures have been historically associated with estimates of species diversity; however, in this case they are being used to assess the diversity of patch types across the landscape. Simpson's diversity index represents the probability that any two randomly drawn patches will be of a different type. A higher value indicates greater diversity of patch types. Similarly, larger values of evenness indicate greater landscape diversity (i.e., less dominance by any particular patch type). FRAGSTATS implements a variety of diversity and evenness indices; however, these were selected because they are considered easier to interpret (McGarigal and Marks 1995, Magurran 2004).
    - ♦ Assessment: Categorical maps (e.g., groups, openings, etc.) based on satellite imagery and/or aerial photography
    - ♦ Frequency: Annually to track broad-scale change or when suitable imagery becomes available.
    - ♦ Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
    - ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.

Tier 1 Suggested Indicators: Soil moisture relative to forest opening size and orientation.

- Forest openings, depending on their size and orientation, promote greater snowpack accumulation and retention and hence greater soil water storage (Baker and Ffolliott 2003). Deeply rooted plants, such as mature ponderosa pines, that depend on moisture from winter precipitation are expected to be the most affected by changes in snowpack. Per-tree plant- available soil moisture is expected to be higher in thinned ponderosa pine stands than in unthinned stands (Zou et al. 2008), which should promote plant vigor, resilience to climate variability and perhaps even resistance to wildfire. If, however, restoration treatments (when considered alongside other factors, including grazing) push soil moisture in the opposite direction, recognizing such a trend is critical information that can direct adjustments in treatment approaches. Monitoring of lower elevations, south facing slopes and shallow soils that are susceptible to drying are a priority.

- Assessment: Soil moisture measurements made using soil moisture probes, portable Time Domain Reflectometer (TDR) and/or gravimetric analysis at shallow and deep rooting depths according to a statistical design. Soil moisture may be analyzed within the context of a paired watershed study, but additional monitoring could also be conducted at sensitive sites such as lower elevations, south facing slopes and shallow soils
- Frequency: Pretreatment, post-treatment, annually during pre- and post-monsoon water stress periods
- Threshold/Trigger: Trends of decreasing soil moisture (after adjusting for climatic variability) in stands with similar treatment types and/or physiographic characteristics.
- Adaptive Management: Evaluate treatments and make adjustments in treatment methods and forest pattern as appropriate, especially at lower elevations, on south facing slopes and on shallow soils that are susceptible to drying.

Monitoring for Composition

Relevant Desired Conditions

Conservation of Biological Diversity

a. Ponderosa pine ecosystems provide the necessary … composition… that contributes to the diversity of native plant and animal species…
b. Viable, ecologically functional populations of native species that include common, listed, rare, and sensitive species persist in natural patterns of distribution and abundance.
c. All pre-settlement trees are retained.
d. Understory vegetation composition and abundance are consistent with the natural range of variability.
e. Protect old-growth forest structure during planned and unplanned fires. [Implementation Monitoring]
f. Natural and prescribed fires maintain and enhance but do not degrade habitat for listed, rare, and sensitive species.
g. Habitat management is contributing to the recovery of listed species.
h. Planned an unplanned fires support diverse native understory communities and their associated biodiversity.
i. Populations of native species occur in natural patterns of distribution and abundance.

Ecosystem Resilience

a. There is reduced potential for introduction, establishment, and spread of invasive species. Additionally, efforts are made to reduce existing infestations.
b. Exotic species are rare or absent and do not create novel ecological communities following disturbance.

Conservation and Maintenance of Soil, Water, and Air Resources:

Emissions factors, smoldering and smoke residence times are reduced as fires burn more grass and less green or woody biomass over time.

Description and Justification

Many desired conditions are specified to reflect a number of aspects of forest composition. Both the USFS desired conditions for ponderosa pine and 4FRI Stakeholder desired conditions identify certain patch components (e.g., Gambel oak (Quercus gambelii), snags, coarse woody debris, and old-growth) that contribute disproportionately to habitat values and the diversity of a patch or landscape (Bennetts et al. 1996, Kotliar et al. 2002, Bunnell and Houde 2010). In contrast, desired conditions for the understory and wildlife are specified both for their contributions to diversity and their ability to indicate ecosystem functionality.

Monitoring of understory composition could be used as an indication of both ecosystem resilience and soil productivity. Reductions in overstory pine volumes can be correlated with increased understory production (Laughlin and Grace 2006, Laughlin et al. 2005), and this increased understory productivity is a key assumption being used in the 4FRI NEPA analysis. However, stand replacing wildfire in ponderosa pine forests may lead to shifts toward exotic, invasive species dominance in understory plant communities (Crawford et al. 2001). Minimal or temporary increases over time in invasive species populations indicate high ecological resilience. Establishment and rapid spread of invasive species populations may lead to native species replacement and indicate low ecological resilience. Additional consideration for soil properties will be given below; however, for the purposes of this document soil productivity is interpreted as the ability of the soil to sustain native vegetation.

Many of the desired conditions for wildlife species are specified with respect to both viability and natural patterns of distribution and abundance. Historically, viability has been difficult or impossible to assess particularly when resources are limited due to the difficulty of gathering reliable estimates of all of the relevant population rates. Literature searches can provide a valuable starting point; however, case studies of viability rarely reveal generalizations useful for conservation management (Traill et al. 2007). As a potential solution to this issue, Flather et al.

2011 recommend focusing on those factors most likely to cause declines in a species such that it may become unviable particularly when the demographic data necessary for calculating fitness or viability are unknown. Monitoring of population response (particularly productivity and abundance) of threatened, endangered, and rare species should be focused on those areas directly impacted by treatment (e.g., Mexican Spotted Owl Protected Activity Centers within some yet to be determined distance of restoration treatments or wildfire) as these are likely to be directly impacted by the presence of personnel, equipment, and infrastructure associated with treatments and disturbance.

The majority of species affected by 4FRI are likely to be affected through changes in habitat particularly at larger scales. Site occupancy can be used in a monitoring context to reflect the current state of the population, and, through multi-season extensions, provide information related to population trends. Estimating occupancy often require fewer detections than other density estimation techniques allowing for more precise estimates of rare or infrequently detected species (MacKenzie et al. 2003, MacKenzie et al. 2005). Furthermore, efforts to relate occupancy to habitat-relevant covariates allow estimation and prediction of changes in population state due to coarser-scale changes in land-use and climate (e.g., Dickson et al. 2009, Mattsson and Marshall 2009). Deriving these habitat-occupancy relationships using high-resolution satellite imagery provides the opportunity to identify the impacts of more localized changes (e.g., forest restoration treatments) across larger spatial scales.

Monitoring for forest composition will require both field measurements and sophisticated modeling techniques to determine the degree to which restoration treatments are achieving desired conditions at all scales. Given uncertainties in the response of both wildlife and invasive species, this monitoring is especially important. Many of the indicators identified below will require significant resources to assess. Financial support from stakeholders and other organizations will be required to adequately monitor these indicators.

Fine-scale Assessment

Tier 1 Suggested Indicators: Rare Ecosystem Elements (Springs Protection)

- Forest restoration thinning has the potential to improve the hydrogeology of springs by increasing soil water storage and groundwater recharge (McCarthy and Dobrowolski 1999). Because springs create rare habitat for multiple threatened species as well as more common wildlife species, understanding the relationship between treatments and spring responses is critical for making adaptive management decisions to optimize springs restoration projects. A collaborative group with skills in spring assessment is available to assist the Forest Service in selecting springs for monitoring and restoration.
  - ♦ Assessment: Groundwater Dependent Ecosystems Protocol (USDA FS 2011) or similar appropriate protocols
  - ♦ Spring discharge measurements
  - ♦ Frequency: Pre- and post-treatment, every two years following treatment for the first 6 years after treatment, then every 5 years.
  - ♦ Threshold/Trigger: No net increase in facultative and obligative wetland species at springs or wet meadows targeted for both forest and spring restoration. Decrease in spring discharge (adjusted for climate variation) following treatments.
  - ♦ Adaptive Management: Review spring restoration techniques. Review treatment methods in the recharge area. Make appropriate adjustments.

Tier 1 Suggested Indicators: Understory Species Composition (Percent Foliar Cover, Percent Bare Ground)

- Native species composition and the percentage of bare mineral soil provide an indication of soil productivity. In addition, restoration treatments have potential to increase abundance of native plant communities (Laughlin et al. 2006, Moore et al. 2006, McGlone et al. 2009b); however, invasive plant species may also increase in cover on sites where restoration thinning, prescribed fire, and livestock grazing occur (McGlone et al. 2009b). Native plant communities that are minimally disturbed during thinning or burning activities may better resist compositional shifts toward invasive species (Korb et al. 2004, McGlone et al. 2011). While assessment at the “Group” scale is not necessary, stand-scale assessment will require field sampling that can be accomplished more easily with university and volunteer partners.
  - ♦ Assessment: Field collected quadrats.
  - ♦ Frequency: Within 5 years of treatment for cover. Within 5 years of treatment for bare soil. Within 10 years of treatment for seedlings
  - ♦ Threshold/Trigger: Within 5 years of mechanical treatment, the cover should increase 20 percent +/- 5 percent (15-25 percent) above controls (Laughlin et al 2011). Within 5 years of treatment (mechanical and/or fire), bare soil should comprise less than 20 percent of area affected by treatment. Within 10 years of treatment, seedling and sapling density should be within 0.4 to 3.6 plants/hectare/decade on basalt soils (Mast et al 1999).

- Adaptive Management: If cover threshold is not reached, then re-evaluate treatment for management change, taking into account soils and burn treatment (e.g. reduce overstory basal area). If bare soil exceeds 20 percent of area within plots, re-evaluate restoration treatment for modification. If seedlings and saplings fall below this range at broad scales where regeneration is a desired condition, then evaluate implementation of BMPs to increase probability of successful regeneration. If regeneration falls above this range, then more aggressive prescription burning may be necessary to reduce plant density.

Tier 1 Suggested Indicators: Understory Species Composition (Invasive species)

With regards to invasive species control, the first and most important management strategy is preventing the establishment or spread of invasive species. The best way to achieve this is by increasing the health and resilience of native plant communities. Below is a list of species most likely to be affected by management.

Watch List: These species are currently not known to fall within 4FRI treatment areas, and if they do show up and are detected, aggressive eradication efforts should be a top priority and applied quickly.

These species include Malta starthistle (Centaurea melitensis L.), Russian olive (Eleagnus angustifolia), Himalayan blackberry (Rubus armeniacus and Rubus discolor), giant reed (Arundo donax), sulfur cinquefoil (Potentilla recta), tree of heaven (Ailanthus altissima), Siberian elm (Ulmus pumila), halogeton (Halogeton glomeratus), dyer’s woad (Isatis tinctoria), Eurasian water-milfoil (Myriophyllum spicatum), oxeye daisy (Leucanthemum vulgare), and Canada thistle (Cirsium arvense).

High Risk: These species currently have limited geographic distribution within 4FRI treatment areas, and if current inventories indicate their presence within treatment areas, these species should be eradicated immediately.

These species include leafy spurge (Euphorbia esula), camelthorn (Alhagi maurorum), yellow starthistle (Centaurea solstitalis), spotted knapweed (Centaurea biebersteinii), diffuse knapweed

(Centaurea diffusa), Russian knapweed (Acroptilon repens), white top (Cardaria draba), Mediterranean sage (Salvia aethiopis), Scotch thistle (Onopordum acanthium), tamarisk (Tamarix spp.), common teasel (Dipsacus sylvestris), and musk thistle (Carduus nutans).

Medium Risk: These species have widespread distribution within 4FRI treatment areas in large populations, with either no effective treatment, or cost-prohibitive effective treatment, or for which effectiveness of current treatment strategies is unknown or not monitored. Areas should be prioritized for treatment based on risk to conservation value (presence or proximity of TES species) and areas of high wildlife habitat value (e.g., pine- sagebrush ecotones). Weed treatment strategies be monitored for effectiveness to gauge return on investment.

These species include Dalmatian toadflax (Linaria dalmatica), bull thistle (Cirsium vulgare), and wild oats (Avena fatua).

Cheatgrass (Bromus tectorum): Cheatgrass invasion of ponderosa pine systems after restoration- based treatments is a burgeoning issue of significant concern (Keeley and McGinnis 2007, McGlone et al. 2009a and b). Widespread invasion of cheatgrass often shifts invaded ecosystems into irreversible alternate stable states where cheatgrass-mediated fire intervals exclude native understory plants (Brandt and Rickard 1994, D’Antonio and Vitousek 1992, Brooks et al. 2004). Means of prevention and treatment have not been adequately tested or found successful in ponderosa pine systems; however the risk of ecological transformation caused by cheatgrass warrants aggressive monitoring and adaptive management in the 4FRI project. Preventative actions pre-treatment will be just as critical as adaptive management responses post-treatment, and will require identification of areas at risk for cheatgrass invasion prior to project implementation, such as areas where cheatgrass is already present or ecotonal areas adjacent to existing cheatgrass populations.

- Assessment: Percent cover of native and non-native species based on field sampling.
- Frequency: Pre- and immediately post-disturbance (i.e., mechanical thinning, prescribed fire, and wildfire); every 5 years thereafter.
- Thresholds/Triggers: Identification of new or existing "watch list" or "high risk" invasive species populations. Identification of new or existing "medium risk" invasive species populations. Identification of areas at high risk of cheatgrass introduction or spread.
- Adaptive Management: If inventories, surveys and map checks indicate presence of high risk or watch list species (see narrative), evaluate all BMPs, especially for cleaning equipment moving from infested sites to clean sites and management activities (including grazing) that may be a contributing factor. Consider aggressive treatments leading to population eradication or modifications to other management activities. If treatments do not reduce the cover of "watch list" species by 90 percent in one year or "high risk" species by 50 percent in 2 years, consider new approaches to eradication.

If inventories, surveys and map checks indicate presence of medium risk species (see narrative), consider controlling these species on individual basis especially when high value areas or habitats are at risk. If treatments do not reduce the cover of "medium risk" species by 20 percent in 5 years, consider new approaches to weed management.

If inventories, surveys and map checks indicate areas with a high risk of cheatgrass introduction or spread, treatments could include (but should not be limited to):1

- Chemically treating and native reseeding of small infestations of cheatgrass prior to thinning and burning
- Avoiding whole-tree skidding and other actions that cause significant soil disturbance
- Removing slash and avoiding creation of large slash piles resulting from thinning operations
- Properly manage grazing so that perennial grasses are maintained
- Deferring burns in heavily infested areas
- Delaying burns and lengthening fire return intervals post-thinning to allow native perennials time to establish
- Applying native, perennial seed (e.g., bottlebrush squirrel tail, which has shown promise in successfully competing with cheatgrass) after fire.
- Cleaning equipment and clothing after working in infested areas

Tier 2 Suggested Indicators: Old trees

- Old Trees (Number of Old Trees): The 4FRI Landscape Strategy places a large emphasis on pre-settlement trees. Furthermore, higher levels of biodiversity have been attributed to those areas that still contain old-growth components (Binkley et al. 2007) and these components may be susceptible to mortality immediately post-treatment (Fulé et al. 2007, Roccaforte et al. 2010). Evidence suggests, however, that this mortality can be avoided through a variety of "protection" measures and that over time restoration treatments can increase the vigor of old trees (Kolb et al. 2007).

- ♦ Assessment: Rapid assessment conducted while collecting diameter distribution data on plots (or use of aerial imagery once techniques become available)or other evidence
- ♦ Frequency: Immediately post-treatment (either mechanical or prescribed fire); every 5 years thereafter
- ♦ Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
- ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.

Tier 2 Suggested Indicators: Habitat Suitability (Occupancy Probability)

- Occupancy, in cases where sample sizes are large, can be defined as the proportion of total area occupied and can provide a useful alternative to density or abundance, especially for uncommon species (MacKenzie et al. 2006). More generally, occupancy can also be interpreted as the probability of locating an individual of species x in location y. This interpretation (probability of occupancy) reflects an a priori expectation that a site will be occupied based on a hypothesis

  If cheatgrass begins to dominate at broad scales after thinning and burning treatments within the 4FRI project area, consider delaying further treatments in areas of high risk until the Forest Service, stakeholders and experts can be convened to evaluate alternative management options about the underlying process determining occupancy. The former interpretation (proportion of area occupied) is the realization of that process, given large sample sizes (MacKenzie et al. 2006). Higher probabilities of occupancy may be interpreted to indicate more "use" of a habitat by a particular species. Information on songbird occupancy (based on existing Rocky Mountain Bird Observatory Data) will be used to evaluate changes in songbird species richness and its associated adaptive management strategy.

  - ♦ Assessment: Field surveys of presence & absence at both treated and untreated sites
  - ♦ Frequency: Immediately post-treatment and every 2 years thereafter
  - ♦ Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
  - ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.

Tier 1 Suggested indicator: Songbird Species Richness (Jackknife2, Chao 2, or ICE Species Richness Estimator)

- While estimating the changes in the aforementioned forest structural components provides some indication of how 4FRI treatments may be contributing to diversity goals, documenting the ways in which restoration treatments facilitate ponderosa pine forests contribution to native diversity ultimately requires knowledge of how diversity is changing over time. We anticipate that the abundance of species will change due to treatment and incidence or occurrence-based estimators are a way of documenting the actual change in the number of species. These incidence based species richness estimators have been shown to be more accurate and potentially less biased than historical estimators of species richness (e.g., Shannon's Index, Simpson's Diversity Index) (Walther and Moore 2005). These estimators can be computed within EstimateS, (http://viceroy.eeb.uconn.edu/estimates), a freely available diversity-estimation software program, using existing, ongoing surveys conducted by Bird Conservancy of the Rockies in conjunction with the Forests.

- ♦ Assessment: Field sampling of communities of interest (e.g., songbirds)
- ♦ Frequency: Immediately post-treatment (either mechanical or prescribed fire); every 3-5 years thereafter.
- ♦ Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
- ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.

Tier 2 Suggested Indicators: Rare Ecosystem Elements (Percent Cover of Gambel Oak, Aspen, and other Riparian Communities)

- Oak, aspen, and riparian areas contribute heavily to the diversity of ponderosa pine forests in the Southwest. For example, pine-oak forests tend to have a greater diversity of songbirds and small mammals than ponderosa forests that lack an oak component (Block et al. 2005, Jentsch et al. 2008). Removal of overstory competition from ponderosa pine and more regular low-severity fire are likely to alter the cover and composition of the oak component within treated stands. Removal of ponderosa pine competition may also encourage aspen regeneration and increase the size of riparian communities due to increases in available water.
    - ♦ Assessment: Assessment of plot-based percent cover while collecting diameter distribution data (or use of aerial imagery once techniques become available)
    - ♦ Frequency: Immediately post-treatment (either mechanical or prescribed fire); every 5 years thereafter
    - ♦ Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
    - ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.

Tier 2 Suggested Indicators: Snags, rare ecosystem elements, understory species composition; responses of rare, sensitive, threatened, and endangered species; habitat "suitability", species richness, evenness

- Snags (Number, Size Distribution, Condition): The number and size of snags present will be sampled within treated sites due to their role in providing valuable habitat for a variety of wildlife species (e.g., Kotliar et al. 2002) and the potential for restoration treatments to alter snag composition within treated sites (Bagne et al. 2008, Hessburg et al.2010). In addition, assessing the condition of the snags (sound vs. soft) can provide an indication of the expected longevity for those snags.
    - ♦ Assessment: Rapid assessment conducted while collecting diameter distribution data on plots (or use of aerial imagery once techniques become available)

- ♦ Frequency: Immediately post-treatment (either mechanical or prescribed fire); every 5 years thereafter
- ♦ Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
- ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.

Broad-Scale Assessment

Tier 1 Suggested Indicators: Response of Rare, Threatened, and Endangered Species and Regional Sensitive Species (Population trends)

- Treatments conducted under 4FRI may affect rare, threatened, or endangered species through a variety of mechanisms and at a variety of scales. This is particularly true for wildlife species such as the Northern Goshawk and Mexican Spotted Owl. Understanding the effects of treatment on productivity (and thus viability) of these species likely requires a research effort beyond the scope of the monitoring proposed here. We will monitor Mexican Spotted Owl as directed by the biological opinion provided by U.S. Fish and Wildlife Service. Northern Goshawk will be monitored according to the field protocols established in the USFS National Goshawk Inventory Guidelines or as appropriate based on approved methods.
  - ♦ Assessment: Mexican spotted owl monitored as directed in the U.S. Fish and Wildlife Service biological opinion. Northern goshawk occupancy monitored using USFS protocols (USDA FS 2006) or as appropriate based on approved methods.
  - ♦ Frequency: In accordance with the aforementioned protocols.
  - ♦ Thresholds/Triggers: As directed in the Mexican spotted owl section of the U.S. Fish and Wildlife Service biological opinion. If northern goshawk occupancy trends show a decline over a 5 to 10 year average at treatment and 4FRI landscape scales.
  - ♦ Adaptive Management: As directed in the Mexican spotted owl section of the U.S. Fish and Wildlife Service biological opinion and in consultation with U.S. Fish and Wildlife Service. Evaluate treatments and consider increasing or focusing monitoring on area where northern goshawk is declining. Consider comparing to regional monitoring data trends. As a high profile species, additional monitoring may be conducted even if the decline is not a statistically significant.

Tier 2 Suggested Indicators: Wildlife Response (Landscape Predictions of Songbird Species, Richness)

- Field assessment of these indicators (with the exception of connectivity) can be used in conjunction with remotely sensed habitat covariates to track changes at larger scales and provide information on landscape distribution patterns. In addition, hierarchical modeling could provide a multi-scalar inference by using other information collected from other field assessments identified here. These models can be used to create “map-based” depictions of occupancy and richness that can then be summarized at multiple scales. Development and subsequent validation of these models will be especially critical for threatened, endangered, sensitive, and rare species and will likely require partnership with research institutions. Ongoing field assessment of songbird populations and the subsequent ability to estimate occupancy as a function of forest structural covariates will be critical for this indicator.

- ♦ Assessment: Field sampling in conjunction with remote sensing
- ♦ Frequency: Annual interpretations of new satellite imagery
- ♦ Thresholds/Triggers: Any non-zero decline over a 5-year period within the functional groups listed below.
- ♦ Adaptive Management:
  - i. Closed Canopy Species: Evaluate data and best science available. Adaptive management could include implementing one of the following changes:
    - ▪ Increase group density for all treatments.
    - ▪ Increase group size for all treatments.
    - ▪ Reduce intensity of UEA 40-55 treatments within the treatment category to be applied to the next round of task orders.
    - ▪ Identify 25 percent of planned UEA 40-55 treatments and reduce intensity to 25- 40 interspace.
  - ii. Open Canopy Species: Evaluate implementing one of the following changes:
    - ▪ Increase the size of openings in all treatment types.
    - ▪ Identify 25 percent of planned UEA 25-40 treatments and increase intensity to 40-55.
  - iii. Pine-Sage Species: Alter timing of treatment to reduce impacts on sage; Delay post-treatment burning to allow sage recover
  - iv. Pine-Oak Species: Evaluate implementing one of the following changes:
    - ▪ Restrict ungulate access to stands to allow oak regeneration.
    - ▪ Increase emphasis on management of oak component in non-“Restricted Habitat” stands.

