Appendix D – Alternatives 2 and 3 Implementation Plan

The environmental impact statement (EIS) for the Rim Country Project describes the purpose and need, alternatives, and the potential maximum effects from the activities in those alternatives. This implementation plan is designed to be integral to the selected alternative and record of decision (ROD). The process described in this appendix describes the link from the EIS to the project-specific work without the need for additional NEPA analysis. It should be considered in conjunction with Appendix C that provides the design features, best management practices, and mitigation and conservation measures. Tables D-1 contain checklists designed to support implementation compliance.

Essentially, if the quantity of treatments in Tables D-1 are within the bounds of the treatments analyzed in Chapter 3 of the EIS and the specialist reports, the program of work is considered to be consistent with that effects analysis. Tables D-1 shows the compliance evaluation and documentation requirements to demonstrate this compliance. ***Sections A through E provide direction that would be used by implementers to ensure that implementation meets the purpose and need and forest plan standards and guidelines. Silvicultural prescriptions will document the stand level desired conditions and objectives which is consistent with this analysis, incorporate design features (Appendix C), and provide the course of action needed to move toward the project desired conditions.

Description of Plan Components

Section A Implementation Checklist: The checklist is designed to track compliance with the NEPA decision and ensure activities are consistent and compliant with the analysis and decision (correct location, appropriate number of acres by treatment type). The checklist is designed to be used by the implementation team leader. Sources of data to populate row three are found in Chapter 3 and the specialists reports.

Section B Management Direction, Desired Conditions and Treatment Design: This section includes existing forest plan management direction, desired conditions, and treatment-specific silvicultural design. It is designed to be used by the district implementation team.

Section C Old Tree Implementation Plan: This section provides the Old Tree Implementation Plan, including old tree descriptions, illustrations, and guidance.

Section D Large Tree Implementation Plan: Section D includes guidance and the Large Tree Implementation Plan. This guidance is designed to be reviewed by the district implementation team and silviculturist during the development of site-specific prescriptions and during implementation.

Section E Density Management and the Relationship between Treatment Intensity, Tree Group Density, and Overall Average Density

Section F Flexible Toolbox Approach: Two flexible toolbox approaches being used in the Rim Country Project. Mechanical Treatments Flexible Toolbox Approach uses decision matrices based on vegetation or stand conditions for flexibility in prescribed treatments. It is designed to be used during the planning process and implementation. The Flexible Toolbox Approach for Aquatics and Watershed Restoration Activities uses a different type of decision matrix for implementation of and prioritizing restoration projects.

Section A – Implementation Checklist

Table 107. Implementation Plan Checklist

Implementation Plan Checklist	Yes	No	Not Applicable
Is the treatment on a line officer approved 5 year plan?			
For burning, is the treatment burn plan completed and signed? • Objectives have been developed in interdisciplinary manner and are clearly delineated? • Objectives are consistent with management direction? • Are burn plans reviewed and signed off by district interdisciplinary team? • All burning and burn plan check lists completed?			
For timber operations, are timber sale prep checklist, timber sale folder check list, timber sale package checklist completed? • Are timber sales reviewed through a plan-in-hand process and signed off by district interdisciplinary team?			
Are treatment silviculture prescriptions completed and signed? • Objectives have been developed in interdisciplinary manner and are clearly delineated? • Objectives are consistent with management direction? • Have silviculturist signed off on desired forest conditions in burn plans?			
Is treatment consistent with design features?			
Are wildlife and botanical surveys, if necessary, complete? In threatened and endangered species habitat, are the actions consistent with the FWS biological opinion?			
Are heritage surveys complete? Is the action consistent with the letter of concurrence from AZ SHPO?			
Are rights-of-way and land line locations in place (if applicable)?			
Are treatments consistent with desired conditions and implantation strategies in the Implementation Plan?			
Has implementation monitoring and adaptive management strategies been documented and used/planned for higher quality outcome?			
Are Road Packages completed for timber sales?			

Section B – Management Direction, Desired Conditions, and Treatment Design

Mexican Spotted Owl Habitat (MSO) Habitat

Protected Activity Center (PAC)

Vegetation Management Direction: Retain key forest species such as Gambel oak; retain key habitat components such as snags and large down logs; generally harvest conifers less than 18 inches in diameter only within those PACs treated to abate fire risk and implement burn only treatments in 100-acre nest cores as described in the MSO recovery plan.

Desired Conditions: Table C.2 (USDI 2012) lists guidance for minimum desired structural elements within PACs. Other key habitat components includes snags greater than 18 inches, down logs greater than 12 inch midpoint diameter, hardwoods, and an understory vegetation layer that includes shrubs and herbaceous species.

Strive for a diversity of patch sizes with minimum contiguous patch size of 2.5 ac with larger patches near activity center; mix of sizes towards periphery. Forest type may dictate patch size (i.e., mixed conifer forests have larger and fewer patches than pine-oak forest). Strive for between patch heterogeneity. Horizontal and vertical habitat heterogeneity within patches, including tree species composition. Patches are contiguous and consist of trees of all sizes, unevenly spaced, with interlocking crowns and high canopy cover. Tree species diversity, especially with a mixture of hardwoods and shade-tolerant species. Diverse composition of vigorous native herbaceous and shrub species.

Opening sizes between 0.1 - 2.5 ac. Openings within a forest are different than natural meadows. Small canopy gaps within forested patches provide for prey habitat diversity. Openings should be small in nest/roost patches, may be larger in rest of PAC. Minimum canopy cover of 40 percent in pine-oak and 60 percent in mixed conifer. Measure canopy cover within stands.

Diversity of tree sizes with goal of having trees ≥16” DBH contributing ≥50 percent of the stand BA.

PAC Mechanical Thin and Burn Treatment Design

Each PAC has 100-acre burn only area, called the core, around the known nest or roost sites.

Outside the 100-acre core burn only area, trees may be thinned and/or prescribed burns may be used to protect habitat, treat fuels and mitigate fuel hazards where feasible.

Prescribed Burning Objectives and Tactics

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired MSO PAC habitat forest structure, tree densities, snag densities, and course woody debris levels.

- Course woody debris would be managed for 3 to 10 tons per acre, and downed logs greater than 12 inch midpoint diameter would be managed for three per acre ≥12 inches. Averages are at the landscape scale;
- 100-acre burn only area around the known nest or roost sites managed for low intensity fire and low forest severity to forest canopy

- Outside the 100-acre core burn only area, treat fuels and mitigate fuel hazards with low intensity fire and moderate to low severity to forest canopy;
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;
- Prescribed burning includes following concurrence and consultation advice from FWS;

Mechanical Thinning Objectives and Tactics

Use mechanize equipment to reduce and remove hazardous live and dead fuel loading;

Design tree thinning treatments to meet desired conditions. Retain and promote large hardwoods such as Gambel oak; other species may be felled to meet desired conditions;

Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff;

Snags greater than 18 inches would be managed for two per acre in ponderosa pine and three per acre in mixed conifer. Averages are at the landscape scale;

Recovery Nesting/Roosting Habitat

Vegetation Management Direction: MSO recovery habitat is defined by the recovery plan and established through FWS consultation. Decision of Rim Country EIS determines where MSO recovery habitat stratification in the project area. Two types of forested recovery nesting/roosting habitat exist it the project: mixed-conifer and pine-oak. 25 percent of mixed-conifer recovery habitat is managed for recovery nesting/roosting habitat. 10 percent of pine-oak recovery habitat is managed for recovery nesting/roosting habitat. Where possible, retain key forest species such as oak, snags and large down logs. Refrain from falling trees 24.1 inches DBH and greater.

Desired Conditions: Table C.2 & C.3 (USDI 2012) lists guidance for minimum desired structural elements within recovery nesting/roosting habitat. Other key habitat components includes snags greater than 18 inches, down logs >12- inch midpoint diameter, hardwoods, and an understory vegetation layer that includes shrubs and herbaceous species. The following represents additional desired conditions from Table C.3 (USDI 2012):

- Basal area for pine-oak recovery nesting/roosting habitat at least 110 ft2 basal area per acre;
- Basal area for mixed-conifer recovery nesting/roosting habitat at least 120 ft2 basal area per acre;
- Basal area by the following size classes: at least 30 percent of the basal area in trees 12-18 in DBH and at least 30 percent of the basal area in trees 18 in DBH or greater;
- Density of 12 trees per acre of trees greater than or equal to 18 inches DBH;

Recovery Nesting/Roosting Habitat Mechanical Thin and Burn Treatment Design

Prescribed Burning Objectives and Tactics:

Prescribed burns will be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired recovery nesting/roosting habitat forest structure, tree densities, snag densities, and course woody debris levels.

- Course woody debris would be managed for 3-10 tons per acre, and downed logs greater than 12 inch midpoint diameter would be managed for three per acre ≥12 inches. Averages are at the landscape scale;
- Prescribed burning management to meet desired condition with low intensity and low to moderate severity to forest canopy;
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;
- Prescribed burning includes following concurrence and consultation advice from FWS;

Mechanical Thinning Objectives and Tactics:

- Use mechanized equipment to reduce and remove hazardous live and dead fuel loading;
- Design tree thinning treatments to meet desired conditions. Retain Gambel oak; remaining species may be felled to meet desired conditions;
- Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff;
- Where possible, manage for the sustainability of large oaks by removing ladder fuels and overtopping trees;
- Snags greater than 18 inches would be managed for two per acre in ponderosa pine and three per acre in mixed conifer. Averages are at the landscape scale;
- Retain trees greater than 24 inches DBH;
- Stands of recovery nesting/roosting habitat that are currently simultaneously meeting conditions in Table C3 of the MSO recovery plan should not go below identified levels.

Recovery Foraging/Non-breeding Habitat

Vegetation Management Direction: MSO recovery habitat is defined by the recovery plan and established through FWS consultation. Decision of Rim Country EIS determines where MSO recovery habitat stratification in the project area. Two types of forested recovery foraging/non-breeding habitat exist it the project: mixed-conifer and pine-oak. These areas are mixed-conifer and pine-oak stands that are outside of PACs and recovery nesting/roosting habitat. MSO habitat management overrides other habitat management such as with goshawk habitat overlap. Manage to desired conditions appendix C in the revised MSO recovery plan (USDI 2012).

Desired Conditions: Sustainable uneven aged stand structure. Improved forest health by an immediate reduction of risk of bark beetle attacks and/or reduction of dwarf mistletoe stand severity and landscape intensity to historical levels. Sustainable horizontal and vertical stand structure diversity. Sustainable amount of key habitat components such as snags greater than 18 inches, down logs greater than 12-inch midpoint diameter, shade, old age trees and hardwoods.

Recovery Foraging/Non-breeding Habitat Mechanical Thin and Burn Treatment Design

Prescriptions should strive to maintain conditions for key habitat components (snags, logs, shade, and old trees) while achieving management objectives such as fuels reduction and ecosystem sustainability.

Prescribed Burning Objectives and Tactics:

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired recovery foraging/non-breeding habitat forest structure, tree densities, snag densities, and course woody debris levels.

- Course woody debris would be managed for 3 to 10 tons per acre, and downed logs greater than 12 inch midpoint diameter would be managed for three per acre ≥12 inches. Averages are at the landscape scale;
- Prescribed burning management for low to moderate intensity fire with low to moderate severity to forest canopy;
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;
- Prescribed burning includes following concurrence and consultation advice from FWS;

Mechanical Thinning Objectives and Tactics:

Design tree thinning treatments to meet desired conditions. Retain Gambel oak; other tree species may be felled to meet desired conditions;

Silviculture objectives include improve and maintain forest health conditions, maintain and increase tree species diversity, improve understory grass/forb diversity, create and maintain a sustainable uneven aged forest environment and reduce tree densities to facilitate low fire intensities that could occur during severe fire weather conditions.

Use mechanize equipment to reduce and remove hazardous live and dead fuel loading;

Manage for tree groups of dominate age classes stratified by young, mid-aged, and old-aged tree groups. Retain groups of dominate and codominant trees. Where age or size class diversity is not present, management activities should strive to encourage horizontal and vertical diversity.

In general, manage for tree groups with grassy interspaces or random tree spacing. Site level determination based on soil types, habitat type and regeneration rates shall confirm the proper determination to create or not create grassy interspaces. Stand level target basal area of 40 to 70 ft2 BA/acre in recovery foraging/non-breeding habitat for ecosystem resiliency; pine-oak stands could have group basal areas represent 40 to 110 ft2 BA/acre; mixed conifer stands could have group basal areas represent 40 to 135 ft2 BA/acre. Gambel oak, juniper, and pinyon species greater than 5-inch DRC may be considered as residual trees in the target group spacing and stocking. The objective is to manage for a sustainable range of density and structural characteristics.

Silviculture cutting systems include uneven aged thinning, intermediate thinning or stand improvement thinning. Soil types, current condition and historical reference conditions guide the type of silviculture cutting system.

In moderate and heavy dwarf mistletoe infection centers prescribe an intermediate thinning (IT) treatment that retains full stocking densities of trees. Retain the dominant and codominant trees with the least amount of mistletoe. Reduce the amount of release to the residual stand where mistletoe exist.

Activity and residual slash may be removed, lopped and scattered or piled to burn in place;

Where possible, manage for the sustainability of large oaks by removing ladder fuels and overtopping trees;

Snags greater than 18 inches would be managed for two per acre in ponderosa pine and three per acre in mixed conifer. Averages are at the landscape scale;

Retain all trees greater than 24 inches DBH unless the tree is considered a hazard to public safety

Northern Goshawk Habitat

Post-Fledging Family Area (PFA)

Vegetation Management Direction: Northern Goshawk (goshawk) habitat is stratified into nesting areas, post- fledging family areas and foraging areas. Goshawk foraging areas are managed in the general Ponderosa Pine and other forest desired conditions and do not pertain to this section. Nest areas are within post- fledging family areas. Goshawk post- fledging family areas, approximately 420 acres in size, and nest areas, 30 acres in size. These habitats are determined by historical nesting locations and are analyzed in the Rim Country EIS. Goshawk post- fledging family areas and nest areas could be identified in future surveys.

Management for goshawk post-fledging family areas are similar to the general Ponderosa Pine forest conditions, except post-family fledging areas generally are managed to contain 10 to 20 percent higher basal area in mid-aged to old tree groups. Nest area management needs to have dense canopies of mid-age and old trees. Prescribed fire treatments are low intensity and low severity fire to tree canopies. Other treatment to meet stand level objectives and desired conditions include silviculture management systems with the use of mechanize equipment and hand thinning.

Desired Conditions: Goshawk post-fledging family areas may contain 10 to 20 percent higher basal area in mid-aged to old tree groups or random tree spacing than goshawk foraging areas and the surrounding forest. Goshawk nest areas have forest conditions that are multi-aged and dominated by large trees with relatively denser canopies than the surrounding forest.

Goshawk Post Fledging Family Area Mechanical Thin and Burn Treatment Design

Prescribed Burning Objectives and Tactics:
Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired goshawk nest habitat forest structure, tree densities, snag densities, and course woody debris levels.

- Course woody debris would be managed for 3-10 tons per acre, and downed logs greater than 12 inch midpoint diameter would be managed for three per acre ≥12 inches. Averages are at the landscape scale;
- 30 acre nesting area around the known nest or roost sites are managed for low intensity fire and low severity to forest canopy;
- Outside the 30 acre nesting area within the 420 acre post-fledging family area, treat fuels and mitigate fuel hazards with low intensity fire and moderate to low severity to forest canopy;
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;

Mechanical Thinning Objectives and Tactics:
Design tree cutting treatments to meet desired conditions. Retain Gambel oak; all other species may be felled to meet desired conditions;

- Silviculture objectives in goshawk post-fledging family areas include improve and maintain forest health conditions, maintain and increase tree species diversity, improve understory grass/forb diversity, create and maintain a sustainable uneven aged forest environment and reduce tree densities to facilitate low fire intensities that could occur during severe fire weather conditions. Maintain higher densities within mid aged and old aged trees;
- In general, nest stands will receive a low thinning treatment. Use mechanize equipment to reduce and remove hazardous live and dead fuel loading;
- Manage for uneven aged structure, stratified by young, mid-aged, and old-aged trees (grouped or random). Retain groups of dominant and codominant trees. Where age or size class diversity is not present, management activities should strive to encourage vertical diversity;
- In general, tree group density would be managed at higher group densities within mid-aged and old aged tree groups when group selection treatments are implemented. Young tree groups are managed to maintain tree stocking necessary to provide for desired future mid age and old age group densities;
- When group selection treatments are implemented, residual tree groups, on average, would range in size from 0.1 to 1 acre. Group size would vary within this range depending on site quality, existing stand structure, and pre-settlement tree evidence. Abiotic factors such as aspect, drainages and slope are other field determinations made for prescribing tree group sizes;
- When group selection treatments are implemented, manage for tree groups with grassy interspaces. Site level determination based on soil types, habitat type and regeneration rates shall confirm the proper determination to create or not create grassy interspaces. Gambel oak, juniper, and pinyon species greater than 5-inch DRC may be considered as residual trees in the target group spacing and stocking. The objective is to manage for a sustainable range of density and structural characteristics;
- Silviculture cutting systems include group selection with intermediate treatments, intermediate treatments only or individual tree selection. Even aged cutting systems may be used to improve forest health while meeting desired conditions. Soil types, current condition and historical reference conditions guide the type of silviculture cutting system;
- In moderate and heavy dwarf mistletoe infection centers, prescribe an intermediate thinning (IT) treatment that retains full stocking densities of trees. Retain the dominant and codominant trees with the least amount of mistletoe. Reduce the amount of release to the residual stand where mistletoe exist.
- Mistletoe free trees within the dominant and codominant crown position would have priority for retention. Where age class diversity is not present, 1 to 10 suppressed and intermediate trees per group could be retained for vertical diversity.
- Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff;
- Where possible, manage for the sustainability of large oaks by removing ladder fuels and overtopping trees;

- Snags greater than 18 inches would be managed for two per acre in ponderosa pine. Snag creation is not necessary. Select slow dying top killed trees that are greater than 18 inches DBH for retention to promote snag recruitment. Averages are at the landscape scale;

Goshawk Post Fledging Family Area Mechanical Thin Silviculture Prescription
Prescriptions are developed based on silviculture systems and management schemes. Uneven aged (UEA), Intermediate Treatment (IT) and Stand Improvement (SI). The prescriptions abbreviated for goshawk post fledging family areas (PFA) are the following: PFA UEA40-55, PFA UEA25-40 and PFA UEA10-25. The numbers next to the abbreviated prescription represent the intensity of interspace and openness created from the prescription.

