Appendix A – Map Packet

Note: Paper copies of the DEIS include a packet of poster-sized maps for alternatives 2 and 3. Electronic copies of the DEIS are available in DVD and web-based formats. For those viewing the DEIS electronically, maps can be viewed online or map packets are available upon request.

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 inter-mixed 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 d.b.h. would be determined with the USFWS. Treatments up to 9 inches d.b.h. 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.

156 **Table 207. Current Forest Plan Language and Proposed Amendment Language**

Current Tonto Forest Plan Direction	Proposed Language for Tonto Forest Plan Amendment
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.*	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.

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Appendix C – Design Features, Best Management Practices, Mitigation, and Conservation Measures

Table C-1 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 type of treatment or activity and then by resource. Implementation teams should review and utilize the design features listed for "all treatments" as well as those listed for the particular type of treatment they are implementing.

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Table 208. Design Features, Best Management Practices, Mitigation and Conservation Measures

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
1. All Treatments				
Aquatics				
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 water bodies for any reason will also follow these procedures. This applies to entry into every aquatic restoration site and in between sites."	To minimize potential for spreading aquatic diseases or invasive species.	X	
AQ014	Minimize removal of desirable vegetation around springs and wetlands.	To reduce detrimental effects to sensitive habitats.	X	X
AQ015	Minimize disturbance of existing vegetation in ditches and at stream crossings.	To provide vegetative filters that reduce sedimentation to aquatic habitats.		X
AQ018	Structural erosion control measures will not include materials that can trap reptiles or amphibians. This requirement will be described in a standard contract provision BT6.6 (erosion prevention and control), BT6.67 (erosion control structure maintenance) and within the road package, or specified in any agreements as a provision. Structural erosion control measures not made of biodegradable material (e.g., silt fences) will be removed and material contoured in or removed within one year to prevent them from causing resource issues and decomposing on site.	To minimize detrimental effects to federally listed, sensitive, or other reptiles and amphibians.	X	X
AQ020	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ021	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.	X	X
AQ025	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. 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.	X	
AQ026	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.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ031	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.	X	X
AQ035	During all implementation, maintain shade, bank stability, and large woody material recruitment potential.	Minimize detrimental disturbance of desirable riparian/aquatic conditions to the greatest extent practical.	X	
AQ036	Inspect daily for fluid leaks before leaving the vehicle staging area for operation.	To prevent petroleum contamination into aquatic systems and habitats.		X
Botany and Noxious Weeds				
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.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.	X	
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.	X	
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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
NW010	Prevent any new noxious or invasive weed species from becoming established, contain or control the spread of known weed species, and eradicate species that are the most invasive and pose the greatest threat to the biological diversity and watershed condition. Maintain stockpiled, uninfested material in a weed-free condition.	Prevent establishment and spread of invasive weed populations	X	
Caves and Karst				
CK003	Take measures to ensure that petroleum products, herbicides, and other pollutants do not contaminate karst buffers by following proper storage and transport procedures.	To avoid contamination/pollution of caves/karst features.	X	X
Cultural Resources and Tribal Relations				
CT001	Minimize effects on archaeological sites from wildland fires by implementing the agreed-upon standard site protection measures from in Appendix J of the Southwestern Region Programmatic Agreement (PA) with AZ SHPO, or any additional mitigation measures recommended in consultation with the AZ SHPO and Tribes.	Regulatory requirement. Compliance with NHPA and Southwestern Region PA with AZ SHPO.	X	X
CT002	All activities will comply with the NHPA, 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.	X	X
CT003	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.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
CT004	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.	X	X
CT005	Monitoring during and after project implementation shall occur to document site protection and condition.	Compliance with Southwestern Region PA (Appendix J) with AZ SHPO.	X	X
CT006	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)	X	X
CT007	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.	X	X
CT008	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.	X	X
CT009	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
CT010	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	X	X
CT011	Locate, record, and evaluate the General Crook and other significant historic trails within the project area well before implementation.	Regulatory requirement. Compliance with NHPA and Southwestern Region PA with AZ SHPO.	X	X
CT012	Maintain historic and scenic integrity of the General Crook Trail and other historic trails, roads and National Recreation Trails.	NHT and NRT requirements, Recreation Opportunity Spectrum	X	X
CT013	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.	Site protection, ARPA (prevention of looting)	X	X
CT014	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	X	X
CT015	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)	X	X
CT016	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.	X	X
CT017	Roads to National Register-eligible and unevaluated sites identified to be closed post implementation will be closed immediately after implementation is completed.	Regulatory requirement. Compliance with NHPA and Southwestern Region PA with AZ SHPO.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
CT019	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		X
Rangeland Management				
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. 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.		X
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.		X
Recreation and Scenery				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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	X	X
RS002	Historic trails, roads and trail markers in the project area will be protected during project implementation in accordance with timber sale contract provision BT6.221, and BT6.22 (protection of improvements not owned by the forest service and those owned by the forest service respectively). 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 and National Scenic Trails in compliance with the National Trails System Act.	X	X
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	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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 6 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	X	X
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. Inform Arizona Trail Association as early as possible but at a minimum of 3 months prior to closure of sections of the Arizona Trail and/or closure of trailheads accessing the trail.	Public safety	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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. This includes the management of fire, which should be carried out using minimum impact suppression tactics, or other tactics appropriate for the protection of identified ORVs.	To protect eligible and suitable wild and scenic rivers	X	
Lands, Minerals, and Special Uses				
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.		X
SU002	Ensure non-federal land boundaries are known and marked in advance of any activities or treatments near those lands.	To ensure that project activities occur only on NFS lands.		X
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.		X
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.		X
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		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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	X	X
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.		X
SU008	Protect highway ROW infrastructure from damage by management activities	To ensure ROW infrastructure remains functional for its intended purposes		X
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.		X
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. 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		X
Soils and Watershed				
SW011	Establish staging areas 150 feet outside of AMZs or from natural water bodies and wetlands for storage of vehicles, equipment and fuels, and fueling/servicing areas to minimize erosion into or contamination of streams, wetlands, and floodplains.	To prevent the spread of invasive and noxious weeds, aquatic diseases, and invasive species, and to prevent petroleum contamination and minimize ground disturbance and sedimentation in aquatic and associated habitats	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW018	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.	X	X
SW020	Spill prevention, containment, and counter measure plans are required if the fuel exceeds 660 gallons in a single container or if the total fuel storage at a site exceeds 1,360 gallons.	To protect soil/water resources and aquatic species from petroleum contamination.	X	X
SW021	Any leaks originating from contractor equipment shall be repaired or the equipment replaced in a timely manner.	To protect soil/water resources and aquatic species from petroleum contamination.	X	X
SW022	During servicing and refueling of equipment, pollutants shall not be allowed to enter any waterway, riparian area or stream course. Construct berms where necessary to contain potential spills. An authorized FS Official shall also be aware of actions to be taken in case of a hazardous substance spill.	To protect water resources and aquatic species from petroleum contamination.	X	X
SW023	Equipment operators shall maximize that recovery and proper disposal of all fuels, fluids, lubricants, empty containers, and replacement parts.	To protect soil/water resources and aquatic species from petroleum contamination.	X	X
SW024	Refuse resulting from the contractor's use, servicing, repair or abandonment of equipment shall be removed from National Forest System lands by the contractor to the appropriate disposal facilities.	To protect soil/water resources and aquatic species from petroleum contamination.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW026	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.	X	X
SW089	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.		X
SW090	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.	X	
SW091	Potential revegetation seeding for individual sites should utilize the Apache-Sitgreaves, Coconino, and Tonto NFs (Terrestrial Ecosystem Surveys (TES) to identify species to be utilized. Where feasible, protect site with a variety of methods (e.g., ungulate proof fence, spreading slash, etc.).	Minimize noxious weed spread.	X	
SW101	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW105	Erosion control work would be kept current immediately preceding expected seasonal periods of precipitation or runoff.	To avoid and minimize impacts to water quality and watershed integrity.	X	X
Wildlife				
WL038	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.	X	X
WL049	In goshawk habitat outside of Mexican spotted owl protected activity centers (PACs): Goshawk surveys will be done across the management analysis area prior to habitat modifying activities. Surveys will include areas ½ mile beyond treatment boundaries and exclude a ¼ mile buffer beyond PAC boundaries.	Conduct pre-treatment surveys while avoiding harassing owls by broadcasting calls of a potential predator and avoid potential disturbance to owls by survey crews.	X	X
WL054	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.	X	X
2. Mechanical Thinning				
Aquatics				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ012	Leave sufficient numbers of cut trees (large woody debris) onsite for needed surface flow grade control. 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.	X	X
Botany and Noxious Weeds				
BT001	During layout, protect Southwestern Region sensitive or analysis plant groups 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.		X
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.	X	
BT008	Landings, machine slash piles and other ground disturbing activities (e.g., firelines, parking areas, etc.) and other ground-disturbing activities 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.	X	X
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 WO-C/CT 6.36.	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 CT WO-C/CT 6. 36 and watershed best management practices.	X	X
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.	X	X
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		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
Caves and Karst				
CK001	A buffer with 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. 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	X	X
CK002	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. Slash piles should be located at least 50 feet from any karst features.	To protect cave ecosystems from negative fire effects and to minimize alteration of the chemical, physical, and biological conditions of karst features.	X	X
Fire				
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.		X
Rangeland Management				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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		X
RM003	All fences 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.		X
Recreation and Scenery				
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 or first 300', whichever is greater.	Reduce unauthorized use	X	X

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. Mark on the side of trunk not seen from trails, roads and sensitive travel ways. (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 minimize visibility of treatment activities and 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; and (f) the ridgeline silhouette should have a textural effect of small, natural-appearing openings rather than large, thinned areas and unnatural-appearing breaks	Scenic integrity	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	(g) Minimize mechanized treatments within ¼ mile of the Arizona Trail, General Crook Trail, and Highline Trail corridors . Where mechanized treatments are authorized, restore visual evidence of mechanized treatment activity within ¼ mile of the trails in order to promote a naturally appearing setting. (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 Association 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.			
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 the original contours, fine grading, and seeding with native seed mix. Skidding activities and fuel piles. Skidding activities and fuel piles would avoid National and forest system trailsexcept 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. 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	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
RS008	Mechanical thinning operations shall not damage cairns or markers.	Resource protection and avoid substantial interference with the nature and purposes of the trail. (in compliance with Section 7 (c) of the National Trails System Act).	X	X
RS009	If trails are temporarily closed due to thinning, trails shall be returned to pre-treatment conditions.	Resource protection	X	X

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) 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; (f) Highest emphasis for slash treatment, temporary road closures and road decommissioning will be placed on eligible or suitable wild and scenic river corridors and national scenic trail corridors; foreground (up to 300 feet) of developed	Resource protection and scenic integrity and avoid substantial interference with the nature and purposes of the trail. (in compliance with Section 7 (c) of the National Trails System Act).	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	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. (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, placing cull logs perpendicular to the route, and disguising entrances;. (j) Avoid using FS designated trails as skid trails or for temporary roads. (k) 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.			

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 sides and private property. Flush cut or low cut to 8" in other distance zones where topography and operational safety allows, with 12-inch heights as the exception and rarely occurring. (c) Slash should be removed, burned, or otherwise treated to return the area to its pre-implementation condition 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.	Maintain scenic integrity and avoid substantial interference with the nature and purposes of the trail. (in compliance with Section 7 (c) of the National Trails System Act).	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.	X	X
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 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	X	X
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.	X	X
RS017	Retain healthy, 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 ¼ mile of the trail. Avoid lines of trees; strive to achieve a grouped appearance to avoid abrupt changes in the landscape character along the trail corridor.	Protect visitor experience	X	X
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.	Reduces noise and dust during hauling	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.	X	
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	X	
Soils and Watershed				
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. 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.	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.	X	X
SW002	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW003	Stream channels to be protected with a prescribed aquatic management zone (AMZ) will be shown on the project task order, contract maps, or burn plan maps. AMZ widths will be clearly labeled or described.	Reduce ground disturbance by limiting the turning of equipment in or near the stream channels, and retain as much of the filtering effect of undisturbed ground cover as possible.		X
SW004	Accepted activities within AMZs include mechanical and conventional tree felling, yarding, skidding, backing fire. Landings, decking areas, machine or hand piles, 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.	To avoid, improve, or minimize effects on aquatic species and habitat.	X	X
SW005	If completing mechanical vegetation treatments within an AMZ, the preferred method of using feller-buncher or grapple skidder equipment is to approach the material to be extracted on the contour as much as possible to the stream, then back equipment out. Turning machines and skidding within AMZs should be minimized to the greatest extent possible.	Allows for a reduction in ground disturbance by limiting the number of passes required to extract material and turning of equipment. Maintaining this type of travel pattern aims to reduce potential concentrated run-off and sediment delivery downslope compared to travel courses that follow the slope direction. 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW006	Landings, log decks, and burn piles should be placed in upland locations and will not be allowed in areas such as: meadows, riparian areas, springs, seeps, AMZs, stream channels, or at the heads of stream channels. Landings, log decks and burn piles will be located outside at least 100 feet from these features, far enough away that direct (unfiltered) entry of sediment, bark, ash and burning products will not enter. The authorized FS officer AND a watershed specialist may authorize landings in these areas if absolutely required.	Limit the overall amount and extent of heavy ground disturbance that implicates soil stability/ productivity as well as the filtering capacity of upland areas.	X	X
SW007	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.		X
SW008	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.		X
SW009	If completing mechanical vegetation treatments within an AMZ, do not cut trees where the root system is important in maintaining channel morphology.	To provide for bank stability and minimize erosion and bank instability to streams or other aquatic habitats.	X	X
SW010	New temporary road construction is not allowed in AMZs.	To minimize adverse environmental effects within aquatic management zones.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW015	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.		X
SW025	All dry meadow locations identified during the layout phase of a project sale will be clearly labeled on sale contract maps.	To improve implementation.		X
SW032	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.	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.		X
SW033	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. 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. Waterbar spacing should be approximately 130 feet for slopes 0-5%, and 100 feet for slopes 6-10%. 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.	X	X

