United States
Department of
Agriculture

Forest
Service

Aquatics Specialist Report

Four Forest Restoration Initiative

Flagstaff Ranger District, Coconino National Forest, Coconino County, Arizona.

Williams and Tusayan Ranger District, Kaibab National Forest
Mogollon and Red Rock Ranger Districts – small acreages included

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Introduction

This report will describe the potential effects to aquatic biota and habitat (including Federally listed, candidate species, Forest Service sensitive species, and aquatic management indicator species (MIS) from the alternatives proposed for the Four Forest Restoration Initiative.

Methodology

Analysis of effects on aquatic habitat and species included compilation of unpublished sampling data from Arizona Game and Fish Department (C. Benedict, pers. comm.), Forest Service reports and unpublished records, GIS analysis of perennial, intermittent, and ephemeral stream courses in and downstream from the project area, proposed burn areas and associated slope, and use of the effects analyses in the Soils Report (Steinke 2014) and Riparian and Water Report (MacDonald 2013) for this project.

Regulatory Requirements

Regulatory Framework

The Forest Service is legally required to comply with a number of federal laws, regulations, and policy, including: the Endangered Species Act of 1973, as amended (ESA), Forest Service Manual (FSM) 2600, National Environmental Policy Act, 1969, National Forest Management Act, 1976 (as amended), and Coconino and Kaibab National Forest Land and Resource Management Plans (as amended).

The Endangered Species Act

The ESA directs all Federal agencies to use their authorities to carry out programs for the conservation of listed species. It prohibits Federal agencies from carrying out actions likely to jeopardize the continued existence of species listed under the Endangered Species Act. It further requires federal agencies to consult with the Fish and Wildlife Service (FWS) on actions authorized, funded, or carried out by such agencies that may affect listed species and/or their designated Critical Habitat. The ESA mandates consultation with the Secretary of the Interior whenever an action is likely to jeopardize the continued existence of any species proposed for listing as threatened or endangered, or whenever an action might result in destruction or adverse modification of Critical Habitat proposed for listing.

The Endangered Species Act (ESA, PL 93-205), Forest Service Manuals (FSM) 2670.11, 2670.21, and 2670.31, and Forest Plan standards and guidelines all require that National Forest land be managed for both conservation and recovery of endangered, threatened, and proposed (TEP) species. Section 7(a)(2) of the ESA requires that the agency actions are not likely to jeopardize the continued existence of federally listed species. FSM 2670 directs Forests to manage habitats, to assist in the recovery of TEP species, and to avoid actions "which may cause a species to become threatened or endangered".

Forest Service Manual (FSM) direction

The biological evaluation (BE) was prepared in accordance with FSM direction 2672.42 and meets legal requirements set forth under Section 7 of the Endangered Species Act of 1973, as amended, and implementing regulations [19 U.S.C. 1536 (c), 50 CFR 402.12 (f) and 402.14 (c)] to ensure that Forest Service actions do not contribute to loss of viability of any native or desired non-native plant or animal species, or contribute to trends toward Federal listing of any species; and, to provide a process and standard by which to ensure that threatened, endangered, proposed, and sensitive species receive full consideration in the decision making process.

The National Forest Management Act of 1976

The National Forest Management Act of 1976, required the Secretary of Agriculture to develop guidelines for land management planning with the individual forest being the planning unit or area. The Act states that "Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area." (36 C.F.R. § 219.19). A viable population is defined as "[a population] which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area." (§ 219.19). Therefore, management of viable populations is intended to be accomplished at the individual National Forest level (planning area).

National Environmental Policy Act of 1969 (NEPA)

NEPA established procedures for decision making, disclosure of effects, and public involvement on all major federal actions. Forest Service Manual 1950.2 requires a consideration of the impacts of Forest Service proposed actions on the physical, biological, social, and economic aspects of the human environment (40 CFR § 1508.14).

Forest Service Sensitive Species

Sensitive species are defined as "those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by: a) significant current or predicted downward trends in population numbers or density, or b) significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution (FSM 2670.5(19)). 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). Key policies regarding sensitive species are to 1) assist states in achieving their goals for conservation of endemic species, 2) as part of the National Environmental Policy Act process, review programs and activities, through a biological evaluation, to determine their potential effect on sensitive species, 3) avoid or minimize impacts to species whose viability has been identified as a concern, 4) if impacts cannot be avoided, analyze the significance of potential adverse effects on the population or its habitat within the area of concern and on the species as a whole, but the decision must not result in loss of species viability or create significant trends toward federal listing, and 5) establish management objectives in cooperation with the state when projects on National Forest system lands may have a significant effect on sensitive species population numbers or distributions. Establish objectives for federal candidate species, in cooperation with the U.S. Fish and Wildlife Service and Arizona State (FSM 2670.32).

Management Indicator Species (MIS)

Management Indicators are: "Plant and animal species, communities, or special habitats selected for emphasis in planning, and which are monitored during forest plan implementation in order to assess the effects of management activities on their populations and the populations of other species with similar habitat needs which they may represent" (FSM2620.5). Forest-wide assessments summarize current knowledge of population and habitat trends for management indicator species on both the Coconino (USDA Forest Service 2002) and Kaibab (USDA Forest Service 2010) NFs.

Purpose and Need

The purpose and need for proposing an action was determined by comparing the objectives and desired conditions in the Coconino NF and Kaibab NF Land Resource and Management Plans (forest plans) to the existing conditions related to forest resiliency and forest function. The results of the comparison are displayed in narrative, tables, and photographs; in summary, there is a need for:

- moving vegetation structure and diversity towards desired conditions by creating a mosaic of interspaces and tree groups of varying sizes and shapes
- moving towards a forest structure with all age and size classes represented as identified in the 1996 forest plan amendment for northern goshawk and Mexican spotted owl habitat
- managing for old age (pre-settlement) trees such that old forest structure is sustained over time across the landscape by moving towards forest plan old growth standards of 20 percent at a forest EMA scale
- improving forest health by reducing the potential for stand density-related mortality and by reducing the level of dwarf mistletoe infection
- moving towards desired conditions for vegetation diversity and composition by maintaining and promoting Gambel oak, aspen, grasslands, and pine-sage
- moving towards the desired condition of having a resilient forest by reducing the potential for undesirable fire behavior and its effects
- moving towards the desired condition of maintaining the mosaic of tree groups and interspaces with frequent, low-severity fire by having a forest structure that does not support wide-spread crown fire
- moving toward desired conditions in riparian ecosystems by having springs and seeps function at, or near, potential
- moving towards desired conditions for degraded ephemeral channels by restoring channel function
- moving towards restoring select closed and unauthorized roads to their natural condition by restoring soil function and understory species

Existing and Desired Conditions

Forest Structure and Spatial Pattern

This analysis utilizes canopy density and openness, the relationship of vegetation structural stage (VSS) to age/size class and diversity, stand density and key habitat components, and old growth as criteria to describe existing and desired conditions for forest structure and spatial pattern in the project area.

Tree Density and Canopy Openness

A characteristic of historic southwest ponderosa pine forests was the grass/forb/shrub (interspace) interspersed among small groups of trees (Reynolds et al, 2013) This interspace typically comprised a large portion of the landscape (Woolsey 1911, Cooper 1960, White 1985, Pearson 1950, Covington et a1. 1997, Abella and Denton 2009). Low-severity fires occurred every 2 to 22 years and maintained an open canopy structure (Weaver 1951, Cooper 1960, Swetnam 1990, Swetnam and Baison 1990, Fulé et al. 1997a, Covington et al. 1997, Heinlein et al. 2005, Fulé et al. 2003). Typical historical tree groups ranged from 0.1 to 0.75 acres in size and were comprised of 2 to 72 plus trees per group (White 1985, Fulé et al.

2003, Covington et al. 1997, Reynolds et al. 2013, p iii). Reference conditions for openness ranged from 52 to 90 percent open (Reynolds et al. 2013, p iii). Others (including Fulé and Woolsey) have described historical ponderosa pine forests as having low tree-density, open, savanna-like stands consisting of groups of pine trees interspersed with grassy or shrubby openings (White 1985, Fulé et al. 2003, Woolsey 1911). For this analysis, the term “openness” is used to convey the percentage of the forested area that is grass/forb/shrub interspace. It is often used interchangeably with the term “canopy density.”

In contrast to having a ponderosa pine ecosystem consisting of groups of trees mixed with interspaces, approximately 74 percent of the ponderosa pine forest type within the project area is departed from historical reference conditions[1].

Table 1. Canopy openness (classification percent of interspace) by restoration unit

Restoration Unit	Acres	Very Open percent	Open percent	Moderately Closed percent	Closed percent
1	144,113	1	14	28	58
3	129,226	1	13	25	60
4	134,278	4	22	35	39
5	59,034	12	57	23	9
6	41,189	2	30	40	29
All ponderosa pine	507,839	3	22	29	45

Overall, the desired condition is to reestablish non-forested openings that have been invaded by ponderosa pine since fire exclusion and reconfigure the forests toward their natural spatial pattern. At the fine scale, groups of trees would typically range from 0.1 acre to 1.0 acre in size.