PFA UEA40-55, PFA UEA25-40, PFA and UEA10-25 represent uneven-age silviculture systems (group selection and individual tree selection). These stand level prescriptions would be used to establish grass forb interspace between tree groups, thin tree groups, and establish regeneration areas. Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 108.

Table 108. Desired Condition of tree groups and interspaces for PFA UEA treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
UEA40	45–60%	40–55%	55'–70'	60-80 ft^2
UEA25	60–75%	25–40%	40'–55'	65-85 ft^2
UEA10	75–90%	10–25%	25'–40'	70-90 ft^2

Approximate interspace width between tree groups would average from 25 to 70 feet with a maximum width of 200 feet. Table D-2 Displays average interspace width depending on prescription.

Regeneration openings (group selection) account for 10 to 20 percent of tree groups. They would average 0.25 to 1 acre and would be no larger than 2 acres. Regeneration openings are irregular shape and size. They would only be established by removing most abundant tree size classes and/or where tree health compromised by bark beetles or dwarf mistletoe. Avoid retaining dwarf mistletoe infected trees in or around regeneration areas.

Priority for regeneration openings would surround healthy vigorous advanced regeneration. Regeneration openings would be created adjacent to tree groups and would not be surrounded by interspace. Regeneration areas need to be large enough and placed appropriately to be resilient to low severity fires. In general, ponderosa pines are resilient to low severity fires after approximately 10 years of age. Where advanced regeneration is not present, retain seed trees arranged in groups in openings greater than an acre in size.

Treatments would strive to attain an overall average density of 70 to 80 square feet of BA per acre outside of regeneration areas.

PFA IT 40 PFA IT 25 and PFA IT10 represent intermediate treatments. These treatments would be used to establish interspace between individual trees and tree groups and thin tree groups within post family fledging areas with moderate and high dwarf mistletoe infection Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 109.

Table 109. Desired condition of tree groups and interspaces for PFA IT Treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
IT40	45–60%	40–55%	60'–80'	60-80 ft^2
IT25	60–75%	25–40%	40'–60'	65-85 ft^2
IT10	75–90%	10–25%	25'–40'	70-90 ft^2

Approximate interspace width between tree groups would average from 25 to 80 feet with a maximum width of 200 feet. Table 109 Displays average interspace width depending on prescription.

Treatments would strive to attain an overall average density of 70 to 90 square feet of BA per acre outside of regeneration areas.

PFA SI40 PFA SI25 and PFA SI10 represent thinning for stand improvement. These treatments would be used to establish interspace between tree groups and thin tree groups within PFA even-age sites and/or stand dominated by young aged trees. Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 110.

Table 110. Desired condition of tree groups and interspaces for PFA SI treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
SI40	45–60%	40–55%	60'–80'	60-80 ft^2
SI25	60–75%	25–40%	40'–60'	65-85 ft^2
SI10	75–90%	10–25%	25'–40'	70-90 ft^2

Interspace width between tree groups would average from 25 to 80 feet with a maximum width of 200 feet. Table D-4 Displays average interspace width depending on prescription. Some stands, desired conditions for SI treatments can be achieved through non-commercial thinning and spacing guidelines. The main objective would be to create resiliency to fire while growing the stand to meet desired conditions into the future. Other objectives include reducing individual tree competition and selecting quality formed trees for retention.

Ponderosa Pine Forests

Outside of Mexican Spotted Owl Habitat and Landscapes outside of Goshawk PFAs

Vegetation Management Direction: Ponderosa pine forest pertaining to this section is stratified outside of MSO habitat and goshawk PFAs. Please refer to previous sections for MSO habitat and goshawk PFA for direction. Some goshawk foraging areas are managed in the general Ponderosa Pine.

Ponderosa Pine forest are managed for uneven-aged forest conditions. Uneven aged forest conditions include young, mid-aged and old aged trees. Prescribed fire treatments are low intensity and low severity fire to tree canopies. Other treatment to meet stand level objectives and desired conditions include silviculture management systems with the use of mechanize equipment including hand thinning.

Desired Conditions

Landscape Scale

- The ponderosa pine forest is a mosaic of structural states ranging from young to old trees. Forest structure is variable but uneven-aged and open in appearance. Sporadic areas of even-aged structure may be present on 10 percent or less of the landscape to provide structural diversity.
- The forest arrangement consists of individual trees, small clumps, and groups of trees with variably-sized interspaces of grasses, forbs, and shrubs. Vegetation associations are similar to reference conditions. The size, shape, and number of trees per group and the number of groups per area vary across the landscape. Tree density may be greater in some locations, such as north-facing slopes and canyon bottoms.
- The ponderosa pine forest is composed predominantly of vigorous trees, but declining, top-killed, lightning-scarred, and fire-scarred trees provide snags and coarse woody debris. Snags and coarse woody debris are well distributed throughout the landscape. Ponderosa pine snags are typically 18 inches or greater in diameter and average 1 to 2 per acre.
- Coarse woody debris, including logs, ranges from 3 to 10 tons per acre. Logs average 3 per acre within the forested area of the landscape.
- Where it naturally occurs, Gambel oak is present with all age classes represented. It is reproducing to maintain or expand its presence on capable sites across the landscape. Large Gambel oak snags are typically 10 inches or larger in diameter and are well distributed.
- Grasses, forbs, shrubs, needles, leaves, and small trees support the natural fire regime.
- Old growth occurs throughout the landscape, in small, discontinuous areas consisting of clumps of old trees, or occasionally individual old trees. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).
- Frequent, low to mixed severity fires, occurring approximately every 2 to 17 years.

Midscale

- Ponderosa pine forest is characterized by variation in the size and number of tree groups depending on elevation, soil type, aspect, and site productivity. The more biologically productive sites contain more trees per group and more groups per area, resulting in less space between groups. Interspaces typically range from 10 percent in more biologically productive sites to 70 percent in the less productive sites. Tree density within forested areas ranges from 20 to 80 square feet basal area per acre.
- The tree group mosaic composes an uneven-aged forest with all age classes, size classes, and structural stages present. Occasionally, patches of even-aged forest structure are present (less than 50 acres). Disturbances sustain the overall age and structural distribution.
- Fires burn primarily on the forest floor and do not spread between tree groups as crown fire.
- Forest structure in the wildland-urban interface (WUI) may have smaller, more widely spaced groups of trees than in the non-WUI areas.

Fine scale

- Trees typically occur in irregularly-shaped groups and are variably spaced with some tight clumps. Tree crowns in the mid- to old-aged groups are interlocking or nearly interlocking.
- Interspaces surrounding tree groups are variably shaped and composed of a grass, forb, and shrub mix. Some may contain individual trees or snags.

- Trees within groups are of similar or variable ages and may contain species other than ponderosa pine. Tree groups are typically less than 1 acre and average ½ acre. Mid- to old-aged tree groups consist of approximately 2 to 40 trees with interlocking canopies.
- Where Gambel oak occurs, the majority are single trunk trees over 8 inches in diameter with full crowns.

Ponderosa Pine Forest Mechanical Thin and Burn Treatment Design

Prescribed Burning Objectives and Tactics:

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired forest structure, tree densities, snag densities, and course woody debris levels.

- A mix of prescribed fire intensities and severities to forest crowns would be used to meet desired conditions.
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;

Mechanical Thinning Objectives and Tactics:

Design tree cutting treatments to meet desired conditions. Retain Gambel oak; other tree species may be felled to meet desired conditions;

- Silviculture objectives include improve and maintain forest health conditions, maintain and increase tree species diversity, improve understory grass/forb diversity, create and maintain a sustainable uneven aged forest environment and reduce tree densities to facilitate low fire intensities that could occur during severe fire weather conditions. Maintain higher densities within mid aged and old aged tree groups;
- Use mechanize equipment to reduce and remove hazardous live and dead fuel loading in coordination with fire/fuels staff to see if the amount and arrangement of fuel loading left behind is appropriate for prescribed burning as well as does not present a safety concern for wildfire;
- Manage for uneven-aged structure stratified by young, mid-aged, and old-aged tree (grouped or random). Retain groups of dominate and codominant trees. Where age or size class diversity is not present, management activities should strive to encourage vertical diversity;
- In general, tree group density would be managed at higher group densities within mid-aged and old aged tree groups when group selection treatments are implemented. Young tree groups are managed to maintain tree stocking necessary to provide for desired future mid age and old age group densities;
- When group selection treatments are implemented, residual tree groups, on average, would range in size from 0.1 to 1 acre. Group size would vary within this range depending on site quality, existing stand structure, and pre-settlement tree evidence. Abiotic factors such as aspect, drainages and slope are other field determinations made for prescribing tree group sizes;
- When group selection treatments are implemented, manage for tree groups with grassy interspaces. Site level determination based on soil types, habitat type and regeneration rates shall confirm the proper determination to create or not create grassy interspaces. Gambel oak, juniper, and pinyon

species greater than 5-inch DRC may be considered as residual trees in the target group spacing and stocking. The objective is to manage for a sustainable range of density and structural characteristics;

- Silviculture cutting systems include group selection with intermediate treatments, intermediate treatments only or individual tree selection. Even aged cutting systems may be used to improve forest health while meeting desired conditions. Soil types, current condition and historical reference conditions guide the type of silviculture cutting system;
- In moderate and heavy dwarf mistletoe infection centers where regeneration areas would not meet the desired conditions, prescribe an intermediate thinning (IT) treatment. Retain the dominant and codominant trees with the least amount of mistletoe. Mistletoe free trees within the dominant and codominant crown position would have priority for retention. Where age class diversity is not present, 1 to 10 suppressed and intermediate trees per group would be retained for vertical diversity.
- Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff;
- Where possible, manage for the sustainability of large oaks by removing ladder fuels and overtopping trees;
- Snags greater than 18 inches would be managed for two per acre in ponderosa pine. Snag creation is not necessary. Select slow dying top killed trees that are greater than 18 inches DBH for retention to promote snag recruitment. Averages are at the landscape scale;
- Savanna prescriptions are scattered within ponderosa pine forest. These prescriptions would restore pre-settlement tree density and pattern using pre-settlement evidence as guidance. Generally, these areas are open with a reference condition of 10 to 30 percent of tree canopy;
- Savanna prescriptions would retain all pre-settlement trees and the largest post-settlement trees that most closely resemble old trees in size and form as replacement trees adjacent to pre-settlement tree evidences at a 1:1 ratio. Some younger trees would also be retained to maintain uneven-aged structure.
- Generally, savanna prescriptions manage for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individuals. Amount of interspace would vary within this range depending on reference conditions. Juniper and pinyon species in the seedling/sapling, young, and mid-aged stages would generally be removed except where needed as replacements for pre-settlement trees.

Ponderosa Pine Forest Mechanical Thin Silviculture Prescription

Prescriptions are developed based on silviculture systems and management schemes. Uneven aged (UEA), Intermediate Treatment (IT) and Stand Improvement (SI). The prescriptions abbreviated are for ponderosa pine forest are the following: UEA 40-55, UEA 25-40 and UEA 10-25. The numbers next to the abbreviated prescription represent the intensity of interspace and openness created from the prescription. Same principles apply to some dry mixed conifer stands.

UEA 40-55, UEA 25-40 and UEA 10-25 represent uneven-age silviculture systems (group selection and individual tree selection). These stand-level prescriptions would be used to establish grass forb interspace between tree groups, thin tree groups, and establish regeneration areas. Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 111.

Table 111. Desired condition of tree groups and interspaces for UEA treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
UEA40-55	45–60%	40–55%	60’-100’	40-60 ft^2
UEA25-40	60–75%	25–40%	40’-60’	45-65 ft^2
UEA10-25	75–90%	10–25%	25’-40’	50-70 ft^2

Approximate interspace width between tree groups would average from 25 to 120 feet with a maximum width of 200 feet. Table D-5 Displays average interspace width depending on prescription.

Regeneration openings (group selection) account for 10 to 20 percent of tree groups. They would average 0.25 to 1 acre and would be no larger than 2 acres. Regeneration openings are irregular shape and size. They would only be established by removing most abundant tree size classes and/or where tree health compromised by bark beetles or dwarf mistletoe. Avoid retaining dwarf mistletoe infected trees in or around regeneration areas.

Priority for regeneration openings would surround healthy vigorous advanced regeneration. Regeneration openings would be created adjacent to tree groups and would not be surrounded by interspace. Regeneration areas need to be large enough and placed appropriately to be resilient to low severity fires. In general, ponderosa pines are resilient to low severity fires after approximately 10 years of age. Where advanced regeneration is not present, retain seed trees arranged in groups in openings greater than an acre in size.

Treatments would strive to attain an overall average density of 40 to 70 square feet of BA per acre outside of regeneration areas.

IT 40, IT 25 and IT 10 represent intermediate treatments. These treatments would be used to establish interspace between individual trees and tree groups and thin tree groups within post family fledging areas with moderate to high dwarf mistletoe infection Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 112.

Table 112. Desired condition of tree groups and interspaces for IT treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
IT40	45–60%	40–55%	60'–80'	40-60 ft^2
IT25	60–75%	25–40%	40'–60'	45-65 ft^2
IT10	75–90%	10–25%	25'–40'	50-70 ft^2

Approximate interspace width between tree groups would average from 25 to 80 feet with a maximum width of 200 feet. Table 112 Displays average interspace width depending on prescription.

Treatments would strive to attain an overall average density of 40 to 70 square feet of BA per acre outside of regeneration areas.

SI40, SI25 and SI10 represent thinning for stand improvement. These treatments would be used to establish interspace between tree groups and thin tree groups within even-age sites and/or stand dominated by young aged trees. Tree groups and interspaces would occupy the following approximate percent of the area by treatment intensity as described in Table 113.

Table 113. Desired condition of tree groups and interspaces for SI treatments

Prescription	Tree Groups	Percent of Interspace	Interspace Width (feet)	Residual Basal Area
SI40	45–60%	40–55%	60'–80'	40-60 ft^2
SI25	60–75%	25–40%	40'–60'	45-65 ft^2
SI10	75–90%	10–25%	25'–40'	50-70 ft^2

Interspace width between tree groups would average from 25 to 80 feet with a maximum width of 200 feet. Table D-7 Displays average interspace width depending on prescription. Some stands, desired conditions for SI treatments can be achieved through non-commercial thinning and spacing guidelines. The main objective would be to create resiliency to fire while growing the stand to meet desired conditions into the future. Other objectives include reducing individual tree competition and selecting quality formed trees for retention.

Aspen Stands or Inclusions in Mixed Conifer Forests

Vegetation Management Direction: Management activities that kill or stress overstory trees may be used since they mimic natural disturbances and enhance aspen regeneration. Aspen restoration efforts may include removing conifer competition and fencing to exclude ungulates.

Desired Conditions: Aspen is successfully regenerating and recruiting into older and larger size classes. Size classes have a natural distribution, with the greatest number of stems in the smallest classes. Coniferous species comprise less than 10 percent of the overstory.

Landscape Scale

- Areas of aspen occur and shift across the forested landscape. They are successfully regenerating and being recruited into older and larger size classes. Size classes have a natural distribution, with the greatest number of stems in the smaller size classes.

Mid-scale

- Aspen may compose 10 to 100 percent of the area depending on disturbance (e.g., fire, insects, silvicultural treatments) in multistoried patches.
- As an early seral species, aspen reproduction and recruitment benefit from low severity surface fires.

Aspen Mechanical Thin and Burn Treatment Design

Inclusions of aspen remnants within portions of other forested areas would be regenerated by removing all post-settlement conifers from within 100 feet of the aspen clone. Some removal of aspen within the clone as well as ground-disturbing activity or burning may occur to stimulate suckering.

Treatments for aspen clones would meet desired conditions. Silvicultural cutting treatments include weeding other coniferous trees to reduce competition and protection of regeneration through jackstraw, fencing, and coppice cutting and planting.

Each clone would be evaluated as to need for fencing or creation of other barriers to reduce ungulate browsing of regenerating aspen.

Prescribed burns may be used where and when feasible to treat fuels, mitigate fuel hazards, and to produce effects that stimulate aspen suckering and regeneration, and growth of native herbaceous vegetation. Inclusions of aspen remnants within portions of ponderosa pine stands could be regenerated by prescribed burning to stimulate suckering.

Prescribed burns are designed to reduce post-settlement conifer stocking within 100 feet of the aspen clone and disturb the site with sufficient intensity to encourage aspen regeneration.

Piñon-juniper Woodlands

Vegetation Management Direction: Manage for uneven-age conditions to sustain a mosaic of vegetation densities (overstory and understory), age classes, and species composition well distributed across the landscape. Provide for reserve trees, snags, and down woody debris.

Desired Conditions: Mosaic of young and mature, species diverse patches of trees interspersed with interspace across the landscape to promote the growth grasses and herbaceous understory species. Mature patches would be structurally diverse, containing large live and dead standing trees as well as trees with dead or broken tops, gnarls, and burls. The structure and composition reflects the natural range of variation.

Landscape Scale

- A mix of desired species, ages, heights, and groupings of trees create a mosaic across the landscape.
- In persistent PJ woodlands, tree canopy cover is closed (greater than 30 percent), shrubs are sparse to moderate, and herbaceous cover is patchy.
- PJ savanna is open in appearance with trees occurring as individuals or in small groups and ranging from young to old. Overall, tree canopy cover is 10 to 15 percent, but may range up to 30 percent.
- Snags, averaging one to two per acre, and older trees with dead limbs and tops are scattered across the landscape. Coarse woody debris averages 2 to 5 tons per acre.
- Old growth includes old trees, dead trees (snags), downed wood (coarse woody debris), and/or structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).
- Fire is less frequent and more variable than in the savanna due to patchiness of ground cover. The fires that do occur are mixed to high severity.

Mid-scale

- Grass and forb cover is maximized, based on site capability, to protect and enrich soils.

Piñon-juniper Woodland Mechanical Thin and Burn Treatment Design

Prescribed Burning Objectives and Tactics:

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height and reducing litter/duff cover and other surface fuel loading. Prescribed fires are designed to maintain and enhance desired forest structure, tree densities, snag densities, and course woody debris levels.