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SW034	Erosion control structures and measure must be in place prior to an erosive event. The integrated resource service contract 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.	X	X
SW035	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.		X
SW036	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.	Rough piling minimizes disturbance to existing ground cover and the surface soil.		X
SW037	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.	X	X
SW038	Seed mixes for post-thinning erosion control 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.	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.	X	
SW039	Mechanical crushing of lopped slash can only occur on 0–25 percent slopes.	Incorporate slash into the soil to promote long term soil productivity.	X	
SW040	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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW042	Felling to the lead would be required within the integrated resource service contract 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.	X	
SW043	Culverts, temporary bridges, low-water crossings, or log-fords will be required on all temporary roads and skid crossings on all streams that will have flowing water during the life of the temporary crossing. Temporary road and skid trail crossings will be removed 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.	X	X
SW044	During thinning, operators shall avoid excavating skid trails whenever practical	To prevent soil displacement		X
SW045	During thinning, operators shall locate skid trails where the need for sidecasting is minimized	To prevent soil displacement		X
SW046	During thinning, avoid adverse skidding to the greatest extent possible unless specialized equipment capable of adverse skidding without creating adverse soil impacts is utilized	To prevent excess rutting and compaction of soil surfaces and minimize downhill movement of slash and soils.		X
SW047	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.		X
SW048	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.	To prevent soil displacement from cable yarding operations.		X
SW049	Operators shall minimize the yarding of logs across streams or wetlands	To prevent adverse effects to water quality		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW050	Cable yarding across ephemeral streams shall be performed in ways that minimize soil and bank disturbances.	To prevent erosion and sedimentation by reducing potential for damage to stream banks and beds		X
SW051	Operators shall minimize the numbers and widths of yarding corridors.	To minimize soil disturbance and prevent erosion and sediment delivery to streams		X
SW052	Where it is necessary to yard across intermittent or perennial streams or wetlands, it shall be done by swinging the yarded material free of the ground to the greatest extent practicable (i.e., full suspension)	To prevent adverse effects to stream banks, beds and wetlands.		X
SW053	During cable thinning, operators shall install effective cross ditches that drain onto undisturbed forest floor 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.		X
SW054	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.	Limit the overall amount and extent of heavy ground disturbance that implicates soil stability/ productivity as well as the filtering capacity of upland areas.		X
SW055	Landings and decks should be clearly designated on the project area task order or contract maps.	To aid in implementation of project.		X
SW056	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW057	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.	X	X
SW058	Skid trails, landings, and temporary roads are to be closed 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.	X	X
SW059	In meadow restoration sites where trees are being removed, designate skid trails in order to limit disturbance from skidding. Where material is not being removed, lop and scatter or manually remove slash from meadow; these are the preferred methods of treating slash.	To minimize impacts to streams and soils in meadows from tree thinning operations.	X	
SW060	When thinning trees, no skidding is allowed across wetlands or springs and their outflows.	To minimize impacts to streams and soils in meadows from tree thinning operations.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW061	The authorized FS officer 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		X
SW062	In grassland restoration sites, limit skidding and designate skid trails if wood is to be removed. Where material is not to be removed, do not skid logs in meadows, and lop and scatter is the preferred method of treating slash. Do not machine pile within meadows. If skidding has to occur across a riparian or nonriparian stream course, designate any crossing prior to skidding.	Minimize effects on streams and soils in meadows from tree thinning operations.	X	
SW063	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 or contract 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW064	Only hand-felling methods will be permitted when removing trees from designated protected areas and other sensitive areas such wet meadows, or around springs, seeps, and other wet features unless approved by a watershed specialist or a biologist. The use of end-lining for removal of encroachment trees in these areas will be determined on a case-by-case basis by the authorized FS officer AND 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.		X
SW065	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.		X
SW066	Mechanized equipment usage for thinning timber or biomass will be restricted to slope gradients of 25 percent or less on fragile or sensitive soil types (e.g., cinder cones).	Severe erosion hazards are present on soil types above these slope gradients.		X
SW067	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 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.	To protect highly erodible/sensitive soils on steep slopes by preventing traffic by heavy machinery on soils that are susceptible to destabilization and erosion.		X
SW068	Use of specialized thinning 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 equipment must be specified in the contract.	To insure that highly erodible/sensitive soils on steep slopes are protected during the layout of mechanical vegetation treatments.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW069	All ground disturbing activities using heavy equipment must be done under conditions which maintain soil condition (i.e. avoiding excess rutting, compaction, displacement).	Insure that mechanical operations do not take place when ground conditions are such that detrimental soil compaction and topsoil displacement can occur.		X
SW070	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.	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.	X	X
SW071	At landings and within 75 feet of landings, rutting depths greater than 10 inches will not be allowed. Equipment 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.	X	X
SW072	Rutting 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. If unsurfaced, guideline will be the same as for terminal and service roads.	Prevents rutting of the road traveled way that could lead to concentrated runoff, erosion and adverse effects to surface water quality.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW073	For any other locations (e.g., interior locations) 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.	X	X
SW076	Surface fuel loading 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).	X	X
SW079	Avoid treatment intensities (mechanical thinning and prescribed burning) which may cumulatively produce undesirable effects in subwatersheds. A watershed specialist will evaluate the potential for adverse cumulative subwatershed effects prior to implementation. Methodologies may include but are not limited to an Equivalent Disturbed Area analysis or watershed modeling software. If it is determined that potential cumulative effects may be adverse to watershed function and condition, treatments can be spread out spatially and/or temporally.	Reduce potential cumulative effects which may adversely affect subwatershed scale (HUC12) condition or function.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW080	If a watershed analysis is not completed, the default limit of areal extent of mechanical treatment which may occur in a subwatershed (HUC12) is 25% in a given year and 40% over 5 years of that subwatershed. For prescribed burning the percentages of subwatershed treated can be doubled over the same time periods.	Reduce potential cumulative effects which may adversely affect subwatershed scale (HUC12) condition or function.		X
SW083	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.		X
SW084	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 IRSC and T- specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X
SW085	Road maintenance through the integrated resource service contract should require pre-haul and post-haul maintenance on all roads to be used for haul.	To minimize soil movement, maintain water quality, and to minimize effects on severe erosion soils.	X	X
SW086	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.		X
SW094	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW095	The project fisheries biologist/hydrologist will ensure that project design features are incorporated into implementation contracts. If a biologist or hydrologist is not the Contracting Officer Representative, then the project Contracting Officer Representative must regularly coordinate with the biologist or hydrologist to ensure project design features and conservation measures are being followed.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X
SW099	Streambank vegetation will be protected except where its disturbance or removal is absolutely necessary for completion of the work.	To protect riparian vegetation and stream channel stability.		X
SW102	Placement of lop / scatter material or piling for burning will occur outside of fragile or sensitive soil types.	Minimize disturbance of sensitive soil.		X
Wildlife				
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 to Mexican spotted owl habitat while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and to comply with ESA and the 2012 MSO Recovery Plan, pp. 268-269.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.	X	X
WL005	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.	X	X
WL008	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 habitat.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL009	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 to Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and comply with ESA.	X	X
WL010	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.		X
WL012	All stands included in the proposed mechanical treatments for Mexican spotted owl protected activity centers (PACs) would be hand-marked for thinning, 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.		X
WL020	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.		X
WL021	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.		X
WL024	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 or if the nest is inactive.	To minimize disturbance to eagles while restoring/protecting nesting habitat.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL028	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.	X	X
WL029	Manage prescribed fire to retain ponderosa pine and roosting cover for turkeys.	To minimize disturbance to turkeys while restoring forest habitat.	X	X
WL030	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.	Minimize disturbance to rookeries while restoring forest habitat.		X
WL032	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.	X	X
WL033	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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL034	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.	Minimize disturbance to bats and their habitat, including detrimental effects to the cave/karst microclimate and hydrology, and to prevent collapse and sedimentation.		X
WL039	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.		X
WL040	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.	X	
WL041	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.	X	
WL042	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.		X
WL043	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL044	Snags: Emphasize retention of snags exhibiting loose bark to provide habitat for roosting bats.	Maintain a key but limited wildlife habitat component while restoring forest structure.	X	X
WL045	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.		X
WL048	Defer thinning in a ¼ mile radius around known black bear den sites from April 15 to June 30.	Minimize potential for disturbance.		X
3. Mechanical Thinning in Riparian Areas				
Aquatics				
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 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ012	Leave sufficient numbers of cut trees (large woody debris) onsite for needed surface flow grade control. 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.	X	X
Botany and Noxious Weeds				
BT001	During layout, protect Southwestern Region sensitive or analysis plant groups 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.		X
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.	X	
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.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
BT008	Landings, machine slash piles and other ground disturbing activities (e.g., firelines, parking areas, etc.) and other ground-disturbing activities 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.	X	X
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		X
Caves and Karst				
CK001	A buffer with 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. 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	X	X
CK002	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. Slash piles should be located at least 50 feet from any karst features.	To protect cave ecosystems from negative fire effects and to minimize alteration of the chemical, physical, and biological conditions of karst features.	X	X
Fire				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.		X
Rangeland Management				
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		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
RM003	All fences 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.		X
Recreation and Scenery				
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 or first 300', whichever is greater.	Reduce unauthorized use	X	X

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. Mark on the side of trunk not seen from trails, roads and sensitive travel ways. (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 minimize visibility of treatment activities and 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; and (f) the ridgeline silhouette should have a textural effect of	Scenic integrity	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	small, natural-appearing openings rather than large, thinned areas and unnatural-appearing breaks (g) Minimize mechanized treatments within ¼ mile of the Arizona Trail, General Crook Trail, and Highline Trail corridors . Where mechanized treatments are authorized, restore visual evidence of mechanized treatment activity within ¼ mile of the trails in order to promote a naturally appearing setting. (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 Association 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.			
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 the original contours, fine grading, and seeding with native seed mix. Skidding activities and fuel piles would avoid National and forest system trails, 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. 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	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
RS008	Mechanical thinning operations shall not damage cairns or markers.	Resource protection	X	X
RS009	If trails are temporarily closed due to thinning, trails shall be returned to pre-treatment conditions.	Resource protection	X	X

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) 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; (f) Highest emphasis for slash treatment, temporary road closures and road decommissioning will be placed on eligible or suitable wild and scenic river corridors and national scenic trail corridors; foreground (up to 300 feet) of developed	Resource protection and scenic integrity and scenic integrity and avoid substantial interference with the nature and purposes of the trail. (in compliance with Section 7 (c) of the National Trails System Act).	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	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. (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, placing cull logs perpendicular to the route, and disguising entrances;. (j) Avoid using FS designated trails as skid trails or for temporary roads. (k) 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.			

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 sides and private property. Flush cut or low cut to 8" in other distance where topography and operational safety allows, with 12-inch heights as the exception and rarely occurring. (c) Slash should be removed, burned, or otherwise treated to return the area to its pre-implementation condition 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.	Maintain scenic integrity and avoid substantial interference with the nature and purposes of the trail. (in compliance with Section 7 (c) of the National Trails System Act).	X	X

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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 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	X	X
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.	X	X
RS017	Retain healthy, 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 ¼ mile of the trail. Avoid lines of trees; strive to achieve a grouped appearance to avoid abrupt changes in the landscape character along the trail corridor.	Protect visitor experience	X	X
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.	Reduces noise and dust during hauling.	X	X
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.	X	
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	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
Silviculture				
SI003	All snags will be maintained within the AMZ unless deemed a hazard tree.	To provide habitat for snag-dependent wildlife and future coarse woody debris.		X
Soils and Watershed				
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. 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.	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.	X	X
SW002	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW003	Stream channels to be protected with a prescribed aquatic management zone (AMZ) will be shown on the project task order, contract maps, or burn plan maps. AMZ widths will be clearly labeled or described.	Reduce ground disturbance by limiting the turning of equipment in or near the stream channels, and retain as much of the filtering effect of undisturbed ground cover as possible.		X
SW004	Accepted activities within AMZs include mechanical and conventional tree felling, yarding, skidding, backing fire. Landings, decking areas, machine or hand piles, 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.	To avoid, improve, or minimize effects on aquatic species and habitat.	X	X
SW005	If completing mechanical vegetation treatments within an AMZ, the preferred method of using feller-buncher or grapple skidder equipment is to approach the material to be extracted on the contour as much as possible to the stream, then back equipment out. Turning machines and skidding within AMZs should be minimized to the greatest extent possible.	Allows for a reduction in ground disturbance by limiting the number of passes required to extract material and turning of equipment. Maintaining this type of travel pattern aims to reduce potential concentrated run-off and sediment delivery downslope compared to travel courses that follow the slope direction. 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW006	Landings, log decks, and burn piles should be placed in upland locations and will not be allowed in areas such as: meadows, riparian areas, springs, seeps, AMZs, stream channels, or at the heads of stream channels. Landings, log decks and burn piles will be located outside at least 100 feet from these features, far enough away that direct (unfiltered) entry of sediment, bark, ash and burning products will not enter. The authorized FS officer AND a watershed specialist may authorize landings in these areas if absolutely required.	Limit the overall amount and extent of heavy ground disturbance that implicates soil stability/ productivity as well as the filtering capacity of upland areas.	X	X
SW007	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.		X
SW008	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.		X
SW009	If completing mechanical vegetation treatments within an AMZ, do not cut trees where the root system is important in maintaining channel morphology.	To provide for bank stability and minimize erosion and bank instability to streams or other aquatic habitats.	X	X
SW010	New temporary road construction is not allowed in AMZs.	To minimize adverse environmental effects within aquatic management zones.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW015	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.		X
SW038	Seed mixes for post-thinning erosion control 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.	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.	X	
SW039	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.	Rough piling minimizes disturbance to existing ground cover and the surface soil.		X
SW040	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.	X	X
SW043	Culverts, temporary bridges, low-water crossings, or log-fords will be required on all temporary roads and skid crossings on all streams that will have flowing water during the life of the temporary crossing. Temporary road and skid trail crossings will be removed 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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW044	During thinning, operators shall avoid excavating skid trails whenever practical.	To prevent soil displacement		X
SW047	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.		X
SW052	Where it is necessary to yard across intermittent or perennial streams or wetlands, it shall be done by swinging the yarded material free of the ground to the greatest extent practicable (i.e., full suspension).	To prevent adverse effects to stream banks, beds and wetlands.		X
SW053	During cable thinning, operators shall install effective cross ditches that drain onto undisturbed forest floor 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.		X
SW059	In meadow restoration sites where trees are being removed, designate skid trails in order to limit disturbance from skidding. Where material is not being removed, lop and scatter or manually remove slash from meadow; these are the preferred methods of treating slash.	To minimize impacts to streams and soils in meadows from tree thinning operations.	X	
SW060	When thinning trees, no skidding is allowed across wetlands or springs and their outflows.	To minimize impacts to streams and soils in meadows from tree thinning operations.	X	

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SW061	The authorized FS officer 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		X
SW062	In grassland restoration sites, limit skidding and designate skid trails if wood is to be removed. Where material is not to be removed, do not skid logs in meadows, and lop and scatter is the preferred method of treating slash. Do not machine pile within meadows. If skidding has to occur across a riparian or nonriparian stream course, designate any crossing prior to skidding.	Minimize effects on streams and soils in meadows from tree thinning operations.	X	
SW063	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 or contract 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW064	Only hand-felling methods will be permitted when removing trees from designated protected areas and other sensitive areas such wet meadows, or around springs, seeps, and other wet features unless approved by a watershed specialist or a biologist. The use of end-lining for removal of encroachment trees in these areas will be determined on a case-by-case basis by the authorized FS officer AND 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.		X
SW066	Mechanized equipment usage for thinning timber or biomass will be restricted to slope gradients of 25 percent or less on fragile or sensitive soil types (e.g., cinder cones).	Severe erosion hazards are present on soil types above these slope gradients.		X
SW067	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 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.	To protect highly erodible/sensitive soils on steep slopes by preventing traffic by heavy machinery on soils that are susceptible to destabilization and erosion.		X
SW068	Use of specialized thinning 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 equipment must be specified in the contract.	To insure that highly erodible/sensitive soils on steep slopes are protected during the layout of mechanical vegetation treatments.	X	X
SW069	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.		X

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SW070	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.	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.	X	X
SW071	At landings and within 75 feet of landings, rutting depths greater than 10 inches will not be allowed. Equipment 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.	X	X
SW072	Rutting 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. If unsurfaced, guideline will be the same as for terminal and service roads.	Prevents rutting of the road traveled way that could lead to concentrated runoff, erosion and adverse effects to surface water quality.	X	X
SW073	For any other locations (e.g., interior locations) 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.	X	X

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SW076	Surface fuel loading 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).	X	X
SW079	Avoid treatment intensities (mechanical thinning and prescribed burning) which may cumulatively produce undesirable effects in subwatersheds. A watershed specialist will evaluate the potential for adverse cumulative subwatershed effects prior to implementation. Methodologies may include but are not limited to an Equivalent Disturbed Area analysis or watershed modeling software. If it is determined that potential cumulative effects may be adverse to watershed function and condition, treatments can be spread out spatially and/or temporally.	Reduce potential cumulative effects which may adversely affect subwatershed scale (HUC12) condition or function.		X
SW080	If a watershed analysis is not completed, the default limit of areal extent of mechanical vegetative treatments which may occur in a subwatershed (HUC12) is 25% in a given year and 40% over 5 years of that subwatershed. For prescribed burning the percentages of subwatershed treated can be doubled over the same time periods.	Reduce potential cumulative effects which may adversely affect subwatershed scale (HUC12) condition or function.		X
SW083	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.		X

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SW084	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 IRSC and T-specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X
SW085	Road maintenance through the integrated resource service contract should require pre-haul and post-haul maintenance on all roads to be used for haul.	To minimize soil movement, maintain water quality, and to minimize effects on severe erosion soils.	X	X
SW086	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.		X
SW087	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.	X	X
SW094	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	X	