Tree group size would exceed 1 acre as needed to respond to site-specific conditions including the presence of pre-settlement trees or mature and mid-aged trees that are developing old-tree characteristics. Tree groups in the mid-age and older structural stages (VSS 4, 5, and 6) would have canopies that provide moderate-to-closed conditions and where canopies are touching, or nearly touching, in order to provide connectivity for wildlife that are dependent on this type of habitat.

There would be a mix of very open, open, moderately closed, and closed canopy conditions at the landscape (ponderosa pine vegetation) scale. Moderate-to-closed canopy conditions would be widely distributed on the landscape. Habitat for goshawk and MSO, steep slopes, and buffers for resources such as bald eagle roosts, other raptor nests, caves, and special designations that would not be treated (including wilderness and most research natural areas) provide connectivity with moderate-to-closed canopy conditions. At the landscape scale (extent of ponderosa pine vegetation), openness would range from very open (up to 90 percent) within the savanna and grassland matrix to closed (as low as 10 percent) on the highly productive forest areas to achieve a heterogeneous condition across the landscape.

There is a need to use management strategies that move tree group pattern, interspaces, and canopy density towards the natural range of variability (sum of reference conditions) and provide a mix of open, moderately-closed, and closed canopy conditions at the fine (group) to landscape (ponderosa pine vegetation) scale. There is a need to amend the Coconino NF forest plan to provide for grass/forb/shrubs (interspace) interspersed among tree groups.

Vegetation Structural Stage (VSS) – Age and Size Class Diversity

Vegetation structural stage (VSS) is a method of describing forest age and tree size from seedling to old forests. The VSS classification is based on the tree size class with the highest square foot of basal area and is an indication of the dominant tree diameter distribution. A group of trees with a single age class is considered even-aged while a group of trees with multiple age classes is uneven-aged.

Figure 1. Even-aged Forest Structure Common throughout the Project Area

Forest resiliency and diversity is dependent on the distribution of age and size classes and the capacity of an area. Currently, over 50 percent of the forested acres in the project area lacks age and size class diversity and is in an even-aged structure. This has resulted in a homogenous landscape with reduced resiliency. Reduced resiliency is expressed as the increased potential for severe effects from wildfire, increased stand density-related mortality, reduced resiliency to bark beetle attack, increased dwarf mistletoe spread, and reduced understory productivity. Figure 1 displays a dense, even-aged forest structure that is common throughout the project area.

Forest Structure – Old Growth

The old growth standards for the Coconino NF state, "Until the forest plan is revised, allocate no less than 20 percent of each forested ecosystem management area to old-growth as depicted in the table below. In the long term, manage old-growth in patterns that provide for a flow of functions and interactions at multiple scales across the landscape through time. Allocations will consist of landscape percentages meeting old-growth conditions and not specific acres" The old growth guideline for the Coconino NF states, "All analyses should be at multiple scales—one scale above and one scale below the ecosystem management areas" (USDA 1987, page 70-1).

To be consistent with the Coconino NF forest plan, scales of analysis based on existing divisions of the landscape were developed specifically for this project. The smallest scale is represented at the stand level with stands averaging less than 100 acres in size. The Ecosystem Management Area (EMA) is the restoration sub-unit. Sub-units range in size from 4,000 to 109,000 acres. The scale above the EMA is the restoration unit, which ranges in size from 46,000 to 335,000 acres.).

In the Kaibab forest plan, the desired condition at the landscape scale (over 10,000 acres) is to have old growth occur throughout the landscape as a component of uneven-aged management with the location of old growth shifting on the landscape as a result of succession and disturbance (USDA 2014).

There are approximately 507,839 acres of ponderosa pine in the 4FRI treatment area. Of this total, 160,816 acres (36 percent) are the closest to meeting old growth conditions. Currently, all restoration units meet or exceed the 20 percent minimum Coconino NF forest plan requirement. Currently, the Kaibab NF has old growth occurring throughout the landscape (consistent with forest plan desired conditions). Approximately 31 percent (83,186 acres) of the Kaibab NF in the 4FRI treatment area has the desired older size-classes and old growth components well represented.

Table 2 (table 9 in the FEIS) displays acres of ponderosa pine old growth by restoration unit/forest for all the ponderosa pine within the 4FRI treatment area as well as ponderosa pine (within the project area) that have been analyzed in separate vegetation analyses (see silviculture report). For the Coconino NF, the acres displayed in table 2 are the acres allocated/managed as old growth (consistent with forest plan direction. The acres listed in table 2 for the Kaibab NF represent the areas currently closest to having, or attaining the desired old growth components, dominated by trees in the largest size classes.

Table 2. Ponderosa pine old growth acres and percent by national forest and restoration unit

RU	Ponderosa Pine Total Acres (4FRI / Other Projects) Total		Ponderosa Pine Old Growth Acres (4FRI / Other Projects) Total		Ponderosa Pine Old Growth Percent	
	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF
1	(144,113 / 48,876) 192,989	This RU does not occur on Kaibab NF	(64,090 / 12,507) 76,597	This RU does not occur on Kaibab NF	40	This RU does not occur on Kaibab NF
3	(58,327 / 29,176) 87,503	(70,899 / 57,886) 128,785	(21,486 / 10,894) 32,380	(25,177 / 13,746) 38,923	37	30
4	(56,957 /5,941) 62,898	(77,320 / 14,089) 91,409	(17,717 / 1,965) 19,682	(30,342 / 2,140) 32,482	31	36
5	(59,034 /45,022) 104,056	This RU does not occur on Kaibab NF	(23,716 / 8,441) 32,157	This RU does not occur on Kaibab NF	31	This RU does not occur on Kaibab NF
6	This RU does not occur on Kaibab NF	(41,189 / 7,450) 48,639	This RU does not occur on Kaibab NF	(10,291 /1,490) 11,781	This RU does not occur on Kaibab NF	24
Total	(318,432 / 129,015) 447,447	(189,408 / 79,425) 268,833	127,009 / 33,807) 160,816	(65,810 / 17,376) 83,186	36	31

Most sites on the Coconino NF currently do not fully meet the minimum criteria for old growth conditions. However, the habitat types noted below are currently the closest to meeting old growth conditions. This approach is consistent with Coconino NF forest plan direction, which states: "strive to create or sustain as much old growth compositional, structural, and functional flow as possible over time at multiple-area scales…and seek to develop or retain old- growth function on at least 20 percent of the naturally forested area by forest type in any landscape" (USDA 1987).

The old growth acreage/percentage for ponderosa pine includes 100 percent of MSO protected habitat, 100 percent of MSO target/threshold habitat, 40 percent of MSO restricted habitat that is uneven-aged with low dwarf mistletoe infection, and 80 percent of MSO restricted habitat that is even-aged and mid-aged to old with low dwarf mistletoe infection. In goshawk habitat, the old growth acreage/percentage for ponderosa pine includes 100 percent of goshawk nest stands, 40 percent of goshawk PFA and foraging areas that are uneven-aged with low dwarf mistletoe infection, and 80 percent of goshawk PFA and foraging areas that are even-aged and mid-aged to old with low dwarf mistletoe infection.

There are approximately 23,316 acres of pinyon-juniper within the 4FRI treatment area. Of this total, 15,626 acres (68 percent) are closest to meeting old growth conditions as described by the Coconino NF forest plan. Currently, all restoration units meet or exceed the 20 percent minimum Coconino NF forest plan requirement. Currently, the Kaibab NF has old growth occurring throughout the landscape (consistent with forest plan desired conditions), with approximately 58 percent of the Kaibab NF in the 4FRI treatment area dominated by trees in the largest size-classes and having or attaining old growth components. Table 3 (table 10 in the FEIS) displays acres of pinyon-juniper old growth by restoration unit/forest for all pinyon-juniper within the 4FRI project area as well as pinyon-juniper (within the treatment area) that have been analyzed in other vegetation analyses (see silviculture report). For the Coconino NF, the acres displayed in table 3 represent the acres allocated to old growth (per forest plan direction). The acres listed in table 3 for the Kaibab NF represent the areas currently having, or attaining, the desired conditions associated with old growth.

Table 3. Pinyon-juniper old growth acres and percent by national forest

RU	Pinyon-Juniper Total Acres (4FRI / Other Projects) Total		Pinyon-Juniper Old Growth Acres (4FRI / Other Projects) Total		Pinyon-Juniper Old Growth Percent	
	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF
1	(1,141 / 2,135) 3,276	This RU does not occur on Kaibab NF	(611 / 447) 1,058	This RU does not occur on Kaibab NF	32	This RU does not occur on Kaibab NF
3	(832 / 0) 832	(3,201 / 3,533) 6,734	(356 / 0) 356	(1,747 / 2,245) 3,992	43	59
4	(42 / 0) 42	(7,123 / 0) 7,123	(42 / 0) 42	(4,116 / 0) 4,116	100	58
5	(8,771 / 0) 8,771	This RU does not occur on Kaibab NF	(7,302 / 0) 7,302	This RU does not occur on Kaibab NF	83	This RU does not occur on Kaibab NF
6	This RU does not occur on Kaibab NF	(2,206 / 550) 2,756	This RU does not occur on Kaibab NF	(1,452 / 110) 1,562	This RU does not occur on Kaibab NF	57
Total	(10,786 / 2,135) 12,921	(12,530 / 4,083) 16,613	(8,311 / 447) 8,758	(7,315 / 2,355) 9,670	68	58

Figure 9 (in the FEIS) displays the general locations of ponderosa pine and pinyon-juniper in the treatment area that are closest to meeting old growth conditions/components. In both ponderosa pine and pinyon juniper, the desired condition is to allocate sites on the Coconino NF and manage for old growth components on the Kaibab NF. Where management occurs within ponderosa pine and pinyon-juniper cover type, there is a need to maintain the old growth characteristics and components.

