Four Forest Restoration Initiative – Rim Country

Aquatics Specialist Report

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For:
Lakeside and Black Mesa Ranger Districts, Apache-Sitgreaves National Forests
Payson and Pleasant Valley Ranger Districts, Tonto National Forest
Red Rock and Mogollon Ranger Districts, Coconino National Forest

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Table of Contents

Introduction 6
Regulatory Framework 6
Land and Resource Management Plans 6
Desired Condition 6
Other Relevant Laws, Regulations, Policies, and Plans 7
Issues Addressed in This Analysis 8
Issues 8
Other Resource Concerns 8
Methods 8
Information Sources 9
Incomplete and Unavailable Information 10
Spatial and Temporal Context for Effects Analysis 10
Assumptions 11
Resource Indicators and Measures 12
Affected Environment 16
Watershed Condition 16
Riparian Condition 18
Ecological Restoration Units (Vegetation Types) 19
Streams and Aquatic Species 21
Threatened and Endangered Species Analyzed in Detail 25
Sensitive Species Analyzed in Detail 38
Management Indicator Species (MIS) 50
Summary of Alternatives 51
Alternative 1 – No Action 51
Action Alternatives 51
Project Design Features 54
Environmental Consequences 66
Alternative 1 – No Action 66
Actions Common to Alternative 2 and 3 67
Alternatives 2 and 3 89
Sensitive Species not covered by Resource Indicators and Measures 98
Cumulative Effects 99
Determination of Effects 102
Required Monitoring 113
Land Management Plan Amendment Environmental Consequences – By Alternative or in a summary 114
Summary 114
Degree to Which the Purpose and Need for Action is Met 114
Degree to Which the Alternatives Address the Issues 114
Summary of Environmental Effects 114
Compliance with LMP and Other Relevant Laws, Regulations, Policies and Plans 118
Other Relevant Mandatory Disclosures 118
Required Permits 118
Irreversible and Irretrievable Commitments of Resources 118
Land Management Plan Consistency 118
Other Agencies and Individuals Consulted 119
References Cited 121

Appendix A. Plan Components from Forest Land Management Plans applicable to aquatic and riparian habitats. 126
Appendix B: Watershed Condition Framework aquatic habitat indicators by subwatershed. 134
Appendix C. Condition-based Management Approach for Aquatics and Watershed Restoration Treatments 135
Salt River 136
Little Colorado River 136
Aquatics and Watershed Restoration Condition-based Management 137
Introduce Evaluation Methods 138
Project Screening and Decision Matrix 139
Prioritization 143
Project Checklist and ARRT Review 144
Implementation of Restoration Projects 144
Validation and Collaboration Period 144
Restoration Assessment Framework 145

Tables

Table 1. Resource indicators and measures for assessing effects between alternatives. 12
Table 2. Average Riparian Condition from watershed condition framework for species analysis areas. 19
Table 3. Acreages of Ecological Restoration types and individual Ecological Restoration Units (ERUs) within the entire Rim Country Project Area. 20
Table 4. Miles of each stream type within the Rim Country project area. 21
Table 5. Federally listed and Forest Service Sensitive aquatic species and/or their habitat expected to occur within the Rim Country project area. 23
Table 6. Miles of streams and associated 6th Code subwatersheds with Gila trout within the Rim Country proposed project area 25
Table 7. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Gila trout within the Rim Country proposed project area. 26
Table 8. Miles of streams and associated 6th Code subwatersheds (HUC) with occupied or suitable habitat for Little Colorado spinedace within the Rim Country proposed project area. 27
Table 9. Little Colorado spinedace designated critical habitat acres by stream unit and 6th Code subwatershed (HUCs) within the Rim Country proposed project area. 28
Table 10. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Little Colorado spinedace within the Rim Country proposed project area. 29
Table 11. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Gila chub within the Rim Country proposed project area. 30
Table 12. Riparian condition score from Watershed Condition Framework for 6th Code HUCs with Gila topminnow within the Rim Country proposed project area 31
Table 13. Riparian condition score from Watershed Condition Framework for 6th Code HUCs with loach minnow within the Rim Country proposed project area. 31
Table 14. Riparian condition score from Watershed Condition Framework for 6th Code HUCs with spikedace or spikedace designated critical habitat within the Rim Country proposed project area. 33
Table 15. Spikedace designated critical habitat units, streams and associated subwatersheds within the Rim Country action area 33
Table 16. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Narrow-headed gartersnake within the Rim Country proposed project area. 34

Table 17. Narrow-headed gartersnake proposed Critical Habitat acres by stream unit and 6th Code subwatershed (HUCs) within the Rim Country proposed project area. 34
Table 18. Chiricahua Leopard Frog sites associated with the Rim Country project area. 36
Table 19. Acres of occupied or suitable habitat within dispersal distance for Chiricahua leopard frog by 6th code subwatershed (HUCs) within the Rim Country project area. 36
Table 20. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Chiricahua leopard frog the Rim Country project area. 37
Table 21.Chiricahua leopard frog designated critical habitat acres by stream unit and 6th Code subwatershed (HUCs) within the Rim Country proposed project area. 37
Table 22. Miles of occupied or suitable habitat for desert sucker by stream and 6th Code subwatershed (HUCs) within the Rim Country project area. 39
Table 23. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Desert sucker the Rim Country proposed project area. 40
Table 24. Miles of occupied or suitable habitat for Sonoran sucker by stream and 6th Code subwatershed (HUCs) within the Rim Country proposed project area. 41
Table 25. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Sonoran sucker the Rim Country project area. 41
Table 26. Miles of occupied or suitable habitat for Little Colorado sucker by stream and 6th Code subwatershed (HUCs) within the Rim Country proposed project area. 42
Table 27. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Little Colorado sucker the Rim Country project area. 42
Table 28. Miles of occupied or suitable habitat for headwater chub by stream and 6th Code subwatershed (HUCs) within the Rim Country project area. 44
Table 29. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Headwater chub the Rim Country project area. 44
Table 30. Miles of occupied or suitable habitat for roundtail chub by stream and 6th Code subwatershed (HUCs) within the Rim Country project area. 45
Table 31. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Roundtail chub the Rim Country proposed project area. 46
Table 32. Acres of occupied or suitable habitat within dispersal distance for northern leopard frog by 6th code subwatershed (HUCs) within the Rim Country proposed project area. 47
Table 33. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with northern leopard frog the Rim Country proposed project area. 47
Table 34. Macroinvertebrate data collected on the Tonto National Forest from 2006 and 2009. Summarized by streams surveyed that are meeting, not meeting, or have mixed results for the indexes of biological integrity (IBI) rating. 51
Table 35. Summary of Alternatives 2 and 3 Treatments as analyzed for aquatic resources. 53
Table 36. Design Features which reduce potential impacts, their relationship to resource indicators and what resource measures they are associated with. 54
Table 37: Change miles of open Forest Service roads treatments for Alternatives 2 & 3 as compared to Alternative 1 within the project area. 67
Table 38: Change by species in miles of open Forest Service roads within species habitats for Alternative 2 &3 as compared to Alternative 1. Percentages reflect changes in miles of ML-1 roads within species habitat. 69
Table 39: Change by species in miles of open Forest Service roads within species action areas for Alternative 2 &3 as compared to Alternative 1. Percentages reflect changes in acreages within species action areas. 70
Table 40: Number of low water road/stream crossings on perennial and intermittent streams for proposed action as compared to existing condition within species habitat or critical habitat. Increases in number of low water crossings reflect opening ML-1 roads. 72

Table 41: Number of low water road/stream crossings on perennial and intermittent streams for proposed action as compared to existing condition outside species AMZs, but within species or critical habitat action areas. Increases in number of low water crossings reflect opening ML-1 roads. 73
Table 42. In Woods Processing Sites and associated acreages. 74
Table 43. Change by species in the acres of In Woods Processing Sites for Alternatives 2 & 3 as compared to Alternative1. Percentages reflect changes in acreages within species analysis areas. These are considered indirect impacts..... 75
Table 44. Current acreage of proposed rock pits for use and proposed acreage pit expansion. 77
Table 45. Change by species or critical habitat in the acres of rock pits for Alternatives 2 & 3 as compared to Alternative 1. Percentages reflect changes in acreages within species analysis areas. These are considered indirect impacts..... 77
Table 46. Techniques that would be used for riparian restoration projects and potential effects to species. 79
Table 47. Effects of techniques for improving spring outflows: 80
Table 48. Effects of techniques for improving road or trail interactions with stream courses, springs, or other wetlands. 82
Table 49. Effects of techniques for improving the form and function of stream channels and floodplains 84
Table 50. Miles of general and heavy mechanical stream restoration by species or critical habitat for Alternatives 2 & 3 as compared to Alternative 1. Percentages reflect changes in acreages within species analysis areas. 87
Table 51. Change by species in the acres of mechanical vegetation treatments for Alternative 2 as compared to Alternative1. Percentages reflect increases in acreage within direct effects analysis areas for species. 89
Table 52. Change by species in acres of mechanical vegetation treatments for Alternative 2 as compared to Alternative 1. Percentages reflect increases in acreage within species analysis areas. These are considered indirect impacts..... 91
Table 53. Affected acres by species and the percent of change in the acres of prescribed burning for all alternatives. Percentages reflect changes in acreages within species habitats. 95
Table 54. Change by species in the acres of prescribed burning for all alternatives. Percentages reflect changes in acreages within species analysis areas. 96
Table 55. Threatened, endangered, Region 3 sensitive, and Tonto National Forest management indicator species with effects determinations by alternative. 112
Table 56. Summary comparison of environmental effects to aquatic resources. 115
Table D-3. Considerations for prioritizing where and when treatments are implemented..... 143
Table D-4. Appropriate restoration methods based on existing condition, resource issues, and concerns for springs..... 146
Table D-5. Appropriate restoration methods based on existing condition, resource issues, and concerns for wetlands 147
Table D-6. Appropriate restoration methods based on existing condition, resource issues, and concerns for montane Meadows 147
Table D-7. Appropriate restoration methods based on existing condition, resource issues, and concerns for unneeded roads 148
Table D-8. Appropriate restoration methods based on existing condition, resource issues, and concerns for road and stream or wetland crossings 148
Table D-9. Appropriate restoration methods based on existing condition, resource issues, and concerns for streams 149
Table D-10. Methods for improving native riparian or aquatic vegetation 151
Table D-11. Methods for improving spring outflows..... 151

Table D-12. Tools for improving road or trail interactions with stream courses, springs, or other wetlands 151
Table D-13. Tools for improving the form and function of stream channels and floodplains 153
Table D-14. Generalized circumstances for when or where methods would or would not apply 154

Figures

Figure 1. Number of subwatersheds by condition class for selected indicators. 18
Figure 2. Temporary berm to divert water from project area. Downcutting on stream below a low water crossing. 82
Figure D-6. Oregon Administrative Rule bubble diagram of review criteria 139
Figure D-7. Guidance for decision-making process (Roca et al. 2017) 139
Figure D-8. Diagram of conceptual linkages and questions to be addressed in assessments used to identify and prioritize restoration actions (Beechie et al. 2008) 142

Introduction

This biological evaluation and aquatic resources report contains an analysis of existing and desired aquatic and riparian habitat conditions for the Rim Country planning area and an analysis of effects from proposed activities on aquatic threatened, endangered, Region 3 sensitive species, the Tonto National Forest Land and Resource Management Plan (hereafter Tonto Land Management Plan) aquatic management indicator species, and aquatic habitat.

This specialists report is being prepared for the National Environmental Policy Act document, which is the Final Environmental Impact Statement (FEIS) for the *Rim Country Restoration Project.* The report does not replicate the complete descriptions for the purpose and need, proposed action, and alternatives; as these are disclosed and discussed in detail within chapters one and two of the FEIS for the Rim Country Restoration Project (hereinafter referred to as Rim Country).

Regulatory Framework

Land Management Plans

The Apache-Sitgreaves, Tonto, and Coconino National Forest Land Management Plans (LMP) provide desired conditions, objectives, standards and guidelines for forest restoration and aquatics species/habitats. The Apache-Sitgreaves and Coconino NFs have new LMPs; while the Tonto is currently working under their 1985 Land Management Plan while undergoing Plan Revision.

In order to achieve overall ecosystem health and provide for species diversity and viability, the primary emphasis of the Land Management Plans (LMPs) is, over time, to achieve satisfactory watershed conditions and restore ecological function, especially fire regimes. The focus for implementing LMP objectives is desired conditions, while individual projects and activities maintain or incrementally move current conditions toward or maintain desired conditions (as shaped by applicable standards and guidelines). Appendix A includes a list of all the desired conditions, standards, and guidelines within the LMPs related to aquatic species and their habitats and summarizes any impacts resulting from the proposed action.

The LMPs provide standards and guidelines for aquatic species and habitat under various section of the Land Management Plans. Applicable Standards and Guidelines in relation to this report are list below in Table 1. All Land Management Plan components (Desired Conditions, Standards, and Guidelines) associated with aquatic resources are in Appendix A.

Desired Condition

Desired conditions are defined in the current Land Management Plans for Apache-Sitgreaves, Coconino, and Tonto National Forests at different scales. These desired conditions are integrated and summarized below in relation to aquatic species, habitats, and the ecological components that influence them.

At the landscape scale, conditions should provide for the life history, distribution, and natural population fluctuations of species within the capability of the landscape. Ecological conditions should contribute to self-sustaining populations of native and desirable nonnative plants and animals that are healthy, well distributed, connected, and genetically diverse. Habitat configuration and availability promotes genetic flow between populations and allows them to adjust their movements in response to climate. Habitat quality, distribution, and abundance should support recovery of federally listed species as well as native and desirable nonnative species.

Water quality, stream channel stability, and aquatic habitats should retain their inherent resilience to natural and other disturbances. Instream flows provide for channel and floodplain maintenance, recharge of riparian aquifers, water quality, and minimal temperature fluctuations. Streams and their adjacent floodplain are capable of filtering, processing, and storing sediment; aiding floodplain development; improving floodwater retention; and increasing groundwater recharge. The water and sediment balance between streams and their watersheds allow a natural frequency of low and high flows. Stream condition is sufficient to withstand floods without disrupting normal stream characteristics or uncharacteristically altering stream dimensions. Riparian-wetland conditions maintain water-related processes (e.g. hydrologic, hydraulic, and geomorphic) as well as their physical and biological community characteristics, functions, and processes. Stream (lotic) riparian-wetland areas have vegetation, landform, and/or large coarse woody debris to dissipate stream energy associated with high waterflow.

Natural ecological disturbances (e.g. flooding, scouring) promote a diverse plant structure consisting of herbaceous, shrub, and tree species of all ages and size classes necessary for the recruitment of riparian-dependent species. Riparian obligate plant species within wet meadows, around springs and seeps, along streambanks, and active floodplains provide sufficient vegetative ground cover (herbaceous vegetation, litter, and woody riparian species) to protect and enrich soils, trap sediment, mitigate flood energy, stabilize streambanks, and provide for aquatic and riparian dependent species.

Streams and aquatic habitats should support aquatic species providing the quantity and quality of aquatic habitat within reference conditions. Aquatic species habitat conditions provide the resiliency and redundancy necessary to maintain species diversity and metapopulations. Streamflows provide connectivity among aquatic species populations and provide unobstructed routes critical for fulfilling needs of aquatic species. Floodplains and adjacent upland areas provide diverse habitat components (e.g. vegetation, debris, logs) as necessary for migration, hibernation, and brumation (extended inactivity) specific to the needs of riparian-obligate species (e.g. narrow-headed gartersnake).

Other Relevant Laws, Regulations, Policies, and Plans

Executive Order 11988 of 1977 (floodplain management) requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

Executive Order 12962 of 1995 (aquatic systems and recreational fisheries) requires federal agencies to conserve, restore, and enhance aquatic systems to provide for increased recreational fishing opportunities nationwide. The order requires federal agencies to evaluate the effects of federally funded actions on aquatic systems and document those effects relative to the purpose of this order.

Executive Order 13112 of 1999 (invasive species) requires federal agencies to take actions to prevent the introduction and spread of invasive species, provide for invasive species control, and minimize the economic, ecological, and human health impacts of invasive species.

The three principle laws relevant to aquatic management are the National Forest Management Act of 1976, the Endangered Species Act of 1973, as amended (16 United States Code 1531 et seq.), and the Clean Water Act of 1972 (33 United States Code §1251 et seq.). Direction relative to aquatics is as follows:

- The National Forest Management Act requires the Forest Service to manage fish and wildlife habitat to maintain viable populations of all native and desirable nonnative wildlife species and

conserve all listed threatened or endangered species populations (36 Code of Federal Regulations 219.19).

- The Endangered Species Act requires Forest Service to manage for the recovery of threatened and endangered species and ecosystems upon with they depend. Forests are required to consult with the U.S. Fish and Wildlife Service or the National Marine Fisheries Service if a proposed activity may affect the population or habitat of a listed species.

- The Clean Water Act establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. It governs water temperatures and directs following of best management practices.

Forest Service policies related to biological evaluations are outlined in Forest Service Manual 2672.42 as follows: Biological evaluations should

- Identify all listed, proposed, and sensitive species known or expected to be in the project area or that the project potentially affects.
- Identify and describe all occupied and unoccupied habitat recognized as essential for listed or proposed species recovery, or to meet objectives for sensitive species.
- Analyze all effects of the proposed actions on species, occupied habitat or unoccupied habitat required for recovery.
- Discuss cumulative effects from the project in relation to existing conditions and other related projects.
- Determination of effect on species with the process and rationale for the determination documented.

Regional Forester Sensitive Species

Sensitive species are defined as "those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by: a) significant current or predicted downward trends in population numbers or density, or b) significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution (FSM 2670.5(19)). A primary objective of Forest Service policy is to develop and implement management practices to ensure that species do not become threatened or endangered due to Forest Service actions (FSM 2670.22).

Issues Addressed in This Analysis

Issues

No issues identified through the scoping process are related to aquatic species or habitat.

Other Resource Concerns

Trout Unlimited and AZGFD brought forth a concern for resilience of cold-water stream temperatures to climate change. These concerns are also part of desired conditions for the Land Management Plans and are addressed by the purpose and need as well as design features.

Methods

Analyses included the changes (i.e., increase, decrease, or change from current conditions) for resource indicators or measures, and how changes can affect aquatic species and their habitats. While vegetation

treatment types will differ in the level of ground disturbance and inherent impacts to aquatic habitat and species, the analysis will assume the highest level of potential disturbance (mechanical harvest). Effects to aquatic species and their habitats will be similar from various types of vegetation treatments so those were grouped into two implementation types: mechanical vegetation removal and prescribed burning. Actions that were the same for both Alternative 2 and 3 are described in the 'Actions Common to Alternative 2 and 3 section where appropriate. Effects specific to each species or critical habitat were described in the determination of effects section.

The transportation system (roads) needed to implement Rim Country was analyzed quantitatively and qualitatively. Quantitative analysis was completed based on existing Forest Service roads (operation level existing condition) and the number of ML-1 roads opened in the proposed action. While the analysis assumes all ML-1 roads will be opened for use, intuitively not all the roads will be opened or used at the same time across the project area. It also assumes all ML-1 roads are currently closed and not in use; therefore, the analysis is over-estimating the potential impacts of the proposed action. Low water road-stream crossings were calculated quantitatively by intersecting the road analysis described above with streams within the dispersal distance action areas. Maintenance level 1 & 2 roads were assumed to have low water crossings in the analysis because they are in storage between intermittent uses or open for use by high clearance vehicles. Passenger cars, user comfort and convenience are not considerations. Maintenance level 3-5 roads were not assessed for low water crossings because they are maintained for standard passenger cars and thus are most likely to have culverts or bridges. Road relocation, decommissioning, and temporary roads were analyzed qualitatively for the action alternatives as the location of these activities is unknown. Miles proposed for each were based on averages across the three Forests over a given time period. Therefore, a more accurate analysis by species was not feasible.

In Woods Processing Sites was analyzed quantitatively for the Coconino and Tonto NFs where exact locations and acreages of proposed sites were available. A qualitative analysis was completed for the Apache-Sitgreaves because they are not proposing the use of identified processing sites, only in woods drying of biomass as needed. The acres of rock pit use and expansion was analyzed quantitatively.

Miles of stream identified for general and heavy mechanical stream restoration were identified spatially using factors that promote successful treatments and project design features. Potential locations for general stream treatments were based on stream gradient. Stream gradient was mapped using LiDAR data and averaged within reaches. Reaches with low (0-2%) and moderate (2-4%) stream gradient were used for general stream treatment identification based on Rosgen stream types and gradients where stream restoration is the most successful. Heavy mechanical stream reaches are a subset of the identified general stream restoration reaches that were then filtered by the ability of machinery to access locations and design features (slope restriction). These were identified by removing reaches with canyon slopes >25% and further than 0.25 miles from roads.

Information Sources

The effects analyses are based on best available science, observations and professional judgement of the project fisheries biologist. Species and habitat distribution data were created specifically for this project from existing GIS datasets, survey reports, Federal Register listings, 5-Year Reviews, and local agency knowledge. Species occupied and potential habitat mapping was reviewed collaboratively by state and federal biologists to be as accurate as possible. Ongoing surveys and population monitoring for listed aquatic species are led by U.S. Fish and Wildlife Service (USFWS) and Arizona Game and Fish Department (AZGFD), with assistance from Forest Service. Available survey and monitoring results and relevant literature were cited and used in development of this biological evaluation.

Incomplete and Unavailable Information

The precise distribution of the aquatic organisms or the quality of their habitat is not well known throughout the entire analysis area. Therefore, species occurrence was extrapolated from existing survey information then reviewed by Arizona Game and Fish Department regional fisheries managers, Forest Service biologists, and/or the U.S. Fish and Wildlife Service consultation biologist to incorporate local knowledge. Recent stream habitat survey information was not available to determine the current habitat conditions for most streams within the project area. For analyses proposed, these species were assumed to occur throughout the stream(s) where they have been documented to provide for movement during high flow events.

Aquatic macroinvertebrate species (i.e., sensitive and management indicator species) have had very few surveys across the project area, and known occurrences are very limited. Information was used from recent Forest level analyses such as Land Management Plan Revision or Travel Management Planning to incorporate the most recent species or habitat distribution. For this project, aquatic macroinvertebrate species were assumed to occur throughout the stream(s) where they have been documented.

Because of these imprecisions, the analysis relies heavily on Watershed Condition Framework to define existing conditions and the implementation of the project design features, best management practices, conservation measures, and guidance in the aquatic and watershed condition-based management to support effects analysis conclusions and lay the framework for implementation.

Spatial and Temporal Context for Effects Analysis

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

Effects Boundaries

The action area is defined as the project area and all 6th HUC subwatersheds that intersect with the project area. The full extent of the action area is shown in Figure 1. This accounts for any downstream effects that may occur from project activities and includes up to 142 subwatersheds. For each species, effects were analyzed for alternatives in two ways: within species habitats and riparian corridors and outside habitats within subwatersheds (species action areas) that drain into species habitat.

Actions that occur within species occupied or suitable habitat and riparian corridors which can have an immediate and direct effect/consequence to species or habitat were assessed using Aquatic Management Zones (AMZs) defined in project design features. A 150-foot AMZ on all aquatic species habitat was used to quantify treatments and analyze effects directly to species or habitats. For fish and gartersnakes, AMZs along occupied or suitable habitat streams were utilized. Chiricahua and northern leopard frogs, which readily move along streams or overland, dispersal habitat was mapped using the 1-3-5-mile Chiricahua leopard frog recovery plan guidelines from all currently occupied sites within or near the project boundary and any known proposed stockings in the next 5-10 years. Dispersal habitat includes streams and stock tanks where frogs could move during the life of the project. Aquatic Management Zones on every stream and stock tank were used to quantify treatments and address effects to frogs and

their habitat. Dispersal mapping was reviewed and refined by district personnel familiar with their populations and habitat.

Effects to riparian and aquatic habitat from upstream or upland treatments were assessed by species action areas as defined in the affected environment. For fish and gartersnakes. 6th HUC subwatersheds outside of species habitats (AMZs) equate to species action areas. For frogs, dispersal areas outside of species habitats define the action areas. Proposed treatments within species action areas and outside of AMZs, were quantified to capture all potential consequences that could occur using riparian condition as a baseline. Riparian areas and their condition strongly influence aquatic habitats. Therefore, changes to riparian condition can affect aquatic habitat quality and quantity in a positive, negative or neutral manner.

Designated or proposed critical habitat was similarly addressed by actions occurring within critical habitat and actions upstream or within uplands. Actions within or draining into critical habitat were quantified and any effects to primary constituent elements or primary biological features addressed. Assessment of indirect effects differed for frogs as compared to fish and gartersnakes. Fish and gartersnake critical habitat occur solely along streams, therefore all subwatersheds that drain into the proposed or designated habitat were used to quantify treatments and analyze effects. Chiricahua leopard frog critical habitat occurs in uplands and small segments of streams; therefore, indirect action areas were mapped by identifying the uplands that drained into each critical habitat polygon which was smaller than the entire watershed.

The temporal boundaries for analyzing effects to aquatic species will be 10-15 years given habitat conditions and species occupancy can change over that timeframe. Short-term effects occur over a timeframe of <5 years to factor in at least one entire growing season for vegetation, such as within a single timber pay unit or prescribed burn. Long-term effects to habitat can last for >5 years or seasons to address entire sale areas within multiple subwatersheds.

Cumulative Effects Boundaries

The spatial boundaries for cumulative effects is the action area described above under effects boundaries including private lands and non-Forest Service lands. Temporal boundaries went back 30 years in time to include any activity with geospatial data on for quantitative analysis. Past management activities that did not have geospatial data were described by general resource area along with potential last effects going back further in time.

Assumptions

- Species occurrence geospatial layers utilized for analysis contain up-to-date information as of December 2020 and represent species current occurrence as well as potential suitable habitat.
- Species analysis areas represent the drainage network where direct and indirect impacts could occur to species or habitat.
- Watershed Condition Framework assessments utilized for existing condition accurately reflect resource indicators for aquatic species and habitats.
- Analyzing mechanical vegetation and prescribed burning treatments across vegetation types will address the highest level of impacts that may occur; therefore, impacts less than that are inherently addressed.
- Low water road-stream crossings are likely to occur on maintenance level 1-2 roads because they are not for passenger car use.
- Project implementation will include all project design features which are expected to minimize impacts throughout the analysis.

- The aquatic and watershed condition-based management approach is adaptive management and guidance within the document will be implemented, including circumstances on where treatments are applicable, which inherently minimize impacts to aquatic species and habitats.
- Projects lists and acreages provided for Cumulative Effects analysis accurately represent past, current, and future activities within the project area.

Resource Indicators and Measures

Resource measures were identified for those components that could be spatially defined and carried through the analysis of alternatives. Quantitative analyses were conducting for the following resource measures: 1) acres of mechanical thinning, 2) acres of prescribed burning, 3) miles of open ML-1, 4) number of low water crossings, 5) acres of In Woods Processing Sites, 6) acres of rock pits use and expansion, 7) miles of general stream restoration, and 8) miles of heavy mechanical stream restoration. For some species (e.g., sensitive aquatic macroinvertebrates) quantitative evaluation is not possible, so the analyses will be more limited and/or qualitative for some species. Qualitative analyses were used for components that could not be spatially defined such as temporary roads, road relocation, and road decommissioning which are part of both action alternatives. Resource indicators will allow for the comparison between the existing condition and each alternative, and how they may directly or indirectly impact aquatic species and their habitats. Resource elements are larger in context and represented by the resource indicators for analysis. For example, riparian condition represents both aquatic habitat quality and quantity. Measures represent the amount effect to the resource indicators; therefore if acres or miles of measures increase then potential effects to resource indicators may increase. Impacts to indicators will be addressed on the temporal context described previously as well as by direct and indirect impacts. Additional information is provided later for each group of species (i.e., fish, frogs, snakes, and invertebrates) analyzed within the effects sections. The resource indicators, elements, and measures are listed in Table 1 below.

Aquatic invertebrate species were not quantitatively analyzed using the resource indicators and measures. This was not possible primarily due to the species limited or unknown distributions, or no or limited impacts that could result from the proposed actions. Maps were reviewed for both alternatives to qualitatively assess the impacts that could occur to these species from action alternatives.

Table 1. Resource indicators and measures for assessing effects between alternatives.

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LMP S/G; law or policy, BMPs, etc.)?
Habitat Quality Habitat Quantity Impacts to Individuals	1. Riparian condition -Short term effects negative - Long term effects neutral or positive 2. Modification of gartersnake behavior - Short term effects negative - Long term effects neutral or positive 3. Harm of gartersnakes - Short term effects negative - Long term effects Neutral 4. Pollutants, exotic species and/or disease - Short- and long-term effects negative	Acres of mechanical thinning treatments	Yes	LMP S/G, BMPs
Habitat Quality Habitat Quantity Impacts to Individuals	1. Riparian condition - Short term effects negative - Long term effects neutral or positive 2. Modification of gartersnake behavior - Short term effects negative - Long term effect neutral or positive 3. Harm of gartersnakes - Short term effects negative - Long term effects neutral 4. Pollutants, invasive species and/or disease - Short-and long-term effects negative	Acres of Prescribed Burning	Yes	LMP S/G, BMPs
Habitat Quality Habitat Quantity	1. Riparian condition - Short term effects negative - Long term effects neutral or positive 2. Habitat connectivity - Short term effects negative - Long term effect neutral or positive 4. Pollutants, invasive Species - Short- and long-term effects negative	Miles of open ML-1 roads (road density and location) , temporary roads, and low water crossings	Yes	LMP S/G, BMPs
Habitat Quality Habitat Quantity	1. Riparian condition - Short term effects negative - Long term effect neutral	Acres of In Woods Processing Sites (IWPS)	Yes	LMP S/G, BMPs
Habitat Quality Habitat Quantity	1. Riparian condition - Short term effects negative - Long term effect neutral	Acres of Rock Pits	Yes	LMP S/G, BMPs

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

Riparian Condition

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

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

Habitat quality and quantity analysis topics include:

- Changes in streamside vegetation cover and structure.
- Changes in sediment delivery to streams altering aquatic habitat and food base.
- Changes in recruitment of large woody debris from riparian areas to streams altering aquatic habitat.

- Changes to stream temperatures as a result of warm water runoff from upland sources or reduced streamside canopy cover.

- Changes to aquatic habitat as a consequence of increased flows caused by removal of upland vegetation resulting in increased storm water runoff.

Riparian and wetland areas are the interface between terrestrial and aquatic ecosystems and are an integral part of the watersheds in which they occur. Consequently, the health of these areas is closely interrelated to the condition of the surrounding watershed (Debano and Schmidt 1989, Hornbeck and Kochenderfer 2000). The health of riparian corridors is dependent on the storage and movement of sediment through the channel system but also the movement of sediment and water from surrounding hillslopes into the channel system. These processes can be altered by human induced and natural disturbances either indirectly to the watershed or directly to riparian areas themselves. Riparian areas provide localized microclimate, stream shading, bank stability, and inputs of large wood and organic matter to streams. They are critical for maintenance of water quality and quantity, contribute to sediment retention and stream bank building and maintenance, and influence in-channel geomorphic processes.

Streamside canopy cover and structure are important to riparian and aquatic habitat by providing riparian habitat for gartersnakes, stream shading, bank stability, and nutrients in the form of organic matter. Removal of trees and shrubs can reduce vegetation structure, canopy cover and stream shading. This can potentially lead to increased stream temperatures, reduced bank stability, and reduced organic matter (allochthonous material) reaching the stream. It can also lead to reduce habitat quality and quantity for riparian obligate species that are dependent upon streamside canopy and structure as part of their life history.

While streams can process normal sediment levels, elevated levels can cause negative impacts. Most streams carry or move sediment and the amount varies seasonally. Sediment transport involves detachment and entrainment of particles, their transport, and their deposition. When additional fine sediments are transported, they can accumulate in relatively clean or porous substrate such as gravels and habitats such as pools. Increased levels of sedimentation can have adverse effects on aquatic species, habitats, and riparian ecosystems. Fine sediment deposited in spawning gravels can reduce egg survival (Hicks et al., 1991) by reducing the availability of dissolved oxygen in the gravel. Primary production, benthic macroinvertebrate abundance, and thus food availability for fish and gartersnakes (prey) may be reduced as sediment levels increase. Large wood in streams is an important roughness element influencing channel morphology, sediment distribution, and water routing. Common sources of large wood include falling of dead trees, wind-throw and breakage, and landslides. Large wood influences channel gradient by creating step pools and dissipating energy, lengthens streams by increasing sinuosity, and serves as an important agent in pool formation. In low order streams, in particular, large wood collects sediment and larger substrates during high flows events and can account for a large proportion of sediment/substrate storage sites. It is also instrumental in nutrient retention.

Stream temperatures can affect the survival and production of fish throughout all life stages. Warm water temperatures can reduce survival of eggs as well as hatching success. For juveniles, growth can decline above certain temperatures, which differs by species, and is accompanied by decreased feeding, increased stress, and increased warm water diseases or parasites. Finally, at a certain point, temperatures become lethal for all fish.

Alteration of flows can have major physical effects on aquatic ecosystems. Increases in peak flows or frequency can increase bed scour or accelerate bank erosion negatively impacting aquatic habitat. Small streams are the more easily altered as they are intimately associated with their riparian zones and are highly responsive to alterations in riparian vegetation and the surrounding watershed. These streams

carry water, sediment, nutrients, and large wood from upper portions of the watershed which influence the quality of aquatic habitat downstream.

Impacts to individuals

Impacts to individuals are considered direct impacts and can include mortality and modification of behavior. Mortality would only occur from actions within species habitats. Modification of behavior can include factors such as disruption of social and feeding behavior that could reduce potential breeding or the health of individuals. It also includes displacement from an area temporarily which can also impact breeding or health. Therefore, increased acres or miles of treatments within the direct effects analysis area equates to an increase in potential impacts to individuals.

Habitat Connectivity

This was selected as a resource indicator specifically for roads as they can fragment aquatic or riparian habitat and impede or reduce movement. Therefore, increased miles of open roads equates to decreased habitat connectivity.

Road density has been considered a useful index of several ecological effects of roads in a landscape. Effects are evident for faunal movement, population fragmentation, human access, hydrology, aquatic ecosystems, and fire patterns. Hydrologic effects, such as altered groundwater conditions and altered drainage upslope, are sensitive to road densities. Increased peak flows in streams and macroinvertebrate diversity may be impacted with increasing road densities. Road density is an overall index that averages patterns over an area; its effects probably are sensitive to road type and width, traffic density, and network connectivity.

Pollutants, Invasive Species, and Disease

This was selected as resource indicator for habitat quality to address the potential for introduction into aquatic habitats. Pollutants and disease introduced into aquatic habitats reduces habitat quality. Use of mechanical equipment and storage of fuels in or around streams or other water bodies can also introduce contaminants. Equipment that is not cleaned or leaking can bring oils or fuel directly into water.

Most chemical transport from roads occurs in storm water runoff through or over soil (Trombulak and Frissell 2000). Runoff pollutants alter soil chemistry, may be absorbed by plants, can affect stream ecosystems, where they are dispersed and diluted over considerable distances. Typical water-quality responses to road runoff include altered levels of heavy metals, salinity, turbidity, and dissolved oxygen. These water quality changes can be sporadic and localized due to fluctuations in water quantity.

Similarly, roads promote the dispersal of exotic or invasive species by altering habitats, stressing native species, and providing movement corridors that further spread these species. Mechanical equipment can carry exotic species or aquatic invasive species from one water body to another. This can spread species such as Didymo *(Didymosphenia geminata)* and Eurasian milfoil which can reduce aquatic habitat quality.

Affected Environment

Watershed Condition

The proposed project occurs within portions of 142 different 6th HUC subwatersheds. Of these watersheds, thirty-eight have less than 5% of their total area within the project boundary. Overall, the project area is dominated

by functional-at-risk (fair) subwatersheds (about 451,500 acres, or 46 percent of the analysis area) with several impaired (poor) subwatersheds (about 316,800 acres, or about 32 percent of the analysis area) and a few properly functioning (good) subwatersheds (about 220,400 acres, or about 22 percent of the analysis area). Forty-nine subwatersheds are within aquatic species analysis areas throughout this document.

Watershed Condition Framework (WCF) rankings were used to described existing conditions for aquatic species analysis areas at this scale. Five indicators most relevant to water quality and aquatic species are discussed in more detail: aquatic habitat, aquatic biota, riparian/wetland vegetation, water quality, and roads and trails (Figure 1). A more comprehensive analysis of all Watershed Condition Framework scores for the Rim Country Project Area can be found in the Watershed Cumulative Effects Specialist Report.

For aquatic habitat, 10 subwatersheds were rated in good condition, 25 in fair condition and 14 watersheds rated in poor condition based on habitat quality, fragmentation, and stream channel condition (Figure 1and Appendix B). Watersheds in 'poor condition' for aquatic habitat largely reflect past land uses (i.e. grazing, logging), including fragmentation by roads, lack of large wood in channels, and altered channel morphology. Many of these conditions continue to persist long after the original impact.

For aquatic biota, 5 subwatersheds were rated in good condition, 27 in fair condition, and 17 watersheds were rated in poor condition based on community structure (natives vs. nonnatives/invasives) and continuity of populations.

For the riparian vegetation indicator, 9 subwatersheds were rated in good condition, 21 rated in fair condition, and 19 rated in poor condition based on relative condition and departure from potential. As with aquatic habitat, riparian conditions also reflect past land uses that are no longer active or allowed as well as current impacts (i.e. recreation, OHV).

For water quality, 25 subwatersheds were rated in good condition, 17 fair condition, and 7 rated in poor condition. This attribute rating is based on 303(d) status (percent of miles listed) and other known water quality impairments.

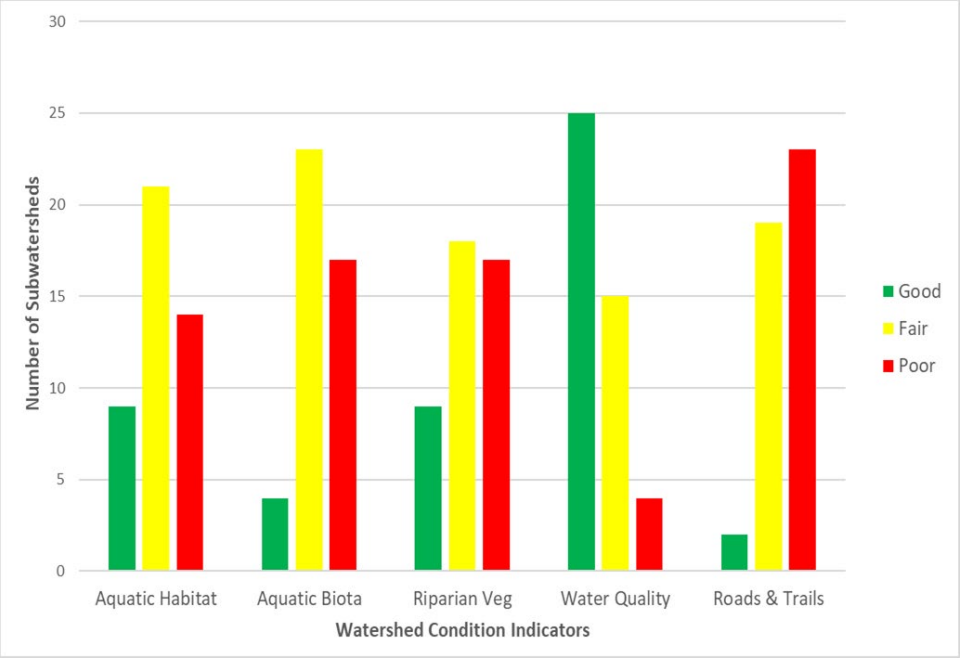

Figure 1. Number of subwatersheds by condition class for selected indicators.

Watershed function and health, as they relate to roads and trails, were based on factors that include open road density, maintenance investment, and proximity to water. Two were rated in good condition, 22 rated in fair condition, and 25 watersheds rated poor condition. Road management is an ongoing agency emphasis, with national direction for transportation analysis to identify a 'sustainable' (economic, social, and ecological) road system, and develop a plan to reduce road impacts. Ongoing challenges include desire for public access for various purposes, needs for access for resource management and protection, and diminished funding for maintenance and storage or decommissioning of unneeded roads.

The desired condition is to have watershed function maintained or improved towards functioning properly (Good Rating). Watersheds would exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. Tree density would be reduced and moving toward the historical range. Unneeded roads would be decommissioned or restored to their natural condition improving the road and trail indicator. Soil and riparian condition and function would be improved and moving towards satisfactory and properly functioning.

Riparian Condition

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

No species have riparian condition rated in good condition which equates to functioning properly. Proper functioning condition indicates adequate vegetation, landform, and/or large woody debris are present to:

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

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

Six species have riparian condition rated in fair condition, which is considered Functioning at Risk. These riparian areas are in limited functioning condition; however, existing hydrologic, vegetative, or geomorphic attributes make them susceptible to impairment. Disturbance partially compromises proper functioning condition of native vegetation attributes along stream corridors, wetlands, or water bodies. Native vegetation demonstrates a moderate loss of vigor, reproduction and growth, or changes in composition; particularly in areas most susceptible to human impact. Areas displaying light to moderate impact to structure, composition and cover may occupy 25 to 80% of the overall riparian area with only a few areas displaying significant impacts. Up to 25% of species cover or composition occurs from early seral species, but the communities across the watershed are still dominated by mid to late seral stages.

Xeric herbaceous communities exist where water relationships have been altered but are relatively small, localized, and do not dominate across the watershed.

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

Table 2. Average Riparian Condition from watershed condition framework for species analysis areas.

Species	Riparian Condition	Associated Rating
Gila trout	2.3	Fair
Gila chub	2.0	Fair
Gila topminnow	2.0	Fair
Little Colorado spinedace	2.5	Poor
loach minnow	2.0	Fair
spikedace	2.0	Fair
narrow-headed gartersnake	2.0	Fair
desert sucker	2.6	Poor
Sonoran sucker	2.7	Poor
Little Colorado sucker	2.3	Fair
headwater chub	2.4	Fair
roundtail chub	2.0	Fair
northern leopard frog	2.2	Fair

Ecological Restoration Units (Vegetation Types)

Ecological Response Units (ERUs) are map unit constructs, technical groupings, from the National Vegetation Classification. Each unit combines finer scale vegetation classes that share similar ecosystem processes and successional dynamics as well as potential vegetation under historic disturbance regimes. These units are supposed to facilitate landscape analysis and strategic planning.

The Rim Country project area contain six overarching ERU types: riparian, human/other, grassland, shrubland, woodland, and forest. These types encompass a total of 25 ERUs varying in overall acreage within the project area (Table 2). Riparian and human/other ERUs occur on approximately 22,300 acres (<2% of project area) and represent vegetation types most closely associated with aquatic species and habitats analyzed in this report. However, it should also be noted that many high elevation streams are within Forested ERUs where vegetation such as ponderosa pine or mixed conifer are providing riparian functions such as stream shading and bank stabilization.

Table 3. Acreages of Ecological Restoration types and individual Ecological Restoration Units (ERUs) within the entire Rim Country Project Area.