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SW095	The project fisheries biologist/hydrologist will ensure that project design features are incorporated into implementation contracts. If a biologist or hydrologist is not the Contracting Officer Representative, then the project Contracting Officer Representative must regularly coordinate with the biologist or hydrologist to ensure project design features and conservation measures are being followed.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X
SW099	Streambank vegetation will be protected except where its disturbance or removal is absolutely necessary for completion of the work.	To protect riparian vegetation and stream channel stability.		X
SW102	Placement of lop / scatter material or piling for burning will occur outside of fragile or sensitive soil types.	Minimize disturbance of sensitive soil.		X
Wildlife				
WL034	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.	Minimize disturbance to bats and their habitat, including detrimental effects to the cave/karst microclimate and hydrology, and to prevent collapse and sedimentation.		X
4. Prescribed Fire				
Botany and Noxious Weeds				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.	X	
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.		X
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.	X	
BT008	Landings, machine slash piles and other ground disturbing activities (e.g., firelines, parking areas, etc.) and other ground-disturbing activities 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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.		X
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		X
Caves and Karst				
CK001	A buffer with 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. 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	X	X
CK002	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. Slash piles should be located at least 50 feet from any karst features.	To protect cave ecosystems from negative fire effects and to minimize alteration of the chemical, physical, and biological conditions of karst features.	X	X
Fire				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.		X
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.	X	X
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.		X
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.	X	X
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. (See SW015 (#498)) (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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.		X
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.	Minimize air quality impacts	X	X
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.	X	X
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.		X
Rangeland Management				
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.	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.		X
Recreation and Scenery				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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 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 and the national trail administrator regarding use of national trails as control lines.	Resource protection	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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 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	X	X
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.	X	X
RS017	Retain healthy, 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 ¼ mile of the trail. Avoid lines of trees; strive to achieve a grouped appearance to avoid abrupt changes in the landscape character along the trail corridor.	Protect visitor experience	X	X
Soils and Watershed				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. 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.	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.	X	X
SW002	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.	X	X
SW003	Stream channels to be protected with a prescribed aquatic management zone (AMZ) will be shown on the project task order, contract maps, or burn plan maps. AMZ widths will be clearly labeled or described.	Reduce ground disturbance by limiting the turning of equipment in or near the stream channels, and retain as much of the filtering effect of undisturbed ground cover as possible.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW006	Landings, log decks, and burn piles should be placed in upland locations and will not be allowed in areas such as: meadows, riparian areas, springs, seeps, AMZs, stream channels, or at the heads of stream channels. Landings, log decks and burn piles will be located outside at least 100 feet from these features, far enough away that direct (unfiltered) entry of sediment, bark, ash and burning products will not enter. The authorized FS officer AND a watershed specialist may authorize landings in these areas if absolutely required.	Limit the overall amount and extent of heavy ground disturbance that implicates soil stability/ productivity as well as the filtering capacity of upland areas.	X	X
SW012	Site-specific criteria whereby either fire is allowed to burn in AMZs or is actively ignited will be solely driven by the need to maintain or improve riparian and stream habitat. 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.		X
SW013	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 do not disturb soils or cause erosion.	To minimize the disturbance of riparian vegetation.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW014	The following direction should be incorporated in developing the burn plan: High soil burn severity should not occur on greater than 5 percent areal extent of the uplands or an AMZ in each burn unit. 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.	X	X
SW015	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.		X
SW017	Domestic livestock grazing within an AMZ affected by prescribed fire will be deferred until ground cover is adequately re-established.	Promote recovery and establishment of riparian species, protect floodplain function, and provide for resilient stream systems.		X
SW074	No 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW075	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.		X
SW076	Surface fuel loading 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).	X	X
SW077	High soil burn severity fire should occur on no more than 5 percent of the entire treatment area for all prescribed fire in the project area.	Maintain long term soil productivity by minimizing erosion from containment lines and minimizing high soil burn severity to the degree possible.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW079	Avoid treatment intensities (mechanical thinning and prescribed burning) which may cumulatively produce undesirable effects in subwatersheds. A watershed specialist will evaluate the potential for adverse cumulative subwatershed effects prior to implementation. Methodologies may include but are not limited to an Equivalent Disturbed Area analysis or watershed modeling software. If it is determined that potential cumulative effects may be adverse to watershed function and condition, treatments can be spread out spatially and/or temporally.	Reduce potential cumulative effects which may adversely affect subwatershed scale (HUC12) condition or function.		X
SW080	If a watershed analysis is not completed, the default limit of areal extent of mechanical treatment which may occur in a subwatershed (HUC12) is 25% in a given year and 40% over 5 years of that subwatershed. For prescribed burning the percentages of subwatershed treated can be doubled over the same time periods.	Reduce potential cumulative effects which may adversely affect subwatershed scale (HUC12) condition or function.		X
SW102	Placement of lop / scatter material or piling for burning will occur outside of fragile or sensitive soil types.	Minimize disturbance of sensitive soil.		X
Wildlife				
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 to Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and comply with ESA.	X	X
WL008	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 habitat.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL013	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.	X	X
WL014	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.	X	X
WL015	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.	X	X
WL016	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 adverse effects to Mexican spotted owls and comply with ESA.	X	X
WL018	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.	X	X
WL019	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL025	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.		X
WL026	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.		X
WL027	If new Mexican spotted owl protected activity centers (PACs) are established in areas with planned or ongoing 4FRI activities then existing design features would apply to management activities.	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.	X	X
WL031	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.	Minimize disturbance to rookeries while restoring forest habitat.		X
5. Prescribed Fire and Fuels Treatments in Riparian Areas				
Aquatics				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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 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.		X
AQ012	Leave sufficient numbers of cut trees (large woody debris) onsite for needed surface flow grade control. 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.	X	X
Botany and Noxious Weeds				
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.	X	
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.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.		X
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.	X	
Caves and Karst				
CK001	A buffer with 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. 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	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
CK002	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. Slash piles should be located at least 50 feet from any karst features.	To protect cave ecosystems from negative fire effects and to minimize alteration of the chemical, physical, and biological conditions of karst features.	X	X
Fire				
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.		X
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.		X
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.	X	X
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.	X	X
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.	X	X
Rangeland Management				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.	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.		X
Recreation and Scenery				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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 and the national trail administrator regarding use of national trails as control lines.	Resource protection	X	X
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 or first 300', whichever is greater.	Reduce unauthorized use	X	X

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) 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; (f) Highest emphasis for slash treatment, temporary road closures and road decommissioning will be placed on eligible or suitable wild and scenic river corridors and national scenic trail corridors; foreground (up to 300 feet) of developed	Resource protection and scenic integrity and avoid substantial interference with the nature and purposes of the trail. (in compliance with Section 7 (c) of the National Trails System Act).	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	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. (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, placing cull logs perpendicular to the route, and disguising entrances;. (j) Avoid using FS designated trails as skid trails or for temporary roads. (k) 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.			

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 sides and private property. Flush cut or low cut to 8" in other distance zones where topography and operational safety allows, with 12-inch heights as the exception and rarely occurring. (c) Slash should be removed, burned, or otherwise treated to return the area to its pre-implementation condition 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	Maintain scenic integrity.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	of these areas, it is acceptable to scatter root wads and debris or use them to help close temporary roads or skid trails			
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 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	X	X
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.	X	X
RS017	Retain healthy, 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 ¼ mile of the trail. Avoid lines of trees; strive to achieve a grouped appearance to avoid abrupt changes in the landscape character along the trail corridor.	Protect visitor experience	X	X
Silviculture				
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		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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		X
SI003	All snags will be maintained within the AMZ unless deemed a hazard tree.	To provide habitat for snag-dependent wildlife and future coarse woody debris.		X
SI004	To protect legacy trees, thinning from below is allowed, If conifers are even-aged pole, sapling, or mid-seral with no legacy trees, thin existing trees to the degree necessary to promote a low- to moderate-severity burn.	To facilitate desired fuel conditions for broadcast burning		X
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		X
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		X
SI014	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		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SI015	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	X	
SI016	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.	X	
SI017	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		X
SI018	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		X
SI019	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		X
SI020	If seeding is a part of the action, consider whether seeding would be most appropriate before or after juniper treatment.	To provide desired vegetation composition in riparian areas and wetlands		X
Soils and Watershed				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. 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.	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.	X	X
SW002	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.	X	X
SW003	Stream channels to be protected with a prescribed aquatic management zone (AMZ) will be shown on the project task order, contract maps, or burn plan maps. AMZ widths will be clearly labeled or described.	Reduce ground disturbance by limiting the turning of equipment in or near the stream channels, and retain as much of the filtering effect of undisturbed ground cover as possible.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW006	Landings, log decks, and burn piles should be placed in upland locations and will not be allowed in areas such as: meadows, riparian areas, springs, seeps, AMZs, stream channels, or at the heads of stream channels. Landings, log decks and burn piles will be located outside at least 100 feet from these features, far enough away that direct (unfiltered) entry of sediment, bark, ash and burning products will not enter. The authorized FS officer AND a watershed specialist may authorize landings in these areas if absolutely required.	Limit the overall amount and extent of heavy ground disturbance that implicates soil stability/ productivity as well as the filtering capacity of upland areas.	X	X
SW012	Site-specific criteria whereby either fire is allowed to burn in AMZs or is actively ignited will be solely driven by the need to maintain or improve riparian and stream habitat. 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.		X
SW013	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 do not disturb soils or cause erosion.	To minimize the disturbance of riparian vegetation.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW014	The following direction should be incorporated in developing the burn plan: High soil burn severity should not occur on greater than 5 percent areal extent of the uplands or an AMZ in each burn unit. 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.	X	X
SW015	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.		X
SW017	Domestic livestock grazing within an AMZ affected by prescribed fire will be deferred until ground cover is adequately re-established.	Promote recovery and establishment of riparian species, protect floodplain function, and provide for resilient stream systems.		X
SW066	Mechanized equipment usage for thinning timber or biomass will be restricted to slope gradients of 25 percent or less on fragile or sensitive soil types (e.g., cinder cones).	Severe erosion hazards are present on soil types above these slope gradients.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW074	No 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.		X
SW075	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.		X
SW076	Surface fuel loading 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).	X	X
SW077	High soil burn severity fire should occur on no more than 5 percent of the entire treatment area for all prescribed fire in the project area.	Maintain long term soil productivity by minimizing erosion from containment lines and minimizing high soil burn severity to the degree possible.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW078	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.		X
SW079	Avoid treatment intensities (mechanical thinning and prescribed burning) which may cumulatively produce undesirable effects in subwatersheds. A watershed specialist will evaluate the potential for adverse cumulative subwatershed effects prior to implementation. Methodologies may include but are not limited to an Equivalent Disturbed Area analysis or watershed modeling software. If it is determined that potential cumulative effects may be adverse to watershed function and condition, treatments can be spread out spatially and/or temporally.	Reduce potential cumulative effects which may adversely affect subwatershed scale (HUC12) condition or function.		X
SW080	If a watershed analysis is not completed, the default limit of areal extent of mechanical vegetative treatments which may occur in a subwatershed (HUC12) is 25% in a given year and 40% over 5 years of that subwatershed. For prescribed burning the percentages of subwatershed treated can be doubled over the same time periods.	Reduce potential cumulative effects which may adversely affect subwatershed scale (HUC12) condition or function.		X
SW099	Streambank vegetation will be protected except where its disturbance or removal is absolutely necessary for completion of the work.	To protect riparian vegetation and stream channel stability.		X
SW102	Placement of lop / scatter material or piling for burning will occur outside of fragile or sensitive soil types.	Minimize disturbance of sensitive soil.		X
Wildlife				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL035	Utilize firing technique that ensure low severity and intensity fire in Chiricahua Leopard Frog occupied habitats or suitable habitat within dispersal distance from occupied sites. No direct ignition will occur in occupied habitat (unless to ensure low severity fire) or in riparian areas. If fuel conditions result in significant ash and sediment flow into an occupied site that cannot be mitigated though erosion control measures, the resource advisor or wildlife biologist will contact AGFD and USFWS. If thinning occurs in occupied riparian areas, timing restrictions would be placed on harvesting operations with 150 ft of each stream bank during or 3 days after a rain event greater than one tenth inch.	Minimize disturbance while restoring forest conditions.	X	X
WL036	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 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 silviculturist 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.	X	X
WL046	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.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL047	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.		X
6. Road Construction and Reconstruction				
Aquatics				
AQ006	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 abandoned and the stream channel and banks restored.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	X	X
AQ016	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.		X
AQ017	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.	X	X
Botany and Noxious Weeds				
BT008	Landings, machine slash piles and other ground disturbing activities (e.g., firelines, parking areas, etc.) and other ground-disturbing activities 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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
BT009	Prohibit temporary road construction and reconstruction, tracked vehicles, and pits within populations of Southwestern Region sensitive plants.	Eliminates direct loss of plants.		X
BT010	Sensitive plant populations would be avoided when constructing temporary roads.	Prevents direct impacts to sensitive plant species.		X
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	X	X
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		X
NW008	Equipment (other than for hauling, unless coming from sites with known invasive weed populations) would be inspected and cleaned before entering rock pit areas to prevent introduction of invasive weeds.	Prevent establishment and spread of invasive weed populations		X
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		X
Caves and Karst				
CK001	A buffer with 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. 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	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
CK002	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. Slash piles should be located at least 50 feet from any karst features.	To protect cave ecosystems from negative fire effects and to minimize alteration of the chemical, physical, and biological conditions of karst features.	X	X
Rangeland Management				
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		X
Recreation and Scenery				
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 or first 300', whichever is greater.	Reduce unauthorized use	X	X

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) 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; (f) Highest emphasis for slash treatment, temporary road closures and road decommissioning will be placed on eligible or suitable wild and scenic river corridors and national scenic trail corridors; foreground (up to 300 feet) of developed recreation sites, private homes or communities; and Concern	Resource protection and scenic integrity and avoid substantial interference with the nature and purposes of the trail. (in compliance with Section 7 (c) of the National Trails System Act).	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	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. (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, placing cull logs perpendicular to the route, and disguising entrances;. (j) Avoid using FS designated trails as skid trails or for temporary roads. (k) 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.			

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 sides and private property. Flush cut or low cut to 8" in other distance zones where topography and operational safety allows, with 12-inch heights as the exception and rarely occurring. (c) Slash should be removed, burned, or otherwise treated to return the area to its pre-implementation condition 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	Maintain Scenic Integrity and avoid substantial interference with the nature and purposes of the trail. (in compliance with Section 7 (c) of the National Trails System Act).	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	of these areas, it is acceptable to scatter root wads and debris or use them to help close temporary roads or skid trails.			
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.	To ensure that wild river segments and IRAs maintain their primitive characteristics and to protect the largely undeveloped character of scenic river segments	X	
Soils and Watershed				
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. 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.	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW002	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.	X	X
SW003	Stream channels to be protected with a prescribed aquatic management zone (AMZ) will be shown on the project task order, contract maps, or burn plan maps. AMZ widths will be clearly labeled or described.	Reduce ground disturbance by limiting the turning of equipment in or near the stream channels, and retain as much of the filtering effect of undisturbed ground cover as possible.		X
SW010	New temporary road construction is not allowed in AMZs.	To minimize adverse environmental effects within aquatic management zones.		X
SW015	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.		X
SW025	All dry meadow locations identified during the layout phase of a project sale will be clearly labeled on sale contract maps.	To improve implementation.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW041	Skid trail stream crossings will not be allowed unless pre-approved by the authorized FS officer AND 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.		X
SW043	Culverts, temporary bridges, low-water crossings, or log-fords will be required on all temporary roads and skid crossings on all streams that will have flowing water during the life of the temporary crossing. Temporary road and skid trail crossings will be removed 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.	X	X
SW061	The authorized FS officer 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		X
SW083	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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW084	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 IRSC and T- specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X
SW085	Road maintenance through the integrated resource service contract should require pre-haul and post-haul maintenance on all roads to be used for haul.	To minimize soil movement, maintain water quality, and to minimize effects on severe erosion soils.	X	X
SW086	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.		X
SW087	Site rehabilitation on riparian sites for stream channel and road reconstruction projects where ground disturbance occurs: seed at 5 pounds per acre 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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW088	Site rehabilitation on disturbed sites and stream channel shaping on previously decommissioned roads: Site rehabilitation 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. Minimize noxious weed spread.		X
SW092	Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, large wood, trees, etc.), seeding, or planting with local native seed mixes or plants.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	X	
SW093	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		X
SW094	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X
SW097	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. 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.		X
SW098	Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork as quickly as possible and prior monsoon season. 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.	X	X
SW099	Streambank vegetation will be protected except where its disturbance or removal is absolutely necessary for completion of the work.	To protect riparian vegetation and stream channel stability.		X
SW100	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.		X
Transportation and Roads				
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		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.		X
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: 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, and appropriately spaced water bars or water spreading drainage features.	To protect long-term soil productivity and water quality.		X
TR004	Utilize road safety signage with any project road activities that are related to project implementation.	Provide for user safety.		X
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.		X
TR006	Existing and newly constructed roads are maintained throughout the life of the project. Drainage control structures will receive maintenance prior to monsoon season and winter shutdown of project operations. Drainage should be maintained and improved as needed. Consider wildlife in the design, installation, and maintenance of these structures.	Proper maintenance of roads throughout the life of the project will ensure that drainage structures are functioning correctly and that concentrated surface run-off does not occur.		X
TR007	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.		X
TR009	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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
TR010	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.		X
TR012	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.		X
TR013	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.		X
TR014	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.		X
TR015	When deemed necessary in order to prevent potential damage to water pipelines, the Forest Service shall coordinate any hauling activity which will cross water pipelines with the owner of the line. Care shall be taken to prevent damage to pipelines which may include mitigation measures such as gravel padding or other suitable measures.	Prevent damage to water pipelines		X
TR016	While 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.		X
Wildlife				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL007	In Mexican spotted owl protected activity centers (PACs), 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 to Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and comply with ESA.	X	X
WL011	In Mexican spotted owl protected activity centers (PACs), road maintenance would not occur during the nesting season (Effective March 1 to August 31).	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.	X	X
WL017	In Mexican spotted owl protected activity centers (PACs), recovery nest/roost, goshawk post-fledging family areas, no old trees would be cut during the rehabilitation of temporary roads.	To protect/retain old trees and maintain or develop key habitat components.		X
WL023	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.	X	X
7. Road Decommissioning and Rehabilitation				
Aquatics				
AQ006	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 abandoned and the stream channel and banks restored.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ016	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.		X
AQ017	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.	X	X
Botany and Noxious Weeds				
BT008	Landings, machine slash piles and other ground disturbing activities (e.g., firelines, parking areas, etc.) and other ground-disturbing activities 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.	X	X
BT009	Prohibit temporary road construction and reconstruction, tracked vehicles, and pits within populations of Southwestern Region sensitive plants.	Eliminates direct loss of plants.		X
BT010	Sensitive plant populations would be avoided when constructing temporary roads.	Prevents direct impacts to sensitive plant species.		X
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	X	X
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		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
NW008	Equipment (other than for hauling, unless coming from sites with known invasive weed populations) would be inspected and cleaned before entering rock pit areas to prevent introduction of invasive weeds.	Prevent establishment and spread of invasive weed populations		X
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		X
Recreation and Scenery				
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 or first 300', whichever is greater.	Reduce unauthorized use	X	X