Forest Health – Insect and Disease

Bark Beetle

Forest health is defined by the vigor and condition of the forest stands (see previous discussion on stand density) and the presence of insects and disease that affect the sustainability of the forest. Ponderosa pine is attacked and killed by several different bark beetles in the genera *Dendroctonus* and *Ips*. Approximately 7 percent of the ponderosa pine analysis area has a low bark beetle hazard rating, while 15 percent of the area has a moderate rating, and the remaining 77 percent has a high bark beetle hazard rating (table 4). Areas with a low or moderate hazard rating would be expected to be resistant to successful bark beetle attack and large-scale mortality.

Table 4. Existing Ponderosa Pine Beetle Hazard Rating (Percent of Area in each RU)

Hazard Rating	RU 1	RU 3	RU 4	RU 5	RU 6	Analysis Area Acres/Percent of Total
Low	3	6	8	26	0	37,993/7
Moderate	12	11	27	46	25	106,132/21
High	85	83	65	28	75	363,775/72

Dwarf Mistletoe

Dwarf mistletoe infection in ponderosa pine is common throughout the project area. Mistletoe-infected trees slowly weaken, experience growth loss, and eventually die.

Approximately 66 percent of the area is not infected or has a low infection level (with less than 20 percent of the trees infected). Thirty-four percent of the area is moderately infected (20 to 50 percent of the trees infected) or heavily infected (50 to 80 percent of the ponderosa pine infected). The average range of infection is from 4 to 10 percent in the none/low infection level group and 33 to 42 percent in the moderate/high infection level group (Table 5). Several stands have an extreme infection rating where 80 percent or more of the trees are infected.

Table 5. Existing Dwarf Mistletoe Infection Level by Restoration Unit (RU)

Infection Level	RU 1	RU 3	RU 4	RU 5	RU 6	Percent of Analysis Area
None/Low – Percent of Area	53	57	73	92	82	66
None/Low – Average Percent Trees Infected	5	6	4	10	5	6
Moderate/High – Percent of Area	47	43	26	8	18	34
Moderate/High – Average Percent Trees Infected	38	33	38	41	42	36
Extreme Percent of Area	1	<1	<1	0	0	<1
Extreme – Percent of Area	86	86	85	–	–	86

The desired condition is to move towards a forest structure that would allow beetles and dwarf mistletoe to function at naturally occurring or historic levels. There is a need to manage insect and disease in a manner that reduces, but does not eliminate bark beetle or dwarf mistletoe in order to provide nesting, resting, foraging, and catching sites for birds and mammals including Abert's/tassel-eared squirrels.

Vegetation Diversity and Composition

Gambel Oak

Vegetation diversity throughout the project area has declined. Gambel oak, a sub-type within ponderosa pine, is important to many wildlife species as it provides important nesting and foraging habitat. A lack of fire led to increased stand densities of pine and resulted in Gambel oak becoming overtopped by fast-growing ponderosa pine (Figure 2 in the FEIS) (Abella and Fulé 2008).The desired condition is to develop and maintain a variety of oak size classes and forms where they occur. Oak should range from shrubby thickets and pole-sized clumps to large trees across the landscape in order to provide habitat for a large number and variety of wildlife species (Brown1958, Kruse 1992, Rosenstock 1998, Abella and Springer 2008, Abella 2008). There is a need to stimulate new growth, maintain growth in large-diameter trees, and use management strategies that provide for a variety of shapes and sizes across the landscape.

Figure 2. Ponderosa Pine Overtopping Gambel Oak in the Bar-M (Coconino NF) Portion of the Project Area

Asp

There are approximately 1,522 acres of aspen in the project area. Aspen is dying or rapidly declining on both forests due to the combined effects of conifer encroachment, browsing, insects, disease, severe weather events, and lack of fire disturbance (USDA 2009, USDA 2008). A study by Fairweather et al. (2008) on the Coconino NF indicates that aspen on low-elevation dry sites (less than 7,500 feet) has sustained 95 percent mortality since 2000. Mortality on these sites is expected to continue as many live trees currently have only 10 to 30 percent of their original crown. Figure 3 displays an unhealthy aspen stand within the project area. The desired condition is to maintain and/or regenerate aspen. Where possible, there is a need to stimulate growth and increase individual recruitment of aspen.

Figure 3. Existing Condition of Aspen near Government Prairie, Kaibab NF

Grasslands

There are approximately 48,703 acres of montane/subalpine and Colorado Plateau/Great Basin grasslands within the project area. Only 2 percent of the Great Basin grasslands on the Coconino NF were historically comprised of very large shrubs, closed canopies, and very large trees. Currently, this percentage is 19 percent (USDA 2009). Within montane/subalpine grasslands, encroachment has increased from 0 to 33 percent (USDA 2009). Conifers on the Kaibab NF have invaded at least 8 percent of grasslands (USDA 2008).

Figure 4 and Figure 5 display grassland encroachment within the project area over a 100-year period. On both forests, the desired condition for grasslands is to move towards the natural range of variability. Tree cover would range from 0 to 9 percent, grasses and forbs would dominate and fire return intervals would average 10 years (Cooper 1960, Swetnam 1990, Swetnam and Baison 1996, Fulé et al.1997a, Fulé et al.1997b, Heinlein et al. 2005). Fire would function within its natural fire regime across the landscape without causing loss to ecosystem function or to human safety, lives, and values. When fire does occur, it typically replaces more than 75 percent of the dominant vegetation type (USDA 2009). There is a need to reduce and/or remove tree encroachment, which has reduced the size and function of landscapes that were historically grasslands.

Figure 4. Fern Mountain (Hart Prairie) Grassland Circa 1880s

Figure 5. Fern Mountain (Hart Prairie) Grassland Circa 1980s

Pine-Sage

Based on review of the project area, ponderosa pine trees are encroaching and shading out the sage on about 5,261 acres. Without treatment, pine density is likely to increase and entirely shade-out the sage component. The desired condition is to restore the historic pattern within the pine-sage mosaic and manage fire to enhance sage. There is a need to remove post-settlement pine that is currently overtopping and shading sage. Figure 6 displays the post-treatment desired condition. This figure portrays an area just south of Tusayan, Arizona approximately six years after a low-severity prescribed fire.

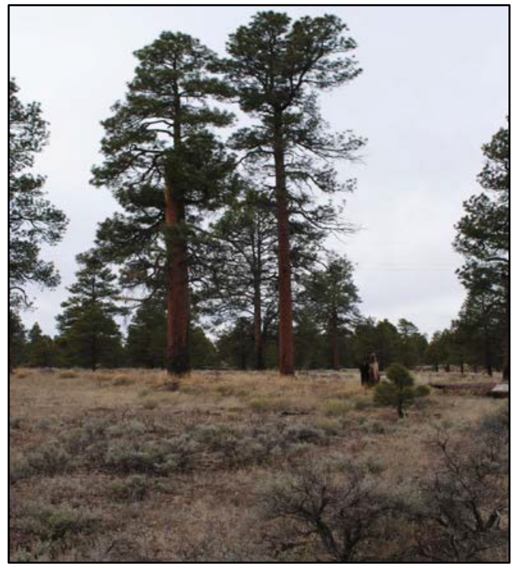


Figure 6. Post-Treatment Pine-Sage Desired Condition (Kaibab NF)

Forest Resiliency

Fire Behavior

Canopy Characteristics and Surface Fuels Affecting Fire Behavior

Canopy bulk density and canopy base height are canopy characteristics used to measure the potential for crown fire. Higher canopy bulk densities mean that fire can easily move through the crowns of trees and there are more fuels to burn. With more fuels, fire intensity would increase. Approximately 61 percent of the ponderosa pine in the project area has a canopy bulk density rating greater than 0.050 kg per cubic meter (kg/m3). The desired condition in ponderosa pine to reduce the potential for crown fire is to have canopy bulk density below 0.050 kg/m3.

The canopy base height of a stand is the lowest height above the ground at which there is a sufficient amount of canopy fuel to spread fire vertically into the canopy (Scott and Reinhardt 2001). The lower the canopy base height, the easier it is for crown fire to initiate. Currently, canopy base heights in the project area average approximately 15 feet. To minimize the potential for crown fire initiation, the desired condition is to have average stand canopy base height above 18 feet. Table 6 summarizes existing and desired conditions for fire risk.

Table 6. Existing and Desired Fire Potential in Ponderosa Pine in the Project Area

Evaluation Criteria	Existing Condition	Desired Condition
Potential crown fire (%)	34	Up to 10
Canopy Base Height (ft.)*	15	>18
Canopy Bulk Density (kg/m3)*	0.059	<0.050
Potential surface fire (%)	64	Up to 90

*Stand average across the project area

Surface fuels (as analyzed for fire behavior and effects) include litter, duff, and CWD greater than 3-inch diameter. High surface fuel loading can result in high-severity effects because they can smolder in place for long periods, transferring more heat into soil and tree cambiums. Mechanical treatments generally do not remove surface fuels from a treatment area, so they remain a potential source of heat (fire effects) and emissions.