Tier 2 Suggested Indicator: Landscape Connectivity and Permeability

- Changes in landscape connectivity and permeability for several species representing closed canopy (black bear OR grey fox) and open canopy (pronghorn) conditions. Building connectivity models for species that are predicated on various aspects of patch structure, density, and orientation provides an opportunity to evaluate the effects of landscape heterogeneity on a key ecosystem process. Furthermore, these models can be validated through the use of telemetry studies, a property not shared by fire models (our other landscape metric). While a variety of factors can and do influence connectivity, the models will be formulated to reflect specific hypotheses related to landscape structure.
  - ♦ Assessment: Field sampling in conjunction with remote sensing
  - ♦ Frequency: Immediately post-treatment; five years post-treatment, ten years post-treatment
  - ♦ Thresholds/Triggers: Restriction in bear/fox movement after treatment (reduced connectivity between patches)
  - ♦ 79. No increase in pronghorn movement after treatment
  - ♦ 80. Adaptive Management:
    - i. Bear/Fox: Evaluate implementing one of the following changes:

- Increase group size.
- Decrease treatment intensity within known pathways

ii. Pronghorn: Evaluate implementing one of the following changes:

- Increase opening sizes.
- Increase treatment intensity within known pathways

Biophysical Monitoring for Function (or Process)

Relevant Desired Conditions

- Conservation of Biological Diversity:
  - ♦ Ponderosa pine ecosystems provide the necessary processes that contributes to the diversity of native plant and animal species
  - ♦ Natural disturbance processes (e.g., fire, drought-mortality, endemic levels of forest pests and pathogens) are the primary agents shaping forest ecosystem structure, dynamics, habitats, and diversity over time.
  - ♦ There is low potential for unnaturally severe fire to spread at broad scales.
  - ♦ Wherever practicable, natural fire regimes regulate forest structure and composition.
  - ♦ Planned and unplanned fires support diverse native understory communities and their associated biodiversity.
- Ecological Resilience:
  - ♦ Ponderosa pine ecosystems in the 4FRI are capable of adapting to or persisting with climate change without rapid, large scale type shifts.
  - ♦ Low intensity frequent fire operates as the primary natural process maintaining forest structure and function.
  - ♦ Mixed severity fire is sometimes used as a restoration tool in appropriate ecological and social settings (e.g., non-wildland-urban interface areas) to restore and maintain natural forest types[Implementation Monitoring – not addressed in this document]
  - ♦ Forest insects and pathogens occur and operate at endemic levels.
  - ♦ Ponderosa pine ecosystems in the 4FRI are capable of regeneration and recovery following natural disturbance (e.g., fire, outbreaks of insects and pathogens).
  - ♦ A majority of the ponderosa pine ecosystems supports frequent, low-intensity fire.
  - ♦ Mixed severity fire is used as a restoration tool where it is consistent with reference conditions and safe to do so. [Implementation Monitoring – not addressed in this document.]
  - ♦ Natural disturbance processes (e.g., fire, endemic pests, and pathogens) are within the natural range of variability.
  - ♦ Strategically placed treatments allow fire managers to safely manage planned and unplanned natural ignitions fires in a way that benefits and enhances the resilience of forest ecosystems.
  - ♦ Restoration results in forests that are trending toward natural variability, self- regulating, and positioned to adapt to climate change without large, rapid type shifts.

- Conservation of Soil, Water, and Air Resources:
  - ♦ Soil productivity, watershed function, and air quality are not at risk of being degraded by uncharacteristically severe disturbances (e.g., landscape level high- severity fire).
  - ♦ Sensitive soils are protected through use of appropriate timber harvesting equipment and techniques to reduce erosion and sedimentation that could otherwise damage aquatic life, increase flooding, reduce reservoir capacity, and increase costs of maintaining infrastructure in the vicinity of waterways. [Implementation Monitoring]Fire is used as a management tool to support hydrologic function while minimizing impacts to soils and other natural resource values. [Implementation Monitoring]
  - ♦ Rare and ecologically valuable springs and wet meadows are protected and enhanced through appropriate restoration treatments where needed.
  - ♦ Ponderosa pine vegetation treatments are implemented so as to minimize negative impacts to water quality, soil productivity, and air quality. Short- term impacts are minimized through the implementation of best management practices and strategies.
  - ♦ Restored ponderosa pine ecosystems accommodate natural and other fires without uncharacteristic impacts to soil productivity and or watershed resources.
  - ♦ Ponderosa pine vegetation within the analysis area is managed strategically and at a level appropriate to prevent degradation of air quality beyond regulatory standards (through wildland fire or managed fire).
  - ♦ Hydrologic processes are re-established to restore springs and wet meadow ecosystems.
  - ♦ Strategically placed treatments allow fire managers to manage planned and unplanned fires in locations, seasons and conditions that maximize smoke dispersion and minimize smoke impacts.
  - ♦ Stable, restored ecosystems foster watersheds that yield enhanced water quantity and quality and are resilient to climatic variability.

Description and Justification

The majority of 4FRI desired conditions focus on the need to maintain ecosystem processes within the natural range of variability. While the desired conditions are numerous, indicators for assessing them fall into several major categories: ecosystem type shifts, fire size and severity, forest pests and pathogens, soil stability and sedimentation, and the generation of smoke.

An ecosystem that is resilient shows persistence in relationships and low probability of extinction (Holling 1973). A resilient system absorbs fluctuations in state variables (e.g., population numbers) and processes. Persistence and return of characteristic ecosystem structure and function following disturbance indicate high ecological resilience. Rapid, large-scale type shifts indicate low ecological resilience.

Future climate models for the southwestern United States predict warmer and drier conditions (Seager et al. 2007). Potential impacts of climate changes include increased tree morality as a function of drought, fire, and pathogens. In addition, tree regeneration may be affected by loss of seed trees and drought-induced seedling mortality. Potential impacts of climate change are likely to be exacerbated under current forest conditions. Restoration treatments in ponderosa pine forests have the potential to increase growth and vigor of residual trees, lower potential for crown fire, provide growing space and microsites for tree regeneration, and increase available resources for native plant communities (Laughlin et al. 2006, Kolb et al. 2007, Roccaforte et al. 2008). Such effects are likely to buffer the ecosystem against climate change and enhance resilience at fine to coarse scales (Fulé 2008).

Ponderosa pine forests were historically resilient and persisted under a frequent, low-intensity fire regime. Current forest conditions are outside the historical range of variability in terms of tree density and structure. Fire under current structural conditions has greater potential to be stand- replacing, indicating conditions of low ecological resiliency. Restoration treatments that reduce forest density and fuel loading can in turn reduce potential for stand-replacing crown fire (Fulé et al. 2001, Roccaforte et al. 2009).

Ponderosa pine trees are coevolved with native insect herbivores and pathogens. Forests with endemic levels of insects and pathogens do not experience large-scale and long-term type shifts. Epidemic levels of insects and pathogens may lead to rapid ecological shifts, which represents conditions of low ecological resilience.

Bark beetles, dwarf mistletoe, and to some extent, root diseases are the major damaging insects and pathogens of ponderosa pine forests (Wilson and Tkacz 1996). Overly dense forest conditions may lead to increased susceptibility to these agents and result in extensive tree mortality (Wilson and Tkacz 1996, Negrón et al. 2000). Restoration thinning can enhance tree resistance to various insects and pathogens (Kolb et al. 2007). Severe fire effects, whether from prescribed burning or wildfire, can increase susceptibility to damaging insects and pathogens (McHugh et al. 2003).

Hydrologically, there are five fundamental watershed functions, and two secondary functions: (1) collection of the water from rainfall, snowmelt, and storage that becomes runoff, (2) storage of various amounts and durations, (3) discharge of water as runoff (4) sediment transport, and (5) groundwater recharge. In fact, the first and third of these functions have long been incorporated in the commonly-used terms, "catchment" and "watershed"; storage is the inevitable consequence of water being detained within an area between "catching" and "shedding." Ecologically, the watershed functions in two additional ways: (1) it provides diverse sites and pathways along which vital chemical reactions take place, and (2) it provides habitat for the flora and fauna that constitute the biological elements of ecosystems. Large, uncharacteristically severe wildfires such as the Rodeo- Chediski, Schultz and Wallow have had deleterious effects on watershed function through downcutting of channels, soil erosion, and excessive sediment transport (Gottfried et al. 2003, Moody and Martin 2009). Mechanical thinning and prescribed burning can help maintain hydrologic function of ponderosa pine forests. Yet, side effects of restoration treatments, such as soil compaction from heavy equipment and fire-related damage to the soil biotic community and soil nutrient balance, must be monitored, particularly in the context of other ongoing management activities (including grazing) to inform adaptive management.

Smoke is a natural consequence of ponderosa pine forest material combustion, and can be managed through a variety of prescribed conditions that managers use in controlling fire, including fuel moisture content, fuel loading and arrangement, air temperature, relative humidity, wind direction and speed, and seasonality of burn (lower atmosphere ventilation). Smoke from forest combustion is also a contributor to visual haze, and the timing, amount, and quality of its generation from controllable sources such as prescribed burns is regulated by the Arizona Department of Environmental Quality (ADEQ) because of smoke’s impacts on human health.

While restoration activities accomplished by 4FRI will generate a substantial amount of smoke, coordinated efforts to manage underlying and prescribed conditions will help to mitigate the amount and quality of smoke released, and reduces total impacts on air quality.

With the exception of tree mortality and regeneration dynamics, the ecosystem processes described above operate at broad scales. Thus, assessing progress towards desired conditions will require a variety of remotely sensed and modeled data to interpret the effects of restoration treatments within the context of the larger landscape. Developing more robust and accurate models of these processes will benefit greatly from information gathered as part of a field sampling effort.

Fine-Scale Assessment

Tier 2 Suggested Indicators: Tree mortality, regeneration, insect pathogen dynamics, fuel hazard

- Tree Mortality (Stand Density, Basal Area, and Species Composition): Monitoring for desired conditions with respect to ecosystem type shifts should focus on tree mortality and tree regeneration. Values for stand density, basal area, and percentage species composition can be used to track tree mortality as well as contribute to determining effects of restoration treatments on fire behavior.
    - ♦ Assessment: Field sampling within treated sites
    - ♦ Frequency: Immediately post-treatment and every five years thereafter
    - ♦ Thresholds/Triggers: No threshold has been identified for this indicator. It will be developed as new information becomes available.
    - ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.
- Regeneration (Density of Seedlings, Poles and Saplings): Regeneration is the second critical component of determining whether type shifts are occurring. These measurements require field sampling since it is not possible to assess regeneration accurately using remote sensing technology.
    - ♦ Assessment: Field sampling within treated sites
    - ♦ Frequency: Immediately post-treatment and every five years thereafter
    - ♦ Thresholds/Triggers: No threshold has been identified for this indicator. It will be developed as new information becomes available.
    - ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.
- Insect and Pathogen Dynamics (Bark Beetle Rating, Dwarf Mistletoe Rating, and Number of Trees Affected by Pests/Pathogens): Monitoring of insects and pathogens should focus on levels of tree mortality as described above. In addition, bark beetle and mistletoe rating systems (Hawksworth 1977, Sánchez-Martínez and Wagner 2002) should be used in field plot measurements in order to track changes in levels of occurrence.
    - ♦ Assessment: Field sampling within treated sites
    - ♦ Frequency: Immediately post-treatment and every five years thereafter
    - ♦ Thresholds/Triggers: No threshold has been identified for this indicator. It will be developed as new information becomes available.

- ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.

- Fuel Hazard (Crown Bulk Density, Crown Base Height, and Surface Fuel Loading): Monitoring of forests' potential to support frequent, low-intensity fire should be focused on structural conditions and fuel loading.
  - ♦ Assessment: Field sampling within treated sites
  - ♦ Frequency: Immediately post-treatment and every five years thereafter
  - ♦ Thresholds/Triggers: No threshold has been identified for this indicator. It will be developed as new information becomes available.
  - ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.
- Stream quality (Physical Morphology, Aquatic Habitat Suitability (abiotic and biotic) for native fish and invertebrates, and Native Obligate Plant and Animal Species):
  - ♦ Monitoring of aquatic habitat quality should be focused on the structural characteristics, biotic and abiotic conditions that support productive aquatic habitat and the associated riparian biota.
  - ♦ Assessment: Field sampling within treated sites
  - ♦ Frequency: TBD
  - ♦ Thresholds/Triggers: Decrease in channel condition and aquatic habitat indices after accounting for non-treatment factors such as climate variability.
  - ♦ Adaptive Management: Evaluate source of degradation and address through changes in actions. Consider adding mitigation measures or structural improvements to stream.
- Surface Water Response (Baseflow discharge, Period of Perennial Flow, Precipitation/Runoff Response):
  - ♦ Monitoring of surface water flow should be focused on the precipitation events and surface water flow.
  - ♦ Assessment: Field sampling within treated sites
  - ♦ Frequency: Short term (1-5 year) and long term (10-30 year)
  - ♦ Thresholds/Triggers: Significant decreases in baseflow and wetted areas or significant increases in peak flows downstream of treatment areas
  - ♦ Adaptive Management: If increase in peak flow or decrease in baseflow, evaluate treatment methods and/or BMPs (bare ground, skid trails, burn intensity, etc.) and consider making adjustments or implementing additional mitigation measures.

Broad-Scale Assessment

Tier 1 Suggested Indicators: Fuel/fire hazard, fire occurrence, soil and watershed function

- Fuel/Fire Hazard (Crown Bulk Density, Crown Base Height, Surface Fuel Loading, and Predicted Fire Behavior): These indicators allow assessment of the ability of restoration treatments to meet strategic goals with respect to large-scale, uncharacteristically severe fire. Data to assess these conditions can be obtained from remote sensing techniques (Landfire updates and future LIDAR as data becomes available), although ground truth and calibration plots are likely to be necessary.

- ♦ Assessment: Remote sensing information
- ♦ Frequency: Immediately post-treatment and every five years thereafter
- ♦ Thresholds/Triggers: No threshold has been identified for this indicator. It will be developed as new information becomes available.
- ♦ Adaptive Management: Evaluate the potential causes and develop appropriate adaptive management actions.

- Fire Occurrence (Severity and Size of Fires, Acres of High Severity Fire, Total Acres Burned,): As restoration progresses, the size and severity of wildfire should decrease. Use of freely-available information from the Monitoring Trends in Burn Severity program and Forest- level databases on managed fire can be used to assess how treatments affect size and severity of fires. It should be noted that this assessment is limited to those portions of the landscape where restoration treatments are complete.
  - ♦ Assessment: Monitoring Trends in Burn Severity data
  - ♦ Frequency: Available annually for all fires larger than 1000 acres
  - ♦ Thresholds/Triggers: Patch size of adjacent pixels expressing stand replacing fires is greater than 50 acres after 5 years. Patch size of adjacent pixels expressing stand replacing fires is greater than 10 acres after 10 years
  - ♦ Adaptive Management: Evaluate the potential causes (e.g. number of acres treated, prescription type) and develop appropriate adaptive management actions.
- Groundwater Response (Subsurface water spring/seep flow and riparian soil moisture):
  - ♦ Monitoring of groundwater flow should be focused on the water flow at springs and seeps and indicators of persistent soil moisture in associated riparian areas.
  - ♦ Assessment: Field sampling within treated sites
  - ♦ Frequency: TBD
  - ♦ Thresholds/Triggers: Changes in subsurface water, spring/seep flow, riparian soil moisture after accounting for non-treatment factors such as climate variability
  - ♦ Adaptive Management: If decrease or no change in subsurface water, evaluate treatment methods and consider changing treatment intensity.
  - ♦ If increase in subsurface water, consider replicating treatment methods elsewhere.

Tier 1 Suggested Indicator: Soil and Watershed Function (Sensitive Soils Protection)

- Highly and moderately erodible soils and slopes are classified within the Terrestrial Ecosystem Survey Units (TESU). Forest management activities are planned to avoid impacting these areas to reduce compaction, erosion, and sediment transport downstream. TESU maps can be overlain with management activity maps to ensure that protection has occurred, and field plots could sample areas where mitigation measures were implemented to assess the percentage of area that has been affected.

- While the USFS Soil Disturbance Protocol (Page-Dumroese et al. 2009) is a useful qualitative method for evaluating soil impacts from operator actions and for guiding BMPs and mitigation. This information can be supported with additional quantitative measurements that can be used in statistical analyses of trends (DeLuca and Archer 2009).
    - ♦ Assessment: Remotely sensed data, TESU maps, field plots, Forest Disturbance Monitoring Protocol 2009 (WO82A and WO82B), Bulk density and infiltration capacity
    - ♦ Frequency: Immediately post -treatment and every 5 years thereafter, with more frequent follow -up in heavily impacted places to assess recovery
    - ♦ Thresholds/Triggers: Soil disturbance is over 15 percent of the treated area; Increasing bulk density trend; Decreasing infiltration rate trend
    - ♦ Adaptive Management: Evaluate treatment methods and/or BMPs, and consider making adjustments or implementing additional mitigation measures

Tier 2 Suggested Indicators: Tree mortality, Airshed function

- Tree Mortality (Canopy Cover, Number of Pathogen-affected Patches, Size of Mortality Patches, and Percent of Landscape in Mortality Patches): These indicators can help assess changes in mortality dynamics across the larger 4FRI landscape particularly those that result from endemic pests and pathogens. Freely available data from the National Agricultural Image Program (NAIP) and the National Forest Health Monitoring (NFHM) Program can be used to generate these estimates.
    - ♦ Assessment: NFHM assessment and NAIP imagery
    - ♦ Frequency: NFHM data is available annually, NAIP imagery is available every 3 years
    - ♦ Thresholds/Triggers: No threshold has been identified for this indicator. It will be developed as new information becomes available.
    - ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.
- Airshed Function (Air Quality): There are air quality attainment goals for each geographical “airshed” dictated by ADEQ. Several measures could be used to qualitatively assess the contribution of prescribed burning activities toward the attainment of those ADEQ goals including: the percent of prescribed burns within prescriptions that reduce smoke generation, the percent (by area) of prescribed fires conducted during high ventilation periods (May -September), modeled outputs of smoke from burned slash piles (grams/hectare treated), modeled outputs of smoke from broadcast burns (grams/hectare) and modeled output of smoke avoided from uncharacteristic wildfire (grams/hectare)
    - ♦ Assessment: Model runs, ADEQ attainment or exceedance ranking
    - ♦ Frequency: During prescribed and other burns
    - ♦ Thresholds/Triggers: No threshold has been identified for this indicator. It will be developed as new information becomes available.
    - ♦ Adaptive Management: No management action has been identified at this time. However, once a threshold has been identified, the corresponding data will be thoroughly reviewed and appropriate adaptive management actions will be developed.

Table 131. Broadscale Assessment

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
1	1	Composition	Effects to Threatened or Endangered Species are within those disclosed in the Biological Assessment for the 4FRI project	As directed in the U.S. Fish and Wildlife Service (USFWS) biological opinion	Various	As directed in the biological opinion	Broad Scale	As described in the biological opinion for this project	As directed in the Mexican spotted owl section of the USFWS biological opinion and in consultation with USFWS	Mexican spotted owl survey $10/acre; PAC survey $175
2	1	Composition	Effects to Regional Forester designated Sensitive species within those disclosed in the Sensitive Species Biological Analysis/ Evaluation for the project	Forest trends	Various	Regional field protocols	Broad Scale	When indicator trends suggest a need for listing under the Endangered Species Act	As appropriate in consultation with USFWS	TBD

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
3	1	Structure	There is reduced potential for introduction, establishment, and spread of invasive species. Additionally, efforts are made to reduce existing infestations.	Invasive Plants	Species cover	Field methods	Fine Scale	Identification of new or existing “watch list” or “high risk” invasive species populations	If inventories, surveys and map checks indicate presence of 'high risk' or 'watch list' species (see narrative), evaluate all BMPs, especially for cleaning equipment moving from infested sites to clean sites and management activities (including grazing) that may be a contributing factor. Consider aggressive treatments leading to population eradication or modifications of other management activities. If treatments do not reduce the cover of “watch list” species by 90 percent in one year or “high risk” species by 50 percent in 2 years, consider new approaches to eradication.	$80/acre

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
4	1	Structure	There is reduced potential for introduction, establishment, and spread of invasive species. Additionally, efforts are made to reduce existing infestations.	Invasive Plants	Species cover	Field methods	Fine Scale	Identification of new or existing “medium risk” invasive species populations	If inventories, surveys and map checks indicate presence of 'medium risk' species (see narrative), consider controlling these species on individual basis especially when high value areas or habitats are at risk. If treatments do not reduce the cover of “medium risk” species by 20 percent in 5 years, consider new approaches to weed management.	$80/acre
5	1	Structure	There is reduced potential for introduction, establishment, and spread of invasive species. Additionally, efforts are made to reduce existing infestations.	Invasive Plants	Cheatgrass	Resource specialist assessment	Fine Scale	Identification of areas at high risk of cheatgrass introduction, spread, or dominance	Potential preventative measures are described in the narrative.	$80/acre

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
6	1	Structure	Restore forest structure and pattern, forest health, and vegetation composition and diversity. Ponderosa pine ecosystems are heterogeneous in structure and distribution at the analysis area scale. Openings and densities vary within the analysis area to maintain a mosaic appropriate to support resilience of individual trees and groups of trees. (Many additional)	Landscape Structure	Landscape metrics (patch characteristic s; configuration; diversity and evenness)	Remote sensing and spatial pattern analysis tools	Fine and Broad Scale	TBD	TBD	20,000
7	1	Composition	Understory vegetation composition and abundance are consistent with the natural range of variability.	Diversity and Abundance(understory communities)	Substrate and plant functional group percent cover native species	Field collected – quadrats, point – line intercept	Fine Scale	Within 5 years of mechanical treatment, the cover should increase 20 percent +/- 5 percent (15-25 percent) above controls	If this threshold is not reached, then re-evaluate treatment for management change, taking into account soils and burn treatment, (e.g. reduce overstory basal area).	*Included in Plot Costs Below

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
8	1	Composition	Understory vegetation composition and abundance are consistent with the natural range of variability.	Diversity and abundance (understory communities)	Percent Bare Soil within treatment *blocks*	*Field collected – point – line* Field collected – quadrats, point-line intercept	Fine Scale	Within 5 years of treatment (mechanical and/or fire), bare soil should comprise less than 20 percent of area affected by treatment.	If bare soil exceeds 20 percent of area within plots, re-evaluate restoration treatment for modification.	*Included in Plot Costs Below
9	1	Composition	Understory vegetation composition and abundance are consistent with the natural range of variability.	*Diversity and Abundance (understory communities)Regeneratio n*	Seedlings and saplings density	Field collected – quadrats/ *transects*	Fine Scale	Within 10 years of treatment, seedling and sapling density should be within 0.4 to 3.6 plants/hectare/ decade on basalt soils.	If seedlings and saplings fall below this range at fine where regeneration is a desired condition, then evaluate implementation of BMPs to increase probability of successful regeneration. If regeneration falls above this range, then more aggressive prescribed burning may be necessary to reduce plant density.	*Included in Plot Costs Below

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
10	1	Process	There is low potential for unnaturally severe fire to spread at broad scales.	Fuel/Fire Hazard	Crown bulk density, crown base height, surface fuels, and predicted fire behavior	Remote sensing and modeling	Broad Scale	§ No threshold has been identified for this indicator. It will be developed as new information becomes available.	Evaluate the potential causes and develop appropriate adaptive management actions.	10000
11	1	Process	There is low potential for unnaturally severe fire to spread at broad scales.	Fire Occurrence	*Modeled* severity and size of fire; acres of high severity fire; and total acres burned	Remote sensing and Modeling *using metrics from Indicator #10*	Broad Scale	§ Patch size of adjacent pixels expressing stand replacing fires is greater than 50 acres after 5 years § Patch size of adjacent pixels expressing stand replacing fires is greater than 10 acres after 10 years	Evaluate the potential causes (e.g. number of acres treated, prescription type) and develop appropriate adaptive management actions.	TBD

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
12	1	Process	Sensitive soils are protected through use of appropriate timber harvesting equipment and techniques to reduce erosion and sedimentation that could otherwise damage aquatic life, increase flooding, reduce reservoir capacity, and increase costs of maintaining infrastructure in the vicinity of waterways.	Soils	Sensitive soil protection	Remote sensing and field methods	Fine and Broad Scale	Fine Scale- § Increasing bulk density trend § Decreasing infiltration rate trend Broad Scale- § Soil disturbance is > 15 percent of the treated area	Evaluate treatment methods and/or BMPs, and consider making adjustments or implementing additional mitigation measures	TBD
14	1	Process	Sensitive soils are protected through use of appropriate timber harvesting equipment and techniques to reduce erosion and sedimentation that could otherwise damage aquatic life, increase flooding, reduce reservoir capacity, and increase costs of maintaining infrastructure in the vicinity of waterways.	Soils	Soil moisture	Soil moisture sensors, time domain reflectometer and gravimetric analysis	Broad Scale	Trends of decreasing soil moisture (after adjusting for climatic variability) in stands with similar treatment types and/or physiographic characteristics.	Evaluate treatments and make adjustments in treatment methods and forest pattern as appropriate, especially at lower elevations, on south facing slopes and on shallow soils that are susceptible to drying.	?