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) 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; (f) Highest emphasis for slash treatment, temporary road closures and road decommissioning will be placed on eligible or suitable wild and scenic river corridors and national scenic trail corridors; foreground (up to 300 feet) of developed recreation sites, private homes or communities; and Concern	Resource protection and scenic integrity and avoid substantial interference with the nature and purposes of the trail. (in compliance with Section 7 (c) of the National Trails System Act).	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	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. (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, placing cull logs perpendicular to the route, and disguising entrances;. (j) Avoid using FS designated trails as skid trails or for temporary roads. (k) 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.			

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 sides and private property. Flush cut or low cut to 8" in other distance zones where topography and operational safety allows, with 12-inch heights as the exception and rarely occurring. (c) Slash should be removed, burned, or otherwise treated to return the area to its pre-implementation condition 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	Maintain scenic integrity and avoid substantial interference with the nature and purposes of the trail. (in compliance with Section 7 (c) of the National Trails System Act).	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	of these areas, it is acceptable to scatter root wads and debris or use them to help close temporary roads or skid trails.			
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.	X	X
Soils and Watershed				
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. 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.	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.	X	X
SW002	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW003	Stream channels to be protected with a prescribed aquatic management zone (AMZ) will be shown on the project task order, contract maps, or burn plan maps. AMZ widths will be clearly labeled or described.	Reduce ground disturbance by limiting the turning of equipment in or near the stream channels, and retain as much of the filtering effect of undisturbed ground cover as possible.		X
SW015	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.		X
SW058	Skid trails, landings, and temporary roads are to be closed 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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW061	The authorized FS officer 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		X
SW083	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.		X
SW084	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 IRSC and T- specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X
SW085	Road maintenance through the integrated resource service contract should require pre-haul and post-haul maintenance on all roads to be used for haul.	To minimize soil movement, maintain water quality, and to minimize effects on severe erosion soils.	X	X
SW086	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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW087	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.	X	X
SW088	Site rehabilitation on disturbed sites and stream channel shaping on previously decommissioned roads: Site rehabilitation 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. Minimize noxious weed spread.		X
SW092	Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, large wood, trees, etc.), seeding, or planting with local native seed mixes or plants.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW093	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		X
SW094	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	X	
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X
SW097	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. 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.		X
SW098	Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork as quickly as possible and prior monsoon season. 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.	X	X
SW100	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.		X
Transportation and Roads				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
TR008	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.		X
TR011	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.		X
Wildlife				
WL007	In Mexican spotted owl protected activity centers (PACs), 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 to Mexican spotted owls while restoring Mexican spotted owl habitat, contribute towards the recovery of the owl, and comply with ESA.	X	X
WL023	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.	X	X
8. Stream Restoration				
Aquatics				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ003	When using pressure treated lumber for fence posts, complete all cutting/drilling offsite (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.		X
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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.	X	X
AQ006	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 abandoned and the stream channel and banks restored.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.	X	X
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 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.		X
AQ012	Leave sufficient numbers of cut trees (large woody debris) onsite for needed surface flow grade control. 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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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 50 feet 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.	X	X
AQ016	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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ017	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.	X	X
AQ019	• 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.	X	X
AQ022	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. 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.		X
AQ023	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.		X

AQ024	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. 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.	To minimize sedimentation and detrimental effects to aquatic species and habitat during aquatic and watershed restoration projects.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	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. 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.			

AQ027	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. • 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	To minimize loss of fish passage during headcut and channel grade stabilization treatments.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	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.			

AQ028	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.	To guide successful large wood and boulder stream restoration treatments.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	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.			

AQ029	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. Diameter This key to establishing a logjam is utilizing larger diameter	To guide engineered log jam stream treatments.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	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.			

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ030	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ032	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.	X	X
AQ033	Ensure that an experienced engineer, fisheries biologist, wildlife biologist, hydrologist and geomorphologist are involved in the design of all aquatic restoration projects. The experience should be commensurate with technical requirements of a project and needs to involve all.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X
AQ034	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.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ037	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. 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		X
AQ038	Within the primary shade zone 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 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.		X
Botany and Noxious Weeds				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
BT001	During layout, protect Southwestern Region sensitive or analysis plant groups 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.		X
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.	X	
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
BT008	Landings, machine slash piles and other ground disturbing activities (e.g., firelines, parking areas, etc.) and other ground-disturbing activities 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.	X	X
Caves and Karst				
CK001	A buffer with 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. 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	X	X
CK002	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. Slash piles should be located at least 50 feet from any karst features.	To protect cave ecosystems from negative fire effects and to minimize alteration of the chemical, physical, and biological conditions of karst features.	X	X
Rangeland Management				
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.		X
Recreation and Scenery				
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 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	X	X
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	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
Silviculture				
SI003	All snags will be maintained within the AMZ unless deemed a hazard tree.	To provide habitat for snag-dependent wildlife and future coarse woody debris.		X
SI008	Source trees for placement in stream restoration should come from but are not limited to: over or fully stocked upland and riparian stands, 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		X
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		X
SI010	Identified wildlife trees shall not be felled.	To maintain nest/roost habitat.		X
SI011	Trees may be removed by cable, ground-based equipment, horses or helicopters.	To facilitate riparian restoration activities		X
SI012	Trees may be stockpiled for future instream restoration projects.	To facilitate riparian restoration activities		X
SI013	The project manager for an aquatic restoration activity will coordinate with a wildlife biologist in tree-removal planning efforts.	To assure protection of wildlife habitat features		X
Soils and Watershed				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. 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.	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.	X	X
SW002	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.	X	X
SW003	Stream channels to be protected with a prescribed aquatic management zone (AMZ) will be shown on the project task order, contract maps, or burn plan maps. AMZ widths will be clearly labeled or described.	Reduce ground disturbance by limiting the turning of equipment in or near the stream channels, and retain as much of the filtering effect of undisturbed ground cover as possible.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW005	If completing mechanical vegetation treatments within an AMZ, the preferred method of using feller-buncher or grapple skidder equipment is to approach the material to be extracted on the contour as much as possible to the stream, then back equipment out. Turning machines and skidding within AMZs should be minimized to the greatest extent possible.	Allows for a reduction in ground disturbance by limiting the number of passes required to extract material and turning of equipment. Maintaining this type of travel pattern aims to reduce potential concentrated run-off and sediment delivery downslope compared to travel courses that follow the slope direction. 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.		X
SW010	New temporary road construction is not allowed in AMZs.	To minimize adverse environmental effects within aquatic management zones.		X
SW012	Site-specific criteria whereby either fire is allowed to burn in AMZs or is actively ignited will be solely driven by the need to maintain or improve riparian and stream habitat. 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW015	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.		X
SW016	Do not apply surface fertilizer within an AMZ.	To protect water quality	X	X
SW081	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.		X
SW082	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.		X
SW084	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 IRSC and T- specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW086	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.		X
SW087	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	X	X
SW088	Site rehabilitation on disturbed sites and stream channel shaping on previously decommissioned roads: Site rehabilitation 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. Minimize noxious weed spread.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW092	Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, large wood, trees, etc.), seeding, or planting with local native seed mixes or plants.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	X	
SW093	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		X
SW094	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	X	
SW095	The project fisheries biologist/hydrologist will ensure that project design features are incorporated into implementation contracts. If a biologist or hydrologist is not the Contracting Officer Representative, then the project Contracting Officer Representative must regularly coordinate with the biologist or hydrologist to ensure project design features and conservation measures are being followed.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X
SW097	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. 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW098	Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork as quickly as possible and prior monsoon season. 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.	X	X
SW099	Streambank vegetation will be protected except where its disturbance or removal is absolutely necessary for completion of the work.	To protect riparian vegetation and stream channel stability.		X
Wildlife				
WL004	In Mexican spotted owl protected activity centers (PACs), springs, riparian and stream restoration would not occur during the breeding season (March 1 to August 31), if occupied.	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.	X	X
WL006	In Mexican spotted owl protected activity centers (PACs), springs, riparian and stream restoration would not occur during the breeding season (March 1 to August 31), if occupied.	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.	X	X
WL022	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL034	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.	Minimize disturbance to bats and their habitat, including detrimental effects to the cave/karst microclimate and hydrology, and to prevent collapse and sedimentation.		X
WL050	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.	X	X
WL051	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.	X	X
WL052	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.	X	X
WL053	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.	X	X
9. Floodplain Restoration				
Aquatics				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.	X	X
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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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 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.		X
AQ012	Leave sufficient numbers of cut trees (large woody debris) onsite for needed surface flow grade control. 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.	X	X
AQ019	• 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.	X	X
AQ022	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. 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ023	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.		X
AQ032	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.	X	X
AQ033	Ensure that an experienced engineer, fisheries biologist, wildlife biologist, hydrologist and geomorphologist are involved in the design of all aquatic restoration projects. The experience should be commensurate with technical requirements of a project and needs to involve all.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ034	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.	X	
AQ037	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. 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		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ038	Within the primary shade zone 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 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.		X
Botany and Noxious Weeds				
BT001	During layout, protect Southwestern Region sensitive or analysis plant groups 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.	X	
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.		X
Caves and Karst				
CK001	A buffer with 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. 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	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
CK002	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. Slash piles should be located at least 50 feet from any karst features.	To protect cave ecosystems from negative fire effects and to minimize alteration of the chemical, physical, and biological conditions of karst features.	X	X
Rangeland Management				
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.		X
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.		X
Recreation and Scenery				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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 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	X	X
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	X	
Silviculture				
SI003	All snags will be maintained within the AMZ unless deemed a hazard tree.	To provide habitat for snag-dependent wildlife and future coarse woody debris.		X
SI008	Source trees for placement in stream restoration should come from but are not limited to: over or fully stocked upland and riparian stands, 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		X
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		X
SI010	Identified wildlife trees shall not be felled.	To maintain nest/roost habitat.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SI011	Trees may be removed by cable, ground-based equipment, horses or helicopters.	To facilitate riparian restoration activities		X
SI012	Trees may be stockpiled for future instream restoration projects.	To facilitate riparian restoration activities		X
SI013	The project manager for an aquatic restoration activity will coordinate with a wildlife biologist in tree-removal planning efforts.	To assure protection of wildlife habitat features		X
Soils and Watershed				
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. 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.	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.	X	X
SW002	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW003	Stream channels to be protected with a prescribed aquatic management zone (AMZ) will be shown on the project task order, contract maps, or burn plan maps. AMZ widths will be clearly labeled or described.	Reduce ground disturbance by limiting the turning of equipment in or near the stream channels, and retain as much of the filtering effect of undisturbed ground cover as possible.		X
SW006	If completing mechanical vegetation treatments within an AMZ, the preferred method of using feller-buncher or grapple skidder equipment is to approach the material to be extracted on the contour as much as possible to the stream, then back equipment out. Turning machines and skidding within AMZs should be minimized to the greatest extent possible.	Allows for a reduction in ground disturbance by limiting the number of passes required to extract material and turning of equipment. Maintaining this type of travel pattern aims to reduce potential concentrated run-off and sediment delivery downslope compared to travel courses that follow the slope direction. 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.		X
SW010	New temporary road construction is not allowed in AMZs.	To minimize adverse environmental effects within aquatic management zones.		X
SW012	Site-specific criteria whereby either fire is allowed to burn in AMZs or is actively ignited will be solely driven by the need to maintain or improve riparian and stream habitat. 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW015	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.		X
SW016	Do not apply surface fertilizer within an AMZ.	To protect water quality	X	X
SW081	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.		X
SW082	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.		X
SW084	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 IRSC and T- specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW086	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.		X
SW087	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.	X	X
SW088	Site rehabilitation on disturbed sites and stream channel shaping on previously decommissioned roads: Site rehabilitation 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. Minimize noxious weed spread.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW092	Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, large wood, trees, etc.), seeding, or planting with local native seed mixes or plants.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	X	
SW093	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		X
SW094	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	X	
SW095	The project fisheries biologist/hydrologist will ensure that project design features are incorporated into implementation contracts. If a biologist or hydrologist is not the Contracting Officer Representative, then the project Contracting Officer Representative must regularly coordinate with the biologist or hydrologist to ensure project design features and conservation measures are being followed.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X
SW097	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. 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW098	Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork as quickly as possible and prior monsoon season. 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.	X	X
SW099	Streambank vegetation will be protected except where its disturbance or removal is absolutely necessary for completion of the work.	To protect riparian vegetation and stream channel stability.		X
Wildlife				
WL034	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.	Minimize disturbance to bats and their habitat, including detrimental effects to the cave/karst microclimate and hydrology, and to prevent collapse and sedimentation.		X
WL050	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.	X	X
WL051	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.	X	X
WL052	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL053	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.	X	X
10. Riparian Restoration				
Aquatics				
AQ003	When using pressure treated lumber for fence posts, complete all cutting/drilling offsite (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.		X
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.	X	
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.	To maximize success of riparian planting and reduce maintenance on fencing.		X
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.		X
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 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ012	Leave sufficient numbers of cut trees (large woody debris) onsite for needed surface flow grade control. 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.	X	X
AQ019	• 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.	X	X
AQ022	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. 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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ023	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.		X
AQ034	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.	X	
Botany and Noxious Weeds				
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.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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.		X
Caves and Karst				
CK001	A buffer with 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. 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	X	X
CK002	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. Slash piles should be located at least 50 feet from any karst features.	To protect cave ecosystems from negative fire effects and to minimize alteration of the chemical, physical, and biological conditions of karst features.	X	X
Fire				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.		X
Rangeland Management				
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.		X
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.		X
Recreation and Scenery				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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 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	X	X
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	X	
Silviculture				
SI003	All snags will be maintained within the AMZ unless deemed a hazard tree.	To provide habitat for snag-dependent wildlife and future coarse woody debris.		X
SI007	Exclosure fencing to prevent utilization of plantings by deer, elk, and livestock is permitted.	To provide desired vegetation composition in riparian areas		X
SI021	Experienced silviculturists, botanists, ecologists, or associated technicians shall be involved in designing vegetation treatments.	To provide desired vegetation composition in riparian areas and wetlands		X
SI022	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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SI023	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		X
SI024	Sedge and rush mats should be sized to prevent their movement during high flow events.	To minimize streambank erosion		X
SI025	Concentrate plantings above the bankfull elevation.	To provide desired vegetation composition in riparian areas		X
SI026	Removal of native and non-native vegetation that will compete with plantings is permitted.	To provide desired vegetation composition in riparian areas		X
Soils and Watershed				
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. 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.	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW002	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.	X	X
SW010	New temporary road construction is not allowed in AMZs.	To minimize adverse environmental effects within aquatic management zones.		X
SW016	Do not apply surface fertilizer within an AMZ.	To protect water quality	X	X
SW081	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.		X
SW082	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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW084	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 IRSC and T- specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X
SW086	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.		X
SW087	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW088	Site rehabilitation on disturbed sites and stream channel shaping on previously decommissioned roads: Site rehabilitation 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. Minimize noxious weed spread.		X
SW092	Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, large wood, trees, etc.), seeding, or planting with local native seed mixes or plants.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	X	
SW093	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		X
SW094	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW095	The project fisheries biologist/hydrologist will ensure that project design features are incorporated into implementation contracts. If a biologist or hydrologist is not the Contracting Officer Representative, then the project Contracting Officer Representative must regularly coordinate with the biologist or hydrologist to ensure project design features and conservation measures are being followed.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X
SW097	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. 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.		X
SW098	Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork as quickly as possible and prior monsoon season. 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.	X	X
SW099	Streambank vegetation will be protected except where its disturbance or removal is absolutely necessary for completion of the work.	To protect riparian vegetation and stream channel stability.		X
Wildlife				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL004	In Mexican spotted owl protected activity centers (PACs), springs, riparian and stream restoration would not occur during the breeding season (March 1 to August 31), if occupied.	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.	X	X
WL006	In Mexican spotted owl protected activity centers (PACs), springs, riparian and stream restoration would not occur during the breeding season (March 1 to August 31), if occupied.	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.	X	X
WL010	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.		X
WL022	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.	X	X
WL052	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.	X	X
WL053	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.	X	X
11. Spring Restoration				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
Botany and Noxious Weeds				
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.	X	
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.		X
Caves and Karst				
CK001	A buffer with 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. 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	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
CK002	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. Slash piles should be located at least 50 feet from any karst features.	To protect cave ecosystems from negative fire effects and to minimize alteration of the chemical, physical, and biological conditions of karst features.	X	X
Rangeland Management				
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.		X
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.		X
Recreation and Scenery				
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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
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 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	X	X
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	X	
Soils and Watershed				
SW002	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.	X	X
SW010	New temporary road construction is not allowed in AMZs.	To minimize adverse environmental effects within aquatic management zones.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW016	Do not apply surface fertilizer within an AMZ.	To protect water quality	X	X
SW019	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.		X
SW027	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.		X
SW028	At spring restoration sites, ensure that each livestock or wildlife water development has a float valve or similar device, a return flow system, a fenced overflow area, or similar means to minimize water withdrawal and potential runoff and erosion.	To reduce water withdrawal, protect stream/spring flows, and channel functionality.		X
SW029	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 groundwater-dependent ecosystems (GDE) and minimize effects on these sensitive systems.		X
SW030	When necessary, construct barriers around spring developments to prevent damage from wild or domestic ungulates, OHVs, or other recreational impacts.	To maintain or improve the integrity of springs and other groundwater-dependent ecosystems (GDE) and minimize effects on these sensitive systems.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW031	Spring developments shall have a return flow system to minimize the diversion of surface and subsurface water from the catchment area. Consider using a float valve or similar device to reduce the amount of water withdrawn from the groundwater-dependent ecosystems (GDE).	To maintain or improve the integrity of springs and other groundwater-dependent ecosystems (GDE) and minimize effects on these sensitive systems.		X
SW084	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 IRSC and T- specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X
SW086	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.		X
SW087	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW088	Site rehabilitation on disturbed sites and stream channel shaping on previously decommissioned roads: Site rehabilitation 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. Minimize noxious weed spread.		X
SW092	Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, large wood, trees, etc.), seeding, or planting with local native seed mixes or plants.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	X	
SW093	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		X
SW094	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW095	The project fisheries biologist/hydrologist will ensure that project design features are incorporated into implementation contracts. If a biologist or hydrologist is not the Contracting Officer Representative, then the project Contracting Officer Representative must regularly coordinate with the biologist or hydrologist to ensure project design features and conservation measures are being followed.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X
SW097	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. 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.		X
SW098	Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork as quickly as possible and prior monsoon season. 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.	X	X
SW099	Streambank vegetation will be protected except where its disturbance or removal is absolutely necessary for completion of the work.	To protect riparian vegetation and stream channel stability.		X
Wildlife				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL004	In Mexican spotted owl protected activity centers (PACs), springs, riparian and stream restoration would not occur during the breeding season (March 1 to August 31), if occupied.	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.	X	X
WL006	In Mexican spotted owl protected activity centers (PACs), springs, riparian and stream restoration would not occur during the breeding season (March 1 to August 31), if occupied.	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.	X	X
WL010	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.		X
WL022	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.	X	X
WL037	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.	X	X
12. Livestock Fencing and Watering and Stream Crossings				
Aquatics				