Currently, litter, duff, and CWD average 10 tons per acre. When averaged, the existing surface fuels do not exceed recommended surface fuel loading (Brown et al. 2003). However, there are areas that exceed desired surface fuel loadings. Most of these areas are near, or associated with, MSO habitat (see the fire ecology report).

Overall, the desired condition is to have fire maintain a mosaic of diverse native plant communities. In ponderosa pine, no more than 10 percent of the project area should be prone to crown fire under modeled conditions, with high severity acres spatially distributed (Swetnam and Baison 1996, Roccaforte et al. 2008). In grasslands, no more than three percent should be prone to crown fire. In this analysis, 'crown fire' in grasslands is a reference to crown fire in trees growing in the grasslands. In both vegetation types, when crown fire does occur, it should be mostly passive crown fire, occurring in single trees, groups, clumps, or areas where there had been mortality (wind throw, insects, etc.). High-intensity surface fire should be rare with surface fuel loadings (including CWD, litter, and duff) ranging between 5 and 20 tons per acre (Brown et al. 2003).

The desired condition is to have fire function as a natural disturbance within the ecosystem without causing loss to ecosystem function or to human safety, lives, and values. Over time, conditions would allow managers to use fire to maintain the area as a functioning ecosystem. There is a need to reduce canopy bulk density and raise canopy base height in order to reduce the potential for crown fire. In order to reduce the potential for high-severity surface fire, there is a need to maintain surface fuel loadings that meet desired conditions and reduce excessive surface fuel loadings in areas adjacent to and within MSO habitat.

Fire Regime Condition Class

Fire Regime Condition Class (FRCC) is a coarse-scale evaluation protocol developed to support planning and risk assessments (Schmidt et al. 2002). FRCC assessments determine how departed a landscape's fire regime is from its historic fire regime. It is scaled from 1 to 3, with 3 being the most departed and 1 being the least departed. One of the components that is used to determine FRCC is Vegetation Condition Class (VCC). Like FRCC, it is scaled from 1 to 3, with 3 being the most departed. Approximately 61 percent of the project area is in VCC 3. This indicates the vegetation is significantly departed from historical ranges (Table 7). The project area, as a whole, is in FRCC 3, so the risk of losing key ecosystem components is high. Approximately 25 percent of the project area is in VCC 2, indicating the vegetation is moderately departed from its historical range. The departure in fire frequency has resulted in dramatic alterations to fire size, intensity, severity, landscape patterns, and/or vegetation attributes.

The desired condition is to have the overall project area FRCC rating move from FRCC 3 to FRCC 2, and for there to be no acres left in VCC 3. In FRCC 2, fire regimes would no longer be highly departed from historical ranges and the risk of losing key ecosystem components would be moderate. There is a need to reduce the percent of the ponderosa pine and grassland vegetation in FRCC 2 and FRCC 3 and move the fire regimes towards FRCC 1.

Table 7. Existing and Desired Fire Regime Condition Class Ponderosa Pine

	2010	
	Acres	**%**
VCC1	71,097	14%
VCC2	126,960	25%
VCC3	309,782	61%
FRCC of treatment area =	**3**	

Soil Productivity and Watershed Function

Soils

Approximately 85 percent of soils and strata in the project area are in satisfactory soil condition and have the ability to resist accelerated erosion. Most strata in the ponderosa pine type currently have a closed stand structure and appear to have high canopy covers and densities. This has reduced understory forage productivity although there is generally sufficient vegetative ground cover to reduce accelerated erosion. Due to the closed stand structure, most soils and strata are at risk from the relatively high potential for crown fire (about 86 percent in FRCC 2 and 3). This also poses a high risk of moderate- or high-burn severity effects to the watersheds under normal or extreme fire behavior conditions. Fires resulting in moderate or high burn severity pose substantial risk to soil productivity, watershed function, and downstream water quality to connected streamcourses on soils with moderate or high erosion hazard following storm events.

The desired condition is to protect long-term soil productivity by maintaining or improving soil condition and function (toward satisfactory). The vegetative ground cover would be adequate to protect against accelerated erosion resulting in maintained soil stability and vegetative productivity. Soil loss would be below tolerance, and no visible signs of excessive erosion are present. Surface soil hydrologic function would be in satisfactory condition with well-aggregated, granular surface soil structure and tubular pores with sufficient porosity to effectively infiltrate water. Soil nutrient cycling would be in satisfactory condition. Vegetative ground cover, including surface litter and plant basal cover, and herbaceous understory would approach natural conditions identified in the Terrestrial Ecosystem Survey Potential Plant Community Ecological Processes and Function (USDA 1984).

Watersheds at the 6th Hydrologic Unit Code (HUC) Scale

The project lies within 82 6th code watersheds. Overall, ponderosa pine vegetation types are dominated by functional-at-risk 6th HUC watersheds (about 451,500 acres, or 46 percent of the analysis area); with several impaired watersheds (about 316,800 acres, or about 32 percent of the analysis area) and a few properly functioning watersheds (about 220,400 acres, or about 22 percent of the analysis area).

The desired condition is to have watershed function maintained or improved towards functioning properly. 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. Soil and riparian condition and function would be improved and moving towards satisfactory and properly functioning.

Springs

Springs play an important role on the landscape for hydrological function of watersheds and they are very important for wildlife and plant diversity. They are natural water features that existed prior to Euro-American settlement and were probably functional due to lack of human disturbances (USDA 2009).

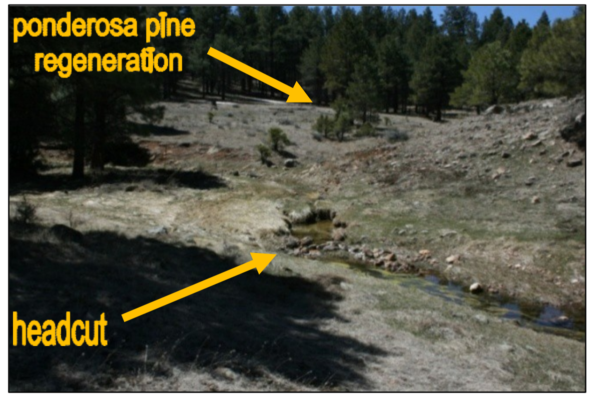


Figure 7. Degraded Babbitt Spring on the Coconino NF

Forty–nine (49) developed springs on the Coconino NF are not functioning at or near potential and 25 springs on the Kaibab NF have reduced function (MacDonald 2013)[5]. However, springs are well represented throughout all the major watersheds on the forest. Spring function within the project area has been altered by human activities including flow regulation through installation of spring boxes and piping of discharge to off-site locations, recreational impacts, urbanization, and other construction activities, and grazing by domestic livestock and wildlife herbivores. As a result, many springs exhibit static or degraded conditions. Excessive disturbance can also result in these features becoming non-functional (USDA 2009).

Figure 7 is a photo of Babbitt Spring, which has an impaired function. Babbitt Spring is located in the Lake Mary watershed on the Flagstaff District (Coconino NF) and is example of spring conditions within the project area. The headcut in the spring outflow, the encroachment of ponderosa pine into the spring site, and the lack of riparian vegetation normally associated with a functioning riparian site are indicators of impaired function.

[5] Out of 78 total springs within the 4FRI project area, 4 springs were removed from treatment due to lack of information.

Figure 8 displays Hoxworth Spring in a restored condition. This figure provides an example of successfully meeting restoration desired conditions. Vegetative composition and spring outflow has improved. Bank headcutting in the spring's outflow has been addressed and tree encroachment that affected spring function has been removed. Figure 9displays protective measures (fencing) that have been successfully used in the past to attain restoration desired conditions.

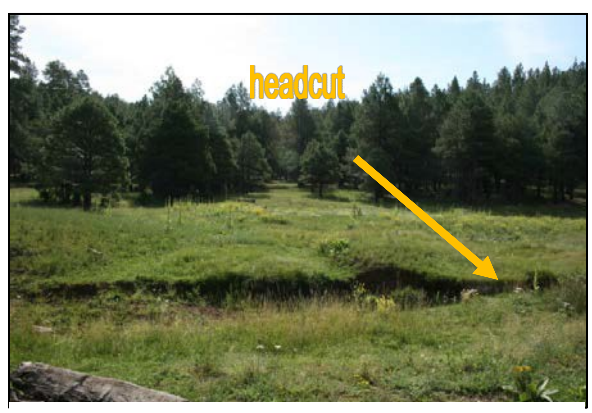
Figure 8. Restored Hoxworth Spring

The desired condition for springs is to have the necessary soil, water and vegetation attributes to be healthy and functioning at or near potential. Water flow patterns, recharge rates, and geochemistry would be similar to historic levels and persist over time. Water quality and quantity would maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence would be resilient to natural disturbances (USDA 1987). There is a need to improve the condition and function of 74 springs in order to sustain these features on the landscape. On some springs, this means maintaining and promoting existing vegetation. On others, there is a need to reduce tree encroachment, reduce the presence of noxious weeds, and limit the potential for future disturbance. On all springs, there is a need to return fire, a natural disturbance process, to the system.