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
15	1	Process	Restored ponderosa pine ecosystems accommodate natural and other fires without uncharacteristic impacts to soil productivity and watershed resources.	Watershed Function	*Springs protection Spring flow and water quality*	Groundwater Dependent Ecosystems Protocol, discharge measurements	Fine Scale	Triggers: 1. No net increase in facultative and obligative wetland species at springs or wet meadows targeted for both forest and spring restoration, 2. Decrease in spring discharge (adjusted for climate variation) following treatments	Review spring restoration techniques. Review treatment methods in the recharge area. Evaluate making appropriate adjustments such as improving structure of patches and openings to promote snow accumulation and retention to enhance recharge.	TBD

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
16	1	Structure	Ponderosa pine ecosystems are heterogeneous in structure and distribution at the analysis area scale. Openings and densities vary within the analysis area to maintain a mosaic appropriate to support resilience of individual trees and groups of trees. Ponderosa pine ecosystems provide the necessary composition, structure, abundance, distribution and process that contribute to the diversity of native plant and animal species across the 2.4 million acre 4FRI landscape.	*Fine: Opening patch size, pre and post treatment* *Broad: Patch (canopy and opening) metric assessment for heterogeneity metrics: Geddis G; Edge-to-Area ratio (see text)*Canopy Openness	*Percent Canopy cover and percent opening (together = 100%);* *patch metrics (including size minimum/maximum/median/range) for both canopy and openings*	*Remote sensing, spatial pattern analysis tools or field sampling*	*Fine and Broad Scale*	§ No threshold has been identified for this indicator.	TBD	TBD

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
17	1	Structure	Viable, ecologically functional populations of native species that include common, listed, rare, and sensitive species persist in natural patterns of distribution and abundance.	Diversity (wildlife communities)	Songbird species occupancy and richness: closed canopy species	Field (RMBO songbird surveys), RS, Modeling, Statistics	Fine and Broad Scale	Fine Scale- TBD Broad Scale- Any non-zero decline over a 5-year period	Fine Scale- TBD Broad Scale- Evaluate implementing one of the following changes: § Increase group density for all treatments. § Increase group size for all treatments. § Reduce intensity of all UEA 40-55 treatments. § Identify 25 percent of planned UEA 40-55 treatments and reduce intensity to 25-40	$1000 per grid (1 grids per 1,000 acres?)
18	1	Structure	Viable, ecologically functional populations of native species that include common, listed, rare, and sensitive species persist in natural patterns of distribution and abundance.	Diversity (wildlife communities)	Songbird species occupancy and richness: open canopy species	Field (RMBO songbird surveys), RS, Modeling, Statistics	Fine and Broad Scale	Fine Scale- TBD Broad Scale- Any non-zero decline over a 5-year period	Fine Scale-TBD Broad Scale- Evaluate implementing one of the following changes: § Increase the size of openings in all treatment types. § Identify 25 percent of planned UEA 25-40 treatments and increase intensity to 40-55	TBD

Indicator No.	**Monitoring Tier**	**Ecological Framework**	**Desired Condition or Resource and monitoring Questions**	**Indicator**	**Indicator Metric**	**Method and Sampling Techniques**	**Fine Scale or Broad Scale**	**Trigger (Threshold indicating possible need for change)**	**Adaptive Management**	**Annual Cost Estimate**
19	1	Structure	Viable, ecologically functional populations of native species that include common, listed, rare, and sensitive species persist in natural patterns of distribution and abundance.	Diversity (wildlife communities)	Songbird species occupancy and richness: pine- sage species	Field (RMBO songbird surveys), RS, Modeling, Statistics	Fine and Broad Scale	Fine Scale- TBD Broad Scale- Any non-zero decline over a 5-year period	Fine Scale- TBD Broad Scale- *Evaluate implementing one of the following changes:* *§ Alter timing of treatment to reduce impacts on sage;* *§ Delay post-treatment burning to allow sage recover*	TBD
20	1	Structure	Viable, ecologically functional populations of native species that include common, listed, rare, and sensitive species persist in natural patterns of distribution and abundance.	Diversity (wildlife communities)	Songbird species occupancy and richness: pine- oak species	Field (RMBO songbird surveys), RS, Modeling, Statistics	Fine and Broad Scale	Fine Scale- TBD Broad Scale- Any non-zero decline over a 5-year period	Fine Scale- TBD Broad Scale- Evaluate implementing one of the following changes: § Increase the size of openings designated for oak regeneration § Restrict ungulate access to stands to allow oak regeneration. § Increase emphasis on management of oak component in non- “Restricted Habitat” stands	TBD

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
21	1	Composition	Viable, ecologically functional populations of native species that include common, listed, rare, and sensitive species persist in natural patterns of distribution and abundance.	Northern goshawk	Occupancy	USFS National Goshawk Inventory Guidelines or other approved methods	Broad Scale	If northern goshawk occupancy trends show a decline over a 5 to 10 year average at treatment and 4FRI landscape scales	Evaluate treatments and consider increasing or focusing monitoring on area where northern goshawk is declining. Consider comparing to regional monitoring data trends. As a high profile species, additional monitoring may be conducted even if the decline is not a statistically significant	TBD
22	1	Structure	Viable, ecologically functional populations of native species that include common, listed, rare, and sensitive species persist in natural patterns of distribution and abundance.	Diversity (wildlife communities)	Changes in landscape connectivity and permeability: bear/fox	Field sampling in conjunction with remote sensing	Broad Scale	Restriction in bear/fox movement after treatment (reduced connectivity between patches)	Evaluate implementing one of the following changes: § Increase group size. § Decrease treatment intensity within known pathways	125000
23	1	Structure	Viable, ecologically functional populations of native species that include common, listed, rare, and sensitive species persist in natural patterns of distribution and abundance.	Diversity (wildlife communities)	Changes in landscape connectivity and permeability: pronghorn	Field sampling in conjunction with remote sensing	Broad Scale	No increase in pronghorn movement after treatment	Evaluate implementing one of the following changes: § Increase opening sizes. § Increase treatment intensity within known pathways	125000

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
24	1	Structure, Composition & Process	Ponderosa pine ecosystems are composed of all age and size classes within the analysis area and are distributed in patterns more consistent with reference conditions.	Diameter Distributions	Tree diameters, density	Field Methods	Fine Scale	TBD	TBD	$2000/plot to install, $1000 to remeasure includes analysis time. (500m grid; 1 plot per 25ha, 61.2 acres)
25	2	Structure, Composition & Process	Protect old-growth forest structure during planned and unplanned fires.	Old Trees	Old tree density, conditions	Field Methods	Fine Scale	Any loss old tree that is cut outside of those identified as allowed in the Old Tree Implementation Plan	TBD; however, when an old tree is cut, the cause or rationale will be reviewed by the MPMB	(*Included in Plot costs)
26	2	Structure	*Forest insects and pathogens occur and operate at endemic levels.*	*Insects and Pathogens*	Bark beetle rating, dwarf mistletoe rating, number of trees affected by pests	Field Methods	Fine Scale	TBD	TBD	(*Included in Plot costs)

Indicator No.	**Monitoring Tier**	**Ecological Framework**	**Desired Condition or Resource and monitoring Questions**	**Indicator**	**Indicator Metric**	**Method and Sampling Techniques**	**Fine Scale or Broad Scale**	**Trigger (Threshold indicating possible need for change)**	**Adaptive Management**	**Annual Cost Estimate**
27	2	Composition	Rare and ecologically valuable springs and wet meadows are protected and enhanced through appropriate restoration treatments where needed. Oak and Aspen stands are maintained and enhanced across the landscape.	Rare/ Unique Habitats	Percent cover	Field Methods	Fine Scale	TBD	TBD	TBD
28	2	Process *Discuss is this is going to stay in the document.*	Restored ponderosa pine ecosystems accommodate natural and other fires without uncharacteristic impacts to soil productivity and watershed resources.	Watershed Function	Water balance	§ Field data: some snow water equivalence and soil moisture data § Remote sensing: snow water equivalence, soil moisture, evapotranspi ration and groundwater	Broad Scale	§ Static or decreasing soil moisture post-treatment § Static or decreasing surface water discharge § Diminished water quality (measured by turbidity and total organic carbon) § Increase in water stress (after accounting for climate variability)	Evaluate treatment methods and/or BMPs, and consider making adjustments or implementing additional mitigation measures	TBD

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
29	2	Process	Ponderosa pine vegetation within the analysis area is managed strategically and at a level appropriate to prevent degradation of air quality beyond regulatory standards (through wildland fire or managed fire).	Air Quality	Smoke output	Modeling	Broad Scale	TBD	TBD	TBD
30	2	Structure, Composition & Process	Ponderosa pine ecosystems are composed of all age and size classes within the analysis area and are distributed in patterns more consistent with reference conditions.	Snags	Snag sizes, density, conditions	Field Methods	Fine Scale	TBD	TBD	(*Included in Plot costs)
31	2	Structure, Composition & Process	Protect old-growth forest structure during planned and unplanned fires.	Tree Mortality	Stand Density, basal area, and species composition, Canopy cover, number of pathogen-affected patches, size of dead patches and percent of mortality on landscape	Field Methods, NFHM and Remote sensing	Fine and Broad Scale	TBD	TBD	(*Included in Plot costs)

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
32	2	Process	A majority of the ponderosa pine ecosystems supports frequent, low- intensity fire.	Fuel Hazard	Crown bulk density, crown base height, and surface fuels	Fuel load	Fine Scale	TBD	TBD	(*Included in Plot costs)
33		Structure and process	Watersheds, riparian, and aquatic ecosystems have functional soil, vegetation, morphology, and flow regimes, consistent with site and watershed potential. These systems provide diverse habitats for an array of native obligate and facultative plants and animal species.	Surface water in response to precipitation events	Baseflow discharge, period of perennial flow, total yield, precipitation/runoff response, flood behavior, (soil moisture?), etc.	Collect hydrograph through discharge gages; Precipitation gages/weather stations; LiDAR/ SNOTEL (for snowpack & configuration) (Some past and current data collected by: USFS, SRP, USGS, NRCS-SNOTEL gages)	Fine and Broad Scale	Address the following questions over both short-term (1-5 years) and long-term (10-30 years scales) and account for non-treatment factors such as climate variability. 1. Significant decreases in baseflow and wetted areas 2. Significant Increases in peak flows downstream of treatment areas	If increase in peak flow or decrease in baseflow, evaluate treatment methods and/or BMPs (bare ground, skid trails, burn intensity, etc.) and consider making adjustments or implementing additional mitigation measures.	

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
34		Structure and process	Watersheds, riparian, and aquatic ecosystems have functional soil, vegetation, morphology, and flow regimes, consistent with site and watershed potential. These systems provide diverse habitats for an array of native obligate and facultative plants and animal species.	Ground water level	Subsurface water, spring/seep flow, riparian soil moisture	piezometers, flow rate, soil moisture gage	Fine and Broad Scale	Changes in subsurface water, spring/seep flow, riparian soil moisture after accounting for non-treatment factors such as climate variability.	If decrease or no change in subsurface water, evaluate treatment methods and consider changing treatment intensity. If increase in subsurface water, consider replicating treatment methods elsewhere.	

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
35		Structure & Composition	Watersheds, riparian, and aquatic ecosystems have functional soil, vegetation, morphology, and flow regimes, consistent with site and watershed potential. These systems provide diverse habitats for an array of native obligate and facultative plants and animal species.	Aquatic habitat suitability for native fish, invertebrates (abiotic & biotic)	Draw from existing protocol. Possible metrics include: EPT, channel stability, channel shading, underbank cover, overbank cover, course woody debris, depth of pools, persistence of water in deep pools, substrate embeddedness, hydraulic habitat diversity, water quality, macroinvertebrate species assemblage and abundance, wet extent and persistence, water temperature, sediment loads, etc.	*Many field methods/ indices exist such as: Functional Condition of Stream-Riparian Ecosystems in the American Southwest and AGFD Native Stocking Habitat Assessment*	*Fine and Broad*	Decrease in habitat suitability indices after accounting for non-treatment factors such as climate variability.	Evaluate source of degradation and address through changes in actions. Consider adding mitigation measures or structural improvements to stream.	

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
36		Structure & Composition	Watersheds, riparian, and aquatic ecosystems have functional soil, vegetation, morphology, and flow regimes, consistent with site and watershed potential. These systems provide diverse habitats for an array of native obligate and facultative plants and animal species.	Physical morphology	Draw from existing protocol. Possible metrics include channel stability, floodplain and riparian connectivity, channel roughness, presence of meanders, bank stability.	Many field methods exist such as: Functional Condition of Stream-Riparian Ecosystems in the American Southwest and the USDA Watershed Condition Framework	Fine and Broad Scale	Degradation in condition of channel morphology/indices after accounting for non-treatment factors such as climate variability.	Evaluate source of degradation and address through changes in actions. Consider adding mitigation measures or structural improvements to riparian zone.	
37		Structure & Composition	Watersheds, riparian, and aquatic ecosystems have functional soil, vegetation, morphology, and flow regimes, consistent with site and watershed potential. These systems provide diverse habitats for an array of native obligate and facultative plants and animal species.	Native obligate plant species	Draw from existing protocol. Possible metrics include native riparian plant diversity, extent, cover, structural complexity, vigor, demography, recruitment, survival, etc.	Many field methods exist such as: Functional Condition of Stream-Riparian Ecosystems in the American Southwest and the USDA Watershed Condition Framework	Fine and Broad Scale	Decrease in extent, cover, diversity, recruitment, or survival of native riparian vegetation after accounting for non-treatment factors such as climate variability.	Evaluate source of decline and address through changes in actions. Consider adding mitigation measures or structural improvements.	

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
38		Composition	Watersheds, riparian, and aquatic ecosystems have functional soil, vegetation, morphology, and flow regimes, consistent with site and watershed potential. These systems provide diverse habitats for an array of native obligate and facultative plants and animal species.	Native obligate animal species	Draw from existing protocol. Possible metrics include species presence, species diversity, population size, recruitment, survival, demography, etc.	Standard abundance protocols by taxa.	Fine and Broad Scale	Decrease in species presence, diversity, or population size after accounting for non-treatment factors such as climate variability.	Evaluate source of decline and address through changes in actions. Consider adding mitigation measures or structural improvements.	
39		Structure and process	Watersheds, riparian, and aquatic ecosystems have functional soil, vegetation, morphology, and flow regimes, consistent with site and watershed potential. These systems provide diverse habitats for an array of native obligate and facultative plants and animal species.	Soil condition	Draw from existing protocol. Possible metrics include water-holding capacity, bulk density, soil aggradation/ erosion rates, rainfall/ runoff response directly above and downstream of focal area.	Consult soil scientists.	Fine and Broad Scale	Decrease in water-holding capacity or increases in bulk density; increase in erosion rates after accounting for non-treatment factors such as climate variability.	Evaluate source of decline and address through changes in actions. Consider adding mitigation measures or stabilization features.	

Indicator No.	Monitoring Tier	Ecological Framework	Desired Condition or Resource and monitoring Questions	Indicator	Indicator Metric	Method and Sampling Techniques	Fine Scale or Broad Scale	Trigger (Threshold indicating possible need for change)	Adaptive Management	Annual Cost Estimate
40		Structure, Composition & Process	Watersheds are properly functioning consistent with site and watershed potential.	watershed condition	12 measure metric as outlined in watershed condition framework 1. Water Quality 2. Water Quantity 3. Aquatic Habitat 4. Aquatic Biota 5. Riparian/Wetland Vegetation 6. Roads and Trails 7. Soils 8. Fire Regime or Wildfire 9. Forest Cover 10. Rangeland Vegetation 11. Terrestrial Invasive Species 12. Forest Health	USFS watershed condition framework. https://www.fs.fed.us/biology/resources/pubs/watershed/maps/watershed_classification_guide2011FS978.pdf. Existing data exists for all 5th codes	Broad scale (6th code watershed)	Decrease in metric(s)	Evaluate source of decline and address through changes in actions. Consider adding mitigation measures or stabilization features.	

Socioeconomic Monitoring

Introduction and Background

Preparation and tracking of both the social and economic impacts of the Four Forest Restoration Initiative (4FRI) project is paramount to the success of the project. Social awareness, knowledge and support coupled with economic viability, such as a prepared workforce, adequate infrastructure, and reliable wood supplies, are critical factors that will be primary drivers of the project's progression. Typically, social and economic monitoring has not been a priority and was identified as one of the five major challenges by the Rural Voice for Conservation Coalition's (RVCC) Issue Paper (2011) in stating, "There is insufficient monitoring of the social and economic impacts of land management" and they further stressed this as a key recommendation for the U.S. Forest Service (USFS). Robbins and Daniels (2011) affirm this by reiterating, "…that the socioeconomic aspects of restoration are 'underemphasized, or often ignored all together'" (Aronson et al. 2010). Thus, ensuring integration of ecological, social and economic impacts will augment effective management actions that will address multiple criteria necessary for community health and sustainability.

As the monitoring frameworks were conceptualized, beginning with a broad vision for both social and economic factors affected by restoration can be drawn from the 4FRI Stakeholder Group's foundational documents, such as the Path Forward (2010a). Within the Path Forward, the importance of integrating monitoring that includes ecological, social and economic impacts was raised in stating, "Landscape-scale restoration efforts should adopt and make full use of rigorous science, including research, monitoring, and adaptive management that enhances our understanding about their ecological, social, and economic implications" (4FRI Stakeholder Group 2010a).

Purpose and Application

The purpose of this report is to provide a framework to guide socioeconomic monitoring of the Four Forest Restoration Initiative (4FRI) and the Rim Country project area. Both the 4FRI Multiparty Monitoring Board (MPMB) and the USFS contribute to monitoring the socioeconomic aspects of the project. The 4FRI project is funded, in part, through the Omnibus Land Management Act of 2009, Title IV-Forest Landscape Restoration. The 4FRI socioeconomic monitoring process is geared towards the purpose of the Act:

The purpose of this title is to encourage the collaborative, science-based ecosystem restoration of priority forest landscapes through a process that--

1. Encourages ecological, economic, and social sustainability;
2. Leverages local resources with national and private resources;
3. Facilitates the reduction of wildfire management costs, including through reestablishing natural fire regimes and reducing the risk of uncharacteristic wildfire; and
4. Demonstrates the degree to which--
    a. various ecological restoration techniques--
        i. achieve ecological and watershed health objectives; and
        ii. affect wildfire activity and management costs; and
    b. the use of forest restoration byproducts can offset treatment costs while benefitting local rural economies and improving forest health.

The monitoring objectives identified in this report overlap with many of the key social and economic issues analyzed by the USFS in the “Environmental Consequences” section of the EIS. In the EIS, the USFS assessed the social and economic elements of 4FRI implementation. This analysis included the Coconino, Apache-Sitgreaves, and Tonto National Forests and associated counties.

There are two main components to the USFS social and economic analysis that include: 1) the affected environment description and, 2) the assessment of environmental consequences. The USFS analysis of the social and economic affected environment description in the EIS considers population and demographic characteristics and trends (e.g. population change and educational attainment), employment and income data (e.g. economic specialization and median income), and environmental justice concerns (e.g. the distribution of minority and low income populations in the study area and their relationship to the Forest lands). This included estimates of employment and income consequences during the 4FRI implementation lifecycle. Input- output- analyses using IMPLAN (http://www.implan.com) estimates the employment and income effects of the 4FRI project. Ultimately, the estimates from IMPLAN can be compared to actual economic outcomes that will be collected as primary data from contractors, subcontractors, etc.

The USFS environmental consequences analysis estimates are primarily a qualitative assessment and describe how 4FRI implementation activities will affect quality of life, non- market economic values and employment and income in the study area. For quality of life, some of the key indicators are: 1) Particulate matter (PM) pollution from wildfire and prescribed fire (air quality modeling) and how PM pollution may lead to reduced quality of life through activity days, respiratory events, hospital admissions, etc.; 2) recreation opportunities (e.g., 4FRI implementation may temporary displace some activities; uncharacteristic wildfire can have long- term displacement consequences, etc.) and; 3) local economic sustainability; this will extend the quantitative economic discussion of employment and income to the social sphere to discuss how changing economic conditions affect community well-being. Non-market values will be measured chiefly through ecological indicators provided by other USFS specialists in their analysis (e.g. effects on habitat, water quality, soil quality, etc.). The economic efficiency of 4FRI implementation will also be analyzed by the USFS by using data on federal and private expenditures and the projected benefits of ecological restoration.

To supplement the USFS socioeconomic monitoring data and analyses, the 4FRI MPMB will utilize the information contained in this report to complete both social and economic monitoring of the 4FRI project. Although this report contains an extensive list of possible objectives that could be monitored, based on the 4FRI Stakeholders’ priorities and the information gaps contained in the USFS required socioeconomic monitoring, specific objectives/questions will be targeted. To assure the project’s success and longevity, it is recommended that socioeconomic monitoring is conducted before project implementation and there is immediate and ongoing execution within approximately the first five years of project implementation (Personal Communication, Nielsen 2011). Once socioeconomic monitoring data verifies the 4FRI project is socially and economically on track, the pressing need to conduct this type of monitoring will dissipate and the priority socioeconomic factors can be monitored less frequently to assess longitudinal changes as project implementation progresses.

The purpose of the joint effort of the MPMB and the USFS monitoring process is to assess the accuracy of USFS estimates and provide data for adaptive management. In this way, the information provided by the USFS in the EIS, coupled with this monitoring framework, are linked to support a thorough and on-going assessment of social and economic conditions in the study area.