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
AQ016	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.		X
AQ017	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.	X	X
Fire				
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.		X
Rangeland Management				
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.		X
Soils and Watershed				
SW027	At spring development restoration sites, place watering troughs far enough from a steam or surround with a protective surface to prevent mud and 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.		X
SW028	At spring restoration sites, ensure that each livestock or wildlife water development has a float valve or similar device, a return flow system, a fenced overflow area, or similar means to minimize water withdrawal and potential runoff and erosion.	To reduce water withdrawal, protect stream/spring flows, and channel functionality.		X
SW084	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 IRSC and T- specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW087	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.	X	X
SW088	Site rehabilitation on disturbed sites and stream channel shaping on previously decommissioned roads: Site rehabilitation 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. Minimize noxious weed spread.		X
SW092	Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, large wood, trees, etc.), seeding, or planting with local native seed mixes or plants.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW093	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		X
SW094	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	X	
SW095	The project fisheries biologist/hydrologist will ensure that project design features are incorporated into implementation contracts. If a biologist or hydrologist is not the Contracting Officer Representative, then the project Contracting Officer Representative must regularly coordinate with the biologist or hydrologist to ensure project design features and conservation measures are being followed.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X
SW097	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. 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.		X
SW098	Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork as quickly as possible and prior monsoon season. 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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW099	Streambank vegetation will be protected except where its disturbance or removal is absolutely necessary for completion of the work.	To protect riparian vegetation and stream channel stability.		X
13. Erosion Control in Aquatic Management Zones and Riparian Areas				
Botany and Noxious Weeds				
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.	X	
Rangeland Management				
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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.		X
Soils and Watershed				
SW002	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.	X	X
SW016	Do not apply surface fertilizer within an AMZ.	To protect water quality	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW041	Skid trail stream crossings will not be allowed unless pre-approved by the authorized FS officer AND 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.		X
SW043	Culverts, temporary bridges, low-water crossings, or log-fords will be required on all temporary roads and skid crossings on all streams that will have flowing water during the life of the temporary crossing. Temporary road and skid trail crossings will be removed 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.	X	X
SW074	No 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.		X
SW075	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.		X
SW083	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.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW084	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 IRSC and T- specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X
SW086	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.		X
SW088	Site rehabilitation on disturbed sites and stream channel shaping on previously decommissioned roads: Site rehabilitation 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. Minimize noxious weed spread.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW092	Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, large wood, trees, etc.), seeding, or planting with local native seed mixes or plants.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	X	
SW093	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		X
SW094	If soil compaction occurs during implementation, mitigate through ripping, seeding with native weed-free seed, and covering compacted areas with slash.	Minimize soil compaction, soil detachment, and sediment transport. To maintain long term soil productivity.	X	
SW095	The project fisheries biologist/hydrologist will ensure that project design features are incorporated into implementation contracts. If a biologist or hydrologist is not the Contracting Officer Representative, then the project Contracting Officer Representative must regularly coordinate with the biologist or hydrologist to ensure project design features and conservation measures are being followed.	To ensure technical skill and planning requirements for all aquatic and watershed restoration treatments.		X
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW097	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. 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.		X
SW098	Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork as quickly as possible and prior monsoon season. 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.	X	X
SW099	Streambank vegetation will be protected except where its disturbance or removal is absolutely necessary for completion of the work.	To protect riparian vegetation and stream channel stability.		X
14. Aggregate Production for Road Surfacing (Rock Pits)				
Botany and Noxious Weeds				
BT009	Prohibit temporary road construction and reconstruction, tracked vehicles, and pits within populations of Southwestern Region sensitive plants.	Eliminates direct loss of plants.		X
BT010	Sensitive plant populations would be avoided when constructing temporary roads.	Prevents direct impacts to sensitive plant species.		X
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	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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		X
NW008	Equipment (other than for hauling, unless coming from sites with known invasive weed populations) would be inspected and cleaned before entering rock pit areas to prevent introduction of invasive weeds.	Prevent establishment and spread of invasive weed populations		X
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		X
Cultural Resources and Tribal Relations				
CT018	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.	X	X
Recreation and Scenery				
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 or first 300', whichever is greater.	Reduce unauthorized use	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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 and wildlife.	X	X
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.	Reduces noise and dust during hauling.	X	X
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	X	X
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.	X	
Soils and Watershed				
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. 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.	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW002	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.	X	X
SW084	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 IRSC and T- specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X
SW092	Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, large wood, trees, etc.), seeding, or planting with local native seed mixes or plants.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	X	
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW097	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. 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.		X
SW103	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.		X
SW104	All operators at a proposed rock pit site must obtain coverage under an Arizona Pollutant Discharge Elimination System Permit (AZPDES) and establish and implement a stormwater pollution prevention plan (SWPPP), if required to comply with State water requirements based on the magnitude of the specific rock pit operation.	To avoid and minimize impacts to water quality and watershed integrity.	X	
SW106	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.		X
SW107	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.		X
SW108	Mine pit areas would be designed to be internally draining during mining activity.	To avoid and minimize impacts to water quality.		X
SW109	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.		X
SW110	Stockpiled material should be placed and shaped to prevent water from ponding and to direct water to a drainage system.	To protect water quality.		X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW111	Keep 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 avoid and minimize impacts to water quality.		X
SW112	Removal of pit material will not involve disturbance of riparian areas or alteration of streambeds and/or floodplain.	To protect riparian and stream habitat.	X	
SW113	Replace topsoil, revegetate, and reclaim mined areas pit as soon as possible once pit use is discontinued.	To protect soil and water resources.		X
Transportation and Roads				
TR016	While 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.		X
Wildlife				
WL055	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.	X	X
WL056	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 during the nesting season, unless a wildlife biologist determines this restriction is unnecessary.	To avoid or minimize potential impacts to MSOs.	X	X
WL057	Material hauling from rock pits in or within ¼ miles of occupied PACs would occur outside of the Mexican spotted owl nesting season.	To avoid or minimize potential impacts to MSOs.	X	X
WL058	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.	To minimize impacts to Northern goshawk	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
WL059	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 goshawks		X
WL060	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	X	X
15. In-Woods Processing and Storage Sites				
Botany and Noxious Weeds				
BT008	Landings, machine slash piles and other ground disturbing activities (e.g., firelines, parking areas, etc.) and other ground-disturbing activities 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.	X	X
Recreation and Scenery				
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 or first 300', whichever is greater.	Reduce unauthorized use	X	X

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) 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; (f) Highest emphasis for slash treatment, temporary road closures and road decommissioning will be placed on eligible or suitable wild and scenic river corridors and national scenic trail corridors; foreground (up to 300 feet) of developed	Resource protection and scenic integrity and avoid substantial interference with the nature and purposes of the trail. (in compliance with Section 7 (c) of the National Trails System Act).	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
	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. (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, placing cull logs perpendicular to the route, and disguising entrances;. (j) Avoid using FS designated trails as skid trails or for temporary roads. (k) 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.			

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	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.	Reduces noise and dust during hauling.	X	X
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	X	
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	X	
SU013	Petroleum storage in aboveground storage 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 a SPCC plan is required. A permit for installation of an aboveground storage tank is also required through the AZ State Fire Marshall's Office: https://www.dfbls.az.gov/ofm/AGST.aspx	Ensure proper authorization and permitting of in-woods processing sites	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SU014	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 would be closed during the winter months, 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	X	X
SU015	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	X	
SU016	Aggregate surfacing of the processing site location would be required to minimize soil rutting, control surface water runoff and allow for operations during wet weather periods	Ensure proper design and construction of in-woods processing sites	X	
SU017	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	X	

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SU018	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.	X	
Soils and Watershed				
SW001	All stream channels will be protected with Aquatic Management Zones (AMZs), measured as the slope distance from the edge of each side the stream. 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.	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.	X	X
SW002	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.	X	X

DF/BMP/M&CM Number	Description	Primary Purpose	Forest Plan Compliance	Specialist Recommendation
SW084	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 IRSC and T- specs.	Minimize soil movement, maintain water quality, and minimize effects on severe erosion soils.	X	X
SW096	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.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.		X
SW097	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. 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.		X

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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 D-1 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 >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% in pine-oak and 60% in mixed conifer. Measure canopy cover within stands.

Diversity of tree sizes with goal of having trees ≥16" DBH contributing ≥50% 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 3-10 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% of mixed-conifer recovery habitat is managed for recovery nesting/roosting habitat. 10% 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 ft^2 basal area per acre;
- Basal area for mixed-conifer recovery nesting/roosting habitat at least 120 ft^2 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 to bark beetle attacks and/or reducing 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 >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 3-10 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. 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 40-70 ft^2 BA/acre in recovery foraging/non-breeding habitat for ecosystem resiliency; pine-oak stands could have group basal areas represent 40 to 110 ft^2 BA/acre; mixed conifer stands could have group basal areas represent 40 to 135 ft^2 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 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 to heavy dwarf mistletoe infection centers where regeneration areas would not meet the desired conditions, prescribe an intermediate treatment. 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 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 thinning 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 tree groups;
- In general, mechanically thin nest stands to an intermediate treatment. Use mechanize equipment to reduce and remove hazardous live and dead fuel loading;
- Manage for three age classes stratified by young, mid-aged, and old-aged tree groups. 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. Young tree groups are managed to maintain tree stocking necessary to provide for desired future mid age and old age group densities;
- 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;
- In general, 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 to heavy dwarf mistletoe infection centers where regeneration areas would not meet the desired conditions, prescribe an intermediate treatment. Retain the dominant and codominant trees with the least amount of mistletoe. Reduce the amount of release to the residual stand;
- Mistletoe free trees within the dominant and codominant crown position would have priority for retention within groups. 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 are for goshawk post fledging family areas (PFA) are the following: PFA UEA 55-70, 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 UEA 55-70, 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 D-2.

Table D-2. Desired Condition of tree Groups and Interspaces for PFA UEA Treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)
UEA40	45–60%	40–55%	55'–70'
UEA25	60–75%	25–40%	40'–55'
UEA10	75–90%	10–25%	25'–40'

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 IT40 PFA IT25 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 to high dwarf mistletoe infection that are uneven age or even age with a QMD ≥ 8.5 inches. Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table D-3.

Table D-3. Desired Condition of tree Groups and Interspaces for PFA IT Treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)
IT40	45–60%	40–55%	60'–80'
IT25	60–75%	25–40%	40'–60'
IT10	75–90%	10–25%	25'–40'

Approximate interspace width between tree groups would average from 25 to 80 feet with a maximum width of 200 feet. Table D-3 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 D-4.

Table D-4. Desired Condition of tree Groups and Interspaces for PFA SI Treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)
SI40	45–60%	40–55%	60'–80'
SI25	60–75%	25–40%	40'–60'
SI10	75–90%	10–25%	25'–40'

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. Uneven-aged management techniques are used primarily. Even-aged treatments may be applied in the short term for forest health concerns (e.g., heavy dwarf mistletoe infections) to facilitate a transition to uneven-aged management.