Figure 9. Hoxworth Springs Restoration

Ephemeral Streams

Ephemeral streams are important for hydrological function of watersheds and provide important seasonal habitat for a variety of wildlife, in particular, migratory birds and dispersing amphibians. Ephemeral streams are categorized as riparian or non-riparian. On the Coconino NF, approximately 32 miles of ephemeral streams are heavily eroded with excessive bare ground, denuded vegetation, and head cuts. Of the total miles, approximately 6 miles are riparian streams and 26 miles are non-riparian streams. The Kaibab NF has approximately 7 miles (total) of degraded non-riparian streams. Figure 10 shows an active headcut and lateral bank cutting that resulted in accelerated erosion rates. This condition is common in the project area.



The desired condition is to restore the functionality of ephemeral streams (USDA 1987). On some of the total miles of stream, there is a need to maintain and promote existing vegetation. On others, there is a need to reduce tree encroachment, noxious weeds, and limit the potential for future disturbance. On all ephemeral streams, there is a need to return fire, a natural disturbance process, to the system.

Figure 11. Restored Hoxworth Spring Drainage Immediately Post-treatment (Photo on Left) and 1-Year Post-treatment (Photo on Right)

The left-hand side of figure 11 shows the channel immediately after re-contouring. The purpose of this figure is to display what restoration is likely to look like in the short term. The right-hand side of the figure displays the channel 1 year after treatment. This figure displays the desired condition for ephemeral stream restoration.

Roads and Unauthorized Routes

The Coconino and Kaibab NFs have identified the needed road system for public and administrative motorized use through the Travel Management Rule (TMR) process (see the transportation specialist report for details on forestwide transportation analyses). The TMR process identified a need to decommission approximately 726 miles of existing system and unauthorized roads on the Coconino NF. On the Kaibab NF, approximately 134 miles of unauthorized roads (often referred to as user-created routes) were recommended for decommissioning.

The desired condition is to restore decommissioned road prisms to their natural condition (USDA FS 1987, USDA FS 2014). Soils would be in satisfactory condition so that the soil can resist erosion, recycle nutrients, and absorb water. Understory species (e.g., grasses, forbs, and shrubs) diversity would be consistent with site potential and provide for infiltration of water and reduction of accelerated erosion. The understory would have a variety of heights of cool and warm season vegetation. Impacts to wildlife and habitat would be minimized.

About 2,787 miles of road would be needed to implement the project. Of this total, approximately 2,267 miles are existing, open roads. However, portions of these existing roads have resource concerns, which require maintenance or reconstruction prior to utilizing. In some parts of the project area there are no existing roads that could provide access to treatments, or records and field review indicate the roads have been decommissioned in previous projects. For additional information, see the transportation inventory in the project record.

The desired condition is to minimize soil and vegetation disturbance from roads. There is a need to have adequate access to the project area for implementation while being consistent with the CFLR Act (which does not allow for the development of permanent roads). Adequate access includes utilizing existing roads and temporarily creating roads that can be returned to their natural state (decommissioned) at the completion of project activities. Maintenance, reconstruction, and restoration actions would be designed to meet the site-specific condition as possible and practicable.

Decision Framework

The Coconino and Kaibab NFs Supervisors are the Forest Service officials responsible for deciding whether or not to select the preferred alternative (alternative C), select one of the other action alternatives (alternative B, D, E), or select no action (alternative A). Their decision includes determining: (1) the location and treatment methods for all restoration activities, (2) design criteria, mitigation and monitoring requirements, (3) the components that will be included in the adaptive management plan, (4) the components that will be included in the implementation checklist and plan, (5) the estimated products or timber volume to make available from the project, (6) whether the forest plans will be amended as proposed, and (7) documentation needed to demonstrate compliance with the 2014 Land and Resource Management Plan for the Kaibab National Forest.

The Forest Supervisors will make a decision on all acres but those associated with the Coulter Experimental Forest. Only the Rocky Mountain Research Station (RMRS) is authorized to make decisions for the Experimental Forest.

Other Planning Efforts

Restoration activities (actions on the Forests, private, state, and other non–Forest Service lands) that influence/are complementary to this analysis are addressed in cumulative effects.

Relationship to the Forest Plans

The Coconino NF and Kaibab NF forest plans set forth in detail the direction for managing the land and resources of the forests. The desired conditions for the project are based on forest plan objectives, goals, standards, and guidelines. This analysis tiers to the Coconino NF Final EIS (USDA 1987) for the forest plan as encouraged by 40 CFR 1502.20. This analysis tiers to the Final EIS for the Kaibab National Forest Land and Resource Management (USDA 2014). Best available science was used to develop desired conditions that are consistent with forest plan revision.

Management Direction

The project area includes 23 management areas (MA) as described in the Coconino National Forest Plan (pages 46 to 206–113). Table 8 displays the MAs located within the project area, forest plan MA emphasis, and the relationship between MA total acreage to the project. The MA direction for the Flagstaff/Lake Mary Ecosystem Analysis Area (FLEA) MA is displayed throughout the 10 MAs that make up the FLEA.

Table 8 displays the acreage associated with the MAs in the project area where the majority of restoration actions are proposed.

For additional information, see chapter 4 of the Coconino National Forest Land Management Plan, pages 21 to 206-118; Chapter 3 of the Kaibab National Forest Land Management Plan, pages 85 to 107) where detailed descriptions of forest-wide resource direction specific to the management or geographic areas and land use zones is located.

Table 8. Forest Plan Management Areas (MA), within the Coconino National Forest and Project Area

Forest Plan Management Areas (MA) and Geographic Areas (GA) within the Project Area*	Description	Forest Plan Emphasis	Forestwide MA and GA Acres	MA and GA Acres within Project Area	Acres/Percent (%) of Forestwide MA/GA Proposed for Treatment
Coconino National Forest					
MA 3	Ponderosa pine and mixed conifer on less than 40% slope	Sustained yield of timber and firewood, wildlife habitat, grazing, high quality water, dispersed recreation	511,015	236,245	190,687/37
MA 35	Lake Mary Watershed	Maintenance and/or improvement of soil condition and watershed function, reduced fire risk in urban/rural influence zone	62,536	59,301	35,994/58
MA 38	West	Reduced fire risk in urban/rural influence zone, recreation, scenic quality	36,298	36,134	19,538/54
MA 33	Doney	Reduced fire risk in urban/rural influence zone, recreation, grasslands, scenic quality	40,530	25,779	14,024/35
MA 36	Schultz	Reduce wildfire risk, maintain watershed health and water quality	21,289	21,130	4,393/21
MA 37	Walnut Canyon	Reduce fire risk in urban/rural interface zone, progress towards desired forest structure including MSO and goshawk habitats	20,566	18,030	6,420/31
MA 13	Cinder Hills	OHV recreation opportunities and amenities, scenic integrity, geologic features	13,711	13,732	13,670/99
MA 6	Unproductive timber lands	Wildlife habitat, watershed condition, grazing	67,146	12,115	11,628/17

Forest Plan Management Areas (MA) and Geographic Areas (GA) within the Project Area*	Description	Forest Plan Emphasis	Forestwide MA and GA Acres	MA and GA Acres within Project Area	Acres/Percent (%) of Forestwide MA/GA Proposed for Treatment
MA 4	Ponderosa pine and MC above 40%	Wildlife habitat, watershed condition, and dispersed recreation	46,382	11,793	8,145/18
MA 32	Deadman Wash	Grasslands, un-roaded landscape, grazing, hunting	58,133	11,659	11,380/20
MA 31	Craters	Restore natural grasslands, re-establish or maintain fire in pinyon-juniper woodland	29,940	8,969	8,969/30
MA 10	Transition grassland/sparse PJ above Mogollon Rim	Range management, watershed condition, and wildlife habitat	160,494	8,544	8,011/5
MA 9	Mountain grasslands	Livestock grazing, visual quality, wildlife habitat	9,049	7,102	5,385/60
MA 20	Highway 180 corridor	Scenic attraction, access to year-round recreation and Grand Canyon NP	7,608	6,213	4,237/56
MA 7	PJ woodlands < 40%	Firewood production, watershed condition, wildlife habitat, grazing	19,077	3,206	3,203/17
MA 5	Aspen	Wildlife habitat, visual quality, sustain yield of firewood production, watershed condition, dispersed recreation	3,450	2,761	695/20
MA 28	Schnebly Rim	Seasonal gateway, conserve winter range for deer, elk, turkey	5,090	2,455	2,455/48
MA 34	Flagstaff	Reduce risk of catastrophic wildfire, recreation, scenic quality	1,781	1,675	1,417/80
MA 18	Environmental Study Areas (Griffith's Springs ESA)	Visual resource management, watershed condition, manage for low fire potential with fire re-established	1,577	1,611	325/21

Forest Plan Management Areas (MA) and Geographic Areas (GA) within the Project Area*	Description	Forest Plan Emphasis	Forestwide MA and GA Acres	MA and GA Acres within Project Area	Acres/Percent (%) of Forestwide MA/GA Proposed for Treatment
MA 12	Riparian and open water	Wildlife habitat, visual quality, fish habitat, watershed condition on the wetlands, riparian forest, and riparian scrub, dispersed recreation on the open water portions	20,490	653	609/3
MA 8	PJ woodlands > 40 %	Firewood production, watershed condition, wildlife habitat, and livestock grazing	273,815	451	248/<1
MA 15	Developed recreation sites	Developed recreation	874	805	48/6
MA 14	Oak Creek Canyon	Scenery, recreation, wildlife habitat, healthy streams, clean air and water, manage fire hazards and risk	5,388	7	7/<1

*Acres and percentages are approximate as many mapping inconsistencies were found when we compared the management area boundary maps to vegetation stand data. Forest plan MA mapping was conducted at a very coarse scale whereas the numbers associated with our vegetation stand data is much more precise. The FLEA MA on the Coconino NF is comprised of MA 3, 4, 5, 8, and 9 which are included in the table.