Methodology in Developing Social and Economic Monitoring Framework

The 4FRI Science and Monitoring Working Group (which was later succeed by the MPMB) developed both social and economic monitoring frameworks to assess relevant socioeconomic factors that will determine these effects in planning, implementation and adaptive management of the 4FRI project. Relative to other land management activities, monitoring issues that need to be addressed within ecological restoration projects are broader and should encompass objectives that affect the widest variety of stakeholders (Egan and Estrada-Bustillo 2011; Fulé 2003). As a starting point, social and economic desired conditions from the Landscape Restoration Strategy for the First Analysis Area (landscape restoration strategy) (4FRI Stakeholder Group 2010b) were compiled from the report (appendix A). Additional economic desired conditions were extrapolated from appendix A of the landscape restoration strategy report. Within the landscape restoration strategy report, both economic and social desired conditions were defined within three spatial scales that include landscape, analysis area and firescape. These spatial scales are more applicable to biophysical conditions; therefore, for the purpose of developing this monitoring framework, the socioeconomic desired conditions were not delineated by these spatial scales. At times, the original sets of desired conditions were either repeated within each scale or they were not applicable as a socioeconomic desired condition for monitoring.

Once the final set of desired conditions, or broad goals, were determined, firm, measurable monitoring objectives (University of Oregon 2011) were developed through broad and extensive stakeholder input. As objectives were developed, considerations were based on those that the stakeholder group and/or the USFS have the ability to influence and adapt (University of Oregon 2011).

Monitoring questions were matched to the objectives to ensure that the questions addressed essential information that is needed to measure the stated objectives. Indicator selection was based on attributes that can be easily measured, are precise, and concisely describe current conditions (Moote 2011) as well as those that are sensitive to changes overtime (Moote 2011; Eagan and Estrada-Bustillo 2011). In addition, indicators that can satisfy multiple objectives should be recognized to assist in the efficacy of the monitoring process (Derr et al. 2005). The methods used to evaluate the selected indicators are described in the “Toolbox” section of this report. Once the appropriate assessment(s) were delineated, the recommended frequencies of the assessments, how often the monitoring data and analyses are completed, were matched to the assessment. Lastly, data sources, whether primary or secondary, were delineated to retrieve the necessary data to answer the questions. It is important to note that these frameworks should be viewed as a “continuing, inclusive and evolutionary process” (A. Egan Personal Communication 2011) that is malleable and adaptive over time.

Consideration of temporal and spatial scales is critical to the monitoring process and effects should be addressed at micro and macro levels as well as in the short and long-term. For example, results from project-level monitoring will provide necessary information to assess a variety of programmatic (cumulative) monitoring objectives/questions that can be tracked over time (University of Oregon 2011).

The social and economic framework matrices included in this report are not exhaustive; however, provide a basis for framing a 4FRI social and/or economic monitoring project (appendix C and D). For example, there may be several monitoring questions for a specific objective; however, the associated monitoring questions may not be relevant and/or appropriated funding will only support answering one of the monitoring questions. Similarly, there is a fairly comprehensive list of indicators; however, not all will be measured for a respective monitoring project. In the end, the purpose of the study, the constituency requesting the information, how the information will be used, and available funding will ultimately dictate a specific methodology of the monitoring project.

Due to the groundbreaking nature of the landscape scale 4FRI project and the unpredictability of the results, the "If Statements" or triggers for adaptive management, are described as "Undesirable Conditions" (Personal Communication, T. Cheng 2011). The "Undesirable Conditions" have been initially expressed as broad qualitative statements that will delineate trends. As socioeconomic monitoring projects are completed, and baseline information is established, these triggers can be adjusted to more specific acceptable quantitative ranges that will indicate whether or not adaptive management is necessary for each specific objective/question that is being assessed. Similarly, awarded contracts and contractor business plans can inform the development of economic triggers and assessments can be designed to determine whether implementation is in line with contractors' business plans.

In most cases, when socioeconomic studies are conducted, several monitoring questions can be addressed simultaneously, thus increasing the efficiency of the monitoring project. For example, a mail survey to residents in the first analysis area can provide necessary data for multiple monitoring questions. Similarly, as economic studies are planned and conducted, contractor surveys can track several indicators and these data can be used for multiple monitoring requirements.

Program Evaluation

As monitoring protocols are established and implemented for the 4FRI project, program evaluation can be used as an appropriate social science methodology. Program evaluation is a set of "systematic procedures used in seeking facts or principles" so that theoretical positions can be tested (Royse et al. 2010). Program evaluation follows a simple research design procedure that includes four main steps: 1. formulate a problem or question, 2. develop a research design for data collection efforts, 3. collect data, and 4. analyze the data (Royse et al. 2010). Although this design is similar to a traditional research design, the underlying distinction is based on the results. In most instances, in a research design, results can be generalized to a broader population, while results from a program evaluation may only be applicable to the specific project or multiple projects that have distinct similarities. Moreover, program evaluation is designed to facilitate a "structured comparison" so that conclusions have a type of relative valuation (Royce 2010).

Ideally monitoring should be conducted before and after implementation so that pre- and post-measurements can be compared. Due to the ongoing and malleable nature of monitoring, a process evaluation can be conducted throughout the life of the project that provides a program's description, a program's monitoring protocol and quality assurance measures (Royse et al. 2010). Due to the nature of process evaluation, operations are documented and will provide the necessary information to replicate or convey the technology of a specific project. Process evaluations are typically used for research and demonstration projects as they provide information that will inform what was learned during project implementation (Royse et al 2010).

To take this one step further, a program logic model developed by the W. K. Kellogg Foundation (2004) supports this application whereas evaluations are seen as adaptive, applying mid-course adjustments as needed, while at the same time, documenting its successes (W. K. Kellogg Foundation 2004). This evaluative approach also encourages a broad participatory base of all involved stakeholders, from developing the question to analyzing the data. The logic model does not just focus on the outcome but explains what you are doing, the expected results and a series of outcomes from immediate to long-term (W. K. Kellogg Foundation 2004). Moreover, this model helps to identify whether the project is on-track and emphasizes learning as an ongoing process - an integral part of the evaluation.

Institutional Review Board (IRB)

When collecting information on human subjects, an Institutional Review Board (IRB) should complete a review of the proposed project. As subjects participate in research projects, he/she should be informed that their participation is voluntary and all of their answers are confidential and reported as an aggregate, or as a group response. If research is conducted remotely, through the telephone or the Internet, informed consent is completed verbally or in a screen that is read by the respondent. If participants are interviewed face-to-face, participants should sign consent forms before the interview/focus groups begin. The consent and reviews protect the rights of human subjects when used in research and prevent unethical treatment during the process (Northern Arizona University 2014).

Tool Box for Assessment

Scale – Sampling Frame

As the purpose of socioeconomic studies is conceptualized, and objectives/questions are designed to study a specific population (e.g. "local"), a concise, self-determined definition is necessary to pinpoint the sampling frame, or scale, of the population under study (University of Oregon 2011). Since this definition is dependent on the purpose of the study and, ultimately how the information will be used, it could vary considerably from study to study. The definition of the study's population, or the sampling frame, should reflect one or more factors that include geographic (natural, physical), administrative, social, and/or economic boundaries/conditions that are adequately representative of the location, political and/or public service jurisdictions, group of people or economic factors (Environmental Protection Agency 2002).

Study Design

Both social and economic monitoring should begin with an assessment of current conditions by establishing baseline data before project implementation and/or education and outreach programs or events. Once a baseline is established, proceeding data collection should occur after major interventions to assess the change from the baseline to post-intervention and continue to assess changes longitudinally to track them over time. Depending on the selected social or economic analysis, accounting for specific issues and concerns within the population or the designated area of the study (e.g. community, city, county, EIS Analysis Area, etc.) should be considered and integrated in the study design (Egan and Estrada-Bustillo 2011). In addition, the study's design will be dependent on the goals of the study, the constituency, or who is requesting the monitoring results, and ultimately, how the monitoring information will be used. Ideally, socioeconomic monitoring should be a priority and should be implemented immediately and tracked for the first five years to assure the project's success (Personal Communication, Nielsen 2011).

The type of study that is initiated will dictate whether the purpose of the study is exploratory, descriptive or explanatory. Exploratory studies are typically conducted when researchers are breaking new ground, want to better understand the issue at hand, test the feasibility of developing a more extensive study and/or develop methods to employ in a subsequent study

(Babbie 2010). Descriptive research is precise reporting or measurements and answers the what, when, how and where questions and explanatory research reports relationships among the area of study and answers the question, why (Babbie 2010). In general, as socioeconomic research designs are conceptualized, more than one study type will be integrated in its design.

To illustrate utilizing multiple study types in assessing social systems affected by the 4FRI project, understanding the general publics' perceptions will most likely take two types of research to adequately answer the monitoring questions. First, an exploratory study that consists of focus groups of the general public and personal interviews with land managers will provide information that is specific to the defined area of study (e.g. 1st Analysis Area, city, county, Forest etc.). Once this qualitative data is analyzed, this information will give researchers a basis for a more structured (quantitative/qualitative) descriptive and/or explanatory study that is geared towards the population in question. For example, if exploratory studies were conducted in the first and second analysis areas, commonalities and differences can be identified between the subpopulations and subsequently, questions relevant to both populations can be formulated as well as modules that are specific to each subpopulation.

Another key driver in the study's design is how the information will be used. If the constituency requesting monitoring data requires findings to be representative of the population in question, probability sampling must be employed. This occurs if all of the individuals in the population have an equal chance of being selected and the selection method is randomized. If this is the case, the results of the study can be generalized to the population as a whole (Babbie 2010). Probability sampling verifies the sample is not biased and enables estimates of the precision that the results reflect the study's population (Fowler 2002). These results can be statistically verified with a sampling error, the degree of inaccuracy in the sampling design, as well as a confidence level, that the results are representative of the population. Non-probability sampling can be appropriate when a complete list of the study's population is unavailable, resources are limited, study requirements do not dictate stringent probability sampling results or the purpose of the study is exploratory. For example, "purposive sampling" is appropriate when a select number of key informants provide information needed to understand the key issues and is either used to understand specific circumstances and/or develop a more stringent study that can be generalized to a broader population.

To the greatest extent possible, the MPMB would ensure that the results of socioeconomic studies are reliable (results consistently yield similar findings) and valid (results adequately represent the concept under consideration) (Royse et al. 2010). However, at times, there is a tradeoff between reliability and validity. Factors such as the purpose of the study, the constituency, and how the results will be used, will aid in determining the degree to which a greater emphasis should be placed on reliability or validity or whether this distinction is necessary.

Data Sources

Data sources listed in both the social and economic frameworks include both primary and secondary data. The social analyses primary data collection includes focus groups, interviews, surveys and content analysis. Data collections of this type, if federally sponsored, are subject to the Paperwork Reduction Act (PRA) and must receive PRA clearance from the Office of Management and Budget prior to implementation. Secondary data sources for social analyses include reports by forests, government reports (city, county state and federal) and federal and private databases, such as Headwaters Institute and Firewise Communities USA.

The economic analyses primary data sources include contractor, visitor and business surveys. These data collections, if federally sponsored, are also subject to PRA clearance. Secondary data for the economic analyses includes various government reports (forest, municipal, state and federal), previous studies and government databases used in similar studies. As monitoring projects are developed and conducted, data sources in the frameworks will be reassessed and refined and new data sources will be added.

Literature Review

Generally, upon initiation of a socioeconomic study, background research through a literature review is conducted to assess previous research on the topic. More specifically, previous studies can assist with determining a study's design, questionnaire/protocol development, relevant data sources, and various analyses that were used and, whether previous studies reveal consistent findings. In addition, this information can reveal whether there are consistent flaws in previous research that may be remedied (Babbie 2010).

Census Research

Census data provide information that is inclusive of all individuals in a population (Fowler 2002). Census data covers 200 specific topics that describe a population or a "community" that includes demographic information such as employment, education, income, a population's size, and "urban" versus "rural" communities (EPA 2002). Census data can also be used to verify that the demographic data in the study group is reflective of the demographics of the area under study.

Survey Research

The choice of data collection mode, whether it's through the mail, telephone, personal interviews or group administration will be based on the sampling frame, the research question, characteristics of the sample, required response rates, question format, availability of trained staff and facilities and funding available for the project (Fowler 2002).

Surveys are one of the best methods used to describe a population's attitudes and orientations that are too large to observe directly and provide a standardized measurement across individuals in a given population (Fowler 2002). There are self-administered questionnaires and survey administered by interviewers. Self-administered surveys through the mail or on the Internet are generally less representative of a population due to typically low response rates. In administering Internet surveys, many times the population is not representative as the sampling frame is not inclusive of the entire population, nor is the Internet regularly accessible to a broader population. However, Internet surveys can be appropriate to populations that have known computer access, such as USFS employees. In general surveys, coupled with valid operationalization of concepts through appropriately worded questions, provide uncanny accuracy of a population's beliefs and attitudes (Babbie 2010). In addition, data collection through surveys can also provide a population's characteristics (demographics) that can be linked to the responses thus, increasing understanding of specific group's perceptions or beliefs (EPA 2002).

Primary data collected through self-administered surveys from contractors or others involved in the restoration process, are the best method, as contractors need to track the information and refer to their records. In collecting primary data from contractors, the sooner they are aware of these efforts and receive the survey forms/files, the easier it will be for them to track the necessary information.

Personal Interviews and Focus Groups

Personal interviews that occur face-to-face can be appropriate when the questions require: qualitative in-depth answers, high response rates, interviewer observation, longer interviews, rapport building and allow for multi data collection modes that could include diagrams (Fowler 2002). Personal interviews can include key informants that will provide valuable in-depth information such as, USFS personnel and community leaders such as, the County Board of Supervisors. Focus groups are a useful tool and usually engage 12-15 people in a guided discussion of a topic. The participants would not statistically represent segments of the population; therefore, this mode of observation is used to more deeply explore a topic and become more familiar with the issues under consideration (Babbie 2010). These results can be used to design a descriptive or explanatory study and/or used for strategic planning efforts (EPA 2002).

Content Analysis

Content analysis is used when various mediums of communication provide information in either a written form, such as newspaper articles, or in a multimedia format such as movies, speeches, photos etc.

(Environmental Protection Agency 2002). These analyses reveal recorded historic human communication or the artifacts of a social group (Babbie 2010). Content analysis will reveal what has been communicated and the analysis will answer the question “why” it was communicated and “what was the effect” of the communication (Babbie 2010). To complete the qualitative analyses of the various formats, a software program, NVivo (2012), can be used for evaluation of the data.

Collaborative Performance

The first collaborative performance evaluation has been conducted through a Survey Monkey instrument developed in conjunction with the 4FRI Stakeholders and the US Institute for Conflict Resolution (October 2011, Appendix E). In addition, a separate evaluation conducted by Northern Arizona University (W. Greer, E. Nielsen) and Colorado State University (T. Cheng) that includes a 4FRI Case History and a Collaborative Governance Case History will supplement the 4FRI Collaborative’s effectiveness and performance measures (May 2012). The intent is to track performance over time and to adaptively manage the Collaborative so that improvements are made to key areas identified by stakeholders.

Economic Analyses

Economic analyses are essential tools for planning, prioritizing and evaluating restoration projects (Robbins and Daniels 2011). Economics will provide a suite of tools to inform decision-making and improve transparency in selecting projects (Robbins and Daniels 2011). Based on a recent review of literature in describing economic concepts in the context of ecological restoration, Robbins and Daniels (2011) outline decision-analysis frameworks that incorporate an inclusive array of restoration benefits and costs. A “travel costs method” is employed to determine values associated with recreational sites by assessing visitor time and expenditures. “Stated preference method” or assessing willingness to pay for environmental improvements is used when indirect values, such as watershed protection, are being assessed. The stated preference method can be measured by a “contingent valuation,” or how much individuals are willing to pay for a policy or project. As an alternative, an “experimental choice method” can be employed as a non-monetary valuation that asks individuals to choose from a set of alternatives and rank their preferences. “Benefit costs analysis” includes total benefits or revenues and costs (using a weighted distribution of each) of a project over time with a defendable discount rate. Alternatively, “cost effective analysis” can provide a framework to compare relative costs of alternative methods geared towards achieving the same outcome. Lastly, “multi-criteria decision analysis” uses nonmonetary values through relative quantitative or qualitative performance scores. This review also revealed that although direct costs and revenues should be easy to capture, they are rarely reported. To address this lack of accounting, as suggested early in this report, streamlining expenditure, revenue and employment data reporting with prepared protocols and contractor reporting forms as well as creating a centralized data base prior to project implementation, should assist in closing this gap.

Additionally, to capture local economic conditions, economic base theory, a causal model, can be employed that divides the local economy into two sectors: 1) a basic, or non-local and 2) non- basic, or local. This theory is grounded on the premise that the basic sector, or those businesses that are dependent on non-local firms to buy their products, is the driver of the local economy.

Thus, the local economy is strongest when it is not dependent on local factors and can better insulate itself from local economic downturns. This distinction is important because the means of strengthening a local economy is to develop and enhance the basic sector (McClure 2009).

Prioritization

Although there are a multitude of monitoring objectives/questions in both the social and economic frameworks, due to identified preferences of the stakeholders and limitations in resources, objectives/questions need to be prioritized by the 4FRI Stakeholders. A basis for prioritizing the questions/objectives are issues and concerns that are relevant to the communities that are directly affected by the ensuing forest restoration efforts as well as those across the four Forests and the State.

In a study conducted by Egan and Estrada-Bustillo (2011), a model to prioritize socioeconomic indicators was developed through a Delphi process. Based on project objectives and availability of resources, results indicate there are three levels of indicators that include: 1) a core set that utilizes minimum effort at the forest or stand level; 2) includes the set of core indicators and balances ecological with socioeconomic dimensions and is used for long-term projects requiring more time and expertise and; 3) includes the first two sets of indicators; however, the primary focus is socioeconomic outcomes and is used across jurisdictions on landscape-scale projects and requires the highest level of expertise and resources. In addition to the recommended intensity of the socioeconomic monitoring, specific indicators can be weighted in using an average/median rating. Based on these results, overall socioeconomic objectives/questions can be identified, will provide guidance in selecting the best indicators for the assessment, and can guide resource allocation for a given project.

Adaptive Management

To complete the adaptive management loop, an initial assessment of the public's awareness, knowledge and support of pressing issues, as well as critical economic factors and conditions, is necessary to determine effects of outreach as well as implementation. Once these factors are understood, hypothesis testing of changes in behavior are developed, empirical data is collected and tracked to monitor the effectiveness of future outreach and implementation efforts. These steps tie back in to the logic model that explains what you are doing, the expected results and a series of outcomes from immediate to long-term (W.K. Kellogg Foundation 2004). Using this model helps to identify whether the project is on-track and emphasizes learning as an ongoing process - an integral part of the evaluation and a critical component of the adaptive management model.

According to a study conducted by Brown and Squirrell (2010), adaptive management is premised on flexibility and job security that enables risk taking. To integrate consistent adaptive management within the USFS, results from this study suggest the need to establish mutual trust between key stakeholders, such as other agencies, nongovernmental organizations, citizens, politicians and the courts, and the USFS. Due to the groundbreaking nature of the 4FRI project and the lack of science based adaptive management within the USFS, solidifying the adaptive management process is a critical step in ensuring the project's success. Stakeholders that are concerned about potential management outcomes are more likely to support management actions if they are confident results from these actions are carefully monitored (Rural Voice for Conservation Coalition 2011). In the end, monitoring should not be viewed as an added expense, but as an instrument that can ultimately reduce overall costs by minimizing ineffective management practices and potentially reducing objections and litigation (Rural Voice for Conservation Coalition 2011). Table E 5 and table e 6 show the socioeconomic monitoring framework.

I. GOAL: There is broad public awareness, understanding, knowledge and support for collaboratively based forest restoration decisions, processes, and outcomes, including the use of fire as a management tool.

Table 132. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems, Goal I

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
There is broad public awareness for collaboratively based forest restoration.	Is the public aware of the collaboratively-based 4FRI forest restoration project (e.g. current decisions, processes and outcomes)?	Awareness of the collaboratively-based 4FRI forest restoration project (e.g. current decisions, processes and outcomes).	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public is unaware of the collaboratively-based 4FRI forest restoration project (e.g. current decisions, processes and outcomes).
There is broad public understanding/ knowledge for collaboratively based forest restoration.	Is the public knowledgeable of the collaboratively-based 4FRI forest restoration efforts (e.g. current decisions, processes and outcomes)?	Public's understanding/ knowledge for collaboratively-based forest restoration.	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public is not knowledgeable of collaboratively-based forest restoration.
There is broad public support/acceptance for collaboratively based forest restoration.	Is there broad public support/acceptance for the collaboratively-based 4FRI forest restoration project (e.g. current decisions, processes and outcomes)?	Support /acceptance for collaboratively-based 4FRI forest restoration project (e.g. current decisions, processes and outcomes).	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public does not support/accept collaboratively-based forest restoration.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
Number of objections and lawsuits for 4FRI projects are minimized.	Are the number of objections and lawsuits for 4FRI projects at a minimum and/or decreasing?	Number & length of time of lawsuits.	Objections database available at: http://www.fs.fed.us/emc/applit/ (Cortner et. al 2003).	Track annually for first 5 years post/analysis area.	Objections database available at: http://www.fs.fed.us/emc/applit/ (Cortner et. al 2003).	Objections and lawsuits for 4FRI projects are delaying project implementation.
There is broad public awareness for the use of fire as a management tool.	Is the public aware of the use of fire as a management tool?	Public awareness for the use of fire as a management tool.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public is unaware of the use of fire as a management tool.
There is broad public understanding/ knowledge for the use of fire as a management tool.	Does the public understand/have knowledge of the use of fire as a management tool?	Public understanding/ knowledge for the use of fire as a management tool.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public does not have the understanding/ knowledge for the use of fire as a management tool.
There is broad public support/acceptance for the use of fire as a management tool.	Does the public support/accept the use of fire as a management tool?	Public support/acceptance for the use of fire as a management tool.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public does not support/accept the use of fire as a management tool.

II. GOAL: The public is knowledgeable/understands, accepts/supports the byproduct of smoke from prescribed and managed fires.

Table 133. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems, Goal II

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
The public is knowledgeable/ understands the byproduct of smoke from prescribed/managed/ pile fires (presence & duration.)	Is the public knowledgeable/ understands why prescribed/managed/ pile fires are necessary and will have the byproduct of smoke?	Public knowledgeable / understanding of why prescribed fire is necessary and will have the byproduct of smoke.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area. 4. USFS complaint logs.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Public does not understand why prescribed fire is necessary and will have the byproduct of smoke.
The public accepts/supports the byproduct of smoke from prescribed/managed/ pile fires (presence & duration.).	Does the public accepts/support the byproduct of smoke from prescribed/managed/ pile fires?	Public acceptance/ support of the byproduct of smoke from prescribed fire.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area. 4. USFS complaint logs.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Public does not accept/support the byproduct of smoke from prescribed fire.

III. Goal: The public understands, accepts, and supports fire's natural role in forest ecosystems.

Table 134. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems, Goal III

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
The public understands fire's natural role in forest ecosystems.	Does the public understand fire's natural role in forest ecosystems?	Public understanding fire's natural role in forest ecosystems.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Public does not understand fire's natural role in forest ecosystems.
The public accepts/ supports fire's natural role in forest ecosystems.	Does the public accept/support fire's natural role in forest ecosystems?	Public acceptance/ support for fire's natural role in forest ecosystems.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Public does not accept/support fire's natural role in forest ecosystems.