- Prescribed fire intensity and severity to forest crowns would be used to meet desired conditions.
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;

Mechanical Thinning Objectives and Tactics:
Design tree thinning treatments to meet desired conditions. All tree species may be felled to meet desired conditions;

- Silviculture objectives include creating woodland conditions to facilitate future prescribed fire desired conditions. Other objectives would improve and maintain forest health conditions, maintain and increase tree species diversity, improve vigor in pinyon pine species and improve understory grass/forb diversity;
- Use mechanize equipment and fuelwood activities to reduce and remove hazardous live and dead fuel loading;
- In general, manage for tree groups with grassy interspaces to meet desired conditions.
- Silviculture cutting systems may include group selection with intermediate treatments, intermediate treatments only or individual tree selection. Even aged cutting systems may be used to improve forest health while meeting desired conditions. Soil types, current condition and historical reference conditions guide the type of silviculture cutting system;
- Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff.
- Savanna prescriptions within woodland the landscape would restore pre-settlement tree density and pattern using pre-settlement evidence as guidance. Generally, these areas are open with a reference condition of 10 to 30 percent of tree canopy;
- Savanna prescriptions would retain all pre-settlement trees and the largest post-settlement trees that most closely resemble old trees in size and form as replacement trees adjacent to pre-settlement tree evidences at a 1:1 ratio. Some younger trees would also be retained to maintain uneven-aged structure.
- Generally, savanna prescriptions manage for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individuals. Amount of interspace would vary within this range depending on reference conditions. Juniper and pinyon species in the seedling/sapling, young, and mid-aged stages would generally be removed except where needed as replacements for pre-settlement trees.

Grasslands

Vegetation Management Direction: Reduce conifer encroachment within grasslands as identified by mollisol soils.

Desired Conditions: Restore historic grassland/forest edge as indicated by existing pre- settlement conifers and evidence of pre-settlement conifers.

Landscape

- Perennial herbaceous species dominate and include native grasses, grass-like plants (sedges and rushes), and forbs, and in some locations, a diversity of shrubs.

- Herbaceous vegetation and litter provide for and maintain the natural fire regime.
- In montane/subalpine grasslands it ranges from approximately 2 to 400 years, depending on the adjacent forested Forest type.
- Landscapes associated with montane/subalpine grasslands vary from natural appearing where human activities do not stand out (high scenic integrity) to unaltered where only natural ecological changes occur (very high scenic integrity).

Mid-scale

- Woody (tree and shrub) canopy cover is less than 10 percent.

Prescribed Burning Objectives and Tactics:

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing reducing tree densities to desired conditions. Prescribed fires are designed to maintain and enhance grassland conditions.

- Prescribed fire intensity and severity to tree crowns would be used to meet desired conditions.
- Other activities tied to prescribe burning include line preparation which includes fuel breaks. Logical fuel breaks include existing roads and minimal line construction would be used depending on road system density;

Mechanical Thinning Objectives and Tactics:

Design tree thinning treatments to meet desired conditions. All tree species may be felled to meet desired conditions;

- Silviculture objectives include creating woodland conditions to facilitate future prescribed fire desired conditions. Other objectives would improve and maintain forest health conditions, maintain and increase tree species diversity, improve vigor in pinyon pine species and improve understory grass/forb diversity;
- Use mechanized equipment and fuelwood activities to reduce and remove hazardous live and dead fuel loading;
- In general, manage for tree groups with grassy interspaces to meet desired conditions.
- Silviculture cutting systems may include group selection with intermediate treatments, intermediate treatments only or individual tree selection. Even aged cutting systems may be used to improve forest health while meeting desired conditions. Soil types, current condition and historical reference conditions guide the type of silviculture cutting system;
- Activity and residual slash may be removed, lopped and scattered or piled to burn in place in coordination with fire/fuels staff.
- Treatments are designed to promote and reestablish the historic meadow edge as defined by pre-settlement trees and evidences and the current forest structure of young trees encroaching on the edge of the grassland.
- Tree group arrangement, size, and density are a function of existing pre-settlement trees and evidence. Retain all pre-settlement trees and the largest post-settlement trees that most closely resemble old trees in size and form as replacement trees adjacent to pre-settlement tree evidences at a 1:1 ratio.

Section C – Old Tree Implementation Plan

Old Tree Descriptions and Illustrations

Old trees would be retained, with few exceptions, regardless of their diameter, within the Rim Country analysis area. Removal of old trees would be rare. Exceptions would be made for threats to human health and safety, and those rare circumstances where the removal of an old tree is necessary in order to prevent additional habitat degradation. Old trees would not be cut for forest health reasons or to balance age or size class distributions.

Threats to human health and safety would include hazard trees as defined by Forest Service Manual and Forest service Handbook Direction (currently FSM 2332.1, FSM 2332.11, and FSH 7709.59). A hazard tree is defined as a tree that has both a structural defect that increases the chance of a tree or its parts to fail and a target (people, buildings, cars, etc.) would be hit when the tree fails.

One example of a situation where the removal of an old tree is necessary in order to prevent additional habitat degradation is in the rare case of an old tree growing on the side of an existing curve in a road. Hauling equipment may require a wider turning radius. The options are to relocate the road or cut the old tree and widen the curve to accommodate the larger turning radius. Relocating the road would result in a larger area of the forest being permanently disturbed, versus the large tree and widening the curves radius. This is an example where cutting the old tree would result in less habitat degradation then relocating a road.

This old tree implementation plan will be applied to the Rim Country Environmental Impact Statement Record of Decision and may not apply to subsequent decisions on the same project area or on other areas within Region 3. Subsequent decisions may include an old tree implementation plan that reflects project specific current conditions and the purpose and needs of subsequent projects.

Old Tree Descriptions and Illustrations - Old trees will be determined by the following characteristics described in Figure D-1:

- Age –Established prior to 1870, predating Euro-American settlement.
- D.B.H. – Site dependent. Old trees on higher productivity sites would likely have larger diameters than old trees on lower productivity sites
- Bark – Ranging from reddish brown, shading to black in the top with moderately large plates between the fissures to reddish brown to yellow, with very wide, long, and smooth plates.
- Tops – Ranging from pyramidal or rounded (occasionally pointed) to flat (making no further height growth).
- Branching – Ranging from upturned in upper third of the crown, horizontal in the middle third, and drooping in the lower third of the crown to mostly large, drooping, gnarled, or crooked. Branch whorls range from incomplete and indistinct except at the top to completely indistinct and incomplete.

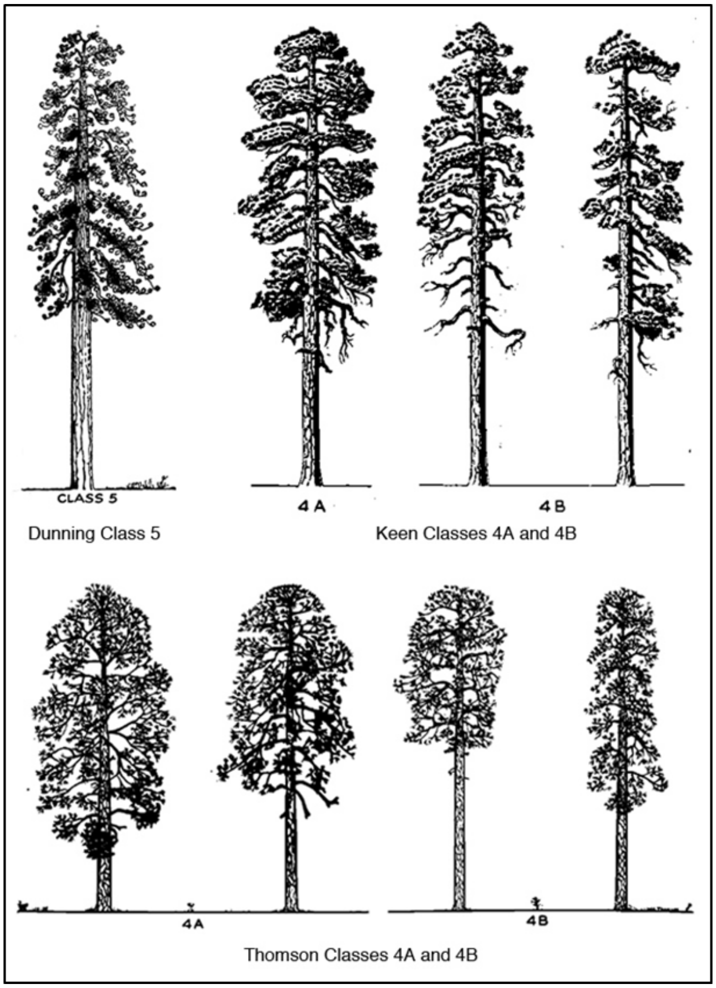

Figure 94. Illustrations of mature size classes derived from Dunning (1928), Keen (1943), and Thompson (1940)

Ponderosa Pine Age Class Descriptions

Dunning (1928) Age Class 5: Overmature; usually largest trees in stand; bark light yellow with wide, long and smooth plates; tops flat with terminals rarely discernable; nearly all branches are drooping, gnarled, and crooked.

Keen (1943) Age Class 4: Overmature; making no further height growth; diameter growth very slow; bark light yellow, uniform for entire bole (except in extreme top), with wide, long and smooth plates and often shallow fissures; tops usually flat or occasionally rounded or irregular; branches large, heavy, and often gnarled or crooked and mostly drooping except in extreme top.

Thomson (1940) Age Class 4: Mature-overmature; trees usually large; bark reddish-brown to yellow with wide, long and smooth plates; tops usually flat and making no further height growth; branches mostly large and drooping, gnarled or crooked.

Thompson (1940) Age Class 3: Intermediate-mature; bark reddish brown shading to black in the top with moderately large plates between the fissures; tops usually pyramidal or rounded, occasionally pointed; branches upturned in top third of crown, those in the middle horizontal and drooping in the lower third

Section D – Large Tree Implementation Plan

The large tree implementation plan is designed to inform implementation. The plan's ecological objectives are consistent with the desired conditions found in the three Rim Country forest plans as well as the enacting language of the Collaborative Forest Landscape Restoration Program "maximizing the retention of large trees, as appropriate for the forest type, to the extent that the trees promote fire-resilient stands." (Omnibus Public Land Management Act of 2009).

For the purpose of this document, large post-settlement trees, as defined by the socio-political process, are those that are 16-inch DBH or larger. Groups of trees greater than or equal to 18-inch DBH represent the largest and (sometimes) oldest trees. These size classes best correspond with the successional stage classification system that was developed to address the forest dynamics of southwestern ponderosa pine.

This plan may not include every instance where large post-settlement trees may be removed. There may be additional areas and/or circumstances where large post-settlement trees need to be removed in order to achieve restoration objectives. During implementation (prescription development), if there is a condition where forest plan desired conditions conflict with the exception condition categories listed below, no large trees would be felled until the NEPA decision is reviewed by the District. The District would decide whether the action is consistent with the analysis and the decision made. The exception categories for falling large trees are listed below.

Seeps and Springs

Seeps are locations where surface-emergent groundwater causes ephemeral or perennial moist soil or bedrock. Standing or running water is infrequent or absent. Vegetation and other biological diversity are adapted to mesic habitat with moist, adequate soil moisture. Springs are small areas where surface-emergent groundwater causes ephemeral or perennial standing or running water and wet or moist soils. Vegetation and other biological diversity are adapted to mesic habitat or aquatic environments (Feth and Hem 1963).

Seeps and springs exhibit unique, often isolated biophysical conditions that can sustain unique, mesic-adapted biological diversity, and can facilitate endemism and speciation. Springs also provide water and other habitat to terrestrial wildlife. In the late 1800s, unsustainable livestock grazing practices significantly reduced herbaceous cover, reducing competition pressure on pine seedlings. Coupled with the onset of fire suppression in the early 1900s, pine trees rapidly encroached and recruited into native grasslands (e.g., Moore and Huffman 2004, Coop and Givnish 2007). This cause and effect relationship allowed for an increase in pine tree development. Due to the absence of frequent fires and the presence of livestock grazing, the establishment of large post-settlement trees may reduce available soil moisture (Simonin et al. 2007) and block the sunlight necessary to support the unique biophysical conditions associated with seeps and springs.

Removal of trees that have encroached upon seeps and springs may constitute a relatively small part of an overall seep and spring restoration effort, when compared to fully addressing root causes of overall degradation. Thinning alone, without addressing other sources of degradation, is unlikely to fully restore seeps and springs (Thompson et al. 2002). However, it is a necessary step leading to the restoration of these ecologically important areas.

Ecological Objectives

- The biophysical conditions in seeps and springs upon which terrestrial, mesic-adapted, and aquatic native biological diversity depend are conserved and restored.

- The integrity of the spring's unique biophysical attributes is not compromised by tree rooting and shading.
- Mesic habitats associated with a seep or spring are not encroached upon by conifers.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.

Riparian

Riparian areas occur along ephemeral or perennial streams or are located downgradient of seeps or springs. These areas exhibit riparian vegetation, mesic soils, and/or aquatic environments.

Riparian areas exhibit unique biophysical conditions that can sustain unique, mesic-adapted, or aquatic biological diversity. Riparian areas and the streams, springs, and seeps connected to them often harbor imperiled species that can be sources of endemism. Riparian areas also provide water and other habitat to terrestrial and aquatic wildlife. In the absence of frequent fires and in the presence of other competing factors, large post-settlement trees may have become established and grown within riparian areas to the point that they compromise available soil moisture or light that support the unique biophysical conditions that are associated with the riparian areas. Conifer trees encroaching into riparian zones of any size may need to be removed to retain or improve riparian vegetation and condition

Ecological Objectives

- The biophysical conditions in riparian habitat upon which terrestrial and aquatic native biological diversity depends are conserved and restored.
- The use of soil and water best management practices (BMPs) minimize the impacts of removing trees within riparian areas.
- Removal of trees constitutes a relatively small part of an overall riparian area restoration effort, when compared to the fundamental causes of overall degradation. Riparian areas are fully restored by using an array of tools that address all sources of degradation.
- Available soil moisture or light that support that area's unique biophysical conditions is not compromised by growing (rooted) trees.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.
- Post-treatment snags and logs that include large trees are available onsite.

Wet Meadows

High elevation streamside or spring-fed meadows occur in numerous locations throughout the Southwest. However, less than 1 percent of the landscape in the region is characterized as wetland (Dahl 1990), and wet meadows are just one of several wetland types that occur. Patton and Judd (1970) reported that approximately 17,700 hectares of wet meadows occur on national forests in Arizona and New Mexico.

Wet meadows may be referred to as riparian meadows, montane (or high elevation) riparian meadows, sedge meadows, or simply as wet meadows. Wet meadows are usually located in valleys or swales, but may occasionally be found in isolated depressions, such as along the fringes of ponds and lakes with no outlets. Where wet meadows have not been excessively altered, sedges (Carex spp.), rushes (Juncus spp.), and spikerush (Eleocharis spp.) are common species (Patton and Judd 1970, Hendrickson and Minckley 1984, Muldavin et al. 2000). Willow (Salix) and alder (Alnus spp.) often occur in or adjacent to these meadows (Long 2000, Long 2002, Maschinski 2001, Medina and Steed 2002). High elevation wet meadows frequently occur along a gradient that includes aquatic vegetation at the lower end and mesic meadows, dry meadows, and ponderosa pine or mixed conifer forest at the upper end. These vegetation gradients are closely associated with differences in flooding, depth to water table, and soil characteristics (Judd 1972, Castelli et al. 2000, Dwire et al. 2006). While relatively rare, wet meadows are believed to be of disproportionate value because of their use by wildlife and the range of other ecosystem services they provide. Wet meadows perform many of the same ecosystem functions associated with other wetland types, such as water quality improvement, reduction of flood peaks, and carbon sequestration.

Wet meadows are one of the most heavily altered ecosystems. They have been used extensively for grazing livestock, have become the site of many small dams and stock tanks, have had roads built through them, and have experienced other types of hydrologic alterations. Most notably, the lowering of their water tables due to stream down thinning, surface water diversions, or groundwater withdrawal (Neary and Medina 1996) has occurred. Due to the presence of livestock grazing and hydrologic changes, large post-settlement trees may have established and grown within wet meadows such that they compromise available soil moisture or light creating unique biophysical conditions.

Ecological Objectives

- The biophysical conditions of wet meadows upon which terrestrial native biological diversity depend are conserved and restored.
- Wet meadow function is not impaired by growing (rooted) trees.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.
- Removal of large trees constitutes a relatively small part of an overall riparian area restoration effort, when compared to the fundamental causes of overall degradation. Wet meadows are fully restored by using an array of tools that address all sources of degradation.

Encroached Grasslands

Encroached grasslands are herbaceous ecosystems that have infrequent to no evidence of pine trees growing prior to settlement. The two prevalent grassland categories in the 4FRI landscape are montane (includes subalpine) grasslands and Colorado Plateau (a subset of Great Basin) grasslands, with montane grasslands being most common (Finch 2004). A key indicator of grasslands is the presence of mollisol soils. Mollisol soils are typically deeper with higher rates of accumulation and decomposition of soil organic matter relative to soils in the surrounding landscape. Grasslands in this region evolved during the Miocene and Pliocene periods, and the dark, rich soils observed in grasslands today have taken more than 3 million years to produce. In addition to their association with mollic soils, grasslands in this region are maintained by a combination of climate, fire, wind desiccation, and, to a lesser extent, by animal herbivory (Finch 2004).

Typical montane grasslands in this region are characterized by Arizona fescue (Festuca arizonica) meadows on elevated plains of basaltic and sandstone residual soils. Montane grasslands generally occur in small (<100 acres) to medium sized (100 to 1,000 acres) patches. Historic maintenance of the herbaceous condition in these grasslands is subject to some debate though appears to be primarily driven by periodic fire. The cool-season growth of Arizona fescue also plays a large role in maintenance of parks and openings by directly competing with ponderosa pine seedlings. Identification of grasslands in this region should use a combination of the threatened, endangered, and sensitive (TES), Southwest Regional GAP Analysis, and Brown and Lowe Vegetation Classification (Brown and Lowe 1982, TNC GIS Layer 2006), TEU data, EAU, among other existing vegetation and soils data.

Prior to European settlement, conifer trees were rarely established in grasslands because they were either suppressed by production of cool-season grasses or killed by frequent fire (Finch 2004). In the late 1800s, unsustainable livestock grazing practices significantly reduced herbaceous cover, reducing competition pressure on conifer seedlings. Coupled with the onset of fire suppression in the early 1900s, pine trees rapidly encroached and recruited into native grasslands (e.g., Moore and Huffman 2004, Coop and Givnish 2007). Plant diversity is particularly important in grassland ecosystems. Grassland plots with greater species diversity have been found to be more resistant to drought and to recover more quickly than less diverse plots (Tilman and Downing 1994). This resilience will become even more important in a warming climate. Conifer tree removal, restoration of fire, and appropriate livestock numbers are all necessary to restore structure and function of native grasslands.

Ecological Objectives

- Grasslands are enhanced, maintained, and function with potential natural vegetation (as defined by vegetative mapping units).
- Grasslands function with a natural fire regime.
- Existing grasslands are not encroached upon by conifers.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.

Aspen Stands and Patches

Quaking aspen (*Populus tremuloides*) generally occurs within mixed conifer forests. It is ecologically important due to the high concentration of biodiversity that depends on aspen for habitat (Tew 1970, DeByle 1985, Finch and Reynolds 1987, Griffis-Kyle and Beier 2003). Aspen is currently declining at an alarming rate (Fairweather et al. 2008).