Table 9. Forest Plan Management Areas within the Kaibab National Forest and Project Area

Kaibab National Forest					
Forest Plan Management Areas within the Project Area*	**Description**	**Forest Plan Emphasis**	**Forestwide MA and GA Acres**	**MA and GA Acres within Project Area**	**Acres/Percent (%) of Forestwide MA/GA Proposed for Treatment**
Kendrick Mountain Wilderness	Designated Wilderness	Manage for natural processes	6,660	6,660	0/0

Arizona Bugbane Botanical Area	Designated Area	AZ bugbane habitat protection	490	490	0/0
Wildland Urban Interface (WUI)	Areas surrounding human development	Wildland fires are low intensity surface fires	389,720	117,272	60,273/51
Grand Canyon Game Preserve	Game preserve	Range of habitats and desired nonnative wildlife species, including predators	612,736	2,395	2,395/<1
Developed Recreation Sites	Recreation sites, trailheads,	Developed Recreation	1,556	1,556	1,556/100
Bill Williams Mountain	Multiple uses	High natural, cultural and economic value	17,745	17,745	20/<1
Garland Prairie	Former proposed research natural area	serves as reference for study of ecological changes	340	340	340//100
Arizona National Scenic Trail	Non-motorized scenic trail		90 Miles	19 miles	19 miles/21

*Acres based on Alternative C. Acres and percentages are approximate as many mapping inconsistencies were found when we compared the management area boundary maps to vegetation stand data. Forest plan MA mapping was conducted at a very coarse scale whereas the numbers associated with our vegetation stand data is much more precise. The FLEA MA on the Coconino NF is comprised of MA 3, 4, 5, 8, and 9 which are included in the table.

Alternatives Considered in Detail

This FEIS documents the analysis of five alternatives, including the no action (alternative A), the final proposed action (alternative B), and three additional alternatives (alternatives C -E). Alternatives C through D respond to recommendations and issues raised by the public during the extended scoping period. Alternative E was developed in response to comments on the DEIS. A brief summary of the alternatives is provided below.

Alternative A is the no action alternative as required by 40 CFR 1502.14(c). There would be no changes in current management and the forest plans would continue to be implemented. Approximately 82,592 acres of ongoing vegetation treatments and 96,125 acres of ongoing prescribed fire projects would continue to be implemented adjacent to the treatment area. Approximately 86,771 acres of vegetation treatments and 142,869 acres of prescribed fire and maintenance burning would be implemented adjacent to the treatment area by the Forests in the foreseeable future (within 5 years). Alternative A is the point of reference for assessing action alternatives B-E.

Alternative B is the P**roposed Action.** This alternative would mechanically treat 384,966 acres of vegetation and utilize prescribed fire on 583,330 acres. It incorporates comments and recommendations received during eight months of collaboration with individuals, agencies, and organizations. It proposes mechanically treating up to 16-inch dbh in 18 Mexican spotted owl (MSO) Protected Activity Areas (PACs) and includes low-severity prescribed fire within 70 MSO PACs, including 54 core areas. Three non-significant forest plan amendments on the Coconino NF would be required to be in compliance with the plan.

Alternative C is the **preferred alternative.** This alternative would mechanically treat 431,049 acres of vegetation and utilize prescribed fire on 586,110 acres. It responds to Issue 2 (conservation of large trees), and Issue 4 (increased restoration and research). It adds acres of grassland treatments on the Kaibab NF, incorporates wildlife and watershed research on both forests, and mechanically treats and uses prescribed fire within the proposed Garland Prairie Research Natural Area on the Kaibab NF. It proposes mechanically treating up to 18-inch dbh in 18 MSO PACs and includes low-severity prescribed fire within 70 MSO PACs, including 54 core areas. Key components of the stakeholder-created Large Tree Retention Strategy are incorporated into the alternative's implementation plan. Three non-significant forest plan amendments on the Coconino NF would be required to be in compliance with the plan.

Alternative D would mechanically treat 384,966 acres of vegetation and utilize prescribed fire on 178,441 acres. This alternative was developed in response to Issue 1, Prescribed Fire Emissions. It decreases the acres that would receive prescribed fire. It proposes mechanically treating up to 16-inch dbh in 18 Mexican spotted owl (MSO) Protected Activity Areas (PACs) but the PACs would not be treated with prescribed fire. Three non-significant forest plan amendments on the Coconino NF would be required to be in compliance with the plan.

Alternative E: This alternative would mechanically treat 431,049 acres of vegetation and utilize prescribed fire on 586,110 acres. It responds to Issue 3 (post-treatment landscape openness and canopy cover), and Issue 5 (range of alternatives and comparison between alternatives). It is similar to alternative C in that it adds acres of grassland treatments on the Kaibab NF and incorporates wildlife and watershed research on both forests. It proposes mechanically treating up to 9-inch dbh in 18 MSO PACs and includes low-severity prescribed fire within 70 MSO PACs, excluding 54 core areas. Key components of the stakeholder-created Large

Tree Retention Strategy are incorporated into the alternative's implementation plan. No forest plan amendments are proposed.

Actions Common to Alternatives (B–E)

All action alternatives (B–E) propose additional actions including restoring springs and ephemeral channels, constructing protective fencing in select aspen stands, constructing (and decommissioning) temporary roads, reconstructing and improving roads, relocating a minimal number of road miles, and decommissioning existing roads and unauthorized routes (table 1).

On those acres proposed for prescribed fire, two fires would be conducted over the 10-year period.

Design features, best management practices (BMPs), and mitigation to be used as part of alternatives B–E are located in volume 1, appendix C of the FEIS.

All action alternatives incorporate key components of the Old Tree Protection Strategy into the alternative's design features (volume 1, appendix C, FEIS), implementation plan (volume 1, appendix D, FEIS), and monitoring and adaptive management plan (volume 1, appendix E, FEIS). The Forest Service worked collaboratively with stakeholders to develop the final monitoring and adaptive management and implementation plan.

All action alternatives include adaptive management actions that would be taken as needed to restore springs, ephemeral channels, and naturalize decommissioned and unauthorized roads (Table 10).

Table 10. Alternative B–E springs, channels, and roads adaptive management actions

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
Roads and unauthorized routes located in upland (non-meadow) and in meadows	Soils are in satisfactory condition so that soil can resist erosion, recycle nutrients, and absorb water. Understory species (grasses, forbs, and shrubs) diversity is consistent with site potential and provides for infiltration of water and reduction of accelerated erosion. The understory has a variety of heights of cool and warm season vegetation.	Up to 904 miles of road/route are in unsatisfactory soil condition due to accelerated erosion, lack of effective ground cover, and compaction.	Reestablish former drainage patterns, stabilize slopes, and restore vegetation; Block the entrance to a road or install water bars; Remove culverts, reestablish drainages, remove unstable fills, pull back road shoulders, and scatter slash on the roadbed; Eliminate the roadbed by restoring natural contours and slopes; and Other methods designed to meet the specific conditions associated with the unneeded road.	Miles of road treated Soil condition assessment	Soil condition is impaired or unsatisfactory as defined in a soil condition assessment. Time is 5 years after treatment.	Additional drainage Additional revegetation efforts (including mulching) Short-term fencing to protect revegetation Complete removal of roadbed
Roads and unauthorized routes located in the filter strips of identified riparian and nonriparian stream courses	Soils are in satisfactory condition so that the soil can resist erosion, recycle nutrients, and absorb water. Understory species (e.g., grasses, forbs, and shrubs) diversity is consistent with site potential and provides for infiltration of water and reduction of accelerated erosion. The understory has a variety of heights of cool and warm season vegetation.	All roads are in unsatisfactory soil condition due to accelerated erosion, lack of effective ground cover, and compaction.	1. Reestablish former drainage patterns, stabilize slopes, and restore vegetation; Block the entrance to a road or install water bars; Remove culverts, reestablish drainages, remove unstable fills, pull back road shoulders, and scatter slash on the roadbed; Eliminate the roadbed by restoring natural contours and slopes; and Other methods designed to meet the specific conditions associated with the unneeded road.	Miles of road treated Soil condition assessment	Soil condition is impaired or unsatisfactory as defined in the soil condition assessment. Time is 5 years after treatment.	Additional drainage Additional revegetation efforts (including mulching) Short-term fencing to protect revegetation
Undeveloped spring in a forested	Springs and associated streams and wetlands have the necessary soil, water,	Undeveloped springs occur on both forests in a	If vegetation/soils are satisfactory options include: Remove tree canopy to pre-	Properly functioning condition	Drop in PFC class, monitoring displays a	ID stressor, protect from stressor (fence/