ERU Type	ERU	Acres
Riparian		**21,326**
	Arizona Alder - Willow	228
	Arizona Walnut	68
	Fremont Cottonwood - Conifer	169
	Fremont Cottonwood / Shrub	539
	Herbaceous Riparian	4,270
	Historic Riparian - Residential/Urban	298
	Narrowleaf Cottonwood / Shrub	7,584
	Ponderosa Pine / Willow	5,607
	Sycamore - Fremont Cottonwood	946
	Willow - Thinleaf Alder	1,617
Human/Other		**974**
	Water	974
Grasslands		**38,758**
	Colorado Plateau / Great Basin Grassland	14,086
	Montane / Subalpine Grassland	24,672
Shrubland		**2,542**
	Gambel Oak Shrubland	0
	Interior Chaparral	2,542
Woodland		**97,787**
	Juniper Grass	2,409
	Madrean Encinal Woodland	16,457
	Madrean Pinyon-Oak Woodland	3,868
	PJ Evergreen Shrub	27,150
	PJ Grass	10,087
	PJ Woodland	37,815
Forest		**1,076,784**
	Mixed Conifer - Frequent Fire	106,633
	Mixed Conifer w/ Aspen	62,700
	Ponderosa Pine Forest	749,600
	Ponderosa Pine / Evergreen Oak	157,849
Total		**1,238,171**

Riparian areas are directly coupled to streams, the portions of watersheds required for maintaining hydrologic, geomorphic, and ecological processes that directly affect streams, stream processes, and aquatic habitats. Riparian areas are shaped by disturbances characteristic of upland ecosystems, such as fire and windthrow, as well as disturbance processes unique to stream systems, such as lateral channel erosions, peakflows, depositions by floods and debris flows. The near-stream riparian areas and floodplains may contain an increased diversity of plant species and extensive hydrologic nutrient cycling interactions between groundwater and riparian vegetation. This vegetation, ranging from conifers to deciduous hardwoods, provides organic debris to stream channels and associated aquatic invertebrate communities. Further, riparian vegetation moderates light exposure and stream temperature, helps armor stream banks with extensive root systems, and contributes large wood into the stream channel.

Stream-riparian ecosystems naturally experience periodic catastrophic disturbances, which then moved through a series of recovery states over a period of decades to centuries, resulting in a landscape that varies in suitability for aquatic species. A pulse disturbance is one that allows an ecosystem to recovery to pre-disturbance conditions, and a press disturbance is one that prohibits an ecosystem from rebounding to pre-disturbance conditions. The dominant pulse disturbances aquatic species are adapted to include

natural fire regimes, fire related landslides, and floods, all working in concert in a manner that produce habitat patches, varying in quality and quantity. In short, fires would burn through an area, landslides and mass wasting would distribute the sediment and debris throughout stream networks. The pulse disturbance regime, or varying forms thereof, was altered with the onset of fire suppression and extensive timber harvest. The resulting effects are different from the natural pulse regime in that sediment is transported in the system without wood, the interval between disturbances had been drastically reduced in most cases, and harvest and road construction is widely distributed, resulting in chronic sedimentation across a larger landscape.

Streams and Aquatic Species

The Rim Country project area encompasses the headwaters of three major river basins in Arizona; the Salt, Verde, and Little Colorado Rivers. There are approximately 4,055 miles of stream channels within the proposed project area, including ephemeral, intermittent, and perennial channels (Table 3). Ephemeral streams only carry water during runoff and do not support riparian vegetation. Intermittent and perennial streams support riparian vegetation and various species that use those habitats. USGS defines ephemeral streams as channels above the water table at all times and only flow in direct response to precipitation (runoff). Therefore, they do not support riparian vegetation. Intermittent streams flow receive water from rainfall runoff, springs, or other surface sources such as snowmelt. Perennial streams normally have water in the channel at all times. Therefore, intermittent and perennial streams are capable of supporting riparian vegetation and providing aquatic habitat. Of these streams, approximately 360 miles are occupied or suitable habitat for aquatic species such as fish, gartersnakes, frogs, and invertebrates.

Table 4. Miles of each stream type within the Rim Country project area.

Forest	Ephemeral	Intermittent	Perennial	Total
Apache-Sitgreaves NF	719.6	876.3	51.6	1647.5
Coconino NF	23.9	1,077.0	118.9	1,219.8
Tonto NF	1.3	969.5	217.3	1188.1
Total	**744.8**	**2,922.8**	**387.8**	**4,055.4**

Most streams and aquatic and riparian habitats have experienced considerable degradation and alteration from a variety of human and management related activities (Rinne 1994, Rinne and Minckley 1991); their ability to recover and improve has been affected, especially as ongoing and new impacts occur. Habitat quality and complexity have resulted from loss of pool habitat, loss of large wood within streams (Faustini and Jones 2003), riparian area impacts, channel alterations, and down cutting. Increased sedimentation rates can adversely impact habitat and species through negative impacts to water quantity and quality. Fish population surveys and sampling efforts have also shown declines for some species, while some non-native species have shown increases.

Decline of aquatic species and their habitats can be traced to a variety of factors that are common in the western United States. These include major and minor dams, water diversions, channelization, and groundwater mining for irrigation and municipal use (Rinne 1994); sediment (Newcombe and MacDonald 1991), land management activities including grazing (Ohmart 1996), road construction Trombulak and Frissell 2000), and timber-harvest; increased fuel loading leading to uncharacteristic wildfire (Rieman et al, 2003; Young et al., 2002), loss of riparian vegetation through land conversion; and introduction of species for sport fishing (Post et al. 2002). The pattern of degradation in aquatic habitats and communities

closely parallels human settlement and land use. Concurrent with the extensive modification of aquatic habitats was the introduction of nonnative species that leading to competition, hybridization, and predation with native fishes (Rahel 2000; Rinne 1994; Rinne and Minckley 1991). Native fish populations have been reduced from large, interconnected populations to isolated populations within severely altered and degraded habitats. All the native species have lost much of their population redundancy within and outside the forests. This is reflected in the historic and recent population declines and fragmentation of fish species in the Southwest (Fagan 2002).

Native aquatic species and habitats analyzed here have persisted environmental disturbances altering them from historic conditions. (e.g., fire and suppression of fire, climate variation, degraded watersheds and aquatic habitat, altered hydrologic conditions, loss of riparian and aquatic habitat, recreation demands, non-native species introductions, roads). While most of these impacts have occurred slowly over many decades, the individual and collective impacts still remain today. Current conditions for aquatic species and habitats at the 5th level HUC watershed can be attributed to many factors. Diversions and water withdrawals reduce surface waters and alter flowing streams into intermittent streams, reservoirs, or dewatered channels reducing available habitat. Stream channelization for flood control or from altered hydrologic regimes reduces riparian and aquatic habitat quantity and quality. Competition and predation by non-native species has also reduced native populations. Other general factors that have directly or indirectly altered habitats include roads, recreation, livestock grazing, timber harvest and fire suppression.

Federally listed and regional forester sensitive species lists for all three Forests were screened to determine species that occur or have suitable habitat with the project and action area. Eleven federally listed species and nineteen sensitive aquatic species occur within the three Forests. Of those, nine federally listed and sixteen sensitive individual species will be analyzed in detail (Table 4). Two of the species (gartersnakes) are both federally listed and sensitive species.

Springs

A majority of the springs in the project area have been surveyed. High concentrations of springs are present in the headwaters of Upper Clear Creek, West Clear Creek and East Verde River 5th code watersheds. Of the approximate 360 springs that have been inventoried by the Spring Stewardship Institute within the Rim Country project area, 214 have survey information. Information regarding historic flow or water quality from these springs is minimal. Most springs within the project area are either rheocrene- meaning they flow directly from the ground resulting in a small stream, helocrene- they emerge from low gradient wetlands, or hillslope – they emerge from confined or unconfined aquifers on a hillslope (typically 30–60º); often with indistinct or multiple sources.

Eighty springs have been assessed using the Spring Ecosystem Assessment Protocol within the Rim Country project boundary, all of them located on the Coconino NF. The Spring Ecosystem Assessment Protocol (SEAP) http://springstewardshipinstitute.org/springs-1 is a process of evaluating the inventory data as well as other external information to generate a condition and risk score in each of the six predefined categories of variables. Risk is interpreted as the potential threat or the “condition inertia” of that variable. In other words, what is the probability of that variable remaining unchanged? The six variable categories are: aquifer and water quality, site geomorphology, habitat and microhabitat array, site biota, human uses and influences, and administrative context under which the spring is managed. Of these eighty springs, 82 percent were identified to be at low to no risk with the remaining 18 percent at moderate or greater risk. Many springs within the project area have been adversely affected by human activities including flow regulation through installation of spring boxes and piping of discharge to off-site locations, recreational effects, urbanization and other construction activities, and grazing by domestic livestock and wildlife herbivores”.

Table 5. Federally listed and Forest Service Sensitive aquatic species and/or their habitat expected to occur within the Rim Country project area.

Species	Status	Occurrence	Notes
Gila trout (*Oncorhyncus gilae*)	Threatened	Documented Occurrence	Occurs within the project and action areas
Little Colorado Spinedace (*Lepidomeda vittata*)	Threatened, with designated critical habitat	Documented Occurrence	Occurs within the project and action areas
Gila chub *(Gila intermedia)*	Endangered with designated critical habitat	Documented Occurrence	Occurs outside the project area, but within the action area.
Gila topminnow *(Poeciliopsis occidentalis occidentalis)*	Endangered	Documented Occurrence	Occurs outside the project area, but within the action area.
Loach minnow *(Tiaroga cobitis)*	Endangered with designated Critical habitat	Species not present, designated critical habitat does occur.	Occurs outside the project area, but within the action area.
Spikedace *(Meda fulgida)*	Endangered with designated Critical habitat	Documented Occurrence	Occurs outside the project area, but within the action area.
Narrow-headed gartersnake (*Thamnophis rufipunctatus*)	Threatened, with proposed Critical Sensitive	Documented Occurrence	Occurs within the project area
Desert sucker *(Catostomus clarki)*	Sensitive	Documented Occurrence	Occurs within the project area
Sonoran sucker *(Catostomus insignis)*	Sensitive	Documented Occurrence	Occurs within the project area
Little Colorado sucker *(Catostomus sp. 3)*	Sensitive	Documented Occurrence	Occurs within the project area
Headwater chub *(Gila nigra)*	Sensitive	Documented Occurrence	Occurs within the project area
Roundtail chub *(Gila robusta)*	Sensitive	Documented Occurrence	Occurs within the project area
Netwing Midge *(Agathon arizonicus)*	Sensitive	Documented Occurrence	Occurs within the project area.
A Mayfly *(Fallceon eatoni)*	Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the project area.
A Stonefly *(Capnia caryi)*	Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the project area.
Parker's cylloepus riffle beetle *(Cylloepus parkeri)*	Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the project area.
A Mayfly *(Fallceon eatoni)*	Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the project area.
A Mayfly *(Moribaetis mimbresaurus)*	Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the project area.
A Caddisfly *(Lepidostoma apache)*	Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the project area.

Species	Status	Occurrence	Notes
A Caddisfly *(Lepidostoma knulli)*	Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat exists in the project area.
A Caddisfly *(Limnephillus granti)*	Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat of springs in ponderosa pine exist within project area.
A Caddisfly *(Wormaldia planae)*	Forest Service Sensitive	Documented Occurrence	Occurs within the action area
Ferris' Copper *(Lycaena ferrisi)*	Forest Service Sensitive	Suspected to Occur	Little is known about the species, but suitable habitat of herbaceous wetlands exist within project area.
Nokomis Fritillary (aka Great Basin Silverspot) *(Speyeria nokomis nokomis)*	Forest Service Sensitive	Documented Occurrence	Little is known about the species, but suitable habitat of herbaceous wetlands and streams exist within project area.
Fossil springsnail *(Pyrgulopsis simplex)*	Forest Service Sensitive	Documented Occurrence	Occurs within the action area
California floater *(Anodonta californiensis)*	Forest Service Sensitive	Documented Occurrence	Occurs within the project and action areas
Aquatic macroinvertebrates (various species)	Management indicator species (TNF only)	Documented Occurrence	Occurs within the project and action area
Species Not Analyzed in Detail			
Apache trout *(Oncorhyncus gilae apache)*	Threatened	No Documented Occurrence	Does not occur within the project or action area
Colorado pikeminnow *(Ptychochelus lucius)*	Experimental-Nonessential Population	No Documented Occurrence	Does not occur within the project or action area
Razorback sucker *(Xyrauchen texanus)*	Endangered with designated Critical habitat	No Documented Occurrence	Does not occur within the project or action area
A Caddisfly *(Wormaldia planae)*	Forest Service Sensitive	Not Suspected to Occur	Does not occur in the project area, and elevation range is lower than that of the project.
Balmorhea Saddle-Case Caddisfly *(Protoptila balmorhea)*	Forest Service Sensitive	Not Suspected to Occur	Does not occur in the project or action Area, associated ERU semidesert grassland does not occur.

Threatened and Endangered Species Analyzed in Detail

Gila trout *(Oncorhynchus gilae gilae)*

Status: Threatened (USDI 2006a).

Gila trout are one of three native trout in the Southwestern Region of the Forest service. The Gila trout was first described by Robert Rush Miller in 1950. At that time there were fewer than 10 remaining populations of Gila trout. The natural history and historical distribution of the Gila trout is fully described in the Gila Trout Recovery Plan (USDI, 2006b) and in the final rule reclassifying Gila trout from Endangered to Threatened (USDI, 2005). That information is incorporated by reference into this BA.

The most recent status of the Gila trout is described in the Recovery Plan and Reclassification Final Rule (Fish and Wildlife Service, 2003, 2006) and is incorporated by reference into this BA. The current recovery plan identifies potential restoration streams for the management and recovery of the species. Gila trout were originally recognized as endangered under the Federal Endangered Species Preservation Act of 1966, and subsequently, they were listed as endangered under the ESA of 1973. No critical habitat has been designated for Gila trout. The Gila trout was downlisted from endangered to threatened in 2006. With the reclassification to threatened status, a special rule under section 4(d) of ESA was established, allowing the New Mexico Department of Game and Fish and the Arizona Game and Fish Department to promulgate special regulations in collaboration with the U.S. Fish and Wildlife Service allowing recreational fishing of Gila trout. Over the last 15+ years, the Arizona Game and Fish Department and Forest Service have implemented some recovery actions to improve the species status in Arizona; however, wildfires and drought have impacted those efforts.

In Arizona, there are currently 5 streams that have been stocked to establish recovery populations and there are several streams that Arizona Game and Fish intends to stock for recreational purposes.

Threats to the species include the destruction, modification, and curtailment of its habitat or range; livestock grazing; fire; timber harvest operations and the associated erosion, siltation, and increases in water temperatures; and the introduction of nonnative trout species that hybridize and compete with the Gila trout. Further information on this species can be found at:
https://www.fws.gov/southwest/es/arizona/Gila_Trout.htm

Habitat in the Analysis Area

Gila trout occur in approximately 32 miles of streams within the project area (Table 5). The six streams are either currently occupied by the species or provide suitable habitat for recovery efforts.

Table 6. Miles of streams and associated 6th Code subwatersheds with Gila trout within the Rim Country proposed project area.

Stream Name	6th HUC subwatershed	Recovery or Recreation	Stream miles in Project Area
Chase Creek		**Recovery**	**4.4**
	East Verde River Headwaters		4.4
Christopher Creek		**Recreational**	**8.2**
	Bull Tank Canyon-Tonto Creek		0.0
	Christopher Creek		8.1
Dude Creek		**Recovery**	**2.2**

Stream Name	6th HUC subwatershed	Recovery or Recreation	Stream miles in Project Area
	East Verde River Headwaters		2.2
Ellison Creek		**Recreational**	**4.4**
	Ellison Creek – East Verde River		4.4
Haigler Creek		**Recovery &Recreational**	**8.9**
	Haigler Creek		8.9
Workman Creek		**Recreational**	**4.0**
	Workman Creek		4.0
Grand Total			**32.1**

Six watersheds (6th HUCs) contain Gila trout streams within the project area. Riparian condition within these watersheds ranges from good (n=1) to poor (n=3) (Table 6). The average riparian condition for Gila trout watersheds is 2.3, which equates to fair.

Table 7. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Gila trout within the Rim Country proposed project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Bull Tank Canyon-Tonto Creek	3	Poor
Christopher Creek	3	Poor
East Verde River Headwaters	3	Poor
Ellison Creek-East Verde River	2	Fair
Haigler Creek	2	Fair
Workman Creek	1	Good
Average	**2.3**	**Fair**

Little Colorado Spinedace *(Lepidomeda vittata)* and designated Critical Habitat

Status: Threatened with designated critical habitat (USDI, 1987).

The natural history of Little Colorado spinedace can be found in the Recovery Plan (USDI 1987), and the 5-Year Review (USDI 2008). The Little Colorado spinedace is a member of the Cyprinidae family and is typically less than 10 cm long. This species is predacious, feeding on aquatic and terrestrial insects, as well as filamentous algae. Spinedace inhabits medium to small streams and is characteristically found in pools with water flowing over fine gravel and silt-mud substrates. Many of the streams are seasonally intermittent, at which times the Little Colorado spinedace persists in the deep pools that retain water. During flooding the spinedace redistributes itself throughout the stream. Spawning primarily occurs in late-spring to early-summer but can extend to the fall. Typical habitat ranges in elevation from 4,000 to 8,000 feet.

Past threats and declines of this species have resulted from habitat alterations and loss due to impoundment, removal of water from streams, channelization, grazing, road building, urban growth, and other human activity. Their decline is also related to the introduction and spread of non-native predatory and competitive fish species, and the use of pesticides (ichthyotoxins) in many of its native streams. Current threats to the survival of the species include changes in stream flow patterns, declines in water quality and quantity, modifications of watersheds (logging, dams, road construction), manipulations of fish populations (use of chemicals and other factors) and interactions with introduced fishes and other aquatic species. Recent impacts to the species are due to drought, non-native species, and alteration of natural hydrographs in occupied habitat. Livestock and wild ungulate grazing have also been identified as contributing to poor watershed conditions which exacerbate the effects of drought and result in

diminished habitat quality. Fuels reduction, forest restoration projects, and fire management actions have also contributed to altered hydrographs and sediment loads in streams occupied by spinedace. Further information on Little Colorado spinedace can be found at:
https://www.fws.gov/southwest/es/arizona/Little.htm

Based on the 5-Year Review spinedace are consistently located in West Leonard and Leonard Canyons, Lower Chevelon Creek on private land, Little Colorado River on two AZGFD properties, Rudd Creek, and Nutrioso Creek.

The most recent survey and habitat data for each watershed are indicated below from the 5-Year Status Review (USFWS 2008).

Chevelon Creek Watershed: Currently, spinedace occupies a section of Chevelon Creek, several miles upstream of Chevelon Creek's confluence with the LCR on the privately own Rock Art Ranch. Chevelon Creek through the Rock Art Ranch supports robust populations of spinedace, where large schools of fish (40-50 individuals) can be seen swimming in pools downstream of The Steps, something not seen in any other currently occupied area.

On July 23, 2007, AZGFD stocked 95 spinedace into five pools on West Chevelon Creek on the ASNFs. This tributary to middle Chevelon Creek contains only native fish at this time and is expected to provide habitat for spinedace. In July 2008, surveys located spinedace within the perennial pools where they were originally stocked and downstream of the area in ephemeral reaches. It is unclear how many fish are still present or if they spawned in 2008. Further surveys and stockings of this area are needed in order to ensure that spinedace persist in West Chevelon Creek if it is to contribute to recovery.

East Clear Creek Watershed: Spinedace currently occupy small, perennial pool habitats in West Leonard Canyon, Leonard Canyon (including Dines Tank), Bear Canyon, Dane Canyon, and Yeager Canyon. These populations and available habitat are all relatively small throughout the watershed, but West Leonard and Leonard Canyons continue to be one of the most dependable locations to find spinedace in the entire watershed. Bear, Dane, and Yeager Canyon populations are sustained by moving spinedace from West Leonard Canyon and Dines Tank to these areas. Spinedace were introduced into Turkey Creek and Gentry Creek in September 2018; future surveys will determine if the stocking is successful as well as if the population becomes self-sustaining in the future.

Habitat in the Analysis Area

Little Colorado spinedace occur or have suitable habitat in approximately 132 miles of streams within the project area (Table 7). Streams listed in the table below are either currently occupied by the species or provide suitable habitat for recovery efforts. Two sections of East Clear Creek are identified as designated critical habitat within the project area: 13 miles of stream above Blue Ridge Reservoir and 18 miles of stream from the confluence of Leonard Canyon upstream to Blue Ridge Reservoir.

Table 8. Miles of streams and associated 6th Code subwatersheds (HUC) with occupied or suitable habitat for Little Colorado spinedace within the Rim Country proposed project area.

Stream Name	6th HUC subwatershed	Total
Barbershop Canyon		**2.7**
	Barbershop Canyon	2.7
Bear Canyon		**7.3**
	Bear Canyon	7.3
Chevelon Creek		**7.7**

Stream Name	6th HUC subwatershed	Total
	Durfee Draw-Chevelon Canyon	7.7
Dane Canyon		**4.8**
	Barbershop Canyon	4.8
East Clear Creek		**36.1**
	East Clear Creek-Blue Ridge Reservoir	16.1
	East Clear Creek-Clear Creek	20.0
	Leonard Canyon	0.0
	Miller Canyon	0.0
East Leonard Canyon		**2.5**
	Leonard Canyon	2.5
Gentry Canyon		**1.0**
	Gentry Canyon-Upper Clear Creek	1.0
Kehl Canyon		**1.5**
	East Clear Creek-Blue Ridge Reservoir	1.5
Leonard Canyon		**23.7**
	Leonard Canyon	23.7
Middle Leonard Canyon		**1.5**
	Leonard Canyon	1.5
Miller Canyon		**7.0**
	Miller Canyon	7.0
Potato Lake Draw		**0.6**
	East Clear Creek-Blue Ridge Reservoir	0.6
Turkey Creek		**3.1**
	Gentry Canyon-Upper Clear Creek	3.1
West Chevelon Creek		**4.2**
	Upper West Chevelon Canyon	4.2
West Leonard Canyon		**4.9**
	Leonard Canyon	4.9
Willow Creek		**22.5**
	East Clear Creek-Clear Creek	0.0
	Gentry Canyon-Upper Clear Creek	0.0
	Lower Willow Creek	13.3
	Upper Willow Creek	9.2
Yeager Canyon		**0.8**
	East Clear Creek-Clear Creek	0.8
Grand Total		**131.8**

Designated critical habitat for Little Colorado spinedace occurs in East Clear Creek above and below Blue Ridge Reservoir within the project area and is occupied (Table 8).

Table 9. Little Colorado spinedace designated critical habitat acres by stream unit and 6th Code subwatershed (HUCs) within the Rim Country proposed project area.

Critical Habitat Unit	6th HUC subwatershed	Total Acres
East Clear Creek		**130.3**
	Barbershop Canyon	0.1
	East Clear Creek-Blue Ridge Reservoir	53.6

Critical Habitat Unit	6th HUC subwatershed	Total Acres
	East Clear Creek-Clear Creek	76.6
Total		**130.3**

Eleven watersheds (6th HUCs) contain Little Colorado spinedace streams within the project area. Riparian condition within these watersheds ranges from good (n=1) to poor (n=7) (Table 9). The average riparian condition for Little Colorado spinedace watersheds is 2.5, which equates to poor.

Table 10. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Little Colorado spinedace within the Rim Country proposed project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Barbershop Canyon	3	Poor
Bear Canyon	3	Poor
Durfee Draw-Chevelon Canyon	1	Good
East Clear Creek-Blue Ridge Reservoir	3	Poor
East Clear Creek-Clear Creek	2	Fair
Gentry Canyon-Upper Clear Creek	3	Poor
Leonard Canyon	3	Poor
Lower Willow Creek	2	Fair
Miller Canyon	3	Poor
Upper West Chevelon Canyon	2	Fair
Upper Willow Creek	3	Poor
Average	**2.5**	**Poor**

Gila chub *(Gila intermedia)* and designated Critical Habitat

Status: Endangered with designated critical habitat (USFWS, 2005).

Recently, the taxonomy of the genus *Gila* within the Gila river basin has changed, with the American Fisheries Society lumping *Gila nigra, Gila robusta* and *Gila intermedia* into a single species (*Gila robusta).* The USFWS is currently conducting a species status review of the Gila robusta complex rangewide. Regardless, Gila chub populations as described in the listing and draft recovery plan are a federally listed species with designated critical habitat and analyzed as such in this document (USFWS 2005).

Most of the available information for this species has been summarized and reviewed within the Proposed and Final Rules for the "Listing Gila Chub as Endangered with Critical Habitat" completed in 2002 and in 2005, respectively. This species is found in pools in smaller streams and cienegas ranging in elevation from approximately 600 to 1675 meters. They are highly secretive, and adults prefer deeper water in pools and eddies below riffles or runs; often remaining in cover from terrestrial vegetation, boulders, and fallen logs. Young use the shallow margins of pools with aquatic vegetation or debris for cover, while older juveniles may be found in higher velocity runs and riffles. Primary food items are aquatic and terrestrial insects and filamentous algae. Breeding primarily occurs in late spring to summer, males follow the larger females over beds of aquatic plants, and there is no parental care of the young. Temperature may be the primary cue for initiation of spawning.

Gila chub are becoming rare, especially where land use practices such as overgrazing lead to incision of floodplains and lowering of water tables, which, in turn, drain marshlands and other stream-associated

habitats. Threats to the chub include introduction of nonnative aquatic competitors and predators (e.g., fish, bullfrogs, and crayfish), continued water use for development purposes, and habitat degradation due to improper land management on the watershed. Erosion from roads or off bare ground on the watersheds can fill in the deep pools needed by the species, thus degrading the habitat. Where it is still present, populations are often small, fragmented, and at risk from known and potential threats and from random events such as drought, flood events, and wildfire. Further information on the species can be found at: https://www.fws.gov/southwest/es/arizona/GilaChub.htm

Habitat in the Analysis Area

Gila chub and their designated habitat do not occur within the project boundary but do occur 10 miles downstream of the project area in Red Tank Draw on the Coconino NF. Approximately 11,600 acres of the Red Tank Draw subwatershed (32%) occur within the project area. Riparian condition for Red Tank Draw subwatershed is 2.0, which equates to fair (Table 10).

Table 11. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Gila chub within the Rim Country proposed project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Red Tank Draw	2	Fair
Average	**2.0**	**Fair**

Gila topminnow *(Poeciliopsis occidentalis occidentalis)*

Status: Endangered (USFWS 1967).

The Gila topminnow is a small, guppy-like, live-bearing fish. It occurs in small streams, springs, and cienegas below 4,500 ft. elevation, primarily in shallow areas with aquatic vegetation and debris for cover. It can tolerate relatively high water temperatures and low dissolved oxygen. Breeding occurs primarily during January through August, but in thermally constant springs young may be produced through the year. Gila topminnow are opportunistic omnivorous feeders. Primary food includes detritus, vegetation, amphipods, ostracods, and insect larvae.

Historically, it was one of the most common fish throughout the Gila River drainage in Arizona, Mexico, and New Mexico. Currently, most of the remaining naturally occurring populations in are in the Santa Cruz River system. The species occurs in small streams, springs and cienegas in Gila, Pinal, Graham, Yavapai, Santa Cruz, Pima, Maricopa, and La Paz counties, Arizona. It has been released at almost 200 locations in efforts to reestablish populations.

Impacts to the species include introduction and spread of nonindigenous predatory and competitive fishes, water impoundments and diversions, water pollution, groundwater pumping, stream channelization, and habitat modification. Further information on this species can be found at: https://www.fws.gov/southwest/es/arizona/Gila_Top.htm

Habitat in the Analysis Area

Gila topminnow does not occur within the project area but does occur within a watershed the action area. Gila topminnow were stocked into Fossil Creek from 2007-2011. Surveys in 2016 observed topminnow in two reaches: reach 1 from High Falls to Fossil Springs dam and reach 4 from the constructed fish barrier to Sally May Wash. The species occurs in Fossil Creek over 7 miles downstream of the project area in the Lower Fossil Creek subwatershed. Approximately, 12,300 acres of the Upper Fossil Creek watershed (48%) occurs within the project area. Riparian condition for the Lower Fossil Creek subwatershed is rated as Functioning at Risk (Table 11).

Table 12. Riparian condition score from Watershed Condition Framework for 6th Code HUCs with Gila topminnow within the Rim Country proposed project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Lower Fossil Creek	2	Fair
Upper Fossil Creek	1	Good
Average	**1.5**	**Fair**

Loach minnow *(Tiaroga cobitis) and designated Critical Habitat*

Status: Endangered with designated critical habitat (USDI 2012b).

Loach minnow are found in turbulent, rocky riffles of rivers and tributaries from approximately 2,300 to 8,000 feet in elevation. Loach minnow are bottom-dwelling inhabitants of shallow, swift waters flowing over gravel and cobble substrates in mainstream rivers and tributaries. They use the spaces between, and the protective shelter of larger substrates for resting and spawning. The species is rare or absent from habitats where fine sediments fill the spaces between larger substrate. The first spawn of loach minnow generally occurs in their second year, primarily from March through May; and they may also spawn in the fall. Spawning occurs in the same riffles occupied by adults during the non-spawning season. The adhesive eggs of the loach minnow are attached under the downstream side of a rock that forms the roof of a small cavity in the substrate. Longevity is typically 15 months to two years, although loach minnow can live as long as three years. Loach minnow feed exclusively on aquatic insects; and they are opportunistic bottom-feeding insectivores, feeding primarily on riffle-dwelling larval mayflies and midges. They actively seek their food on bottom substrates, rather than pursuing food items in the drift.

During the last century, both the distribution and abundance of the loach minnow has been greatly reduced throughout the species range. Competition and predation by nonnative fish and habitat destruction have reduced the historic range of the loach minnow by about 85 percent. Both historic and present landscapes surrounding loach minnow habitats have been impacted to varying degrees by domestic livestock grazing, mining, agriculture, timber harvest, recreation, development, or impoundments. These activities degrade loach minnow habitats by altering flow regimes, increasing watershed and channel erosion and thus sedimentation, and adding contaminants to streams and rivers. As a result, these activities may affect loach minnow through direct mortality, interference with reproduction, and reduction of invertebrate food supplies. Further information on this species can be found at: https://www.fws.gov/southwest/es/arizona/Loach.htm

Habitat in the Analysis Area

Loach minnow does not occur within the project area but was stocked into Fossil Creek directly downstream of the project area in the Lower Fossil Creek subwatershed. Monitoring determined the species failed to establish in 2016 and no more stockings will occur. No designated critical habitat occurs within the project area, but does occur in Lower Fossil Creek. Approximately, 12,300 acres of the Upper Fossil Creek watershed (48%) occurs within the project area and drains into Lower Fossil Creek. Upper and Lower Fossil Creek subwatersheds define the action area for loach minnow. Average riparian condition for the subwatersheds is rated as fair (Table 12).

Table 13. Riparian condition score from Watershed Condition Framework for 6th Code HUCs with loach minnow within the Rim Country proposed project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Lower Fossil Creek	2.0	Fair
Upper Fossil Creek	1.0	Good

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Average	1.5	Fair

Spikedace *(Meda fulgida)*

Status: Endangered with designated critical habitat (USDI 2012).

Adult spikedace are 2.5 to 3.0 inches long; the eyes are large, the snout fairly pointed, and the mouth is slightly sub-terminal with no barbells present. The species is slender and somewhat anteriorly compressed. Spikedace can live up to 24 months, although few survive more than 13 months; and reproduction occurs primarily in one-year-old fish. Spawning extends from the middle of March into June and occurs in shallow riffles with gravel and sand bottoms and moderate flow. By the middle of May, most spawning has occurred, although in years of high water flows, spawning may continue into late May or early June. Spikedace feed primarily on aquatic and terrestrial insects.

Spikedace occupy mid-water habitats usually less than 3 feet deep, with slow to moderate water velocities over sand, gravel, or cobble substrates. Adults often occur in shear zones along gravel-sand bars where rapid water borders slower flow, quiet eddies on the downstream edges of riffles, and broad shallow areas above gravel-sand bars. The preferred habitat of the spikedace varies seasonally and with maturation. In winter, the species congregates along stream margins with cobble substrates. The erratic flow patterns of southwestern streams that include periodic and recurrent flooding are essential to the feeding and reproduction of the spikedace by scouring the fine sediment and keeping gravels clean. Spikedace larvae and juveniles tend to occupy shallow, peripheral portions of streams that have slow currents and sand or fine gravel substrates, but will also occupy backwater habitats.

Spikedace is native to the Gila River drainage, including the San Francisco drainage, except in the extreme headwaters. Relict spikedace populations exist only in the upper Verde River and Aravaipa Creek in Arizona and portions of the Gila River in New Mexico. Although, spikedace have not been collected in the Verde River in recent years. In New Mexico the species is generally absent from the Gila River from the confluence of the West and East Forks downstream to the mouth of Turkey Creek, and occurs irregularly downstream from the mouth of the Middle Box of the Gila River to the Arizona-New Mexico state line. There are reestablished populations in the Blue River AZ, San Francisco River NM, and Fossil Creek AZ.

The majority of historic habitat for the spikedace has been drastically altered or destroyed by human uses of the rivers, streams, and watersheds. Causes of such alterations and degradation include damming, water diversion, channel down-cutting, excessive groundwater pumping, lowering water tables, channelization, riparian vegetation destruction, erosion, mining, grazing, and other watershed disturbances. An increasing threat to spikedace includes the introduction and spread of non-native species that compete or predate upon spikedace. Further information on this species can be found at:
https://www.fws.gov/southwest/es/arizona/Spikedace.htm

Habitat in the Analysis Area

Spikedace does not occur within the project area but does occur within the action area. The species occurs in Fossil Creek downstream of the project area in the Lower Fossil Creek subwatershed. Spikedace were stocked in Fossil Creek from 2007-12 as a recovery action and are considered a self-sustaining population in Reach 4 from Sally Mae Wash downstream to the fish barrier more than ten miles downstream of the project area. Approximately, 12,300 acres of the Upper Fossil Creek watershed (48%) occurs within the

project area and drains into Lower Fossil Creek. Upper and Lower Fossil Creek subwatersheds define the action area for spikedace. Average riparian condition for the subwatersheds is rated as fair (Table 13).

Table 14. Riparian condition score from Watershed Condition Framework for 6th Code HUCs with spikedace or spikedace designated critical habitat within the Rim Country proposed project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Lower Fossil Creek	2	Fair
Rock Creek-Spring Creek	2	Fair
Spring Creek	2	Fair
Upper Wet Beaver Creek	2	Fair
Average	**2.0**	**Fair**

Critical Habitat

Spikedace designated critical habitat does not occur within the project area but does occur within the action area. Four streams within two critical habitat units are within the action area (Table 14). Primary constituent elements for designated critical habitat are in the biological assessment and incorporated by reference.

Table 15. Spikedace designated critical habitat units, streams and associated subwatersheds within the Rim Country action area.

Critical Habitat Unit	6th HUC subwatershed	Stream
Salt River Subbasin (Unit 2)	Rock Creek-Spring Creek	Rock Creek
	Spring Creek	Spring Creek
Verde River Subbasin (Unit 1)	Upper Wet Beaver Creek	Wet Beaver Creek
	Lower Fossil Creek	Fossil Creek

Narrow-headed gartersnake *(Thamnophis rufipunctatus)* and Proposed Critical Habitat

Status: Designated as Threatened on July 8, 2014 (USDI 2014a). Critical Habitat was proposed on April 23, 2020 (USDI 2020).

Historical range of the narrow-headed gartersnake included perennial drainages across the Mogollon Rim from northern and eastern Arizona, southeast into southwestern New Mexico.

The species is strongly associated with clear, rocky streams using predominately pool and riffle habitat that includes cobbles and boulders. Narrow-headed gartersnakes specialize on fish as their primary prey, feeding almost exclusively on native or soft-rayed fish. They are ambush predators that often anchor to stream cobbles and wait for fish to pass. They bask on nearby rocks, boulders and vegetation and seek cover in crevices and beneath rocks. Brumation occurs during fall and winter in rocky outcroppings above the high water mark, usually within 0.5 mi of the stream. Threats to this species include harmful nonnative species, destruction and modification of habitat and effects from wildfire on their prey base (USDI 2014b). Additional information for the narrow-headed gartersnake can be found at: https://www.fws.gov/southwest/es/arizona/N-HGartersnake.htm

Habitat in the Analysis Area

Narrow-headed gartersnake occurs or has suitable habitat in Canyon and Haigler Creeks within in the project and action area based on recent surveys. Multiple gartersnake surveys in Canyon Creek from 2015-2018 which found a relatively stable population with multiple size classes within the project area (Ryan et al. 2019). Haigler Creek was surveyed in 2014 with three juvenile narrow-headed gartersnakes

observed with in the project area (Goode and Parker 2015). Lower Haigler Creek in the action area has not been surveyed recently but is assumed to be occupied.

Two subwatersheds contain narrow-headed gartersnakes and proposed critical habitat within the project area. The average riparian condition for narrow-headed gartersnake watersheds is 2.0, which equates to fair (Table 15).

Table 16. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Narrow-headed gartersnake within the Rim Country proposed project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Canyon Creek Headwaters	2	Fair
Haigler Creek	2	Fair
Average	**2.0**	**Fair**

Critical Habitat

Proposed critical habitat occurs within the project area in Canyon and Haigler creeks (Table 16). USFWS considers all proposed critical habitat as occupied. Primary constituent elements for proposed critical habitat are in the biological assessment and incorporated by reference.

Table 17. Narrow-headed gartersnake proposed Critical Habitat acres by stream unit and 6th Code subwatershed (HUCs) within the Rim Country proposed project area.

Critical Habitat Unit	6th Code HUC subwatershed	Acres within Project area
Canyon Creek		**154.8**
	Canyon Creek Headwaters	154.8
Tonto Creek Subbasin		**106.1**
	Haigler Creek	106.1
Total		**260.8**

Chiricahua leopard frog *(Lithobates chiricahuensis)* and designated Critical Habitat

Status: Designated as Threatened on June 13, 2002 (USDI 2002). Critical Habitat was designated on March 20, 2012 (USDI 2012a).

The range of the Chiricahua leopard frog includes central and southeastern Arizona; west-central and southwestern New Mexico; and in Mexico, northeastern Sonora, the Sierra Madre Occidental of northwestern and westcentral Chihuahua, and possibly as far south as northern Durango Within the species' range, aquatic habitats historically and/or currently used by the frogs include a variety of natural and human-constructed waters between elevations of 3,281 and 8,890 ft (1,000 and 2,710 m), including rivers, permanent streams and permanent pools in intermittent streams, beaver ponds, cienegas (i.e., wetlands), springs, and earthen livestock tanks. They are occasionally found in livestock drinkers, irrigation sloughs or acequias, wells, abandoned swimming pools, ornamental ponds, and mine pits (USFWS 2007: 17). The number of populations in much of the species' range has declined drastically over the past 20 years.

The Chiricahua leopard frog is distinguished from other members of the leopard frog complex by a combination of characters, including a distinctive pattern on the rear of the thigh consisting of small, raised, cream colored spots or tubercles (wart-like projections) on a dark background; folds on the back and sides that, towards the rear, are interrupted and deflected towards the middle of the body; stocky body

proportions; relatively rough skin on the back and sides; eyes that are positioned relatively high on the head; and often green coloration on the head and back (Platz and Mecham 1979; Degenhardt et al. 1996).

Frogs at lower elevations below 5,900 ft (1,798 m) tend to lay eggs from spring through late summer, with most activity taking place before June. Populations above 5,900 ft (1,798 m) bred in June, July, and August. Chiricahua leopard frogs at warm springs may lay eggs year-round due to elevated water temperatures as compared to most breeding habitat. Eggs hatch in approximately 8 to 14 days depending on temperature. After hatching, tadpoles remain in the water, where they feed and grow. Tadpoles turn into juvenile frogs in 3 to 9 months (Sredl and Jennings 2005). The distribution of Chiricahua leopard frog populations has been seriously affected by chytridiomycosis. Chytridiomycosis is an introduced fungal skin disease caused by the organism Batrachochytrium dendrobatidis or ‘‘Bd.’’

Chiricahua leopard frogs have a complex life cycle consisting of eggs and larvae that are entirely aquatic and adults that are primarily aquatic. Each stage of the frogs’ life history has its own set of environmental or habitat requirements that influence its susceptibility to changes in its habitat, but in general Chiricahua leopard frogs need permanent to semi- permanent water that is free, or nearly so, of non-native aquatic predators. However, frogs are known to move among aquatic sites and can be found in upland sites, roadside puddles, and habitats that only hold water briefly during these movements. The CLF Recovery Plan identifies suitable habitat to include all perennial waters within: 1) elevational range of the frog (3,400 to 9,000 feet), 2) a mixture of aquatic and perimeter vegetation to provide oviposition sites, thermoregulation, and refuge from predators, 3) absence or low densities of nonnative aquatic species, and 4) a variety in substrate and range of shallow to deeper water for potential hibernacula. The recovery of Chiricahua leopard frog is divided into distinct recovery unit areas and each unit contains management areas that contain the best habitats for establishment of metapopulations. Designated critical habitat occurs on specific waterbodies and connecting overland corridors within the management areas.

Ongoing Recovery Efforts

The Arizona Game and Fish Department (AZGFD) and The United States Fish and Wildlife Service (USFWS) have partnered with Forest Service, USFW, and Phoenix Zoo (PZ) to implement captive rearing/head-starting recovery actions throughout the species range, including sites within the proposed action area. It is due to this stakeholders’ groups continued efforts that this species is persisting in the wild. This continuing partnership is critical to keeping leopard frogs on the landscape and is only possible due to the continued commitment to the species from the stakeholders’ group. These recovery actions include, 1) releasing headstarted frogs to unoccupied sites, 2) augmenting known CLF sites with headstarted frogs to increase genetic variability, and 3) translocating wild egg masses to new or existing sites.

Since 2009, AZGFD has released CLFs to multiple sites on the Tonto National Forest. Since 2016, more releases have occurred in Gentry and Upper Verde MAs. There have also been releases to the Pleasant Valley Ranger District within the 4FRI footprint. These sites are included above in Table 25. Six future release sites within the next 5-10 were provided by the Payson Ranger District biologist and included in the analysis if they were within the project area or within dispersal distance of it. Gruwell Spring occurs within the project area, while Rim tank, Grasshopper tank, Martin tank, Lost tank, and Pine Spring are within dispersal distance.

Species Distribution in the Project Area

The Rim Country Project Area occurs in both Recovery Units 5-Mogollon Rim and 6- Gila-White Mountain. Unit 5 Management Areas overlapping the project area include Gentry Creek, Upper Verde River, West Mogollon, Alder Creek/West Chevelon Canyon, and East Clear Creek. All occupied sites and critical habitat areas are in the south flowing drainages (Table 17). There no currently occupied areas or designated Critical Habitat within the north flowing Little Colorado River drainages.

Table 18. Chiricahua Leopard Frog sites associated with the Rim Country project area.