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 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. 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 three 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 vertical diversity;
- In general, tree group density would be managed at higher group densities within mid-aged and old aged tree groups. Young tree groups are managed to maintain tree stocking necessary to provide for desired future mid age and old age group densities;
- 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;
- In general, 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 to heavy dwarf mistletoe infection centers where regeneration areas would not meet the desired conditions, prescribe an intermediate treatment. Retain the dominant and codominant trees with the least amount of mistletoe. Reduce the amount of release to the residual stand;
- Mistletoe free trees within the dominant and codominant crown position would have priority for retention within groups. 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 55-70, UEA40-55, UEA25-40 and UEA10-25. 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 55-70, UEA40-55, UEA25-40 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 D-5.

Table D-5. Desired Condition of tree Groups and Interspaces for PFA UEA Treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)
UEA55-70	30–45%	55–70%	80’-120’
UEA40-55	45–60%	40–55%	60’-100’
UEA25-40	60–75%	25–40%	40’-60’
UEA10-25	75–90%	10–25%	25’-40’

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.

IT40, IT25 and 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 to high dwarf mistletoe infection that are uneven age or even age with a QMD ≥ 8.5 inches. Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table D-6.

Table D-6. Desired Condition of tree Groups and Interspaces for IT Treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)
IT40	45–60%	40–55%	60'–80'
IT25	60–75%	25–40%	40'–60'
IT10	75–90%	10–25%	25'–40'

Approximate interspace width between tree groups would average from 25 to 80 feet with a maximum width of 200 feet. Table D-6 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 D-7.

Table D-7. Desired Condition of tree Groups and Interspaces for PFA SI Treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)
SI40	45–60%	40–55%	60'–80'
SI25	60–75%	25–40%	40'–60'
SI10	75–90%	10–25%	25'–40'

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 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. Silviculture cutting treatments include weeding other coniferous trees to reduce competition and protection of regeneration through jackstraw, fencing, 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.

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 semi-desert grasslands, the natural fire return interval is approximately every 2 to 10 years. In Great Basin grasslands the natural fire return interval is approximately every 10 to 30 years. 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 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.
- 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.

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.
- D.B.H. – Site dependent.
- 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.

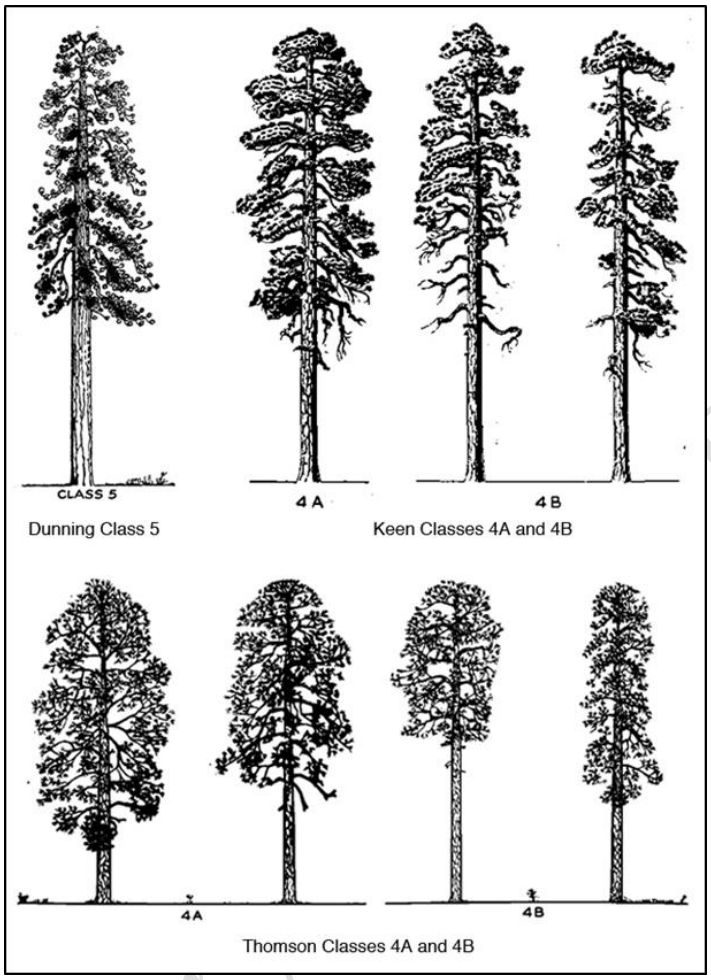


Figure D-1. Illustrations of mature size classes derived from Dunning (1928), Keen (1943) and Thompson (1940).

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.

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.

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.
    1.

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.
    2.
    3.

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 Forest and Woodland

Quaking aspen (*Populus tremuloides*) occurs within ponderosa pine 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). In addition, stable aspen stands serve as an indicator of ecological integrity (Di Orio et al. 2005). 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. Almost all of the aspen occurring within conifer forests of the Rim Country project area is seral aspen, which regenerates after disturbance through root sprouting and rarely from seed production (Quinn and Wu 2001).

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 forests and woodlands 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 gambeli*) 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 upto 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 >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 D-8. Relationship to treatment intensity, tree group density and average density

Treatment Intensity	Percent of Area		Percent of Treed Area		Avg. Group BA to Achieve Overall BA of:					
	Interspace	Tree	Groups and Individuals	Regeneration	40	50	60	70	80	90
10–25	10	90	90	0		56	67	78	89	100
			85	5		59	71	82	94	
			80	10		63	75	88	100	
			75	15		67	80	93	107	
			70	20		71	86	100	114	
	15	85	85	0		59	71	82	94	106
			80	5		63	75	88	100	
			75	10		67	80	93	107	
			70	15		71	86	100	114	
			65	20		77	92	108	123	
	20	80	80	0		63	75	88	100	113
			75	5		67	80	93	107	
			70	10		71	86	100	114	
			65	15		77	92	108	123	
			60	20		83	100	117	133	
25–40	25	75	75	0		67	80	93	107	120
			70	5		71	86	100	114	
			65	10		77	92	108	123	
			60	15		83	100	117	133	
			55	20		91	109	127	145	
	30	70	70	0		71	86	100	114	129
			65	5		77	92	108	123	
			60	10		83	100	117	133	
			55	15		91	109	127	145	
			50	20		100	120	140	160	
	35	65	65	0		77	92	108	123	138
			60	5		83	100	117	133	
			55	10		91	109	127	145	

			50	15		100	120	140	160	
			45	20		111	133	156	178	
40–55	40	60	60	0	67	83	100	117	133	150
			55	5	73	91	109	127	145	
			50	10	80	100	120	140	160	
			45	15	89	111	133	156	178	
			40	20	100	125	150	175	200	
	45	55	55	0	73	91	109	127	145	164
			50	5	80	100	120	140	160	
			45	10	89	111	133	156	178	
			40	15	100	125	150	175	200	
			35	20	114	143	171	200	229	
	50	50	50	0	80	100	120	140	160	180
			45	5	89	111	133	156	178	
			40	10	100	125	150	175	200	
			35	15	114	143	171	200	229	
			30	20	133	167	200	233	267	
55–70	55	45	45	0	89	111	133	156		
			40	5	100	125	150	175		
			35	10	114	143	171	200		
			30	15	133	167	200	233		
			25	20	160	200	240	280		
	60	40	40	0	100	125	150	175		
			35	5	114	143	171	200		
			30	10	133	167	200	233		
			25	15	160	200	240	280		
			20	20	200	250	300	350		
	65	35	35	0	114	143	171	200		
			30	5	133	167	200	233		
			25	10	160	200	240	280		
			20	15	200	250	300	350		
			15	20	267	333	400	467		

Note: Red fill indicates red SDI zone for all diameters. Red zone group BA ranges from 125 BA for 8-inch QMD to 195 BA for 24-inch QMD.

* Average Group Basal Area (BA) to achieve overall BA.

Note: SDI "zones" are explained in the silviculture report.

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 D-2 demonstrates the toolbox process using cover and habitat cover types, a decision matrix and modifiers.

Figure D-2. 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% 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% 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.

Decision Matrix for the CNF and ASNF

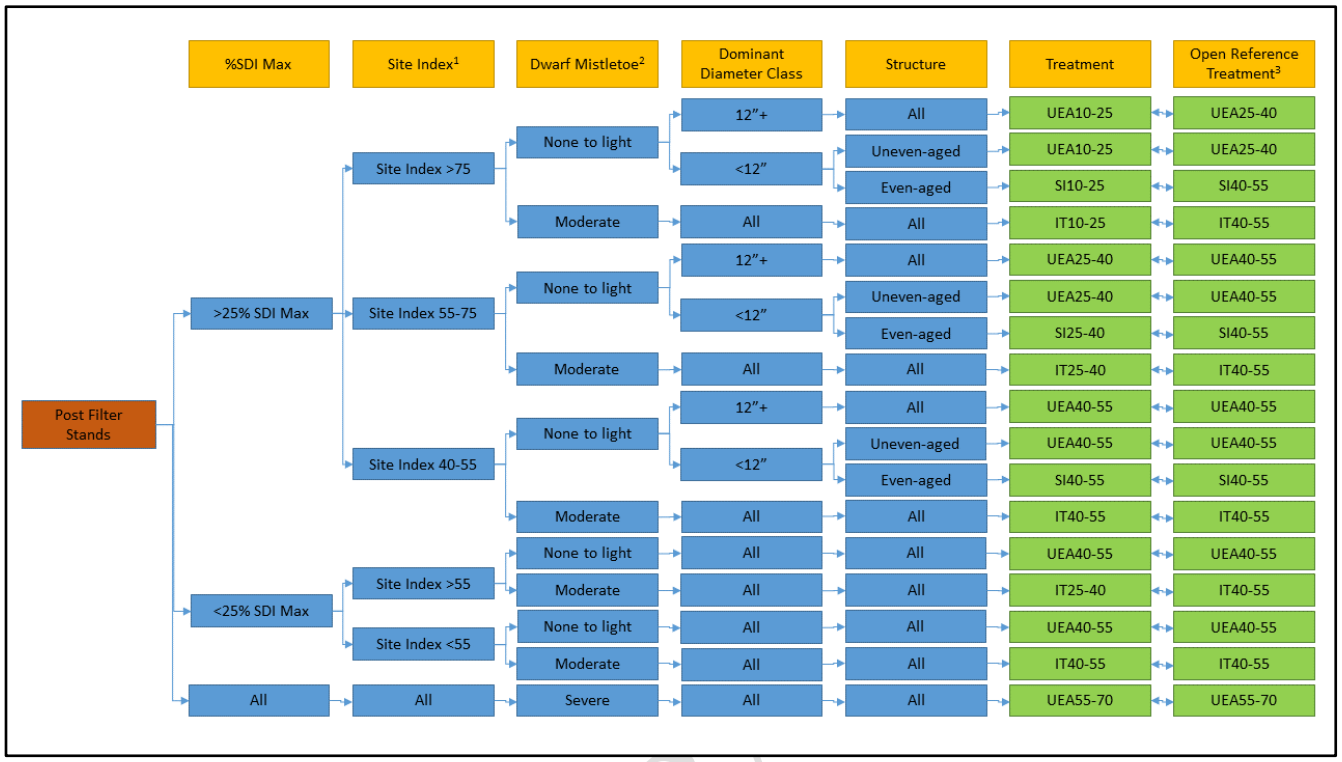


Figure D-3 Decision Matrix for the CNF and ASNF

[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.

Decision Matrix for the TNF

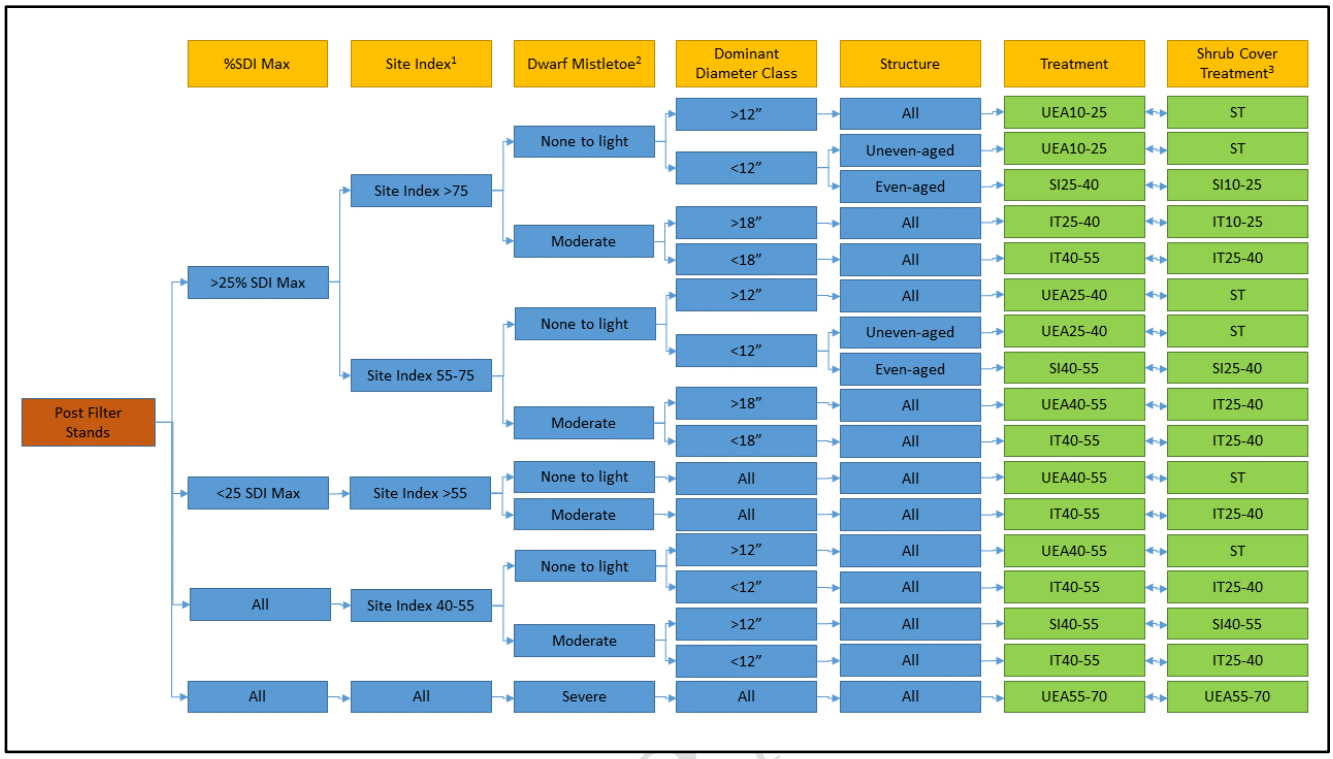


Figure D-4 Decision Matrix for the TNF

[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." Many of the stand delineations are 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 with Severe Dwarf Mistletoe Infection

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 resiliency and sustainability of ponderosa pine ecosystems within the Rim Country project area, it would be beneficial to develop restoration-based treatments that focus on reducing the abundance and intensity of dwarf mistletoe infection in stands.