IV. GOAL: Rural communities are protected from high-severity fire and their quality of life is enhanced through forest restoration.

Table 135. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems, Goal IV

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
Rural communities' risks from high-severity fire are reduced.	Is the frequency and size of high severity fires decreasing?	1. Frequency of wildfires. 2. Size (acres) of wildfires	Frequency and size of wildfires 5 years post-4FRI implementation vs. frequency and duration of wildfires 5 years pre-4FRI implementation	5 years	USFS by Forests (Greater Flagstaff Forest Partnership 2010)	Rural communities' risk from high-severity fire are not decreasing
Rural community residents' perceived risk of high-severity fire is reduced.	[If frequency and size of high severity fires are decreasing] Do rural community residents' perceive rural communities are being protected from high- severity fire?	Rural community residents' perception of risk of high severity fires.	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Rural community residents' perceived risk of high-severity fire is not decreasing.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
Landowners adjacent to or in the proximity of the four forests (e.g. state, private, tribal, municipal, etc.) are encouraged to participate in restoring all forested lands in Northern Arizona.	Q1: Are landowners adjacent to or in the proximity of the four forests participating in restoring their forested lands? Q2: What programs are in place to encourage land owners to treat their lands?	Q1/Q2: 1. Land ownership, location, number and total dollar value of: State Fire Assistance grants, Tribal Forest Protection Act, AZ Forest Health Program, Forest Stewardship Program, etc. 2. Fire behavior including adjacent non-USFS lands.	Q1: Tracking land ownership/location and respective treatments (fire behavior). Q2: 1. Tracking outreach efforts to state, private, tribal, municipal landowners. 2. Tracking land ownership, location number and total $ value of grants awarded.	5 years	Headwaters Institute. State, private, tribal, municipal grant/project reports. USFS by Forests. 4FRI Stakeholder Group.	Landowners adjacent to or in the proximity of the four forests (e.g. state, private, tribal, municipal, etc.) are not encouraged to participate/are not restoring forested lands in Northern Arizona.

V. GOAL: Social values and recreational opportunities are protected and/or enhanced through forest restoration activities

Table 136. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems, Goal V

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
Recreational opportunities are protected through forest restoration activities.	Q1: Are recreational opportunities protected as restoration projects are implemented? Q2: Does the public perceive recreational opportunities are protected through forest restoration activities?	Q1: Number & type of recreational activities. Q2: Public perception of protection of recreational opportunities through forest restoration activities.	Q1: Analysis of USFS, AZG&F, USFWS reports. Q2: 1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Q1: 1. National Visitor Use Monitoring Program (USDA FS 2011). 2. Headwaters Institute 3. AZG&F The Economic Importance of Fishing and Hunting (utilizes IMPLAN input/output model) (Silberman2002). 4. USFWS National Survey of Fishing, Wildlife, Hunting, & Wildlife Assoc. Recreation (USDI FWS 2006). 5. Visitor surveys. Q2: Focus group, interview and survey results.	Recreational opportunities are not protected as forest restoration activities occur.
Recreational opportunities are enhanced through forest restoration activities.	Q1: Are recreational opportunities improving as restoration projects are implemented? Q2: Does the public perceive recreational opportunities are improving as forest restoration activities are occurring?	Q1: Number & type of recreational activities. Q2: Public perception of improving recreational opportunities as forest restoration activities are occurring.	Q1: 1. Analysis of USFS, AZG&F, USFWS reports. 2. Visitor surveys Q2: 1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation/ outreach. Track annually for first 5 years post.	As above.	Q1: Recreational opportunities are not improving as restoration projects are implemented. Q2: Public perceives recreational opportunities are not improving as forest restoration activities are occurring.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
Aesthetic values are protected through forest restoration activities.	Does the public perceive aesthetic values are protected through forest restoration activities?	Public perception that aesthetic values are protected through forest restoration activities.	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area. Comparative analysis of field trips to treated vs. untreated sites (*timing relevant to post-implementation is critical-minimum one- year post).	1. Pre- post-implementation/ outreach. Track annually for first 5 years post.	Focus group, interview and survey results. Headwaters Institute.	The public perceives that aesthetic values are not being protected as forest restoration activities are occurring.
Aesthetic values are enhanced through forest restoration activities.	Does the public perceive aesthetic values are enhanced through forest restoration activities?	Public perception that aesthetic values are enhanced through forest restoration activities.	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area. Comparative analysis of field trips to treated vs. untreated sites (*timing relevant to post-implementation is critical-minimum one- year post).	1. Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results. Headwaters Institute.	The public perceives that aesthetic values are not enhanced as forest restoration activities are occurring.

VI. GOAL: Rural communities play an active part in reducing fire risk by implementing FireWise actions and creating defensible space around their property.

Table 137. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems, Goal VI

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
Rural community residents are aware/ knowledgeable of FireWise principles/ FireWise communities.	Are rural community residents aware/ knowledgeable of FireWise principles/FireWise communities?	Public awareness/ knowledge for FireWise principles.	1. Focus groups with community members. 2. Interviews with fire prevention managers. 3. Telephone survey with residents in study area.	Pre- post- Implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Rural community residents are unaware/not knowledgeable of FireWise principles/ FireWise communities.
Rural community residents are aware/ knowledgeable of implementing defensible space.	Are rural community residents aware/ knowledgeable of implementing defensible space?	Public awareness/ knowledge of implementing defensible space.	1. Focus groups with community members. 2. Interviews with fire prevention managers. 3. Telephone survey with residents in study area.	Pre- post- implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Rural community residents are unaware/not knowledgeable of implementing defensible space.
Number of communities that are recognized as FireWise increases.	Are the number of communities that are recognized as FireWise increasing?	Number of communities recognized as FireWise.	Track no. of communities recognized as Firewise.	Pre- post- implementation /outreach. 5 years.	Firewise Communities USA (http://www.firewise.org/Communities/USA-Recognition-Program.aspx).	Number of communities that are recognized as FireWise is not increasing.

VII. GOAL: there is broad public support for the 4FRI Collaborative as forest restoration activities are implemented

Table 138. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems, Goal VII

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
The public is aware of the 4FRI Collaborative.	Is the public aware of the 4FRI Collaborative?	Public awareness of the 4FRI Collaborative.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public is not aware of the 4FRI Collaborative.
The public is knowledgeable/ understands the 4FRICollaborative's role in the 4FRI Initiative.	Is the public knowledgeable/understands the 4FRI Collaborative's role in the 4FRI Initiative?	Public's knowledge of the 4FRI Collaborative's role in the 4FRI Initiative.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation/ outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public does not understand the 4FRI Collaborative's role in the 4FRI Initiative.
The public is supportive of the 4FRI Collaborative.	Is the public supportive of the 4FRI Collaborative?	Public support for the 4FRI Collaborative.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first years post.	Focus group, interview and survey results.	The public is not supportive of the 4FRI Collaborative.

VIII. GOAL: There is public support for the US Forest Service (USFS) as forest restoration activities are implemented

Table 139. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems, Goal VIII

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
The public is aware of the USFS's involvement/role with the 4FRI Collaborative.	Is the public aware of the USFS's involvement/role with the 4FRI Collaborative?	Public awareness for the USFS's involvement/ role with the 4FRI Collaborative.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public is not aware of the USFS's involvement/ role with the 4FRI Collaborative.
The public is aware of the USFS's involvement with the 4FRI Project.	Is the public aware of the USFS's involvement with the 4FRI Project?	Public awareness for the USFS's involvement/role with the 4FRI Project.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public is not aware of the USFS's involvement with the 4FRI Project.
The public is supportive of the USFS's involvement with the 4FRI Collaborative.	Is there public support/acceptance for the USFS's involvement with the 4FRI Collaborative?	Public support for the USFS's involvement with the 4FRI Collaborative.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public is not supportive of the USFS's involvement with the 4FRI Collaborative.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
The public is supportive of the USFS's involvement with the 4FRI Collaborative.	Is there public support/acceptance for the USFS's involvement with the 4FRI Collaborative?	Public support for the USFS's involvement with the 4FRI Collaborative.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The public is not supportive of the USFS's involvement with the 4FRICollaborati ve.

IX. GOAL: The general public is aware, knowledgeable and supportive of 4FRI implemented treatments within the analysis area

Table 140. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems, Goal IX

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
The general public is aware of 4FRI implemented treatments within the analysis area.	Is the general public aware of 4FRI implemented treatments within the analysis area?	Public awareness of 4FRI implemented treatments within the analysis area.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The general public is unaware of 4FRI implemented treatments within the analysis area.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
The general public is knowledgeable/ understands 4FRI implemented treatments (mechanical thinning, road alteration, etc. as necessary tools) for ecological restoration within the analysis area.	Is the general public knowledgeable/ understands 4FRI implemented treatments for ecological restoration within the analysis area?	Public knowledge/ understanding 4FRI implemented treatments (mechanical thinning, road alteration, etc.) as necessary tools for ecological restoration within the analysis area.	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area.	Pre- post-implementation/ outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The general public is not knowledgeable/ does not understand 4FRI implemented treatments (mechanical thinning, road alteration, etc.) as necessary tools for ecological restoration within the analysis area.
The general public is supportive of 4FRI implemented treatments within the analysis area.	Is the general public supportive of 4FRI implemented treatments within the analysis area?	Public support for 4FRI implemented treatments within the analysis area.	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area.	Pre- post-implementation/ outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The general public is not supportive of 4FRI-implemented treatments within the analysis area.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
There is ample notification to the public of 4FRI implemented projects that may include road construction, mechanical thinning, prescribed and managed fires, etc.	Q1: Does the public believe there is ample notification of restoration projects? Q2: What campaigns and public notifications are in place to inform the public of restoration treatments and/or prep for those treatments?	Q1: Public perception of notification of restoration projects/ activities. Q2: Website postings, newspaper, radio, direct signage in the forest, 4FRI 800#, etc.	Q1: 1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area. Q2: Number, type, content analysis of public campaigns/notifications	Pre- post-implementation outreach. Track annually for first 5 years post.	Q1: Focus group, interview and survey results. Q2: Results from content analysis.	Q1: Public perception of notifications of 4FRI implemented projects is not sufficient (road construction, mechanical thinning, prescribed and managed fires, etc.). Q2: An insufficient amount of campaigns and public notifications are in place to adequately inform the public of restoration treatments and/or prep for those treatments.

X. GOAL: The general public is aware of 4FRI educational and outreach programs and has the opportunity to participate in the 4FRI effort.

Table 141. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems, Goal X

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
The general public is aware of 4FRI educational and outreach programs.	Is the general public aware of 4FRI educational and outreach programs?	Public awareness of 4FRI educational and outreach programs.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The general public is unaware of 4FRI educational and outreach programs.
The general public has the opportunity to participate in the 4FRI educational and outreach programs.	Does the general public have the opportunity to participate in the 4FRI educational and outreach programs?	Public's opportunity to participate in the 4FRI educational and outreach programs.	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area. Number, frequency, type of educational and outreach programs.	Annual	Focus group, interview and survey results. USFS by forest. 4FRI Collaborative Stakeholder group.	The general public has not had ample opportunity to participate in the 4FRI educational and outreach programs.
Youth are aware of 4FRI educational and outreach programs.	Are youth aware of 4FRI educational and outreach programs?	Youth awareness for 4FRI educational and outreach programs.	1. Focus groups with community members.2. Interviews with land managers/key decision-makers.3. Telephone survey with residents in study area.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Youth are not aware of 4FRI educational and outreach programs.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
Youth has the opportunity to participate in the 4FRI educational and outreach programs.	Do youth have the opportunity to participate in the 4FRI educational and outreach programs?	Opportunities for youth to participate in the 4FRI educational and outreach programs.	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area. Survey local youth group coordinators. Number, frequency, type of youth programs related to the 4FRI effort.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Youth have not had ample opportunity to participate in the 4FRI educational and outreach programs.
Low income/minority populations are aware of 4FRI educational and outreach programs.	Are low income/minority populations aware of 4FRI educational and outreach programs?	Awareness of low income/minorit y populations of 4FRI educational and outreach programs.	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area. Oversample low income/minority populations. Number, frequency, type of outreach programs geared towards low income/minority populations related to the 4FRI effort.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Low income/minority populations are unaware of 4FRI educational and outreach programs.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
Low income/minority populations have the opportunity to participate in the 4FRI educational and outreach programs.	Do low income/minority populations have the opportunity to participate in the 4FRI educational and outreach programs?	Low income/minority populations opportunity to participate in the 4FRI educational and outreach programs.	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area. Oversample low income/minority populations. Number, frequency, type of outreach programs geared towards low income/minority populations related to the 4FRI effort.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Low income/minority populations have not had ample opportunity to participate in the 4FRI educational and outreach programs.
The general public has the opportunity to participate in the 4FRI effort.	Does the general public have the opportunity to participate in the 4FRI effort?	Public's opportunity to participate in the 4FRI effort.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area. 4. Number, frequency, type of outreach programs for public participation in the 4FRI effort.	Pre- post-implementation/ outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	The general public has not had ample opportunity to participate in the 4FRI effort.

XI. GOAL: Treatments within the analysis area minimize short-term impacts and enhance vegetation characteristics valued by Forest users over the long-term

Table 142. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems, Goal XI

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
Treatments within the analysis area minimize short-term impacts such as skid trails, decks, excessive slash, roads etc.	Q1: What are the short-term impacts of concern to Forest users? Q2: Are treatments within the analysis area minimizing short-term impacts such as: skid trails, decks, excessive slash, roads etc.?	Q1: Treatments' short-term impacts of concern to forest users. Q2: Public's perception of short-term impacts of treatments.	Q1: Review BMP monitoring reports. Q2: 1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area. 4. Field trips/focus groups to restoration sites.	Pre- post-implementation outreach. Track annually for first 5 years post.	Q1: BMP Reports Q2: Focus group, interview, field trip and survey results.	Treatments within the analysis area are not minimizing short-term impacts of concern to forest users (e.g. skid trails, decks, excessive slash, etc.).
Treatments within the analysis area enhance vegetation characteristics valued by Forest users over the long-term.	Q1: What are the vegetative characteristics valued by Forest users over the long-term? Q2: Do these treatments enhance vegetation characteristics valued by Forest users over the long-term?	Q1: Vegetative characteristics valued by Forest users over the long-term. Q2: Public's perception of vegetative characteristics that are valued by Forest users over the long-term.	Focus groups with community members. Interviews with land managers/key decision-makers. Telephone survey with residents in study area. Field trips/focus groups to restoration sites.	Pre- post-implementation outreach. Track annually for first 5 years post.	Focus group, interview and survey results.	Treatments within the analysis area do not enhance vegetation characteristics that are valued by Forest users over the long-term.

I. *GOAL: The byproducts of mechanical forest restoration offset the costs of treatment implementation*

Table 143. Four Forest Restoration Initiative socioeconomic monitoring framework for economic systems, I. Goal

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Wood byproduct sales exceed the costs of implementation (Contractors are operating at a profit and the USFS does not have to pay contractors' treatment costs).	Q1: Do byproduct sales exceed operational costs? Q2: Are treatments adequately sequenced to enable contractors to offset their overall operational costs? Q3: Are USFS contracting costs decreasing?	Q1: 1. Operational costs of treatments: a. Mobilization: to move equipment from site to site, to move operators (daily) from home base to site. b. Loading: cutting, skidding, delimbing, piling slash, loading stems. c. Haul: transport costs from landing to processing site (time & distance). 2. Amount of wood and its value (4FRI Stakeholder Group 2010c). 3. Degree of deviation from business plan(s). Q2: 1. No. of task orders and location. 2. Wood yields/task order ((4FRI Stakeholder Group 2010c).	Q1: Operational costs of treatments vs. amount of wood & its value ((4FRI Stakeholder Group 2010c). Q2: Average wood yields vs. No. of task orders balanced on semi-annual or quarterly basis ((4FRI Stakeholder Group 2010c).	Dependent on business plan(s).	1. Contractor surveys 2. USFS business plans (D. Jaworski Personal Communication 2011). 3. Contracts: federal databases a.USAspending.gov b. USFS Natural Resource Manager Database (University of Oregon 2011). 4. Headwaters Institute	Q1: Operational cost of treatments exceeds byproduct sales. Q2: Average wood yields per task order does not support contractors operating at a profit.

II. GOAL: The economic value of ecosystem services provided by restored forests (such as the value of recreation or water) are captured and reinvested to support forest restoration and ecosystem management

Table 144. Four Forest Restoration Initiative socioeconomic monitoring framework for economic systems, II. Goal

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
The economic value of ecosystem services provided by restored forests, such as the value of recreation/tourism, are captured and reinvested to support forest restoration and ecosystem management.	Q1: What is the increase (percent) in direct service revenues related to recreation/tourism? Q2: What is the increase (percent) in revenues associated w/fee imposed recreation activities (e.g. hunting, fishing, pass/entry fees etc.)? Q3: 1. Has a portion of the determined value of increased recreational revenues been reinvested in forest restoration? 2. How many collaborators are involved in contributing to this program?	Q1: 1. Lodging, Restaurant, Groceries, Gas/Oil, Other transportation, Activities, Admissions/ Fees, Souvenirs/ Other expenditures (USDA FS 2011). Q2: 1. AZG&F license sales by County. 2. Visitor fees. Q3: Dollar value of fees invested in forest restoration activities.	Q1-Q3: Travel cost method using: USFS, AZG&F, USFWS reports tracked with investments made in forest restoration from fees/licenses/ private revenues.	5 years (USDA FS 2011; USDI FWS 2006)	Q1: 1. National Visitor Use Monitoring Program (USDA FS 2005). 2. Headwaters Institute Q2: 1. AZG&F The Economic Importance of Fishing and Hunting (utilizes IMPLAN input/output model) (Silberman 2002). USFWS National Survey of Fishing, Wildlife, Hunting, & Wildlife Assoc. Recreation (USDI FWS 2006). Visitor surveys. Q3: S&MWG database	Q1/Q2: Direct service revenues and license fees related to recreation/tourism are decreasing as forest restoration activities are occurring. Q3: A portion of revenues generated from recreation and tourism are not being reinvested in forest restoration activities.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
The economic value of ecosystem services provided by restored forests, such as the value of water, are captured and reinvested to support forest restoration and ecosystem management.	Q1: What is the effect in water yield, pre-post-restoration? Q2: What is the effect in sedimentation, pre-post-restoration? Q3: What is the economic value of increase/loss of water yield? Q4: [If increased] Has a portion of the determined value of increased water yield been reinvested in forest restoration? Q5: Are restoration projects reducing the costs of producing a potable water supply? Q6: How many collaborators are involved in contributing to this program and what is the $ value of each?	Q1/Q2: SRP Paired Watershed Study Costs associated w/: Transport, Treating, Developing new/existing water supplies, Capture, Delivery Q3-Q5: Watershed fund revenues (e.g. assess a fee to each water consumer based on use per 5,000 gallons per month (Santa Fe Watershed Association 2009; City of Flagstaff 2010). Operation & maintenance expenses Taxes/transfers Capital additions/replacement Debt services (principle/interest) Allocated indirect costs Administration (City of Flagstaff 2010).	Q1/Q2: SRP Paired Watershed Study compares results to Beaver Creek and Castle Creek Watershed Studies (Arizona Forest Resource Task Group 2010). Q3-Q5: Determined value of increased water yield vs. proportion of this value invested in forest restoration activities.	Dependent on SRP Study and Promotion of Ecosystem Services Investment.	Q1/Q2: 1.SRP/NAU Beaver Creek Watershed Study Castle Creek Watershed Study (Arizona Forest Resource Task Group 2010). Watershed Conditions Framework (USFS). Q4/Q5/Q6: City of Flagstaff Utilities (Water) Dept. Long-term Financial Plan & Rate & Fee Study (City of Flagstaff 2010). S&MWG database.	Q1: Water yield is decreasing as restoration activities are occurring. Q2: Sedimentation is increasing as restoration activities are occurring. Q3: A portion of revenues generated from watershed restoration and protection are not being reinvested in forest restoration activities. Q5: Restoration projects are not assisting in reducing the costs of producing a potable water supply.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
The economic value of ecosystem services provided by restored forests, such as wildlife habitat creation and preservation, are captured and reinvested to support forest restoration and ecosystem management.	Are forest restoration activities maintaining and enhancing habitat for wildlife to an extent that biodiversity offsets and compensation programs can be implemented and resulting funds are reinvested into forest restoration activities?	Wetland & Stream Ecosystems Compensation. Endangered Species Compensation. Conservation Banking (Madsen et al. 2010).	Value of compensation for preservation of wetland and stream ecosystems and endangered species vs. the proportion reinvested into forest restoration activities (Madsen et al. 2010).	10 years	USFWS NMFS (Madsen et al. 2010).	Forest restoration activities are not maintaining and enhancing habitat for wildlife to an extent that biodiversity offsets and compensation programs can be implemented and resulting funds are reinvested into forest restoration activities.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
The economic value of ecosystem services provided by restored forests, such as wildfire cost savings, are captured and reinvested to support forest restoration and ecosystem management.	Q1: What are the fire suppression costs incurred 5 years post 4FRI implementation and how does this compare to 5 years pre 4FRI implementation? Q2: What is the amount of cost savings (avoided costs vs. treatment costs) of wildfire suppression that has been reinvested in forest restoration activities?	Q1: Federal, state and local suppression costs, Private property losses (insured & uninsured), Damage to utility lines, Damage to recreation facilities, Loss of timber resources, Aid to evacuees (WFLC 2010), Resurveying land boundaries (M. Lata Personal Communication 2011). Q2: 1. Acres treated & $ amount/acre of risk reduction. 2. Dollar value reinvested in restoration activities.	Wildfire suppression costs 5 years post-4FRI implementation (control for increases in population and housing) vs. the amount of cost savings that is reinvested in forest restoration activities.	5 years post-implementation	Q1: 1. Direct suppression costs obtained from: USFS, BLM, NRCD, NIFC, State, County, FEMA, DHS, Insurance companies, American Red Cross (Western Forestry Leadership Coalition 2010). Q1/Q2: 1. Direct treatment costs obtained from: USFS, contractors. Headwaters Economics (population/housing). USFS budget staff (D. Jaworski Personal Communication 2011) S&MWG database.	Q1: Fire suppression costs are not decreasing (5 years post 4FRI when compared to 5 years pre 4FRI). Q2: A proportion of cost savings of wildfire suppression has not been reinvested in forest restoration activities.