5th Code	Recovery Unit	Site	Management Area	Critical Habitat
Canyon Creek	5	FROG POND	GENTRY CREEK	
		WEST PRONG GENTRY CREEK	GENTRY CREEK	Yes
		CANYON CREEK	NOT APPLICABLE	
Cherry Creek	5	BOTTLE SPRING	GENTRY CREEK	Yes
		CARROLL SPRING	GENTRY CREEK	Yes
		CHERRY CREEK	GENTRY CREEK	Yes
		CROUCH CREEK	GENTRY CREEK	Yes
		NAEGELIN RIM TANK	GENTRY CREEK	
		NAEGELIN SPRING CANYON	GENTRY CREEK	
		RAMER TANK	GENTRY CREEK	
		TRAIL TANK	GENTRY CREEK	Yes
		UNMARKED TANK	GENTRY CREEK	
		UNMARKED TANK	GENTRY CREEK	Yes
		UNMARKED TANK	GENTRY CREEK	
		UNMARKED TANK	GENTRY CREEK	
		UNMARKED WILDLIFE CATCHMENT	GENTRY CREEK	
		UNNAMED TANK	GENTRY CREEK	
		128 RD TANK NO 2)	GENTRY CREEK	
		H-Y TANK)	GENTRY CREEK	Yes
East Verde River	5	DUDE CREEK	UPPER VERDE RIVER	
		EAST VERDE RIVER	UPPER VERDE RIVER	
		ELLISON CREEK	UPPER VERDE RIVER	
		ELLISON CREEK	UPPER VERDE RIVER	
		LEWIS CREEK	UPPER VERDE RIVER	Yes
		PIEPER HATCHERY SPRING	UPPER VERDE RIVER	
		MOORE TANK 4	UPPER VERDE RIVER	
		LOWER MOORE	UPPER VERDE RIVER	
		MIDDLE MOORE	UPPER VERDE RIVER	
		MOORE TANK 3	UPPER VERDE RIVER	
		UPPER MOORE	UPPER VERDE RIVER	
		BORROW PIT	UPPER VERDE RIVER	
		UNNAMED TRIB OF ELLISON CREEK (=TRIB 4)	UPPER VERDE RIVER	
Fossil Creek - Verde River	5	DOWNSTREAM OF PROJECT AREA	WEST MOGOLLON	Yes
Haigler Creek-Tonto Creek	5	BIG CANYON	NOT APPLICABLE	
		CABIN DRAW	NOT APPLICABLE	
		UNNAMED CREEK	NOT APPLICABLE	
		UNNAMED TRIB TO BIG CANYON	NOT APPLICABLE	
Upper Chevelon Canyon	5	UNOCCUPIED	ALDER CREEK/WEST CHEVLON CANYON	
Upper Clear Creek	5	UNOCCUPIED	EAST CLEAR CREEK	

Habitat in the Analysis Area

Chiricahua leopard frog habitat includes all the known and recently occupied locations, potential release sites, and habitats frogs can disperse to from all those locations. Based on that, habitat within the analysis area encompasses an area across portions of fourteen subwatersheds (15,281 acres). This area describes where Chiricahua leopard frog could occur during the project (Table 18).

Table 19. Acres of occupied or suitable habitat within dispersal distance for Chiricahua leopard frog by 6th code subwatershed (HUCs) within the Rim Country project area.

6th HUC subwatershed	Acres
Bull Tank Canyon-Tonto Creek	725
Canyon Creek Headwaters	2,117
Crouch Creek	102
East Verde River Headwaters	2,826
Ellison Creek-East Verde River	4,291
Gentry Canyon-Canyon Creek	499
Green Valley Creek	644
Gruwell Canyon-Cherry Creek	605
Haigler Creek	624
Horton Creek-Tonto Creek	893
Houston Creek	48
Parallel Canyon-Cherry Creek	1,340
Upper East Verde River	28
Webber Creek	541
Total	**15,281**

Riparian condition for Chiricahua leopard frog ranged from fair (n=7) to poor (n=7). Average riparian condition for these watersheds averages a rating of 2.5 or poor (Table 19).

Table 20. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Chiricahua leopard frog the Rim Country project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Bull Tank Canyon	3	Poor
Canyon Creek Headwaters	2	Fair
Crouch Creek	2	Fair
East Verde River Headwaters	3	Poor
Ellison Creek-East Verde River	2	Fair
Gentry Canyon-Canyon Creek	3	Poor
Green Valley Creek	3	Poor
Gruwell Canyon-Cherry Creek	3	Poor
Haigler Creek	2	Fair
Horton Creek-Tonto Creek	2	Fair
Houston Creek	3	Poor
Parallel Canyon-Cherry Creek	3	Poor
Upper East Verde River	2	Fair
Webber Creek	2	Fair
Average	**2.5**	**Poor**

Critical Habitat

Designated critical habitat exists within the project area on several areas of the Gentry Creek management area including Cherry Creek and the West Fork of Gentry Creek and within the East Verde management area within the headwaters of Ellison Creek (Table 20).

Table 21.Chiricahua leopard frog designated critical habitat acres by stream unit and 6th Code subwatershed (HUCs) within the Rim Country proposed project area.

Critical Habitat Unit	6th Code HUC subwatershed	Acres within Project area
Crouch, Gentry, Cherry Creeks and Parallel Canyon		**1.7**
	Crouch Creek	0.0
	Parallel Canyon-Cherry Creek	1.7
Ellison and Lewis Creek		**0.5**
	Ellison Creek-East Verde River	0.5
Fossil Creek		**0.0**
	Upper Fossil Creek	0.0
Total		**2.2**

Sensitive Species Analyzed in Detail

Narrow-headed gartersnake *(Thamnophis rufipunctatus)*

For information regarding this species' biology, habitat, historical range, species status reviews, and presence in the action area refer to Affected Environment: Threatened and Endangered Species Analyzed in Detail above.

Desert sucker *(Pantosteus clarki)*

The desert sucker (*C. clarki*), also known as the Gila mountain-sucker, is a moderate-sized member of the sucker family (Catostomidae), reaching lengths of up to 12 inches. Its mouth is ventral with large lips, and has well-developed cartilaginous scraping edges on the jaws. The coloration is silvery tan to dark greenish above, silvery to yellowish below. During spawning, both sexes may display an orange red lateral stripe.

Desert sucker occurs in the Bill Williams, Salt, Gila, San Francisco, and Verde River drainages in Arizona and New Mexico. It is characteristic of small to moderately large streams, at elevations of about 1,000 to 6,000 feet. Desert sucker does not occur in reservoirs, and dams and diversions of free-flowing streams have diminished its range somewhat. The species is generally common throughout its range, however continuing threats of water development make its future uncertain. This report will analyze effects to desert sucker and its habitat, as it is present in Oak Creek and Sycamore Creek.

Desert sucker is found in rapids and flowing pools of streams, primarily over bottoms of gravel-rubble with sandy silt in the interstices. Adults live in pools, moving at night to swift riffles and runs, where they feed on encrusting algae scraped from stones. Young inhabit riffles throughout the day, feeding on midge larvae. Individuals exhibit little seasonal movement and resist downstream displacement during floods. The desert sucker is highly adaptive to a wide range of temperatures, tolerating water temperatures as high as 90°F. It may be able to tolerate lower oxygen levels than other native stream fishes.

Chironomid larvae (midges) are the primary food of juveniles. As an adult, the desert sucker is primarily herbivorous, scraping filamentous algae from stones as well as ingesting plant detritus, aquatic insect larvae, and other invertebrates. Individuals often turn completely upside-down as they glean food off surfaces of stones.

Desert suckers spawn in late winter or early spring on riffles, where adults congregate in large numbers. Spawning typically occurs with one larger female and two or more smaller males. Lateral movements of the female's body form a depression in the stream channel substrates, and adhesive eggs are buried in loose gravels. Eggs hatch in a few days, and larvae gather in quiet pools near the bank, moving to swifter waters as they mature. Juveniles are mature by the second year of life at a length of 4 to 5 inches. More information on desert sucker can be found at:
https://www.fws.gov/southwest/es/arizona/Desert_Sucker.htm

Habitat in the Analysis Area

Desert sucker occurs in approximately 106 miles of streams within the proposed project area (Table 21). These eighteen streams are either currently occupied or provide suitable habitat for the species.

Table 22. Miles of occupied or suitable habitat for desert sucker by stream and 6th Code subwatershed (HUCs) within the Rim Country project area.

Stream	6th HUC subwatershed	Miles in Project Area
Bear Canyon		**2.9**
	Upper West Clear Creek	2.9
Buzzard Roost Creek		**2.2**
	Buzzard Roost Canyon	2.2
	Rock Creek	0.0
Canyon Creek		**5.9**
	Canyon Creek Headwaters	5.9
Cherry Creek		**0.7**
	Gruwell Canyon-Cherry Creek	0.7
Christopher Creek		**7.5**
	Christopher Creek	7.5
Dane Canyon		**9.2**
	Barbershop Canyon	9.2
East Bear Canyon		**2.7**
	Bear Canyon	2.7
East Clear Creek		**13.3**
	East Clear Creek-Clear Creek	13.3
	Leonard Canyon	0.0
Gordon Creek		**4.5**
	Gordon Canyon	4.5
Haigler Creek		**8.9**
	Haigler Creek	8.9
Hunter Creek		**2.6**
	Christopher Creek	2.6
Miller Canyon		**13.2**
	East Clear Creek-Blue Ridge Reservoir	0.0
	Miller Canyon	13.2
Mule Creek		**2.1**
	Canyon Creek Headwaters	2.1
Pine Creek		**8.5**
	Pine Creek	8.5
Rock Creek-Salt		**4.5**
	Rock Creek	4.5
Tonto Creek		**8.7**
	Bull Tank Canyon-Tonto Creek	3.1
	Christopher Creek	0.0
	Horton Creek-Tonto Creek	5.5
Turkey Creek		**2.1**
	Rock Creek	2.1
Webber Creek		**6.5**

Stream	6th HUC subwatershed	Miles in Project Area
	Webber Creek	6.5
Grand Total		**106.1**

Eighteen watersheds (6th HUCs) contain Desert sucker streams within the project area. Riparian condition within these watersheds ranges from fair (n=8) to poor(n=10) (Table 22). The average riparian condition for Desert sucker watersheds is 2.6, which equates to poor.

Table 23. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Desert sucker the Rim Country proposed project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Barbershop Canyon	3	Poor
Bear Canyon	3	Poor
Bull Tank Canyon-Tonto Creek	3	Poor
Buzzard Roost Canyon	2	Fair
Canyon Creek Headwaters	2	Fair
Christopher Creek	3	Poor
East Clear Creek-Blue Ridge Reservoir	3	Poor
East Clear Creek-Clear Creek	2	Fair
Gordon Canyon	3	Poor
Gruwell Canyon-Cherry Creek	3	Poor
Haigler Creek	2	Fair
Horton Creek-Tonto Creek	2	Fair
Leonard Canyon	3	Poor
Miller Canyon	3	Poor
Pine Creek	3	Poor
Rock Creek-Spring Creek	2	Fair
Upper West Clear Creek	2	Fair
Webber Creek	2	Fair
Average	**2.6**	**Poor**

Sonoran sucker *(Catostomus insignus)*

Sonora sucker (*C. insignis*), also known as the Gila sucker, is a large, robust member of the sucker family (Catostomidae), commonly reaching lengths between 12 and 24 inches. Its mouth is ventral with large fleshy lips. The body is sharply bi-colored, brownish dorsally and yellow beneath. During breeding season, males develop large nuptial tubercles on their anal and caudal fins, and on the lower, posterior part of the body.

Sonora sucker is widely distributed and common between 1,000 and 6,500 feet elevation in the Gila, Verde, Bill Williams, and San Francisco River Basins of Arizona and New Mexico. It is uncommon in the upper Santa Cruz River in Arizona. Except in Aravaipa Creek, it has been extirpated from the San Pedro River in southern Arizona and northern Sonora, Mexico. The species is intolerant of reservoir conditions (Minckley 1973). Dams and diversions of free-flowing streams, water pollution, and sedimentation of streams have diminished its range, and the status of the species is uncertain. This report will analyze effects to Sonora sucker and its habitat, as it is present in Oak Creek and Sycamore Creek.

Sonora sucker is characteristic of gravelly or rocky pools of creeks and rivers. It can be found in a variety of habitats from warm water rivers to trout streams. Adults tend to remain near cover in daylight, but move to runs and deeper riffles at night. Young Sonora sucker typically live in runs and quiet eddies.

Individuals are sedentary, exhibiting little seasonal movement and resisting downstream displacement during floods. Information on temperature tolerances or other habitat preferences has not been obtained.

Foods appear to vary with availability. In Aravaipa Creek it is almost exclusively a carnivore, feeding upon the abundant aquatic insect larvae (primarily mayflies) of that stream. In other places, especially where large populations are concentrated in pools in summer, intestines are filled with plant debris, mud, or algae. Seeds of cottonwood trees are taken seasonally. Young feed along the margins of streams upon tiny crustaceans, protozoans, and other animal and plant groups (Minckley 1973).

Spawning begins in February and extends until July. Eggs are deposited in riffles and fall into the interstices between gravel particles where they incubate. Larval fish appear within a few days. Areas where suckers have been spawning may often be identified as elongated patches of "cleaned" gravel on riffles, marking the places where algae-covered bottom materials have been shifted about. Spawning does not appear correlated with any specific pattern of stream flow or temperature. Information on age and growth has not been developed. Further information on this species can be found at: https://www.fws.gov/southwest/es/arizona/Sonora_Sucker.htm

Habitat in the Analysis Area

Sonoran sucker occurs in approximately 13.1 miles of streams within the proposed project area (Table 23). The three streams (Canyon Creek, East Verde River, and Tonto Creek) are either currently occupied by the species or provide suitable habitat.

Table 24. Miles of occupied or suitable habitat for Sonoran sucker by stream and 6th Code subwatershed (HUCs) within the Rim Country proposed project area.

Stream	6th HUC subwatershed	Miles in Project Area
Canyon Creek	Canyon Creek Headwaters	5.9
East Verde River	East Verde River Headwaters	7.1
Tonto Creek	Bull Tank Canyon – Tonto Creek	0.2
Total		**13.1**

Three watersheds (6th HUCs) contain Sonoran sucker streams within the project area. Riparian condition within these watersheds ranges from fair (n=1) to poor (n=2) (Table 24). The average riparian condition for Sonoran sucker watersheds is 2.7, which equates to poor.

Table 25. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Sonoran sucker the Rim Country project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Bull Tank Canyon-Tonto Creek	3	Poor
Canyon Creek Headwaters	2	Fair
East Verde River Headwaters	3	Poor
Average	**2.7**	**Poor**

Little Colorado sucker *(Catostomus sp. 3)*

This species is similar to flannelmouth sucker and is endemic to the upper portion of the Little Colorado River and many of its north flowing tributaries at elevations from 2,200 to 7,100 ft. (Minckley 1973). It has also been introduced into the Salt River. It occurs in creeks, small to medium rivers, and impoundments. Predominantly found in pools with abundant cover, and also in riffles. Foods consist of detritus, algae, and aquatic invertebrates. Reduction in distribution is thought to be a result of habitat loss

due to stream flows, water diversions, dam construction, channel and watershed erosion, and interactions with non-native fish species.

Habitat in the Analysis Area

Little Colorado sucker occurs in approximately 147 miles of streams within the project area (Table 25). The eight streams are either currently occupied by the species or provide suitable habitat within the Little Colorado drainage.

Table 26. Miles of occupied or suitable habitat for Little Colorado sucker by stream and 6th Code subwatershed (HUCs) within the Rim Country proposed project area.

Streams	6th HUC subwatershed	Miles in Project Area
Barbershop Canyon		**14.7**
	Barbershop Canyon	14.7
	East Clear Creek-Clear Creek	0.0
Bear Canyon		**6.6**
	Bear Canyon	6.6
Chevelon Creek		**22.6**
	Durfee Draw-Chevelon Canyon	7.8
	Long Tom Canyon-Chevelon Canyon	7.8
	Upper Chevelon Canyon-Chevelon Canyon Lake	7.0
East Clear Creek		**38.4**
	East Clear Creek-Blue Ridge Reservoir	18.4
	East Clear Creek-Clear Creek	19.9
	Leonard Canyon	0.0
	Miller Canyon	0.0
Leonard Canyon		**20.6**
	Leonard Canyon	20.6
Miller Canyon		**13.2**
	Miller Canyon	13.2
West Leonard Canyon		**8.5**
	Leonard Canyon	8.5
Willow Creek		**22.5**
	East Clear Creek-Clear Creek	0.0
	Gentry Canyon	0.0
	Lower Willow Creek	13.3
	Upper Willow Creek	9.2
Grand Total		**147.1**

Fourteen watersheds (6th HUCs) contain Little Colorado sucker streams within the project area. Riparian condition within these watersheds ranges from fair (n=3) to poor (n=8) (Table 26). The average riparian condition for Little Colorado sucker watersheds is 2.3, which equates to fair.

Table 27. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Little Colorado sucker the Rim Country project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Barbershop Canyon	3	Poor

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Bear Canyon	3	Poor
Durfee Draw-Chevelon Canyon	1	Good
East Clear Creek-Blue Ridge Reservoir	3	Poor
East Clear Creek-Clear Creek	2	Fair
Gentry Canyon-Upper Clear Creek	3	Poor
Leonard Canyon	3	Poor
Long Tom Canyon-Chevelon Canyon	1	Good
Lower Willow Creek	2	Fair
Miller Canyon	3	Poor
Pine Creek	1	Good
Rock Creek-Spring Creek	2	Fair
Upper West Clear Creek	3	Poor
Webber Creek	3	Poor
Average	**2.3**	**Fair**

Headwater chub (*Gila nigra*)

Life history, distribution, status of the species range-wide and listing factors are found in documents located on the FWS website: http://www.fws.gov/southwest/es/arizona/Headwater_Chub.htm . An account of the taxonomy, biology, and reproductive characteristics of this species is found in the 2015 Federal Register designating a threatened DPS species status and the Species Status Assessment (USDI 2015). All these documents are incorporated by reference into this document.

Headwater chubs occupy middle to headwater reaches of medium- sized streams of the Gila River Basin at elevations of 3,035 to 6,651 ft. They are usually found in large pools and associated with cover such as undercut banks, large pools, or deep places created by obstructions such as trees or rocks. Typical adult microhabitat consists of deep, nearshore pools adjacent to swifter riffles and runs. Headwater chub life span is 8-10 years and they can grow rapidly but growth is dependent on water temperature.

Headwater chub inhabit mid-sized headwater streams with warm or cool water in the Gila River Basin and have been documented between 4,000 to 6,500 feet. Maximum water temperatures where chubs were observed were 20- 26° C (68- 74°F) which suggests temperature is a limiting factor for distribution of chub species (Bestgen & Propst, 1989). Habitat requirements for adults are deep pools near shorelines and swift riffles, associated with a structure (downed logs or boulders) within pools, undercut banks, overhanging cliff walls, root wads and other types of cover while juveniles prefer relatively shallow, slower moving water with overhead cover and sand substrates. Headwater chub are omnivorous and like the roundtail chub, are known to feed on vegetation, detritus, terrestrial and aquatic insects, and fish(USDI 2015a, b).

Historical distribution of headwater chub is poorly understood because this species was only recently designated as *Gila nigra* in 2000 (Minckely & DeMarais, 2000). The headwater chub is believed to be a hybrid species from the interbreeding of the roundtail chub *Gila robusta* and the Gila chub *Gila intermedia*(USDI 2017). This species was likely distributed throughout the Gila River Basin but likely did not have an extensive range. Recent studies pertaining to the headwater chub indicate that this species is declining across its entire range. Currently, headwater chub only occupy 40 percent of their historic range and today, only exist in four separate drainage basins: the Verde River, San Carlos, Tonto Creek, and upper Gila River Basins (USFWS, 2006).

Threats to headwater chub include a combination of habitat loss and degradation related to dams, diversions, groundwater pumping, mining, recreation, and livestock grazing, and competition and predation from non-native fish.

Habitat in the Analysis Area

Headwater chub occur in approximately 47.8 miles of streams within the project area (Table 27). The nine streams are either currently occupied by the species or provide suitable habitat.

Table 28. Miles of occupied or suitable habitat for headwater chub by stream and 6th Code subwatershed (HUCs) within the Rim Country project area.

Streams	6th HUC subwatershed	Miles in Project Area
Buzzard Roost Canyon		**2.2**
	Buzzard Roost Canyon	2.2
	Rock Creek	0.0
East Verde River		**1.7**
	East Verde River Headwaters	1.7
Gordon Creek		**4.5**
	Gordon Canyon	4.5
Haigler Creek		**8.8**
	Haigler Creek	8.8
Pine Creek		**8.5**
	Pine Creek	8.5
Rock Creek		**4.8**
	Rock Creek	4.8
Turkey Creek		**2.1**
	Rock Creek	2.1
Upper Tonto Creek		**8.8**
	Bull Tank Canyon-Tonto Creek	3.1
	Horton Creek-Tonto Creek	5.7
Webber Creek		**6.5**
	Webber Creek	6.5
Grand Total		**47.8**

Nine watersheds (6th HUCs) contain Headwater chub streams within the project area. Riparian condition within these watersheds ranges from fair (n=5) to poor (n=4) (Table 28). The average riparian condition for Headwater chub watersheds is 2.4, which equates to fair.

Table 29. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Headwater chub the Rim Country project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Bull Tank Canyon-Tonto Creek	3	Poor
Buzzard Roost Canyon	2	Fair
East Verde Headwaters	3	Poor
Gordon Canyon	3	Poor
Haigler Creek	2	Fair
Horton Creek-Tonto Creek	2	Fair
Pine Creek	3	Poor

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Rock Creek-East Verde River	2	Fair
Webber Creek	2	Fair
Average	**2.4**	**Fair**

Roundtail chub (*Gila robusta*)

Roundtail chub utilize slow moving, deep pools for cover and feeding. They are found in the main stems of major rivers and smaller tributary streams. Roundtail chub utilize a variety of substrate types (silt, sand, gravel, and rocks) and prefer murky water to clear. Habitat use varies by life stages (adult, juvenile, and young-of-year). Juveniles and young-of-year are found in quiet water near the shore or backwaters with low velocity and frequent pools rather than glides and riffles. Juveniles use instream boulders for cover, while young-of-year are found in gaps between and under boulders or the slack-water area behind boulders. Adults generally do not frequent vegetation and avoid shallow water cover types, such as overhanging and shoreline vegetation. Adults are found in eddies and pools adjacent to strong current and use instream boulders as cover. Roundtail chub are carnivorous and opportunistic feeders, and food items include aquatic and terrestrial insects, fish, snails, crustaceans, and algae.

Threats to the roundtail chub include habitat alteration and degradation from water diversions, groundwater pumping, dewatering, mining, contaminants, urban and agricultural development, livestock grazing, and predation and competition by non-native aquatic species. Further information on this species can be found at: https://www.fws.gov/southwest/es/arizona/Roundtail.htm

Habitat in the Analysis Area

Roundtail chub occur in approximately 34 miles of streams within the project area (Table 29).The five streams are either currently occupied by the species or provide suitable habitat.

Table 30. Miles of occupied or suitable habitat for roundtail chub by stream and 6th Code subwatershed (HUCs) within the Rim Country project area.

Stream	6th HUC subwatershed	Miles
Canyon Creek		**5.4**
	Canyon Creek Headwaters	5.4
Cherry Creek		**0.8**
	Gruwell Canyon-Cherry Creek	0.8
Chevelon Creek		**7.7**
	Durfee Draw-Chevelon Canyon	7.7
	Upper Chevelon Canyon-Chevelon Canyon Lake	0.0
East Clear Creek		**19.5**
	East Clear Creek-Clear Creek	18.0
	Echinique Draw-Clear Creek	1.5
	Leonard Canyon	0.0
	Wilkins Canyon	0.0
Salome Creek	Upper Salome Creek	**0.9**
		0.9
Grand Total		**34.4**

Nine watersheds (6th HUCs) contain roundtail chub streams within the project area. Riparian condition within these watersheds ranges from good (n=3) to poor (n=3); the remaining watersheds are rated as fair (Table 30). The average riparian condition for Roundtail chub watersheds is 2.0, which equates to fair.

Table 31. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with Roundtail chub the Rim Country proposed project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Canyon Creek Headwaters	2	Fair
Durfee Draw-Chevelon Canyon	1	Good
East Clear Creek-Clear Creek	2	Fair
Echinique Draw-Clear Creek	1	Good
Gruwell Canyon-Cherry Creek	3	Poor
Leonard Canyon	3	Poor
Upper Chevelon Canyon-Chevelon Canyon Lake	1	Good
Upper Salome Creek	2	Fair
Wilkins Canyon	3	Poor
Average	**2.0**	

Northern leopard frog (*Lithobates pipiens*)

Northern leopard frog uses a variety of habitats including forest, grassland, and woodlands usually in permanent waters with aquatic vegetation. The species is generally associated with streams and rivers, although lakes, marshes, and stock tanks are also occupied. Adult frogs feed on small invertebrates while larvae eat algae, plant tissue, organic debris, and likely small invertebrates.

This species historically ranged from the northern tier United States, western states and southern Canadian provinces. In Arizona, northern leopard frog was well-distributed across northern Arizona above and below the Mogollon Rim. The species is greatly reduced and/or extirpated from a significant portion of its western range in the United States. In Arizona, northern leopard frogs are largely restricted to man-made waters on the Coconino National Forest.

Northern leopard frog was present in multiple stock tanks around the Stoneman Lake area on the Coconino National Forest. Based on surveys the area functioned as a metapopulation then seemed to disappear. However, the area is considered occupied and within dispersal distance of known populations. Introduction of northern leopard frog occurred in three locations on the Apache-Sitgreaves National Forests in 2020 within the project area: Turkey Creek, Double Cabin tank and Twin Lakes. By the end of October the Double Cabin tank site was dry and Turkey Creek was isolated pools. More stockings will likely occur at these locations in an effort to create a stable, breeding population. Two other potential release sites also occur within the project area on the Apache-Sitgreaves National Forests: West Park Tank and Buckskin Wash. All of these areas were included in analyses.

Threats to the species include introduction of exotic predators (e.g sportfish, bullfrogs, and crayfish), loss of habitat and likely disease. Much of the species habitat has been modified by human activities including draining of wetlands, channelization and damming of rivers, and development of irrigation systems.

Habitat in the Analysis Area

Northern leopard frog habitat includes all the known and recently occupied locations, potential release sites, and habitats frogs can disperse to from all those locations. Based on that, habitat for the species encompasses an area across portions of eleven subwatersheds (47,569 acres). This area describes where the species could occur during the project (Table 31).

Table 32. Acres of occupied or suitable habitat within dispersal distance for northern leopard frog by 6th code subwatershed (HUCs) within the Rim Country proposed project area.

6th HUC subwatershed	Acres
Buckskin Wash	2,400
Bull Flat Canyon	2,231
Double Cabin Park-Jacks Canyon	10,091
Gentry Canyon-Upper Clear Creek	11,046
Leonard Canyon	66
Mormon Lake	164
Rattlesnake Canyon	4,353
Red Tank Draw	11,631
Upper Phoenix Park Wash	2,737
Upper Woods Canyon	1,011
Wilkins Canyon	1,839
Total	**47,569**

Eleven subwatersheds contain northern leopard frog occupied or suitable dispersal habitat within the project area. Riparian condition within these watersheds ranges from fair (n=7) to poor (n=4) (Table 32). The average riparian condition for northern leopard frog subwatersheds is 2.2, which equates to fair.

Table 33. Riparian condition scores from Watershed Condition Framework for 6th Code HUCs with northern leopard frog the Rim Country proposed project area.

Occupied 6th HUCs	WCATT Riparian Condition Score	Associated Rating
Buckskin Wash	2	Fair
Bull Flat Canyon	2	Fair
Double Cabin Park-Jacks Canyon	2	Fair
Gentry Canyon-Upper Clear Creek	3	Poor
Leonard Canyon	3	Poor
Mormon Lake	2	Fair
Rattlesnake Canyon	2	Fair
Red Tank Draw	2	Fair
Upper Phoenix Park Wash	2	Fair
Upper Woods Canyon	3	Poor
Wilkins Canyon	3	Poor
Average	**2.2**	**Fair**

A Net-winged midge *(Agathon arizonicus)*

This species requires swift-moving streams, typically with waterfalls, that supports its larvae. Adults do not leave the riparian corridor. The species is currently known only from Workman Creek in the Sierra Ancha Mountains. Little information exists on the species, but suitable habitat exists.

Net-winged midge larvae live in clean, cool, well-oxygenated rapid streams (cascades, rapids, waterfalls) attached to rocks or other smooth hard substrate. Adults usually stay in the riparian zone and are often seen resting on the undersides of leaves on riparian trees or on wet overhanging rock faces. Larvae are highly specialized scapers, grazing on periphyton and other organic matter on submerged rocks; diatoms are a major component of their diet.

A stonefly *(Capnia caryi)*

The newly described species is found in only two high elevation locations in the southern Rocky Mountains of New Mexico and Arizona (Baumann and Jacobi, 2002). It was found in two tiny creeks where substrate consisted of scattered boulders and a mixture of cobble with gravels. The gradient was 3% and the water was clear and cool, with low amounts of dissolved materials (Baumann and Jacobi, 2002).

In New Mexico, it has been recorded from New Mexico in Catron Co. (Upper Iron Creek) and Arizona in Apache County (Mamie Creek at Escudilla Mountain); both near the border of southern Arizona and New Mexico (Baumann and Jacobi, 2002). Little information exists on the species, but suitable habitat exists.

Parker's cylloepus riffle beetle (*Cylloepus parkeri*)

This species is associated with perennial, flowing streams. It is associated with stream riffles and is only known from two creeks in Bloody Basin.. Little information exists on the species, but suitable habitat exists.

Riffle beetles are frequent members of the invertebrate community in running water (streams). All species have aquatic larvae; some species adults are terrestrial but most are aquatic. Most species occur in well-aerated streams, but can occur on wave-washed lake shores. Little is known about the food of adults or larvae, but they appear to be collector-gathers and scrapers that feed chiefly on algae and detritus.

A Mayfly (*Fallceon eatoni*)

Originally collected in 1892 from northern Sonora, Mexico (USDI 2010). The species had not been recorded since then until a single specimen was identified from collections in 2005 from Salt River Canyon, Gila Co., Arizona (NatureServe). Another occurrence was recently reported from Cottonwood Canyon in the San Bernardino Mountains in Riverside Country, California. Little information exists on the species, but suitable habitat exists.

A Mayfly *(Moribaetis mimbresaurus*)

This is one of six species of the genus in North and South America, and the only member north of Mexico. The species is only known from a single locality in the Salt River Canyon in Gila County as well as Pumphouse Wash in Oak Creek. It is associated with perennial and ephemeral streams as well as springs associated with Cottonwood Willow Riparian Forest and Mixed Broadleaf Riparian Forest given mayflies have a strictly aquatic larval stage (McCafferty 2006). Little information exists on the species, but suitable habitat exists.

Mayflies are relatively primitive insects and exhibit a number of ancestral trails that were likely present in the first flying insects. Nymphs live primarily in streams under rocks, in decaying vegetation, or in sediments (substrate). Larval mayflies are mostly herbivores or detritivores feeding on algae, diatoms, or detritus but a few are predators. Adults do not feed but stay near water for reproduction as eggs are laid in the water.

A caddisfly (*Lepidostoma apache*)

Limited information is known about this recently described species. It is found in freshwater habitat, but the larval habitat is unknown. It has only been found in the Blue River, on the ASNF (Houghton, 2001a, b). Little information exists on the species, but suitable habitat exists.

A caddisfly (*Lepidostoma knulli*)

This is a medium-sized caddisfly of the diverse Lepidostoma family, endemic to higher elevation southwestern United States watersheds ranging from 4500 to 8530 feet in elevation. It occurs in cool stream segments with swift flowing water, dominated by large cobbles with low embeddedness of interstitial gravels (Blinn and Ruiter 2009). Threats to the species include limited distribution or endemism in addition to threats to ecosystem or aquatic diversity. It is associated with Mixed Broadleaf Riparian Forest or Cottonwood Willow Riparian Forest.

This species is uncommon in Arizona, Montana, New Mexico, and Mexico. It has been found in eastern Arizona in two sites on the ASNFs and in Pumphouse wash and Indian Gardens in Oak Creek Canyon on the COC. It has been listed in sites in Apache and Coconino County Arizona. Little information exists on the species, but suitable habitat exists.

A caddisfly *(Limnephilus granti)*

The species is extremely rare. All specimens have been collected from springs and their immediate outlets in the ponderosa pine region of eastern Arizona. It is known only from the type specimen and a few additional specimens found in Grant Creek in Graham County, Government Spring, south of Greer in Apache County, and Rosey Creek, near Greer also in Apache County (Blinn and Ruiter, 2009). Little information exists on the species, but suitable habitat exists within the project area.

Caddisflies are one of the largest groups of aquatic insects and are adapted to a wide range of microhabitats. Larval caddisflies have very diverse diets and feeding strategies, and occupy different trophic levels and functional feeding groups, including predators and filter feeders. Larvae are mainly herbivorous scavengers, feeding mainly on plant fragments and other living and dead organisms. Functionally, they can be collectors, shredders, scrapers, and predators. Feeding strategies may vary seasonally depending on items available and size of the caddisfly larvae. The larvae of most caddisfly species can be found in a variety of benthic habitats, including temperate lakes, streams, and ponds. Larvae of some species can tolerate low oxygen concentrations. Habitats can include benthic areas of streams, both cool and warm, lakes, marshes, and ponds. Caddisfly larvae are adapted to species-specific water temperatures and velocities, mineral and pollutant concentrations, and sunlight exposure. Because of this, many species can occur together in a single stream or river. Adult caddisflies are terrestrial, nocturnal, and hide in cool, moist habitats (e.g., riparian vegetation) during the day.

Ferris' copper butterfly *(Lycaena ferrisi)*

The species is the only one in its range that resembles the Ruddy copper butterfly. Its host plant in the larval stage is Arizona dock (also known as wild rhubarb) (*Rumex hymenosepalus*), while the adult feeds on nectar including that of yellow composites. Its primary habitat is open meadows and cienegas springs. Threats include fire suppression because it results in the invasion of meadow habitats by dense conifer forests and an understory of grasses (USFWS 2009).

This species has a very limited distribution and is known only in the White Mountains of eastern Arizona. It is known to occur in the White Mountains of Apache County, near McNary and Maverick, and in Greer County, Arizona (USDI 2009). It is critically imperiled globally and in Arizona. There may be only a single metapopulation, and there may be less than 20. Little information exists on the species, but suitable habitat of meadows and wetlands exists.

Nokomis Fritillary (aka Great Basin Silverspot) *(Speyeria nokomis nokomis)*

This species is associated with permanent spring-fed meadows, seeps, marshes, and boggy streamside meadows with flowing water in arid country. Presence of its larval foodplant (bog violet [*Viola nephrophylla*]) is a key habitat component. The species is only known from Apache Country, Arizona. There was a recently confirmed locality in Gila County. Little information exists on the species, but suitable wetland habitat exists.

California Floater (*Anodonta californiensis*)

This mussel prefers shallow areas of clean, clear lakes, ponds and large rivers. It prefers lower elevations and soft, silty substrate to burrow into. The life cycle of California floater includes a parasitic larval stage during which it is dependent upon a host fish, usually a member of the Gila genus, for food and dispersal. The adult and juvenile phases are sedentary, filter-feeders. It is associated with perennial springs and streams in every riparian forest type. There are no occupied locations within the proposed project area, but suitable habitat does exist.

Distribution used to range from southern British Columbia south to northern Baja California, and east to Wisconsin. Today, numbers have been depleted to the point that it is extinct throughout much of its former range, including Utah, the entire Sacramento River system, and most of Arizona. Specimens have been found in Chevelon Creek, East Clear Creek near the confluence of Leonard Canyon, and Show Low Creek. It is believed to have been present historically within the proposed project area in the Beaver Creek, Cherry Creek-Verde River, Fossil Creek-Verde River, Lower Clear Creek, Upper Clear Creek, and West Clear Creek 5th HUC watersheds. There are presently no known extant populations within the proposed project area.

Management Indicator Species (MIS)

Aquatic macroinvertebrates (various species)

Management indicator species are species of vertebrates and invertebrates whose population changes are believed to best indicate effects of land management activities. Through the management indicator species concept, the total number of species found within a planning area is reduced to a subset of species that collectively represent habitats, species, and associated management concerns. Management indicator species are used to assess the maintenance of populations (the ability of a population to sustain itself), and biological diversity (including genetic diversity, species diversity, and habitat diversity), and to assess effects on species in public demand.

The Tonto Land Management Plan identifies aquatic macroinvertebrates as management indicator species for healthy aquatic and riparian habitats across that forest (USDA Forest Service 1985). Riparian ecosystems occur at the margins of standing and flowing water, including intermittent stream channels, ephemeral ponds, and wetlands. Aquatic macroinvertebrates are an indicator for water habitat within the Tonto NF, particularly water quality and fisheries habitat because these species require water for a portion of their life. Based on the Tonto Land Management Plan, 28,989 acres of water occur on the forest (Holderman 2016).

Groups or species of aquatic macroinvertebrates are classified by habitat types, feeding preferences, and pollution tolerances. These organisms can detect changes in water quality, stream temperatures, and substrate composition. Their composition in an aquatic system change in response to changes in their

environment. As a group, aquatic macroinvertebrates are generally larger than 0.5 mm, lack a backbone and require an aqueous environment to persist.

Riparian habitats are important to aquatic macroinvertebrates for several reasons including providing organic material as a food source in forested headwater streams, providing cover and shade for species dependent on cool water temperatures, as well as for providing dense vegetation to armor streambanks. Some of the functions of riparian areas are to act as a sediment trap for streams, nutrient sinks, water table recharge points, streambank stabilizers, nutrient sources for aquatic species and overhead cover to lower stream temperatures. If these zones are highly modified by wildfire, their functions diminish.

The Tonto Land Management Plan standards and guidelines for macroinvertebrates are to manage for and maintain greater than 70 % biotic condition index (BCI) on all perennial streams. The BCI score indicates as a percentage how close an aquatic ecosystem is to its own potential. Since 2006, the Tonto NF has been relying on Arizona Department of Environmental Quality sampling for aquatic macroinvertebrates. ADEQ utilizes multimetric indexes of biological integrity (IBI) for scoring and there is no crosswalk to BCI. Therefore, IBI will be utilized for the environmental baseline. Table 32 summarizes the results of Forest-wide aquatic macroinvertebrate monitoring relative to LRMP S&Gs.

Table 34. Macroinvertebrate data collected on the Tonto National Forest from 2006 and 2009. Summarized by streams surveyed that are meeting, not meeting, or have mixed results for the indexes of biological integrity (IBI) rating.

Stream	# of streams	% of total
Streams meeting LMP standard	12	80%
Streams not meeting LMP standard	2	13%
Streams with mixed results	1	7%

The majority of the streams surveyed were meeting statewide ADEQ standards. No new survey data was provided by the forest for this analysis and no repeated surveys at the same locations have occurred to determine a trend.

Summary of Alternatives

Alternative 1 – No Action

The No Action alternative is required by 40 CFR 1502.14(c). It represents no changes to current management, and current Land Management Plans would continue to be implemented. Ongoing vegetation treatments and fire management activities, as well as road maintenance, recreation, firewood gathering, authorized livestock grazing, and other activities already authorized in separate NEPA decisions would continue. There would be no other restoration activities approved with the Rim Country Project. The potential direct, indirect, and cumulative effects from no action will be analyzed. The no action alternative is the baseline for assessing the action alternatives (Alternatives 2 and 3).

Action Alternatives

Proposed restoration activities include various types of upland vegetation treatments (mechanical thinning and prescribed burning) as part of several restoration treatments described below (Table 34). Associated actions that are needed to implement the vegetation treatments includes: In Woods Processing Sites, use/expansion of rock pits, construction of temporary roads as well as use and maintenance of ML-1 roads. The proposed action also includes comprehensive restoration activities to restore form and

function to riparian, wetland, grassland, spring, and stream systems as well as projects to improve the interaction of roads with stream and riparian systems including decommissioning, relocation, and restoration of road crossings.

Upland vegetation treatments include a variety of methods such as mechanical harvest, mastication, grinding, chipping, and hand thinning. Methods to be implemented are dependent upon site conditions, design features, topography, and type of treatment. Equipment that may be utilized includes, but is not limited to, ground-based or cable operations, chainsaws, chippers, grinders, masticators, and mulchers. Smaller scale vegetation treatments for restoration of riparian vegetation will also be implemented using the Condition Based Management Approach for Mechanical Treatments.

General Vegetation Treatments: Silvicultural treatments to improve forest density, structure and composition. Mechanical vegetation treatments will also include associated actions such as machine or hand piling as well as lop and scatter of slash material.

Facultative Operations: Mechanical treatment non-target cover types (e.g. juniper) using ground-based logging systems or hand thinning as well as prescribed burning on non-target cover types to support treatments in target cover types. This treatment also includes associated actions such as machine or hand piling as well as lop and scatter of slash material.

Aspen Restoration: Mechanically remove non-aspen species with ground-based logging systems within 66 feet (one chain) of an aspen clone to promote growth. This treatment also includes associated actions such as machine or hand piling as well as lop and scatter of slash material. Installation of fencing will also likely be necessary.

Severe Disturbance Treatment Areas: These areas represent a variety of post high-intensity fire conditions. Treatments include mechanical thinning and mastication of undesirable species such as juniper, thinning of pine in areas with an abundance of regeneration (ground-based logging systems), and reforestation (planting with site preparation) where inadequate regeneration occurs. Site preparation can range from Reforestation can be completed by hand or using machinery such as a gas-powered auger or skid steer with an auger attachment. Site preparation can include mechanical, prescribed burning, or mulching. This treatment also includes associated actions such as machine or hand piling as well as lop and scatter of slash material. Broadcast and pile burning are also included.

Savanna Restoration: Mechanical treatments to reduce encroachment to pre-settlement densities using ground-based logging systems, hand thinning, and prescribed fire to restore and sustain these habitat types.

Grassland and Meadow Restoration: Mechanical vegetation treatments to remove conifer encroachment. Methods include ground-based logging systems and hand thinning to restore and sustain these habitat types.

Riparian and Wet Meadow Restoration: Mechanical Vegetation and prescribed fire treatments to remove encroachment using ground base logging systems, hand thinning, and prescribed fire. Planting desirable riparian species may occur using methods ranging from planting by hand (e.g., dibble or hoedad) to a skid-steer with an auger.

Prescribed Fire Treatments: Prescribed burning is being analyzed as part of every mechanical vegetation treatment described above. Implementation could occur using both hand and aerial ignition as well as associated fireline needed to contain burn units. It includes broadcast burning as well as pile burning.

For the purposes of this analysis, mechanical vegetation management and prescribed burning are analyzed across the proposed restoration treatments rather than in the categories described above.

Road Use: Utilize and maintain approximately 5,682 miles of Forest system roads for implementation of all treatments. This includes, opening 2,076 miles of existing closed roads (ML-1) to utilize them for the time period that they are needed to provide access for restoration work. These roads shall be closed upon completion of work in the area they access returned to a closed status (ML-1).