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
setting. Vegetation and soils range from satisfactory condition (waterflow is occurring) to vegetation/ soils are below potential or are impaired/ unsatisfactory (there is no evidence of waterflow from spring).	and vegetation attributes to be healthy and functioning at or near potential. Waterflow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural disturbances. Soils are in satisfactory condition.	forested setting. There are six springs on the Coconino NF that are located in forested areas, but the status of development is unknown.	settlement condition within 2–5 chains of the spring; Apply for water right if none exists; Prescribe burn, or No action. If vegetation/soils are below potential or are impaired/unsatisfactory options include: Remove tree canopy to pre-settlement condition within 2–5 chains of the spring; Apply for water right if none exists; Remove noxious weeds; Prescribe burn; or Identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.) and/or Other methods designed to meet the desired conditions.	(PFC), Museum of Northern Arizona level 1 monitoring, waterflow (possible new direction for spring monitoring from FS), photo points	dropping trend. Monitoring every 1–10 years	jackstraw, close road, relocated road, etc.) No action
Developed springs in a forested setting.	Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning	There are 26 springs on the Kaibab NF that are located in forested areas and	Negotiate with holders of water rights that are non-Forest Service at Alto, Chimney, Dairy, Double, Garden, Griffiths, Howard, Little Elden, Lower Hull, Mud, Pat,	PFC, Museum of Northern Arizona level 1	Drop in PFC class, monitoring displays a dropping trend. Monitoring every	ID stressor, protect from stressor (fence/ jackstraw, close road,

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
Vegetation and soils range from satisfactory condition (waterflow is occurring) to vegetation/ soils are below potential or are impaired/ unsatisfactory (there is no evidence of waterflow from spring).	at or near potential. Waterflow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural disturbances. Soils are in satisfactory condition.	the status of development is unknown. There are 40 developed springs on the Coconino NF that are located in forested areas. There are six springs on the Coconino NF that are located in forested areas and the status of development is unknown.	Sawmill, Seven Anchor, and Upper Hill Springs on the Coconino National Forest and springs on the Kaibab NF to explore the possibility of releasing water above their water right for riparian conditions. If vegetation/soils are below potential or are impaired/unsatisfactory: Remove tree canopy to pre-settlement condition within 2–5 chains of the spring, Prescribe burn, Remove existing water right (see list above) to expand current riparian conditions, Identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.), and/or Apply other methods designed to meet the desired conditions.	monitoring, waterflow (possible new direction for spring monitoring from FS), photo points	1–10 years	relocated road, etc.) No action
Undeveloped spring in a meadow setting. Vegetation and	Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning	Springs occur on the two national forests that are not developed and occur in a	If vegetation/soils are satisfactory: Apply for water right if none exists, Prescribe burn, and/or	PFC, Museum of Northern Arizona level 1	Drop in PFC class, monitoring displays a dropping trend. Monitoring every	ID stressor, protect from stressor (fence/ jackstraw, close road,

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
soils range from satisfactory condition (waterflow is occurring) to vegetation/ soils are below potential or are impaired/ unsatisfactory (there is no evidence of waterflow from spring).	at or near potential. Waterflow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural disturbances. Soils are in satisfactory condition.	meadow setting. There is one spring on the Coconino NF (Scott Spring) that is located in meadow areas, but the status of development is unknown. There is one spring on the Kaibab NF that is located in meadow areas, but the status of development is unknown.	Take no action. If vegetation/soils are below potential or are impaired/unsatisfactory: Apply for water right if none exists, Remove noxious weeds, Prescribe burn, Identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.), and/or select Other methods designed to meet the desired conditions.	monitoring, waterflow (possible new direction for spring monitoring from FS), photo points	1–10 years	relocate road, etc.) No action
Developed spring in a meadow setting. Vegetation and soils range from satisfactory condition (waterflow is occurring) to vegetation/ soils are below potential or are impaired/	Springs and associated streams and wetlands have the necessary soil, water, and vegetation attributes to be healthy and functioning at or near potential. Waterflow patterns, recharge rates, and geochemistry are similar to historic levels and persist over time. Water quality and quantity maintain native aquatic and riparian habitat and water for wildlife and designated	Springs occur on the two national forests that are developed and occur in a meadow setting. There are four springs on the Coconino NF that are located in meadow areas and are developed.	If vegetation/soils are satisfactory: Prescribe burn, Re-plumb spring to allow for water above existing water right to be released to expand current riparian conditions, and /or Other methods designed to meet the specific conditions associated. If vegetation/soils are below potential or are impaired/unsatisfactory:	PFC, Museum of Northern Arizona level 1 monitoring, waterflow (possible new direction for spring monitoring from FS), photo points	Drop in PFC class, monitoring displays a dropping trend. Monitoring every 1–10 years	ID stressor, protect from stressor (fence/ jackstraw, close road, relocated road, etc.) No action

Evaluation Criteria	Desired Condition	Existing Condition	Possible Management Actions*	Monitoring Measure	Trigger Indicating Additional Action is Needed (What/When)	Adaptive Options*
unsatisfactory (there is no evidence of waterflow from spring).	beneficial uses, consistent with water rights and site capability. Plant distribution and occurrence are resilient to natural disturbances. Soils are in satisfactory condition.		Prescribe burn, Remove noxious weeds, Re-plumb spring to allow for water above existing water right to be released to expand current riparian conditions, Identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.), and/or Other methods designed to meet the desired conditions.			

*Adaptive actions will need to be assessed to evaluate whether they are consistent with the NEPA analysis and decision made.

Table 11. Alternative B through E road activity miles by restoration unit (RU)

RU	Decommission		Temporary Road Construction and Decommission	Reconstruction–Relocation	Reconstruction –Improvement[1]
	Closed Roads	Unauthorized Roads	Temporary Roads		
1	190	0	111	2.2	8
3	100	77	172	2.8	9
4	184	33	198	1.1	9
5	252	0	25	0	3
6	0	24	15	3.3	1
Total	**726**	**134**	**520**	**10**	**30**

*Temporary roads that are constructed would be decommissioned once implementation is complete. Gates or other devices would be used as needed to manage motorized access during implementation.

Table 12. Alternative B through E springs, riparian, ephemeral streams, and aspen activities by restoration unit (RU)

RU	Springs Restoration (Number)	Riparian Habitat and Ephemeral Stream Restoration (Miles)	Aspen Restoration Mechanical Treatment (Acres)	Aspen Restoration Prescribed Fire (Acres)	Aspen Restoration Protective Fencing* (Miles)
1	32	24	182	167	11
3	24	7	201	0	17
4	14	5	451	46	41
5	4	2	392	10	14
6	0	<1	0	0	0
Total	**74**	**39**	**1,227**	**223**	**82**

[1] Road reconstruction improvements are estimated miles for the restoration units.

Alternative B – Proposed Action

The Coconino and Kaibab NFs propose to conduct approximately 583,330 acres of restoration activities over approximately 10 years or until objectives are met. On average, 45,000 acres of vegetation would be mechanically treated annually. On average, 40,000 acres of prescribed fire would be implemented annually across the Forests (within the treatment area). Two prescribed fires would be conducted on all acres proposed for treatment over the 10-year period. Restoration activities would:

- Mechanically cut trees and apply prescribed fire on approximately 384,966 acres. This includes: (1) mechanically treating up to 16-inch dbh within 18 MSO PACs and, (2) using low-severity prescribed fire within 70 MSO PACs (excluding core areas).
- Utilize prescribed fire only on approximately 198,364 acres.
- Construct approximately 520 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed).
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 726 miles of existing system and unauthorized roads on the Coconino NF.
- Decommission 134 miles of unauthorized roads on the Kaibab NF.
- Restore 74 springs and construct up to 4 miles of protective fencing.
- Restore 39 miles of ephemeral channels.
- Construct up to 82 miles of protective (aspen) fencing.
- Allocate/manage as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF and manage 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF.

Three non-significant forest plan amendments would be required on the Coconino NF to implement alternative B:

Amendment 1 (Coconino) would add language to allow mechanical treatments up to 16-inch dbh to improve habitat structure (nesting and roosting habitat) in 18 MSO PACs The amendment would remove language that limits PAC treatments in the recovery unit to 10 percent increments and language that requires the selection of an equal number of untreated PACs as controls. The amendment would remove language referencing monitoring (pre and post treatment, population, and habitat monitoring). Replacement language would defer final project design and monitoring to the FWS biological opinion specific to MSO for the project. Definitions of target and threshold habitat would be added.

Amendment 2 (Coconino) would add the desired percentage of interspace within uneven-aged stands to facilitate restoration in goshawk habitat (excluding nest areas), add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 28,952 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.

Amendment 3 (Coconino) would remove the cultural resource standard that requires achieving a “no effect” determination and would add the words “or no adverse effect” to the remaining standard. In effect, management would strive to achieve a “no effect” or “no adverse effect” determination.