In lightly (0-20% infection) and moderately (20-80% infection) infected stands, the restoration treatments in the modified proposed action will address dwarf mistletoe. In stands with light infections, project design features are included to allow for removal of infected trees as part of the uneven-aged group selection, single-tree selection, stand improvement, weed and release, and grassland 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 (20-50%). Towards the higher end of the moderate range (50-80% infection), mistletoe would remain as a component of the stand, while remaining basal area would be sufficient to prevent 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% or more of the target species in the stand are infected) would be treated with a UEA 55-70 treatment. This approach would maximize interspace and minimize residual basal area in order to retain the uninfected component of the stand, as well as control the spread of the dwarf mistletoe. The analysis of the UEA 55-70 treatments would allow for the application of a variety 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. 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, up to 70% 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% of trees is >15" diameter at breast height (DBH), and b) there is >50 square feet/acre of basal area (BA) in trees >16" 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% interspace (UEA 10-25), would be treated to 10% 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 D-5 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 Aquatics and Watershed Restoration Treatments

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 1. General decision-making process (Roca, et al. 2017)

rovide 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:

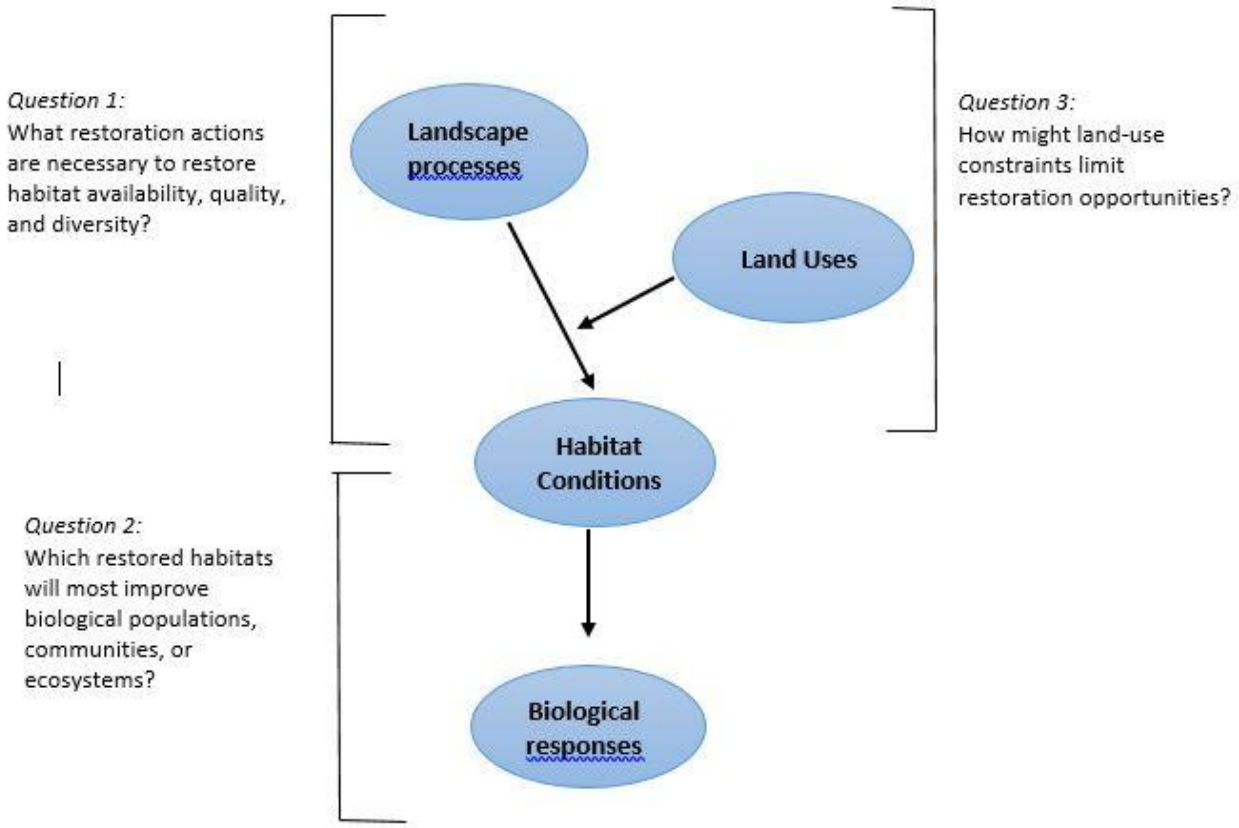
- Site reconnaissance: IDT, partners, stakeholders walk the potential project area to identify areas of concern and potential causes.
    - Landforms (valley type (transport vs. depositional reaches), relic channels, floodplains, very old trees, distinct reach breaks.
    - Occurrence of excess erosion 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:



6.

Figure 2. Diagram of conceptual linkages and questions to be addressed in assessments used to identify and prioritize restoration actions (Beechie et al. 2008).

7.

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 1. Considerations for prioritizing where and when treatments are implemented.

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.

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

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.

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.

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. Need for frequent maintenance that impacts aquatic and watershed resources.	Confinement of stream channel, degradation of wetlands, erosion into aquatic habitats, draining of wetlands, channel widening. Concentration of flows that were originally spread across a wide area via drainage capture by ditching or berms. Potential changes in peak flows. 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 Improving road or trail interactions and/or form and function of stream channels and floodplains. Improving road or trail interactions and/or form and function of stream channels and floodplains.

Road and Stream or Wetland Crossings:

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	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.	habitat. Undersize culverts may cause an increase in stream velocity causing scour and downcutting. 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.

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). • Most stream habitat is riffles or runs with little to no pool habitat and pool cover. Pool to riffle ratio is low. • Large woody debris and recruitment is not present to create instream habitat complexity and cover. • Spawning habitat for various species (i.e., clean gravel bars, clean sand) are lacking. • Stream substrate is compacted or becoming cemented (i.e., tightly packed). Stream substrate is covered in fine sediment above natural levels. 8.	Aquatic species need a variety of habitats to complete their life cycle. • Pool habitat is critical for resting habitat and thermal refugia for many species of fish • Lack of large woody debris contributes to poor stream habitat diversity. • Spawning habitat is essential to maintaining fish populations. • 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.	
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 and/or native riparian or aquatic vegetation
Stream is confined; it has been straightened or confined.		Improving form and function of stream channels and floodplains
Stream width and depth ratio is inappropriate for stream type.	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.	

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Hydrologic cycles are altered leading to reduced flood flows, or increased frequency of high flows (e.g., post fire flooding). Streams and associated floodplains are not dissipating flood water energy causing damage to streambanks. Meander pattern altered. Water quality is poor due to turbidity, sedimentation, or other factors other than temperature. Large woody debris is not present in channels or wetlands to reduce stream energy, provide cover, and create complex habitat. Riparian communities are not functioning at potential to support geomorphic and biotic needs of the aquatic community. • Leaf litter from riparian vegetation (allochthonous material) is lacking. • Existing riparian woody vegetation is lacking or out competed by conifers. • Floodplain vegetation has converted to upland species. • Riparian area is narrowing. • Soil compaction and accelerated soil erosion/sedimentation and bank instability.	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. 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. 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. 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. Lack of large woody debris recruitment to streams reduces roughness, cover, and habitat complexity. Riparian communities (both woody and herbaceous) are essential to the health of instream aquatic systems. • Organic matter (leaves) provide nutrients and food source for macroinvertebrates, prey species for fish. • Loss or decline of riparian vegetation, stream shade, and bank stability.	Improving form and function of stream channels and floodplains Improving form and function of stream channels and floodplains Improving form and function of stream channels and floodplains Improving form and function of stream channels and floodplains Improving form and function of stream channels and floodplains

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
	• Riparian vegetation aids in flood resilience, dissipation of flows (roughness), large woody debris and bank stability for stream systems. • 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. • 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 Improving form and function of stream channels and floodplains and/or improving native riparian vegetation

Flexible Toolbox: Tools described by general type of resource issues or concerns they may address.

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.

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.	Drying of spring outflow, reduced aquatic and riparian vegetation, reduced habitat, reduced soil function, spring not functioning properly

Hand methods for fixing springboxes, piping, or diversions to split spring flow.	
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

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 leadout 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.
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.

Tools	Resource Issues or Concerns Addressed
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.

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.

Tools	Resource Issues or Concerns Addressed
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 (might be too big of a word) - 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. The generalized circumstances table 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.

Generalized circumstances for when or where tools would or 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.	In low and medium gradient stream reaches where wetland, riparian, or aquatic plant species should be present.	In stream reaches where upland species are the dominant plant species. High gradient stream reaches.
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	
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	
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.

Treatments/Tools	Circumstances where treatments would apply	Circumstances where treatments would not apply
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.	
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 leadout 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.	
Armor downstream culvert outlets using mechanical roads treatments.	ML 2-4 roads where erosion is occurring from culverts.	
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.	
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.	
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
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	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches

Treatments/Tools	Circumstances where treatments would apply	Circumstances where treatments would not apply
from somewhere else, yarding over trees, helicopter wood, mechanical installation.		
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

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Appendix E – Monitoring and Adaptive Management Plan

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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.

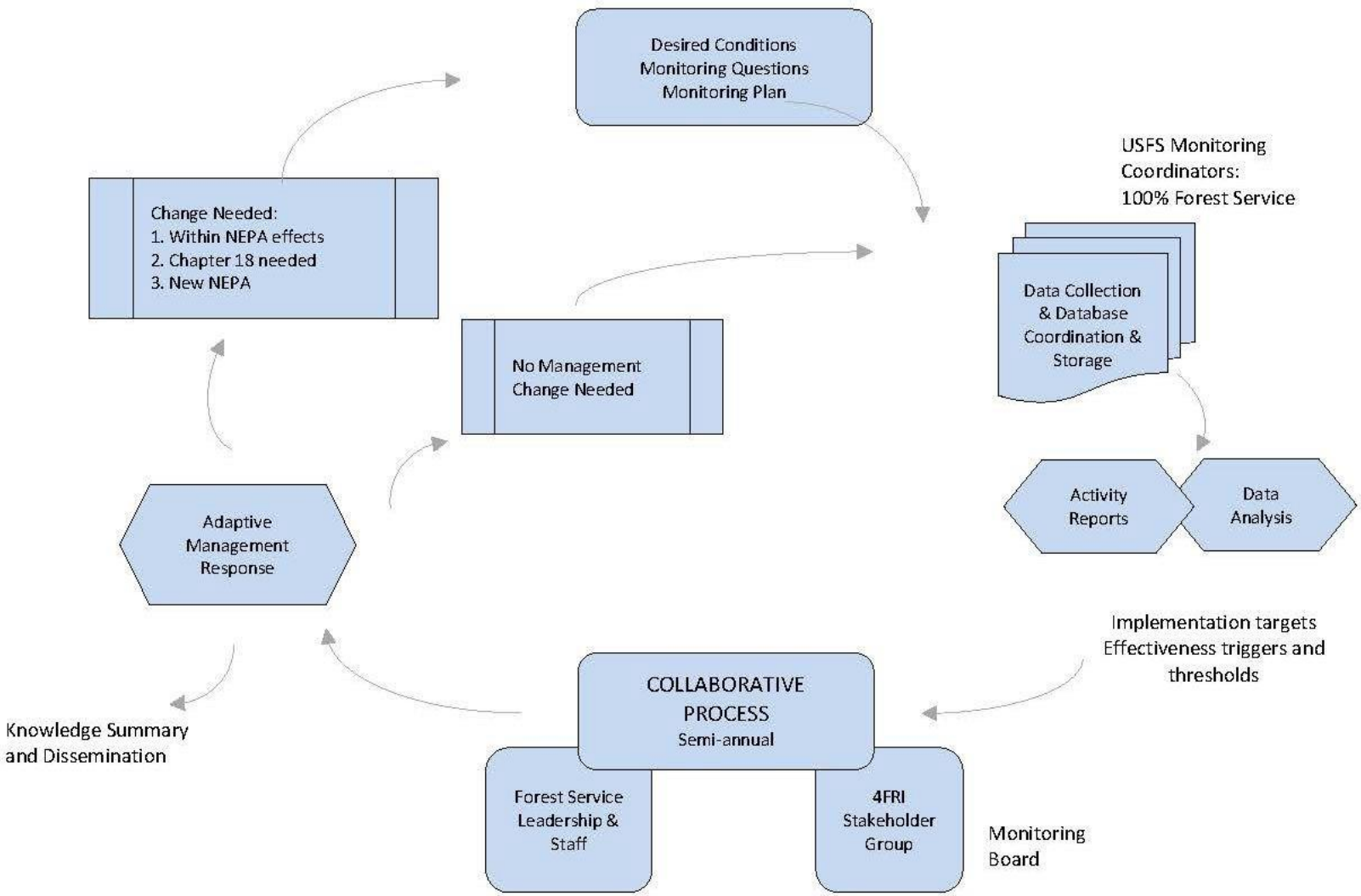

Figure E 1. 4FRI Adaptive Management Process

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 E-1. 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 E-2. Scale Terms Used by Stakeholders and USFS *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)*

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

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 E 3. 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

Monitoring Questions Derived from Desired Condition	Monitoring Indicator	Assessment Method	Frequency of Measurement
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
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		Contract inspection and	Ongoing and at post-

undesired impacts to cultural resources in accordance with design features, BMPs, and mitigation measures?	Compliance	specialist review	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

I. 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.

II. 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.

III. 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.

9.

Broad-Scale Assessment

Tier 1 Suggested Indicators: Canopy openness, patch size, patch configuration, patch diversity, and patch evenness.

10. 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.
11. 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.
12. Frequency: Immediately post-treatment (either mechanical or prescribed fire) or as soon as appropriate aerial photography becomes available; every 3-10 years thereafter.
13. Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available. TBD
14. Adaptive Management: Assess potential sources of deviation, including prescription and implementation; increase monitoring efforts in future task orders.

15. 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).

16. Assessment: Categorical maps (e.g., groups, openings, etc.) based on satellite imagery and/or aerial photography
17. Frequency: Annually to track broad-scale change or when suitable imagery becomes available.
18. Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
19. 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.

20. 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).
21. Assessment: Categorical maps (e.g., groups, openings, etc.) based on satellite imagery and/or aerial photography
22. Frequency: Annually to track broad-scale change or when suitable imagery becomes available.
23. Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
24. 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.

25. 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).

26. Assessment: Categorical maps (e.g., groups, openings, etc.) based on satellite imagery and/or aerial photography
27. Frequency: Annually to track broad-scale change or when suitable imagery becomes available.
28. Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
29. 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.

30. 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
31. Frequency: Pretreatment, post-treatment, annually during pre- and post-monsoon water stress periods
32. Threshold/Trigger: Trends of decreasing soil moisture (after adjusting for climatic variability) in stands with similar treatment types and/or physiographic characteristics.
33. 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

I. 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.

II. 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.

34.

III. Conservation and Maintenance of Soil, Water, and Air Resources:

a. 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:

35. Groundwater Dependent Ecosystems Protocol (USDA FS 2011) or similar appropriate protocols
36. Spring discharge measurements
37. Frequency: Pre- and post-treatment, every two years following treatment for the first 6 years after treatment, then every 5 years.

- ***Threshold/Trigger:***

38. No net increase in facultative and obligative wetland species at springs or wet meadows targeted for both forest and spring restoration.
39. Decrease in spring discharge (adjusted for climate variation) following treatments.
40. 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.

41. Assessment: Field collected quadrats.

- ***Frequency:***

42. Within 5 years of treatment for cover
43. Within 5 years of treatment for bare soil
44. Within 10 years of treatment for seedlings

- ***Threshold/Trigger:***

45. Within 5 years of mechanical treatment, the cover should increase 20 percent +/- 5 percent (15-25 percent) above controls (Laughlin et al 2011).
46. Within 5 years of treatment (mechanical and/or fire), bare soil should comprise less than 20 percent of area affected by treatment.
47. 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:***

48. 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).
49. If bare soil exceeds 20 percent of area within plots, re-evaluate restoration treatment for modification
50. 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.

51. Assessment: Percent cover of native and non-native species based on field sampling.
52. Frequency: Pre- and immediately post-disturbance (i.e., mechanical thinning, prescribed fire, and wildfire); every 5 years thereafter.

- ***Thresholds/Triggers:***

53. Identification of new or existing "watch list" or "high risk" invasive species populations.
54. Identification of new or existing "medium risk" invasive species populations.
55. Identification of areas at high risk of cheatgrass introduction or spread.

- ***Adaptive Management:***

56. 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.

57. 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).

58. Assessment: Rapid assessment conducted while collecting diameter distribution data on plots (or use of aerial imagery once techniques become available)or other evidence
59. Frequency: Immediately post-treatment (either mechanical or prescribed fire); every 5 years thereafte
60. Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
61. 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

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62. [1] 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.

63. Assessment: Field surveys of presence & absence at both treated and untreated sites
64. Frequency: Immediately post-treatment and every 2 years thereafter
65. Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
66. 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.

67. Assessment: Field sampling of communities of interest (e.g., songbirds)
68. Frequency: Immediately post-treatment (either mechanical or prescribed fire); every 3-5 years thereafter.
69. Threshold/Trigger: No threshold has been identified for this indicator. It will be developed as new information becomes available.
70. 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:***

71. Mexican spotted owl monitored as directed in the U.S. Fish and Wildlife Service biological opinion.
72. Northern goshawk occupancy monitored using USFS protocols (USDA FS 2006) or as appropriate based on approved methods.
73. Frequency: In accordance with the aforementioned protocols.

- ***Thresholds/Triggers:***

74. As directed in the Mexican spotted owl section of the U.S. Fish and Wildlife Service biological opinion
75. If northern goshawk occupancy trends show a decline over a 5 to 10 year average at treatment and 4FRI landscape scales.
76.