Road Decommissioning: Stabilize and restore approximately 1,290 miles of existing system roads and existing unauthorized routes to a more natural state. Methods include the full spectrum of decommissioning options from blocking the entrance, revegetation and water barring, removing fills and culverts, establishing drainage ways and removing unstable road shoulders, all the way to full obliteration (recontouring and restoring natural slopes).

Temporary Road Construction/Decommission: Construct or improvement of new temporary roads or existing non-system roads to facilitate all proposed treatments; decommission all temporary roads when treatments are completed.

Rock Pits: The use, including potential expansion, of 12 individual rock pits totaling approximately 131 acres on the Apache-Sitgreaves National Forests. The removal and transportation and of the rock pit materials will be used for improvement and maintenance of roads for specific projects that utilize maintenance level 1 (closed roads, for administrative use only), maintenance level 2 roads (maintained for high-clearance vehicles). Rock pit material could also be used for construction and maintenance of temporary roads.

In Woods Processing Sites: Construction of 13 wood processing sites, totaling approximately 142 acres. Tasks carried out at processing sites includes drying, debarking, chipping stems and bark, cutting logs, manufacturing and sorting logs to size, scaling and weighing logs and creating poles from suitable sized logs. Equipment types commonly used at processing sites include circular or band saws, various sizes and types of front-end loaders, log loaders and chippers of several types and may include timber processors, planers and mechanized cut to length systems, associated conveyers and log sorting bunks for accumulation and storage of logs. Electric motors and gas or diesel generators are also used to provide power.

Stream Restoration: Restore function and aquatic habitat in up to 628 miles of streams. In addition, approximately 200 miles of protective barriers around springs, aspen, native willows, and big-tooth maples, as needed for restoration objectives. Methods for stream restoration vary and specific treatments will be determined prior to implementation. The aquatic and watershed condition based management document outlines the potential treatments that are being analyzed (Appendix C).

Spring Restoration: Restore approximately 184 springs as outlined in the aquatic and watershed condition based management document (Appendix C)

Table 35. Summary of Alternatives 2 and 3 Treatments as analyzed for aquatic resources.

Treatment	Alternative 2 acres/miles	Alternative 3 acres/miles
Mechanical Vegetation Treatments	876,510 acres	468,750 acres
Prescribed Burning	991,060 acres	528,850 acres
Miles of Open ML-1 Roads	2,076 miles	2,076 miles
Road Decommissioning	1,290 miles	1,290 miles
Temporary Roads Used	300 miles	170 miles

Treatment	Alternative 2 acres/miles	Alternative 3 acres/miles
Rock Pits	131 acres	131 acres
In Woods Processing Sites	142 acres	142 acres
Stream Restoration	628 miles	628 miles
Total	**991,059**	**528,851**

Alternative 2 is the Proposed Action as presented for scoping, with changes in response to public comments received. It is designed to implement restoration treatments across the entire project area. This alternative responds to the Dwarf Mistletoe Mitigation issue through the use of regular restoration treatments that focus on dwarf mistletoe infections.

Alternative 3 is designed to focus proposed treatments in areas that are the most highly departed from the natural range of variation (NRV) of ecological conditions, and/or that put communities at risk from undesirable fire behavior and effects. High value assets will be better protected and burn boundaries will be designed to create conditions safe for personnel and to ensure fire can meet objectives. Treatment areas would be chosen to optimize ecological restoration, those areas that are most important to treat and can be moved the furthest toward desired conditions. Focusing on the higher priority ecological restoration will result in fewer acres being treated. The proposed treatments in Alternative 3 will be used to address moderate and high levels of mistletoe infection, but to a lesser extent on the fewer acres proposed for mechanical treatment and fire. The presence of dwarf mistletoe will not be used to prioritize areas for treatment, but it will be addressed where it exists, using the same types of treatments as Alternative 2.

Alternative 2: Modified Proposed Action

- Largest extent of vegetation treatments (mechanical and prescribed fire).
- Moderate reduction in tree basal area across landscape
- Significant reduction in undesirable fire behavior & effects across landscape

Alternative 3: Focused Alternative

- Smallest extent of vegetation treatments (mechanical and prescribed fire).
- Moderate reduction in tree basal area where treated
- Reduction in undesirable fire behavior and fire effects near WUI and high value resources.

Project Design Features

The following project design features key to the aquatic analysis and herein incorporated by reference. Table 35 provides additional detail regarding what actions and resource indicators the design features are associated with and the relationship between the two. Project design features are the same for both Alternatives 2 and 3.

Table 36. Design Features which reduce potential impacts, their relationship to resource indicators and what resource measures they are associated with.

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ001	Any equipment or personnel for activities in and around streams, natural or constructed waters, springs, or wetlands of any kind will use decontamination procedures to prevent the spread of disease (Chytrid fungus) and aquatic invasive species. Personnel entering the water will follow Appendix G in the 2007 Chiricahua Leopard frog Recovery Plan and the Stop Aquatic Hitchhikers Clean, Drain, Dry procedure: http://stopaquatichitchhikers.org/prevention/#clean-drain-dry.	To minimize potential for spreading aquatic diseases or invasive species.	Land Management Plan compliance
AQ002	**Porous Boulder Structures and Vane Restoration Treatments:** • Full channel spanning boulder structures are to be installed only in highly uniform, incised, bedrock-dominated channels to enhance or provide fish habitat in stream reaches where log placements are not practicable due to channel conditions (not feasible to place logs of sufficient length, bedrock dominated channels, deeply incised channels, artificially constrained reaches, etc.), where damage to infrastructure on public or private lands is of concern. • Install boulder structures low in relation to channel dimensions so that they are completely overtopped during channel-forming flow events (approximately a 1.5 flow event). • Boulder step structures are to be placed diagonally across the channel or in more traditional upstream pointing “V” or “U” configurations with the apex oriented upstream. • Boulder step structures are to be constructed to allow upstream and downstream passage of all native fish species and life stages that occur in the stream. Plunges shall be kept to less than 6 inches in height. • The use of gabions, cable, or other means to prevent the movement of individual boulder in a boulder step structure is not allowed. • Rock for boulder step structures shall be durable and of suitable quality to assure long-term stability in the climate in which it is to be used. Rock sizing depends on the size of the stream, maximum depth of low, planform, entrenchment, and ice and debris loading. • The project designer or an inspector experienced in these structures should be present during installation. • Full spanning boulder step structure placement should be coupled with measures to improve habitat complexity and protection of riparian areas to provide long-term inputs of large wood.	To guide porous boulder structures and vane restoration treatments for aquatic and watershed restoration.	Specialist recommendation
AQ003	When using pressure treated lumber for fence posts, complete all cutting/drilling offsite of the designated aquatic management zone (AMZ) (to the extent possible) so that treated wood chips and debris do not enter water or flood prone areas.	To prevent detrimental effects of chemicals from entering aquatic habitats.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ004	**Set-back or removal of existing berms:** • Design actions to restore floodplain characteristics-elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type. • Remove drainpipes, fences, and other capital projects to the extent possible. • To the extent possible, remove nonnative fill material from the floodplain to an upland site. • Where it is not possible to remove or set-back all portions of berms, or in areas where existing berms support abundant riparian vegetation, openings will be created with breaches. Breaches shall be equal to or greater than the active channel width to reduce the potential for channel avulsion during flood events. In addition to other breaches, the berm, dike, or levee shall always be breached at the downstream end of the project or at the lowest elevation of the floodplain to ensure the flows will naturally recede back into the main channel thus minimizing fish entrapment.	To guide set-back or removal of existing berms, dikes, and levees to reconnect stream channels with floodplains as a means to increase habitat diversity and complexity, moderate flow disturbances, and provide refuge for fish during high flows.	Land Management Plan compliance and specialist recommendation
AQ005	**Channel Reconstruction/Relocation Treatments:** • Construct geomorphically appropriate stream channels and floodplains within a watershed, valley, and reach context. • Design actions to restore floodplain characteristics – elevation, width, gradient, length, and roughness-in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type. • To the greatest degree possible, remove nonnative fill material from the channel and floodplain to an upland site. • When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain where appropriate to support the project goals and objectives. • Structural elements shall fit within the geomorphic context of the stream system. For bed stabilization and hydraulic control structures, constructed riffles shall be preferentially used in pool-riffle stream types, while roughened channels and boulder step structures shall be preferentially used in step-pool and cascade stream types. • Material selections (large wood, rock, gravel) shall also mimic natural stream system materials. • Construction of the stream bed should be based on Stream Simulation Design principles as described in section 6.2 of Stream Simulation: An Ecological Approach to Providing Passage of Aquatic Organisms at Road-Stream Crossings or other appropriate design guidance documents (United States Department of Agriculture (USDA) - Forest Service (USFS) 2008).	To guide stream, floodplain, and other stream/watershed restoration treatments to minimize detrimental effects to aquatic habitats.	Land Management Plan compliance and specialist recommendation
AQ006	All aquatic bearing stream crossings must be approved by approved by the sale administrator or contracting officer's representative after coordination with the resource specialist and authorized Forest Service officer in advance of use to minimize the number and length of stream crossings. Such crossings would be at right angles and	To minimize ground disturbance in aquatic and associated habitats during site preparation and	Land Management Plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
	avoid potential spawning or breeding areas to the greatest extent possible. Stream crossings shall not increase the risk of channel re-routing at low and high-water conditions. After project completion, temporary stream crossing would be restored per TR008. Timing of crossings is addressed in AQ017.	sedimentation to aquatic habitats.	
AQ007	For recreation relocation projects—such as trails—move out of the riparian area or as far away from the stream as possible.	To reduce recreation effects on aquatic habitats.	Land Management Plan compliance
AQ008	To the extent feasible, heavy equipment will work from the top of the bank, unless working from within the stream bed would result in less damage to the aquatic ecosystem, as determined by a biologist.	To minimize ground disturbance in aquatic and associated habitats during site preparation and sedimentation to aquatic habitats.	Land Management Plan compliance and specialist recommendation
AQ009	Any fence placement must allow for lateral movement of a stream and to allow establishment of riparian plant species. To the extent possible, fences will be placed outside the channel migration zone. Fences that cross the channel migration and the stream channel proper should include breakaway portions that will not collect debris on the fence and cause potential breach of the debris jam.	To maximize success of riparian planting and reduce maintenance on fencing.	Specialist recommendation
AQ010	When building riparian exclosure fences, minimize vegetation removal, especially potential large wood recruitment sources, when constructing fence lines (see RM006 and SI003).	To reduce detrimental effects to riparian species (flora and fauna) and floodplains.	Specialist recommendation
AQ011	Leave sufficient numbers of cut trees (large woody debris) on site for needed surface flow grade control in systems where large woody debris is appropriate. Fisheries, wildlife, and hydrologist personnel will identify locations for large woody debris during sale preparation.	To minimize impacts to streams and soils in meadows from tree thinning operations.	Land Management Plan compliance and specialist recommendation
AQ012	**Streambank Restoration Treatments:** Without changing the location of the bank toe, restore damaged streambanks to a natural slope and profile suitable for establishment of riparian vegetation. This may include sloping of unconsolidated bank material to a stable angle of repose or the use of benches in consolidated, cohesive soils. • Complete all soil reinforcement earthwork and excavation when soils are sufficiently dry to prevent excessive rutting. When necessary, use soil layers or lifts that are strengthened with biodegradable fabrics and penetrable by plant roots. • Include large wood to the extent it would naturally occur for streambank restoration. If possible, large wood should have untrimmed root wads to provide functional refugia habitat for fish. Wood that is already within the stream or suspended over the stream may be repositioned to allow for greater interaction with the stream. • Rock will not be used for streambank restoration, except as ballast to stabilize large wood. • Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous plants. Vegetation, such as willow, sedge and rush mats, may be gathered from abandoned floodplains, stream channels, etc. Sedge and rush mats should be sized to prevent their movement during high flow events.	To guide streambank and channel restoration/resilience treatments.	Land Management Plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
	• Do not apply surface fertilizer within the AMZ of any stream channel. • Install fencing as necessary to prevent access to revegetated sites by grazing ungulates or unauthorized persons. • Conduct post-construction monitoring and treatment or removal of invasive plants until native plant species are well established in accordance with annual budgetary and program of work considerations.		
AQ013	Minimize removal of desirable vegetation around springs, streams and wetlands.	To reduce detrimental effects to sensitive habitats.	Land Management Plan compliance and specialist recommendation
AQ014	When removing a culvert from a first or second order, non-fish bearing stream, roads managers, biologists, and watershed personnel shall determine if culvert removal should include stream isolation and rerouting in project design. Culvert removal on fish bearing streams shall adhere to the measures described in Fish Passage Restoration.	To reduce impacts to fish passage.	Specialist recommendation
AQ015	For culvert removal projects, restore natural drainage patterns and channel morphology. Evaluate channel incision risk and construct in-channel grade control structures when necessary.	To reduce detrimental effects to floodplains, riparian areas, stream channels and aquatic habitat.	Land Management Plan compliance and specialist recommendation
AQ016	Structural erosion control measures will not include materials (such as straw waddles) that can trap reptiles or amphibians in their habitat. Structural erosion control measures not made of biodegradable material (for example, silt fences) will be removed and material contoured in or removed once the site is stabilized to prevent them from causing resource issues and decomposing on site.	To minimize detrimental effects to federally listed, sensitive, or other reptiles and amphibians.	Land Management Plan compliance and specialist recommendation
AQ017	• Given the potential for multiple aquatic species to occur in a given location, Forest Service, U.S. Fish and Wildlife Service (USFWS), and Arizona Game and Fish Department (AGFD) biologists will cooperatively prioritize aquatic species of concern on a site-specific basis regarding timing restrictions for instream and riparian restoration activities • Work will occur during base-flow conditions, and on dry or frozen riparian soil conditions where possible.	To minimize direct effects to critical habitat (for example, spawning and breeding) for federally listed and forest sensitive species.	Land Management Plan compliance and specialist recommendation
AQ018	Biologists will be consulted during pre-planning for all treatments that will occur in springs, streams, and riparian areas, as well as fens or bogs where histic soils are present, to determine presence of federally listed or sensitives species (plants or animals), as well as mitigations needed for rare or sensitive species in/near the work areas. Also see SI019.	To minimize effects to rare/sensitive aquatic species during project implementation.	Land Management Plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ019	**Narrow-headed gartersnakes:** • AMZ in Narrow-headed gartersnake proposed critical habitat will be 150 ft. on either side of the stream. • No mechanical or hand piling will occur within the gartersnake AMZ to minimize harm during controlled burns or pile burning because gartersnakes utilize piles for cover (also see FE006). • Disturbance of rock/boulder piles and large woody debris in narrow-headed gartersnake habitat or proposed critical habitat will be avoided to the greatest extent practical during their brumation/inactive period (November/December-February, depending on elevation). • Do not build temporary roads in narrow-headed gartersnake AMZs.	To minimize detrimental effects to federally listed gartersnakes.	Land Management Plan compliance and specialist recommendation
AQ020	Coordinate with AGFD, USFWS and the Forest Service district biologist early (at least 6 months prior to implementation) within narrow-headed gartersnake and Chiricahua leopard frog occupied habitat to determine if surveys are required and to determine agreed upon, short-term care facilities for any Chiricahua leopard frog or narrow-headed gartersnakes found prior to or during implementation.	To minimize direct effects to federally listed amphibians and reptiles.	Specialist recommendation
AQ021	Precautions would be taken to ensure fish are isolated from instream work areas during heavy mechanical stream restoration or any road/crossing work where equipment is in the stream or water may be diverted. If dewatering is necessary, ensure diversion passes flows and aquatic species to minimize detrimental effects. If surface water needs to be diverted to meet construction needs and aquatic species are or may be present, fish screen(s) will be installed, operated, and maintained.	To minimize sedimentation and detrimental effects to aquatic species and habitat during aquatic and watershed restoration projects.	Specialist recommendation
AQ022	Avoid water withdrawals from streams bearing aquatic species whenever possible. Water drafting must take no more than 10% of the stream flow and must not dewater the channel to the point of isolating species. Pump intakes shall have fish screens of 3/32 inch mesh or less and will have an intake flow of less than 1 foot/second to prevent entraining fish. Implement decontamination procedures as outlined in AQ001 when drafting from waterbodies and streams. Biologists must be consulted in all situations when pumping water from streams or other natural waterbodies.	To avoid or minimize detrimental effects to native or desirable aquatic species and habitats.	Land Management Plan compliance
AQ023	Avoid discharging water from one source into a different body of water, such as dumping unused water from a water tender in or near a water body other than the water body from which it was acquired.	To avoid spread of invasive species, disease, and contaminants.	Land Management Plan compliance

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ024	**Restoring fish passage during Headcut and Grade Stabilization Treatments:** • In streams with current or historic fish presence, provide fish passage over stabilized headcut through constructed riffles for pool/riffle streams or series of log or rock structures for step/pool channels. If large wood and boulder placement is used for headcut and grade stabilization, refer to Large Wood, Boulder, and Gravel Placement. • Armor headcut with sufficiently sized and amounts of material to prevent continued up-stream migration of the headcut. Materials can include both rock and organic materials which are native to the area. Material shall not contain gabion baskets, sheet pile, concrete, articulated concrete block, and cable anchors. • Focus stabilization efforts in the plunge pool, the headcut, as well as a short distance of stream above the headcut. • Minimize lateral migration of channel around headcut ("flanking") by placing rocks and organic material at a lower elevation in the center of the channel cross section to direct flows to the middle of the channel. • Short-term headcut stabilization may occur without associated fish passage measures. However, fish passage must be incorporated into the final headcut stabilization action and be completed during the first subsequent in-water work period. • In streams without current or historic fish presence, it is recommended to construct a series of downstream log or rock structures to expedite channel aggradation. • Construct structures in a 'V' or 'U' shape, oriented with the apex upstream, and lower in the center to direct flows to the middle of the channel. • Key structures into the stream bed to minimize structure undermining due to scour, preferably at least 2.5 times their exposure height. The structures should also be keyed into both banks – if feasible greater than 8 ft. • If several structures will be used in a series, space them at the appropriate distances to promote fish passage of all life stages of native fish. Incorporate jump height, pool depth, etc. in the design of step structures. Recommended spacing should be no closer than the net drop divided by the channel slope (for example, a one-foot-high step structure in a stream with a two-percent gradient will have a minimum spacing of 50-feet. • Include gradated (cobble to fine) material in the rock structure material mix to help seal the structure/channel bed, thereby preventing subsurface flow and ensuring fish passage immediately following construction if natural flows are sufficient. • If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work session, remove the most upstream barrier first if possible.	To minimize loss of fish passage during headcut and channel grade stabilization treatments.	Specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ025	**Large Wood, Boulder, and Gravel Placement Treatments:** • Place large wood and boulders in areas where they would naturally occur and in a manner that closely mimic natural accumulations for that particular stream type. For example, boulder placement may not be appropriate in low gradient meadow streams. • Structure types shall simulate disturbance events to the greatest degree possible and if appropriate, could include, but are not limited to, log jams, debris flows, windthrow, and tree breakage. • No limits are to be placed on the size and shape of structures as long as such structures are within the range of natural variability of a given location and do not block fish passage. • Projects can include grade control and bank stabilization structures, while size and configuration of such structures will be commensurate with scale of project site and hydraulic forces. • The partial burial of large wood and boulders is permitted. This applies to all stream systems but more so for larger stream systems where use of adjacent riparian trees or channel features is not feasible or does not provide the full stability desired. • Large wood includes whole conifer and hardwood trees, lobs, and root wads. Large wood size (diameter and length) should account for bankfull width and stream discharge rates. When available, trees with root wads should be a minimum of 1.5 times bankfull channel width, while logs without root wads should be a minimum of 2.0 times bankfull width. • Structures may partially or completely span stream channels or be positioned along stream banks. • Stabilizing or key pieces of large wood must be intact, hard, with little decay, and if possible, have root wads (untrimmed) to provide functional refugia habitat for fish. Consider orienting key pieces such that the hydraulic forces upon the large wood increases stability. • Anchoring large wood – Anchoring alternatives may be used in preferential order: 1) Use of adequately sized wood sufficient for stability. 2) Orient and place wood in such a way that movement is limited. 3) Ballast (gravel or rock) to increase the mass of the structure to resist movement. 4) Use of large boulders as anchor points for large wood. 5) Pin large wood with rebar to large rock to increase its weight. For stream that are entrenched (Rosgen F, G, A, and potentially B) or for other streams with very low width to depth ratios (less than 12) and additional 60% ballast weight may be necessary due to greater flow depths and higher velocities.	To guide successful large wood and boulder stream restoration treatments.	Land Management Plan compliance and specialist recommendation

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
AQ026	**Engineered Logjam Treatments:** • Engineered log jams will be patterned, to the greatest degree possible, after stable natural log jams. • Grade control engineered log jams are design to arrest channel downcutting or incision by providing a grade control that retains sediment, lowers stream energy, and increases water elevations to reconnect floodplain habitat and diffuse downstream flood peaks. • Stabilizing or key pieces of large wood that will be relied on to provide streambank stability or redirect flows must be intact and solid (little decay). If possible, acquire large wood with untrimmed root wads to provide functional refugia habitat for fish. • When available, trees with root wads should be a minimum of 1.5 times bankfull channel width, while logs without root wads should be a minimum of 2.0 times bankfull width. • The partial burial of large wood and boulders may constitute the dominant means of placement, and key boulders (footings) or large wood can be buried into the stream bank or channel. • Angle and Offset – The large wood portions of engineered log jam structures should be oriented such that the force of water upon the large wood increases stability. If a root wad is left exposed to the flow, the bole placed into the stream bank should be oriented downstream parallel to the flow direction so the pressure on the root wad pushes the bole into the streambank and bed. Wood members that are oriented parallel to flow are more stable than members oriented at 45 or 90 degrees to the flow. • If large wood anchoring is required, a variety of methods may be used. These include buttressing the wood between riparian trees, the use of manila, sisal or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, such as rebar pinning or bolted connections, may be used. Rock may be used for ballast but is limited to that needed to anchor the large wood. • There is no d.b.h. (diameter at breast height) restriction for large wood, but consider the following before removing and placing trees:	To guide engineered log jam stream treatments.	Land Management Plan compliance and specialist recommendation
	Diameter: This key to establishing a logjam is utilizing larger diameter wood that resists decay. These pieces of wood are often called “key pieces,” and serve as the anchors for the logjam structure. Wood can improve fish habitat only if the wood is large enough to stay, influence flow patterns, and sediment sorting. Larger diameter wood retains its size longer as abrasion and decay occurs over the years. Larger diameter wood is more effective in creating pools and complex channels that improve fish populations. The minimum diameter required for a key piece of wood depends on bankfull width of the stream is found in the following table. Bankfull widths and minimum diameter of logs to be considered key pieces. Bankfull Width* - Feet Minimum Diameter* - Inches		

<table>
<tr><th>DF/BMP/M&CM Number</th><th>Description</th><th>Primary Purpose</th><th>Basis</th></tr>
<tr><td>AQ026 (Continued)</td><td>Bankfull widths and minimum diameter of logs to be considered key pieces.

<table><tr><th>Bankfull Width* - Feet</th><th>Minimum Diameter* - Inches</th></tr><tr><td>0 to 10</td><td>10</td></tr><tr><td>10 to 20</td><td>16</td></tr><tr><td>20 to 30</td><td>18</td></tr><tr><td>Over 30</td><td>22</td></tr></table>* This table was taken from ‘1995 Guide to Placement of Large Wood in Streams.’

Length:

The length of the wood is also important to stability. To be considered a key piece a log with a rootwad still attached should be at least one and one-half times (1.5X) the bankfull or a log without a rootwad should be twice (2X) the length of the stream’s bankfull width. As the best fish habitat is formed around jams composed of 3 to 7 logs, at least 2 key pieces should be used at each structure.

• Mimic natural accumulations of large woody debris based on stream type, valley setting, and community type and ensure future large woody debris recruitment.

• Tailholds as part of tree tipping operations are permitted across perennial, intermittent, and ephemeral streams but the use of protective straps will be required to prevent tree damage.</td><td>To guide engineered log jam stream treatments.</td><td>Land Management Plan compliance and specialist recommendation</td></tr>
<tr><td>AQ027</td><td>Gravel Augmentation Stream Restoration Treatments:
• Gravel can be placed directly into the stream channel, at tributary junctions, or other areas in a manner that mimics natural debris flows and erosion.
• Augmentation will only occur in areas where the natural supply has been eliminated, significantly reduced through anthropogenic disruptions, or used to initiate gravel accumulations in conjunction with other projects, such as simulated log jams and debris flows.
• Gravel to be placed in streams shall be a properly sized gradation for that stream, clean, and non-angular. When possible, use gravel of the same lithology as found in the watershed. Reference the Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-</td><td>To guide gravel augmentation treatments for aquatic and watershed restoration.</td><td>Land Management Plan compliance and specialist recommendation</td></tr>
</table>

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
	Stream Crossings (USDA-USFS 2008) to determine gravel sizes appropriate for the stream. • Gravel can be mined from the floodplain at elevations above bankfull, but not in a manner that would cause stranding during future flood events. Crushed rock is not permitted. • After gravel placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material. • Do not place gravel directly on bars and riffles that are known spawning areas, which may cause fish to spawn on the unsorted and unstable gravel, thus potentially resulting in red destruction.		
AQ028	Imported gravel for use in or around aquatic systems must be free of invasive species, non-native seeds, and aquatic diseases. If necessary, wash gravel prior to placement and allow it to completely dry for a minimum of 2 days to prevent spread of chytrid fungus. More time for drying may be needed depending on the amount of gravel.	To prevent spread or introduction of invasive species and aquatic diseases in stream habitat.	Land Management Plan compliance and specialist recommendation
AQ029	**Off and Side Channel Stream Habitat Restoration:** • When a proposed side channel contains more than 20% of the bankfull flow, the action agencies will ensure that the action is reviewed by the forest or regional fisheries biologist and the forest or regional engineer. • Data requirements and analysis for off- and side-channel habitat restoration include evidence of historical channel location, such as land use surveys, historical photographs, topographic maps, remote sensing information, or personal observation. • Allowable excavation: Off- and side channel improvements can include minor excavation (less than 10% of volume) of naturally accumulated sediment within historic channels. There is no limit as to the amount of excavation of anthropogenic fill within historic side channels as long as such channels can be clearly identified through field or aerial photographs. Excavation depth will not exceed the maximum thalweg depth in the main channel. Excavated material removed from off- or side-channels shall be hauled to an upland site or spread across the adjacent floodplain in a manner that does not restrict floodplain capacity.	To reconnect historic side-channels with floodplains by removing off-channel fill and plugs. Furthermore, new side-channels and alcoves can be constructed in geomorphic settings that will accommodate such features.	Land Management Plan compliance and specialist recommendation
AQ030	Ensure that an experienced engineer, fisheries biologist, hydrologist and/or geomorphologist are involved in the design of all aquatic restoration projects as needed. Their experience should be commensurate with the technical requirements of the project being undertaken.	To ensure technical skills and planning requirements for all aquatic and watershed restoration treatments.	Specialist recommendation
AQ031	Replant each area requiring revegetation prior to or at the beginning of the first growing season following instream or riparian restoration activities. Achieve reestablishment of vegetation in disturbed areas to at least 70% of pre-project levels within three years. Barriers will be installed as necessary to prevent access to revegetated sites by ungulates or unauthorized persons.	To rehabilitate all disturbed areas from aquatic and watershed restoration treatments, minimize erosion and sedimentation to aquatic habitats and potential effects to species.	Land Management Plan compliance

<table>
<tr><th>DF/BMP/M&CM Number</th><th>Description</th><th>Primary Purpose</th><th>Basis</th></tr>
<tr><td>AQ032</td><td>During all implementation within AMZ's, maintain shade, bank stability, and large woody material recruitment potential.</td><td>Minimize detrimental disturbance of desirable riparian/aquatic conditions to the greatest extent practical.</td><td>Land Management Plan compliance</td></tr>
<tr><td>AQ033</td><td>Live conifers and other trees can be felled or pulled/pushed over for in-channel large wood placement in streams only when conifers and trees are fully stocked by silvicultural standards. Tree felling shall not create excessive stream bank erosion, increase the likelihood of channel avulsion during high flows, and does not negatively impact use of spawning gravels or increase width to depth ratios.</td><td>To maintain forest structure and facilitate riparian restoration activities.</td><td>Specialist recommendation</td></tr>
<tr><td>AQ034</td><td>Within the primary shade zone for streams, springs and wet meadows retain 100% of the over-story canopy closure with the exception of hardwood treatments, unless other exceptions listed below are met. Source trees being extracted (either by tipping and/or felling) for stream restoration will not be cut from within the primary shade zone.
<table><tr><th>Hill Slope</th><th>Primary Shade Zone Width (slope distance)</th></tr><tr><td><30%</td><td>50 ft.</td></tr><tr><td>30-60%</td><td>55 ft.</td></tr><tr><td>>60%</td><td>60 ft.</td></tr></table>Exceptions:
The distances listed above may be reduced (but not less than 25 ft.) if any of the following conditions apply:
The trees are located on a south facing slope and therefore do not provide stream shade;
An appropriate level of analysis is completed and documents, such as shade modeling with LiDAR, using site-specific characteristics to determine the primary shade tree width; and/or
Field monitoring or measurements are completed to determine the width where Optimum Angular Canopy Density (65% or greater) is achieved.
If trees are being felled for safety reasons they can be felled toward the stream.</td><td>To maintain or improve the primary shade zone surrounding aquatic habitats.</td><td>Specialist recommendation</td></tr>
<tr><td>AQ035</td><td>In leopard frog occupied and dispersal habitat, a 150 ft. AMZ would be established around designated stream courses, stock tanks, or other water bodies. Designated skid trail crossings through the AMZ are only allowed with biologist recommendation.</td><td>To minimize direct effects to federally listed and sensitive amphibians.</td><td>Specialist recommendation</td></tr>
<tr><td>AQ036</td><td>Utilize prescribed firing techniques that ensure low-severity in native leopard frog AMZs and Arizona toad habitats within dispersal distance from occupied sites. No direct ignition will occur in occupied habitat (unless to ensure low-severity fire) or in riparian areas (FE006 and FE007). If fuel conditions result in significant ash and sediment flow into an occupied site that cannot be mitigated through erosion control measures following guidelines in AQ016, the resource advisor or biologist will contact AGFD and USFWS.</td><td>Minimize disturbance while restoring forest conditions.</td><td>Specialist recommendation</td></tr>
<tr><td>AQ037</td><td>Use of heavy mechanical equipment will temporarily cease in leopard frog dispersal or occupied habitat for the length of an isolated monsoon rain event producing greater than one tenth of an inch over a 24 hour period (based on the</td><td>To minimize direct effects to federally listed and sensitive amphibians.</td><td>Specialist recommendation</td></tr>
</table>

DF/BMP/M&CM Number	Description	Primary Purpose	Basis
	nearest rain gauge/station) in an active treatment area unless continuation of work is supported by a biologist and approved by a sale administrator or COR.		
AQ038	Do not use tanks for water sources that are known to have populations of leopard frogs as water sources for prescribed fire activities. Activities in and around natural or constructed waters would use decontamination procedures to prevent the spread of Chytrid (Bd) fungus and other invasive aquatic species unless an evaluation by a forest biologist determines it unnecessary.	To minimize direct effects to federally listed and sensitive amphibians and introduction of disease.	Specialist recommendation
AQ039	Prior to reinitiating operations in rock pits where standing water is pooled, a biologist will determine if aquatic surveys for sensitive or threatened species should occur.	To avoid or minimize potential impacts to threatened or sensitive aquatic species.	Land Management Plan compliance and specialist recommendation
AQ040	No cable operations would occur within spinedace occupied or critical habitat or slopes above said habitat.	To avoid or minimize potential impacts to threatened aquatic species.	Specialist Recommendation

Environmental Consequences

Alternative 1 – No Action

There would be no direct effects on resource indicators for aquatic species and habitats as a result of the no action alternative, however there would be indirect effects by not moving these resources towards desired conditions. Existing conditions for watersheds would remain degraded and associated loss of habitat would continue which could potentially lead to reductions in populations over time.

Under the No Action Alternative, current conditions within subwatersheds could potentially degrade over time. Overstocked and dense stands within the project area would not be treated, leaving a less healthy, less vigorous, and under productive forest. Encroachment of conifers into riparian areas and wetlands would continue which could decrease shrub and herbaceous ground cover as well as soil hydrologic function. Decreased ground cover and soil function can lead to increased overland flow, erosion, and sedimentation reducing riparian condition and aquatic habitats. Therefore, there is a potential loss of water available for stream flow during dry summer months due to unusually high amounts of water that are lost to overland flow and/or evapotranspiration due to high canopy densities. If current conditions degrade in reference to uplands, then associated riparian condition and aquatic habitat could also degrade, not meeting the need of protection and improvement of aquatic and riparian dependent species habitat. Furthermore, by perpetuating unusually high stand densities the probability for catastrophic fire increases. Uncharacteristic wildfire has the potential to greatly reduce riparian condition and aquatic resources by leaving no shade adjacent to streams (increased stream temperatures), denuding subwatersheds of vegetation thereby leaving exposed soils (increased sediment in streams) and resulting in ash flows.

This alternative would result in no additional acres of ground disturbance or associated actions to riparian condition, habitat connectivity, aquatic habitat, individuals, or increase pollutants/introduced species. Sediment delivery to riparian areas, streams and wetlands would continue at current rates or gradually increase from poor upland conditions. Peak flows may also continue to be altered by reduced soil moisture storage and infiltration capacity producing high peak flows of short duration during high intensity summer precipitation events. Such peak flows can overwhelm riparian areas and streams altering associated riparian and aquatic habitat.

Under the no action alternative, roads would not be decommissioned and the drainage network of a streams remains unnaturally higher. Roads can directly affect the channel morphology of streams by accelerating erosions and sediment delivery and by increasing the magnitude of peak flow. Indirectly, if current conditions degrade then habitat for aquatic species will also degrade. The more roads and stream crossings there are, the higher the probability of sediment delivery to streams, negatively affecting the hydrologic function. In addition, roads affect the hydrograph and drainage density, increasing peak flows and decreasing low flows. This alternative does not meet the need for improvement of aquatic habitat.

The level of risk associated with riparian and watershed conditions as well as species and habitats would be higher with this alternative since the amount and intensity of aquatic restoration would be much less. Furthermore, federally listed native fish would also be at a higher risk of extirpation under current conditions (climate change, low viability, degraded baseline conditions) as it is assumed that minimal aquatic restoration would occur via other projects with the No Action Alternative.

Since no treatments of any kind would be implemented, there would be no direct effects to aquatic resource indicators except for existing Forest Service roads at road/stream crossings. However, the potential for substantial indirect effects would exist through failure to reduce current fuel loading conditions would eventually result in uncharacteristic stand replacing wildfire leading to long term impacts and reduction in watershed conditions. Uncharacteristic fires cause a reduction of riparian condition through loss of canopy cover and structure, increased sedimentation and ash, increased peak flows, and reduction or loss of large wood recruitment. These potential changes in riparian conditions would also result in decreases in food resources, habitat quality, and quantity for all aquatic species. Uncharacteristic wildfire in within riparian areas and streams could harm or reduce species populations either directly or indirectly through alteration of habitat.

Under this alternative, conditions in existing or potential habitat that provide for aquatic species would remain in their current condition, notwithstanding natural processes. No restoration of streams, floodplains, wetlands, or riparian areas would occur. Conifer encroachment would continue into wet and dry montane meadows reducing available habitat. Riparian vegetation would reflect conditions that are suited towards a dryer climate such as grasses. Grass species have less root mass than riparian species and therefore do not have the ability to stabilize the incised streambanks. Current or reduced riparian and watershed conditions of fair or poor would continue to limit the quality of aquatic habitat and therefore species occupancy. Consequently, Alternative 1 would not be beneficial for riparian condition, aquatic habitat quality or aquatic species.

Actions Common to Alternative 2 and 3

Opening ML-1 Roads

For Alternatives 2 and 3, it is assumed that all ML-1 roads may be opened to facilitate vegetation management treatments and closed once treatment units are completed. Use of ML-1 roads add to the open road density when combined with ML2-5 roads. (Table 37). For further explanation see the transportation specialist report.

Table 37: Change miles of open Forest Service roads treatments for Alternatives 2 & 3 as compared to Alternative 1 within the project area.

Maintenance Level	Alternative 1 Total Open Road Miles	Alternative 2 & 3 Potential Open Road Miles
1- Basic Custodial Care (closed)	0	2,184
2 - High Clearance	3,055	3,055
3 - Suitable for Passenger Vehicles	673	673

Maintenance Level	Alternative 1 Total Open Road Miles	Alternative 2 & 3 Potential Open Road Miles
4 - Moderate Degree of User Comfort	68	68
5 - High Degree of User Comfort	3	3
Total System Roads	3,799	5,983

Opening of ML-1 roads under Alternatives 2 & 3 has the potential for short-term impacts to aquatic indicators while roads are in use. Negative effects would result when ML-1 roads occur within species habitat (AMZs). Increases in miles of open roads ranges from 1 to 26 miles (2 -78%) within habitat for nine species or associated critical habitat is proposed for both action alternatives (Table 38). Eight species or associated critical habitat have no increases in open roads within their habitat and therefore no impacts.

Water runoff and sediment yield are key physical processes whereby roads have an impact on streams and other aquatic systems, and the distance of these effects can vary widely. Roads on upper hillslopes concentrate water flow, which can form channels higher on slopes. This process leads to smaller, more elongated first-order drainages and longer total length of the channel network. Water rapidly runs off relatively impervious road surfaces, especially in storm and snowmelt events, increasing runoff. Increased runoff associated with roads may increase the rates and extent of erosion, reduce percolation and aquifer recharge rates, alter channel morphology, and increase peak flows. Increased peak flows can degrade aquatic ecosystems by altering riparian conditions, channel morphology, or aquatic habitat. Surface erosion from forest roads affects the fine sediment budget and may impose a chronic condition of sediment inputs to streams affecting the stream substrate and the health of aquatic life (Luce et al. 2001). Chronic erosion from roads can greatly reduce an aquatic systems integrity, and in some cases can be the primary source of sediment input (Switalski et al. 2004). Sediment concerns are generally highest when roads are not sufficiently drained; with sufficient drainage, water and sediment from upland segments of roads can be diverted, filtered through forest vegetation, and not routed to streams. As such, upland segments of roads can generally be designed to mitigate sediment delivery concerns.

Road density in a watershed affects the collection and transport of water out of the watershed (Burroughs and King 1989, Forman and Alexander 1998). The potential for increases in runoff rates increases with more miles of road. Road closures would be beneficial to water quality if the roads were properly decommissioned and well maintained after closure. A well-maintained, closed road system would result in less sediment from road surface erosion. Roads not proposed for use in the project area may have long-term adverse effects on water quality if they are not properly maintained. For this analysis, it is assumed that when a road is closed it will continue to have impacts on the aquatic system, and both of the action alternatives involve the closure of ML 1 roads and temp roads to use by the public rather than the physical removal of roads.

The primary concern is erosion and sediment delivery from roads that are near streams and that cross streams. Fine sediment is a key physical element to focus on when attempting to delineate land management impacts on aquatic habitat and biota (Rinne 1996). Excessive fine sediment input into a stream can fill pool habitat and reduce both summer and winter rearing habitat for juvenile fish (Heede and Rinne 1990). Stream crossings reduce riparian vegetation and widening of the channel which can also impact water temperature (Poole and Berman 2001, Beschta 1997, and Heede 1980). Not all species and ecosystems are equally affected by roads, but overall the presence of roads is highly correlated with changes in species composition, population sizes, and hydrologic and geomorphic processes that shape aquatic and riparian systems (Trombulak and Frissell 2000).

Chiricahua and northern leopard frogs have the largest increases in ML-1 mileage within their habitat with a potential for 26 and 14 miles respectively. Seven species potentially have 1-3 miles of ML-1 roads within their habitat. Therefore Alternatives 2 and 3 would result in more negative impacts to individuals and habitat by opening ML-1 roads than Alternative 1.

Opening ML-1 roads can cause negative short-term impacts to riparian condition, habitat connectivity, individuals. Effects within species habitat to riparian condition include reduced riparian vegetation cover or structure from removal of vegetation. This would negatively affect leopard frog and gartersnake hiding cover and individuals, particularly if roads occur along streams given these species utilize riparian corridors. Impacts of increased stream temperature could also occur from reduction in canopy cover within riparian areas. Associated ground disturbance and increased sedimentation delivery to riparian areas and streams is expected to occur short-term until the roads were closed.

Pollutants, aquatic invasive species, and disease can be introduced to aquatic systems from machinery or vehicles utilizing ML-1 roads roads but are not expected given implementation of project design features. Pollutants in the form of fuels and lubricants have the potential to be introduced into aquatic systems from staging areas and equipment. Spills and leaks can introduce pollutants to soils and then to streams and riparian areas reducing riparian condition and habitat quality. However, there are six design features to prevent contaminants from entering riparian areas, waterbodies and aquatic habitats which minimizes the potential impact. These measures range from checking for leaks daily to refueling and staging areas being outside AMZs (AQ003, SW015-16, SW074). Similarly, aquatic invasive species or diseases can be introduced to aquatic systems from machinery or vehicles creating or using temporary roads. However, design features for decontamination of equipment (AQ001, AQ023, 028, 038) and not transferring water or materials (AQ026) are expected to reduce potential introduction or spread of invasive species. Implementation of project design features are not expected to introduce or spread any pollutants, disease, or aquatic invasive species.

Table 38: Change by species in miles of open Forest Service roads within species habitats for Alternative 2 &3 as compared to Alternative 1. Percentages reflect changes in miles of ML-1 roads within species habitat.

Species	Alternative 1: Miles of ML-1 Roads	Alternative 2 & 3: Miles of ML-1 Roads/ Percent Increase within species habitat
Gila trout	3	5/ 33%
Gila chub and critical habitat	0	0
Gila topminnow	0	0
Little Colorado spinedace	3	4/ 18%
Little Colorado spinedace critical habitat	<1	<1/ 0%
loach minnow critical habitat	0	0
spikedace	0	0
spikedace critical habitat	0	0
narrow-headed gartersnake	1	2/ 63%
narrow-headed gartersnake critical habitat	<1	<1/ 0%
Chiricahua leopard frog	67	93/ 38%
Chiricahua leopard frog critical habitat	<1	<1/ 0%
desert sucker	8	11/ 32%
Sonoran sucker	2	2/ 0%

Species	Alternative 1: Miles of ML-1 Roads	Alternative 2 & 3: Miles of ML-1 Roads/ Percent Increase within species habitat
Little Colorado sucker	4	5/ 16%
headwater chub	5	5/ 2%
roundtail chub	1	2/ 27%
northern leopard frog	17	31/ 78%

Effects to riparian condition could occur from opening ML-1 roads outside AMZs but within species action areas for all species and critical habitat analyzed (Table 39). Increases in miles of open roads range from 9% to 133% (5-514 miles). Little Colorado sucker and Little Colorado spinedace have the largest increases in road mileage within their action areas. Gila chub, Gila topminnow, loach minnow critical habitat, spikedace and its critical habitat have the lowest increases in open ML-1 road mileage since only a portion of the subwatershed action areas are within the project area. Alternatives 2 and 3 would have more negative impacts from opening ML-1 roads within species action areas than Alternative 1.