III. GOAL: Rural communities receive direct and indirect economic benefits and ecosystem services as a result of forest restoration and resilient forests

Table 145. Four Forest Restoration Initiative socioeconomic monitoring framework for economic systems, III. Goal

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Forest restoration activities will create direct quality jobs in rural communities in Arizona.	Q1: How many direct jobs have been created by forest restoration activities? Q2: What is the quality of the jobs? Q3: Are the jobs filled by local residents? Q4: How many direct jobs have been filled by low-income/minority populations?	Q1-Q3: Number, Types (FT vs. PT vs. seasonal), Positions, percent of jobs over total employment (Egan and Estrada-Bustillo 2011) Average length of employment, percent receiving benefits or payments in lieu of, Wages (average/worker, family-supported), Locations, percent of contracts w/ on the job training, Safety (percent and number of contracts without job related injuries/illnesses resulting in lost work time), percent and number of local workforce (resident zip codes), Distance traveled to work (University of Oregon 2011).	Economic Impact Analysis: Direct reporting of primary and secondary data.	Annual	1. Contractor reporting form/survey. 2. Headwaters Institute (EPS-HDT Socioeconomic profiles). 3. Bureau of Labor Statistics (Stynes 1992).	Q1: Forest restoration activities have not created a sufficient number of direct jobs. Q2: Forest restoration activities have not created a sufficient number of quality jobs (e.g. FT, positions, benefits, trainings, safety, etc.). Q3: Forest restoration activities have not created a sufficient number of jobs that are filled by local residents.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Forest restoration activities will create indirect jobs in rural communities in Arizona.	How many indirect jobs have been created by forest restoration activities?	Direct Jobs: Number, Types (FT vs. PT), Average length of employment (University of Oregon 2011).	Region specific dollar- tracking and multiplier effects of direct employment (for every dollar spent by a business, some number of dollars are created) (Egan and Estrada-Bustillo 2011, Sitko and Hurteau 2010, Stynes 1992).	Annual	Contractor reporting form/survey. Headwaters Institute (EPS-HDT Socioeconomic profiles). Bureau of Labor Statistics (Stynes 1992).	Forest restoration activities have not created a sufficient number of indirect jobs.
Forest restoration activities will create increased retail sales/services in rural communities in Arizona.	Q1: Has city/county sales tax on goods and services increased as forest restoration activities have occurred? Q2: Have retail sales/service revenues increased as forest restoration activities have occurred?	Q1: City/county sales tax on goods and services. Q2: Retail sales & services revenue.	Dollar-tracking and multiplier effects (region-specific) (Sitko and Hurteau 2010) of business activity (Stynes 1992).	Annual	AZ Dept. of Revenue. City reports. County reports. US Census Bureau. U.S. Department of Labor, Bureau of Labor Statistics. Arizona Indicators (Morrison Institute of Public Policy 2011).	Q1: City/county sales tax on goods and services has not increased as forest restoration projects have been implemented. Q2: Retail sales & services revenue has not increased as forest restoration projects have been implemented.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Forest restoration activities will create increased tax revenues (e.g. property tax, business expenditures) in rural communities in Arizona.	Q1: Have taxes generated from forest industry business expenditures increased as forest restoration activities have occurred? Q2: Have property/sales tax/school revenues generated from forest industry employees (direct/indirect jobs) increased as forest restoration activities have occurred?	Q1: 1. Sales of wood products. Capital expenditures of project materials. Subcontract thinning services (Sitko and Hurteau 2010). Q2: 1. Sales/property taxes generated by employees (direct & indirect) (by county). School revenues generated by avg. family. Sales tax generated by avg. per capita expenditures on consumable goods/supplies (by county) (Sitko and Hurteau 2010).	Q1/Q2: Total net employee revenue based on jobs estimates and economic contributions from forest industry employees (direct/indirect). Indirect jobs: use regional multiplier effect, input/output modeling) (Sitko and Hurteau 2010).	Annual	Contractor reporting form/survey. U.S. Bureau of Economic Analysis (Sitko and Hurteau 2010). Headwaters Institute (EPS-HDT Socioeconomic profiles).	Q1: Taxes generated from forest industry business expenditures have not increased as forest restoration activities are implemented. Q2: Property/sales tax/school revenues generated from forest industry employees (direct/indirect jobs) have not increased as forest restoration activities are implemented.
Forest restoration activities will increase recreation/tourism in rural communities in Arizona.	Q1: Has recreation increased as forest restoration activities have occurred?		Forest restoration activities will increase recreation/tourism in rural communities in Arizona.	Q1: Has recreation increased as forest restoration activities have occurred?		Forest restoration activities will increase recreation/touris m in rural communities in Arizona.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Opportunity for local contractors to conduct restoration work increases.	Q1: Have opportunities for local contractors to conduct restoration work increased? Q2: What is the proportion of local to non-local awards? Q3: Where are the contractors located?	Q1/Q3: Location of businesses (zip code by county) Q2: Percentage of local contracted businesses (contractor and subcontractors) and total contractual amount for each (University of Oregon 2011).	Comparative analysis of local contract awards vs. non-local number of contracts and respective value).	Every ten years or length of the contract.	Contracts: federal databases USAspending.gov USFS Natural Resource Manager Database (University of Oregon 2011).	Q1: Opportunities for local contractors to conduct restoration work has not increased. Q2/Q3: Local awards are proportionally lower than non-local awards (# of contracts and respective value).
Construction and/or improvement of infrastructure required for forest restoration activities increase revenues to local businesses.	Have revenues to local businesses providing supplies for infrastructure increased?	Revenues of local businesses providing supplies for infrastructure.	Economic Impact Analysis: Track flow of economic activity associated with construction and/or improvement of infrastructure.	Dependent on timing of infrastructure development /improvement.	1. Contractor reporting form/survey. 2. Local business reporting form/survey. 3. U.S. Bureau of Economic Analysis (Sitko and Hurteau 2010).	Revenues to local businesses Supporting construction and/or improvement of infrastructure does not increase.

IV. GOAL: The average net cost per acre of treatment and/or prep, administrative costs in the 4FRI project/analysis area are reduced significantly

Table 146. Four Forest Restoration Initiative socioeconomic monitoring framework for economic systems, IV. Goal

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
The average net cost (operational costs of the contract) of treatment per acre in the 4FRI project area over a thirty-year period (the life of the project) is decreasing over time.	Are the average net cost of treatment per acre that are attached to the contract in the 4FRI project area decreasing as new contracts are released and awarded?	Operational cost (per acre) attached to the contract (D Fleishman Personal Communication 2011).	Tracking and comparison of operational costs of contracts.	Every ten years or length of the contract.	1. Contracts: federal databases: a. USAspending.gov b. USFS Natural Resource Manager Database (University of Oregon 2011).	The average net costs of treatment per acre that are attached to the contract in the 4FRI project area are increasing as new contracts are released and awarded.
The average net cost of treatment per acre in the analysis area for preparation and administration costs are reduced over time.	Q1: What is the difference in average net cost of treatment per acre in the analysis area for preparation and administrative costs associated with different restoration designations (e.g., description vs. prescription)? Q2: Is average net cost of treatment per acre in the analysis area for preparation and administration costs reduced over time?	Costs include: 1. Project prep 2.Task order/contract administration 3. Planning under NEPA/NFMA 4. Project management 5. Project-level monitoring 6. Contract monitoring (4FRI Stakeholder Group 2010c; Sitko and Hurteau 2010).	Q1: Cost effective analysis (Robbins and Daniels 2011). Q2: Tracking and comparison of prep and admin costs of contracts.	Every ten years or length of the contract.	Southwestern Region Restoration Task Group (4FRI Stakeholder Group 2010b).	Q1: Various restoration designation costs are not analyzed and compared. Q2: The average net cost of treatment per acre in the analysis area for preparation and administration costs is increasing over time.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Mechanical treatment costs are reduced. * See Rx fire costs GOAL: Wildfire management costs are reduced; aggressive fire suppression is unneeded or rare (below).	Are mechanical treatment costs decreasing over time?	1. Move equipment and operators 2. Cutting 3. Skidding 4. Delimbing 5. Loading 6. Slash piling 7. Road Maintenance 8. Overhead (4FRI Stakeholder Group 2010c).	Tracking of mechanical costs over time.	5 years	Contractor surveys.	Mechanical treatment costs increasing over time.

V. GOAL: Sufficient harvest and manufacturing capacity exists to achieve restoration of at least 300,000 acres in the next ten years

Table 147. Four Forest Restoration Initiative socioeconomic monitoring framework for economic systems, V. Goal

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Sufficient contractor capability exists to harvest approx. 30,000 acres per year.	Is there sufficient contractor capability to harvest approx. 30,000 acres per year?	1. Total number of contracts by work type, size and distribution (# of task orders & corresponding acres) (Mosley & Davis, 2010; University of Oregon 2011; 4FRI Stakeholder Group 2010c). 2. Financial incentive programs (e.g. grants, loan guarantees, tax incentives) available to contractors (4FRI Stakeholder Group 2010c).	1. Track contracts by work type, size and distribution. 2. Track financial incentive programs.	Every ten years or length of the contract.	1. Contracts, federal databases a. USAspending.gov b. USFS Natural Resource Manager Database (University of Oregon 2011). 2. Contractor surveys 3. Headwaters Institute-Payments from federal lands (financial incentive programs).	There is insufficient contractor capability to harvest approx. 30,000 acres per year.
Sufficient private infrastructure exists to utilize woody biomass extracted from approx. 30,000 acres per year.	Is there sufficient private infrastructure to utilize woody biomass extracted from approx. 30,000 acres per year?	1. Volume of material produced per biomass plant vs. volume utilized. 2. Location of private infrastructure relative to harvesting activities.	Track type of infrastructure, location and corresponding processing capability.	Tracked annually across ten years (or length of the contract).	Contractor surveys.	There is insufficient private infrastructure to process woody biomass extracted from approx. 30,000 acres per year.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
A sufficient workforce (public & private) exists to harvest and utilize wood byproducts extracted from approx. 30,000 acres per year.	Is there a sufficient workforce (public & private) to harvest and utilize wood byproducts extracted from approx. 30,000 acres per year?	1. # of FTE USFS employees designated for project planning, administration, and implementation. 2. # of FTE private sector employees designated for harvesting & processing. 3. USFS workload (dependent on current conditions- e.g. shift from overgrown forest to savannah system, shift from planning to implementation). 4. USFS workforce by position.	1. # of FTE USFS employees designated vs. # of USFS employees needed to plan/administer/ implement 30,000 acres per year. 2. # of private employees trained and hired vs. # of employees needed to harvest/process 30,000 acres per year. 3. USFS workload vs. USFS positions (M. Lata Personal Communication 2011).	Tracked annually across ten years or length of the contract.	1. USFS by forest. 2. Headwaters Institute (EPS-HDT Socioeconomic profiles). 3. Bureau of Labor Statistics (Stynes 1992). 4. Contractor reporting form/survey.	There is an insufficient workforce (public & private) to harvest and process woody biomass extracted from approx. 30,000 acres per year.

VI. GOAL: Wildfire management costs are reduced; aggressive fire suppression is unneeded or rare

Table 148. Four Forest Restoration Initiative socioeconomic monitoring framework for economic systems, VI. Goal

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Direct wildfire suppression costs in 4FRI treated areas are reduced.	Q1: Are direct costs associated with wildfire suppression in 4FRI treated areas decreasing as forest restoration projects are implemented over time? Q2: What is the difference between direct wildfire suppression costs in 4FRI treated areas and treatment (planning, prep, admin & operational) costs?	Q1: Wildfire Suppression Costs: (as above). Q2: 1. Planning, prep, admin costs: (as above). 2. Operational Costs: (as above).	Q1: Wildfire suppression costs 5 years post-4FRI implementation (control for increases in population and housing) vs. wildfire suppression costs 5 years pre-4FRI implementation. Q2: Wildfire suppression costs 5 years post-4FRI implementation vs. treatment costs (planning, prep, admin & operational costs).	5 years	Q1: 1. Direct suppression costs obtained from: USFS, BLM, NRCD, NIFC, State, County, FEMA, DHS, Insurance companies, American Red Cross (Western Forest Leadership Coalition 2010). 2. Headwaters Institute (EPS-HDT Socioeconomic profiles). 3. USFS budget staff (D. Jaworski Personal Communication 2011). Q2: 1. Southwestern Region Restoration Task Group (4FRI Stakeholder Group 2010c). 2. Contractor surveys.	Q1: Direct costs associated with Wildfire suppression are increasing as forest restoration projects are implemented over time. Q2: Direct wildfire suppression costs are higher than treatment (planning, prep, admin & operational) costs.
Short-term (direct) rehabilitation costs are reduced.	Are short-term (direct) rehabilitation costs associated with wildfire rehabilitation decreasing as forest restoration projects are implemented over time (e.g. Burned Area Emergency Rehabilitation (BAER))?	BAER funds appropriated (tracked annually) (Western Forest Leadership Coalition 2010).	BAER expenditures 5 years post-4FRI implementation vs. BAER expenditures 5 years pre-4FRI implementation.	5 years (annual expenditures)	USFS BAER expenditure database (Western Forest Leadership Coalition 2010).	Short-term (direct) rehabilitation costs associated with wildfire rehabilitation are increasing as forest restoration projects are implemented over time.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Wildfire suppression frequency and duration in 4FRI treated areas are reduced.	Are wildfire suppression efforts in 4FRI treated areas frequency and duration decreasing as forest restoration projects are implemented over time?	Frequency of wildfires. Duration of wildfires.	Frequency and duration of wildfires 5 years post-4FRI implementation vs. frequency and duration of wildfires 5 years pre-4FRI implementation.	5 years	USFS by Forests (Greater Flagstaff Forest Partnership 2010).	Wildfire suppression efforts frequency and duration are increasing as forest restoration projects are implemented.
Managed fire frequency and duration are increasing.	Are managed fire frequency and duration increasing as forest restoration projects are implemented over time?	Frequency of managed fires. Duration of managed fires.	Frequency and duration of managed fires 5 years post-4FRI implementation vs. frequency and duration of managed fires 5 years pre-4FRI implementation.	5 years	USFS by Forests (Greater Flagstaff Forest Partnership 2010).	Managed fire frequency and duration are decreasing as forest restoration projects are implemented.
Prescribed fire frequency and duration are reduced.	Are prescribed fire frequency and duration decreasing as forest restoration projects are implemented over time?	Frequency of prescribed fires. Duration of prescribed fires.	Frequency and duration of prescribed fires 10 years post- 4FRI implementation vs. frequency and duration of prescribed fires 10 years pre-4FRI implementation.	10 years	USFS by Forests (Greater Flagstaff Forest Partnership 2010).	Prescribed fire frequency and duration are increasing as forest restoration projects are implemented.
Prescribed fire costs are reduced.	Are prescribed fire costs decreasing as forest restoration projects are implemented over time?	1. Burn plans 2. Prep work 3. Cutting hand lines” 4. Implement burn 5. Monitor burn (4FRI Stakeholder Group 2011c).	Costs of prescribed fires 10 years post-4FRI implementation vs. costs of prescribed fires 10 years pre-4FRI implementation.	10 years	USFS budget staff (D. Jaworski Personal Communication 2011).	Prescribed fire costs are increasing as forest restoration projects are implemented.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Reduce size, and frequency of pile burns.	Q1: Is the frequency and size of pile burns decreasing as forest restoration projects are implemented over time? Q2: Is the volume of slash that is chipped (not burned) increasing?	Q1: 1. Frequency of pile burns. 2. Size of pile burns. Q2: Volume of slash that is chipped.	Q1: Frequency and size of pile burns 10 years post-4FRI implementation vs. frequency and size of pile burns 10 years pre-4FRI implementation. Q2: Volume of slash chipped 10 years post-4FRI implementation vs. volume 10 years pre-4FRI implementation.	10 years	USFS by Forests (Greater Flagstaff Forest Partnership 2010).	Size and frequency of pile burns is increasing and volume of slash that is chipped is decreasing as forest restoration projects are implemented.

VII. GOAL: There is a sufficient market place for small diameter wood products

Table 149. Four Forest Restoration Initiative socioeconomic monitoring framework for economic systems, VI. Goal

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
A sufficient market exists to consume wood biomass products.	Is there a sufficient market to sell wood biomass products?	1. # of businesses and type of wood biomass material purchased (e.g. clean chips, dirty chips, roundwood and sawtimber) (Sitko and Hurteau 2010). 2. Dollar amount and/or percent of available inventory/sales businesses purchased.	Economic Impact Analysis: include # of businesses, type of small diameter wood material purchased and dollar amount and/or percent of available inventory/sales businesses purchased.	5 years	Business surveys	There is an insufficient market to sell small diameter wood products.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Economic value of wood biomass products is sufficient to profitably process small diameter wood products.	Does the market value of wood products exceed production costs?	Sales ($ value) of wood products. Production costs: raw materials (wood products), hauling, petroleum products, mill equipment/parts, heavy equipment/parts, electricity, vehicle parts/tires, and transport equipment (Sitko and Hurteau 2010).	Financial analysis: Compare sales of wood products to production costs.	5 years	Business surveys	The market value of wood products does not exceed production costs.
Increase the amount of wood products (wood biomass and value-added) that are processed locally.	What is the proportion of biomass processed locally vs. non-local?	Number of local businesses processing small diameter wood products. Number of non-local businesses processing small diameter wood products. Amount of wood (volume) products processed locally. Amount of wood (volume) products processed non-locally (Greater Flagstaff Forest Partnership 2005).	Compare # of local vs. non-local businesses (percent each). Compare local vs. non-local business volume of wood product production (percent each).	5 years	Contractor surveys. Contracts, federal databases USAspending.gov USFS Natural Resource Manager Database (University of Oregon 2011).	The proportion of biomass processed locally is lower than biomass processed outside of the defined local area.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Increase the amount of wood products (wood biomass and value-added) that are distributed locally.	Q1: Where are the wood products distributed? Q2: What is the proportion of end-products distributed locally vs. non-local?	Q1: Location of wood product distribution. Q2: Volume/quantity of wood products distributed locally and non-local.	Compare location of wood product distribution and proportion of volume of wood products distributed locally vs non-local.	5 years	Contractor surveys. Contracts, federal databases USAspending.gov USFS Natural Resource Manager Database (University of Oregon 2011).	Q1/Q2: The amount of wood products (small diameter and value-added) that are distributed locally are not increasing.
Investment, research and development in utilization of wood biomass are increasing.	Is investment, research and development in utilization of wood biomass increasing?	Number of forest product industries involved in market research for small diameter wood uses. Amount invested by businesses for development and research. Type and amount of market analysis. Number of companies applying for grants that support small diameter market research (Greater Flagstaff Forest Partnership 2005).	Track # involved in market research for small-diameter wood uses, amount invested, type and intensity of market research, # of companies applying for grants supporting small diameter product development.	5 years	Contractor/ business surveys. Headwaters Institute	Investment, research and development in utilization of small diameter trees is not increasing.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Uses for wood biomass and/or value-added products are expanded and diversified.	Q1: What is the type and proportion of the production of wood biomass end-products? Q2: Are uses for wood biomass and/or value- added products expanding and diversifying?	Q1/Q2: Percentage production of: Pellets, Pallets, Molding, Small lumber, Biomass-energy, Livestock bedding, Soil fertilizers, (Sitko and Hurteau 2010) OSB, Plywood, Particle board, Fiberboard, Roundwood products (4FRI Stakeholder Group 2010c).	Compare percent of production of type of wood products and track over time.	5 years	Contractor/business surveys.	Q1/Q2: Uses for small diameter material and/or value-added products are not expanding and diversifying.

GOAL: There is a predictable wood supply throughout the life of the 4FRI project

Table 150. Four Forest Restoration Initiative socioeconomic monitoring framework for economic systems

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Ensure the availability of forest material at a sustainable, consistent level to support appropriate forest product industries throughout the life of the 4FRI project.	Q1: Are the length of contracts sufficient to recover costs and realize return on investment? Q2: Do contracts provide the flexibility to respond to fluctuating markets (e.g. pile and burn slash vs. removal) & redetermination of wood product's value? Q3: Do contracts provide guaranteed treatable acres that will provide a return on investment? Q4: Are objections and lawsuits for 4FRI projects hampering the project's progression?	Q1: 1. Length of contracts. 2. Operational cost incurred to complete contracts (as above). 3. Wood yields and respective value/contract. 4. Number of acres/year USFS admin planning are complete. Q2: 1. Pile/burn costs 2. Slash removal costs 3. Wood product value Q3: 1. Avg. wood yield/ treatable acres/contract 2. Operational cost incurred to complete contracts (as above). Q4: Number and length of time (each) of objections and lawsuits that are delaying the 4FRI project's progression.	Q1: Economic Impact Analysis: 1. Operational costs vs. wood yields and respective value. 2. # of acres USFS admin/planning are complete vs. # of acres/contract. Q2: Contract analysis of: 1. Pile/burn slash costs vs. removal costs. 2. Valuation of wood products. Q3: Avg. wood yield per treatable acres/contract and its respective value vs. operational costs. Q4: # & length of time of lawsuits; # of delayed treatable acres, volume and its value.	Ten years or length of the contract.	Q1-Q3: 1. Contractor surveys 2. USFS business plans (D. Jaworski Personal Communication 2011). 3. Contracts: federal databases a. USAspending.gov b. USFS Natural Resource Manager Database (University of Oregon 2011). 4. Headwaters Institute Q4: Objections database available at: http://www.fs.fed.us/emc/applit/ (Cortner et. al 2003).	Q1: The contracts are not long enough to recover costs and realize a return on investment. Q2: Contracts do not provide the flexibility to respond to fluctuating markets & redetermination of wood product's value. Q3: Contracts do not provide guaranteed treatable acres that will yield a return on investment. Q4: Objections and lawsuits for 4FRI projects are significantly delaying the project's progression (acres treated & respective value).

Acronyms used within Socioeconomics Framework Tables

- AZG&F Arizona Game & Fish Department
- BAER Burned Area Emergency Rehabilitation
- BLM Bureau of Land Management
- DHS Department of Homeland Security
- FEMA Federal Emergency Management Agency
- NEPA National Environmental Protection Act
- NIFC National Interagency Fire Center
- NFMA National Forest Management Act
- NMFS National Marine Fisheries Service
- NRCD Natural Resource Conservation Districts
- SRP Salt River Project Power & Water
- SWRRTG Southwestern Region Restoration Task Group
- WMSC White Mountain Stewardship Contract
- USFS United States Forests Service
- FWS United States Fish & Wildlife Service

Appendix F – Glossary

Active crown fire – A fire in which a solid flame develops in the crowns of trees, but the surface and crown phases advance as a linked unit dependent on each other.

Activity fuels – Fuels resulting from, or altered by, forestry practices such as mechanical thinning or fuel management, as opposed to naturally created fuels (National Wildfire Coordinating Group 2018).

Adaptive management – The general framework encompassing the three phases of planning: assessment, plan development, and monitoring (36 CFR 219.5). This framework supports decision-making that meets management objectives while simultaneously accruing information to improve future management by adjusting the plan or plan implementation. Adaptive management is a structured, cyclical process for planning and decision-making in the face of uncertainty and changing conditions with feedback from monitoring, which includes using the planning process to actively test assumptions, track relevant conditions over time, and measure management effectiveness (FSH 1909.12, 05)

Administrative National Forest System roads – Maintenance level 2-5 roads with motorized access restricted to administrative use only. Traffic may be managed with gates. See Road maintenance levels.

Advancing fire – See Head fire.

Age class – A distinct aggregation (grouping) of trees originating from a single natural event commonly consisting of trees of similar age.

Aquatic management zone (AMZ) – An administratively designated zone adjacent to stream channels and other waterbodies. The AMZ is delineated for applying special management controls aimed at maintaining and improving water quality or other water and riparian-dependent values, including groundwater-dependent ecosystems. The width of the AMZ is determined based on site-specific factors and local requirements. AMZ delineation may encompass the floodplain and riparian areas when present.

Background – The distant part of a landscape or surroundings, especially that behind something which provides harmony or contrast. Background is usually located 3 to 5 miles from the observer (Fargo 2018).