Aspen occurs in small patches throughout the Rim Country project area. Bartos (2001) refers to three broad categories of aspen: (1) stable and regenerating (stable), (2) converting to conifers (seral), and (3) decadent and deteriorating. All of the aspen occurring within conifer forests of the Rim Country project area is seral aspen, which usually regenerates after disturbance through root sprouting.

The lack of fire as a natural disturbance regime in southwestern ponderosa pine forests since European settlement has caused much of the aspen dominated lands to cede to conifers (Bartos 2001). Other factors contributing to gradual aspen decline over the past 140 years include reduced regeneration from browsing ungulates (Pearson 1914, Larson 1959, Martin 1965, Jones 1975, Shepperd and Fairweather 1994, Martin 2007). More recently, aerial and ground surveys indicate more rapid decline of aspen, with very high mortality occurring in low and mid-elevation aspen sites. Major factors thought to be causing this rapid decline of aspen include frost events, severe drought, and a host of insects and pathogens (Fairweather et al. 2008) that have served as the “final straws” for already compromised stands.

Favorable soil and moisture conditions maintain stable aspen over time. Aspen stands have been mapped across the entire Rim Country area and map layers are available from existing databases.

Ecological Objectives

- Aspen stands and patches are conserved and restored to their appropriate fire regime.
- Aspen is effectively being regenerated or maintained, and regeneration, saplings, and juvenile trees are protected from browsing.
- There is decreased competition from conifers. Post-settlement conifer tree numbers do not exceed residual targets that have been identified using pre- settlement conifer tree evidences, site visitations, and collected data.
- Removal of large trees constitutes a relatively small part of the aspen restoration effort, when compared to the fundamental causes of overall degradation. Aspen forests and woodlands are fully restored by using an array of tools that address all sources of degradation.

Ponderosa Pine/Gambel Oak Forest (Pine-Oak)

A number of habitat types exist in the southwestern United States that could be described as pine-oak. Ponderosa pine forests are interspersed with Gambel oak (*Quercus gambelii*) trees in locations throughout the Rim Country project area in a habitat association referred to as PIPO/QUGA (USFS 1997, USDI 1995).

In southwestern ponderosa pine forests, Gambel oak has several growth forms distinguished by stem sizes and the density and spacing of stems within clumps. These include shrubby thickets of small stems, clumps of intermediate-sized stems, and large, mature trees that are influenced by age, disturbance history, and site conditions (Kruse 1992, Rosenstock 1998, Abella and Springer 2008, Abella 2008a). Different growth forms provide important habitat for a large number and variety of wildlife species (Neff et al. 1979, Kruse 1992). These include hiding cover in a landscape with limited woody shrub cover, cavity substrate for birds and bats, roost potential for bats, nest sites for birds, and bark characteristics used by invertebrates. Whether as saplings, shrubby thickets, or larger sized trees, oak adds a high value for wildlife in ponderosa pine forests.

Gambel oak provides high quality wildlife habitat in its various growth forms and is a desirable component of ponderosa pine forests (Neff et al. 1979, Kruse 1992, Bernardos et al. 2004).

Gambel oak enhances soils (Klemmedson 1987), wildlife habitat (Kruse 1992, Rosenstock 1998, USDI 1995, Bernardos et al. 2004), and understory community composition (Abella and Springer 2008). Large oak trees are particularly valuable since they typically provide more natural cavities and pockets of decay that allow excavation and use by cavity nesters than conifers. In addition to its important ecological role, Gambel oak has high value to humans as it is a popular firewood that possesses superior heat-producing qualities compared to other tree species (Wagstaff 1984).

Gambel oak densities appear to have increased in many areas with fire exclusion, especially in the small and medium diameter stems (<8-inch DBH, Abella and Fulé (2008)). Chambers (2002) found that Gambel oak on the Kaibab and Coconino NFs was distributed in an uneven-aged distribution, dominated by smaller size classes (<5 centimeter DBH) and few large diameter oak trees. Because of Gambel oak's slow growth rate, there may be little opportunity for these small Gambel oak trees to attain large diameters (>85 centimeters) (Chambers 2002).

Pine competition with oak has been identified as an issue in slowing oak growth, particularly for older oaks (Onkonburi 1999). Onkonburi (1999) also found that for northern Arizona forests, pine thinning increased oak incremental growth more than oak thinning and prescribed fire. Fulé (2005) found that oak diameter growth tended to be greater in areas where pine was thinned relative to burn only treatments and controls. Thinning of competing pine trees may promote large oaks with vigorous crowns and enhanced acorn production (Abella 2008b), and may increase oak seedling establishment (Ffolliott and Gottfried 1991).

Ecological Objectives

All Gambel Oak

- Small oak trees develop into larger size classes.
- Fire treatments retain small and shrubby oak in numbers and distribution.
- All growth forms of Gambel oak are present and larger, older oak trees are enhanced and maintained.
- Large, post-settlement trees are not restricting oak development.
- Frequent, low intensity surface fire occurs in ponderosa pine-Gambel oak forests.
- Brushy thicket, pole, and dispersed clump growth forms of Gambel oak are present and maintained by allowing natural self-thinning, thinning dense clumps, and/or burning.
- Gambel oak growth forms are protected from damage during restoration treatments including thinning and post-thinning slash burning.

In MSO Recovery Habitat

- Within MSO habitat and designated critical habitat, the recovery plan for the MSO improves key habitat components and primary biological factors, which includes Gambel oak.
- Within 30 feet of oak 10- inch DRC or larger, post-settlement mixed conifer trees up to 18-inch DBH (that do not have interlocking crowns with oak) are not restricting oak development.

Outside MSO Recovery Habitat

- Large post-settlement trees' drip lines or roots do not overlap with those of Gambel oak trees exhibiting greater than 8 inch DRC

Within-stand Openings (Interspaces)

Within-stand openings are small openings (generally 0.05 to 1.0 acres) that were occupied by grasses and wildflowers before settlement (Pearson 1942, White 1985, Covington and Sackett 1992, Sánchez Meador et al. 2009). For the purposes of this strategy, within-stand openings are equivalent to interspaces. The within-stand opening management approach described below is distinct from, and should not be considered as guidance relating to regeneration openings.

Pre-settlement openings can be identified by the lack of stumps, stump holes, or other evidence of pre-settlement tree occupancy (Covington et al. 1997). Current openings include fine-scaled canopy gaps. It is not necessary to have desired within-stand openings and groups located in the same location that they were in before settlement (the site fidelity assumption). Trees might be retained in areas that were openings before settlement, and openings might be established in areas which had previously supported pre-settlement trees.

Within-stand openings appear to have been self-perpetuating before overgrazing and fire exclusion (Pearson 1942, Sánchez Meador et al. 2009). Fully occupied by the roots of grasses and wildflowers as well as those of neighboring groups of trees, these openings had low water and nutrient availability because of intense root competition (Kaye et al. 1999). Heavy surface fuel loads insured that tree seedlings were killed by frequent surface fires, reinforcing the competitive exclusion of tree seedlings (Fulé et al. 1997).

These natural openings appear to have been very important for some species of butterflies, birds, and mammals (Waltz and Covington 2004). Often the largest post-settlement trees, typically a single tree, became established in these natural within-stand openings as soon as herbaceous vegetation was removed by overgrazing (Sánchez Meador et al. 2009). Contemporary within- stand openings or areas dominated by smaller post-settlement trees should be the starting point for restoring more natural within-stand heterogeneity.

Ecological Objectives

- The pattern of openings within stands that provide natural spatial heterogeneity for biological diversity are conserved, created, or enhanced.
- Openings break up fuel continuity to reduce the probability of torching and crowning and restore natural heterogeneity within stands.
- Openings promote snowpack accumulation and retention which benefits groundwater recharge and watershed processes at the fine (1 to 10 acres) scale.
- The presence of large trees does not prevent the reestablishment of sufficient within- stand openings to emulate natural vegetation patterns based on current stand conditions, pre-settlement evidences, desired conditions, or other restoration objectives.
- Groups of trees typically range in size from 0.1 acre to 1 acre. Canopy gaps and interspaces between tree groups or individuals are based on site productivity and soil type and range from 10 percent on highly productive sites to as high as 90 percent on those soil types that have an open reference condition.
- Suitable openings for successful natural regeneration in this project would range in size from 3/10 to 8/10 of an acre.

Heavily-Stocked Stands (with High Basal Area) Generated by a Preponderance of Large, Young Trees

In some areas, the increase in post-settlement trees has been so rapid that current stand structure is characterized by high density and high basal area in large, young trees. These stands or groups of stands exhibit continuous canopy which promotes unnaturally severe fire effects under severe fire weather conditions. At the fine scale, the management approach would apply on a case-by-case basis. The removal of large trees may be necessary to meet site-specific ecological objectives as listed below. For example, the removal of large trees may be necessary in order to reduce the potential for crown fire to spread into communities or important habitats that include MSO and/or goshawk nest stands.

In stands where pre-settlement evidences, restoration objectives, community protection, or other ecological restoration objectives indicate much lower tree density and basal area would be desirable, large post-settlement conifers may need to be removed to achieve post-treatment conditions consistent with a desired restoration trajectory. Where evidence indicates higher tree density and basal area would have occurred pre-settlement, only a few large conifers may need to be removed. Many of these areas would support crown fire and, thus, require structural modification to reduce crown fire potential and restore understory vegetation that supports surface fire.

Ecological Objectives

- Natural heterogeneity of forest, savanna, and grasslands occurs at the landscape scale and within stands.
- Groups are restored by retaining the largest trees on the landscape to reestablish old growth structure in the shortest timeframe possible.
- Decreased shading and interception from the canopy, decreased needle litter and duff, and surface fire restore and maintain a mosaic of natural vegetative communities.
- Decreased shading and interception from the canopy fuels allow the growth of continuous herbaceous surface fuels to carry surface fire.
- Reduced horizontal and vertical canopy fuels reduce the potential for crown fire.
- Fire may be used with other methods to maintain forest structure over time.
- Regeneration openings and interspaces contribute to the ecological objective of natural heterogeneity of historical forest structure, age class diversity, and open space.

Section E – Density Management and the Relationship between Treatment Intensity, Tree Group Density, and Overall Average Density

Table 114. Treatment intensity

Treatment Intensity	% Area in Interspace	Total % Treed Area	% Treed Area in Groups and Individuals	% Treed Area in Regeneration Openings	Average Group BA to Achieve Overall BA of 40	Average Group BA to Achieve Overall BA of 50	Average Group BA to Achieve Overall BA of 60	Average Group BA to Achieve Overall BA of 70	Average Group BA to Achieve Overall BA of 80	Average Group BA to Achieve Overall BA of 90
10-25	10	90	90	0	44	56	67	78	89	100
10-25	10	90	85	5	47	59	71	82	94	106
10-25	10	90	80	0	50	63	75	88	100	113
10-25	10	90	75	15	53	67	80	93	107	120
10-25	10	90	70	20	57	71	86	100	114	129
10-25	15	85	85	0	47	59	71	82	94	106
10-25	15	85	80	5	50	63	75	88	100	113
10-25	15	85	75	10	53	67	80	93	107	120
10-25	15	85	70	15	57	71	86	100	114	129
10-25	15	85	65	20	62	77	92	108	123	138
10-25	20	80	80	0	50	63	75	88	100	113
10-25	20	80	75	5	53	67	80	93	107	120
10-25	20	80	70	10	57	71	86	100	114	129
10-25	20	80	65	15	62	77	92	108	123	138
10-25	20	80	60	20	67	83	100	117	133	150
25-40	25	75	75	0	53	67	80	93	107	120
25-40	25	75	70	5	57	71	86	100	114	129
25-40	25	75	65	10	62	77	92	108	123	138
25-40	25	75	60	15	67	83	100	117	133	150
25-40	25	75	55	20	73	91	109	127	145	164
25-40	30	70	70	0	57	71	86	100	114	129

Treatment Intensity	% Area in Interspace	Total % Treed Area	% Treed Area in Groups and Individuals	% Treed Area in Regeneration Openings	Average Group BA to Achieve Overall BA of 40	Average Group BA to Achieve Overall BA of 50	Average Group BA to Achieve Overall BA of 60	Average Group BA to Achieve Overall BA of 70	Average Group BA to Achieve Overall BA of 80	Average Group BA to Achieve Overall BA of 90
25-40	30	70	65	5	62	77	92	108	123	138
25-40	30	70	60	10	67	83	100	117	133	150
25-40	30	70	55	15	73	91	109	127	145	164
25-40	30	70	50	20	80	100	120	140	160	180
25-40	35	65	65	0	62	77	92	108	123	138
25-40	35	65	60	5	67	83	100	117	133	150
25-40	35	65	55	10	73	91	109	127	145	164
25-40	35	65	50	15	80	100	120	140	160	180
25-40	35	65	45	20	89	111	133	156	178	200
40-55	40	60	60	0	67	83	100	117	133	150
40-55	40	60	55	5	73	91	109	127	145	164
40-55	40	60	50	10	80	100	120	140	160	180
40-55	40	60	45	15	89	111	133	156	178	200
40-55	40	60	40	20	100	125	150	175	200	225
40-55	45	55	55	0	73	91	109	127	145	164
40-55	45	55	50	5	80	100	120	140	160	180
40-55	45	55	45	10	89	111	133	156	178	200
40-55	45	55	40	15	100	125	150	175	200	225
40-55	45	55	35	20	114	143	171	200	229	257
40-55	50	50	50	0	80	100	120	140	160	180
40-55	50	50	45	5	89	111	133	156	178	200
40-55	50	50	40	10	100	125	150	175	200	225
40-55	50	50	35	15	114	143	171	200	229	257
40-55	50	50	30	20	133	167	200	233	267	300

Treatment Intensity	% Area in Interspace	Total % Treed Area	% Treed Area in Groups and Individuals	% Treed Area in Regeneration Openings	Average Group BA to Achieve Overall BA of 40	Average Group BA to Achieve Overall BA of 50	Average Group BA to Achieve Overall BA of 60	Average Group BA to Achieve Overall BA of 70	Average Group BA to Achieve Overall BA of 80	Average Group BA to Achieve Overall BA of 90
55–70	55	45	45	0	89	111	133	156	178	200
55–70	55	45	40	5	100	125	150	175	200	225
55–70	55	45	35	10	114	143	171	200	229	257
55–70	55	45	30	15	133	167	200	233	267	300
55–70	55	45	25	20	160	200	240	280	320	360
55–70	60	40	40	0	100	125	150	175	200	225
55–70	60	40	35	5	114	143	171	200	229	257
55–70	60	40	30	10	133	167	200	233	267	300
55–70	60	40	25	15	160	200	240	280	320	360
55–70	60	40	20	20	200	250	300	350	400	450
55–70	65	35	35	0	114	143	171	200	229	257
55–70	65	35	30	5	133	167	200	233	267	300
55–70	65	35	25	10	160	200	240	280	320	360
55–70	65	35	20	15	200	250	300	350	400	450
55–70	65	35	15	20	267	333	400	467	533	600

Note: Red fill indicates high residual within group basal areas, yellow fill indicates moderate within group basal area and green indicates low within-group basal area

Table 115. Trees per Acre by Quadratic Mean Diameter and Basal Area

Group Quadratic Mean Diameter	55 BA^2	60 BA^2	65 BA^2	70 BA^2	75 BA^2	80 BA^2	85 BA^2	90 BA^2	95 BA^2	100 BA^2	105 BA^2	110 BA^2	115 BA^2	120 BA^2	125 BA^2	130 BA^2	135 BA^2	140 BA^2	145 BA^2	150 BA^2	155 BA^2	160 BA^2	165 BA^2	170 BA^2	175 BA^2	180 BA^2	185 BA^2	190 BA^2	195 BA^2
8	158	172	186	200	215	229	243	258	272	286	301	315	329	344	358	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	125	136	147	158	169	181	192	204	215	226	238	249	260	272	283	294	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	101	110	119	128	138	147	156	165	174	183	193	202	211	220	229	238	248	257	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11	83	91	99	106	114	121	129	136	144	152	159	167	174	182	189	197	205	212	220	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	70	76	83	89	96	102	108	115	121	127	134	140	146	153	159	166	172	178	185	191	NA	NA	NA	NA	NA	NA	NA	NA	NA
13	60	65	71	76	81	87	92	98	103	109	114	119	125	130	136	141	147	152	157	163	168	NA	NA	NA	NA	NA	NA	NA	NA
14	51	56	61	66	70	75	80	84	89	94	98	103	108	112	117	122	126	131	136	140	145	150	NA	NA	NA	NA	NA	NA	NA
15	45	49	53	57	61	65	69	73	77	81	86	90	94	98	102	106	110	114	118	122	126	130	NA	NA	NA	NA	NA	NA	NA
16	39	43	47	50	54	57	61	65	68	72	75	79	82	86	90	93	97	100	104	107	111	115	118	NA	NA	NA	NA	NA	NA
17	35	38	41	44	48	51	54	57	60	63	67	70	73	76	79	83	86	89	92	95	98	102	105	108	NA	NA	NA	NA	NA
18	31	34	37	40	42	45	48	51	54	57	59	62	65	68	71	74	76	79	82	85	88	91	93	96	99	NA	NA	NA	NA
19	28	31	33	36	38	41	43	46	48	51	53	56	58	61	63	66	69	71	74	76	79	81	84	86	89	91	NA	NA	NA
20	25	28	30	32	34	37	39	41	43	46	48	50	53	55	57	60	62	64	67	69	71	73	76	78	80	83	NA	NA	NA
21	23	25	27	29	31	33	35	37	40	42	44	46	48	50	52	54	56	58	60	62	64	67	69	71	73	75	77	NA	NA
22	21	23	25	27	28	30	32	34	36	38	40	42	44	46	47	49	51	53	55	57	59	61	63	64	66	68	70	72	NA
23	19	21	23	34	26	28	30	31	33	35	36	38	40	42	43	45	47	49	50	52	54	56	57	59	61	62	64	66	NA
24	18	19	21	22	24	26	27	29	30	32	33	35	37	38	40	41	43	45	46	48	49	51	53	54	56	57	59	61	62

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

Color Coding Key: Green = SDI zones 1 and 2 (15 to 35% of maximum SDI). This is considered the lower range of stocking.

Yellow = SDI zone 3 (36 to 45% of maximum SDI). This is considered the middle range of stocking.

Orange = SDI zone 3 (46 to 55% of maximum SDI). This is considered the upper range of stocking.

Red = SDI zone 4 (56%+ of maximum SDI). Tree groups will not be managed within this zone.