Table 39: Change by species in miles of open Forest Service roads within species action areas for Alternative 2 &3 as compared to Alternative 1. Percentages reflect changes in acreages within species action areas.

Species	Alternative 1: Miles of Open Forest Service Roads	Alternative 2 & 3: Miles of Open Forest Service Roads/ Percent Increase in action area
Gila trout	247	408/ 65%
Gila chub*and critical habitat	59	64/ 9%
Gila topminnow*	63	70/ 11%
Little Colorado spinedace	789	1303/ 65%
Little Colorado spinedace critical habitat	312	394/ 26%
Loach minnow critical habitat	63	70/ 11%
spikedace*	63	70/ 11%
spikedace critical habitat*	111	125/ 12%
narrow-headed gartersnake	108	253/ 133%
narrow-headed gartersnake proposed critical habitat	86	142/ 65%
Chiricahua leopard frog	392	603/ 54%
Chiricahua leopard frog critical habitat	74	87/ 18%
desert sucker	1053	1535/ 46%
Sonoran sucker	116	254/ 118%
Little Colorado sucker	820	1454/ 77%
headwater chub	722	861/ 19%
roundtail chub	478	930/ 95%
northern leopard frog	200	322/ 61%

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

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

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

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

Opening ML-1 roads will also increase road density during the timeframe that proposed project activities are occurring. This will negatively impact the Roads and Trails indicator for Watershed Condition Framework in the interim impacting one of the five factors associated with aquatic species and habitats.

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

Low Water Crossings

Low water road crossings can cause negative short-term impacts to riparian condition, habitat connectivity, individuals, and introduction of pollutants or aquatic invasive species that are similar to the discussion above on ML-1 roads. Low water road crossings can alter riparian condition by reducing riparian vegetation cover or structure, impacting stream channel function and structure, and alter and degrade aquatic habitat through changes in water quality from increased sedimentation. Increased low water stream crossings can also cause harm to individuals when they occur within species habitat or AMZs. Increases in low water stream crossings and associated impacts within species AMZs could occur for four species with the largest increase in crossings (+186) occurring for Chiricahua leopard frog (Table 40). Associated ground disturbance and direct impacts is expected to occur short-term until the ML-1 roads were closed. Design feature SW033 would reduce the amount of sedimentation by requiring either constructed features (culvert) or fill material at crossings that would be removed when ML-1 roads were closed.

As discussed above for ML-1 roads, pollutants and aquatic invasive species or diseases can be introduced by vehicles or equipment into aquatic habitat. While these are adverse effects, implementation of multiple design features discussed previously preclude the potential for this to occur.

Table 40: Number of low water road/stream crossings on perennial and intermittent streams for proposed action as compared to existing condition within species habitat or critical habitat. Increases in number of low water crossings reflect opening ML-1 roads.

Species	Current number of low water crossings from ML-2 roads within species AMZs	Proposed action number of low water crossings with ML-1 & 2 roads within species habitat
Gila trout	9	16/ 177%
Gila chub and critical habitat	0	0/ 0%
Gila topminnow	0	0/ 0%
Little Colorado spinedace	1	2/ 200%
Little Colorado spinedace critical habitat	0	0/ 0%
loach minnow critical habitat	0	0/ 0%
spikedace	0	0/ 0%
spikedace critical habitat	0	0/ 0%
narrow-headed gartersnake	2	7/ 140%↑
narrow-headed gartersnake proposed critical habitat	3	3/ 0%
Chiricahua leopard frog	320	506/ 158%↑
Chiricahua leopard frog critical habitat	0	0/ 0%
desert sucker	18	26/ 44%↑
Sonoran sucker	1	1/ 0%
Little Colorado sucker	4	5/ 25%↑
headwater chub	15	15/ 0%
roundtail chub	1	1/ 0%
northern leopard frog	56	84/ 50%↑

Within species action areas, there is potential for increased sedimentation from additional road stream crossings within watersheds could occur for all species and associated critical habitat. Increases in low water stream crossings range from 2 – 213 from opening of ML1 roads (Table 41). Gila trout, Little Colorado spinedace, and Chiricahua leopard frog analysis areas have the highest increases while species outside the project area have the lowest.

Potential effects are expected to vary based on current riparian condition and number of crossings within the indirect analysis areas. Species with riparian conditions that are currently impaired (spinedace and frog) are expected to have a higher level of effects from sedimentation because riparian areas are currently not capturing or processing sediment, indicating more could potentially reach stream from direct delivery. Riparian areas that are functioning at risk or functioning properly should be capable of processing some levels of sediment; however, increased sediment could still have negative impacts over the short-term timeframe until ML-1 roads were closed.

Table 41: Number of low water road/stream crossings on perennial and intermittent streams for proposed action as compared to existing condition outside species AMZs, but within species or critical habitat action areas. Increases in number of low water crossings reflect opening ML-1 roads.

Species	Current number of low water crossings from ML-2 roads in species action areas	Proposed action number of low water crossings with ML-1 roads in species action areas
Gila trout	240	453/ 89%
Gila chub and critical habitat	61	62/ 2%
Gila topminnow	29	31/ 7%
Little Colorado spinedace	184	375/ 104%
Little Colorado spinedace critical habitat	126	213/ 69%
loach minnow critical habitat	29	31/ 7%
spikedace	29	31/ 7%
spikedace critical habitat	91	93/ 2%
narrow-headed gartersnake	64	133/ 108%
narrow-headed gartersnake critical habitat	64	138/ 116%
Chiricahua leopard frog	320	506/ 63%
Chiricahua leopard frog critical habitat	36	53/ 47%
desert sucker	540	866/ 60%
Sonoran sucker	76	138/ 82%
Little Colorado sucker	184	384/ 109%
headwater chub	365	522/ 43%
roundtail chub	168	301/ 79%
northern leopard frog	56	84/ 50%

In Woods Processing Sites (IWPS) and Biomass Storage

Twelve processing sites ranging in size from 2 to 21 acres are being proposed on the Coconino and Tonto NFs and analyzed for environmental effects for both Alternative 2 and 3 of Rim Country (Table 42). Processing site location and siting considerations include: flat uplands less than 5% slope; more than 200 feet from perennial, intermittent, and ephemeral stream channels/ more than 300 feet from meadows, springs, and karst features; more than ¼ mile from Mexican spotted owl Protected Activity Centers, and outside of northern goshawk Protected Family Areas; more than ¼ mile from system hiking trails, campgrounds, and group event recreation sites; more than ¼ mile from private lands, residences, or offices; and adjacent to roads that are open year-round for product removal. Processing sites were located to provide a buffer of 100 to 300 feet from forest roads and state highways to provide for visual screening from Concern Level 1 and 2 travelways. Site boundaries are approximate and may be further modified during implementation and layout.

The processing of wood at up to eight different sites within or immediately adjacent to the project area may involve such tasks as drying and debarking of logs; chipping stems, bark, and limbs; cutting logs;

sorting logs; producing wood cants (logs sawn flat on one to four sides); scaling and weighing logs; and creating poles from suitable sized logs. Equipment that may be used at processing sites includes circular or band saws, various sizes and types of front-end loaders, log loaders, chippers of several types, mechanized cut to length systems, associated conveyers and log sorting bunks for accumulation and storage of logs, as well as electric motors and gas or diesel generators to provide power. Aboveground fuel storage tanks may be necessary to provide on-site fuel to equipment.

The eight wood processing sites that have been proposed range in size from 4 to 21 acres. These sites were screened so as to be located outside of meadows where some of the most productive forest soils are found, and in relatively flat areas. The siting of processing sites in relatively flat areas would minimize the need for extensive site grading.

In order to facilitate the types of tasks and equipment that may be used at these sites, they would typically have to be cleared and grubbed (i.e., vegetative cover and trees removed) resulting in displacement of top soil and exposure of subsoil. The operation of equipment on these sites would result in compaction of the soil, reducing the ability of soils to infiltrate water. Areas of exposed soil would have to be covered with aggregate to minimize erosion and facilitate use of the site. The aggregate surfacing would cover the surface soil where it is not graded and would protect the soil productivity. Various permits would need to be obtained for fuel storage, industrial site use and stormwater pollution prevention.

Following completion of use of processing sites and removal of all equipment and materials, site rehabilitation would have to be accomplished including but not necessarily limited to removal of aggregate, restoration of pre-disturbance site grades, decompaction of soil for seedbed preparation, and seeding and mulching of the site with native grasses and forbs.

Table 42. In Woods Processing Sites and associated acreages.

Site Name	Acres
FR 117, 1321	4
FR 139, 9729D	14
FR 145A, 9615X	7
FR 288, 2781	4
FR 294, 294D	18
3238, 512	20
FR 582, Hwy 87	5
FR 609, 1938	7
FR 74, 64	8
FR 81, 81E	7
9364L, FH 3	21
9731G, Hwy 87	9
Total (12)	128

No direct effects to any aquatic indicators are expected to occur from in woods processing sites (Table 43). None of the proposed IWPS occur within 0.4 mile of occupied, suitable, or critical habitat. In addition, they occur within conifer ERUs (Ponderosa Pine, Ponderosa Pine-Evergreen Oak, Mixed Conifer w/ Aspen, and Mixed Conifer) and not within any riparian areas.

Indirect impacts from IWPS have the potential to occur to seven of the species based on their action areas. Two species (Gila trout and Sonoran Sucker) would have no indirect impacts. Acreages of IWPS range

from 3.1 to 57.4 acres for both gartersnakes and desert sucker, respectively (Table 42). Negative indirect impacts to riparian condition in the form of sedimentation are possible but limited based on less than 0.5% of any species action area being impacted. In Woods Processing Sites would also have limited negative impacts to aquatic macroinvertebrates based on the very low percentage of IWPS acreage in any of the subwatersheds. For California floater, only two watersheds have the potential for any indirect impacts, with a total of approximately 72 acres of IWPS within those watersheds. The other aquatic macroinvertebrates share similar stream and riparian habitats with fish and gartersnakes; therefore, overall acreages of IWPS are still below 1% combined.

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

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

Similarly, leaving biomass should not directly impact sensitive invertebrates, but could have negative impacts to habitat. For aquatic invertebrate species, increased fine sedimentation can lead to physical effects as well as changes in habitat and food availability and quantity. Physical effects include abrasion, clogging of gills and filter-feeding apparatus, burial, and changes in substrate composition (Jones et al. 2012). Bivalve mollusks, such as California floater, are capable of expelling unwanted particles from their gulls but can also expend more energy doing so than is gain from feeding. Filter feeding caddisfly larvae are generally not present in streams receiving high inputs of fine sediment. Burial presents difficulties for sedentary animals, such as mollusks, but can affect motile invertebrates where rates of deposition are high. When inputs of fine sediment are increased in watersheds, interstices between large particles become filled which reduces refugia from predators or high-flow events. Most aquatic invertebrates are strongly associated with substrate composition; therefore increased fine sediment can alter habitat availability. Increased sedimentation can also decrease the nutritional quality of periphyton (the film of attaches algae, fungi, bacteria, organic matter, and sedimented material found on the surface of stones). Some caddisflies, stoneflies, and mayflies are particularly impacted by sedimentation (Harrison et al. 2007).

Table 43. Change by species in the acres of In Woods Processing Sites for Alternatives 2 & 3 as compared to Alternative1. Percentages reflect changes in acreages within species analysis areas. These are considered indirect impacts.

Species	Alternative 1: Acres of In Woods Processing	Alternatives 2 & 3: Acre of In Woods Processing/ Percentage of species action area
Gila trout	0	3/ 0%
Gila chub and critical habitat	0	0/ 0%

Species	Alternative 1: Acres of In Woods Processing	Alternatives 2 & 3: Acre of In Woods Processing/ Percentage of species action area
Gila topminnow	0	0/ 0%
Little Colorado spinedace	0	26/ 0.01%
Little Colorado spinedace critical habitat	0	7/ 0.01%
Loach minnow critical habitat	0	0/ 0%
spikedace	0	0/ 0%
spikedace critical habitat	0	0/ 0%
narrow-headed gartersnake	0	0/ 0%
narrow-headed gartersnake critical habitat	0	0/ 0%
Chiricahua leopard frog	0	28/ 0.02%
Chiricahua leopard frog critical habitat	0	20/ 0.02%
desert sucker	0	57/ 0.02%
Sonoran sucker	0	0/ 0%
Little Colorado sucker	0	26/ 0.01%
headwater chub	0	8/ 0.01%
roundtail chub	0	20/ 0.03%
northern leopard frog	0	20/ 0.02%

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

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

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

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

Rock Pit Development or Expansion

In order to provide adequate sources of road surfacing material, rock pits will need to be utilized and expanded within the project area. Eleven existing pits on are proposed for expansion. To provide for potential future material needs, all rock pits listed below are proposed for a 30% expansion of their current footprint. Current acreage and proposed future acreage are shown in Table 44.

Table 44. Current acreage of proposed rock pits for use and proposed acreage pit expansion.

Pit Name	Current Acreage	Possible Increase in Acreage	Possible Future Total Acreage	Maximum Expansion in Feet from Existing Pit
34T	14	4	18	500
213	7	2	9	500
Pias Farm	6	2	8	500
115	7	2	9	500
717E	2	1	3	400
34B	2	1	4	500
Promontory	16	5	21	700
Carr Lake	12	4	16	600
Brookbank	1	1	2	400
Borrow	12	4	16	600
Cottonwoods Wash	6	2	8	500
Total	85	28	114	N/A

No effects to any aquatic species or habitats are expected to occur from rock pit use or expansion. No rock pit use or expansion will occur within any species habitats or within ½ mile of any habitats. Effects from rock pit use and expansion within species action areas in upper watershed have the potential to occur within five species action areas (Table 45). Overall, those acreages are less than 1% of the species action areas. Design features for rock pits include limiting vegetation removal, erosion control, and reclamation which are expected to reduce any potential negative impacts to riparian condition from sedimentation.

Table 45. Change by species or critical habitat in the acres of rock pits for Alternatives 2 & 3 as compared to Alternative 1. Percentages reflect changes in acreages within species analysis areas. These are considered indirect impacts.

Species	Alternative 1: Acres of Rock Pits	Alternatives 2 & 3: Acre of Rock Pits/ Percentage of action area
Gila trout	0/ 0%	0/ 0%
Gila chub critical habitat	0/ 0%	0/ 0%
Gila topminnow	0/ 0%	0/ 0%
Little Colorado spinedace	0/ 0%	103/ 0.05%
Little Colorado spinedace critical habitat	0/ 0%	0/ 0%
loach minnow critical habitat	0/ 0%	0/ 0%
Spikedace	0/ 0%	0/ 0%

Species	Alternative 1: Acres of Rock Pits	Alternatives 2 & 3: Acre of Rock Pits/ Percentage of action area
spikedace critical habitat	0/ 0%	0/ 0%
narrow-headed gartersnake	0/ 0%	0/ 0%
narrow-headed gartersnake critical habitat	0/ 0%	0/ 0%
Chiricahua leopard frog	0/ 0%	63/ 0.04%
Chiricahua leopard frog critical habitat	0/ 0%	63/ 0.06%
desert sucker	0/ 0%	5/ 0%
Sonoran sucker	0/ 0%	0/ 0%
Little Colorado sucker	0/ 0%	104/ 0.05%
headwater chub	0/ 0%	5/ 0%
roundtail chub	0/ 0%	0/ 0%
northern leopard frog	0/ 0%	58/ 0.06%

Stream, Riparian, Wet Meadow, and Spring Restoration

The intent of this portion of the proposed action is to curb the loss or decline of wetland, riparian, or aquatic plant species and restore native and/or rare wetland, riparian, and aquatic plant species. Projects would be designed to protect or restore existing native biodiversity, aid in erosion control and restore soil function, or create wildlife forage and habitat. The actions include techniques that promote plant growth and vigor, reduce erosion and sediment inputs to aquatic systems, or removal of riparian or aquatic stressors such as ungulate grazing, OHV impacts, user created trails, and dispersed camping that may be causing resource damage to reduce erosion or aid in bank stability.

Riparian restoration, particularly in headwater meadows, will restore process that could benefit aquatic species by storing more water in riparian floodplains (Hunt et al. 2018) and increasing woody riparian canopy cover (where appropriate) (Wondzell et al. 2019) which should make cooler more abundant water available to the stream during dry periods. Additionally, riparian zones can function to improve water quality and change the sediment regime. In general, the proposed action is to restore the riparian functioning condition and attempt to mimic historic flows within the historic range throughout the watershed. Improving riparian vegetation is one way of improving the proper functioning condition.

Headwater meadows are areas where riparian vegetation can be improved to the benefit of riparian function, water flows and timing of water flows. Species composition in the headwater meadows should include sedges and rushes, due to their high root mass and vegetative density but can also include willow or alder in some systems. Removal of encroaching conifers will help reduce competition and improve vigor of riparian species. Vegetative density should be to the point where the bare ground is covered when high flows push down the plants. The species and height are important and can be tall plants or short plants (mat). Vegetation should be able to lay down the plants in the direction of the water flow and protect the bare ground. This will decrease eroding streambanks and help trap sediments, thus aggrading the site. Riparian vegetation treatment methods will occur within the riparian zones outside of the water so there will be no in stream disturbance to species within the water. Potential short and long-term effects of these treatments are described in Table 46.

Table 46. Techniques that would be used for riparian restoration projects and potential effects to species.

Action	Potential Effects	
Intent	Long term	Restoration of riparian vegetation will restore process that could benefit aquatic species by storing more water in riparian floodplains which should make cooler more abundant water available to the stream during dry periods. Additionally, improved riparian vegetation functions to improve water flows and change the sediment regime: In general, we would like to restore the riparian functioning condition and mimic historic flows within the historic range throughout the watershed. Improving riparian vegetation is one way of improving the proper functioning condition of certain riparian systems and includes an improvement in the species composition and the species density. Headwater meadows are areas where riparian vegetation can be improved to the benefit of riparian function, water flows and timing of water flows. Species composition in the headwater meadows should include sedges and rushes, due to their high root mass and vegetative density. · Vegetative density should be to the point where the bare ground is covered when high flows push down the plants. The species and height are important and can be tall plants or short plants (mat). Vegetation should be able to lay down the plants in the direction of the water flow and protect the bare ground. This will decrease eroding streambanks and help trap sediments, thus aggrading the site.
Hand thinning	Short term	Hand riparian thinning is not likely to have measurable effects for species in stream systems. May have some temporary decrease in shade cover. Some potential for disturbance of frogs and gartersnakes.
Mechanical Thinning	Short term	Mechanical riparian thinning is not likely to have measurable negative effects to aquatic species within the stream systems unless there is ground disturbance. There may be some change in conifer shade cover which could increase stream temperature or change invertebrate abundance. There are design features to maintain stream shade (AQ032, AQ033-34, BT001). There is potential for trampling of frogs or gartersnakes or sedimentation from equipment or tree skidding but design features should minimize these.
Prescribed Fire	Short term	Potential for ash flow into streams, generally riparian vegetation recovers quickly in response to fire. Generally, no adverse effect from smoke to aquatic species unless enough ash is present to create water quality concerns. Potential for direct disturbance for gartersnakes and frogs when prescribed fires are conducted within riparian areas or dispersal areas but design features exist to reduce impacts.
Herbicides	Short term	Not analyzed here. Already covered in forest weed management planning documents.
Hand Planting	Short term	Limited potential for sedimentation where new vegetation is planted. Effects should be minimal, no noticeable effects to species. Riparian planting increases bank stability, shade, and organic matter inputs to streams improving stream habitat.
Mechanical Planting/ Seeding	Short term	Mechanical planting and seeding are not likely to have measurable adverse effects to aquatic species within the stream systems. May have some change in shade cover. Some potential for trampling of gartersnakes or sedimentation from equipment but design features should minimize these. Riparian planting increases bank stability, shade, and organic matter inputs to streams improving stream habitat.

Action	Potential Effects	
Fencing Installation	Short term	Installation of fencing is not likely to have adverse effects species in stream systems. There is some potential for disturbance or trampling of frogs or gartersnakes if mechanized equipment is used.
Seasonal Restriction	Long term	Administrative action which should have long term positive effects to habitats for aquatic species by removing disturbance. May include timing restrictions for species needs or soil conditions.
Trail or Road Removal/ Relocation	Short term	There could be some potential for short term sedimentation from areas that are being rehabilitated or relocated. Effects include disturbance to gartersnakes and frogs or changes in sedimentation.
Trail Creation	**Short term**	**Trails may be created in areas to minimize further resource damage. There could be some negative effects during construction, but design features should help minimize. Effects include disturbance to gartersnakes or changes in sedimentation.**

Spring Restoration and Rehabilitation

The proposed action also includes tools for rehabilitation of springs developed for irrigation or livestock that are no longer needed and is compatible with existing water rights. Projects designed to restore natural spring function and flow which would be beneficial in the long term for aquatic species. Problems addressed include drying of spring outflow, reduced aquatic and riparian vegetation, reduced habitat, reduced soil function, spring not functioning properly. Spring projects are varied but are mainly concentrated on improving the flow and vegetation around springs. Some of this work may occur within wetted areas and could potentially have short term negative effect to species that inhabit the springs (Table 47). There are multiple design features to minimize ground disturbance and impacts to these sensitive areas (SW014, SW018-19, SW045, SW070)

Table 47. Effects of techniques for improving spring outflows:

Action	Potential Effects	
Intent	Long Term	Improved spring flow and habitat around springs and protection of habitat. Beneficial for aquatic species including leopard frogs. Remove unneeded channels to consolidate spring outflow and increase habitat or split flow in developed springs to allow water above existing water rights to be released to spring outflows
Improve or remove boxes or other infrastructure using hand methods for excavation such as shovels, or mechanical methods such as trackhoes, jackhammers, concrete saw to restore natural spring function.	Short term	Surface disturbance, including digging, filling, rock placement, etc. both with machinery or hand tools. If habitats are occupied by listed species there is the potential for direct effects such as trampling of Chiricahua leopard frogs and tadpoles and short-term effects from sedimentation from digging within wetted areas. Design features such as timing restrictions or salvage should minimize these potential effects.
Fencing installation	Short and long term.	Protect spring emergence zone and/or springbrook from direct ungulate disturbance through fencing would be beneficial for aquatic species habitats. Will provide more options for livestock grazing management. Installation of fencing generally occurs outside of wetted areas and is unlikely to have direct negative effects to aquatic species.

Road Improvements

Proposed road projects include road relocation and decommissioning which includes restoring a road surface to a more natural state, as well as projects that improve the interaction of roads with stream channels. These will be designed to improve stream function and morphology. Short-term negative impacts to individuals and riparian condition will be similar to those discussed below for aquatic restoration. Direct impacts to individuals could occur for species in riparian or in stream habitats that interact with these roads.

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

Roads near drainages can have deleterious effects to the form and function of streams (Figure 2). The implementation of well-designed projects can improve these road stream interactions in cases where it is not feasible to relocate roads that are causing damage, which could have positive long-term effects to species habitats. Relocated roads should be constructed in a manner that does not hydrologically connect them to streams to extent practicable. They will also have sufficient drainage features to maintain the integrity of the travel, thereby reducing erosion and sedimentation. New cross drains will discharge to stable areas where the outflow will quickly infiltrate the soil and not develop a channel to a stream. When feasible, relocate roads out of drainage bottoms to upland locations; if this is not possible rock armor outfall of drainage features to dissipate water energy. Multiple design features are associated with road decommissioning (SW045, SW062-64, TR008-9, TR011) and relocation (SW058, TR010-11) to reduce impacts.

Contaminants, aquatic invasive species or diseases can be introduced to aquatic systems from equipment causing negative impacts to aquatic species. Pollutants in the form of fuels and lubricants could be transported directly into streams from equipment or from stormwater runoff from staging areas ore refueling areas. Typical water-quality responses to pollutants include altered levels of heavy metals, salinity, turbidity, and dissolved oxygen. These water quality changes can be sporadic and localized due to fluctuations in water quantity. However, there are six design features to prevent contaminants from entering riparian areas, waterbodies and aquatic habitats which minimizes the potential impact. These measures range from checking for leaks daily to refueling and staging areas being outside AMZs (SW015-16, SW074). Aquatic invasive species or diseases could similarly be introduced to streams or waterbodies through transfer of mud or water. However, design features for decontamination of equipment (AQ001, AQ023, AQ028, AQ038) and not transferring water (AQ026), and using clean gravel (AQ031) are expected to reduce any potential introduction or spread of invasive species and disease.

Road restoration projects using techniques below should generally have long term positive effects for listed aquatic species as described below (Table 48). These projects generally use large machinery and may include both instream work and work within the riparian areas. Short term negative effects may include increased sedimentation, disturbance to individual species, or death of individuals for projects that require temporary dewatering.

Figure 2. Temporary berm to divert water from project area. Downcutting on stream below a low water crossing.

Table 48. Effects of techniques for improving road or trail interactions with stream courses, springs, or other wetlands.

Problem Addressed/Intent	Action	Potential Effects2
Intent of Action- Decrease impacts of the road system to riparian and stream ecosystems. Minimize sediment input from roads and where possible allow stream geomorphology to follow natural progression. Provide for aquatic organism passage at road crossings unless barriers are desired for control of non-native species.		Positive - Projects should result in long term improvements to road impacts including decreased sedimentation, improved stream morphology process, and connectivity (where desired).
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.	Obliterate roads restoring natural contours and vegetation using mechanical roads treatments.	Potential displacement of individual species at project areas, temporary sediment plumes during construction. Areas that require dewatering may cause fish to be killed if they are not salvaged. May have short term effects on all life stages of fish and amphibian species including prey species for gartersnakes or aquatic invertebrates which are prey for aquatic species. Eggs and larval stages are especially vulnerable. Potential increase in sedimentation from opening and use of ML-1 roads. May result in short term decrease in shading or habitat for terrestrial invertebrates which are prey for aquatic species. There is a potential for machinery to introduce invasive species or pollutants. Best management practices and design criteria will minimize these risks.
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.	Decommission unauthorized roads, trails, and dispersed camping areas using mechanical roads treatments.	
Erosion, sedimentation, degradation or loss of vegetation from ML 1 roads.	Return ML 1 roads to closed status after use for restoration treatments by removal of drainage infrastructure (e.g., culverts), reestablishment of road drainage through leadout ditches, water bars, rolling dips, and other means, removal of unstable fill, and placement of slash using mechanical roads treatments.	

Problem Addressed/Intent	Action	Potential Effects2
Increased erosion and scouring downstream of culverts, bank instability, and channel downcutting.	Armor downstream culvert outlets using mechanical roads treatments.	Multiple design features are associated with road decommissioning (SW045, SW062-64, TR008-9, TR011) and relocation (SW058, TR010-11) to reduce impacts of sedimentation during and after road improvement projects.
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.	Upsizing culverts 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.	Installing or adding culverts or culvert arrays using mechanical roads treatments.	
Decreased fish passage, habitat access, passage of high flows and bedload, and decreased channel complexity from road culverts.	Maintaining Aquatic Organism Passage where it exists if road work needed. – Install bridge, replace culvert, or remove crossing 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 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.	
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.	Install and replace bridges on ML1 and ML2 roads needed for mechanical offerings using mechanical roads treatments.	
Restore natural flow paths and connection of flow to floodplain areas.	Raise culverts where invert elevations have resulted in stream incision.	
Restore natural flow paths.	Install raised permeable roadbeds with or without culverts where roads cross areas of seasonal or perennial water inundation.	
Channel widening, erosion and sedimentation upstream or downstream of a road crossing. Loss or degradation of riparian vegetation and soil function.	Restore channels affected by road crossings using mechanical roads treatments.	
Reduce sedimentation and erosion, improve vegetation and soil condition, restore stream banks, restore and improve aquatic and terrestrial habitat.	Decommission or relocate ML1 and ML2 roads needed for mechanical offerings causing resource damage to springs, wetlands or streams using mechanical roads treatments.	

Problem Addressed/Intent	Action	Potential Effects2
Streams, springs, or wetlands have increased sedimentation, increased erosion, and loss or degraded vegetation and soil condition from user created trails.	Developing footpath(s) on existing trails to prevent further erosion using hand or mechanical treatments.	

Stream Restoration

General stream treatments include methods that could either be implemented by hand or using machinery such as driving a vehicle to a site, pneumatic post pounder, or gas-powered auger. Heavy mechanical treatments are those that require machinery such as a trackhoe or front-end loader. Both implementation types could have effects to aquatic species. These methods generally occur within the stream channel and floodplains. Projects utilizing heavy machinery are likely to be larger in scope than those utilizing only hand methods. In addition, there is often a temporal difference in the realization of positive effects from the various methods. Though disturbance may be initially higher with heavy machinery, project effects are often less noticeable soon after the project is completed. Projects that utilize hand methods often take a more natural approach and require several seasons of flow events or vegetation growth to produce measurable improvements to habitats.

Though the long-term effects of stream restoration projects are anticipated to be positive for species, some actions may result in a degree of short-term negative effects to aquatic species and their habitats. Short term effects to generally include disturbance within the streams and nearby floodplains which may result in sediment plumes while work is occurring or during storm events, temporary disturbance of occupied habitats and displacement of individuals, temporary reduction of riparian vegetation cover in the project area and change of channel structure. These impacts are considered short-term (a few weeks) and sediment should be moved downstream during the first high stream flow. Beneficial impacts of general stream treatments can be immediate and long-term. The response to projects such as headcut stabilization may have an immediate impact of improving stream function and restoring fish passage upstream. Potential effects for each suite of methods analyzed are summarized in Table 49 below.

Multiple project design features are included in the project to reduce adverse impacts where feasible given the nature of these methods. Reducing heavy equipment impacts are addressed in AQ008, AQ011, AQ030, SW063, SW065-68, SW070, to reduce direct impacts and sedimentation. Reducing impacts to riparian vegetation is covered by AQ014, AQ035, AQ037, SI001, SI003, SI023, and SW008-9 while protecting stream shade is included in AQ032-34. There also design features for site rehabilitation (SW059-63) and stockpiling materials from uplands for use in streams (SI007).

Table 49. Effects of techniques for improving the form and function of stream channels and floodplains

Problem addressed/Intent	Action	Potential effects
Intent	Long Term- Restoration of stream and floodplains to restore process could benefit aquatic species by improving habitats and storing more water in riparian floodplains and improving groundwater availability to stream flow. Streams more connected to groundwater tend to less affected by air temperature and have more abundant water available during dry periods (Norman et al 2016). In addition, in many areas of the project area, streams lack the habitat diversity needed to support all life stages of listed aquatic species. Restoration projects will be designed to provide long term beneficial effects to species habitats by restoring ecological function. In some areas, projects will be designed that will improve habitat for recreational native and nonnative sport fish as well. Managers will need to examine the potential for projects to change the dynamics between native and non-native aquatic species in order to minimize negative fish community effects.	

Problem addressed/Intent	Action	Potential effects
Techniques proposed for heavy mechanical restoration of channels and floodplains.	Boulder and log deflectors using mechanized installation.	Effects include short term displacement of individuals in project areas and temporary sediment plumes during construction. Areas that require dewatering may cause fish to be killed if they are not salvaged. Activities may also result in short-term increases in sedimentation from activities with surface disturbance. Could have negative effects especially to fish and tadpoles. May cause short-term negative effects to species habitats by increasing embeddedness of substrate or filling in low velocity habitats that are crucial for larval fish, hunting gartersnakes, and developing frogs. Increased embeddedness can cause a temporary decrease in aquatic invertebrates and fish prey base. Design features will help decrease these negative effects both during and post construction.
	Restoring meanders or adding stream length by induced meandering, recontouring the channel, plug and pond, other similar methods mechanically.	
	Channel reconstruction, realignment or floodplain reconnection using mechanical treatments.	
	Flood plain creation, widening, or laying back incised stream banks using mechanical treatments.	
	Removing instream stock tanks and replacing with guzzlers, drinkers, etc. in the uplands using mechanical treatments	
	Reconnection of historic side channels that should be functioning using mechanical treatments.	
	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.	
Techniques proposed for either mechanical or hand restoration of channels and floodplains.	Weirs and Beaver Dam Analogs (BDAs) installed by hand or mechanical methods.	Effects include short-term displacement of individuals at project areas, temporary sediment plumes during construction. Effects may also result in short-term increases in sedimentation during activities with surface disturbance. These effects are expected to be immeasurable and persist until the high flow even occurs. Could have negative effects especially to fish species and tadpoles as well as hunting ability for gartersnakes. May cause negative effects to species habitats by increasing short-term embeddedness of substrate or filling in low velocity habitats that are crucial for larval fish and developing frogs until after a high flow even occurs. May also cause a temporary decrease in aquatic invertebrates and fish which are prey for gartersnakes.
	Wicker, log and rock weirs, vanes, or baffles, brush bundles and root wads using various methods and installed by hand or mechanically.	
	Zuni bowls, one rock dams or other similar methods using mechanical or hand treatments.	
	Maintenance of existing structures using manual or mechanical treatments.	
	Removing existing erosion control structures by hand or mechanically.	
Techniques for hand restoration of channels and floodplains.	Hand girdling trees to provide for future large woody debris stream input.	No effect from girdling. Potential positive effect for future habitat conditions.

Summary of Magnitude of Effects of General and Heavy Mechanical Riparian, Spring, and Stream Restoration on Listed Aquatic Species.

Due to the large area, it is unlikely that restoration will occur in all the acres and stream miles that are being proposed for riparian, spring and stream restoration. In the past only a few projects per year have been implemented. The pace and scale of restoration may be increased from previous years since much of the compliance paperwork will be accomplished with this project. Stream restoration treatments are proposed for areas occupied by all of the species within the project area (Table 50). There are no stream treatments proposed in habitats for the five species or critical habitat occurring outside the project area and none with proposed within Chiricahua leopard frog critical habitat so no effects are expected to occur from proposed treatments. Long term benefits of the restoration are expected to outweigh the short-term negative impacts, but it will be important to monitor projects affecting a given species or population to ensure that viability is not negatively affected.

Benefits from mechanical restoration can be immediate and long-term by improving or restoring riparian condition via one of the following: spring condition, stream structure/complexity, stream sinuosity and length, bank stability, floodplain connectivity. Such results will promote conditions that maintain or decrease stream temperature, reduce turbidity (via stable banks, improved sediment retention through increased channel structure, riparian areas, and floodplains), and improved nutrient input (via increases riparian organic input sources) and retention (via increased channel structure, sinuosity, and floodplain areas). It is anticipated that project related sediment will be flushed out during the first spring high flows after project completion, and site restoration conservation measures are expected to prevent future project related sediment inputs into the stream. Therefore, long-term sediment impacts to sediment and turbidity are not expected. General stream restoration methods which are implemented with hand tools generally have a smaller footprint and less disturbance, but the positive impacts may be more subtle and take a little longer to realize.

Both general and heavy mechanical stream treatments could have negative effects to aquatic indicators. These treatments inherently include short term disturbance in streams, their floodplains, and associated riparian areas in order to improve form and function. For all project types in and near riparian, spring and stream habitats there is a risk of short-term effects to individuals or their habitat from implementation of projects both under general and heavy mechanical restoration. The most likely effects would be from harm or disturbance from the use of heavy equipment around streams, springs and wetlands, temporary stream dewatering if necessary for project implementation, or sediment plumes decreasing water quality. These risks are lower with hand methods due to the mobility of species giving them a high likelihood of moving out of the project area and generally smaller project footprints. Conservation measures to look for and move gartersnakes away from construction zones in occupied areas could be implemented as needed. Similarly, fish could be removed or isolated from instream construction areas during in water work periods to minimize the potential for effects.

Other effects may include temporary decreases in riparian condition, increased sedimentation, and the potential for introduction of contaminants or spreading of aquatic invasive species or disease. There may be short term impacts to prey species such as native fish or aquatic invertebrates which could occur during or shortly after project implementation. In water work periods will be determined on a project specific basis and jointly by Forest Service, U.S. Fish and Wildlife Service and Arizona Game and Fish Department due to the overlapping of federally listed and sensitive species. Instream work timing would be prioritized by listed species present and factors such as spawning/breeding seasons or activity periods. Project level best management practices and mitigations would minimize the potential for introduction of contaminants or spread of aquatic invasive species or disease.

Table 50. Miles of general and heavy mechanical stream restoration by species or critical habitat for Alternatives 2 & 3 as compared to Alternative 1. Percentages reflect changes in acreages within species analysis areas.

Species	Alternative 1	Alternatives 2 & 3: General Stream Treatment Miles/ Percentage of Action Area.	Alternatives 2 & 3: Heavy Mechanical Stream Treatment Miles/ Percentage of Project Area
Gila trout	0	8/ 24%	4/ 13%
Gila chub and critical habitat	0	0/ 0%	0/ 0%
Gila topminnow	0	0/ 0%	0/ 0%
Little Colorado spinedace	0	113/ 86%	11/ 9%
Little Colorado spinedace critical habitat	0	31/ 93%	2/ 7%
loach minnow critical habitat	0	0/ 0%	0/ 0%
spikedace	0	0/ 0%	0/ 0%
spikedace critical habitat		0/ 0%	0/ 0%
narrow-headed gartersnake	0	7/ 47%	3/ 23%
narrow-headed gartersnake critical habitat	0	8/ 85%	4/ 40%
Chiricahua leopard frog	0	19/ 7%	14/ 5%
Chiricahua leopard frog critical habitat	0	0/ 0%	0/ 0%
desert sucker	0	52/ 49%	18/ 17%
Sonoran sucker	0	5/ 40%	3/ 26%
Little Colorado sucker	0	101/ 69%	8/ 6%
headwater chub	0	11/ 23%	7/ 14%
roundtail chub	0	4/ 27%	2/ 18%
northern leopard frog	0	42/ 30%	29/ 21%

While introduction of contaminants, aquatic invasive species or diseases into streams from large equipment could occur, project design features are expected to eliminate the possibility. Best management practices and conservation measures requiring cleaning equipment, checking for leaks, and storage of fuels and staging areas for equipment outside of AMZs minimizes or precludes the likelihood of contaminants occurring. Similarly, the risk of chytrid fungus or aquatic invasive species being spread by both machinery and hand equipment will be minimized by requiring decontamination procedures to be followed when activities take place within wetted areas or the moist perimeter of a tank or ephemeral stream and then immediately moving to another wetted area (AQ001, AQ023, AQ028). Given all the mitigations, adverse effects from introduction or spread of contaminants, aquatic invasive species or disease is not expected to occur.

Riparian condition could be negatively impacted by short-term inputs of increased sedimentation from instream structure placement, opening of side channels, road crossing treatments, and other projects inside or near the bankfull channel. The sediment plume from activities will be most concentrated in the immediate project vicinity and should dissipate throughout the stream channel within a few hours. The amount, extent, and duration of fine sediment inputs and turbidity relate to the following: the type and

duration of heavy machinery used within or near a bankfull channel; soil type; the amount of soil disturbance; whether restoration is in or out of the wetted channel; the sensitivity of the channel banks to erosion and other disturbances; the amount of time it takes for disturbed areas to revegetate and stabilize; and the probability of precipitation events before disturbed areas are re-vegetated or stabilized (AQ006, AQ008, AQ031).

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

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

Where stream flow needs to be diverted for instream work, coffer dams and bypass systems associated with heavy mechanical restoration activities may temporarily block (few days) fish movement up and/or downstream through the instream work area. During project implementation, there may be short-term negative impacts by temporarily restricting habitat or habitat access (displacement) within stream work areas. Fish would be blocked from work areas using block nets. Up and downstream fish movement is possible in ditch bypass systems, downstream movement with plastic-culvert bypass systems, but no fish movement is provided with pump bypass systems. Headcuts and existing structures to be repaired or removed may be acting as existing fish-passage barriers; therefore, temporary coffer dams, culverts, and diversion structures may not present additional barriers than the pre-restoration baseline.

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

Aquatic Macroinvertebrates

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

few flushing flow events. Beneficial effects would occur from improved stream habitats and riparian vegetation long term.

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

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

For all sensitive aquatic macroinvertebrates and management indicator species, streams and riparian areas could have short-term negative indirect impacts from proposed stream restoration as part of Alternatives 2 and 3. Short-term indirect effects of heavy mechanical stream restoration include increased sedimentation and turbidity during project implementation. Project level design features would minimize the potential for introduction of contaminants or spread of aquatic invasive species or disease. Long term beneficial impacts of improved riparian condition and aquatic habitat would also occur.

Alternatives 2 and 3

Mechanical Vegetation Treatments

Mechanical vegetation treatments have the potential for negative short-term impacts to riparian condition and individuals where these activities occur in a species habitat. Alternative 2 is proposing treatments within eleven species habitats. Acres of mechanical vegetation treatments under Alternative 2 ranges from 2 to 12,616 acres within species habitat which equates to 26% - 83% of the species habitats within the project area. Acres mechanically treated within species habitats is slightly reduced under Alternative 3 for the same eleven species or critical habitats. Five fish species or critical habitats would not be impacted by mechanical vegetation treatments under Alternatives 2 or 3. Table 51 displays this information for each species.

Table 51. Change by species in the acres of mechanical vegetation treatments for Alternative 2 as compared to Alternative1. Percentages reflect increases in acreage within direct effects analysis areas for species.

Species	Alternative 1: Acres of Mechanical Vegetation Treatment Acres	Alternative 2: Acres of Mechanical Vegetation Treatment/ Percent within species habitat	Alternative 3: Acres of Mechanical Vegetation Treatment / Percent within species habitat
Gila trout	0	839/ 51%	805/ 49%
Gila chub and critical habitat	0	0/ 0%	0/ 0%
Gila topminnow	0	0/ 0%	0/ 0%
Little Colorado spinedace	0	2,198/ 38%	2,135/ 37%

Species	Alternative 1: Acres of Mechanical Vegetation Treatment Acres	Alternative 2: Acres of Mechanical Vegetation Treatment/ Percent within species habitat	Alternative 3: Acres of Mechanical Vegetation Treatment / Percent within species habitat
Little Colorado spinedace critical habitat	0	102/78%	102/ 78%
Loach minnow critical habitat	0	0/ 0%	0/ 0%
spikedace	0	0/ 0%	0/ 0%
spikedace critical habitat	0	0/ 0%	0/ 0%
narrow-headed gartersnake	0	521/ 85%	443/ 72%
narrow-headed gartersnake critical habitat	0	227/87%	227/ 87%
Chiricahua leopard frog	0	12,616/ 83%	10,118/ 66%
Chiricahua leopard frog critical habitat	0	2/100%	2/100%
desert sucker	0	2,463/ 36%	2,401/ 35%
Sonoran sucker	0	368/ 41%	364/ 41%
Little Colorado sucker	0	2,264/ 36%	2,151/ 35%
headwater chub	0	1,139/ 54%	1,081/ 51%
roundtail chub	0	1,046/ 84%	911/ 73%
northern leopard frog	0	2,812/ 53%	2,113/ 39%

Chamberlin et al. (1991) reviewed literature on timber harvest and watershed processes, which are relative to potential impacts to riparian condition. Mechanical vegetation treatments can increase erosion, sedimentation, and alter peak streamflows via removal of vegetation and ground disturbance. Mechanical thinning can influence both upland erosional processes and the way that streams process sediment in their channels. The potential for surface erosion is related to the amount of bare compacted soil exposed to rainfall and runoff. If soil infiltration is sufficiently reduced, water runs off rather than through soil resulting in higher peaks flows and increased sediment transport. Therefore, features such as landings and skid trails can contribute large quantities of fine sediment and runoff to stream channels. Patterns of yarding and skidding can alter drainage paths and redirect water onto areas more likely to erode than natural channels. In addition to influencing soil structure, mechanical harvest can influence snow accumulation and melt rates as well as evapotranspiration and soil water which can also alter peak flows.