- ***Adaptive Management:***

77. 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.
78. 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.

79. Assessment: Field sampling in conjunction with remote sensing
80. Frequency: Annual interpretations of new satellite imagery
81. Thresholds/Triggers: Any non-zero decline over a 5-year period within the functional groups listed below.

- ***Adaptive Management:***

82. 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.

- 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.
- Pine-Sage Species: Alter timing of treatment to reduce impacts on sage; Delay post- treatment burning to allow sage recover
- 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.

83. Assessment: Field sampling in conjunction with remote sensing
84. Frequency: Immediately post-treatment; five years post-treatment, ten years post-treatment
85. Thresholds/Triggers:
86. Restriction in bear/fox movement after treatment (reduced connectivity between patches)
87. No increase in pronghorn movement after treatment
88. Adaptive Management:
89. Bear/Fox: Evaluate implementing one of the following changes:
90. Increase group size.
91. Decrease treatment intensity within known pathways
92. Pronghorn: Evaluate implementing one of the following changes:
93. Increase opening sizes.
94. Increase treatment intensity within known pathways

Biophysical Monitoring for Function (or Process)

Relevant Desired Conditions

95. Conservation of Biological Diversity:
96. Ponderosa pine ecosystems provide the necessary … processes…that contributes to the diversity of native plant and animal species…
97. 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.
98. There is low potential for unnaturally severe fire to spread at broad scales.
99. Wherever practicable, natural fire regimes regulate forest structure and composition.
100. Planned and unplanned fires support diverse native understory communities and their associated biodiversity.
101. Ecological Resilience:
102. Ponderosa pine ecosystems in the 4FRI are capable of adapting to or persisting with climate change without rapid, large scale type shifts.
103. Low intensity frequent fire operates as the primary natural process maintaining forest structure and function.
104. 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]
105. Forest insects and pathogens occur and operate at endemic levels.
106. Ponderosa pine ecosystems in the 4FRI are capable of regeneration and recovery following natural disturbance (e.g., fire, outbreaks of insects and pathogens).
107. A majority of the ponderosa pine ecosystems supports frequent, low-intensity fire.
108. 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.
109. Natural disturbance processes (e.g., fire, endemic pests, and pathogens) are within the natural range of variability.
110. 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.
111. Restoration results in forests that are trending toward natural variability, self- regulating, and positioned to adapt to climate change without large, rapid type shifts.
112. Conservation of Soil, Water, and Air Resources:
113. 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).

a. 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]

b. Rare and ecologically valuable springs and wet meadows are protected and enhanced through appropriate restoration treatments where needed.

c. 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.

d. Restored ponderosa pine ecosystems accommodate natural and other fires without uncharacteristic impacts to soil productivity and or watershed resources.

e. 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).

f. Hydrologic processes are re-established to restore springs and wet meadow ecosystems.

g. 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.

h. 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.

114. Assessment: Field sampling within treated sites
115. Frequency: Immediately post-treatment and every five years thereafter
116. Thresholds/Triggers: No threshold has been identified for this indicator. It will be developed as new information becomes available.
117. 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.

118. Assessment: Field sampling within treated sites
119. Frequency: TBD
120. Thresholds/Triggers: Decrease in channel condition and aquatic habitat indices after accounting for non-treatment factors such as climate variability.
121. 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.

122. Assessment: Field sampling within treated sites
123. Frequency: Short term (1-5 year) and long term (10-30 year)
124. Thresholds/Triggers: Significant decreases in baseflow and wetted areas or significant increases in peak flows downstream of treatment areas
125. 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.

126. Assessment: Remote sensing information
127. Frequency: Immediately post-treatment and every five years thereafter

- ***Thresholds/Triggers:***

128. No threshold has been identified for this indicator. It will be developed as new information becomes available.
129. 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.

130. Assessment: Monitoring Trends in Burn Severity data
131. Frequency: Available annually for all fires larger than 1000 acres

- ***Thresholds/Triggers:***

132. Patch size of adjacent pixels expressing stand replacing fires is greater than 50 acres after 5 years
133. Patch size of adjacent pixels expressing stand replacing fires is greater than 10 acres after 10 years
134. 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.

135. Assessment: Field sampling within treated sites
136. Frequency: TBD
137. Thresholds/Triggers: Changes in subsurface water, spring/seep flow, riparian soil moisture after accounting for non-treatment factors such as climate variability
138. 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:***

139. Remotely sensed data, TESU maps, field plots
140. Forest Disturbance Monitoring Protocol 2009 (WO82A and WO82B)
141. Bulk density and infiltration capacity
142. Frequency: Immediately post -treatment and every 5 years thereafter, with more frequent follow -up in heavily impacted places to assess recovery

- ***Thresholds/Triggers:***

143. Soil disturbance is over 15 percent of the treated area
144. Increasing bulk density trend
145. Decreasing infiltration rate trend
146. 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 E 4 Suggested Indicators: Forest Service and multiparty monitoring needed for adaptive management [2]

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

[2] Fine Scale = Group, Site and Stand Scale; Broad Scale =Sub-watershed, Watershed, Treatment area, Subunit, Project Area, Landscape

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 characteristics; 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

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

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
9	1	Composition	Understory vegetation composition and abundance are consistent with the natural range of variability.	*Diversity and Abundance (understory communities) Regeneration*	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
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

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
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
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

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
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

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?)

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
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
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)
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

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
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, evapotranspiration 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
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)

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
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)
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/run off response, flood behavior, (soil moisture?), etc.	Collect hydrograph through discharge gages; Precipitation gages/weather stations; LiDAR/ SNOTEL (for snowpack & configuration)	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	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.	

						(Some past and current data collected by: USFS, SRP, USGS, NRCS-SNOTEL gages)		baseflow and wetted areas 2. Significant Increases in peak flows downstream of treatment areas		
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.	
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	*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.	

					abundance, wet extent and persistence, water temperature, sediment loads, etc.					
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.	
38		Composition	Watersheds, riparian, and aquatic ecosystems have functional soil, vegetation, morphology, and flow regimes, consistent with site and watershed	Native obligate animal species	Draw from existing protocol. Possible metrics include species presence,	Standard abundance protocols by taxa.	Fine and Broad Scale	Decrease in species presence, diversity, or population size after accounting	Evaluate source of decline and address through changes in actions. Consider adding mitigation measures or structural improvements.	

			potential. These systems provide diverse habitats for an array of native obligate and facultative plants and animal species.		species diversity, population size, recruitment, survival, demography, etc.			for non-treatment factors such as climate variability.		
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.	

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.

Table E 5. Four Forest Restoration Initiative socioeconomic monitoring framework for social systems

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
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.						
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).	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 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.	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 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).	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 collaboratively-based forest restoration.
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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
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.						
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	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.

			logs.			

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
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.						
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.						
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	5 years	USFS by Forests (Greater Flagstaff Forest Partnership 2010).	Rural communities' risk from high-severity fire are not decreasing.

			years pre-4FRI implementation.			

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
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.	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.	Rural community residents' perceived risk of high-severity fire is not decreasing.
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	1. Headwaters Institute. 2. State, private, tribal, municipal grant/project reports. 3. USFS by Forests. 4. 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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
V. GOAL: Social values and recreational opportunities are protected and/or enhanced through forest restoration activities.						
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.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area. 4. 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.	1. Focus group, interview and survey results. 2. 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.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area. 4. 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.	1. Focus group, interview and survey results. 2. Headwaters Institute.	The public perceives that aesthetic values are not enhanced as forest restoration activities are occurring.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
VI. GOAL: Rural communities play an active part in reducing fire risk by implementing FireWise actions and creating defensible space around their property.						
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.						
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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
The public is knowledgeable/understands the 4FRI Collaborative'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 5 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.						
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.

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 4FRI Collaborative.
The public is supportive of the USFS's involvement with the 4FRI Project.	Is there public support/acceptance for the USFS's involvement with the 4FRI Project?	Public support for the USFS's involvement 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 supportive of the USFS's involvement with the 4FRI Project.
IX. GOAL: The general public is aware, knowledgeable and supportive of 4FRI implemented treatments within the analysis area.						
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.	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 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.	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 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.						
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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
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.	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 educational and outreach programs.	Annual	1. Focus group, interview and survey results. 2. USFS by forest. 3. 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.
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.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area. 4. Survey local youth group coordinators. 5. 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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
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/minority populations 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. 4. Oversample low income/minority populations. 5. 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.
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.	1. Focus groups with community members. 2. Interviews with land managers/key decision-makers. 3. Telephone survey with residents in study area. 4. Oversample low income/minority populations. 5. 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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
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.						
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.).

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF (Undesirable Conditions)
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.	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.	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.

Table E 6. 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)
I. GOAL: The byproducts of mechanical forest restoration offset the costs of treatment implementation.						
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 homebase 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 a 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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
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.						
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, 2. Restaurant, 3. Groceries, 4. Gas/Oil, 5. Other transportation, 6. Activities, 7. Admissions/ Fees, 8. 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). 2. USFWS National Survey of Fishing, Wildlife, Hunting, & Wildlife Assoc. Recreation (USDI FWS 2006). 3. 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/: a. Transport, b. Treating, c. Developing new/existing water supplies, d. Capture, e. 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). a. Operation & maintenance expenses b. Taxes/transfers c. Capital additions/replacement d. Debt services (principle/interest) e. Allocated indirect costs f. 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 2. Beaver Creek Watershed Study 3. Castle Creek Watershed Study (Arizona Forest Resource Task Group 2010). 4. Watershed Conditions Framework (USFS). Q4/Q5/Q6: 1. City of Flagstaff Utilities (Water) Dept. 2. Long-term Financial Plan & Rate & Fee Study (City of Flagstaff 2010). 3. 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?	1. Wetland & Stream Ecosystems Compensation. 2. Endangered Species Compensation. 3. 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.

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. 2. Headwaters Economics (population/housing). 3. USFS budget staff (D. Jaworski Personal Communication 2011) 4. 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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
III. GOAL: Rural communities receive direct and indirect economic benefits and ecosystem services as a result of forest restoration and resilient forests.						
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	1. Contractor reporting form/survey. 2. Headwaters Institute (EPS-HDT Socioeconomic profiles). 3. 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	1. AZ Dept. of Revenue. 2. City reports. 3. County reports. 4. US Census Bureau. 5. U.S. Department of Labor, Bureau of Labor Statistics. 6. 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. 2. Capital expenditures of project materials. 3. Subcontract thinning services (Sitko and Hurteau 2010). Q2: 1. Sales/property taxes generated by employees (direct & indirect) (by county). 2. School revenues generated by avg. family. 3. 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	1. Contractor reporting form/survey. 2. U.S. Bureau of Economic Analysis (Sitko and Hurteau 2010). 3. 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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Forest restoration activities will increase recreation/tourism in rural communities in Arizona.	Q1: Has recreation increased as forest restoration activities have occurred? Q2: Has tourism increased as forest restoration activities have occurred? Q3: Has tourism related jobs/housing increased as forest restoration activities have occurred?	Q1: 1. AZG&F license sales by County. 2. Visitor days Q2: 1. Lodging 2. Restaurant 3. Groceries 4. Gas/Oil 5. Other transportation 6. Activities 7. Admissions/Fees 8. Souvenirs/Other expenditures (USDA FS 2005). 9. Tourism tax (e.g. Flagstaff Bed, Board & Booze (BBB) tax). Q3: 1. Travel and tourism jobs (seasonal employment). 2. Housing related to tourism jobs.	Economic Impact Analysis: Track flow of economic activity associated with tourism.	5 years (USDA FS 2011; USDI FWS 2006).	1. National Visitor Use Monitoring Program (USDA FS 2005). 2. AZG&F The Economic Importance of Fishing and Hunting (utilizes IMPLAN input/output model) (Silberman 2002). 3. USFWS National Survey of Fishing, Wildlife, Hunting, & Wildlife Assoc. Recreation (USDI FWS 2006). 4. Sales Tax by City (if applicable, Tourism tax). 5. AZG&F 6. Headwaters Institute (EPS-HDT SE profiles). 7. Visitor surveys.	Q1: Recreation has decreased as forest restoration activities have occurred. Q2: Tourism has decreased as forest restoration activities have occurred. Q3: Tourism related jobs/housing has decreased as forest restoration activities have occurred.
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.	1. Contracts: federal databases 2. USAspending.gov 3. 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).

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
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.						
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	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.

	reduced 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.						
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	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	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

acres per year.		infrastructure relative to harvesting activities.				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.						
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 &	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.	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	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?		treatment costs (planning, prep, admin & operational costs).		Stakeholder Group 2010c). 2. Contractor surveys.	operational) costs.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
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.
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?	1. Frequency of wildfires. 2. 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?	1. Frequency of managed fires. 2. 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?	1. Frequency of prescribed fires. 2. 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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
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.
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.						
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?	1. Sales ($ value) of wood products. 2. 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?	1. Number of local businesses processing small diameter wood products. 2. Number of non-local businesses processing small diameter wood products. 3. Amount of wood (volume) products processed locally. 4. Amount of wood (volume) products processed non-locally (Greater Flagstaff Forest Partnership 2005).	1. Compare # of local vs. non-local businesses (percent each). 2. Compare local vs. non-local business volume of wood product production (percent each).	5 years	1. Contractor surveys. 2. Contracts, federal databases a. USAspending.gov b. 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.

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	1. Contractor surveys. 2. Contracts, federal databases a. USAspending.gov b. 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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
Investment, research and development in utilization of wood biomass are increasing.	Is investment, research and development in utilization of wood biomass increasing?	1. Number of forest product industries involved in market research for small diameter wood uses. 2. Amount invested by businesses for development and research. 3. Type and amount of market analysis. 4. 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	1. Contractor/ business surveys. 2. Headwaters Institute	Investment, research and development in utilization of small diameter trees is not increasing.
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.

Objective	Monitoring Question	Monitoring Indicator(s) (Metric)	Assessment	Frequency of Assessment	Data Source	Threshold IF… (Undesirable Conditions)
GOAL: There is a predictable wood supply throughout the life of the 4FRI project.						
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:

1. Composition. The biological elements within the different levels of biological organization, from genes and species to communities and ecosystems.
2. 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.
3. 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.
4. 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:

1. provisioning services, such as clean air and fresh water, energy, food, fuel, forage, wood products or fiber, and minerals;
2. 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;
3. supporting services, such as pollination, seed dispersal, soil formation, and nutrient cycling; and
4. cultural services, such as educational, aesthetic, spiritual, and cultural heritage values, recreational experiences, and tourism opportunities (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, 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:

1. 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)
2. Fire Regime II – 0 to 35 year frequency and high severity (greater than 75 percent of dominant overstory vegetation replaced)
3. Fire Regime III – 35 to 100+ year frequency and mixed severity
4. Fire Regime IV – 35 to 100+ year frequency and high severity
5. 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 decisionmaking 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.

Intermediate thinning –

1. In Ponderosa Pine, Ponderosa Pine-Gambel Oak, and Ponderosa Pine-Evergreen Oak cover types:

   Thin tree groups to 70-90 square feet of basal area. Thin areas with low to moderate infections of dwarf mistletoe to improve growth and vigor. Retain the best dominant and co-dominant trees with the least amount of mistletoe in the lower crown. Locate interspaces in currently non-stocked areas and lacking pre-settlement evidence. Intent is to mitigate negative effects of dwarf mistletoe.

2. In Dry Mixed Conifer cover type:

   Thin tree groups to 40-100 square feet of basal area. Thin areas with low to moderate infections of dwarf mistletoe to improve growth and vigor. Retain the best dominant and co-dominant trees with the least amount of mistletoe in the lower crown. Locate interspaces in currently non-stocked areas and lacking pre-settlement evidence. Intent is to mitigate negative effects of dwarf mistletoe.

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:

1. reduce the impacts of restoration activities to the productivity of soils and the functionality of aquatic ecosystems;
2. protect stream water quality and temperature;
3. minimize erosion and protect drainage system integrity on road ways;
4. prevent the invasion or spread of noxious weeds on or originating from National Forest System lands; and
5. 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:

1. 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:

1. 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:

2. 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.
3. 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.
4. 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. Describes an area within or adjacent to private and public property where mitigation actions can prevent damage or loss from wildfire (National Wildfire Coordinating Group 2018).

Woody debris – The dead and downed material on the forest floor consisting of fallen tree trunks and branches.

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