Section F – Flexible Tool Box Approach

Mechanical Treatments Flexible Toolbox Approach

Rim Country Project provides the implementation resource specialists flexibility to apply a higher quality treatment that best meets project desired conditions and stand level prescription objectives. The need for this approach is derived from applying adaptive management considerations and lessons learned from past related projects.

The project decision and analysis used a site specific treatment assigned at the stand level based on biotic and abiotic factors such as known habitat, soil types. The analysis used the best information and tools at the time to model a site specific decision. Field verification could drive change to the baseline prescription for a higher quality of implementation. Baseline prescriptions is a place for field verification to start. This toolbox approach would be used to identify and analyze prescription options when discrepancies occur upon field verification. This approach describes a series of current conditions and then identify a prescription that could stands toward desired conditions. We will use decision matrices with a set of "if…then" determination points, based on conditions at the time of implementation, which would lead to the desired condition. Figure 95 demonstrates the toolbox process using cover and habitat cover types, a decision matrix and modifiers.

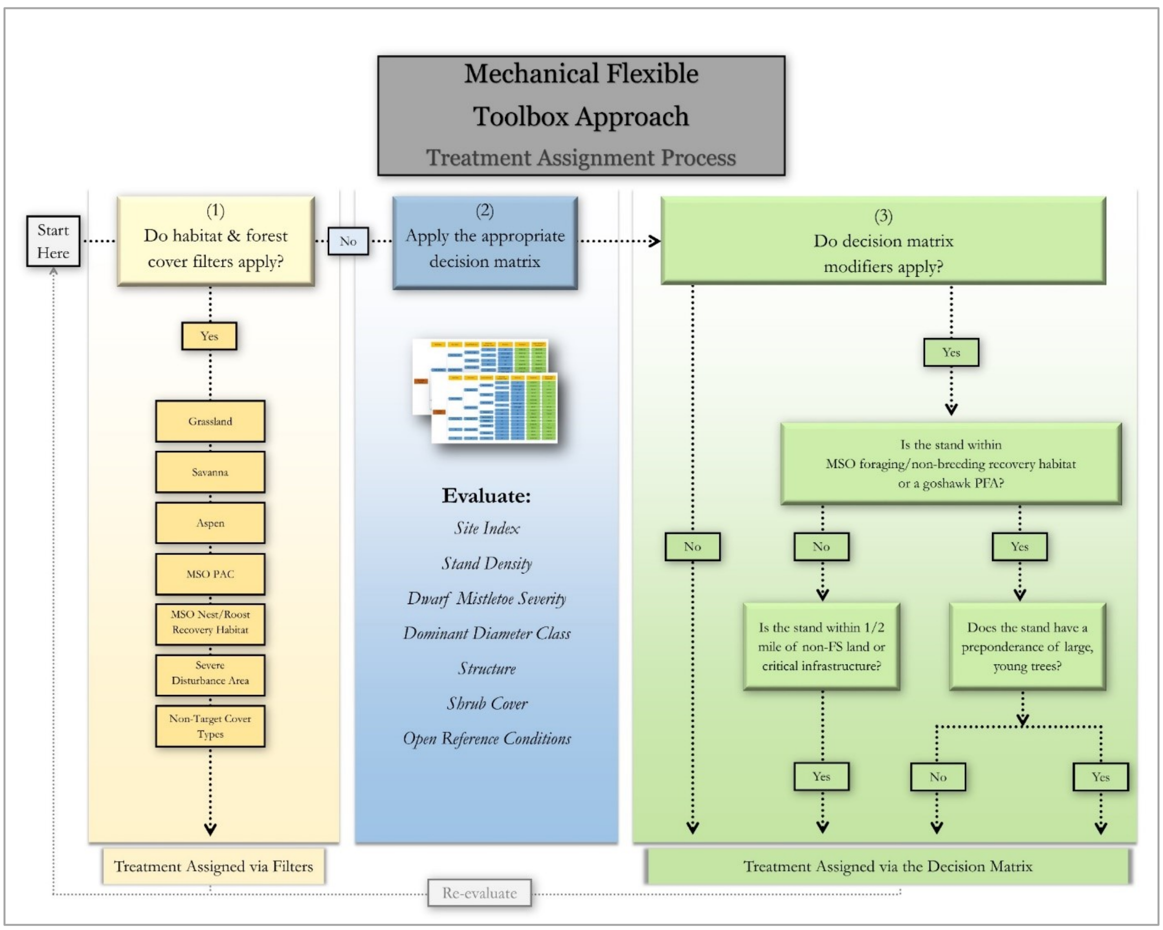

Figure 95. Mechanical Flexible Toolbox Process

Habitat and Ecosystem Cover Filters

Certain habitats are managed to specific treatment objectives and tactics outlined in Section B Management Direction, desired Conditions and Treatment Design. Habitat and ecosystem cover filters include Mexican spotted owl protected activity centers, Mexican spotted owl nest roost recovery, aspen stands, savanna areas, grassland areas, severe disturbance areas and non-targeted cover types for facilitating operations. Stands or areas within these filters would be treated with the objectives and tactics outlined in Section B. Treatments will not be determined as a result of the flexible toolbox decision matrix.

Mexican Spotted Owl Protected Activity Centers and Recovery Nesting and Roosting Habitat

These areas have been consulted on with Fish and Wildlife Service.

Aspen

These stands have been identified as those having the majority of live basal area in aspen. Aspen restoration treatments may include conifer removal from within stands, and barriers to reduce browsing pressure on regeneration. Inclusion of aspen stands not identified in the analysis may be treated as aspen upon field verification.

Grassland

Areas or portions of stands that overlap with a grassland terrestrial ecosystem unit were identified as grassland. Grassland-specific restoration includes a mechanical treatment that removes post-settlement conifers and manages for at least 90% of the treatment area as grass/forb, using pre-settlement tree evidence as guidance. Inclusion of grasslands based on soils that are not identified in the analysis may be treated as grassland upon field verification.

Savanna

Stands or portions of stands that overlap with a savanna terrestrial ecological unit and are adjacent to stands identified for a grassland treatment are classified as savanna. Also, those stands or portions of stands that overlap with a savanna terrestrial ecological unit and with an existing condition of less than 25 percent max SDI were identified as savanna. Savanna restoration includes a mechanical treatment that restores pre-settlement tree density and pattern, and manages for a range of 70 to 90 percent interspace between groups or individual trees, using pre-settlement evidence as guidance. Inclusion of savanna based on soils that are not identified in the analysis may be treated as savanna upon field verification

Severe Disturbance Areas

Severe disturbance areas are those where the spatial extent and/or the pattern of high severity effects is not within Desired Conditions, likely as a result of high-severity wildfire or insect outbreak. In some places this has resulted in aggressively sprouting species, such as alligator juniper and various species of oak dominating the vegetative response, making it difficult or impossible for ponderosa pine to establish or thrive. In other areas, extensive, overly dense patches of ponderosa pine regeneration have put stands on a trajectory toward stagnation, density-related mortality, or additional severe disturbance. In these areas of extensive, pure ponderosa pine regeneration, the decision matrices would be applied.

Restoration treatments in severe disturbance areas will include combinations of reforestation, prescribed fire, lopping/scattering, mastication, and other mechanical methods with the objective of identifying treatments that would be effective in restoring the fuel structure that produces the types of fire to which ponderosa pine is adapted.

Non-target Cover Types (Facilitative Operations)

Facilitative operations (FO) are treatments implemented in non-target cover types as needed to support the use of prescribed fire in target cover types. FO would be used in non-target cover types that lie between target cover types and existing features appropriate to use as prescribed fire boundaries, or that are surrounded by target cover types. FO treatments would either move these areas towards desired conditions as described in the forest plans or maintain the current condition. The inclusion of FO in burn units would be designed to improve safety, improve treatment effectiveness, expand burn windows, and minimize disturbance.

DECISION MATRICES

The following decision matrices have been built to incorporate discrete attributes that can be used to segregate stands for different treatments and build diversity across the landscape. There are two matrices: one for the Apache-Sitgreaves and Coconino NFs and one for the Tonto NF.

The Tonto matrix was developed separately because of the large amount of the ponderosa pine/evergreen oak cover type on the Tonto.

If the goal of a flexible toolbox is to prescribe the right treatment on the right acre, then vegetation condition should guide management decisions. One way to do this is to describe the stand structure, for example if it is even-aged or uneven-aged. We may want to thin even-aged stands differently than uneven-aged stands to move them toward the desired condition of uneven-aged stand structure. An even-aged stand would be treated to develop more openings, to encourage new cohorts and a more uneven-aged structure, and to develop one or two more age classes (additional age classes could be developed in later entries). An uneven-aged stand would be thinned to develop larger groups, in all diameter ranges, to maintain or enhance the current uneven-aged structure.

Another way to provide more flexibility is to consider the variety of site classes that occur across the project area. Stands with a higher site class may be able to be managed at a higher residual basal area and with less interspace. Additionally, the level of dwarf mistletoe infection should be considered in prescribing treatments in order to most effectively improve resilience without releasing or stimulating the infection. Refer to Section B Management Direction, desired Conditions and Treatment Design for specific treatment descriptions. Figure D-3 and Figure D-4 are decision matrices used during field verifications.

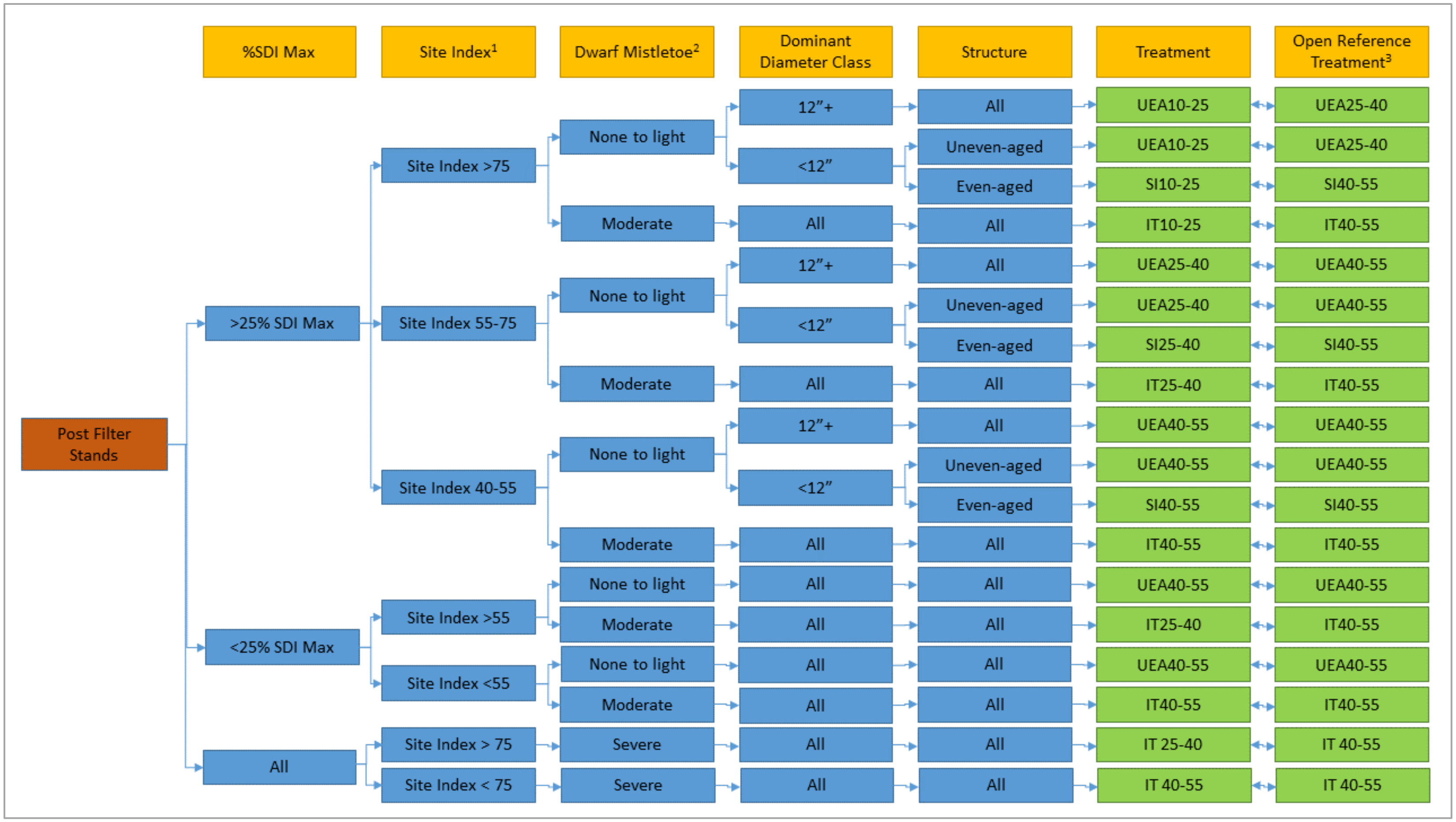

Figure 96. Decision matrix for the Coconino National Forest and Apache-Sitgreaves National Forest

[1]Stands with a Site Index less than 40 are confined to woodland sites.

[2]Dwarf Mistletoe Infection:

Light: < 20% Susceptible TPA infected. Moderate: 20-80% Susceptible TPA infected. Severe: > 80% Susceptible TPA infected

[3]Open Reference Treatment: Alternative treatment applied to those stands or parts of stands that occur on mollic intergrade soils where we have not proposed a savanna treatment as described in the savanna section of the flexible toolbox.

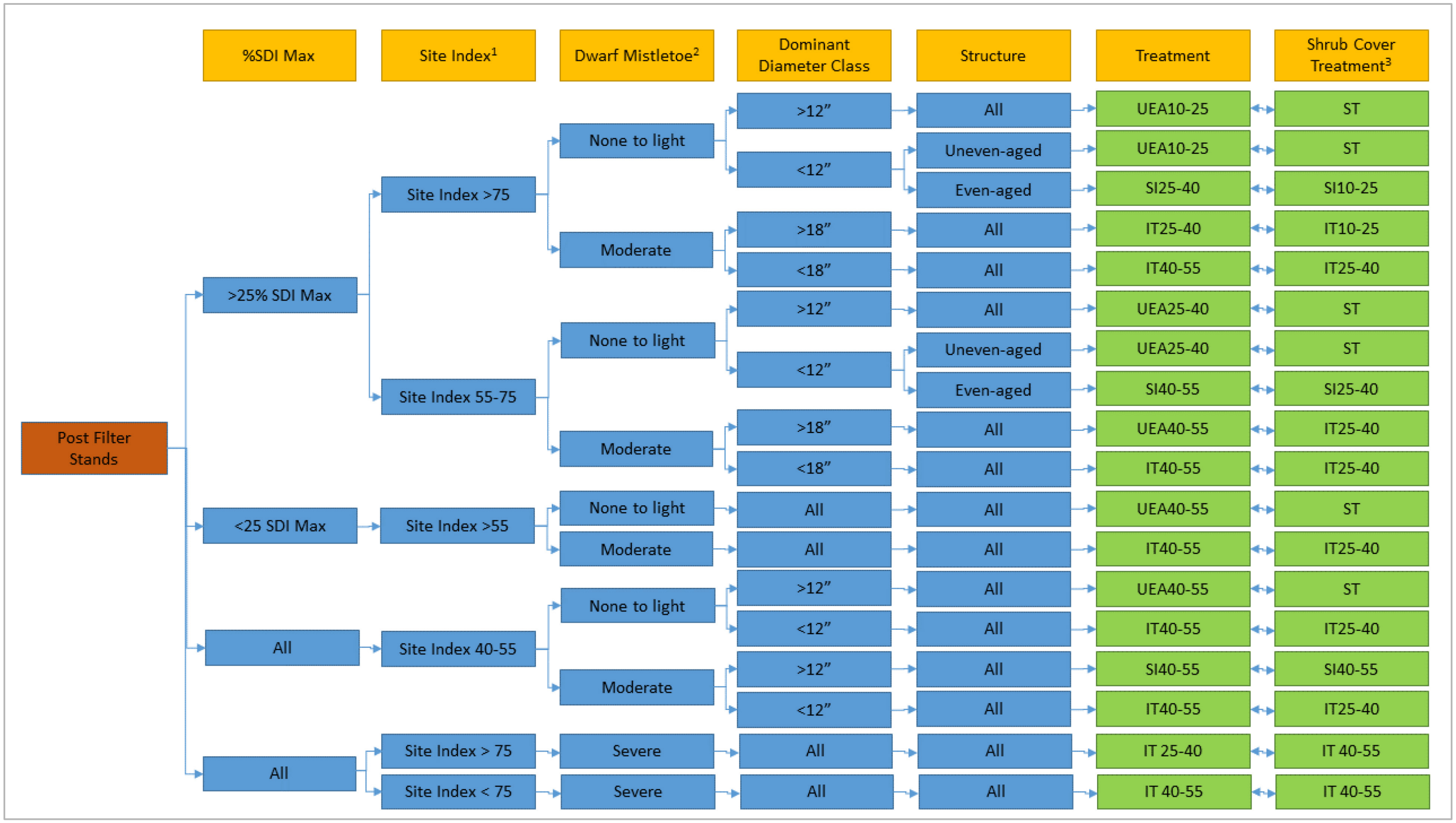

Figure 97. Decision Matrix for the Tonto National Forest

[1]Stands with a site index less than 40 are confined to woodland sites.

[2]Dwarf Mistletoe Infection:

Light: < 20% Susceptible TPA infected. Moderate: 20-80% Susceptible TPA infected. Severe: > 80% Susceptible TPA infected

[3]Shrub Treatment: Alternative treatment designed for when evergreen oak or shrub exceeds 40% of existing cover or when habitat type indicates that an undesirable shrub response would be likely.

The advantage of using this type of matrix is that we are looking at "conditions" and not necessarily "stands." Some of the stand delineations are potentially dated and there is a chance that the conditions that set the stand boundaries have changed, or that conditions within a stand are now changed (partial burns, partial thinning). This flexible approach prescribes treatments according to expected conditions and not necessarily by previously defined stands, so that stand boundaries can be re-delineated based on current conditions. This is particularly important where there is a patchy condition in a stand, such as that caused by dwarf mistletoe or a group of large young trees. If it is necessary to have two or more distinct treatment prescriptions in one stand to accommodate intra-stand variability, then the silviculturist should delineate new stand boundaries.

This approach also allows for a broad range of densities within the individual treatments identified in the decision matrices. This approach helps give fine-, mid-, and landscape-scale perspectives across the project area, in order to determine if proposed treatments are moving toward desired conditions at multiple scales. Stand-level data can be aggregated up to the mid- and landscape-scales for the Rim Country analysis.