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

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

Impacts to individuals in the form of harm or modification of behavior could also occur short-term during implementation. Mechanical vegetation treatments within frog and gartersnake habitat could result in harm of individuals. Frogs and gartersnakes may avoid or move out of these areas while work is occurring causing displacement or disruption of social and feeding behavior. There is a design feature to reduce harm to individual frogs during monsoon season when they are more likely dispersing. These effects have the potential to reduce the health or reproductive capability of individuals.

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

For Alternatives 2 and 3, increased acres of mechanical vegetation treatments also has the potential for indirect occur short-term impacts riparian condition from treatments in the upper watershed. These are indirect impacts that can occur within a species action area (i.e., project watershed area that drains into a species occupied habitat) by changes in the uplands and on tributaries and drainages. Increases in percent of action areas treated under Alternative 2 range from 54% to 94%. Table 52 displays these species habitats as compared to the existing condition (Alternative 1).

Table 52. Change by species in acres of mechanical vegetation treatments for Alternative 2 as compared to Alternative 1. Percentages reflect increases in acreage within species analysis areas. These are considered indirect impacts.

Species	Alternative 1: Acres of Mechanical Vegetation Treatment Acres	Alternative 2: Mechanical Vegetation Treatment Acres/ Percentage of Action Area	Alternative 3: Mechanical Vegetation Treatment Acres/ Percentage of Action Area
Gila trout	0	90,268/ 82%	72,446/ 66%
Gila chub*and critical habitat	0	12,325/ 57%	2,489/ 11%
Gila topminnow*	0	11,628/ 94%	1,327/ 11%
Little Colorado spinedace	0	118,974/ 58%	90,487/ 44%
Little Colorado spinedace critical habitat	0	33,275/ 49%	29,718/ 44%
loach minnow critical habitat	0	11,628/ 94%	1,327/ 11%
spikedace*	0	11,628/ 94%	1,327/ 11%
spikedace critical habitat*	0	16,075/ 90%	2,514/ 14%
narrow-headed gartersnake	0	31,303/ 67%	25,028/ 53%
narrow-headed gartersnake critical habitat	0	31,602/ 68%	25,327/ 54%
Chiricahua leopard frog	0	88,853/ 74%	76,375/ 63%
Chiricahua leopard frog critical habitat	0	8,652/ 98%	8,434/ 96%

Species	Alternative 1: Acres of Mechanical Vegetation Treatment Acres	Alternative 2: Mechanical Vegetation Treatment Acres/ Percentage of Action Area	Alternative 3: Mechanical Vegetation Treatment Acres/ Percentage of Action Area
desert sucker	0	206,464/ 65%	167,754/ 53%
Sonoran sucker	0	37,607/ 72%	30,603/ 59%
Little Colorado sucker	0	123,384/ 55%	96,618/ 43%
headwater chub	0	119,881/ 81%	96,358/ 65%
roundtail chub	0	124,002/ 77%	83,819/ 52%
northern leopard frog	0	20,446/ 48%	13,097/ 31%

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

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

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

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

Design features related to mechanical vegetation treatments are expected to minimize the potential effects described above. The project includes spreading treatments in time and space within a watershed (SW054) as well as for skid trails (SW020-21, SW28, SW030, SW032-33, SW041, SW046), yarding (SW036), and landings (SW038, SW047) are expected to reduce effects. The project also includes a design feature to protect herbaceous regrowth post-treatment from livestock grazing if necessary (RM004, SW012).

Pollutants in the form of fuels and lubricants have a potential to be introduced into aquatic systems from staging areas and equipment that design features are expected to mitigate. Spills and leaks can introduce pollutants to soils and then to streams and riparian areas reducing riparian condition and habitat quality. However, there are four design features to prevent contaminants from entering riparian areas, waterbodies

and aquatic habitats which minimizes the potential effects. These measures range from checking for leaks daily to refueling and staging areas being outside AMZs (AQ003, SW015-16, SW074).

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

In summary, negative effects from mechanical vegetation treatments within species habitats would be similar for Alternatives 2 and 3. Alternative 2 has greater potential for negative effects within species action areas than Alternative 3, but also has the most potential for long term benefits.

Prescribed Burning

Prescribed burning proposed in Alternatives 2 and 3 has the potential for negative short -term impacts to riparian condition and harm to individuals when it occurs within species habitat.. Alternative 2 is proposing treatments in the habitats of thirteen aquatic species or critical habitats (Table 53). Prescribed burning treatments range from 2 to 13,974 acres which equates to 40%-100% of habitat for those species under Alternative 2. Alternative 3 proposes slightly fewer prescribed burn acres for the same thirteen species or critical habitats, except for roundtail chub and northern leopard. For those two species, 30-38% less of their habitat would be impacted under Alternative 3 as compared to Alternative 2. Three species or associated critical habitat have no prescribed burning proposed within their habitat under Alternatives 2 or 3 and therefore no negative effects.

Response of riparian condition and aquatic ecosystems to fire can be highly variable and dependant on fire attributes (e.g. severity, intensity, fire size), magnitude of subsequent storms and snowmelt events, amount of the watershed burned, stream size, and topography (Gresswell 1999, Dwire and Kauffman 2003, Kerschner 2004, Vieira et al. 2004). Indirect fire impacts can consist of altered peak flows and hydrologic processes (Minshall et al. 2001), hillslope erosion and stream sedimentation (Swanson 1981; Megahan 1991; Rinne 1996, Benda et al. 2003, Bisson et al. 2003), disrupted nutrient cycling (Swanson 1981; Megahan 1991; Bozek and Young 1994), loss of streambank vegetation leading to increased stream temperatures (Minshall et al. 2001, Minshall 2003), decreased large woody debris, and fragmented aquatic habitat dynamics (Minshall 2003; Rieman and Clayton 1997; Swanson 1981; Megahan 1991; Bozek and Young 1994). Adverse changes in these attributes can negatively impact riparian condition, as well as aquatic habitat quality and quantity.

Fire related erosion and sedimentation can occur chronically (fine sediment delivery over long periods) or episodically (post-fire ash or sediment pulses, landslides and debris flows) (Dunham et al. 2003). Levels above what a riparian areas and stream can process, based on condition, can lead to negative effects to aquatic habitat quality and quantity. Large increases in sediment can lower pool density, reduce intragravel dissolved oxygen and circulation leading to loss of fish eggs, cover and food sources for benthic macroinvertebrates (Minshall 2003), and reduce the efficiency of filter feeding macroinvertebrates.

Treatments in riparian areas change the vegetative structure, canopy cover, and reduce fuel continuity. This can potentially lead to increased stream temperatures, reduced bank stability, and reduced organic matter (allochthonous material) reaching the stream (Dwire et al. 2016). Reduced fuel continuity provides for resiliency of riparian areas during wildfires by potentially reducing fire intensity and severity. In general, effects of spring or fall prescribed burning on both upland and riparian species composition appear to be either negligible or similar in effects of low-severity wildfire and are generally neutral or

beneficial (Dwire et al. 2016). There are indications that the effects of prescribed fires are much smaller and shorter-lived to the effects of wildfire.

Fire regimes in riparian areas relative to adjacent uplands vary. In drier areas, similar to the project area, historical fire frequencies in uplands and riparian areas are often comparable (Dwire et al. 2016). Dry ponderosa pine/Douglas-fir forest of central Idaho had similar fire return intervals for upland and riparian stands. Where the vegetation composition of riparian areas is similar to adjacent uplands, streamside areas are likely to burn as frequently as the surrounding uplands. Therefore, the suppression of fires for decades has likely altered riparian areas and made them more susceptible to uncharacteristic wildfire similar to uplands.

Prescribed burning can negatively impact riparian condition short-term when it occurs species habitats. Riparian vegetation cover or structure can be decreased as can existing large woody debris. Decreases in willows and other shrubby species reduces hiding and thermal cover for frogs and gartersnakes. This would also impact frog and gartersnake critical habitat as well as potentially impacting some aquatic macroinvertebrate species (Nokomis fritillary) (Earl and Blinn 1999, 2003). This reduction is only expected to occur until vegetation recovers. Reduction in canopy cover also reduces stream shading and can increase stream temperatures. It also reduces organic matter inputs to streams which can alter food webs and prey base for fish and gartersnakes. Indirect impacts of increased stream temperature from loss of canopy cover could also occur but should be limited based on design features associated with limiting high burn severity (mortality) and ignitions within riparian areas.

Riparian condition for Little Colorado spinedace, desert sucker and Sonoran sucker is currently impaired, therefore negative effects are expected to be higher. Vegetation in these systems is not adequate to capture sediment, are often disconnected from the water table and are more reflective of upland species. They already lack adequate streamside cover and structure, therefore those factors could be more susceptible to impacts. Riparian condition for the remaining species is functioning at risk, therefore negative effects are expected to be less as they have more cover and structure. Vegetation in these systems has loss of vigor, growth, or changes in composition, but is present and functioning at some level.

Long term effects of prescribed burning are expected to be positive for riparian condition. Fire plays an important role in maintaining heterogeneity (riparian condition) in aquatic habitats (Gresswell 1999). Periodic variations in the influx of sediment and coarse woody debris from riparian areas to the active stream channel contribute to aquatic habitat heterogeneity by creating complex stream morphology and can be reflected in a diverse fish community (Reeves et al. 1995; Rieman and Clayton 1997; Gresswell 1999; Rieman et al. 2003; Robinson et al. 2005). Reduced fuel loading would protect these areas from uncharacteristic wildfire in the future and impacts of ash flows, altered flows and channel morphology.

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

Table 53. Affected acres by species and the percent of change in the acres of prescribed burning for all alternatives. Percentages reflect changes in acreages within species habitats.

Species	Alternative 1: Acres of Prescribed burning	Alternative 2: Acres of Prescribed Burning/ Percent within species habitat	Alternative 3: Acres of Prescribed Burning/ Percent within species habitat
Gila trout	0	926/ 57%	892/ 55%
Gila chub and critical habitat	0	0/ 0%	0/ 0%
Gila topminnow	0	0/ 0%	0/ 0%
Little Colorado spinedace	0	3,881/ 66%	3,760/ 64%
Little Colorado spinedace critical habitat	0	114/87%	114/ 87%
loach minnow critical habitat	0	0/ 0%	0/ 0%
spikedace	0	0/ 0%	0/ 0%
spikedace critical habitat	0	0/ 0%	0/ 0%
narrow-headed gartersnake	0	548/ 89%	457/ 74%
narrow-headed gartersnake critical habitat	0	233/ 89%	233/ 89%
Chiricahua leopard frog	0	13,974/ 91%	11,018/ 72%
Chiricahua leopard frog critical habitat	0	2/100%	2/100%
desert sucker	0	2,823/ 41%	2,753/ 40%
Sonoran sucker	0	368/ 41%	375/ 42%
Little Colorado sucker	0	4,280/ 69%	4,106/ 66%
headwater chub	0	1,259/ 59%	1,196/ 56%
roundtail chub	0	1,156/ 93%	1,012/ 81%
northern leopard frog	0	3,841/ 72%	2,285/ 43%

Prescribed burning in species action areas (subwatersheds) can indirectly impact riparian condition short-term from increased sediment delivery and peak flows for all analyzed species. For Alternative 2, the 11,990-245,367 acres of species or critical habitat action areas may be treated with prescribed fire (57% to 99%). For alternative 3 proposes fewer acres of burning with 1,327-194,037 acres of species action areas may be treated with prescribed fire. Table 54 displays acres of prescribed burning ins species or critical habitat action areas for all alternatives. However, while five species or associated critical habitat (denoted with an asterisk) show increases in acres treated, it is important to note the overall acreage is small for both action alternatives. This is due to less than half of subwatershed action areas occurring within the project boundary and thus less likelihood of impacts. Therefore, while the percent increase is large the overall potential acres of impacts are much smaller than all other species. Overall impacts would be highest for desert sucker Little Colorado sucker with the largest potential treatment acres and lowest for Gila topminnow, loach minnow critical habitat, and spikedace or its critical habitat for both alternatives.

Prescribed burning can indirectly impact riparian condition short-term from increased sediment delivery and altered peak flows. Loss of ground cover from burning can increase erosion and overland flow which leads to increased sedimentation and peak flows. This could reduce riparian condition, aquatic habitat quality and quantity. However, these impacts are only expected to occur until ground cover vegetation recovers and has the ability to dissipate flows and trap sediment, which depends on when precipitation

comes. Design features for extent of high burn severity as well as spatial and temporal spacing of activities within a watershed are expected to minimize potential impacts.

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

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

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

Design features related to prescribed fire are expected to minimize the potential effects described above. The project includes spreading treatments in time and space within a watershed (SW054), fireline criteria (FE008, SW050-51, TR002), riparian criteria (SW053), general fire (FE003, FE007) and cumulative impacts (FE011) are expected to reduce potential impacts. The project also includes a design feature to protect herbaceous regrowth post-treatment from livestock grazing if necessary (RM004, SW012).

Table 54. Change by species in the acres of prescribed burning for all alternatives. Percentages reflect changes in acreages within species analysis areas.

Species	Alternative 1: Acres of Prescribed burning	Alternative 2: Acres of Prescribed Burning/ Percentage of Action Area	Alternative 3: Acres of Prescribed Burning/ Percentage of Action Area
Gila trout	0	89,598/ 81%	71,775/ 65%
Gila chub and critical habitat*	0	2,358/ 20%	2,296/ 20%
Gila topminnow*	0	11,681/ 94%	1,331/ 11%
Little Colorado spinedace	0	117,052/ 71%	94,099/ 46%
Little Colorado spinedace critical habitat	0	39,410/ 58%	35,848/ 53%
loach minnow critical habitat*	0	11,681/ 94%	1,331/ 11%

Species	Alternative 1: Acres of Prescribed burning	Alternative 2: Acres of Prescribed Burning/ Percentage of Action Area	Alternative 3: Acres of Prescribed Burning/ Percentage of Action Area
spikedace*	0	11,681/ 94%	1,331/ 11%
spikedace critical habitat*	0	27,734/ 92%	3,841/ 13%
narrow-headed gartersnake	0	30,856/ 66%	24,618/ 52%
narrow-headed gartersnake critical habitat	0	43,825/ 94%	30,818/ 66%
Chiricahua leopard frog	0	99,653/ 82%	81,595/ 68%
Chiricahua leopard frog critical habitat	0	8,666/ 99%	8,447/ 96%
desert sucker	0	204,050/ 64%	165,370/ 52%
Sonoran sucker	0	37,572/ 72%	30,606/ 59%
Little Colorado sucker	0	96,943/ 43%	94,882/ 42%
headwater chub	0	113,196/ 76%	95,383/ 64%
roundtail chub	0	144,669/ 90%	97,185/ 60%
northern leopard frog	0	26,742/ 63%	13,836/ 33%

*While the percentage is high for these species action areas, less than half of entire subwatershed(s) are within the project area.

Use or Creation of Temporary Roads

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

Temporary roads have the potential for short and long-term impacts to aquatic indicators. Design features preclude the creation of new temporary roads in an AMZ, but existing non-system roads can be utilized. Negative short-term impacts would result if they occur within species habitat to riparian condition, habitat connectivity, individuals, and introduction of pollutants or aquatic invasive species. Effects to riparian condition include reduced riparian vegetation cover or structure which are components of frog and gartersnake critical habitat as well as some aquatic macroinvertebrate species habitat (Nokomis fritillary). Reduction in canopy cover could subsequently lead to localized increases stream temperature. The number of stream crossings could also increase which can fragment habitat unless they allow for fish passage and lead to increased sedimentation from streambank damage (lead in/out). Harm could potentially occur to individuals at stream crossings or within riparian areas if a temporary road was along a stream. Associated ground disturbance and increased sedimentation delivery to riparian areas and streams is expected to occur short-term until the roads were decommissioned. Design features for limiting stream crossings, not creating new temporary roads in Aquatic Management Zones, and reducing impacts of crossings on temporary roads are expected to minimize the potential impacts discussed above.

Negative impacts of opening temporary roads in species action areas could also occur to riparian condition. In general, roads compact soils and reduce infiltration of water leading to increased erosion and runoff. They increase the drainage network to riparian areas and streams and connect these areas to the uplands by altering surface water pathways. This converts dispersed surface runoff and sediment filtering through a riparian area to direct deliveries of accumulated runoff and sediment. Decreases in

riparian condition from increased in peak flows and sedimentation could occur but would vary based on their current condition.

Pollutants and aquatic invasive species can be introduced to aquatic systems from machinery or vehicles creating or using temporary roads but are not expected given implementation of project design features. Pollutants in the form of fuels and lubricants have the potential to be introduced into aquatic systems from staging areas and equipment. Spills and leaks can introduce pollutants to soils and then to streams and riparian areas reducing riparian condition and habitat quality. However, there are six design features to prevent contaminants from entering riparian areas, waterbodies and aquatic habitats which minimizes the potential impact. These measures range from checking for leaks daily to refueling and staging areas being outside AMZs (AQ003, SW015-16, SW074). Similarly, aquatic invasive species or diseases can be introduced to aquatic systems from machinery or vehicles creating or using temporary roads. However, design features for decontamination of equipment (AQ001, AQ023, AQ028, AQ038) and not transferring water (AQ026) are expected to reduce potential introduction or spread of invasive species. Implementation of project design features are not expected to introduce or spread any pollutants, disease, or aquatic invasive species.

Long term, potential negative impacts of temporary roads would cease as roads were decommissioned and revegetated. Therefore, long term effects are considered neutral to aquatic resource indicators. Overall, the potential short-term negative impacts of temporary roads would be more for Alternative 2 than Alternative 3 and no effects would occur from Alternative 1.

Sensitive Species not covered by Resource Indicators and Measures

Aquatic Macroinvertebrates

Stoneflies, caddisflies, mayflies, midges, and riffle beetles have diverse diets and feeding strategies, occupy different trophic levels and functional feeding groups from predators to filter feeders. Nymphs of the four groups are aquatic while adults stay in the riparian areas for reproduction.

Based on the biology and ecology of these four groups of species, suitable stream and riparian habitat could have negative short term impacts to habitat quality from Alternatives 2 and 3. While vegetation management actions in uplands can increase erosion and sedimentation, project design features are expected to minimize that potential. Treatments within AMZs have the potential for short term impacts of sedimentation, reduced riparian vegetation, and altered stream habitats due to nearness to habitat. Alternatives 2 and 3 would have long-term benefits from reducing the risk of uncharacteristic wildfire and associated impacts to aquatic systems.

Nokomis Fritillary is a sensitive species that utilizes wetlands. Alternatives 2 and 3 could have short term negative and long term beneficial impacts to the species habitat. Mechanical vegetation treatments and prescribed burning in wetlands can increase erosion and sedimentation, alter riparian vegetation as described above, but are minimized by design features. More importantly it could reduce the availability of the butterflies host plant (*Viola nephrophylla*) and thus habitat quality short-term until plants regrew. Alternative 2 and 3 would have long-term benefits of reducing conifer encroachment into wetlands providing higher quality habitat and reducing the risk of uncharacteristic wildfire.

California Floater was once present in Fossil Creek, West Clear Creek, and Upper Clear Creek and it is possible that it may still occur within Chevelon Creek below Chevelon Dam. Direct and indirect negative impacts could occur in two of the watersheds, while only indirect impacts would occur in Chevelon Creek and Fossil Creek. Mechanical vegetation treatments, prescribed burning, and roads can increase erosion and sedimentation, alter riparian vegetation, and alter stream habitats as described for other aquatic

species above. Alternative 2 and 3 would potentially having long-term benefits from reducing the risk of uncharacteristic wildfire and associated impacts to aquatic systems.

Cumulative Effects

The cumulative effects analysis geographic boundary is the Rim Country project area boundary as this area includes all actions associated with implementation for this analysis. The following list summarizes the past, present, and future activities that would add to the total cumulative effects.

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

Cumulative Effects for Alternative 1

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

Cumulative Effects common to Alternatives 2 and 3

Timber Harvest and Vegetation Management

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

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

Recreation and Recreation Management

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

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

Fire Suppression and Fire Management Projects

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

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

Livestock Grazing

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

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

Road and Trail Construction, Maintenance, and Closure

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

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

Special Uses and Permits/Minerals Management/Land Exchanges

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

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

Dam and Reservoir Development/Water Diversions

These projects have resulted in considerable impacts to aquatic habitat and species both directly and indirectly. Dam and reservoir development began in the late 1800's and continued into the 1960's across the project area, altering stream habitat into lake habitat. Most of this activity was to provide for downstream (and off Forests) water use and irrigation as well as to provide for recreational opportunities.

Blue Ridge Reservoir is part of an interbasin transfer to the Verde River from the Little Colorado River drainage to provide water downstream. Most dams and water diversions have detrimental impacts to aquatic species and habitats such as isolated or separated populations, loss of available habitat, and dewatered streams.

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

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

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

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

Determination of Effects

Gila trout

Short term adverse effects could result to recovery and recreational populations of Gila trout within the project area from mechanical thinning and burning. Project design features are expected to minimize potential adverse effects of thinning and burning, particularly spreading out treatments spatially and temporally to reduce overall impact and allow reestablishment of ground cover. Additional design features for thinning and burning in AMZs further reduce potential ground disturbance such as equipment driving in and backing out and no dug handlines in AMZs. Because of implementation of project design criteria, no meaningfully measurable effects are expected. Long term benefits of thinning and burning include reduce risk of uncharacteristic fire and improved watershed condition.

Opening 2 miles of ML-1 roads and an associated 7 low water crossings in Gila trout habitat could have short term adverse effects under alternatives 2 and 3. These increases occur in Ellison (six crossings) and Workman Creeks (one crossing). Additionally, a total of 161 miles of ML-1 roads and 213 low water crossings could be used within the species action area. Road crossings actively produce sedimentation through vehicular disturbance or road maintenance activities and passively through erosion of the

disturbed banks forming the sides of crossings. Subwatersheds that contain Ellison and Workman Creeks have riparian condition that is currently functioning at risk (fair) and show as impaired for the roads and trails indicator. This can mean either high open road density, maintenance costs, and/or proximity to water in the baseline. Increased sedimentation to trout streams can reduce water quality, reduce spawning gravel quality, fill in pools, and reduce food resources. This can result in decreased reproductive success or survival of particularly younger age classes. Roads and crossings within species habitats would have increased effects, but the incremental increases of sediment from roads and crossings would be additive. While not all ML-1 roads or crossings would be utilized at the same time, they have the potential for short adverse effects from increased sedimentation.

Stream restoration could have adverse and beneficial effects to Gila trout under alternatives 2 and 3. Restoration occur in 8 of 32 miles of Gila trout streams; of those only four miles could utilize heavy mechanical stream restoration methods. General stream restoration methods Design features for block netting instream work areas and timing restrictions determined by listed species present (during spawning seasons) reduce the potential for harm individuals or redds. Short-term inputs of sediment could result from mechanical stream restoration that occurs inside or near the bankfull channel. The sediment plume from activities will be most concentrated in the immediate project area and should dissipate within a few hours. The increased stream turbidity may deposit fine sediment on substrate a short distance downstream, encourage fish to move downstream, and alter behavior patterns for a short time. It is anticipated that all project related sediment will be flushed out during the first high flows after project completion. Project design features are expected to prevent sediment inputs from persisting into the future, therefore, long-term negative impacts from sediment are not expected. Stream restoration activities will provide immediate and long-term benefits to Gila trout habitat such as decreased direct sediment inputs from unstable banks or headcuts, increased habitat complexity and thermal refugia, and improved riparian areas and stream shading.

Potential long-term benefits in Gila trout habitat from improved watershed, riparian and stream habitat would contribute to species recovery while reducing potential impacts from uncharacteristic fire. While negative effects are mitigated for most activities, short term effects from ML-1 roads, low water crossings and stream restoration to Gila trout are not at a level where they can be considered insignificant or discountable. Therefore, the determination for Gila trout is “May Affect, Is Likely to Adversely Affect” for alternatives 2 and 3.

Gila Chub and Critical Habitat

While project mechanical thinning and prescribed burning is proposed in the action area, effects are not expected. Occupied and designated critical habitat occurs ten miles downstream of the project area which occurs in the upper portions of the watershed. Less than 10% of the upper Red Tank Draw subwatershed would be mechanically thinned or burned over time. Project design features are expected to minimize potential adverse effects of thinning and burning, particularly spreading out treatments spatially and temporally to reduce overall impact and allow reestablishment of ground cover. Given less than 10% of the subwatershed could be treated, no adverse effects or benefits of reduced fire risk or improved watershed condition are expected. Because of implementation of project design criteria, no effects are expected from mechanical thinning or prescribed burning.

Up to five miles of ML-1 roads and one associated stream crossing would occur within the action area. Given the distance to occupied habitat and no perennial streams associated with these actions, no effects are expected from roads.

Due to location of project activities from occupied or critical habitat, small percentage of action area treated, and associated design features no potential adverse or beneficial effects are expected to occur. Therefore, no effects are expected to occur to Gila chub or its designated critical habitat.

Gila Topminnow

While project activities could occur in the upper Fossil Creek watershed, no negative effects are expected. Species habitat occurs over seven miles downstream of the project area. While mechanical thinning and burning would occur in the Upper Fossil Creek subwatershed over time, design features are expected to minimize any potential negative impacts of sedimentation, particularly spreading out treatments spatially and temporally to reduce overall impact and allow reestablishment of ground cover. Given almost 43% of the Upper Fossil Creek subwatershed would be treated, long-term benefits of improved watershed condition and reduced fire risk may lead to improved watershed function for the species in Lower Fossil Creek. Therefore, the determination for Gila topminnow is "May Effect, Is Not Likely to Adversely Affect" due to the expected beneficial effects.

Little Colorado Spinedace and Critical Habitat

Implementation of the proposed action has the potential to benefit habitat for Little Colorado spinedace by improving stream and riparian conditions and especially by improving conditions in wet meadows. Improvement will help improve water retention in the upland meadows may help maintain water in downstream areas in dry times. In addition, risk of uncharacteristic wildfire in watersheds containing Little Colorado spinedace should be decreased by upland vegetation treatments.

There is the potential some short-term adverse impacts within the project area associated with project implementation. Ground disturbing activities associated with mechanical thinning, prescribed burning, opening of ML-1 roads and stream restoration can impact spinedace by altering water quality and increasing sedimentation into streams, resulting in altered habitat conditions and reduced food resources. Design features associated with the project should minimize potential negative impacts, particularly spreading out treatments spatially and temporally to reduce overall impact and allow reestablishment of ground cover. Within species habitat mechanical thinning, prescribed burning and one mile of ML-1 road with an associated low water crossing may opened across an intermittent tributary to Leonard Canyon. Impacts of channel widening and sedimentation would exist while the road and crossing were open but would be reduced once closed. Even with multiple design criteria to mitigate sedimentation, given close proximity to occupied habitat short term impacts of sedimentation from ground disturbing activities could occur.

There are 113 miles of spinedace habitat within the project area that may be identified for stream restoration. Of those, only eleven miles are heavy mechanical treatments. While heavy mechanical stream restoration has adverse impacts from sedimentation during implementation, the benefits to the species are realized much faster. The impacts of stream restoration generally dissipate faster than vegetation management impacts and benefits can be almost immediate. The potential for harm or harass individuals during instream restoration work is minimized by design features to coordinate and collaborate with USFWS and AZGFD and isolating instream work areas. Within spinedace watersheds and additional 118,974 acres of mechanical thinning and 144,124 acres of burning could occur. In addition, up to 514 miles of ML-1 roads may be utilized with an associated 191 low water crossings during the life of the project. Spreading treatments out in time and space within a watershed and limits on percent of a watershed treated provide for soil condition and herbaceous recovery, but the potential for increased sediment exists particularly given current poor riparian condition. Potential long-term benefits to spinedace habitat from improved watershed, riparian and stream habitat could contribute to species recovery while reducing potential impacts from uncharacteristic fire. While impacts would be mitigated,

short term impacts to spinedace are not at a level where they can be considered insignificant or discountable. Therefore, the determination for spinedace and its designated critical habitat is "May Affect, Is Likely to Adversely Affect".

Effects to spinedace designated critical habitat. Proposed activities within critical habitat include 102 and 114 acres of mechanical thinning and prescribed burning and 31 miles of stream restoration with 2 miles of potential heavy mechanical stream work. Within critical habitat watersheds an additional acre of mechanical thinning, prescribed burning and 7 acres of in woods processing could occur. Design features are expected to minimize effects from these actions. Up to 82 miles of ML-1 roads could be utilized and an associated 87 low water crossings within critical habitat watersheds throughout the life of the project. Short term adverse effects could occur to spinedace critical habitat PCEs 1a, 1d-e, 2b-c from increased sedimentation or ash, decreased vegetative cover, and disease. Project activities would not impact PCEs 1b-c, 2a relating to instream vegetation, nonnatives, presence of water. Potential long-term benefits of improved watershed and stream function should improve value and contribute to recovery. For the reasons stated above and in Table 49 the determination is for spinedace designated critical habitat is "May Effect, Is Likely to Adversely Affect".

Loach Minnow and Critical Habitat

While project activities could occur in the upper Fossil Creek watershed, no beneficial or negative effects are expected to loach minnow. Stockings of loach minnow into Fossil creek were not successful in establishing the species and it is not considered as present. Therefore, the determination for loach minnow is "No Effect".

Effects to designated critical habitat may occur similar to discussions above. The project is not expected to result in adverse effects to loach minnow critical habitat (PCEs 4 & 6) because critical habitat does not occur within with project area. Negative effects to PCEs 1, 2, and 3 from sedimentation or ash in upper portions of the watershed or pollutants are not expected due to stream distance from the project area and implementation of project design features. Project activities would not impact PCE 5 relating to level nonnative species. All the PCEs except 4 &5 may have long term benefits from projected improvement of watershed function and reduced fire risk. For the reasons stated above is "May Effect, Is Not Likely to Adversely Affect" for loach minnow critical habitat due to the potential for long term beneficial effects.

Spikedace and Critical Habitat

The only current population of spikedace in the project area is the recently been reintroduced into Fossil Creek. Initial surveys indicate recruitment and indicate a successful reestablishment of this species over ten miles downstream from the project boundary.

While project activities could occur in the Upper Fossil Creek watershed, no negative effects are expected. Species habitat occurs over seven miles downstream of the project area. Mechanical thinning and prescribed burning could occur within the species area. Project design features are expected to minimize any potential negative impacts of sedimentation, particularly spreading out treatments spatially and temporally to reduce overall impact and allow reestablishment of ground cover. Given almost 43% of the Upper Fossil Creek subwatershed would be treated, long-term benefits of improved watershed condition and reduced fire risk may lead to improved watershed function for spikedace in Lower Fossil Creek. Therefore, the determination for spikedace is "May Effect, Is Not Likely to Adversely Affect" due to the expected beneficial effects.

Effects to designated critical habitat may occur similar to other fish species. The project is not expected to result in adverse effects to spikedace critical habitat (PCEs 4 & 6) because critical habitat does not occur within with project area. Negative effects to PCEs 1, 2, and 3 from sedimentation or ash in upper portions of the watershed or pollutants are not expected due to stream distance from the project area and implementation of project design features. Project activities would not impact PCE 5 relating to level nonnative species. All the PCEs except 4 &5 may have long term benefits from projected improvement of watershed function and reduced fire risk. For the reasons stated above the determination is "May Effect, Is Not Likely to Adversely Affect" for spikedace critical habitat due to the potential for long term beneficial effects for alternatives 2 and 3.

Narrow-headed Gartersnake and Critical Habitat

While implementation of the proposed action has the potential for long term beneficial impacts, short term adverse effects could result to narrow-headed gartersnakes and proposed critical habitat. Overall, there is less than 552 acres of proposed mechanical thinning and burning within narrow-headed gartersnake habitat, 288 acres in Canyon Creek and 262 acres in Haigler Creek. In addition, 31,602 acres of mechanical thinning and 43,825 acres of prescribed burning may occur outside species habitat, but within the action area. Vegetation management within species habitat would reduce herbaceous cover short term. Design features associated with the project should help reduce and minimize any potential negative impacts, particularly spreading out treatments spatially and temporally to reduce overall impact and allow reestablishment of ground cover. Design features for thinning and burning in AMZs (FE006) further minimize reductions in ground cover such as equipment driving in and backing out and limitation on fireline AMZs. Firelines would only be constructed in AMZs with approval and can only consist of non-ground disturbing techniques (SW008). Brushing (cutting woody shrubs) is one method that may be used which would reduce hiding cover for gartersnakes. Additional design criteria specific to gartersnakes reduce potential harm from vegetation management. AQ019 outlines a 150 ft AMZ for gartersnakes and does not allow for piling of any kind to occur within in them. Gartersnakes would utilize piles as hiding cover, which could lead to harm during prescribed burns. The design feature further reduces potential harm during the snake's hibernation period by minimizing disturbance of rock/boulder piles and woody debris within the AMZ. Long term benefits of thinning and burning include reduce risk of uncharacteristic fire and improved watershed condition.

Up to one mile of ML-1 roads could be utilized and an associated five low water crossings added in Canyon Creek within gartersnake habitat throughout the life of the project. Less than 0.03 miles of ML-1 road and no low water crossings would occur in Haigler Creek. Localized impacts of channel widening, and sedimentation would exist while the roads were open but would be reduced once closed. Road crossings actively produce sedimentation through vehicular disturbance or road maintenance activities and passively through erosion of the disturbed banks. Design features for low water crossings would reduce potential sedimentation during that time period but not eliminate it which could lead to behavioral changes (avoidance) at the crossing within gartersnake habitat. To facilitate thinning treatments, an additional 114 miles of ML-1 roads may be opened in the Canyon Creek subwatershed and 30 miles in the Haigler Creek subwatershed with 30 and 39 low water crossings, respectively. While riparian condition in gartersnake action area is functioning at risk (fair), the specific roads trails indicator is functioning at risk for the Canyon Creek subwatershed and impaired for Haigler Creek. This can mean either high open road density, maintenance costs, and/or proximity to water in the baseline. Design features and roads best management practices are expected to reduce sedimentation, but some of the ML-1 roads are along intermittent drainage bottoms such as Lost Salt Canyon which have a higher potential for increased sedimentation to Haigler Creek. Similarly, multiple low water crossings occur on perennial tributaries to Canyon Creek. The incremental increases to the roads and crossings baseline would indicate the potential for measurable increased sedimentation during use and short-term negative effects. Increased

sedimentation leads to turbidity and embeddedness which can reduce prey base and hunting ability for narrow-headed gartersnakes.

Short term adverse effects and long-term benefits to gartersnakes are expected from stream restoration activities. General stream restoration can occur in only 7 miles of gartersnake habitat within Canyon and Haigler Creeks, with the potential for three miles of heavy mechanical treatments in Canyon Creek which have the potential to displace or harm individuals. General stream restoration techniques are geared toward riparian restoration (planting, fencing, etc.) which has the potential to disturb individuals but is not overly ground disturbing or leads to removal of vegetation used for hiding cover, brumation, or thermoregulation. Construction activities associated with heavy mechanical methods would also disturb individuals and could result in a flight response, possibly resulting in harassment, injury, or death. Similar effects could also occur from heavy machinery working next to the stream bank, working in the stream, or during excavation activities. Stream restoration implemented during the surface-active period provides an opportunity for gartersnakes to escape the adverse effects of machinery. Design feature AQ020 provides for biologist to be involved in pre-planning of all treatments in aquatic systems while AQ023 requires early interagency coordination to identify survey needs and disposition of gartersnakes impacted during implementation which are expected to minimize potential harm. Heavy mechanical stream restoration has adverse impacts from sedimentation during implementation, those impacts dissipate after the first high flow event and benefits are almost immediate. Potential long-term benefits in gartersnake habitat from improved watershed, riparian and stream habitat could contribute to species recovery while reducing potential impacts from uncharacteristic fire. Although impacts would be mitigated, impacts to narrow-headed gartersnake are not at a level where they can be considered insignificant or discountable. Therefore, the determination for narrow-headed gartersnake is “May Affect, Is Likely to Adversely Affect”.

The greatest threat to narrow-headed gartersnake populations is lack of water during drought conditions and predation, competition, and effects on the native fish prey base from nonnative fish, bullfrogs, and crayfish. The project may help improve watershed conditions and the ability of streams to maintain water during drought conditions.

Short term negative effects and long-term benefits to narrow-headed gartersnake proposed critical habitat in Canyon Creek and Haigler Creek may occur. Mechanical thinning and prescribed burning are proposed within and outside of critical habitat in Canyon Creek and Haigler Creek. Up to 7 miles of general stream restoration along both critical habitat units is proposed and 3 miles of potential heavy mechanical stream work in Canyon Creek. In addition, up to 56 miles of ML-1 roads could be utilized and an associated 74 low water crossings within critical habitat watersheds throughout the life of the project. The project is not expected to result in adverse effects to narrow-headed gartersnake critical habitat (PCEs 2a, 2b, & 4) associated with flows, hydrologic connections, and nonnatives. Short term adverse effects could occur to PCEs 1a-d, 2c-d, & 3 from increased sedimentation or ash, decreased vegetative cover, and reduced prey base. Project activities would not impact PCE 5 relating to elevation. While short term impacts to PCEs may occur, none should appreciably diminish the value for survival and recovery of the species long term. Potential long-term benefits of improved watershed and stream function should improve value and contribute to recovery. For the reasons stated above the determination is for narrow-headed gartersnake proposed critical habitat is “Not Likely to Adversely Modify”. Should critical habitat be designated in the future, the determination would be “May Effect, Is Likely to Adversely Affect”.

Chiricahua leopard frog

While implementation of alternatives 2 or 3 has the potential for long term beneficial impacts, short term adverse effects could result to Chiricahua leopard frog. Mechanical thinning and prescribed burning are

proposed within frog dispersal habitat and outside of dispersal habitat but within the species action area. Project design features are expected to minimize potential adverse effects of vegetation management from increased sedimentation which can alter water quality and reduced herbaceous or woody cover, particularly spreading out treatments spatially and temporally to reduce overall impact and allow reestablishment of ground cover. Additional design features for thinning and burning in AMZs further reduce potential decreases in ground cover such as equipment driving in and backing out and no dug handlines in AMZs. Design criteria specific to leopard frogs also reduce the potential for harm or harassment in the form of displacement, injury, or death from vegetation management activities. The150 ft AMZ for frogs and does not allow for skid trails without biologist approval. Mechanical thinning in frog habitat would not occur in AMZs within 3 days of a rain event to reduce potential harassment or harm when frogs are most likely to disperse. These mitigations reduce the potential for harm to individual frogs within dispersal habitat. Long term benefits of thinning and burning include reduce risk of uncharacteristic fire and improved watershed condition.

Opening of ML-1 roads and associated low water crossings pose the highest risk and potential effects to frogs and their habitat. Up to 26 miles of ML-1 roads could be utilized and an associated 186 low water crossings added within frog habitat throughout the life of the project. An additional 211 miles of ML-1 roads and 186 low water crossings could be opened outside of frog habitat, but within the action area. Roads and crossings actively produce sedimentation through vehicular disturbance or road maintenance activities and passively through erosion of the disturbed banks forming the sides of crossings. Action area subwatersheds have riparian condition that is currently fair or poor and all have poor ratings for the specific roads and trails indicator. This can mean either high open road density, maintenance costs, and/or proximity to water in the baseline. Design features and roads best management practices are expected to reduce sedimentation, but some of the ML-1 roads are along perennial or intermittent drainage bottoms in multiple areas have a higher potential for increased sedimentation, and reduced cover. Similarly, multiple low water crossings could occur on the same stream creating additive impacts. Use of ML-1 roads and crossings can impact frogs short-term by altering water quality, increasing sedimentation into streams, and reducing herbaceous or woody cover. These lead to altered riparian and terrestrial habitat conditions, reduced algal and macroinvertebrate food resources for tadpoles, reduced foraging and basking habitat, and reduced survival. Design features for low water crossings would mitigate potential sedimentation during that time they were in use but could lead to behavioral changes (avoidance) or possible harm or harassments to dispersing frogs in the form of displacement, injury, or death. While not all ML-1 roads or crossings would be utilized at the same time, those within the same area (timber sale or burn unit) would be. The incremental increases to the roads and crossings baseline would indicate the potential for measurable increased sedimentation during use and short-term negative effects to Chiricahua leopard frog

Short term adverse effects and long-term benefits to Chiricahua leopard frog are expected from stream restoration activities. Stream restoration is proposed in 19 miles of frog dispersal habitat with the potential for fourteen miles are heavy mechanical treatments which have the potential to displace or harm individuals. General stream restoration techniques are geared toward riparian restoration (planting, fencing, etc.) which has the potential to disturb individuals but is not overly ground disturbing nor leads to removal of vegetation used for hiding cover or thermoregulation. Construction activities associated with heavy mechanical methods would also disturb individuals and could result in a flight response, possibly resulting in harassment, injury, or death. Similar effects could also occur from heavy machinery working next to the stream bank, working in the stream, or during excavation activities. Stream restoration implemented during the activity period provides an opportunity for frogs to escape machinery. Design feature AQ018 provides for biologist to be involved in pre-planning of all treatments in aquatic systems while AQ020 requires early interagency coordination to identify survey needs and disposition of frogs or gartersnakes found during implementation which are expected to minimize potential harm, but it exists. Heavy mechanical stream restoration can cause plumes of sediment causing increased turbidity

and embeddedness during implementation, those impacts are short lived and dissipate after the first high flow event. Beneficial effects on improved instream habitat and habitat complexity are almost immediate. Potential long-term benefits in frogs from improved watershed, riparian and stream habitat could contribute to species recovery while reducing potential impacts from uncharacteristic fire. Although impacts would be mitigated, impacts to Chiricahua leopard frog are not at a level where they can be considered insignificant or discountable.

Potential long-term benefits in frog habitat from improved watershed, riparian and stream habitat could contribute to species recovery while reducing potential impacts from uncharacteristic fire and directly improving habitat. Although impacts would be mitigated, impacts to Chiricahua leopard frog are not at a level where they can be considered insignificant or discountable. Therefore, the determination for Chiricahua leopard frog is "May Affect, Is Likely to Adversely Affect" for alternatives 2 and 3.

Effects to designated critical habitat may occur in either a positive or negative manner. Proposed activities within critical habitat units include 1.6 acres of mechanical thinning and prescribed burning in the Crouch, Gentry, Cherry Creeks, and Parallel Canyon unit and 0.4 acres in the Ellison and Lewis Creeks unit for alternatives 2 and 3. No other activities are proposed within Chiricahua leopard frog critical habitat. Within critical habitat action area mechanical thinning, prescribed burning, 20 acres of in woods processing, and 63 acres of rock pits could occur. In addition, up to 13 miles of ML-1 roads could be utilized and an associated 17 low water crossings within critical habitat action area throughout the life of the project. Short term adverse effects could occur to Chiricahua leopard frog critical habitat PCEs 1a, 1d-e, 2b-c from increased sedimentation or ash, decreased vegetative cover, and disease. Project activities would not impact PCEs 1b-c, 2a relating to instream vegetation, nonnatives, presence of water. Potential long-term benefits of improved watershed and stream function should improve value and contribute to recovery. For the reasons stated above the determination is for Chiricahua leopard frog designated critical habitat is "May Effect, Is Likely to Adversely Affect".