Backing fire – Fire spreading, or ignited to spread, into (against) the wind or downslope. A fire spreading on level ground in the absence of wind is a backing fire. May also refer to a portion of a fire with slower rates of fire spread and lower intensity normally moving into the wind and/or down slope. Also called a heel fire (National Wildfire Coordinating Group 2018).

Basal area – The cross-sectional area of all trees, measured in square feet per acre.

Best management practices for water quality (BMPs) – Methods, measures, or practices selected by an agency to meet its nonpoint source control needs. BMPs include but are not limited to structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters (Regulations).

Biomass – Multiple definitions include: organic matter produced by plants and other photosynthetic organisms; total dry weight of all living organisms that can be supported at each level of a food chain or web; dry weight of all organic matter in plants and animals in an ecosystem; plant materials and animal wastes that function as fuel for fire.

Burn – Multiple definitions include: an effect produced by heating; to undergo combustion (consume fuel and give off light, heat, and gases); an area where fire has occurred in the past.

Canopy – A layer of foliage, generally the uppermost layer, in a forest stand. Can be used to refer to midstory or understory vegetation in multilayered stands.

Canopy base height (CBH) – The lowest height above the ground at which there is a sufficient amount of canopy fuel to propagate fire vertically into the canopy (Scott and Reinhardt 2001). It is a critical factor in crown fire initiation and can be used as an indicator of the potential for crown fire initiation ((Agee and Skinner 2005), (Stratton 2009), (Scott 2003)).

Canopy bulk density (CBD) – The mass of available canopy fuel per unit volume. It is a bulk property of a stand of trees, not individual trees (Scott and Reinhardt 2001). CBD is a good indicator of potential active crown fire (Scott 2003; Stratton 2009).

Canopy characteristics – Canopy characteristics include canopy cover, canopy base heights (CBH), and canopy bulk density (CBD) which contribute significantly toward the type of fire that can occur (Scott and Reinhardt 2001). Canopy cover, CBH, and CBD directly affect the incidence and behavior of crown fires and are used for modeling potential fire behavior (Agee and Skinner 2005; Scott 2003; Scott and Reinhardt 2005).

Canopy cover – As used in modeling fire in the fire ecology analysis, canopy cover is the horizontal fraction of the ground that is covered directly overhead by tree canopy, that is, the percent of vertically projected canopy cover in the stand (Scott and Reinhardt 2005).

Clean Water Act – A congressional act that provides the structure for regulating pollutant discharges to waters of the United States. The act's objective is "…to restore and maintain the chemical, physical, and biological integrity of the Nation's waters," and is aimed at controlling both point and nonpoint sources of pollution. The U.S. EPA administers the act, but many permitting, administrative, and enforcement functions are delegated to state governments. In Arizona, the designated agency for enforcement of the Clean Water Act is the Arizona Department of Environmental Quality (1972).

Closed road – An existing system road closed to vehicular traffic, including administrative traffic. Closed roads are coded maintenance level 1 in the forest transportation atlas database.

Clump – The aggregate of stems issuing from the same root, rhizome system, or stool; or an isolated generally dense group of trees (Society of American Foresters 1998). A clump is relatively isolated from other clumps or trees within a group of trees, but a stand-alone clump of trees can function as a tree group or a single structure (Reynolds and others 2013).

Coarse woody debris – Woody debris derived from tree limbs, boles, and roots, and larger than 7.5 cm (3 inches) in diameter (Graham and others 1994).

Comprehensive restoration – Restoration treatments that are designed to complement thinning and prescribed burning restoration treatments in target cover types. These treatments are proposed in order to restore non-target vegetation cover types and improve habitat for aquatic and terrestrial wildlife and rare plants. Comprehensive restoration activities include aspen restoration; restoration of areas that have experienced severe disturbances; restoration of savannas, grasslands, meadows, springs, and streams; road decommissioning and relocation; and construction of barriers to protect sensitive areas and species from grazing. See Target cover type.

Condition class – Depiction of the degree of departure from historical fire regimes, possibly resulting in alterations of key ecosystem components. The risk of loss of key ecosystem components from wildfires increases from Condition Class 1 (lowest risk) to Condition Class 3 (highest risk) (National Wildfire Coordinating Group 2018). See also Fire regime condition class.

Conditional crown fire – A crown fire that is dependent on ladder fuels in adjacent stands in order for fire to access the crowns. In an area with conditional crown fire, ladder fuels are insufficient in a stand for crown fire to initiate, but canopy fuels are sufficient to support crown fire if it moves in from an adjacent stand.

Connectivity – Ecological conditions that exist at several spatial and temporal scales that provide landscape linkages that permit the exchange of flow, sediments, and nutrients; the daily and seasonal movements of animals within home ranges; the dispersal and genetic interchange between populations; and the long distance range shifts of species, such as in response to climate change (36 CFR 219.19).

Contemporary uses – The use of the forest for traditional and cultural purposes by tribes that have aboriginal ties to the land.

Controlled burn – See Prescribed fire.

Cover type – Refers to a forest or woodland type, such as ponderosa pine, pine-oak, or mixed- conifer.

Crown fire – A fire that advances from top to top of trees or shrubs more or less independent of a surface fire. Crown fires are sometimes classed as independent, conditional, or dependent (active or passive) to distinguish the degree of independence from the surface fire (National Wildfire Coordinating Group 2018).

Declining – The senescent (aging) period in the lifespan of plants that (for trees) includes the presence of large dead and/or dying limbs, snag tops, large, old lightning scars, and other characteristics that indicate the later life stages.

Decommissioned roads – Roads that have been permanently removed from the National Forest System. They continue to be tracked in the forest transportation atlas for future reference. See also Road decommissioning.

Density-related mortality – Based upon established forest density/vigor relationships, density- related mortality begins to occur once the forest reaches 45 to 50 percent of maximum stand density, and mortality is likely at density levels over 60 percent of maximum stand density (Long 1985)

Design features – Mitigation measures, best management practices, and conservation measures that are applied in treatment areas in order to mitigate, reduce, or avoid negative impacts of treatment activities. These features are developed based on forest plan direction, the Soil and Watershed Conservation Practices Handbook (USDA, 1990), the National Best Management Practices for Water Quality Management on National Forest System Lands, Volume 1: National Core BMP Technical Guide (FS990a), and resource specialist recommendations.

Desired conditions – A description of specific social, economic, and/or ecological characteristics of the (forest) plan area, or a portion of the (forest) plan area, toward which management of the land and resources should be directed. Desired conditions must be described in terms that are specific enough to allow progress toward their achievement to be determined, but do not include completion dates. Desired conditions are achievable, and may reflect social, economic, or ecological attributes, including ecosystem processes and functions (FSH 1909.12, 05).

Diameter at breast height – A standard measure of tree diameter measured approximately 1.5 meters (4.5 feet) above the ground.

Distance zones – Areas of landscapes (foreground, middleground, or background) denoted by specific distances from the observer. Distance zones are used as a frame of reference in which to discuss landscape characteristics or activities of humans (Fargo 2018).

Disturbance – Any relatively discrete event in time that disrupts ecosystem, watershed, community, or species population structure and/or function and changes resources, substrate availability, or the physical environment (Regulations).

Disturbance regime – A set of recurring conditions due to a variety of disturbances (e.g., fire, flooding, insect outbreak) and their interaction, which characterize an ecosystem within a historic, natural, or human-induced context, within a given climate. This set of recurring conditions includes a specific range for each of the attributes of these disturbances. These attributes include: frequency, rotation period, intensity, severity, seasonality, patch size and distribution, residual structure, causal agent, the relative influence of each causal agent, and how they interact (Suffling and Perera 2004). The attributes researchers choose to represent a regime will vary depending on a researcher's area of interest ((Sousa 1984), (White and Pickett 1985), (Agee 1993), (Skinner and Chang 1996), (Turner and Gardner 2001)). An accurate description of a disturbance regime must include the full range of disturbance events, including those that are rare.

Diversity – The distribution and abundance of different plant and animal communities and species within the area covered by a land and resource management plan.

Drought – Periods of abnormally dry weather sufficiently long enough to cause a serious hydrological imbalance. Drought is a relative term; therefore any discussion of precipitation deficit must refer to the particular precipitation-related activity that is under discussion. For example, there may be a shortage of precipitation during the growing season resulting in crop damage (agricultural drought), or during the winter runoff and percolation season affecting water supplies (hydrological drought) (Werth and others 2011).

Duff – The fermentation and humus layer lying below the litter layer but above mineral soil and consisting of partially decomposed organic matter whose origins can still be visually determined, as well as the fully decomposed humus layer. Neither freshly cast material in the litter layer, nor ash following a fire, is included in the duff layer (Brown and Smith 2000). The top of the duff is where needles, leaves, fruits, and other castoff vegetative material have noticeably begun to decompose. Individual particles usually are bound by fungal mycelia. The bottom of the duff is mineral soil. There is a gradient, not a clear division between litter and duff.

Ecological management unit (EMU) – A specific geographic area, identified based on physiographic provinces, biotic regimes, perceived threats to owls or their habitat, administrative boundaries, and known patterns of owl distribution, which is used to evaluate the status of Mexican spotted owls and for which to specific management guidelines were developed (USDI 2012). The EMUs specific to this analysis are the Upper Gila Mountains and Basin and Range West EMUs.

Ecological restoration – The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on reestablishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystems sustainability, resilience, and health under current and future conditions (FSH 1909.12, 05).

Economic efficiency analysis – Analysis of the net present value of the stream of benefits less the stream of costs over the life of a project (Jaworski 2018).

Economic impact analysis – Analysis of the changes in employment, labor income, and/or output in an economy due to a policy, program, or project (Jaworski 2018).

Ecosystem – A spatially explicit, relatively homogeneous unit of the Earth that includes all interacting organisms and elements of the abiotic environment within its boundaries. An ecosystem is commonly described in terms of its:

> Composition – The biological elements within the different levels of biological organization, from genes and species to communities and ecosystems.
>
> Structure – The organization and physical arrangement of biological elements such as, snags and down woody debris, vertical and horizontal distribution of vegetation, stream habitat complexity, landscape pattern, and connectivity.
>
> Function – Ecological processes that sustain composition and structure, such as energy flow, nutrient cycling and retention, soil development and retention, predation and herbivory, and natural disturbances such as wind, fire, and floods.
>
> Connectivity – See also Connectivity (36 CFR 219.19).

Ecosystem resilience – The ability of an ecosystem to absorb and recover from disturbances without altering its inherent functions (SER 2004).

Ecosystem services – Benefits people obtain from ecosystems, including:

- provisioning services, such as clean air and fresh water, energy, food, fuel, forage, wood products or fiber, and minerals;
- regulating services, such as long-term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood and drought control; and disease regulation;
- supporting services, such as pollination, seed dispersal, soil formation, and nutrient cycling; and
- cultural services, such as educational, aesthetic, spiritual, and cultural heritage values, recreational experiences, and tourism opportunities (FSH 1909.12, 05).

Ecosystem sustainability – The capacity of ecosystems to maintain ecosystem services in perpetuity without degradation of its productivity and function at all scales. For example, in the context of a restoration framework, sustainability results in maintaining the key elements in space and time (Reynolds and others 2013).

Environmental justice – The fair treatment and involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The White House, with Executive Order 12898, elevated environmental justice issues to the Federal agency policy agenda. EO 12898 instructs each Federal agency to identify and address "disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (Clinton 1994).

Ephemeral stream – A stream that flows only briefly during and following a period of rainfall in the immediate locality.

Erosion – The wearing away of the land surface by rain or irrigation water, wind, ice, or other natural or anthropogenic agents that abrade, detach, and remove geologic parent material or soil from one point on the earth's surface and deposit it elsewhere.

Even-aged management – The application of a combination of actions that result in the creation of stands in which trees of essentially the same age grow together. Managed even-aged forests are characterized by a distribution of stands of varying ages (and, therefore, tree sizes) throughout the forest area. The difference in age between trees forming the main canopy level of a stand usually does not exceed 20 percent of the age of the stand at harvest rotation age. Regeneration in a particular stand is obtained during a short period at or near the time that a stand has reached the desired age or size for regeneration and is harvested. Clearcut, shelterwood, or seed tree cutting methods produce even-aged stands.

Even-aged stand – A stand of trees composed of a predominately single age class in which the range of tree ages is usually less than 20 percent of the intended rotation.

Facilitative operations – The use of mechanical treatments or prescribed fire in non-target cover types (e.g., pinyon-juniper) to support the use of prescribed fire in cover types targeted for restoration (e.g., ponderosa pine types) when those non-target cover types lie between target cover types and natural or man-made features appropriate to use as prescribed fire unit boundaries. Facilitative operations are designed to improve safety and treatment effectiveness, expand burn windows, decrease undesirable fire behavior and effects, and minimize disturbance from fireline construction. Mechanical facilitative operations may include mastication/chipping; lop and scatter; thinning/limbing; and moving, rearranging, or removal of jackpots or excessive surface fuels. Prescribed fire facilitative operations may include broadcast burning, jackpotting, pile burning, or blacklining.

Fire ecology – The study of fire's interaction with ecosystems.

Fire front – The part of a fire within which continuous flaming combustion is taking place. Unless otherwise specified, the fire front is assumed to be the leading edge of the fire perimeter. In ground fires, the fire front may be mainly smoldering combustion (National Wildfire Coordinating Group 2018).

Fire-adapted ecosystem – An associated group of plants and animals that have made long-term genetic changes in response to the presence of fire in their environment.

Fireline intensity – Rate of heat release per unit time per unit length of fire front. It is a quantitative measure of fire behavior that is a measure of the fire itself (not its effects). Indicators of fireline intensity include flame length, flame height, peak temperatures, energy output/time, and scorch height (as in indicator of flame height).

Fire regime – A set of recurring fire conditions that characterize an ecosystem, within a historic, natural, or human induced context, within a given climate. This set of recurring conditions includes a specific range of attributes. (Sugihara and others 2006) use the following attributes: seasonality, frequency (fire return interval), intensity, severity, size, spatial complexity, and fire type. An accurate description of a fire regime will include the full range of fire events, including those that are rare and connect to the larger disturbance regime which contains the fire regime as a subset. There are five fire regimes:

Fire Regime I – 0 to 35 year frequency and low (surface fires most common, isolated torching can occur) to mixed severity (less than 75 percent of dominant overstory vegetation replaced)

Fire Regime II – 0 to 35 year frequency and high severity (greater than 75 percent of dominant overstory vegetation replaced)

Fire Regime III – 35 to 100+ year frequency and mixed severity

Fire Regime IV – 35 to 100+ year frequency and high severity

Fire Regime V – 200+ year frequency and high severity

Fire regime current condition class – A qualitative measure classified into three classes describing the relative degree of departure from historical fire regimes, possibly resulting in alterations of key ecosystem components such as species composition, structural stage, stand age, canopy closure, and fuel loadings (National Wildfire Coordinating Group 2018). See also Condition class.

Fire return interval – The number of years between two successive fires in a designated area. The size of the area must be clearly specified (McPherson and others 1990).

Fire risk – In the context of technical risk assessments, the term "risk" considers not only the probability of an event, but also includes values and expected losses. Within wildland fire, "risk" refers only to the probability of ignition (both man- and lightning-caused) (Hardy 2005).

Fire severity – A qualitative evaluation of immediate effects produced by the heat pulse of a fire on the biotic and abiotic components of an ecosystem. Indicators include the amount of biomass consumed, changes in the amount of mineral soil exposed, soil color, and top-killed surface vegetation.

Fire type – Flaming front patterns that are characteristic of a fire.

First order fire effects – Effects resulting directly from the fire, such as fuel consumption and smoke production.

Flame length – The length of flames in the propagating fire front measured along the slant of the flame from the midpoint of its base to its tip.

Flanking (lateral) fire – A fire whose rate or spread and intensity usually falls somewhere in between advancing and backing with spread lateral to the main direction of fire travel (National Wildfire Coordinating Group 2018).

Flexible toolbox approach – A condition-based management framework that allows for consistent selection of the most appropriate treatment for any given set of existing conditions by applying an "if/then" approach. For example, if condition "X" exists on the ground, then treatment "Y" will be applied as the most appropriate means of moving a resource towards desired conditions. Alternatives two and three both incorporate two separate flexible toolbox approaches as part of their proposed activities: one for aquatic and watershed restoration activities and one for mechanical thinning restoration treatments.

Forage – Browse and herbage which is available and can provide food for animals or be harvested for feeding; or to search for or consume forage (Coulloudon and others 1999).

Forb – A broadleaved, herbaceous plant (e.g., columbine).

Foreground – The detailed landscape typically found within zero to one-fourth mile of the observer (Fargo 2018).

Forest health – The perceived condition of a forest derived from concerns about such factors as its age, structure, composition, function, vigor, presence of unusual levels of insects or disease, and resilience to disturbance. Note perception and interpretation of forest health are influenced by individual and cultural viewpoints, land management objectives, spatial and temporal scales, the relative health of the stands that comprise the forest, and the appearance of the forest at a point in time (Foresters).

Forest plan (also referred to as a land and resource management plan or land management plan) – A document or set of documents that provide management direction for an administrative unit of the NFS developed under the requirements of the applicable planning rule. Forest plans provide a framework for integrated resource management and for guiding project and activity decision making on a national forest, grassland, prairie, or other administrative unit (Regulations).

Fuel – Living and dead vegetation that can be ignited.

Fuel continuity – A qualitative description of the distribution of fuel, both horizontally and vertically. Continuous fuel supports fire spread better than discontinuous fuel.

Fuel load – The amount of combustible material (usually measured by weight) present per unit area.

Fuel type – An identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause a predictable rate of spread, or resistance to control under specified weather conditions.

Ground fire – Fire that consumes the organic material below the litter layer, mostly by smoldering combustion. Fires in duff, peat, dead moss and lichens, and partly decomposed wood are typically ground fires. See also Surface fire and Underburn (National Wildfire Coordinating Group 2018).

Group – A cluster of two or more trees with interlocking or nearly interlocking crowns at maturity, surrounded by grass-forb-shrub interspaces. Size of tree groups is typically variable depending on forest type and site conditions and can range from fractions of an acre (e.g., a two-tree group), such as in ponderosa pine or dry mixed-conifer forests, to many acres, as is common in wet mixed-conifer and spruce fir forests. Trees within groups are typically non-uniformly spaced, some of which may be tightly clumped (Reynolds and others 2013).

Group selection – A cutting procedure which creates a new age class by removing trees in groups or patches to allow seedlings to become established in the new opening (Foresters 1998)

Habitat – The dwelling place of an organism or community that provides the requisite conditions for its life processes (Society for Ecological Restoration International Science & Policy Working Group 2004).

Hand thinning – See Mechanical thinning.

Head (advancing) fire – That portion of a fire with rapid fire spread with higher intensity which is normally burning with the wind and/or up slope (National Wildfire Coordinating Group 2018).

Heritage strategy – A strategy developed in consultation with the Arizona State Historic Preservation Officer to assist in reaching a “No Adverse Effect” determination for the project. See Heritage Resource report.

Heterogeneity – For the purposes of this analysis, heterogeneity refers to diversity in terms of habitat types and forest structure across the landscape.

Historical range of variation – See Natural range of variation.

Hydrologic condition – The current state of the processes controlling the yield, timing, and quality of water in a watershed (FSM 2521.05).

Impaired waters – Under section 303(d) of the 1972 Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These impaired waters do not meet water quality standards that states, territories, and authorized tribes have set for them, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop TMDLs for these waters. See the Watershed and Aquatics reports for additional information.

Interspace(s) – Areas not currently under the vertical projection of the outermost perimeter of tree canopies (drip-line). They are generally composed of grass-forb-shrub communities but could also be areas with scattered rock or exposed mineral soil. Interspaces do not include meadows, grasslands, rock outcroppings, and wetlands (i.e., exclusions adjacent to and sometimes within forested landscapes). As spaces between trees, tree groups and tree clumps, interspaces contribute to the "open canopy" character of frequent-fire forests. They often connect with other interspaces and thus are variably shaped and sized. Interspaces and tree group locations are dynamic and shift over time (Reynolds and others 2013). See also Openings.

Invasive – any species which can establish, persist, and spread in an area, and be detrimental or destructive to native ecosystems, habitats, or species, and is difficult to control or eradicate.

Ladder fuel – Fuel, such as branches, shrubs, or an understory layer of trees, which allow a fire to spread from the ground to the canopy.

Landscape scale – A unit of land approximately 10,000 acres or greater, typically composed of variable elevations, slopes, aspects, soils, plant associations, and natural ecological processes. In this analysis, the landscape scale for vegetation is the ponderosa pine extent.

Large tree – A large tree as defined in the revised "Mexican Spotted Owl Recovery Plan" (USDI 2012) is a tree greater than 18 inches d.b.h.

Litter – The top layer of the forest, shrubland, or grassland floor above the duff layer, including freshly fallen leaves, needles, bark, flakes, fruits (e.g., acorns, cones), cone scales, dead matted grass, and a variety of accumulated dead organic matter which is unaltered or only slightly decomposed. This layer typically does not include twigs and larger stems. One rough measure to distinguish litter from duff is that you can pick up a piece of litter and tell what it was (a leaf or leaf part, a needle, etc.). Duff is generally not identifiable. There is a gradient, not a clear division between litter and duff.

Management area – A spatially defined area with a common set of desired conditions, objectives, standards, guidelines, suitability determinations, and monitoring requirements that may differ from those of the general forest. Management areas are defined by the desired settings and types of uses that would occur within in them under the forest plan.

Mature tree – A tree that has attained most of its potential height growth.

Mechanical thinning – Any activity (e.g., silvicultural thinning, biomass removal) performed by human-controlled tools (e.g., chainsaw, feller-buncher) that results in the removal or alteration of wood fiber. Does not include the use of fire.

Middleground – The space between the foreground and background in a viewed landscape. The area is usually located from one-fourth through one-fourth to 3 through 5 miles from the observer (Fargo 2018).

Monitoring – A systematic process of collecting information to evaluate effects of actions or changes in conditions or relationships (Regulations).

Mosaic – The heterogeneous spatial arrangement of habitat measured at many spatial scales from the patch, the stand, and the vegetative community.

Motorized trail – A trail designated for motorized vehicle travel that is wholly or partly within or adjacent to and serving the National Forest System that the Forest Service determines is necessary for the protection, administration, and utilization of the National Forest System and the use and development of its resources (Regulations).

Motorized vehicle – A self-propelled vehicle, other than a vehicle operated on rails or a wheelchair or mobility device (including one that is battery powered) that is designed solely for use by a mobility-impaired person for locomotion and that is suitable for use in an indoor pedestrian area.(Regulations)

National Forest System road – A forest road other than a road which has been authorized by a legally documented right-of-way held by a State, county, or other local public road authority (Regulations).

National Forest System trail – A forest trail other than a trail which has been authorized by a legally documented right-of-way held by a State, county, or other local public road authority (Regulations).

Natural range of variation – A description of the change over time and space in the ecological condition of potential natural vegetation types and the ecological processes that shape those types. Potential natural vegetation types (PNVTs) represent the vegetation type and characteristics that would occur when natural disturbance regimes and biological processes prevail (Keane and others 2009; Reynolds and others 2013; Schussman and Smith 2006).

Native species – A species which is an indigenous (originating where it is found) member of a biotic community. The term implies that humans were not involved in the dispersal or colonization of the species.