Stands Infected with Dwarf Mistletoe

While the overall incidence (distribution and percent of landscape affected) of dwarf mistletoe is thought to have increased only modestly compared to historic conditions, the overall intensity and abundance of mistletoe is thought to have increased considerably (Conklin and Fairweather 2010). In order to meet the purpose of increasing the resilience and sustainability of ponderosa pine ecosystems within the Rim Country project area, restoration-based treatments that would assist in reducing the abundance and intensity of dwarf mistletoe infection in stands are included.

In lightly (0 to 20 percent infection) and moderately (20 to 80 percent infection) infected stands, the restoration treatments in the modified proposed action will address dwarf mistletoe. In stands with light infections, to the proposed action allows for removal of infected trees as part of the uneven-aged thinning, single-tree selection, stand improvement treatments. Pockets of mistletoe infection would be addressed through the reduction of basal area as well as the creation of openings and interspaces as part of these treatments.

In moderately-infected stands, the intermediate thin treatment would be particularly effective at addressing dwarf mistletoe, especially at the lower part of the moderate range (20 to 50 percent). Towards the higher end of the moderate range (50 to 80 percent infection), mistletoe would remain as a component of the stand, while remaining basal area, providing for full stocking, would reduce the stimulation of mistletoe in the remaining trees. Pockets of dwarf mistletoe infection could be addressed through the reduction of basal area as well as the creation of small openings and interspaces.

Heavily infected stands (80 percent or more of the target species in the stand are infected) would be assigned an intermediate thin (IT) treatment. In order to be ecologically responsive, treatment intensities would be applied with respect to site quality, with stands with higher site qualities being prescribed less intense treatments (see Figure 96 and Figure 97). As it has been shown that restoration-based treatments applied at the lowest intensity level are less effective than those implemented at higher intensity levels (Kralicek and Mathiasen, unpublished data), the lowest intensity level (IT 10-25) would be omitted from the treatment assignment process. While the effects were analyzed assuming implementation at the highest intensity within the assigned treatment, this still allows for the application of other restoration-based treatments to be applied to these stands, including a less intense treatment, deferment of mechanical treatment, or use of prescribed fire only. Because of the patchy nature of dwarf mistletoe infections, it is recommended that the district silviculturist consider re-delineating a stand with high mistletoe infection and treating the healthy and infected portions with separate prescriptions.

WUI (non-FS lands and critical infrastructure)

For the purposes of the Rim Country Project, what is commonly referred to as Wildland-Urban Interface, or WUI, will consist of those areas within ½ mile of non-FS lands with structures or critical infrastructure (communication sites, high value recreation sites, transmission lines, FS building complexes). In these areas, in order to protect values at risk, the flexibility is given for more open treatments that will result in up to 70 percent interspace.

Stands or parts of stands within these buffers that are identified as habitat and cover type filters or modifiers (as described in this flexible toolbox approach) will not be considered for these types of increased-intensity treatments, but will be considered for the appropriate treatments per their descriptions in this flexible toolbox approach.

These treatments to protect values at risk will be prioritized with site-specific considerations identified with Community Wildfire Protection Plans and local FS ranger districts, including:

- Susceptibility to wildfire
- Current conditions
- Prevailing winds
- Topography

The current condition of each of these areas will be field-reviewed prior to implementation by an interdisciplinary team of resource specialists, to determine what type and level of mechanical treatment is needed to protect the values at risk.

Habitat and Forest Cover Modifiers

Some habitat and stand structures will make use of the decision matrices but with specific design features to ensure resource protection. For example, while MSO PACs may require certain types of treatment apart from the decision matrices, treatments in northern goshawk (NOGO) Post-Family Fledgling Areas (PFAs) or in Stands with a Preponderance of Large Young Trees (SPLYT) may only require certain design features in addition to decision matrix treatments to provide adequate resource protection. Habitat and forest cover types that will require additional considerations or modifiers in addition to application of the decision matrices are described here.

MSO Foraging/Non-breeding Recovery Habitat

Achieving management objectives within MSO recovery habitat can be addressed with the flexible toolbox approach. Stands in recovery habitat would be assigned a treatment using the decision matrices; however, additional management direction would be applied such as maintaining increased basal area (40-110 BA for pine-oak and 40-135 BA for mixed conifer). This additional direction will be included in the project design features to ensure resource protection.

NOGO Nest Stands

Achieving management objectives for northern goshawk nest stands can be addressed with the flexible toolbox approach. NOGO nest stands would be assigned a treatment using the decision matrices. However, additional direction would be included in project design features, such as maintaining increased basal area within nest areas, to maintain or improve habitat and ensure forest plan compliance.

NOGO Post-Fledging Areas (PFAs)

Management objectives in NOGO PFAs are similar to those in NOGO nest stands and can be addressed with the flexible toolbox approach. NOGO PFA stands would be assigned a treatment using the decision matrices; however, additional direction would be included in project design features, such as maintaining increased basal area within PFAs, to maintain or improve habitat and ensure forest plan compliance.

Stands with a Preponderance of Large Young Trees (SPLYT)

The iterative spatial analysis and field validation effort undertaken by the Forest Service and stakeholders yielded an initial filter for SPLYT located outside of MSO PACs, MSO recovery habitat, and wildland urban interface (WUI). For ponderosa pine SPLYT, criteria are that: a) the Quadratic Mean Diameter (QMD) of the top 20 percent of trees is greater than 15 inches diameter at breast height (DBH), and b) there is more than 50 square feet/acre of basal area (BA) in trees greater than 16 inches DBH. All stands would be field-verified prior to mechanical thinning. Stands (or portions thereof) meeting SPLYT criteria, including those not captured by the data filter, would be treated at the lowest range of intensity within the identified silvicultural prescription. For example, a stand identified by the decision matrices to receive an uneven-aged treatment leaving 10 to 25 percent interspace (UEA 10-25), would be treated to 10 percent interspace and to the upper end of its natural range of variation (NRV) for trees per acre (TPA) and BA in order to maintain large tree dominance and conditions favorable to canopy-dependent species. Stands (or portions thereof) that are identified by the SPLYT criteria data filter but, upon field verification, are determined not to meet the SPLYT criteria, will be treated within the range of intensities applied to other non-SPLYT stands.

Wild and Scenic River Corridors

There are currently no designated wild segments of wild and scenic rivers in the Rim Country project area. However, as part of its forest plan revision process, the Tonto NF is completing an updated eligibility report for wild and scenic rivers to replace the existing eligibility report from 1993. To ensure compliance with current forest plan direction, the Rim Country EIS includes both the eligible rivers reported in the 1993 study, as well as those listed in the current draft eligibility report. Design features have been included in Appendix C specifically for the purpose of adjusting proposed treatments in the future as eligibility and suitability are determined. Any mechanical treatments proposed in eligible wild and scenic river corridors in the Rim Country project area will be modified to meet the purposes of restoring natural geomorphic and ecological processes and the specific outstandingly remarkable values (ORVs) of the river (such as fish and wildlife habitat).

Mechanical Treatment Flexible Toolbox Approach Summary

The objective mechanical treatment flexible toolbox approach is to provide a higher quality treatment by accurately assessing forest stands in fine detail with professional walkthrough assessments. Figure 97 demonstrated the mechanical treatment flexible toolbox approach in more detail. Tables imbedded into this section would be used by field personnel upon prescription writing.

Flexible Toolbox Approach for Aquatic and Watershed Restoration Activities

The Rim Country project area encompasses over 1.2 million acres ranging in elevation from around 4,300 to 8,850 feet and includes 11 target vegetation cover types. This project area includes stream types ranging from high gradient headwater streams, meandering meadow reaches, and low gradient depositional valleys. There are approximately 4,000 miles of stream channels, including perennial, intermittent, and ephemeral. Wetlands such as wet meadows and springs also occur, providing unique aquatic and riparian habitats. There are 411 known springs on the three national forests that are either developed or undeveloped, and occur in meadow or riparian settings. It is estimated there are up to 10 times the number of unmapped springs that are not developed in the Rim Country project area. Riparian areas include vegetation types such as herbaceous sedge/rush, willow/alder, and cottonwood/sycamore vegetation.

Conditions within these watershed and aquatic systems range from relatively pristine to highly impacted. There are legacy impacts from timber management, channel modification, water developments such as springs and stock tanks, unregulated grazing, as well as more contemporary impacts from roads, non-native species, wildfires, recreation, and off-highway vehicle use. Some of these impacts are irreversible; however, in many systems there is potential for a new functional equilibrium. In other systems, there is the opportunity for either full restoration or preventing further degradation.

In general, desired conditions are functional soil, vegetation, and water resources, consistent with their flood regime and flood potential, which provide for diverse habitats. Stream channels have functioning floodplains and dissipate flood energy, as well as support connected riparian areas.

The toolbox addresses the effects of roads on watershed and aquatic systems, such as unauthorized routes and trails and stream crossings. The miles of unauthorized routes (roads or trails) within the project area are unknown, but their effects on these systems can easily be generalized. Based on current mapping, it is estimated that there are over 800 road and stream crossings in the project area. It is assumed that road crossings are generally stable on maintenance level 3 thru 5 roads (suitable for passenger cars to high degree of user comfort), and range from stable to unstable on maintenance level 1 and 2 roads (basic custodial care, i.e., closed, to open to high clearance vehicles). Existing maintenance level 1 and 2 roads which are potentially causing resource damage are addressed in the toolbox as well as maintenance level 3-5 roads which may be destabilizing streams.

Due to the size and complexity of the 1.24-million-acre Rim Country project area, and the variety and scope of the proposed activities, site-specific identification and analysis of all areas of need, or the possible combinations of restoration activities needed for each is not feasible within the necessary timeframe for Rim Country analysis. Complete baseline information on the condition of every acre is not currently available. However, there are a few categories of watershed and aquatic impairments that are common throughout the project area that may be appropriately addressed with a suite of restoration treatments, referred to as ”tools”, with predictable effects that can be analyzed in this project.

There is a wealth of information available to help make informed decisions on what kinds of restoration tools would be appropriate for certain site conditions. Altered or degraded riparian and aquatic habitat conditions generally occur across similar landscape features. To ensure the proper tools are available to help design specific watershed and aquatic restoration treatments for a variety of existing conditions, we propose to use a flexible toolbox approach so that local prescriptive treatments can be customized to current site-specific conditions. Landscape features that affect watershed and aquatic systems and how they function include: valley width, gradient, upland and riparian cover types, slope, access, soil types, hydrology (stream or spring flow), and substrate size. These features would be considered in determining site specific restoration treatments and the appropriate tools.

Having a suite of tools available for restoration helps account for imperfect information and adjust treatments in a variety of existing conditions, enabling project implementers to find the best solutions for a site-specific problem. Tools that might be appropriate in one area (e.g., stream type) may not be the right tool somewhere else. This flexible toolbox approach provides the ability to adapt treatments to unanticipated conditions or adapt treatments if monitoring indicates the effects of the project will differ from what was predicted in the analysis. Treatments that may cause effects potentially beyond the sideboards or limitations described in the original NEPA analysis would require subsequent NEPA analysis. Whenever possible, restoration treatments should be coordinated with other activities in the same area to create efficiencies. Restoration treatments could be incorporated into mechanical thinning contracts or stewardship agreements, or could be stand-alone projects specifically developed to address high-priority needs for comprehensive restoration.

This flexible toolbox approach applies to all action alternatives. Before carrying out aquatics and watershed restoration treatments, project leaders, specialists, and partners would look at a specific area to be treated and select the appropriate restoration tool(s). Some of the factors to be considered when designing these projects are: the extent and cause of the degraded resources, water quality issues, threatened and endangered species habitat, scenic sensitivity levels, and effects on non-forest lands. Design criteria, best management practices, and mitigation and conservation measures developed for the Rim Country Project would be applied to the flexible toolbox.

Implementation Decision Matrix

To guide implementation of aquatics and watershed restoration treatments and assist with their prioritization, a decision matrix was developed to be included in the flexible toolbox approach. The matrix gives guidance on the types of information to collect to identify the need for restoration treatments, identify potential restoration options and constraints, and prioritize projects for implementation.

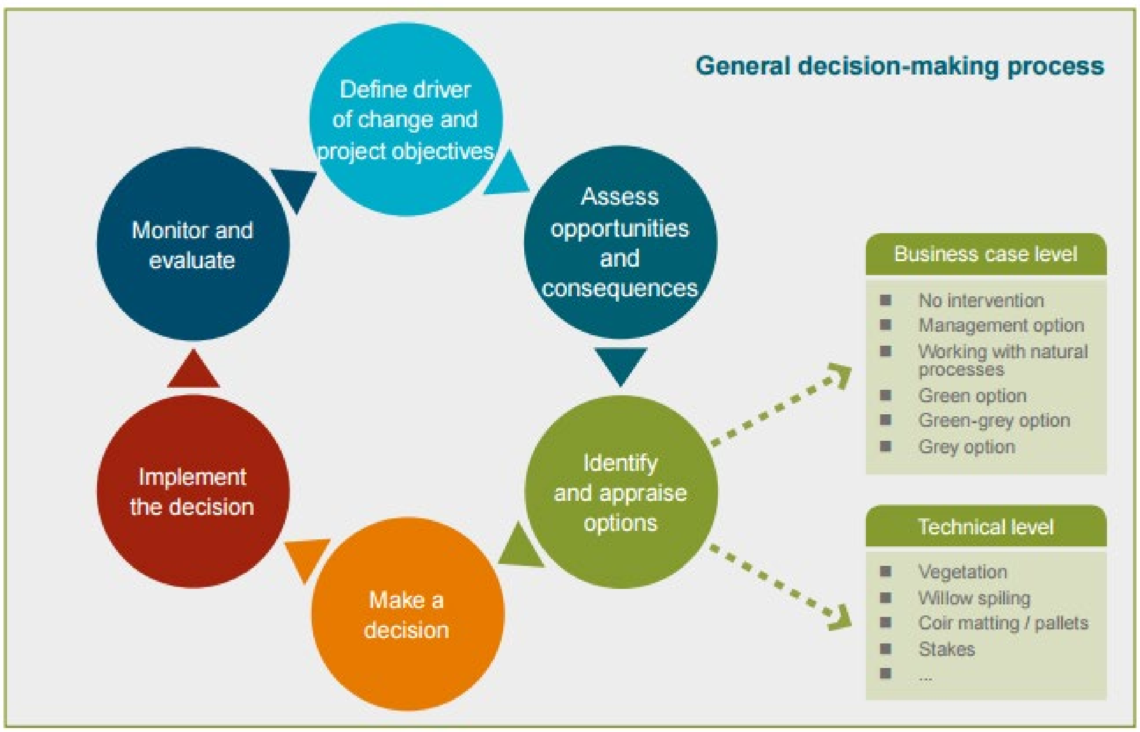

Figure 98. General decision-making process (Roca, et al. 2017)

Define driver of change and project objectives: The first step is identifying potential sites where restoration activities may be needed. Once sites are determined, information is needed to determine the existing baseline conditions and to understand any underlying causes of degradation. A baseline will need to be identified for the activity site using existing conditions and potentially reference sites if the activity site is degraded. The baseline for the site is what all restoration options should be assessed against to provide a basis for comparison. Understanding the drivers of change or causes of degradation is necessary to define the best approach and reach the most appropriate solution. The baseline should account for existing condition and drivers of change. In turn, objectives for the restoration activities in relation to improving the baseline condition should be determined.

Key Information that may be needed:

- Site reconnaissance: IDT, partners, stakeholders walk the potential project area to identify areas of concern and potential causes.
    - ♦ Landforms (valley type (transport vs. depositional reaches), relic channels, floodplains, very old trees, distinct reach breaks.
    - ♦ Occurrence of excess erosion or deposition, loss or change in species composition or density (plant or animal).
    - ♦ Signs of manipulation (berms, ditches, skid roads, landings, unusually flat surfaces, hummocks, old or unauthorized roads, infrastructure, etc.….)
- Research the history of an area.
    - ♦ Historic aerial photos
    - ♦ USFS photo archives, local historical societies, universities
    - ♦ Prior reports and local knowledge
    - ♦ Try to piece together what happened to cause the degradation.
- Characterize the past, current, and likely future trajectory of the area (e.g. SEM or Rosgen stream type, spring type, riparian successional stage, or Proper Functioning Condition.
- Assessment and inventory:
    - ♦ Valley and channel types (valley and channel gradients, entrenchment ratio, width to depth ration, sinuosity)
    - ♦ Hydrology (flood, low flow, bankfull, regional curves, channel bed material, roughness).
    - ♦ Sediment inputs (roads, fires, other land ownership, banks)
    - ♦ Riparian habitat and condition (existing, potential, and function)
    - ♦ Habitat connectivity (aquatic, terrestrial)
    - ♦ Forest resources (terrestrial and aquatic species, rare plants, weeds, etc.…)
    - ♦ Springs Ecosystem Assessment Protocol (SEAP) evaluation (Springs Stewardship Institute).
- Determine potential cause(s) of the problem (I.e. human activity, animals, past management, or natural processes). Whenever feasible, manage the cause of the problem rather than its symptoms.
- Determine the baseline of the system to adequately assess all restoration treatments.
- Identify any drivers likely to impact the system over its lifetime (e.g. growth, climate change).

Assess opportunities, consequences, and constraints: Identifying potential consequences of current condition (e.g. bank or bed erosion) and the opportunities to improve site conditions should be assessed to inform the identification of measures and their prioritization. Constraints of a potential project also need to be identified such as accessibility, nearby land ownership, and roads that cannot be moved are beneficial to determining restoration opportunities, prioritization, and potential treatments to be used.

Potential short and long-term consequences of potential treatments should also be identified. Finally, the scope of the potential activity needs to be evaluated to determine if the fit within the constraints of the NEPA.