Desert Sucker, Sonoran sucker, Little Colorado sucker, headwater chub and roundtail chub

Short term adverse effects could result to sensitive fish species or their habitat within the project area from mechanical thinning and burning. Project design features are expected to minimize potential adverse effects of thinning and burning, particularly spreading out treatments spatially and temporally to reduce overall impact and allow reestablishment of ground cover. Additional design features for thinning and burning in AMZs further reduce potential ground disturbance such as equipment driving in and backing out and no dug handlines in AMZs. Because of implementation of project design criteria, no meaningfully measurable effects are expected. Long term benefits of thinning and burning include reduce risk of uncharacteristic fire and improved watershed condition.

Opening ML-1 roads and associated low water crossings within species habitats could have short term adverse effects under alternatives 2 and 3. Additional ML-1 roads and low water crossings could be used within the species action areas. Road crossings actively produce sedimentation through vehicular disturbance or road maintenance activities and passively through erosion of the disturbed banks forming the sides of crossings. Increased sedimentation to streams can reduce water quality, reduce spawning gravel quality and reduce food resources. This can result in decreased reproductive success or survival of particularly younger age classes. Roads and crossings within species habitats would have increased effects, but the incremental increases of sediment from roads and crossings would be additive. While not all ML-1 roads or crossings would be utilized at the same time, they have the potential for short term adverse effects from increased sedimentation.

Stream restoration could have short term adverse and beneficial effects to sensitive fish under alternatives 2 and 3. General stream restoration methods are expected to have only beneficial effects due to lack of ground or vegetation disturbance. Long term benefits of these actions would also occur from plantings and fencing. Heavy mechanical stream restoration would have adverse effects during implementation to species and habitat. Design features for block netting instream work areas and timing restrictions determined by species present (during spawning seasons) reduce the potential for harm individuals or nests. Short-term inputs of sediment could result from mechanical stream restoration that occurs inside or near the bankfull channel. The sediment plume from activities will be most concentrated in the immediate project area and should dissipate within a few hours. The increased stream turbidity may deposit fine sediment on substrate a short distance downstream, encourage fish to move downstream, and alter behavior patterns for a short time. It is anticipated that all project related sediment will be flushed out during the first high flows after project completion. Project design features are expected to prevent sediment inputs from persisting into the future, therefore, long-term negative impacts from sediment are not expected. Stream restoration activities will provide immediate and long-term benefits to sensitive fish habitat such as decreased direct sediment inputs from unstable banks or headcuts, increased habitat complexity and thermal refugia, and improved riparian areas and stream shading.

Potential long-term benefits from improved watershed, riparian and stream habitat would contribute to species viability and stability while reducing potential impacts from uncharacteristic fire. While negative effects are mitigated for most activities, short term effects from ML-1 roads, low water crossings and stream restoration would have short term effects to individuals and habitat, but long-term benefits in improved habitat quality. Therefore, the determination for desert sucker, Sonoran sucker, Little Colorado sucker, headwater chub, and roundtail chub is may impact individuals or habitat, but would not likely contribute toward federal listing or loss of viability to the population or species for alternatives 2 and 3.

Northern leopard frog

Similar to the discussion above for Chiricahua leopard frog, of alternatives 2 or 3 would have long term benefits and short-term adverse effects to northern leopard frog. Mechanical thinning and prescribed burning are proposed within frog dispersal habitat and within the species action area. Project design features are expected to minimize potential adverse effects of vegetation management from increased sedimentation and reduce hiding cover, particularly spreading out treatments spatially and temporally to reduce overall impact and allow reestablishment of ground cover. Design criteria specific to leopard frogs also reduce the potential for harm or harassment in the form of displacement, injury, or death from vegetation management activities. Mechanical thinning in frog habitat would not occur in AMZs within 3 days of a rain event to reduce potential harassment or harm when frogs are most likely to disperse. These mitigations reduce the potential for harm to individual frogs when they are most likely to disperse. Long term benefits of vegetation management include reduce risk of uncharacteristic fire and improved watershed condition.

Opening of ML-1 roads and associated low water crossings pose the highest potential for negative effects to northern leopard frogs and their habitat. Up to 14 miles of ML-1 roads could be utilized and an associated 28 low water crossings added within northern leopard frog habitat throughout the life of the project. An additional 122 miles of ML-1 roads be opened outside of frog habitat, but within the action area. Roads and crossings actively produce sedimentation through vehicular disturbance or road maintenance activities and passively through erosion of the disturbed banks forming the sides of crossings. Action area subwatersheds have an average riparian condition of fair and all have poor ratings for the specific roads and trails indicator. This can mean either high open road density, maintenance costs, and/or proximity to water in the baseline. Design features and roads best management practices are expected to reduce sedimentation, but some of the ML-1 roads are along perennial or intermittent

drainage bottoms in multiple areas have a higher potential for increased sedimentation, and reduced cover. Similarly, multiple low water crossings could occur on the same stream creating additive impacts. Use of ML-1 roads and crossings can impact frogs short-term by altering water quality, increasing sedimentation into streams, and reducing herbaceous or woody cover. These lead to altered riparian and terrestrial habitat conditions, reduced algal and macroinvertebrate food resources for tadpoles, reduced foraging and basking habitat, and reduced survival. Design features for low water crossings would mitigate potential sedimentation during that time they were in use but could lead to behavioral changes (avoidance) or possible harm or harassments to dispersing frogs in the form of displacement, injury, or death. While not all ML-1 roads or crossings would be utilized at the same time, those within the same area (timber sale or burn unit) would be. The incremental increases to the roads and crossings baseline would indicate the potential for measurable increased sedimentation during use and short-term negative effects to northern leopard frog

Short term adverse effects and long-term benefits to northern leopard frog are expected from stream restoration activities. Stream restoration is proposed in 23 miles of frog dispersal habitat with the potential for three miles are heavy mechanical treatments which have the potential to displace or harm individuals. General stream restoration activities have the potential to disturb individuals but is not overly ground disturbing nor leads to removal of vegetation used for hiding cover or thermoregulation. Construction activities associated with heavy mechanical methods would also disturb individuals and could result in a flight response, possibly resulting in harassment, injury, or death. Similar effects could also occur from heavy machinery working next to the stream bank or in the stream. Stream restoration implemented during the frog activity period provides an opportunity for frogs to escape machinery. Design features provide for biologist to be involved in pre-planning of all treatments in aquatic systems and requires early interagency coordination to identify survey needs and disposition of frogs or found during implementation which are expected to minimize potential harm, but it exists. Heavy mechanical stream restoration can cause plumes of sediment causing increased turbidity and embeddedness during implementation, those impacts are short lived and dissipate after the first high flow event. Beneficial effects on improved instream habitat and habitat complexity are almost immediate. Potential long-term benefits in frogs from improved watershed, riparian and stream habitat could contribute to species viability while reducing potential impacts from uncharacteristic fire.

Potential long-term benefits in frog habitat from improved watershed, riparian and stream habitat could contribute to species viability while reducing potential impacts from uncharacteristic fire and directly improving habitat. Therefore, the determination for northern leopard frog is may impact individuals or habitat but would not likely contribute toward federal listing or loss of viability to the population or species for alternatives 2 and 3.

Aquatic macroinvertebrates

Short term adverse effects could result to sensitive aquatic macroinvertebrates or their habitats could occur from alternatives 2 and 3. Project design features are expected to minimize potential adverse effects of vegetation management activities, particularly spreading out treatments in space and time to reduce overall impact and allow reestablishment of ground cover. Additional design features in AMZs further reduce potential ground disturbance and loss of riparian or wetland vegetation. Because of implementation of project design criteria, no meaningfully measurable effects are expected. Long term benefits of thinning and burning include reduce risk of uncharacteristic fire and improved watershed condition.

Opening ML-1 roads and associated low water crossings within species habitats could have short term adverse effects under alternatives 2 and 3. Road crossings actively produce sedimentation through vehicular disturbance or road maintenance activities and passively through erosion of the disturbed banks

forming the sides of crossings. Increased sedimentation to streams can reduce water quality and reduced habitat quality while roads and crossings were being used. While not all ML-1 roads or crossings would be utilized at the same time, they have the potential for short term adverse effects to stream habitat.

Stream restoration could have short term adverse and beneficial effects to sensitive aquatic macroinvertebrates under alternatives 2 and 3. General stream restoration methods are expected to have only beneficial effects due to lack of ground or vegetation disturbance. Long term benefits of these actions would also occur from plantings and fencing. Heavy mechanical stream restoration would have adverse effects during implementation to species and habitat. The sediment plume from activities will be most concentrated in the immediate project area and should dissipate within a few hours. The increased stream turbidity may deposit fine sediment on substrate a short distance downstream, encourage invertebrates to move downstream, and alter behavior patterns for a short time. It is anticipated that all project related sediment will be flushed out during the first high flows after project completion. Project design features are expected to prevent sediment inputs from persisting into the future, therefore, long-term negative impacts from sediment or reduced habitat quality are not expected. Stream restoration activities will provide immediate and long-term benefits to habitat such as decreased direct sediment inputs from unstable banks or headcuts, increased habitat complexity and improved riparian areas.

Potential long-term benefits from improved watershed, riparian and stream habitat would contribute to species viability and stability while reducing potential impacts from uncharacteristic fire. While negative effects are mitigated for most activities, short term effects from ML-1 roads, low water crossings and stream restoration would have short term effects to individuals and habitat, but long-term benefits in improved habitat quality. Therefore, the determination for sensitive aquatic macroinvertebrates is may impact individuals or habitat but would not likely contribute toward federal listing or loss of viability to the population or species for alternatives 2 and 3.

Aquatic macroinvertebrates as a management indicator on the Tonto National Forest would have the effects as described above. According to the draft Tonto Land Management Plan, there are 700 miles of perennial streams within the Forest boundary. Approximately 217 miles (30%) of those perennial streams are within the Rim Country project area comprising a measurable habitat area for aquatic macroinvertebrates. Based on available information, 80% of streams are meeting state and LRMP standards. Alternatives 2 and 3 would result in increased habitat quality long term in up to 30% of available habitat from stream restoration and reduced risk of uncharacteristic fire which would contribute to the current forest-wide trend. Therefore, the determination is may impact individuals or habitat, but would not likely contribute toward federal listing or loss of viability to the population or species for alternatives 2 and 3.

Table 55. Threatened, endangered, Region 3 sensitive, and Tonto National Forest management indicator species with effects determinations by alternative.

Aquatic species	Status[1]	Alternative 1 (no action)[2]	Alternatives 2 and 3[3]
Gila trout	T	NE	LAA-BE
Gila chub and critical habitat	E/ D	NE	NE
Gila topminnow	E	NE	NLAA-BE
Little Colorado spinedace	T	NE	LAA-BE
Little Colorado spinedace critical habitat	D	NE	LAA-BE
Loach minnow critical habitat	D	NE	NLAA-BE
spikedace	E	NE	NLAA-BE
spikedace critical habitat	D	NE	NLAA-BE

Aquatic species	Status[1]	Alternative 1 (no action)[2]	Alternatives 2 and 3[3]
narrow-headed gartersnake	T	NE	LAA-BE
narrow-headed gartersnake	S	NI	MIIH - BI
narrow-headed gartersnake critical habitat	P	NE	NLAM-BE
Chiricahua leopard frog	T	NE	LAA-BE
Chiricahua leopard frog critical habitat	D	NE	LAA-BE
desert sucker	S	NI	MIIH - BI
Sonoran sucker	S	NI	MIIH - BI
Little Colorado sucker	S	NI	MIIH - BI
headwater chub	S	NI	MIIH - BI
roundtail chub	S	NI	MIIH - BI
northern leopard frog	S	NI	MIIH - BI
roundtail chub	S	NI	MIIH - BI
A net-winged midge	S	NI	MIIH - BI
A stonefly	S	NI	MIIH - BI
Parker's cylloepus riffle beetle	S	NI	MIIH - BI
A mayfly (*Fallceon eatoni*)	S	NI	MIIH - BI
A mayfly (*Moribaetis mimbresaurus*)	S	NI	MIIH - BI
A caddisfly (*Lepidostoma apache*)	S	NI	MIIH - BI
A caddisfly (*Lepidostoma knulli*)	S	NI	MIIH - BI
A caddisfly (*Limnephilus granti*)	S	NI	MIIH - BI
Ferris' copper butterfly	S	NI	MIIH - BI
Nokomis fritillary	S	NI	MIIH - BI
California floater	S	NI	MIIH - BI
Aquatic macroinvertebrates	MIS	NI	MIIH - BI

1. Status: E = endangered, T = threatened, D = designated, P = proposed, S = sensitive, MIS = management indicator species.
2. Alternative 1 effects: NE = no effect, NI = no impact
3. Alternative 2 & 3 effects: NLAA = may affect, not likely to adversely affect; LAA = may affect, likely to adversely affect; BE = beneficial effect; MIIH = may impact individuals or habitat, but would not likely contribute toward federal listing or loss of viability to the population or species; BI = beneficial impact.

Required Monitoring

Monitoring would be conducted as appropriate for a specific action, both during and after a project, to track effects and compliance with this analysis:

A qualified, permitted biologist will be on site during heavy equipment construction activities to attempt to protect leopard frogs or narrow-headed gartersnakes and/or key habitat features during construction. This will occur within frog dispersal areas or critical habitat for construction zones in the following project types:

• Fish Passage Restoration
• Large Wood, Boulder, and Gravel Placement

• Legacy structure removal or maintenance
• Channel Reconstruction/Relocation
• Off- and Side-Channel Habitat Restoration
• Streambank Restoration
• Set-back or Removal of existing berms for aquatic restoration

Land Management Plan Amendment Environmental Consequences – By Alternative or in a summary

There are three project level amendment exceptions proposed as part of Rim Country for the Tonto NF Land and Resource Management Plan. These exceptions are for Mexican spotted owl, northern goshawk and slope restrictions.

The Mexican spotted owl (MSO) exception would update the Tonto Land Management Plan, so it is consistent with the 2012 MSO recovery plan, which the Apache-Sitgreaves and Coconino Land Management Plans already incorporate. This exception updated definitions, language, and treatments within MSO habitat. It does not impact the analysis for aquatic species or habitats for any alternative.

The goshawk exception would update guidance and direction in the Tonto Land Management Plan, so it is consistent with the Apache-Sitgreaves and Coconino NFs revised Land Management Plan management direction. This exception does not impact the analysis for aquatic species or habitats for any alternative.

The slope restrictions exception would remove language from the Tonto Land Management Plan restricting mechanical equipment to slopes less than 40 percent as well as removing language that identifies those slopes as inoperable. Rim Country proposed the use of specialized mechanical equipment to restore steep slopes. The acreages of mechanical vegetation treatments analyzed for aquatic species and habitats includes steep slopes with specialized equipment only for both action alternatives across all three Forests.

Summary

Degree to Which the Purpose and Need for Action is Met

The purpose and need in relation aquatic resources includes restoring riparian and aquatic habitats (riparian condition). Mechanical vegetation treatments and prescribed burning address that need by improving watershed condition and reducing the risk of uncharacteristic wildfire. Stream restoration actions specifically address that need by directly improving these habitats which should lead to improved aquatic habitat and populations. Alternatives 2 and 3 have the potential to improve riparian and stream conditions for all aquatic threatened, endangered, sensitive, and management indicator species within the project area. Alternative 1 would not improve watershed condition or reduce the risk of uncharacteristic wildfire which is threat to all aquatic species and habitats. It would not restore any aquatic habitat, therefore current riparian condition would remain the same or be reduced by encroachment, wildfire, or climate change.

Degree to Which the Alternatives Address the Issues

Aquatic species and/or habitats was not an issue identified during scoping.

Summary of Environmental Effects

Effects of the Rim Country Project on threatened, endangered, Region 3 sensitive, and management indicator species using resource indicators and an assessment of actions occurring within species habitats

as compared to within their action areas. Table 56 shows a summary of the effects to resource indicators from each activity by alternative.

Negative or Neutral Effects

For both action alternatives, short term negative effects to riparian condition, harm to individuals and modification of behavior from vegetation management activities. Design features are expected to minimize negative effects to the point where they are not measurable. Associated activities of in woods processing would have short term negative effects to riparian condition.

Opening ML-1 roads and associated low water crossings would cause short term negative impacts to riparian condition, harm to individuals and modification of behavior elements while the roads were in use. Given the number of potential ML-1 roads and crossings within species habitats, these activities will have negative effects to riparian condition and habitat connectivity. These activities would also have negative effects to aquatic threatened, endangered, sensitive, and management indicator species.

Aquatic restoration actions and road improvements would result in short-term negative effects to riparian condition, instream aquatic habitat, and harm to individuals. It would also have negative effects to aquatic threatened, endangered, sensitive, and management indicator species. The effects would be minimized through implementation of a thorough set of project design criteria developed by the interdisciplinary team, partners and stakeholders.

As long as project design features are implemented and monitored, there would be neutral effects from pollutants, invasive species, and disease from any of the proposed activities.

Use and expansion of rock pits would have a neutral effect on all indicators due to distance from aquatic habitats.

Positive Effects

Road improvements would have a positive and meaningfully measurable effect to riparian condition from road decommissioning and relocation. The Rim Country project would restore upland and riparian forest health and processes and introduce disturbance related fire effects. Alternative 2 would restore more acres as compared to alternative 3 and therefore has more potential benefits to aquatic resources. Aquatic and watershed restoration activities would restore riparian processes and functions resulting in a strong positive effect on resource indicators and aquatic threatened, endangered, sensitive, and management indicator species the same for alternatives 2 and 3.

Table 56. Summary comparison of environmental effects to aquatic resources.

Resource Element	Indicator	Alternative 1	Alternative 2	Alternative 3
Acres of Mechanical Vegetation Treatments				
Habitat Quality Habitat Quantity Impacts to Individuals	Riparian Condition Modification of Behavior Harm of individuals Pollutants, Invasive Species	No potential for short term negative effects to riparian condition, modification of behavior, harm to individuals, and introduction of pollutants or invasive species.	Short term negative impacts from mechanical vegetation treatments on riparian condition, modification of behavior, harm to individuals and introduction of pollutants or invasive species.	Same as alternative 2, but less potential effects from only 468,750 acres of mechanical vegetation treatments

Resource Element	Indicator	Alternative 1	Alternative 2	Alternative 3
		Long term neutral or negative effects by not restoring vegetation toward desired conditions, riparian and watershed condition with remain the same or degrade and the risk of uncharacteristic wildfire to aquatic resources remains.	Design features would minimize or mitigate most negative impacts to resource indicators. 876,510 acres of vegetation treatments will promote or improve riparian and watershed condition long term. The risk for uncharacteristic wildfire is reduced across all treated acres.	
Acres of Prescribed Burning				
Habitat Quality Habitat Quantity Impacts to Individuals	Riparian Condition Modification of Behavior Harm of individuals Pollutants, Invasive Species	No potential for short term negative effects to riparian condition, modification of behavior, harm to individuals, and introduction of pollutants or invasive species. Long term neutral or negative effects by not restoring vegetation to desired conditions and restoring the fire regime, riparian and watershed condition will remain the same or degrade and the risk of uncharacteristic wildfire to aquatic resources remains.	Short term negative impacts from prescribed fire to riparian condition, modification of behavior, harm to individuals and introduction of pollutants or invasive species. Design features would minimize or mitigate most negative impacts to resource indicators. 991,060 acres of prescribed burning will promote or improve watershed and riparian condition long term.	Same as Alternative 2, but less potential effects from only 528,850 acres of prescribed fire.
Miles of Open ML-1 Roads, Temporary Roads, and Low water crossings				
Habitat Quality Habitat Quantity	Riparian Condition Habitat Connectivity Pollutants, Invasive Species	Neutral effects to riparian condition, modification of behavior, harm to individuals, and introduction of pollutants or invasive species.	Short term negative impacts from opening up to 2,184 miles of ML-1 roads and associated low water crossings, and 330 miles of temporary roads to riparian condition, habitat connectivity, and introduction of pollutants or invasive species.	Same as Alternative 2, but slightly fewer potential effects to indicators with only 170 miles of temporary roads.

Resource Element	Indicator	Alternative 1	Alternative 2	Alternative 3
			Design features would reduce but not eliminate negative impacts to resource indicators.	
Acres of In Woods Processing Sites				
Habitat Quality Habitat Quantity	Riparian Condition	Neutral effects to riparian condition.	Short term negative effects in riparian condition. Design features would minimize negative impacts to resource indicators.	Same as Alternative 2.
Acres of Rock Pits				
Habitat Quality Habitat Quantity	Riparian Condition	Neutral effects to riparian condition.	Neutral effects riparian condition. Design features would mitigate or eliminate negative impacts to resource indicators.	Same as Alternative 2.
Miles of General and Heavy Mechanical Stream Restoration				
Habitat Quality Habitat Quantity Impacts to Individuals	Riparian Condition Instream Aquatic Habitat Harm of Individuals Pollutants, Invasive Species	Neutral or long term negative effects to riparian condition, instream aquatic habitat, harm to individuals, and introduction of pollutants or invasive species. Riparian condition and instream aquatic habitat would be maintained at current levels of fair or poor and potentially degrade further over time.	Short term impacts to riparian condition, instream aquatic habitat, harm to individuals. Pollutants, invasive species, and disease would be neutral. Design features would minimize or mitigate most negative impacts to resource indicators. Long term beneficial impacts of improved riparian condition and instream aquatic habitat.	Same as Alternative 2.
Road Improvements (Decommissioning and Relocation)				
Habitat Quality Habitat Quantity Impacts to Individuals	1. Riparian Condition 3. Harm of Individuals	No potential for short to term negative effects to riparian condition or harm to individuals. There would be no decrease in road density or improvement of riparian condition from	Short term impacts to riparian condition from sediment input and harm to individuals from decommissioning up to 200 miles of roads and relocating any roads affecting aquatic resources. Design features would minimize or mitigate most	Same as Alternative 2.

Resource Element	Indicator	Alternative 1	Alternative 2	Alternative 3
		decommissioning or relocating roads.	negative impacts to resource indicators. Long term benefits of improved riparian condition, habitat connectivity and watershed condition from reducing road density, sedimentation, and peak flows. Reduced harm to individuals from roads moved out of species habitat.	

Compliance with LMP and Other Relevant Laws, Regulations, Policies and Plans

Compliance with the plan components of LMPs (Coconino and Apache-Sitgreaves NFs) and LRMP (Tonto NF) is addressed below under Land Management Plan Consistency as well as Appendix D. This Specialist Report along with the associated Biological Evaluation, Biological Assessment and Section 7 consultation under the Endangered Species Act (as amended) fulfill compliance with other laws, regulations, and policies for planning purposes.

Other Relevant Mandatory Disclosures

Required Permits

Any biologists conducting species surveys or monitoring are required to have a federal recovery permit and a state collecting license.

Irreversible and Irretrievable Commitments of Resources

Irreversible and irretrievable commitments of resources will occur for the use and expansion of rock pits. Mineral extraction from rock pits is irreversible as it inherently consumes nonrenewable resources, or a resource than can only be renewed over a long period of time. For aquatic species and habitats, this will not relate to any effects. Pits do not occur within species habitats and are more than ½ mile away from those habitats. Therefore, any potential increase in sedimentation within species action areas is not expected to occur.

Land Management Plan Consistency

NFMA requires that projects and activities be consistent with the governing Land Management Plan (16 USC 1604 (i)).

Desired Conditions – to be consistent with the DCs of the plan, a project or activity, when assessed at the appropriate spatial scale described in the plan (e.g., landscape scale), must be designed to meet one or more of the following conditions:

- Maintain or make progress toward one or more of the DCs of a plan without adversely affecting progress toward, or maintenance of, other DCs; or
- Be neutral with regard to progress toward plan DCs; or
- Maintain or make progress toward one or more of the DCs over the long term, even if the project or activity would adversely affect progress toward or maintenance of one or more DCs in the short term; or
- Maintain or make progress toward one or more of the DCs over the long term, even if the project or activity would adversely affect progress toward other DCs in a negligible way over the long term.

The action alternatives (Alternative 2 & 3) are consistent with the Land Management Plan Desired Conditions as they will either make progress towards DCs or be neutral in regard to some DCs. The condition-based management outlined addresses resource issues and concerns brought forward by the IDT and incorporated project design features to meet those needs where feasible. The proposed activities are designed to either be neutral toward DCs or minimize short-term negative impacts to DCs and progress toward DCs long-term. Land Management Plan consistency is documented for all plan components relative to aquatic species and habitat in the project record.

Standards are constraints upon a project/activity. A project/activity must be consistent with all standards applicable to the type of project or activity and its location in the plan area. A project is consistent with a standard in only one way: It is designed in exact accord with the standard.

Guidelines – a project or activity is consistent with a guideline in either of two ways:

1. The project or activity is designed exactly in accord with the guideline; or

2. A project or activity design varies from the exact words of the guideline, but it is as effective in meeting the purpose of the guideline to contribute to the maintenance or attainment of the relevant desired conditions or objectives.

Other Agencies and Individuals Consulted

Arizona Game and Fish Department: provided geospatial species occurrences and survey reports, review of species occurrence geospatial data created for project, workshops to test the Aquatic and Watershed Condition Based Management.

Yvette Paroz, Regional Fisheries Program Manager, USDA Forest Service, Region 3: assistance with development of Aquatic and Watershed Condition Based Management, review of species occurrence geospatial data created for project, project design features and review of specialist report.

Ernie Taylor, District Ranger, USDA Forest Service, Region 3: assistance with development of circumstances table in the Aquatic and Watershed Condition-based management, and review of specialist report.

David R. Smith (retired), U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office: assistance with development of the aquatic and watershed condition-based management and stream restoration guidance.

Shaula J. Hedwall, U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office: assistance with development of the aquatic and watershed condition-based management, species occurrence, project design features, stream restoration guidance, and integration guidance.

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Appendix A. Plan Components from Forest Land Management Plans applicable to aquatic and riparian habitats.

Land Management Plan Section	Standard (ST), and Guideline (GL).
Apache-Sitgreaves National Forests	
Water Resources	**GL:** Projects with ground-disturbing activities should be designed to minimize long and short term impacts to water resources. Where disturbance cannot be avoided, project specific soil and water conservation practices and best management practices (BMPs) should be developed. **GL:** Streams, stream banks, shorelines, lakes, wetlands, seeps, springs, and other bodies of water should be protected from detrimental changes in water temperature and sediment to protect aquatic species and riparian habitat. **GL:** Aquatic management zones should be in place between streams and disturbed areas and/or road locations to maintain water quality and suitable stream temperatures for aquatic species. **GL:** To protect water quality and aquatic species, heavy equipment and vehicles driven into a water body to accomplish work should be completely clean of petroleum residue. Water levels should be below the gear boxes of the equipment in use. Lubricants and fuels should be sealed such that inundation by water should not result in leaks.
Aquatic Habitat and Species	**ST:** When drafting (withdrawing) water from streams or other water bodies, measures will be taken to prevent entrapment of fish and aquatic organisms and the spread of parasites or disease (e.g., Asian tapeworm, chytrid fungus, whirling disease). **GL:** Management activities should not contribute to a trend toward the Federal listing of a species. **GL:** Activities occurring within federally listed species habitat should apply habitat management direction and species protection measures from recovery plans. **GL:** To prevent degradation of native species habitat and the incidental or accidental introduction of diseases or nonnative species, aquatic species should not be transferred through management activities from one 6th level HUC watershed to another. **GL:** Sufficient water should be left in streams to provide for aquatic species and riparian vegetation. **GL:** Projects and activities should avoid damming or impounding free-flowing waters to provide streamflows needed for aquatic and riparian-dependent species. **GL:** The needs of rare and unique species associated with wetlands, fens, bogs, and springs should be given priority consideration when developing these areas for waterfowl habitat and other uses.
All PNVTs	**ST:** Vegetation treatments shall include measures to reduce the potential for introduction of invasive plants and animals and damage from nonnative insects and diseases. **GL:** During project design and implementation, precautions should be taken to reduce the potential for damage to residual vegetation in order to prevent premature or excessive mortality. **GL:** Landscape scale restoration projects should be designed to spread treatments out spatially and/or temporally within the project area to reduce implementation impacts and allow reestablishment of vegetation and soil cover.

	GL: Restoration methods, such as thinning or prescribed fire, should leave a mosaic of untreated areas within the larger treated project area to allow recolonization of treated areas by plants, small mammals and insects (e.g. long-tailed voles, fritillary butterflies). **GL:** Projects should include quantitative and/or qualitative objectives for implementation monitoring and effectiveness monitoring to assist in moving toward or maintaining desired conditions.
Riparian Areas	**GL:** Ground-disturbing projects (including prescribed fire) which may degrade long term riparian conditions should be avoided. **GL:** Wet meadows, springs, seeps and cienegas should not be used for concentrated activities (e.g. equipment storage, forest product or mineral stockpiling, livestock handling facilities, special uses) that cause damage to soil and vegetation. **GL:** Storage of fuels and other toxicants should be located at least 100 feet outside of riparian areas to prevent spills that could impair water quality or harm aquatic species. **GL:** Equipment should be fueled or service areas should be located at least 100 feet outside of riparian areas to prevent spills that could impair water quality or harm aquatic species. **GL:** Construction or maintenance equipment service areas should be located at least 100 feet from riparian areas, and treated to prevent gas, oil, and other contaminants from washing or leaching into streams.
Ponderosa Pine and Dry Mixed Conifer	**GL:** Where consistent with project or activity objectives, canopy cover should be retained on the south and southwest sides of small, existing forest openings that are naturally cooler and moister. These small (generally one-tenth to one-quarter acre) shaded openings provide habitat conditions needed by small mammals, plants, and insects (e.g., Merriam's shrew, Mogollon clover, four-spotted skipperling butterfly). Where these openings naturally occur across a project area, these conditions should be maintained on an average of 2 or more such openings per 100 acres.
Wildlife and Rare Plants	**GL:** Modifications, mitigations, or other measure should be incorporated to reduce negative impacts to plants, animals, and their habitats and to help provide for species needs, consistent with project activity or objectives. **GL:** Rare and unique features (e.g. talus slopes, cliffs, canyon slopes, caves, fens, bogs, sinkholes) should be protected from damage or loss in order to maintain their distinctive ecological functions and maintain viability of associated species. **GL:** The needs of localized species (e.g. New Mexico meadow jumping mouse, Bebb willow, White Mountains paintbrush) should be considered and provided for during project activities to ensure their limited or specialized habitats are not lost or degraded. **GL:** Constructed features should be maintained to support the purpose(s) for which they are built. Constructed features should be removed when no longer needed.
Invasive Species	**ST:** Projects and authorized activities shall be designed to reduce the potential for introduction of new species or spread of existing invasive or undesirable aquatic or terrestrial nonnative populations. **GL:** Projects and activities should not transfer water between drainages or between unconnected water bodies within the same drainage to avoid spreading disease and aquatic invasive species. **GL:** Project areas should be monitoring to ensure there is no introduction or spread of invasive species.
Overall Recreation Opportunities	**GL:** Constructed features should be maintained to support the purpose(s) for which they were built. Constructed features should be removed when no longer needed.

Motorized Opportunities	**ST:** Temporary road construction shall minimize the impacts to resource values and facilitate road rehabilitation. Temporary roads shall be rehabilitated following completion of the activities for which they were constructed. **ST:** Road maintenance and construction activities shall be designed to reduce sediment (e.g., water bars, sediment traps, grade dips) while first providing for user safety. **GL:** As projects occur in riparian or wet meadow areas, unneeded roads or motorized trails should be closed or relocated, drainage restored, and native vegetation reestablished to move these areas toward their desired condition. **GL**: As projects occur, redundant roads or motorized trails should be removed to reduce degradation of natural resources. **GL:** Roads and motorized trails removed from the transportation network should be treated in order to avoid future risk to hydrologic function and aquatic habitat. **GL:** Roads and motorized trails should be designed and located so as to not impede terrestrial and aquatic species movement and connectivity. **GL**: As projects occur, existing meadow crossings should be relocated or redesigned, as needed, to maintain or restore hydrologic function using appropriate tools such as French drains and elevated culverts. **GL:** After management activities occur in areas with high potential for cross-country motorized vehicle use, methods (e.g., barriers, signing) should be used to control unauthorized motorized use.
Nonmotorized Opportunities	**GL:** New trails and trail relocations should be designed and located so as to not impede terrestrial and aquatic species movement and connectivity. **GL:** Meadow crossings should be designed or redesigned to maintain or restore hydrologic function using appropriate tools such as French drains and elevated culverts.
Minerals and Geology	**GL:** Existing designated mineral material collection areas and community pits should be utilized to the maximum before new areas are developed. Additional mineral material development should balance private and community needs while providing for sustainable administrative use. **GL:** Abandoned mine lands or unneeded mineral material pits should be restored, closed, or rehabilitated to provide for resource protection and public health and safety. **GL:** Common variety mineral activities should not be permitted in designated or recommended special areas or Chevelon Canyon to protect the unique character of these areas.
Tonto National Forest	
Fire Management	**S&G (management areas 1F, 4D, 4F):** Use prescribed fire to treat vegetation for water yield, forage, and wildlife habitat improvement
Forestry and Forest Health	**S&G (management area 4D, 5D):** Timber sale road systems should be designed to minimize impacts on stream channels and water quality. Roads should be located on slopes less than 60%, and should have sustained gradients of less than 8%. Roads should not be located on unstable slopes where mass movement is likely to occur. **S&G (management area 4D):** An Interdisciplinary (I.D.) team will evaluate the need for buffer strips adjacent to water bodies within proposed commercial saw timber sale areas. Where a buffer strip is deemed necessary, the I.D. team will recommend the width of strip needed to achieve adequate protection of aquatic and riparian resources. The width of the buffer strip will depend upon such factors as channel stability, side-slope steepness, erodibility of soils, existing ground cover conditions, and existing aquatic conditions. Logging vehicles will not be allowed to operate within any such designated buffer strips, except at designated crossings.

	S&G (management area 4D, 5D): Slash and debris should be kept out of protected stream channels. **S&G (management area 4D, 5D):** Raise lead end of logs when skidding to minimize gouging. Restrict skidding during wet weather if necessary to prevent watershed damage. Rehabilitate skid trails and landings when logging is completed (provide drainage, repair ruts and gullies, and seed if necessary).
Rangeland Management	**S&G (management area 4D, 5D)**: Wildlife habitat improvement needs will be integrated into range forage improvement projects identified in approved AMPs. Habitat improvement opportunities will also be integrated with timber management activities.
Watershed Management	**S&G:** Cooperate fully with the State Department of Health Services (Division of Environmental Health), and with the Arizona Water Quality Control Council to reduce or eliminate pollution of the river. **S&G (Wild and Scenic River mgmt. areas):** Preserve the free-flowing condition of this river (free-flowing is defined by law as: existing or flowing in a natural condition without impoundment, diversion, straightening, rip-rapping, or other modifications of waterway). Retention of minor structures which existed at the time of designation may be permitted.
Wildlife, Fish, and Rare Plants	**S&G:** Identify, survey, map, and analyze habitat for all Federally-listed species. Identify management conflicts and enhancement opportunities. Correct any management conflicts or problems. **S&G:** Continue to clear all projects for threatened, endangered, proposed, and candidate plant and animal species. Clearances will be done by Wildlife Biologist and reviewed by Forest Biologist. **S&G:** Initiate informal or formal consultation, as required by the ESA, with the USFWS on all actions that effect T&E plant and animal species **S&G:** New additions of listed, proposed or candidate species by the US Fish and Wildlife Service will be protected. **S&G:** Maintain a minimum of 30% effective ground cover for watershed protection and forage production, especially in primary wildlife forage producing areas. Where less than 30% exists, it will be the management goal to obtain a minimum of 30% effective ground cover. **S&G:** Habitat requirements for endangered species will have precedence over threatened species. **S&G:** All Riparian Areas- Rehabilitate and maintain, through improved management practices, mixed broadleaf riparian to achieve 80% of the potential overstory crown coverage. Natural regeneration is anticipated to achieve most of this goal. Artificial regeneration may be necessary in some areas. **S&G:** Re-establish riparian vegetation in severely degraded but potentially productive riparian areas. Natural regeneration is anticipated to achieve this goal, but artificial regeneration may be necessary in some areas. **S&G:** Survey, study and assess the status of candidate species on a priority basis. Identify document and correct any management conflicts to the species or their habitats. **S&G:** Manage riparian areas to the level needed to provide protection and improvement. **S&G:** Where possible, locate roads on natural benches, ridges, flat slopes near ridges or valley bottoms, and away from stream channels. **S&G:** Where channel crossings are necessary, select an area where the channel is straight and cross the channel at right angles. **S&G:** In streams inhabited by fish, structures need to provide for fish passage. In addition, structures containing natural stream bottoms are preferred over culverts.

	S&G: Avoid channel changes or disturbance of stream channels and minimize impacts to riparian vegetation. **S&G (1996 amendments):** Riparian Areas: Emphasize maintenance and restoration of healthy riparian ecosystems through conformance with Land Management Plan riparian standards and guidelines. Management strategies should move degraded riparian vegetation toward good condition as soon as possible. Damage to riparian vegetation, stream banks, and channels should be prevented. **S&G (1996 amendments):** Basin and Range - West: Emphasize restoration of lowland riparian habitats. **S&G (1996 amendments):** Monitoring and evaluation should be collaboratively planned and coordinated with involvement from each national forest, USFWS Ecological Services Field Office, USFWS Regional Office, USDA Forest Service Regional Office, Rocky Mountain Research Station, recovery team, and recovery unit working groups. **S&G (1996 amendments):** Manage the ground surface layer to maintain satisfactory soil conditions i.e., to minimize soil compaction; and to maintain hydrologic and nutrient cycles. **S&G (1996 amendments):** When activities conducted in conformance with these standards and guidelines may adversely affect other threatened, endangered, or sensitive species or may conflict with other established recovery plans or conservation agreements; consult with the USFWS to resolve the conflict. **S&G (1996 amendments):** Manage road densities at the lowest level possible. Where timber harvesting has been prescribed to achieve desired forest condition, use small skid trails in lieu of roads.
Coconino National Forest	
Watersheds and Water	**GL:** Watersheds should have enough vegetative ground cover to recover rapidly from natural and human disturbances and to maintain long-term soil productivity. **GL:** Watershed restoration and maintenance, and vegetation treatments should focus on priority 6th code watersheds to ensure that ecosystem processes, resilient vegetation conditions, and natural disturbance regimes are functioning properly. **GL:** Best management practices for management activities should be identified, implemented, and monitored to maintain water quality, quantity, and timing of flows, and to prevent or reduce accelerated erosion. **GL:** Within existing water rights, excess water should remain in or be allowed to flow freely back into the natural channel, spring, and riparian habitat to maintain and improve ecological function, water quality, quantity, and timing of flows, and to benefit native species and their habitat.
Constructed Waters	**GL:** For new projects and management activities, a site-specific aquatic management zone should be identified and maintained around reservoirs to protect water quality and to avoid detrimental changes in water temperature or chemical composition, blockages of streamcourses, or sediment deposits that would seriously and adversely affect water conditions or aquatic habitat. Soil and vegetation disturbance from management activities should be minimized to meet this intent, but is not necessarily excluded in this zone. **GL:** Earthen stock ponds determined to be important for threatened, endangered, and Southwestern Region sensitive species, should be managed to maintain water and habitat needed for species' survival and reproduction, consistent with existing water rights.

All Riparian Areas	**GL:** Management activities such as vegetation treatments or other restoration actions should be designed to maintain or move toward desired conditions for other uses and resources. **GL:** Riparian areas should be managed to promote natural movement of water and sediment, to maintain ecological functions, and to maintain habitat and corridors for species. **GL:** An aquatic management zone should be identified and maintained in riparian areas to protect water quality and to avoid detrimental changes in water temperature or chemical composition, blockages of stream courses, or sediment deposits that would seriously and adversely affect water conditions, fish habitat, or connected downstream cave, karst, and lava tube resources. Soil and vegetation disturbance from management activities should be managed to meet these intents, but is not necessarily excluded in this zone.
Stream Ecosystems	**GL:** In perennial and intermittent riparian stream courses, projects and management activities should be designed and implemented to retain or restore natural streambank stability, native vegetation, and riparian and soil function. **GL:** An aquatic management zone for non-riparian, intermittent stream courses should be identified and maintained to reduce sedimentation, maintain functioning of the channel within its floodplain, and maintain downstream water quality and riparian habitat and function. This management zone would also avoid detrimental changes in water temperature or chemical composition; blockages of stream courses; or sediment deposits that would seriously and adversely affect water conditions, fish habitat, or connected downstream cave, karst, and lava tube resources. Soil and vegetation disturbance from management activities should be managed to meet these intents, but is not necessarily excluded in this zone.
Springs	**GL:** Spring recharge areas, where known, should be managed to maintain or improve spring discharge. **GL:** Projects and activities should be designed and implemented to maintain or improve soil and riparian function; maintain or improve native vegetation; and/or prevent the introduction or spread of disease, invasive, or undesirable species. Design features could include road, recreation, and/or livestock management. **GL:** Where there is a structure in place to use water from a spring as a water source or when designing restoration projects, priority should be given to the protection of spring source areas and riparian habitat to safeguard the unique ecological and biophysical characteristics, higher biodiversity, endemic species, and cultural values associated with spring sources. For example, water could be piped out of the riparian area to avoid negative impacts to soil, water, and vegetation or if water is to be diverted, a flow-splitter could be installed to maintain some flow at the source.
Riparian Forest Types	**GL:** Connectivity within the unique vegetation community created by the combination of lower elevation riparian forests, and mesquite bosques should be maintained and enhanced. The intent is to maintain ecological functions, tree density, and growth, native understory, and reduce the risk of predation and nest parasitism and to provide habitat for western yellow-billed cuckoo, Bell's vireo, and other wildlife species. **GL:** In riparian forests, recreation activities, permitted uses, and management activities should occur at levels that maintain or allow improvement of soil function, riparian

	vegetation, and water quality at the stream reach scale. This guideline would not apply to fine-scale activities and facilities such as intermittent livestock crossing locations, water gaps, or other infrastructure used to manage impacts to riparian areas at a larger scale. **GL:** Fire wood cutting or wood removal should be managed in remaining mesquite bosques to avoid impacts to understory species, tree density, tree growth, and to avoid channel downcutting and accelerated erosion.
Wildlife, Fish and Plants	**ST:** Direction for species listed as threatened, endangered, proposed, or candidate takes precedence over direction for species not listed by the U.S. Fish and Wildlife Service. **ST:** Timing restrictions will be applied to projects and activities that have the potential to negatively affect federally listed species, bald eagles, and golden eagles to minimize or avoid impacts to survival or successful reproduction. **GL:** Habitat management objectives and species protection measures from approved recovery plans should be applied to activities occurring within federally listed species habitat to promote recovery of the species. **GL:** To improve the status of species and prevent Federal listing, management activities should comply with species conservation agreements, assessments, strategies, or national guidelines. **GL:** Projects and management activities should be designed or managed to maintain or improve habitat for native species and to prevent or reduce the likelihood of introduction or spread of disease. **GL:** Project design should include measures to minimize the negative impact of pesticides, herbicides, or chemicals to species and their habitat. For example, chemical-free buffers could be placed around bat roosts, riparian or aquatic habitat. **GL:** Structural improvements should be planned and managed to provide wildlife with safe use of water, and to allow safe passage for wildlife prone to movement restrictions, such as pronghorn. For example, the bottom wire of fences should be smooth and at least 18 inches high to allow pronghorn passage. **GL:** Timing restrictions should be applied to projects and activities that potentially negatively affect Southwestern Region sensitive species and pronghorn. The intent is to minimize or avoid impacts to survival or successful reproduction. **GL:** Projects and management activities should be designed and implemented to maintain refugia and primary life cycle needs of Southwestern Region sensitive species and to protect and provide for narrowly endemic species and species with restricted distributions where they are likely to occur. **GL:** Established protocols should be followed to prevent the introduction and spread of disease, such as chytrid fungus (*Batrachochytrium dendrobatidis*) that kills amphibians. **GL:** New road and new trail locations should be designed to maintain species access to adjoining habitat, to maintain habitat for dispersal and migration, and to meet species' life history requirements, including fawning habitat for pronghorn.
Invasive Species	**GL:** Measures should be incorporated into authorized activities, project planning, and implementation to prevent, control, contain, and eradicate priority infestations or

	populations of invasive species to ensure the integrity of native species populations and their habitats is maintained. **GL:** Integrated pest management approaches and other treatments to control invasive species should be used to improve watershed condition and maintain ecosystem function while minimizing project impacts on native species.
Roads and Facilities	**GL:** Roads should be located, designed, and maintained to move toward or maintain desired conditions for other uses and resources. **GL:** Soil and water BMPs should be implemented to protect water quality while designing, constructing, reconstructing, or relocating new and existing roads, parking areas and pullouts. For example, permanent and temporary road construction and relocation should: • Occur outside of streamcourses and aquatic management zones, except where crossing is required. • Avoid wetlands, springs, seasonally wet meadows, and montane meadows. • Avoid soils that are unstable and highly erodible where connected to streamcourses. **GL:** Existing roads should be used or realigned before new roads are constructed to avoid areas where disturbance-sensitive threatened and endangered species are present. **GL**: For projects where long-term access is not needed, temporary roads should be used and naturalized in a timely manner. The intention is to have the road footprint, and potential impacts from road use, such as possible introduction of invasive species, modification of scenic integrity objectives, or increased sedimentation into connected waters, on the landscape for as short a time as possible. **GL:** Bridges, culverts, stream crossings on permanent roads, and diversion structures should be designed to allow safe passage for aquatic organisms. Passage barriers are acceptable when needed to physically separate native and non-native species.
Trails and Trailheads	**GL:** Trails and trailheads should be designed, built, rerouted, or maintained utilizing current best practices that promote sustainable trail surfaces, prevent conflicts with neighboring lands, address impacts to other resources, and consider user experiences. **GL:** Unplanned, user-created trails should be managed to prevent future access. Resources damaged by unplanned, user-created trails should be rehabilitated to accelerate recovery and to prevent further resource impacts.