Nesting and roosting recovery habitat – Areas managed to replace nesting and roosting habitat lost to disturbance or senescence and to provide new nesting and roosting habitat for a recovering owl population.

Nonmarket values – The benefits and values associated with national forests that do not have a monetary price including clean water and air, biodiversity, forest products, and other goods and services.

Northern goshawk post-fledging family areas (PFAs) – Areas that surround the nest areas. They represent an area of concentrated use by the northern goshawk family until the time the young are no longer dependent on adults for food. PFAs are approximately 420 acres in size (not including the nest area acres)

Noxious weed – A legal term applied to plants regulated by Federal and state laws, such as plants designated as noxious weeds by the Secretary of Agriculture or by the responsible state official. Noxious weeds generally possess one or more of the following characteristics: aggressive and difficult to manage, poisonous, toxic, parasitic, a carrier or host of serious insect or disease, and being not native or new or not common to the United States or parts thereof.

Nutrient cycling (soil) – The circulation of chemicals necessary for life, from the environment (mostly from soil and water) through organisms and back to the environment.

Objective road maintenance level – The maintenance level to be assigned to a road or road segment at a future date considering future road management objectives, traffic needs, budget constraints, and environmental concerns. The objective maintenance level may be the same as, higher than, or lower than the operational maintenance level. The transition from operational maintenance level to objective maintenance level may depend on reconstruction or disinvestment. (FSH 7709.59, 62.31).

Old growth – In southwestern forested ecosystems is defined differently than the traditional definition based on Northwestern infrequent-fire forests. Due to large differences among Southwest forest types and their characteristic disturbances, old growth forests vary extensively in tree size, age classes, presence and abundance of structural elements, stability, and presence of understory. Important structural features of old growth in frequent-fire forests are large trees, old trees, age variability, snags, large dead and downed fuels, and between-patch structural variability (Reynolds and others 2013).

Old Growth Protection And Large Tree Retention Strategy – Strategy developed by the 4FRI stakeholders in 2011 (revised in 2012), which provides recommendations relating to the retention of large post-settlement and old growth trees (Stakeholders 2012).

Opening a road – The act of allowing motorized use on an existing maintenance level 1 National Forest System road. Activities to accommodate motorized use include removing physical barricades such as berms, boulders, vegetation, and re-establishing and maintaining drainages and runoff patterns along the roadway.

Openings – Generally persistent treeless areas having a fairly distinct shape or size, occurring naturally due to differences in soil types as compared to sites that support forests or woodlands. Openings include meadows, grasslands, rock outcroppings, and wetlands. They may also result from disturbances like severe fire or windthrow, or management activities to intentionally create space for new tree regeneration. Natural and created openings are not the same as interspaces found in frequent-fire forests or woodlands. See also Interspaces.

Openness – In this analysis, openness conveys the percentage of the forested area that is grass-forb-shrub interspace.

Open reference condition – Forested ponderosa pine areas with mollic-integrade soils to be managed as a relatively open forest with trees typically aggregated in small groups within a grass/forb/shrub matrix.

Overmature tree – A tree that has reached that stage of development when it is declining in vigor and health and reaching the end of its natural lifespan.

Passive crown fire – A fire in the crowns of trees in which trees or groups of trees torch, ignited by the passing front of the fire. The torching trees reinforce the spread rate, but these fires are not basically different from surface fires (National Wildfire Coordinating Group 2018).

Percentile weather – For a given weather parameter (such as temperature, wind speed, relative humidity, precipitation, etc.,) the percent of days in a year that fall below it. For example, if the 90th percentile temperature for a given location is 90°F, it means that for 90% of days in a year, the temperature is lower than 90°F.

Piling and burning (pile burning) – Piling slash resulting from logging or fuel management activities and subsequently burning the individual piles (National Wildfire Coordinating Group 2018).

Planned ignition – The intentional initiation of a wildland fire by hand-held, mechanical, or aerial devices where the distance and timing between ignition lines or points, and the sequence of igniting them is determined by environmental conditions (weather, fuel, topography), firing technique, and other factors which influence fire behavior and fire effects. See also Prescribed fire.

Potential natural vegetation type (PNVT) – Coarse-scale groupings of ecosystem types that share similar geography, soils, vegetation, and historic ecosystem disturbances such as fire, drought, and grazing by native species. PNVTs represent the vegetation type and characteristics that would occur when natural disturbance regimes and biological processes prevail.

Precommercial thinning – The removal of trees not for immediate financial return but to reduce stocking to concentrate growth on the more desirable trees (Foresters).

Prescribed fire – A wildland fire originating from a planned ignition to meet specific objectives identified in a written and approved prescribed fire plan for which NEPA requirements (where applicable) have been met prior to ignition. See also Planned ignition.

Proper functioning condition (PFC) – A methodology for assessing the physical functioning of riparian and wetland areas. The term PFC is used to describe both the assessment process and a defined, on-the-ground condition of a riparian-wetland area (National Riparian Service Team Definition, 2013).

Protected activity center (PAC) – An area established around an owl nest (or sometimes roost) site, for the purpose of protecting that area. Management of these areas is largely restricted to managing for forest-health objectives (USDI 2012). See also Recovery habitat.

Proposed action – A proposal made by the Forest Service to authorize or implement an action to meet a specific purpose and need. A proposed action exists when the Agency gives public notice of a proposal (FSH 1909.15, 05).

Recovery habitat (Mexican spotted owl) – Areas outside of protected activity centers (PACs) that are managed as nest/roost, foraging, dispersal, and wintering habitat. Recovery habitat includes pine-oak, mixed-conifer, and riparian forests as well as rocky canyons (USDI 2012). See also Protected activity center.

Recreation opportunity spectrum – A framework for stratifying and defining classes of outdoor recreation environments, activities, and experience opportunities. The settings, activities, and opportunities for obtaining experiences are arranged across a continuum or spectrum of six classes: primitive, semiprimitive non-motorized, semiprimitive motorized, roaded natural, rural, and urban. 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. See the Recreation and Scenery reports for additional information.

Reference condition (also referred to as historic reference condition) – A range of conditions (found in the present or the past) against which the effects of past and future actions can be compared. These states can provide an explicit, historically-based context for comparing different management effects. Examples include periods before fire suppression or the arrival of an invasive species, or a similar but "healthier" modern ecosystem. Ideally, these environmental conditions are based on functioning ecosystems where natural ecosystem structure, composition, and function are operating with limited human intervention (i.e., with very minor human-caused ecological effects).

Regenerate – The act of renewing tree cover by establishing young trees naturally or artificially.

Research natural area – Research natural areas are part of a national network of ecological areas designated in perpetuity for research and education and/or to maintain biological diversity on National Forest System lands. Research natural areas are principally for nonmanipulative research, observation, and study. They also may assist in implementing provisions of special acts, such as the Endangered Species Act of 1973 and the monitoring provisions of the National Forest Management Act of 1976 (Agriculture 2018).

Residence time – Time required for the flaming front of a fire to pass a stationary point at the surface of the fuel. Also, the length of time the flaming front occupies one point, which relates to downward heating and fire effects below the surface.

Resilience – The ability of an ecosystem and its component parts to absorb, or recover from the effects of disturbances through preservation, restoration, or improvement of its essential structures and functions and redundancy of ecological patterns across the landscape (FSH 1909.12, 05).

Resource protection measures – Measures designed to:

> reduce the impacts of restoration activities to the productivity of soils and the functionality of aquatic ecosystems;
>
> protect stream water quality and temperature;
>
> minimize erosion and protect drainage system integrity on road ways;
>
> prevent the invasion or spread of noxious weeds on or originating from National Forest System lands; and
>
> minimize nonpoint source pollution as outlined in the 2013 intergovernmental agreement between the Arizona Department of Environmental Quality and the Southwestern Region of the Forest Service.

The resource protection measures included for this project refer to standard soil and watershed conservation practices and best management practices found in the Soil and Watershed Conservation Practices Handbook (USDA, 1990) and the National Best Management Practices for Water Quality Management on National Forest System Lands, Volume 1: National Core BMP Technical Guide (FS990a). Resource protection measures are implemented to.

Restoration treatments – Treatments that help recover forest ecosystem resilience and the adaptive capacity of forest ecosystems that have been degraded, or are otherwise outside the natural range of variability that would preclude sustainability through time.

Riparian areas – Geographically delineable areas with distinctive resource values and characteristics that are comprised of the aquatic and riparian ecosystems (FSM 2526.05).

Riparian ecosystems – A transition area between the aquatic ecosystem and the adjacent terrestrial ecosystem; identified by soil characteristics or distinctive vegetation communities that require free or unbound water (FSM 2526.05).

Road construction or reconstruction – Supervising, inspecting, actual building, and incurrence of all costs incidental to the construction or reconstruction of a road (36 CFR 212.1).

Road decommissioning – Activities that result in the stabilization and restoration of unneeded roads to a more natural state (Regulations). Forest Service Manual 7734.1 identifies various treatments for road decommissioning which can achieve the intent of this definition. These include revegetation and slope stabilization, blocking the entrance or installing waterbars, removing fills and culverts, reestablishing drainages and removing unstable road shoulders, full obliteration, recontouring and restoring natural slopes, or other methods designed to meet the specific conditions associated with the unneeded road.

Road maintenance – The upkeep of the entire transportation facility including surface and shoulders, parking and side areas, structures, and such traffic-control devices as are necessary for its safe and efficient utilization (Regulations). This work may include brushing of roadside vegetation, falling danger trees, road blading, cleaning ditches, cleaning culvert inlets and outlets, or other activities designed to meet maintenance objectives.

Road maintenance levels – Defines the level of service provided by, and maintenance required for, a specific road, consistent with road management objectives and maintenance criteria (FSH 7709.59, 62.32). There are five levels:

NFS ROADS CLOSED TO ALL MOTOR VEHICLES:

Maintenance level 1 - These are roads that have been placed in storage between intermittent uses. The period or storage must exceed 1 year. Basic custodial maintenance is performed to prevent damage to adjacent resources to an acceptable level and to perpetuate the road for future resource management needs. Emphasis is normally given to maintaining drainage facilities and runoff patterns. Planned road deterioration may occur at this level. Appropriate traffic management strategies are “prohibit” and “eliminate” all traffic. Roads receiving level 1 maintenance may be of any type, class, or construction standard, and may be managed at any other maintenance level during the time they are open for traffic. However, while being maintained at level 1, they are closed to vehicular/ motorized traffic but may be available and suitable for non-motorized uses.

NFS ROADS OPEN TO ALL MOTOR VEHICLES:

Maintenance level 2 - Assigned to roads open for use by high-clearance vehicles. Passenger car traffic, user comfort, and user convenience are not considerations. Warning signs and traffic control devices are not provided with the exception that some signing, such as “Warning No Traffic” signs may be posted at intersections. Motorists should have no expectations of being alerted to potential hazards while driving these roads. Traffic is normally minor, usually consisting of one or a combination of administrative, permitted, dispersed recreation, or other specialized uses. Log haul may occur at this level. Appropriate traffic management strategies are either to (a) discourage or prohibit passenger cars or (b) accept or discourage high-clearance vehicles.

NFS ROADS OPEN ONLY TO HIGHWAY LEGAL VEHICLES:

Maintenance level 3 - Assigned to roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not considered priorities. The Manual on Uniform Traffic Control Devices (MUTCD) is applicable. Warming signs and traffic control devices are provided to alert motorists of situations that may violate expectations. Roads in this maintenance level are typically low speed, with single lanes and turnouts. Appropriate traffic management strategies are either "encourage" or "accept." "Discourage" or "prohibit" strategies may be employed for certain classes of vehicles or users.

Maintenance level 4 - Assigned to roads that provide a moderate degree of user comfort and convenience at moderate travel speeds. Most roads are double lane and aggregate surfaced. However, some roads may be single lane. Some roads may be paved and/or dust abated. Manual on Uniform Traffic Control Devices (MUTCD) is applicable. The most appropriate traffic management strategy is "encourage." However, the "prohibit" strategy may apply to specific classes of vehicles or users at certain times.

Maintenance level 5 – Assigned to roads that provide a high degree of user comfort and convenience. These roads are normally double lane, paved facilities. Some may be aggregate surfaced and dust abated. Manual on Uniform Traffic Control Devices (MUTCD) is applicable. The appropriate traffic management strategy is "encourage."

Road reconstruction and improvement – Any activity that results in an increase of an existing road's traffic service level, expansion of its capacity, or a change in its original design function. Activities include, but are not limited to, the construction of bridges and major culverts, placing bar ditches, subgrade repairs, shoulder widening, lane widening, ditch widening, roadway prism widening, horizontal and vertical alignment changes, curve widening, and improving site distance at road intersections. Vegetation would likely be removed with these activities.

Road reconstruction and relocation – Any activity that moves all or parts of the horizontal and vertical alignment of a road, i.e., the roadway prism, to a new location and decommissions the old alignment. Generally, realignments are for the purpose of moving the road location to a more suitable area to mitigate impacts to streams, critical wildlife habitat, and other natural or cultural resources. Often, reconstruction is used interchangeably with road relocation. This activity includes creating a new road alignment in an upland position, installing the proper drainage features, signage, and surfacing on the new road alignment, and decommissioning of the old road alignment. The new road alignment may require the removal of vegetation at the new alignment site.

Road (route) obliteration – See Road decommissioning.

Road realignment – See Road reconstruction and relocation.

Scenery Management System (SMS) – Guidance developed by the Forest Service for managing scenery and determining the relative value and importance of scenery in national forests. SMS was developed to better accommodate ecosystem management and the time frames and disturbance patterns of natural systems than the Visual Management System which it replaced. SIOs range from very high, meaning the landscape character is unaltered, to very low, meaning the landscape character is highly altered. Intermediate levels include high, moderate, and low. The revised Coconino (2018) and Apache-Sitgreaves (2016) Forest Plans use SMS for managing scenery. See also Visual Management System and the Scenery report for additional information (Fargo 2018).

Second order fire effects – The secondary effects of fire such as tree regeneration, plant succession, and changes in site productivity. Although second order fire effects are dependent, in part, on first order fire effects, they also involve interaction with many other non-fire variables such as weather.

Severity – The quality or state of distress inflicted by a force. The degree of environmental change caused by a disturbance such as fire.

Slash – The residue left on the ground after timber harvest or as a result of storms, fire, girdling, or poisoning. Slash includes unused logs, uprooted stumps, broken or uprooted stems, and the heavier branchwood, lighter tops, twigs, leaves, bark, and chips.

Snag – Standing dead tree from which the leaves or needles have fallen.

Soil function – The characteristic physical and biological activity of soils that influences productivity, capability, and resiliency (FSM 2521.05).

Soil productivity – The capacity of soil, in its normal environment, to support plant growth.

(Soil) Tolerance – The point beyond which there is high risk that potential may be permanently altered or impaired through changes in specified physical, chemical, and biological factors brought about by management activities or natural events (FSM 2521.05).

Spatial pattern – Arrangement of forested areas and openings on the landscape.

Spring – In this analysis, springs are natural water features that existed prior to Euro-American settlement and were probably functional due to lack of human disturbances (Agriculture 2009).

Stand – A contiguous area of trees sufficiently uniform in forest type, composition, structure, and age class distribution, growing on a site of sufficiently uniform conditions to be a distinguishable unit. Four classification characteristics are generally used to distinguish forest stands: biophysical site (soils, aspect, elevation, plant community association, climate, etc.), species composition, structure (density, and age (1-aged, 2-aged, uneven-aged)), and management emphasis (administrative requirements and local management emphasis that will shape structure over time). Based upon Agency guidelines, the minimum stand mapping size is 10 acres.

Stand density – A measure of the degree of crowding of trees within stocked areas commonly expressed by various growing space ratios (e.g., height/spacing).

Stand density index (SDI) – A measure of the stocking of a stand of trees based on the number of trees per unit area and diameter at breast height (d.b.h.) of the tree of average basal area. It may also be defined as the degree of crowding within stocked areas, using various growing space ratios based on crown length or diameter, tree height or diameter, and spacing. The computed value of SDI is often compared to the species maximum to determine the relative "stand density" or stocking of the stand.

Stand structure – The horizontal and vertical distribution of components of a forest stand including the height, diameter, crown layers, and stems of trees, shrubs, herbaceous understory, snags, and down woody debris.

State Historic Preservation Office – The state office responsible for consultation and assistance regarding the presence and significance of cultural resources in a project area, efforts needed to find and evaluate them, whether the project will cause harmful effects to the cultural resource, and how to reduce or avoid the harm.

Stratum/strata (plural) – A layer of soil with internally consistent characteristics that distinguish it from other layers.

Suppression – A wildfire response strategy to “put the fire out”, as efficiently and effectively as possible, while providing for firefighter and public safety (National Wildfire Coordinating Group 2018).

Surface fire – A fire that burns loose debris on the surface, which includes dead branches, leaves, and low vegetation, and which may scorch the bases and crowns of trees. See also Backing fire, Crown fire, Flanking fire, Ground fire, Head fire, and Underburn (National Wildfire Coordinating Group 2018).

Surface fuel – Fuels lying on or near the surface of the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low stature living plants. See also Duff, Fuel, Coarse woody debris, and Litter.

Target cover type –Frequent fire-adapted ponderosa pine and mixed conifer forest types that are the targets for restoration treatments. The four target cover types for Rim Country include ponderosa pine, ponderosa pine-Gambel oak, ponderosa pine-evergreen oak, and dry mixed conifer.

Temporal – A characteristic that refers to the time at which a given data set was acquired. Also relates to measuring time.

Temporary road or trail – A road or trail necessary for emergency operations or authorized by contract, permit, lease, or other written authorization that is not a forest road or trail and that is not included in a forest transportation atlas (Regulations).

Threatened and endangered species – Species identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act, as amended. See the Wildlife report for additional information.

Topography – The physical features of a geographic area, such as those represented on a map, taken collectively, especially the relief and contours of the land.

Total maximum daily load (TMDL) – A written analysis that determines the maximum amount of a pollutant that a surface water can assimilate (the “load”), and still attain water quality standards during all conditions. The TMDL allocates the loading capacity of the surface water to point sources and nonpoint sources identified in the watershed, accounting for natural background levels and seasonal variation, with an allocation set aside as a margin of safety. See the Watershed and Riparian report for additional information.

Torching – See Passive crown fire.

Traditional cultural property (TCP) – Traditional use areas and places that hold a central and important place in American Indian culture and have been used by cultural groups over generations. Natural springs, prominent bodies of water, and mountains are considered TCPs and/or sacred sites by numerous tribes. Many plants are gathered for ceremonial use on or near TCPs.

Travel management atlas – An atlas that consists of a forest transportation atlas and a motor vehicle use map or maps (Regulations)

Travel Management Rule (TMR) – On December 9, 2005, the Forest Service published the TMR. The Agency rewrote direction for motor vehicle use on National Forest System lands under 36 CFR, Parts 212, 251, and 261, and eliminated 36 CFR 295. The rule was written to address, at least in part, the issue of unmanaged recreation. The rule provides guidance to the Forest Service on how to designate and manage motorized recreation on the forests. The rule requires each national forest and grassland to designate those roads, motorized trails, and areas that are open to motor vehicle use.

Trees per acre – a count of the total number of trees on an acre.

Type conversion – Changing one vegetative type to another. Generally thought of as a rapid conversion from one type to a completely different type but can also occur subtly over time. This is different than successional trajectory where vegetation follows expected changes in type over time. An example is converting an area that would naturally contain mixed conifer hardwood forest to a pure conifer forest by removing hardwoods and planting only conifers. Another example could be suppressing frequent fires allowing conifers to shade out hardwoods converting mixed conifer hardwood forests to conifer forests.

Unauthorized road or trail – A road or trail that is not a forest road or trail or a temporary road or trail and that is not included in a forest transportation atlas (Regulations).

Underburn – A fire that consumes surface fuels but not the overstory canopy (National Wildfire Coordinating Group 2018).

Understory – The trees and other woody species growing under a more or less continuous cover of branches and foliage formed collectively by the upper portion of adjacent trees and other woody growth. In this analysis, the term understory is also referred to as "herbaceous understory."

Uneven-aged forests – Forests that are comprised of three or more distinct age classes of trees, either intimately mixed or in small groups.

Uneven-aged management – The application of a combination of actions needed to simultaneously maintain continuous high forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes to provide a sustained yield of forest products. Cutting is usually regulated by specifying the number or proportion of trees of particular sizes to retain within each area, thereby maintaining a planned distribution of size classes. Cutting methods that develop and maintain uneven-aged stands are single-tree selection and group selection. An uneven-aged, regulated forest is one which has a balanced progression of three or more age/size-classes, such that each younger/smaller class is advancing to replace the class above it on approximately the same acreage, until it is mature for harvest or other resource objectives. A regulated forest reaches sustained yield when the volume cut periodically equals the amount of net volume growth for that same period.

Vegetation structural stage (VSS) – A method of describing forest age and tree size from seedling to old forests. The VSS classification is based on the tree size class with the highest square foot of basal area and is an indication of the dominant tree diameter distribution. See Silviculture report for details (Moore 2018).

Visual Management System (VMS) – The VMS was used to develop the visual quality objectives (VQOs) that are prescribed in the forest plan for all lands within the Tonto National Forest. The VQO classifications range from preservation, retention, partial retention, modification, to maximum modification. Since the development of the Tonto Forest Plan in 1985, the VMS has been replaced by the Scenery Management System (SMS). For treatments proposed on the Tonto National Forest, the current VMS is used to ensure consistency with the Tonto Forest Plan. However, the SMS terminology is used in this analysis to more clearly describe effects and for consistency with the terminology in the Coconino and Apache-Sitgreaves Forest Plans. See also Scenery Management System and the Scenery report for additional information (Fargo 2018)

Watershed – A region or land area drained by a single stream, river, or drainage network; a drainage basin (Regulations).

Watershed condition – The state of a watershed based upon physical and biological characteristics and processes affecting hydrologic and soil functions (FSM 2521.05).

Watershed condition framework – A framework established by the Forest Service that provides a new consistent, comparable, and credible process for improving the health of watersheds on national forests and grasslands. The framework includes a technical guide which provides protocol for assessing watershed condition across all 193 million acres of National Forest System lands (http://www.fs.fed.us/publications/watershed).

Water quality – See Clean Water Act

Water yield – The total net amount of water produced including streamflow and groundwater recharge (Coconino NF forest plan glossary).

Wildfire – An unplanned ignition of a wildland fire (such as a fire caused by lightning, volcanoes, unauthorized or accidental human-caused fires) or an escaped prescribed fire.

Wildland fire – A general term describing any non-structure fire that occurs in the wildland.

Wildland-urban interface (WUI) – Generally refers to the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels (National Wildfire Coordinating Group 2018). It is that portion of the landscape where structures and vegetation are sufficiently close that a wildland fire could spread to structures, or a structure fire could ignite vegetation. Many WUI areas are scattered across the project area, though areas of the greatest concern are relatively focused around towns or along travelways. For this analysis, the wildland urban interface is defined by a 0.5 mile buffer surrounding non-Forest System lands where structures are present. Other critical infrastructure (transmission lines and communication sites) and high value Forest Service infrastructure (buildings and recreation sites) were also included within the WUI for this project.

Woody debris – The dead and downed material on the forest floor consisting of fallen tree trunks and branches

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