- Promote resilient ecological functions of the system being assessed.
- Integrate approaches to seek solutions that deliver multiple benefits whilst increasing resilience.
- All feasible options should be clearly set out and described in relation to the baseline.
- Describe and assess key impacts to all stakeholders, both positive and negative for each restoration treatment.
- Determine restoration projects scope
  - ♦ Start big and whittle down based on process drivers.
  - ♦ Find a downstream vertical grade control (start of a canyon reach, natural nick point, etc.)
- For springs (Springs Stewardship Institute): Evaluate condition and need for spring function and species use. Develop specific goals for restoration
  - ♦ Restore the site to as nearly natural and ecologically functioning a condition as possible OR restore specific resources, characteristics or populations as desired by the manager OR restore other desired future condition of the site
  - ♦ Consider: Minimizing maintenance costs and activities
- For developed springs
  - ♦ Evaluate the water use needs and costs, irrigation schedule, and maintenance
  - ♦ Identify features to preserve in situ
  - ♦ Identify features to remove – old pipes, concrete, fencing, roads/trails, etc.
- Consider the following questions from Beechie et al. 2008:

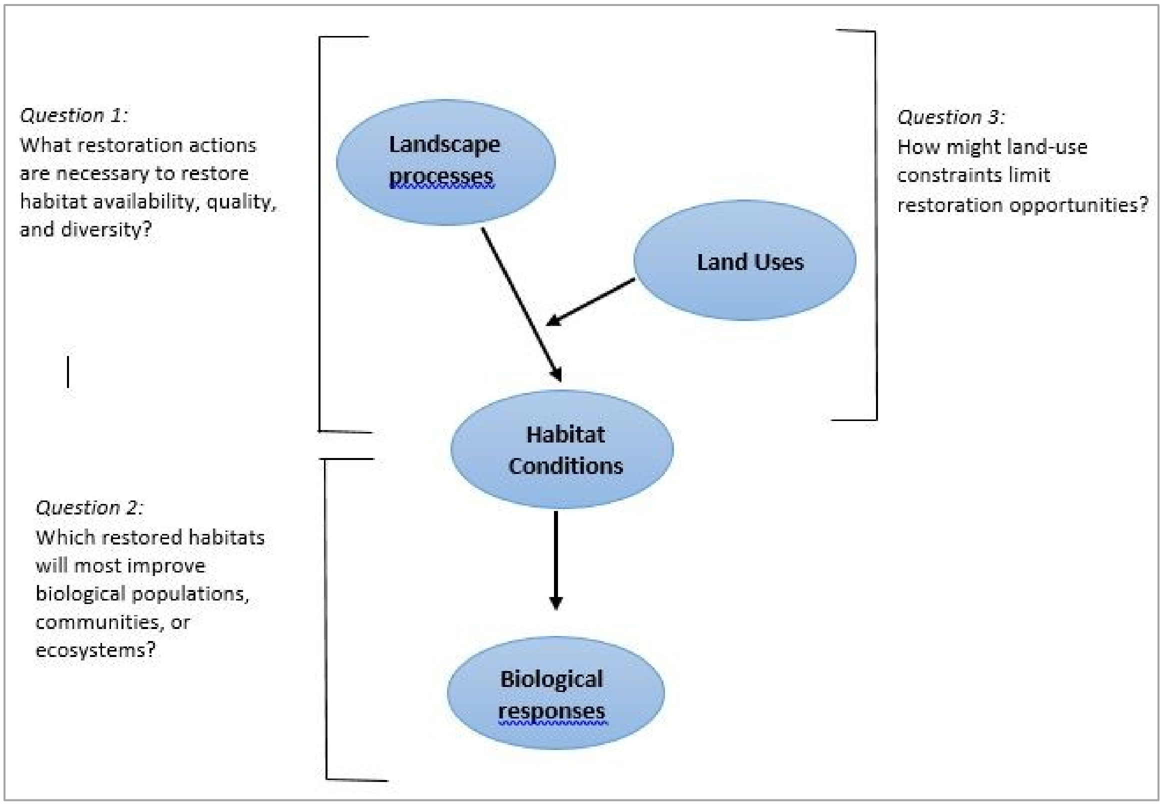

Figure 99. Diagram of conceptual linkages and questions to be addressed in assessments used to identify and prioritize restoration actions (Beechie et al. 2008).

Identify and appraise options: A number of potential options should be considered and appraised in order to provide a robust basis upon which to make a decision on how to move forward. All feasible options and flexible tools should be assessed and clearly described in relation to the baseline (no action) to provide decision makers and partners all the necessary information to base their decisions.

In addition, impacts of all options should be described and assessed. This includes impacts on all stakeholders, both positive and negative. Impacts should be screened for relevance and significance and can be assessed qualitatively or quantitatively where enough information is available to support the assessment.

In summarizing the results of the options, costs and benefits should be aggregated across relevant categories to provide a consistence basis for assessment. Comparisons should be consistent and any uncertainties should also be described and addressed.

- Can the restoration treatment meet and fulfill the objectives for the project?
- What are the chances of success?
- Does it address the causes rather than the symptoms?
- Consider the consequences of taking no action, assess the risks, costs, and benefits of implementing each option.

No Treatment: allows the natural adjustment of a system and therefore is the most sustainable. Should be applied when natural processes are likely to constitute a natural solution to the problem and the system has the ability to adjust (all processes functioning and no anthropogenic constraints).

Management Option(s)/Restoration Activities: Based on addressing the causes of the problem. This option involves restoration treatments to improve existing conditions.

Restoration activities should be developed and prioritized at the forest and district level in collaboration with partners.

Prioritization

Four primary considerations could be used to prioritize locations and timing of aquatic and watershed restoration activities: watershed condition framework, corresponding vegetation restoration activities, partner interest, and presence of federally-listed or candidate species.

Activities that may be identified within a proposed vegetation treatment area include, but are not limited to: thinning conifers along and within riparian areas, restoring incised channels, riparian planting, removing/obliterating unauthorized routes, and/or putting in drainage and closing level 1 system roads after all treatments are completed.

Prioritization of aquatic and watershed restoration projects will depend upon multiple site specific factors. Therefore, we list considerations when prioritizing activities rather than requirements.

Table 116. Considerations for prioritizing where and when treatments are implemented

Factors to Consider	Details and Guidance
Watershed Condition Framework and priority watersheds.	Areas or activities within existing Watershed Restoration Action Plans can increase opportunities to move watersheds into a higher condition class. Maintaining or improving watershed condition where feasible should be taken into consideration. Projects in priority watersheds should be considered.
Projects that improved impaired waters	Projects that improve water quality in ADEQ TMDL (water quality improvement plan) or 303b listed streams.
Vegetation restoration activities within the area.	Incorporating aquatic and watershed restoration activities in an area with other restoration treatments whenever possible is one way to create efficiencies with heavy equipment and personnel.
Partner Interest	Projects that already have partners or interested partners, particularly if funding is available, should be considered.
Presence of federally listed or candidate species	The presence of these species and improving their habitat could increase the prioritization of a project over a site that had none present.
Wet meadows, cienegas, and other similar habitats.	These habitat types store water in upper watersheds and maintain baseflow to other aquatic habitats. They also cool water and can provide for lower stream water temperatures. Maintaining and improving these areas can have great downstream beneficial impacts.
Upper watershed vs. lower	Restoration in upper portions of watersheds can have beneficial impacts downstream such as reduced sedimentation, maintaining baseflow, and cooling stream temperatures. They will have a larger range of beneficial impacts than projects lower in a watershed.
Issues that are new, easily treated, or could quickly spread.	Newer issues have not yet caused that much damage; restoration treatments of these are more cost and time effective as well as preventing more degradation. Projects such as these are ‘low-hanging fruit’ when compared to larger or more widespread issues. In addition, new infestations of noxious weeds or aquatic invasive plants are easier to treat early rather than after they spread.
Force account, contracted, and partner implementation	All three categories have merit, but may have differing financial or oversight costs. These should be considered differently amongst options and assessed. Prioritization may depend upon which category a project occurs in when weighed against work load, capacity, and financial considerations.
Process versus form-based projects	Projects that enhance site conditions, but do not restore the processes that create habitat or site conditions are considered form-based. These types of projects can require more maintenance than projects that restore the processes that create and maintain habitat. Projects that restore processes may be more of a priority than those that address a specific issue rather than the larger problem.

Implementation of the treatment:

Consultation and Implementation:

Pre-implementation surveys will be conducted for Endangered Species Act and sensitive species, rare plants, invasive species, and cultural resources. If federally-listed, rare, or sensitive species, or cultural sites, are found during pre-implementation surveys or during activity implementation, the appropriate mitigation will be incorporated into activity design. Any cultural resource findings will be coordinated with the State Historical Preservation Office.

Validation and Collaboration Period:
Activities will include written specific activity descriptions and associated design criteria. The Implementation Checklist (Appendix D of the EIS, and stand-alone Implementation Plan) will be used to ensure each activity is consistent with the Rim Country analysis and within the scope of the decision.

Pre-project notification will be reported to all required regulatory agencies at least 60 days prior to implementation of the activity.

Monitor and evaluate: The impacts are monitored in order to appraise them against initial objectives of the project. The information should be used to ensure the project is consistent with the assumptions, analysis and biological opinion for the project. It should also be used to inform future restoration treatment decisions on maintenance and adaptive management.

Restoration treatments in the flexible toolbox:

The first set of tables below describe existing conditions and resource concerns for general types of aquatic systems in the toolbox. The second set of tables list the restoration tools grouped by the general set of resource concerns they address.

Table 117. Springs

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Surface flow impacted by hydrological drought, alteration of the source or outflow, springbox, diversion or piping.	Reduced surface and subsurface flows from human created diversions, piping and alterations reduce habitat for aquatic, wetland and riparian obligate species; plants and animals.	Improving spring outflows
Channeling or degraded outflow channels are degraded leading to reduced surface and/or subsurface flow.	Reduced surface and subsurface flows reduce habitat for aquatic, wetland and riparian obligate species; plants and animals.	Improving spring outflows and/or form and function of stream channels and floodplains
Invasive or noxious plants are present and competing with native vegetation.	Native plants are outcompeted or overtaken, habitat degraded, loss or decline of native species.	Improving native riparian or aquatic vegetation
Developed spring is splitting flow from a failing springbox, diversion or piping.	Diversion of flow is dewatering the outflow and associated wetlands.	Improving spring outflows
Riparian or aquatic vegetation and proper soil function is impacted by recreation or overgrazing by livestock or elk.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Plant composition has low similarity compared to historic range of variability. Reduction or loss of habitat.	Improving native riparian or aquatic vegetation
User created trails or roads are impacting wetland and associated vegetation.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Loss or decline of vegetative ground cover and increases in bare soil exposure. Soil compaction and subsequent accelerated erosion causing degradation of proper soil function and site productivity. Potentially leading to altered surface or subsurface flows. Reduction or loss of habitat.	Improving road or trail interactions
Spring is being encroached by upland species or undesirable native species.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Reduction or loss of spring habitat.	Improving native riparian or aquatic vegetation

Table 118. Wetlands (marshes, potholes, wet meadows, and natural ponds)

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Wetland is impacted by invasive plant species	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Plant composition has low similarity compared to historic range of variability. Reduction or loss of habitat.	Improving native riparian or aquatic vegetation
Encroachment by upland species or undesirable native species.	Encroachment is identified as an indicator of lowered water table, loss or decline of native and/or rare wetland, riparian, and aquatic plant species.	Improving native riparian or aquatic vegetation
Vegetation and soils may be impacted by excessive livestock or elk herbivory, unauthorized routes, etc.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Loss or decline of vegetative ground cover and increases in bare soil exposure. Soil compaction and subsequent accelerated erosion causing degradation of proper soil function and site productivity. Potentially leading to altered surface or subsurface flows. Reduction or loss of habitat.	Improving native riparian or aquatic vegetation.
Evidence of incision, slumping, excessive soil erosion/sedimentation or other such issues that are draining the wetland.	Reduced surface and subsurface flows draining the wetlands, narrowing or loss of wetland, riparian, and aquatic plant species. Reduction or loss of habitat.	Improving form and function of stream channels and floodplains
Poorly located or user created roads and trails causing degradation to soil function and site productivity.	Streams or wetlands have increased sedimentation, increased erosion, accelerated peak flows and loss or degraded vegetation from user created roads or trails.	Improving road or trail interactions

Table 119. Montane Meadows

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Native vegetation is impacted by invasive plant species.	Loss or decline of native plant species. Plant composition has low similarity compared to historic range of variability. Reduction or loss of habitat.	Improving native riparian or aquatic vegetation
Encroachment by upland species or undesirable native species.	Encroachment is an indicator of lowered water table, loss or decline of native plant species.	Improving native riparian or aquatic vegetation
Vegetation and soils may be impacted by excessive livestock or elk herbivory, unauthorized routes, OHV use, camping, etc.	Loss or decline of vegetation and ground cover, increases in bare soil exposure. Soil compaction and subsequent accelerated erosion causing degradation of proper soil function and site productivity. Potentially leading to altered surface or subsurface flows. Reduction or loss of habitat.	Improving native riparian or aquatic vegetation
Evidence of incision, slumping, excessive soil erosion/sedimentation or other such issues that are draining the meadow.	Reduced surface and subsurface flows draining the meadows. Reduction or loss of habitat.	Improving form and function of stream channels and floodplains
Poorly located or user created roads and trails causing degradation to soil function and site productivity.	Increased sedimentation, erosion, and accelerated peak flows from user created roads or trails.	Improving road or trail interactions

Table 120. Unneeded Roads and Unauthorized Routes and Trails

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Poorly located or user created roads and trails causing excessive soil disturbance, erosion and soil compaction.	Soil compaction and erosion. Soil compaction and subsequent erosion causing increased sedimentation if road networks are connected to stream channels.	Improving road or trail interactions
Stream or wetland damage due to poorly located or user created roads within the floodplain, wet meadow, spring outflow, or other such wetland habitats.	Confinement of stream channel, degradation of wetlands, erosion into aquatic habitats, draining of wetlands, channel widening.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Need for frequent maintenance that impacts aquatic and watershed resources.	Concentration of flows that were originally spread across a wide area via drainage capture by ditching or berms. Potential changes in peak flows.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Need for frequent maintenance that impacts aquatic and watershed resources.	Impacts to active channel or flood plain dimension that alters function (energy dissipation or sediment transport).	Improving road or trail interactions and/or form and function of stream channels and floodplains

Table 121. Roads and Stream or Wetland Crossing

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Road crossings are increasing sedimentation to streams, springs, wet meadows, and other wetlands. Road crossings are causing excessive soil erosion/sedimentation that may be impacting nearby downstream vegetation stability/productivity.	Increased sedimentation to aquatic systems degrading spawning habitat, reducing macroinvertebrate and algae food base. Loss or decline of native wetland vegetation and proper soil stability/productivity downstream from road crossing.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Roads and associated stream crossings are changing the character of flow across the landscape, such as concentrating flows into a culvert.	Alteration of flows/hydrology within a stream valley is causing channel incision.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Road crossings are causing geomorphic changes to stream channels such as stream widening.	Roads may cause widening of channels which can cause increased stream temperatures, alterations to the channel, and degraded stream habitat. Undersize culverts may cause an increase in stream velocity causing scour and downcutting.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Road crossing geometry is impairing sediment transport capacity and competency.	Alteration of sediment transport is causing long-term aggradation/degradation of the stream channel.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Aquatic organism passage (where it is meant to exist) is completely or partially impeded due to lack of stream flow, perched culverts, degraded culverts or other such issues.	Aquatic organisms cannot pass part or all of the time impeding migration, genetic flow, distribution, and access to refuge habitats.	Improving road or trail interactions and/or form and function of stream channels and floodplains
Roads are impacting stream and wetland plant communities through physical disturbance and soil compaction.	Roads may cause vegetation trampling, soil cover loss and soil compaction that can lead to decreased diversity of native species, loss of ground cover, and invasion of exotic species.	Improving road or trail interactions and/or form and improving native and riparian vegetation.

Table 122. Streams (channels, floodplains, and riparian)

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Stream habitat complexity is lacking, where it should exist, in relation to all aquatic species life stages (e.g. rearing and juvenile habitat).	Aquatic species need a variety of habitats to complete their life cycle.	Improving form and function of stream channels and floodplains
Most stream habitat is riffles or runs with little to no pool habitat and pool cover. Pool to riffle ratio is low.	Pool habitat is critical for resting habitat and thermal refugia for many species of fish.	Improving form and function of stream channels and floodplains
Large woody debris and recruitment is not present to create instream habitat complexity and cover.	Lack of large woody debris contributes to poor stream habitat diversity.	Improving form and function of stream channels and floodplains
Spawning habitat for various species (i.e. clean gravel bars, clean sand) are lacking.	Spawning habitat is essential to maintaining fish populations.	Improving form and function of stream channels and floodplains
Stream substrate is compacted or becoming cemented (i.e., tightly packed). Stream substrate is covered in fine sediment above natural levels.	Cemented substrate affects habitat availability for small bodied fish, macroinvertebrate habitat, and spawning habitat. Decreased pool depth and cover.	Improving form and function of stream channels and floodplains
Stream temperatures are high or reaching thermal tolerance of aquatic species.	Many aquatic species in the southwest are living at the edge of their thermal tolerance, drought conditions or warming temperatures may make habitats unsuitable.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation
Stream has or is currently incising and no longer connects with its floodplain or historic channels. Streambanks are incised or laterally unstable, and/or historic channels are abandoned.	Floodplain connection is critical for maintaining stream geomorphic function, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Laterally unstable banks are causing high erosion and sedimentation rates that alter aquatic and riparian habitat quality. Sediment transport is also affected. Historic channels provide habitat for varying ages classes of species, dissipate flood flows, provide riparian and aquatic habitat.	Improving form and function of stream channels and floodplains
Stream is confined; it has been straightened or confined.	Artificially confined streams may not function properly. Confinement may cause incision or other issues due to changes in stream power and sediment transport. These areas often have issues during flood flows.	Improving form and function of stream channels and floodplains

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Stream width and depth ratio is inappropriate for stream type.	Overly wide streams may lack pools and habitat diversity and have higher stream temperatures than streams with a lower width depth ratio. Conversely, artificially confined streams may be not be able to dissipate stream energy.	Improving form and function of stream channels and floodplains
Hydrologic cycles are altered leading to reduced flood flows, or increased frequency of high flows (e.g. post fire flooding).	Aquatic and riparian species are adapted to certain hydrologic cycles which can be important to their life cycles. Flood flows are essential for maintaining properly functioning stream channels, floodplains and substrate distribution.	Improving form and function of stream channels and floodplains
Streams and associated floodplains are not dissipating flood water energy causing damage to streambanks. Meander pattern altered.	Altered channel roughness or meander pattern is causing excessive erosion, limiting energy dissipation from high flows, changes to channel morphology, altering stream habitat and floodplains.	Improving form and function of stream channels and floodplains
Water quality is poor due to turbidity, sedimentation, or other factors other than temperature.	Poor water quality can cause a shift in macroinvertebrate and fish assemblages to more disturbance tolerant species. It can also alter primary or secondary productivity leading to changes in food availability.	Improving form and function of stream channels and floodplains
Large woody debris is not present in channels or wetlands to reduce stream energy, provide cover, and create complex habitat.	Lack of large woody debris recruitment to streams reduces roughness, cover, and habitat complexity.	Improving form and function of stream channels and floodplains
Riparian communities are not functioning at potential to support geomorphic and biotic needs of the aquatic community.	Riparian communities (both woody and herbaceous) are essential to the health of instream aquatic systems.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation
Leaf litter from riparian vegetation (allochthonous material) is lacking.	Organic matter (leaves) provide nutrients and food source for macroinvertebrates, prey species for fish.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation
Existing riparian woody vegetation is lacking or out competed by conifers.	Loss or decline of riparian vegetation, stream shade, and bank stability.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation
Floodplain vegetation has converted to upland species.	Riparian vegetation aids in flood resilience, dissipation of flows (roughness), large woody debris and bank stability for stream systems.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Tools for:
Riparian area is narrowing.	Narrowing riparian area could indicate reduced water table, disconnected floodplain, or other constraints leading to loss of bank stability, shade, large woody debris, and possibly reduced flows.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation
Soil compaction and accelerated soil erosion/sedimentation and bank instability.	Decreased soil function leading to stream bank soil instability and reduced site productivity of desirable native, riparian vegetation.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation

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

Table 123. Tools for Improving native Riparian or Aquatic Vegetation

Tools	Resource Issues or Concerns Addressed
Removing tree(s), tree canopy, or shrub encroachment of upland species with hand thinning, mechanical thinning or prescribed fire.	Loss or decline of wetland, riparian, or aquatic plant species. Indicators of drying that can be associated with past land management practices
Remove and manage noxious or invasive plants using hand methods or herbicides as described in forest weed management plans.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Protection or restoration of existing native biodiversity, erosion control, wildlife forage and habitat.
Plant native aquatic or riparian plant species by hand or mechanically, including seeding.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species, increased bank stability and leaf litter. Loss of site diversity and proper soil function.
Protect and promote existing native aquatic or riparian plant species. Site protection or fencing, which could be for seasonal restrictions, temporary restrictions, or year round. Install fencing, remove/relocate roads or trails, create defined trails for recreation management using manual or mechanical tools.	Promote plant growth and vigor, reduce erosion and sediment inputs to aquatic systems, removal of riparian or aquatic stressors. Reduce ungulate grazing, excessive soil disturbance, OHV impacts, created trails, and dispersed camping causing resource damage. Reduce erosion, bank instability
Prescribed burning.	Natural disturbance leading to regeneration of riparian plant species, reduction in fuel loading and fuel corridors.