Appendix B: Watershed Condition Framework aquatic habitat indicators by subwatershed.

Subwatershed	Aquatic Physical Habitat	Aquatic Biota	Aquatic Riparian/ Wetland Vegetation	Water Quality	Roads & Trails
Barbershop Canyon	Fair	Poor	Poor	Good	Good
Bear Canyon	Fair	Poor	Poor	Good	Fair
Buckskin Wash	Poor	Fair	Fair	Fair	Fair
Bull Flat Canyon	Poor	Fair	Fair	Poor	Fair
Bull Tank Canyon-Tonto Creek	Poor	Fair	Poor	Poor	Fair
Buzzard Roost Canyon	Fair	Fair	Fair	Good	Poor
Canyon Creek Headwaters	Fair	Poor	Fair	Good	Fair
Christopher Creek	Poor	Poor	Poor	Poor	Poor
Crouch Creek	Fair	Fair	Fair	Good	Fair
Double Cabin Park-Jacks Canyon	Fair	Good	Fair	Fair	Poor
Durfee Draw-Chevelon Canyon	Good	Poor	Good	Good	Fair
East Clear Creek-Blue Ridge Reservoir	Fair	Poor	Poor	Good	Fair
East Clear Creek-Clear Creek	Fair	Poor	Fair	Good	Poor
East Verde River Headwaters	Poor	Fair	Poor	Good	Poor
Echinique Draw-Clear Creek	Good	Poor	Good	Good	Good
Ellison Creek-East Verde River	Good	Fair	Fair	Good	Poor
Gentry Canyon-Canyon Creek	Fair	Good	Poor	Fair	Poor
Gentry Canyon-Upper Clear Creek	Poor	Good	Fair	Good	Poor
Gordon Canyon	Poor	Fair	Poor	Good	Poor
Green Valley Creek	Fair	Good	Poor	Fair	Poor
Gruwell Canyon-Cherry Creek	Poor	Fair	Poor	Good	Poor
Haigler Creek	Fair	Fair	Fair	Good	Poor
Horton Creek-Tonto Creek	Fair	Poor	Fair	Fair	Poor
Houston Creek	Fair	Fair	Poor	Poor	Poor
Leonard Canyon	Poor	Poor	Poor	Good	Fair
Long Tom Canyon-Chevelon Canyon	Good	Poor	Good	Good	Poor
Lower Willow Creek	Fair	Poor	Fair	Good	Fair
Miller Canyon	Good	Fair	Poor	Fair	Fair
Mormon Laake	Fair	Fair	Good	Fair	Poor
Parallell Canyon – Cherry Creek	Good	Poor	Poor	Fair	Poor
Pine Creek	Poor	Fair	Poor	Good	Good
Red Tank Draw	Poor	Poor	Fair	Poor	Good
Rock Creek-East Verde River	Fair	Fair	Fair	Fair	Poor
Rock Creek-Spring Creek	Fair	Fair	Fair	Fair	Poor
Upper Chevelon Canyon-Chevelon Canyon Lake	Poor	Poor	Good	Good	Fair
Upper East Verde River	Fair	Fair	Fair	Poor	Fair
Upper Fossil Creek	Good	Fair	Good	Fair	Fair
Upper Phoenix Park Wash	Poor	Fair	Fair	Fair	Fair
Upper Salome Creek	Fair	Fair	Fair	Good	Poor

Subwatershed	Aquatic Physical Habitat	Aquatic Biota	Aquatic Riparian/ Wetland Vegetation	Water Quality	Roads & Trails
Upper Spring Creek	Fair	Fair	Fair	Good	Poor
Upper West Chevelon Canyon	Fair	Fair	Poor	Fair	Fair
Upper West Clear Creek	Good	Fair	Good	Good	Fair
Upper Willow Creek	Poor	Poor	Fair	Poor	Poor
Upper Woods Canyon	Fair	Fair	Poor	Fair	Poor
Webber Creek	Fair	Fair	Fair	Fair	Poor
Wilkins Canyon	Fair	Good	Poor	Good	Fair
Workman Creek	Good	Poor	Good	Good	Poor

Appendix C. Condition-based Management Approach for Aquatics and Watershed Restoration Treatments

The Rim Country project area encompasses over 1.2 million acres ranging in elevation from around 4,300 to 8,850 feet and includes 11 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 and 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.

Seeps, springs, wet meadows, riparian areas, and Emory oak groves are all places that may have cultural significance for tribal communities and could be sensitive for cultural resources. Input from tribes and heritage program staff should be solicited during project design and before project implementation.

Conditions within these watershed and aquatic systems range from relatively pristine to highly impacted. There are legacy impacts from timber management, fire suppression, 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.

Areas for potential aquatic and riparian restoration were identified using Riparian Mapping (RMAP) layers and information from Terrestrial Ecological Unit Inventory (TEUI). TEUI is a system to classify ecosystem types and map ecological units at different spatial scales. Streams that have been identified as candidate areas for stream restoration were identified spatially using factors that promote successful treatments and project design features. It was determined that most restoration techniques are more successful in lower gradient streams. In addition, many of the low gradient areas are those that have been impacted and are in need of restoration. Stream gradient was mapped using LiDAR data and averaged within reaches. Reaches based on Rosgen stream types with low (0-2 percent) and moderate (2-4 percent) stream gradient are identified for general stream treatment. A subset of those stream restoration areas where there is the potential to use large machinery were further identified as heavy mechanical treatment

areas. These were identified by the ability of machinery to access locations and design features (slope restriction). Reaches with canyon slopes more than 25 percent and further than 0.25 miles from roads were excluded from the heavy mechanical subset. In areas where restoration is needed for issues such as conifer encroachment within riparian areas, prescribed fire may be the preferred restoration method and are identified.

It is anticipated that project proposals for riparian restoration will be developed both by Forest Service personnel and by the array of partners and cooperating agencies that have developed this project. In addition to restoration projects, it is important to also focus on protecting areas with intact processes and high-quality habitat. As projects are developed, they should be developed and evaluated by appropriate professionals (for example, hydrologists, geomorphologist, biologists), regardless of whom proposes them, regarding how the project will achieve progress toward restoration goals. Projects should follow these guidelines (1) principles of watershed processes, (2) protecting existing high-quality habitats, and (3) current knowledge of the effectiveness of specific techniques (Roni et al. 2002).

There are two major drainage systems encompassed in the action area, the Little Colorado River which flows northerly, and the Salt River which flows southerly. The restoration goals in the north and south flowing streams are outlined below with the intention to guide project prioritization and to provide a framework for project development. Watershed restoration assessments, which outline needed restoration work are in place and are being implemented for some but not all of the watersheds within the project area. There are many areas where projects have not yet been developed.

Salt River

South flowing streams of the project area are mainly on the Tonto National Forest. Many of these streams are managed both for native species as well as recreational fishing. Primary effects are from diverse land management practices including grazing, road building, and high levels of recreation which have led to soil compaction, increased erosion, impairment of riparian and stream habitat, reduction in water quality, and overgrown and decadent forests at higher risk of large uncharacteristic fires. Large, often stand-replacing, fires over the past 25 to 30 years in this watershed have resulted in high amounts of sediment input into the system. Post-fire flooding, channel instability, and sediment contributions to the East Verde River are evident at several locations along the stream. In the East Verde River headwaters, which is one of the priority watersheds for the Tonto National Forest, high flood events, exacerbated by denuded headwaters and hydrophobic soils resulting from large fires, heavily scoured much of the East Verde River, in many places down to bedrock. Recent projects have concentrated on diversifying instream habitats to increase abundance and age class diversity for both native and sport fish.

Little Colorado River

The streams on the north part of the project area flow north into the Little Colorado River. Many of these are currently or were historically occupied by Little Colorado Spinedace. One of the main limiting factors for this species is the limited amount of perennial surface water flow in many of these streams. These streams are very vulnerable to drought or other stressors which exacerbate intermittency. Historically, meadows primarily in the headwaters and along the floodplain functioned as important water source/storage areas to help maintain flow for these systems during dry seasons, functioning as a sponge. In addition, these meadow systems could help regulate and store water during high flow events, minimizing damaging flows downstream. Historic and current uses such as high levels of grazing, roads, logging, and other uses have contributed to the formation of headcuts and other degraded conditions through many of those meadows which has limited their ability to store water. The 1999 East Clear Creek Watershed Recovery Strategy and Watershed Condition Framework scores indicate soil conditions in the meadows are unsatisfactory due to past heavy livestock grazing, roads, and current wild ungulate use, as

well as recreation pressures that have reduced ground cover, compacted soils, and contributed to the lowering of the water table. Meadow areas are located within almost all headwater drainages of the Little Colorado River streams. Compaction and unsatisfactory soil conditions in the headwater meadows leads to increased runoff, sedimentation, and reduced baseflows, which have the potential of negatively affecting spinedace habitat as well as perennial flow much farther downstream.

The priority goal for aquatic restoration in the Little Colorado River drainages would be to enhance and protect surface water flow and increase habitat for Little Colorado Spinedace. Projects focused on restoring hydrologic function to headwater wet meadows and floodplains along these streams are crucial to maintaining and improving flow in downstream areas, restoring surface water permanency crucial for spinedace persistence and population expansion and recovery. Other high priorities would include projects to decommission or relocate poorly located roads which have confined stream channel morphology or altered water movement through meadow systems, as well as addressing headcuts and their root causes lower in the drainage network.

Aquatics and Watershed Restoration Condition-based Management

Due to the size and complexity of the 1.24-million-acre Rim Country project area the site-specific identification and analysis of all areas of need and the possible combinations of restoration activities is not available within the necessary timeframe for Rim Country analysis. Prior to proposing aquatics and watershed restoration treatments, project leaders, specialists, and partners would need consider the restoration needs and goals for the specific area, the extent and cause of degraded resources, water quality issues, threatened and endangered species habitat, scenic sensitivity levels, and effects on non-forest lands. 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 such as downcutting of streams and lack of floodplain connection, especially in low gradient areas. In order to have a variety of methods that could address the most common restoration needs a suite of restoration treatments are being proposed.

Having a suite of tools available for designing restoration projects will enable managers and partners to find the best solutions for a site-specific problem. It is anticipated for a given project, a variety of tools may be integrated within the project design to achieve the desired outcome. In addition, tools that might be appropriate in one area (for example stream type) may not be the right tool somewhere else. 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. Condition-based management also provides the ability to adapt treatments to unanticipated conditions within the analysis framework. It does not cover every foreseeable situation that may require restoration and some treatments that may cause effects potentially beyond the sideboards or limitations described in this NEPA analysis would require subsequent NEPA analysis.

The suite of tools helps address 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 generally have similar effects on these systems. 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, such as closed, to open to high clearance vehicles). The tools presented should give adequate flexibility to design projects to address problems with existing maintenance level 1 and 2 roads which are causing resource damage as well as maintenance for level 3-5 roads which may be destabilizing streams.

Whenever possible, restoration treatments should be coordinated with other activities in the same area to create efficiencies, focus efforts, and reduce miles of roads or trips to an area. 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.

Introduce Evaluation Methods

Aquatic Restoration Review Team

It is anticipated that an Aquatic Restoration Review Team (ARRT) would be established to guide restoration priorities and review all aquatic and watershed restoration proposals submitted. The ARRT is proposed to consist of a three-member core group of fish biologists and hydrologists, one each from the US Forest Service, USFWS, and Arizona GFD for the Rim Country Project area. The core team would have on-the-ground knowledge of aquatic systems in the Rim Country Project area and possess expertise and experience in their field. Additional core team members from Bureau of Reclamation or Army Corp of Engineers may be considered. Additional technical experts from needed fields of expertise (such as fluvial geomorphology, engineering, riparian ecology, soils) from these or other agencies may be recruited depending upon projects to be reviewed. Projects which require additional technical experts may include actions like stage-0 restoration, large aquatic passage projects, and channel realignment. In Oregon and Washington, the interagency group that works with salmon habitat restoration has developed a matrix of review based on the anticipated impacts and stream response (Skidmore et al. 2011) and could be adapted to fit the ARRT needs. Oregon Watershed Enhancement Board's restoration proposal evaluation criteria of Proposal Clarity, Technical Soundness, Watershed Context, Capacity of Applicant, and Cost Effectiveness, may also be useful review criteria to incorporate (*see diagram D-6 for additional information).*

A request for proposals would occur biannually, after which the ARRT would meet to review project proposals and facilitated by Forest Service personnel and/or a stakeholder. It is anticipated that the ARRT would review both heavy mechanical and general project proposals initially but would later focus on only heavy mechanical project proposals once processes are refined and implementer expertise is further developed. Additionally, as local personnel gain experience with project implementation and understanding, the ARRT may decrease the review needs for projects that are similar to those already implemented.

After proposal submittal and prior to the ARRT meeting, site visits of all proposal projects would occur including the proponent and at least one member of the ARRT core group. During the review meeting a notetaker would be present and team members would review proposals focusing on their strengths, concerns, and other relevant information. The ARRT makes recommendations of either Support, Support with Conditions, or Do Not Support, and then they priority rank them. The recommendations are then provided to the 4FRI Board of Directors and presented by the ARRT to the 4FRI stakeholder group.

Focus areas for projects would be guided by the ARRT and preferred projects would focus on hydrological function of the project streams and species recovery. Watershed restoration action plans have been developed or are in progress for priority watersheds within the Rim Country action area and these can assist in determining priorities. These include East Verde River Headwaters, Tonto National Forest, Long Tom Canyon-Chevelon Canyon and Upper Wildcat Canyon on the Apache Sitgreaves National Forest, and East Clear Creek-Blue Ridge Reservoir on the Coconino National Forest. These plans outline priority projects to improve watershed conditions and could provide initial guidance for needed restoration. In addition, some projects have already been implemented over the past decades and could help provide some guidance for what methods have worked well or not. Yochum and Reynolds (2020) provide guidelines for Forest Service stream restoration projects and the information needed to

development and design. In addition, a variety of case studies of various methods are presented in the documents cited above.

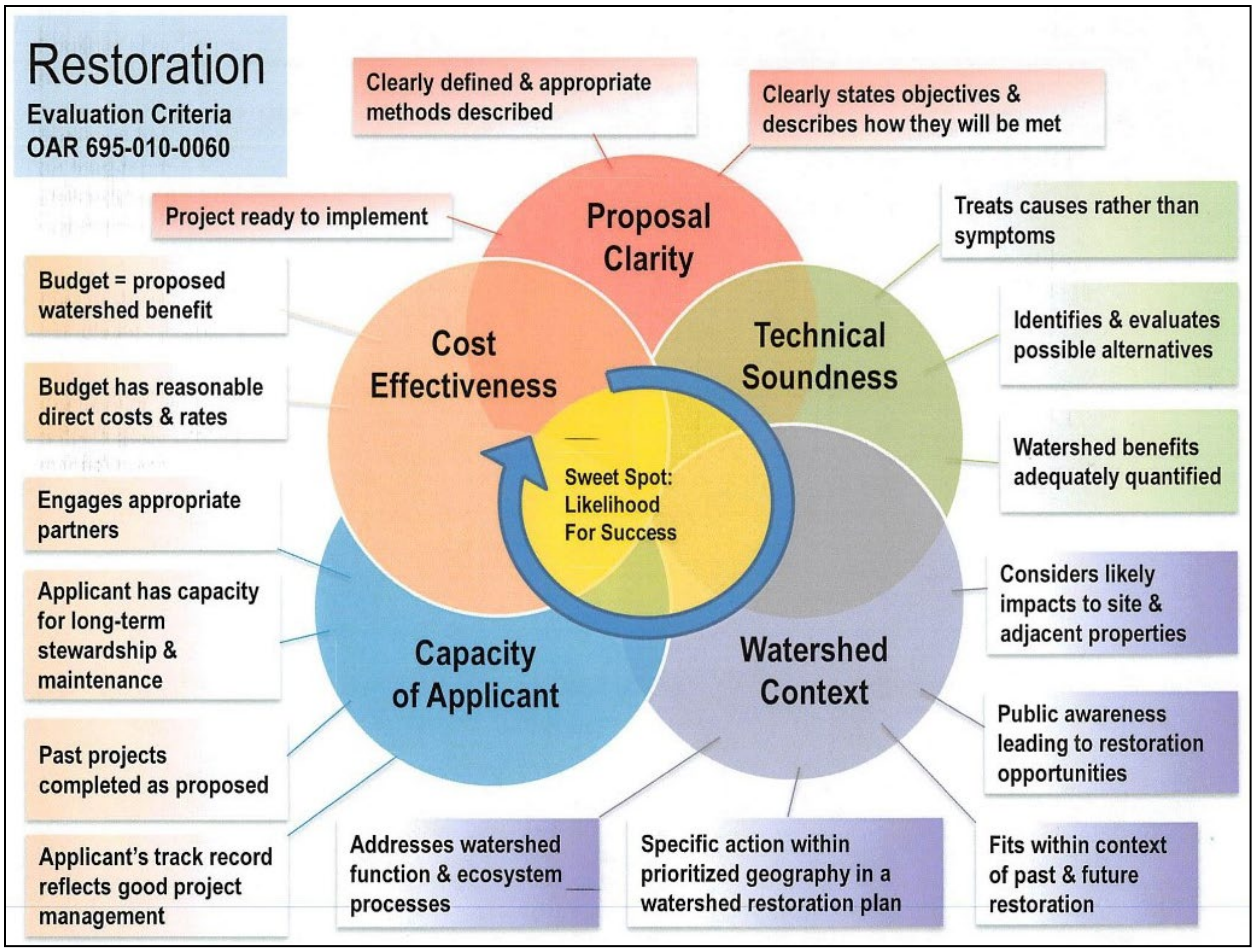

Figure D-3. Oregon Administrative Rule bubble diagram of review criteria

Project Screening and Decision Matrix

To guide the planning and implementation of site-specific aquatics and watershed restoration treatments and assist with their prioritization, a decision matrix was developed to be included in the condition-based management approach. The decision 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 D-4. Guidance for decision-making process (Roca et al. 2017)

Define project objectives and driver of change: The first step is identifying the primary goals for watershed management within a given area and issues that need to be addressed. An example for the Little Colorado River drainage might be the goal to increase habitat for Little Colorado spinedace with the objective to protect and enhance surface flow within drainages. Evaluation of the watershed conditions will allow managers to identify the main drivers that influence surface flow and subsequently identify potential sites where restoration activities may be needed.

Information such as management history, hydrology, and geology is needed to inform the existing baseline conditions and to understand underlying causes of degradation. Understanding the drivers of change or causes of degradation is necessary to help design the best approach and reach the most appropriate solution. Many times projects are also driven by opportunities, driven either by funding or adjacent projects, however all projects should contribute to the goals for the given watershed (Table D-7).

Key information that may be needed for managers and project designers to understand issues and restoration needs include:

- Site reconnaissance: IDT, partners, stakeholders walk the potential project area to identify areas of concern and potential causes of degradation. Things that the group would take note of include:
    - 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), loss of floodplain and in-channel roughness elements (large and coarse wood, vegetation, etc.)
    - 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, Forest Service photo archives, local historical societies, universities
    - Prior reports and local knowledge
    - Use information to piece together what happened to cause the degradation
- Characterize the past, current, and likely future trajectory of the area (for example, SEM or Rosgen stream type, spring type, riparian successional stage, or Proper Functioning Condition)
- Assessment and inventory (list in not inclusive as new protocols are developed all the time):
    - Valley and channel types (valley and channel gradients, entrenchment ratio, width to depth ration, sinuosity) for example Rosgen Level 1 and 2
    - Hydrology (flood, low flow, bankfull, regional curves, channel bed material, roughness) for example Rosgen Level 1 and 2
    - 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) https://springstewardshipinstitute.org/protocols
- Determine potential cause(s) of the problem (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 other drivers likely to impact the system over its lifetime (for example, growth, climate change).

Assess opportunities, consequences, and constraints: Identifying potential consequences of current condition (for example, 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. Identification of constraints is 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 it fits within the constraints of the effects analyzed in the Rim Country EIS

- 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 rights, 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. in coordination with heritage specialists
- Consider the following questions from Beechie et al. 2008:

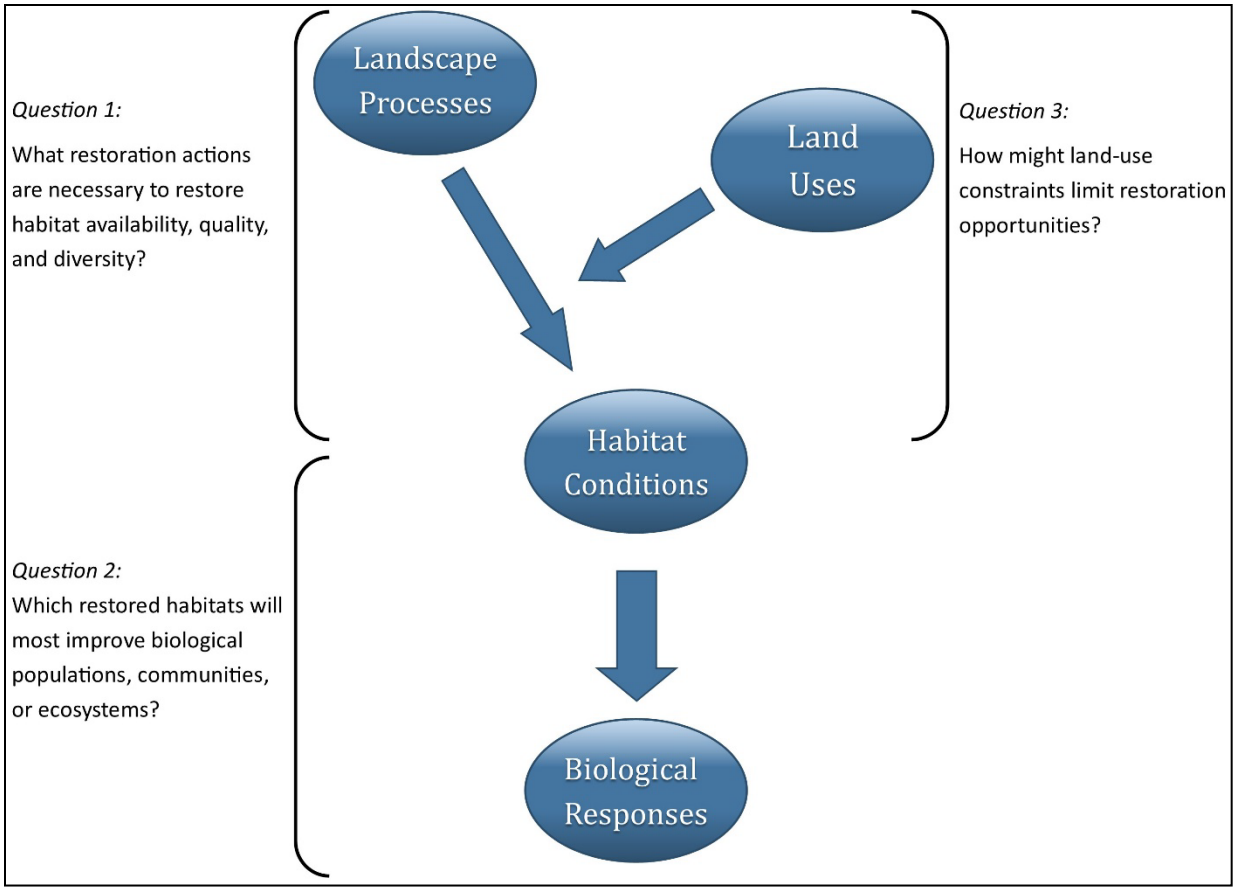

Figure D-5. Diagram of conceptual linkages and questions to be addressed in assessments used to identify and prioritize restoration actions (Beechie et al. 2008)

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 methods 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 consist 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.

Prioritization

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

There are many considerations that could be used to prioritize proposed locations and timing of aquatic and watershed restoration activities: immediate conservation needs and benefits for federally listed, candidate, or sensitive species, watershed condition framework planning, corresponding vegetation restoration activities (see Integration section above), and partner interest. In addition, opportunities may arise during proposed upland vegetation treatments in an area to efficiently accomplish beneficial aquatic restoration 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 D-57. Considerations for prioritizing where and when treatments are implemented

Treatment Consideration Prioritization Element	Considerations for prioritizing where and when implemented
Benefits to 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.
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 improve 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.
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.

Treatment Consideration Prioritization Element	Considerations for prioritizing where and when implemented
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.
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.
Potential to adversely affect cultural resources or tribal values	Seeps, springs, riparian areas and Emory oak groves may have tribal significance and could be sensitive for cultural resources. Input from tribes and heritage program staff should be solicited during project design and before project implementation.

Project Checklist and ARRT Review

A project checklist identified in the implementation plan will be used to ensure site specific aquatic and watershed restoration projects are consistent with the Rim Country analysis, project design criteria, and biological opinion as well as the associated forest Land Management Plan. These types of projects are also submitted to the Aquatic Restoration Review Team for review as described previously. Once the ARRT and appropriate line officer has approved the project, implementation can occur.

Implementation of Restoration Projects

Pre-implementation surveys will be conducted for federally-listed and sensitive species, rare plants, invasive species, and cultural resources in accordance with project design criteria, Rim Country Biological Opinion, and Rim Country SHPO consultation. 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 and Forest Service will coordinate with USFWS and SHPO. Any cultural resource findings will be coordinated with the State Historical Preservation Office.

Validation and Collaboration Period

Monitor and evaluate: Implementation and effectiveness monitoring should occur in order to show consistency with the Rim Country analysis, measure project success, and inform future projects. Project level monitoring should be part of site specific project documentation. It identifies if effects are within the scope of the analysis, if project design features are effective, as well as if project specific objectives were met. Monitoring also builds trust with partners, stakeholders, and the Aquatic Restoration Review Team as aquatic and watershed projects are implemented. Sharing of information provides transparency, which in turn builds trust and integrity. It also provides for project leaders to learn from one another as we move toward ecological restoration. Consider the following five criteria for measuring project success proposed by Palmer et al. 2005 and adapted to a broader view here.

1. A dynamic and ecological endpoint is initially identified and used to guide restoration.
2. The ecological conditions of the aquatic or watershed resource are measurably improved.
3. Through the use of natural fluvial and ecological processes, the restored aquatic or watershed system must be more self-sustaining and resilient to perturbations than pre-restoration conditions, so that minimal maintenance is needed.

4. The implementation of the restoration does not inflict lasting harm.

5. Pre- and post-project assessments are completed and the data are made available so that the restoration community as a whole can benefit from knowledge learned.

Restoration Assessment Framework

Aquatic and watershed condition-based management analyzed under Rim Country was defined using the tables that follow and align with the planning process outlined above.

Step 1: Once inventory and data collection have been completed to determine site specific existing condition and define resource issues, the first set of tables (Table D-4, Table D-5, Table D-6, Table D-7, Table D-8, Table D-9) should be used to identify what suite of methods are appropriate. These tables are broken out into the following specific categories for consistency: springs, wetlands, montane meadows, streams, roads/trails, and road-stream crossings.

Step 2: Use the methods tables (Table D-10, Table D-11, Table D-12, Table D-13) to determine potential alternatives for the project. Multiple methods may apply, but site specific conditions and constraints should assist in identifying and documenting potential methods (alternatives).

Step 3: Utilize circumstances table (Table D-14) and site specific information (stream gradient, distance from roads, slope) to determine if potential methods are excluded from use at the project location.

Tables for determining appropriate restoration methods based on existing condition, resource issues, and concerns.

Springs

Table D-58. Appropriate restoration methods based on existing condition, resource issues, and concerns for springs

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Methods for:
Surface flow impacted by 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 outflow channels are degraded leading to reduced surface and/or subsurface flow.	Reduced surface and subsurface flows result in reduced 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 adversely affected 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 adversely affecting 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 with stream courses, springs, or other wetlands:
Spring is being encroached by upland species or undesirable native species.	Loss or decline of native and/or rare wetland, riparian, and aquatic plant species. Reduction or loss of spring habitat.	Improving native riparian or aquatic vegetation

Wetlands (marshes, potholes, wet meadows, and natural ponds)

Table D-59. Appropriate restoration methods based on existing condition, resource issues, and concerns for wetlands

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Methods for:
Wetland is adversely affected 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.	Increasing presence, diversity, and/or abundance of 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.	Increasing presence, diversity, and/or abundance of native riparian or aquatic vegetation.
Vegetation and soils may be compacted or denuded 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.	Increasing presence, diversity, and/or abundance of 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 with stream courses, springs, or other wetlands:

Montane Meadows

Table D-60. Appropriate restoration methods based on existing condition, resource issues, and concerns for montane Meadows

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Methods for:
Native vegetation is adversely affected 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.	Increasing presence, diversity, and/or abundance of 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.	Increasing presence, diversity, and/or abundance of native riparian or aquatic vegetation.
Vegetation and soils may be compacted or denuded 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.	Increasing presence, diversity, and/or abundance of 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.	Reducing sediment inputs from road or trail interactions.

Unneeded Roads and Unauthorized Routes and Trails

Table D-61. Appropriate restoration methods based on existing condition, resource issues, and concerns for unneeded roads

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Methods 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. Confinement of stream channel, degradation of wetlands, erosion into aquatic habitats, draining of wetlands, channel widening. Concentration of flows that were originally spread across a wide area via drainage capture by ditching or berms. Potential changes in peak flows. Adverse changes in energy dissipation or sediment transport that adversely affect the function of the active channel or flood plain dimension Some unauthorized routes are often used by tribal communities to access forest resources and areas of cultural significance. This should be considered before eliminating these access routes.	Improving road or trail interactions with stream courses, springs, or other wetlands and/or form and function of stream channels and floodplains.
Stream or wetland damage due to poorly located or user created roads within the floodplain, wet meadow, spring outflow, or other such wetland habitats.	Same as above.	Improving road or trail interactions with stream courses, springs, or other wetlands and/or form and function of stream channels and floodplains.

Road and Stream or Wetland Crossings

Table D-62. Appropriate restoration methods based on existing condition, resource issues, and concerns for road and stream or wetland crossings

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Methods for:
Road crossings are increasing sedimentation to streams, springs, wet meadows, and other wetlands. Road crossings are causing excessive soil erosion/sedimentation that may adversely affect downstream vegetation stability/productivity.	Abnormally large sediment inputs 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 with stream courses, springs, or other wetlands:
Roads and associated stream crossings are adversely modifying 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 with stream courses, springs, or other wetlands:
Road crossings are causing unwanted 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 with stream courses, springs, or other wetlands:
Road crossing geometry is reducing sediment transport capacity and competency.	Alteration of sediment transport is causing long-term aggradation/degradation of the stream channel.	Improving road or trail interactions with stream courses, springs, or other wetlands:
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 with stream courses, springs, or other wetlands:

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Methods for:
Roads are causing physical disturbance and soil compaction that results in adverse effects to stream and wetland plant communities	Roads may cause vegetation removal, 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 with stream courses, springs, or other wetlands:
Need for frequent road maintenance that adversely affects aquatic and watershed resources.	Abnormally large sediment inputs 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 maintenance.	Improving road or trail interactions with stream courses, springs, or other wetlands

Streams (Channels, Floodplains and Riparian)

Table D-63. Appropriate restoration methods based on existing condition, resource issues, and concerns for streams

Existing Condition (what, where, how much?)	Resource Issues and Concerns	See Methods for:
Stream habitat complexity is lacking, in relation to all aquatic species life stages (such as rearing and juvenile habitat). --Most stream habitat is riffles or runs with little to no pool habitat and pool cover. Pool to riffle ratio is low. --Large woody debris and recruitment, if appropriate, is not present to create instream habitat complexity and cover. --Spawning habitat for various species (such as clean gravel bars, clean sand) are lacking. --Stream substrate is compacted or becoming cemented (tightly packed). Stream substrate is covered in fine sediment above natural levels.	Aquatic species need a variety of habitats to complete their life cycle. --Pool habitat is critical for resting habitat and thermal refugia for many species of fish --Lack of large woody debris contributes to poor stream habitat diversity. --Spawning habitat is essential to maintaining fish populations. --Cemented substrate affects habitat availability for small bodied fish, macroinvertebrate habitat, and spawning habitat. Decreased pool depth and cover	Improving form and function of stream channels and floodplains.
Stream temperatures are high or reaching thermal tolerance of aquatic species.	Many aquatic species in the southwest are living at the edge of their thermal tolerance; drought conditions or warming temperatures may make habitats unsuitable	Improving form and function of stream channels and floodplains.
Stream has or is currently incising and no longer connects with its floodplain or historic channels. Streambanks are incised or laterally unstable, and/or historic channels are abandoned.	Floodplain connection is critical for maintaining stream geomorphic function, stream habitat diversity, recharge of groundwater sources, and maintenance of riparian vegetation. Laterally unstable banks are causing high erosion and sedimentation rates that alter aquatic and riparian habitat quality. Sediment transport is also affected. Historic channels provide habitat for varying ages classes of species, dissipate flood flows, provide riparian and aquatic habitat.	Improving form and function of stream channels and floodplains and/or native riparian or aquatic vegetation
Stream is confined; it has been straightened or confined.	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 Methods 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 (for example 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 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 may reduce 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. --Leaf litter from riparian vegetation (allochthonous material) is lacking. --Existing riparian woody vegetation is lacking or out competed by conifers. --Floodplain vegetation has converted to upland species. --Riparian area is narrowing. --Soil compaction and accelerated soil erosion/sedimentation and bank instability.	Riparian communities (both woody and herbaceous) are essential to the health of instream aquatic systems. --Organic matter (leaves) provide nutrients and food source for macroinvertebrates, prey species for fish. --Loss or decline of riparian vegetation, stream shade, and bank stability. --Riparian vegetation aids in flood resilience, dissipation of flows (roughness), large woody debris and bank stability for stream systems. --Narrowing riparian area could indicate reduced water table, disconnected floodplain, or other constraints leading to loss of bank stability, shade, large woody debris, and possibly reduced flows. --Decreased soil function leading to stream bank soil instability and reduced site productivity of desirable native, riparian vegetation.	Improving form and function of stream channels and floodplains and/or improving native riparian vegetation

Methods Tables Described by General Type and the Resource Issues or Concerns they may Address

Table D-64. Methods for improving native riparian or aquatic vegetation

Methods	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 or mechanical 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. All added fencing will include bird diverters to protect birds.	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 D-65. Methods for improving spring outflows

Methods	Resource Issues or Concerns Addressed
Improve or remove boxes or other infrastructure, using excavation, shovels, trackhoes, jackhammers, or 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 D-66. Tools for improving road or trail interactions with stream courses, springs, or other wetlands

Methods	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.

Methods	Resource Issues or Concerns Addressed
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 (for example culverts); reestablishment of road drainage through leadout ditches, water bars, rolling dips, and other means; removal of unstable fill; and placement of slash using mechanical roads treatments.	Erosion, sedimentation, degradation or loss of vegetation from ML 1 roads.
Armor downstream culvert outlets using mechanical roads treatments.	Increased erosion and scouring downstream of culverts, bank instability, and channel downcutting.
Upsizing culverts using mechanical roads treatments.	Streams scouring around culverts and over roads, increased erosion to streams or wetlands, reduced aquatic organism passage from road culverts. Potential impacts to channel soil stability and site productivity.
Installing or adding culverts or culvert arrays using mechanical roads treatments.	Loss of stream connectivity, channel width, erosion and sedimentation to streams, channelization and increased channel width due to roads. Potential impacts to channel soil stability and site productivity.
Maintaining Aquatic Organism Passage where it exists. Options for improving passage include installing bridge, replacing culvert, or removing 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 terrestrial 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 D-67. Tools for improving the form and function of stream channels and floodplains

Methods	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 equipment.	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 equipment.	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 equipment.	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.

Circumstances Tables

In general, the tools all have specific circumstances where they would be more successful in moving the restoration project toward desired condition. Each system is unique and may have conditions where some tools would be ineffective, not needed, or potentially cause degradation rather than improving conditions. Listed below are the general circumstances under which each tool would apply or conversely, where they would

not apply. The generalized circumstances table is intended to provide general implementation guidance for the tools as well as to better define where these proposed activities could occur for Rim Country.

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

Table D-68. Generalized circumstances for when or where methods would or would not apply

Treatments/Methods	Circumstances where treatments would apply	Circumstances where treatments would not apply
Removing tree(s), tree canopy, or shrub encroachment of upland species with hand thinning, mechanical thinning or prescribed fire.	In low and medium gradient stream reaches where wetland, riparian, or aquatic plant species should be present.	In stream reaches where upland species are the dominant plant species. High gradient stream reaches.
Remove and manage noxious or invasive plants using hand methods or herbicides as described in forest weed management plans.	Anywhere that noxious or invasive plants are adversely affecting 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. All new fencing will include bird diverters.	In low and medium gradient stream reaches where wetland, riparian, or aquatic plant species should be present. Areas would also have to be reasonably close to road system for access and maintenance.	High gradient stream reaches, narrow or confined valleys.
Improve or remove spring boxes and other infrastructure, using excavation, shovels, trackhoes, jackhammers, concrete saws to restore natural spring function. Removing unneeded channels to consolidate spring outflow and increase habitat.	Low to moderate gradient stream reaches	-
Split flow in developed springs to allow water above existing water rights to be released to spring outflows. Hand methods for fixing springboxes, piping, or diversions to split spring flow.	Low to moderate gradient stream reaches	-
Protect spring emergence zone and/or springbrook from direct ungulate disturbance through fencing.	In areas where ungulate disturbance is impacting springs.	Where ungulate disturbance is not a causative factor.
Obliterate roads restoring natural contours and vegetation using mechanical roads treatments.	Where existing roads causing resource damage such as confining a stream, draining wetlands, loss or degradation of riparian or aquatic vegetation and habitat, and loss or degradation to proper soil function.	-
Close and restore unauthorized roads, trails, and dispersed camping areas using mechanical roads treatments.	For unauthorized roads, trails or recreational impacts causing resource damage such as confining a stream, draining wetlands, loss or degradation of riparian or aquatic vegetation and habitat, and loss or degradation to proper soil function.	-

Treatments/Methods	Circumstances where treatments would apply	Circumstances where treatments would not apply
Return ML 1 roads to closed status after use for restoration treatments by removal of drainage infrastructure (for example culverts), reestablishment of road drainage through leadout ditches, water bars, rolling dips, and other means, removal of unstable fill, and placement of slash using mechanical roads treatments.	Anywhere that ML1 roads are opened for use within Rim Country.	-
Armor downstream culvert outlets using mechanical roads treatments.	ML 2-4 roads where erosion is occurring from culverts.	-
Upsizing culverts using mechanical roads treatments.	ML 2-4 roads in areas where stream or overland flow had increased above the capacity of existing infrastructure.	-
Installing or adding culverts or culvert arrays using mechanical roads treatments.	ML 2-4 roads in areas where stream or overland flow had increased above the capacity of existing infrastructure.	-
Maintaining Aquatic Organism Passage where it exists if road crossing work needed. – Install bridge, replace culvert, or remove crossing using mechanical roads treatments.	Where roads and streams intersect on ML 2-4 roads	ML 1 and ML 5 road/stream crossings or intersections.
Install hardened low water crossings or fords (rock, concrete slab, concrete planks, concrete blocks, geocell fords, and vented fords on existing ML1 and ML2 roads needed for mechanical thinning 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 equipment.	Where ML 1-2 roads intersect with streams	ML 3-5 road and stream intersections
Developing footpath(s) or tread on existing trails to prevent further erosion using hand or mechanical equipment	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

Treatments/Methods	Circumstances where treatments would apply	Circumstances where treatments would not apply
Zuni bowls, one rock dams or other similar methods using mechanical or hand treatments.	Low to moderate gradient stream reaches and valleys.	High gradient stream reaches
Reconnection of historic side channels that should be functioning using mechanical treatments.	Low to moderate gradient stream reaches and valleys.	High gradient stream reaches
Maintenance of existing structures using manual or mechanical treatments.	Generally found in low to moderate gradient stream reaches and valley slopes.	High gradient stream reaches
Removing existing erosion control structures	Generally found in low to moderate gradient stream reaches and valley slopes.	High gradient stream reaches

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