Table 124. Tools for Improving Spring Outflows

Tools	Resource Issues or Concerns Addressed
Improve or remove boxes or other infrastructure, using excavation, shovels, trackhoes, jackhammers, concrete saw to restore natural spring function. Remove unneeded channels to consolidate spring outflow and increase habitat.	Spring developed for irrigation or livestock that is no longer needed and is compatible with existing water rights. Restoring natural spring function and flow
Split flow in developed springs to allow water above existing water rights to be released to spring outflows. Hand methods for fixing springboxes, piping, or diversions to split spring flow.	Drying of spring outflow, reduced aquatic and riparian vegetation, reduced habitat, reduced soil function, spring not functioning properly
Protect spring emergence zone and/or springbrook from direct ungulate disturbance through fencing.	Loss and/or degradation of wetland and riparian species from concentrated ungulate use of spring emergence zone and/or springbrook

Table 125. Tools for improving road or trail interactions with stream courses, springs, or other wetlands

Tools	Resource Issues or Concerns Addressed
Obliterate roads restoring natural contours and vegetation using mechanical roads treatments.	For existing roads causing resource damage such as confining a stream, draining wetlands, loss or degradation of riparian or aquatic vegetation and habitat, and loss or degradation to proper soil function.
Close and restore unauthorized roads, trails, and dispersed camping areas using mechanical roads treatments.	For unauthorized roads, trails or recreational impacts causing resource damage such as confining a stream, draining wetlands, loss or degradation of riparian or aquatic vegetation and habitat, and loss or degradation to proper soil function.
Return ML 1 roads to closed status after use for restoration treatments by removal of drainage infrastructure (e.g., culverts), reestablishment of road drainage through lead-out ditches, water bars, rolling dips, and other means, removal of unstable fill, , and placement of slash using mechanical roads treatments.	Erosion, sedimentation, degradation or loss of vegetation from ML 1 roads.
Armor downstream culvert outlets using mechanical roads treatments.	Increased erosion and scouring downstream of culverts, bank instability, and channel downcutting.
Upsizing culverts using mechanical roads treatments.	Streams scouring around culverts and over roads, increased erosion to streams or wetlands, reduced aquatic organism passage from road culverts. Potential impacts to channel soil stability and site productivity.
Installing or adding culverts or culvert arrays using mechanical roads treatments.	Loss of stream connectivity, channel width, erosion and sedimentation to streams, channelization and increased channel width due to roads. Potential impacts to channel soil stability and site productivity.

Tools	Resource Issues or Concerns Addressed
Maintaining Aquatic Organism Passage where it exists if road work needed. – Install bridge, replace culvert, or remove crossing using mechanical roads treatments.	Decreased fish passage, habitat access, passage of high flows and bedload, and decreased channel complexity from road culverts.
Install hardened low water crossings or fords (rock, concrete slab, concrete planks, concrete blocks, geocell fords, and vented fords on existing ML1 and ML2 roads needed for mechanical offerings using mechanical roads treatments.	Loss or degradation of riparian vegetation or soil function, channel widening, increased erosion, sedimentation to aquatic habitats, increased bank instability from roads crossing streams or wetlands.
Install and replace bridges on ML1 and ML2 roads needed for mechanical offerings using mechanical roads treatments.	Decreased aquatic and wildlife passage through culverts or under exiting bridges, deposition of stream bedload upstream of culverts, high flows are scouring channel and floodplain upstream, log jams are forming upstream of culverts or bridges.
Raise culverts where invert elevations have resulted in stream incision.	Restore natural flow paths and connection of flow to floodplain areas.
Install raised permeable roadbeds with or without culverts where roads cross areas of seasonal or perennial water inundation.	Restore natural flow paths.
Restore channels affected by road crossings using mechanical roads treatments.	Channel widening, erosion and sedimentation upstream or downstream of a road crossing. Loss or degradation of riparian vegetation and soil function.
Decommission or relocate ML1 and ML2 roads needed for mechanical offerings causing resource damage to springs, wetlands or streams using mechanical roads treatments.	Reduce sedimentation and erosion, improve vegetation and soil condition, restore stream banks, restore and improve aquatic and terrestrial habitat.
Developing footpath(s) on existing trails to prevent further erosion using hand or mechanical treatments.	Streams, springs, or wetlands have increased sedimentation, increased erosion, and loss or degraded vegetation and soil condition from user created trails.

Table 126. Tools for improving the form and function of stream channels and floodplains

Tools	Resource Issues or Concerns Addressed
Large woody debris, log Structures, log jams, yarding trees. Tree falling, transport and placement of trees and root wads from somewhere else, yarding over trees, helicopter wood, mechanical installation.	Floodplain connection is critical for maintaining stream geomorphic function, soil stability, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Sediment transport is also affected. Lack of large woody debris recruitment to streams for reduces roughness, cover, and habitat complexity.
Weirs and Beaver Dam Analogs (BDAs) installed by hand or mechanical methods.	Floodplain connection is critical for maintaining stream geomorphic function, soil stability, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Sediment transport is also affected.
Wicker, log and rock wires, vanes, or baffles, brush bundles and root wads using various methods and installed by hand or mechanically.	Lack of channel roughness or meanders is causing excessive erosion, changes to channel morphology, altering stream habitat and floodplains.
Boulder and log deflectors using mechanized installation.	Lack of channel roughness or meanders is causing excessive erosion, changes to channel morphology, altering stream habitat and floodplains. Lack of pool habitat or instream cover.
Hand girdling trees to provide for future large woody debris stream input.	Lack of large woody debris recruitment to streams for reduces roughness, cover, and habitat complexity.
Restoring meanders or adding stream length by induced meandering, recontouring the channel, plug and pond, other similar methods mechanically.	Artificially confined streams may not function properly. Confinement may cause incision or other issues due to increased stream power and sediment transport. These areas often have issues during flood flows.
Channel reconstruction, realignment or floodplain reconnection using mechanical treatments.	Floodplain connection is critical for maintaining stream geomorphic function, soil stability, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Sediment transport is also affected.
Flood plain creation, widening, or laying back incised stream banks using mechanical treatments.	Floodplain connection is critical for maintaining stream geomorphic function, soil stability, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Sediment transport is also affected
Removing instream stock tanks and replacing with guzzlers, drinkers, etc. in the uplands using mechanical treatments	Restore channel width, sediment, flow, and water source for downstream areas.
Zuni bowls, one rock dams or other similar methods using mechanical or hand treatments.	Slow overland flow or stream flow in small channels, reduce erosion and sedimentation.
Reconnection of historic side channels that should be functioning using mechanical treatments.	Floodplain connection is critical for maintaining stream geomorphic function, soil stability, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Sediment transport is also affected.
Maintenance of existing structures using manual or mechanical treatments.	Structures that stabilize banks, create instream cover and channel roughness, etc. from the CCC era forward currently exist on the landscape.
Removing existing erosion control structures	Removing poorly placed or nonfunctional structures can improve channel form and function.

The tools listed above for aquatic and watershed restoration activities would not be used universally across the project area. In general, the tools all have circumstances where they would be more successful in moving the restoration project toward desired condition. Some tools have circumstances where they would not generally apply as they would be ineffective, not needed, or potentially cause degradation rather than improving conditions. Listed below are the general circumstances under which each tool would apply or conversely, where they would not apply. Table 127 is intended to provide general implementation guidance for the tools as well as to better define where these proposed activities could occur for Rim Country.

Characteristics that could be mapped such as stream gradient and road maintenance levels were used to greatest extent possible. However, some characteristics such as presence of ungulate impacts or presence of noxious or invasive plants cannot be defined using remote sensing techniques and will still need to be determined on site Applicability based on stream gradient was determined using Rosgen stream types as well as literature on specific tools.

Table 127. Generalized circumstances for when or where tools would not apply

Treatments/Tools	Circumstances where treatments would apply	Circumstances where treatments would not apply
Removing tree(s), tree canopy, or shrub encroachment of upland species with hand thinning, mechanical thinning or prescribed fire.	N/A see Mechanical toolbox and Design Criteria	N/A see Mechanical treatments flexible toolbox and Design Features in Appendix C
Remove and manage noxious or invasive plants using hand methods or herbicides as described in forest weed management plans.	Anywhere that noxious or invasive plants are impacting native riparian or aquatic vegetation.	Anywhere noxious or invasive plants do not occur
Plant native aquatic or riparian plant species by hand or mechanically, including seeding.	In low and medium gradient stream reaches and all other wetland types where wetland, riparian, or aquatic plant species should be present.	High gradient stream reaches
Protect and promote existing native aquatic or riparian plant species. Site protection or fencing, which could be for seasonal restrictions, temporary restrictions, or year round. Install fencing, jack straw, remove/relocate roads or trails, create defined trails for recreation management using manual or mechanical tools.	In low and medium gradient stream reaches where wetland, riparian, or aquatic plant species should be present. Areas would also have to be reasonably close to road system for access and maintenance.	High gradient stream reaches, narrow or confined valleys
Improve or remove spring boxes and other infrastructure, using excavation, shovels, trackhoes, jackhammers, concrete saws to restore natural spring function. Removing unneeded channels to consolidate spring outflow and increase habitat.	Low to moderate gradient stream reaches	High gradient stream reaches, narrow or confined valleys
Split flow in developed springs to allow water above existing water rights to be released to spring outflows. Hand methods for fixing springboxes, piping, or diversions to split spring flow.	Low to moderate gradient stream reaches	N/A

Treatments/Tools	Circumstances where treatments would apply	Circumstances where treatments would not apply
Protect spring emergence zone and/or springbrook from direct ungulate disturbance through fencing.	In areas where ungulate disturbance is impacting springs.	Where ungulate disturbance is not a causative factor.
Obliterate roads restoring natural contours and vegetation using mechanical roads treatments.	Where existing roads causing resource damage such as confining a stream, draining wetlands, loss or degradation of riparian or aquatic vegetation and habitat, and loss or degradation to proper soil function.	N/A
Close and restore unauthorized roads, trails, and dispersed camping areas using mechanical roads treatments.	For unauthorized roads, trails or recreational impacts causing resource damage such as confining a stream, draining wetlands, loss or degradation of riparian or aquatic vegetation and habitat, and loss or degradation to proper soil function.	N/A
Return ML 1 roads to closed status after use for restoration treatments by removal of drainage infrastructure (e.g., culverts), reestablishment of road drainage through lead-out ditches, water bars, rolling dips, and other means, removal of unstable fill, and placement of slash using mechanical roads treatments.	Anywhere that ML1 roads are opened for use within Rim Country.	N/A
Armor downstream culvert outlets using mechanical roads treatments.	ML 2-4 roads where erosion is occurring from culverts.	N/A
Upsizing culverts using mechanical roads treatments.	ML 2-4 roads in areas where stream or overland flow had increased above the capacity of existing infrastructure.	N/A
Installing or adding culverts or culvert arrays using mechanical roads treatments.	ML 2-4 roads in areas where stream or overland flow had increased above the capacity of existing infrastructure.	N/A
Maintaining Aquatic Organism Passage where it exists if road crossing work needed. – Install bridge, replace culvert, or remove crossing using mechanical roads treatments.	Where roads and streams intersect on ML 2-4 roads	ML 1 and ML 5 road/stream crossings or intersections.
Install hardened low water crossings or fords (rock, concrete slab, concrete planks, concrete blocks, geocell fords, and vented fords on existing ML1 and ML2 roads needed for mechanical offerings using mechanical roads treatments.	Where ML 1-2 roads intersect with streams	ML 3-5 road and stream intersections
Install and replace bridges on ML1 and ML2 roads needed for mechanical offerings using mechanical roads treatments.	Where ML 1-2 roads intersect with streams	ML 3-5 road and stream intersections

Treatments/Tools	Circumstances where treatments would apply	Circumstances where treatments would not apply
Developing footpath(s) or tread on existing trails to prevent further erosion using hand or mechanical treatments	Where trails are within 250 feet from streams	Trails beyond 250 feet from streams.
Large woody debris, log structures, log jams, yarding trees. Tree falling, transport and placement of trees and root wads from somewhere else, yarding over trees, helicopter wood, mechanical installation.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches
Weirs and Beaver Dam Analogs (BDAs) installed by hand or mechanical methods.	Low to moderate gradient stream reaches and valleys (most viable at stream slopes of 0-3%), with wide to narrow floodplains.	High gradient stream reaches. BDAs are less viable at stream slopes of >3%.
Wicker, log and rock wires, vanes, or baffles, brush bundles and root wads using various methods and installed by hand or mechanically.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches.
Boulder and log deflectors using mechanized installation.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches
Hand girdling trees to provide for future large woody debris stream input.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches
Restoring meanders or adding stream length by induced meandering, recontouring the channel, plug and pond, other similar methods mechanically.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains. Wetlands and wet meadows.	High gradient stream reaches
Channel reconstruction, realignment or floodplain reconnection using mechanical treatments.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches
Flood plain creation, widening, or laying back incised stream banks using mechanical treatments.	Low to moderate gradient stream reaches and valleys, with wide to narrow floodplains.	High gradient stream reaches
Removing instream stock tanks and replacing with guzzlers, drinkers, etc. in the uplands using mechanical treatments	Low to moderate gradient stream reaches and valleys.	High gradient stream reaches
Zuni bowls, one rock dams or other similar methods using mechanical or hand treatments.	Low to moderate gradient stream reaches and valleys.	High gradient stream reaches
Reconnection of historic side channels that should be functioning using mechanical treatments.	Low to moderate gradient stream reaches and valleys.	High gradient stream reaches
Maintenance of existing structures using manual or mechanical treatments.	Generally found in low to moderate gradient stream reaches and valley slopes.	High gradient stream reaches
Removing existing erosion control structures	Generally found in low to moderate gradient stream reaches and valley slopes.	High gradient stream reaches

References

The following is a partial reference list useful for ideas and designs of potential treatments:

Adair, Steve, Mary Dereske, James Doyle, Anthony Edwards, Sandra Jacobson, Roy Jemison, Lisa Lewis, Wendy Melgin, Carolyn Napper, Tom Ratcliff, Terry Worhol, 2002. Management Techniques for Riparian Restorations, Roads Field Guide Vol 1 and 2. Rocky Mountain Research Station, General Technical Report RMRS-GTR-102 Vol 1 and 2. Fort Collins, Co.

DeBano, Leonard F., Larry J. Schmidt. 1989. "Improving southwestern riparian areas through watershed management". General Technical Report RM-182. U. S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

ERI. 2005. Restoring Forest Roads: Ecologic Restoration Institute Working Paper 12, ERI Northern Arizona University, Flagstaff, Arizona.

Eubanks, C. Ellen, Dexter Meadows. 2002. A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization. USDA FS, Technology and Development Program, San Dimas, Ca. http://www.fs.fed.us/t-d/pubs/pdf/fs683/cover.pdf

Fischenich, Craig and James V. Morrow, Jr. 2000. Reconnection of Floodplains with Incised Channels, EMRRP Technical Notes Collection (DRDC TN-EMRRP-SR-09), U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/emrrp.

Hoag, Chris, Jon Fripp. 2002. Streambank Soil Bioengineering Field Guide for Low Precipitation Areas. http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmcpussbfglpa.pdf

Roni, Phillip, Andrew H. Fayram, and Michael A. Miller. 2005 Monitoring and Evaluating Instream Habitat Enhancement. Chapter 8 in: Monitoring Stream and Watershed Restoration. Eds. Phillip Roni. American Fisheries Society. Bethesda, Maryland.

Pollock, Michael. M., Timothy J. Beechie, Samuel S. Chan, and Richard Bigley. 2005. Monitoring Restoration of Riparian Forests. Chapter 4 in: Monitoring Stream and Watershed Restoration. Eds. Phillip Roni. American Fisheries Society. Bethesda, Maryland.

Springs Stewardship Institute. 2012. Guidance for spring restoration. https://static1.squarespace.com/static/551345b8e4b05ad7b907caef/t/55160dc8e4b01b711312357b/1427508680024/SSI_SpringsRestorationOutline.pdf (accessed November 10, 2017)

U.S. Department of Agriculture. 1996. Managing roads for wet meadow ecosystem recovery. FHWA-FLP-96-016. 73pgs.

Yochum, Stephen E. 2016. Guidance for Stream Restoration and Rehabilitation. Technical Note TN-102.2. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, National Stream and Aquatic Ecology Center.

Zeedyk, Bill, Van Clothier. 2012. Let the Water Do the Work: Induced Meandering, an Evolving Method for Restoring Channels. Quivera Coalition, Santa Fe, New Mexico.