Table 13. Alternative B mechanical and prescribed fire treatment descriptions and acres

Treatment Type	Treatment Description/Objective	Acres
Aspen	Mechanical treatment that removes post-settlement conifers within 100 feet of aspen clone; stimulates suckering. Accompanied by prescribed fire.	1,227
Prescribed Fire Only	Prescribed fire would be applied exclusively to move treated areas towards desired vegetation conditions.	198,364
Grassland Restoration	Mechanical treatment that removes encroaching post-settlement conifers and manages for up to 90 percent of the treatment area as grass/forb/shrub using pre-settlement tree evidence as guidance. Accompanied by prescribed fire.	11,185
Intermediate Thin (IT) 10 (10 to 25% interspace)	Mechanical treatment that thins tree groups and establishes interspace adjacent to tree groups to an average of 70 to 90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe; Interspace would occupy 10 to 55 percent of the treatment area, respectively. Accompanied by prescribed fire.	7,565
Intermediate Thin (IT) 25 (25 to 40% interspace)		11,871
Intermediate Thin (IT) 40 (40 to 55% interspace)		38,712
MSO Threshold	Same as MSO Target (see below)	1,894
MSO Target	Intermediate thinning (IT) designed to improve forest health, reduce fire risk, and meet forest density, structure, and species composition requirements. Accompanied by prescribed fire.	6,497
MSO Restricted	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, irregular tree spacing, a mosaic of interspaces and tree groups of varying sizes. Accompanied by prescribed fire.	64,065
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk. Accompanied by prescribed fire.	10,284
Pine-sage	Mechanical treatment that restores pre-settlement tree density and pattern using pre-settlement tree evidence as guidance.	5,261

Treatment Type	Treatment Description/Objective	Acres
	Accompanied by prescribed fire.	
Savanna (70 to 90% interspace)	Mechanical treatment that restores pre-settlement tree density and pattern, and manages for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individual trees using pre-settlement tree evidence as guidance. Treatment would be accompanied by prescribed fire.	45,405
Stand Improvement (SI) 10 (10 to 25% interspace)	Mechanical treatment that establishes tree groups and interspace adjacent to tree groups and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees within each group; Interspace would occupy 10 to 55 percent of the treatment area, respectively. Treatments would be accompanied by prescribed fire.	1,914
Stand Improvement (SI) 25 (25 to 40% interspace)		6,618
Stand Improvement (SI) 40 (40 to 55% interspace)		12,303
Uneven-aged (UEA) 10 (10 to 25% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 10 to 25 percent of the treatment area. Accompanied by prescribed fire.	18,082
Uneven-aged (UEA) 25 (25 to 40 % interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 25 to 40 percent of the treatment area. Accompanied by prescribed fire.	39,190
Uneven-aged (UEA) 40 (40 to 55% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 40 to 55 percent of the treatment area. Accompanied by prescribed fire.	100,133
Wildland Urban Interface (WUI) Pinyon-juniper	Mechanical treatment around the community of Tusayan designed to reduce fire risk and meet Community Wildfire Protection Plan (CWPP) objective. Accompanied by prescribed fire.	535
Wildland Urban Interface (WUI) (55 to 70% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 55 to 70 percent of the treatment area. Accompanied by prescribed fire.	2,224

Alternative C – Preferred Alternative

The Coconino and Kaibab NFs would conduct restoration activities on approximately 586,110 acres over a period of 10 years or until objectives are met. On average, 45,000 acres of vegetation would be mechanically treated annually. On average, 40,000 acres of prescribed fire would be implemented annually across the Forests (within the treatment area). Two prescribed fires would be conducted on all acres proposed for treatment over the 10-year period. Restoration activities would:

- Mechanically cut trees on approximately 431,049 acres. This includes: (1) mechanically treating up to 18-inch dbh within 18 Mexican spotted owl protected activity centers, and (2) using low-severity prescribed fire within 70 Mexican spotted owl protected activity areas (including 54 core areas).
- Utilize prescribed fire only on approximately 155,061 acres.
- Construct approximately 520 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed).
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 726 miles of existing system and unauthorized roads on the Coconino NF.
- Decommission 134 miles of unauthorized roads on the Kaibab NF.
- Restore 74 springs and construct up to 4 miles of protective fencing.
- Restore 39 miles of ephemeral channels.
- Construct up to 82 miles of protective (aspen) fencing.
- Construct up to 12 flumes and 12 weather stations and associated instrumentation (up to 3 total acres of soil disturbance) to support the Paired Watershed Study research.
- Allocate/manage as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF and manage 35 percent of ponderosa pine and 58 percent of pinyon-juniper woodland on the Kaibab NF.

Three nonsignificant forest plan amendments would be required on the Coconino NF to implement alternative C:

Amendment 1 (Coconino) would allow mechanical treatments up to 17.9-inch dbh to improve habitat structure (nesting and roosting habitat) in 18 MSO PACs. It would allow low-intensity prescribed fire within 54 MSO PAC core areas. The amendment would remove language that limits PAC treatments in the recovery unit to 10 percent increments and language that requires the selection of an equal number of untreated PACs as controls. The amendment would remove language referencing monitoring (pre- and post-treatment, population, and habitat). Replacement language would defer final project design and monitoring to the FWS biological opinion specific to MSO for the project. Definitions of target and threshold habitat would be added. It would allow 6,299 acres of restricted target and threshold habitat to be managed for a minimum range of 110 to 150 basal area.

Amendment 2 (Coconino) would add the desired percentage of interspace within uneven-aged stands to facilitate restoration in goshawk habitat (excluding nest areas), add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 28,653 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands. The amendment adds language that clarifies canopy cover in 40,496 acres of VSS 4, VSS 5 and VSS 6 would be measured at both the stand and group level.

Amendment 3 (Coconino) would remove the cultural resource standard that requires achieving a “no effect” determination and would add the words “or no adverse effect” to the remaining standard. In effect, management would strive to achieve a “no effect” or “no adverse effect” determination.

Table 14. Alternative C mechanical and prescribed fire treatment descriptions and acres

Treatment Type	Treatment Description/Objective	Acres
Aspen	Mechanical treatment that removes post-settlement conifers within 100 feet of aspen clone; stimulates suckering. Accompanied by prescribed fire.	1,227
Prescribed Fire Only	Prescribed fire would be applied exclusively to move treated areas towards desired vegetation conditions.	155, 061
AZ Game & Fish Research	Mechanical treatment designed to create groups of various sizes ranging from 1 to 15 acres in size. Accompanied by prescribed fire.	4,837
Grassland Restoration	Mechanical treatment that removes encroaching post-settlement conifers and manages for up to 90 percent of the treatment area as grass/forb/shrub using pre-settlement tree evidence as guidance. Accompanied by prescribed fire.	11,230
Grassland Mechanical	Mechanical treatment in grassland vegetation types. Accompanied by prescribed fire.	48,161
Intermediate Thin (IT) 10 (10 to 25% interspace)	Mechanical treatment that thins tree groups and establishes interspace adjacent to tree groups to an average of 70 to 90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe; Interspace would occupy 10 to 55 percent of the treatment area, respectively. Accompanied by prescribed fire.	7,565
Intermediate Thin (IT) 25 (25 to 40% interspace)		11,871
Intermediate Thin (IT) 40 (40 to 55% interspace)		38,616
MSO Threshold	Same as MSO Target (below)	1,892
MSO Target	Intermediate thinning (IT) designed to improve forest health, reduce fire risk, and meet forest density, structure, and species composition requirements. Accompanied by prescribed fire.	6,495
MSO Restricted	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, irregular tree spacing, a mosaic of interspaces and tree groups of varying sizes. Accompanied by prescribed fire.	62,785
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk. Accompanied by prescribed fire.	10,284
MSO PAC Grassland Mechanical	Mechanical treatment designed to re-establish the historic meadow edge as defined by the current forest structure of young trees encroaching around the meadow edge; Retain large trees with long-lived characteristics. Accompanied by prescribed fire.	35
Pine-sage	Mechanical treatment that restores pre-settlement tree density and pattern using pre-settlement tree evidence as guidance. Accompanied by prescribed fire.	5,261
Savanna (70 to 90% interspace)	Mechanical treatment that restores pre-settlement tree density and pattern, and manages for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individual trees using pre-settlement tree evidence as guidance. Treatment would be	45,142

Treatment Type	Treatment Description/Objective	Acres
	accompanied by prescribed fire.	
Stand Improvement (SI) 10 (10 to 25% interspace)	Mechanical treatment that establishes tree groups and interspace adjacent to tree groups and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees within each group; Interspace would occupy 10 to 55 percent of the treatment area, respectively. Treatments would be accompanied by prescribed fire.	1,914
Stand Improvement (SI) 25 (25 to 40% interspace)		6,618
Stand Improvement (SI) 40 (40 to 55% interspace)		12,269
Uneven-aged (UEA) 10 (10 to 25% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 10 to 25 percent of the treatment area. Accompanied by prescribed fire.	17,865
Uneven-aged (UEA) 25 (25 to 40% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 25 to 40 percent of the treatment area. Accompanied by prescribed fire.	38,492
Uneven-aged (UEA) 40 (40 to 55% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 40 to 55 percent of the treatment area. Accompanied by prescribed fire.	95,730
Wildland Urban Interface (WUI) Pinyon-juniper	Mechanical treatment around the community of Tusayan designed to reduce fire risk and meet Community Wildfire Protection Plan (CWPP) objectives. Accompanied by prescribed fire	535
Wildland Urban Interface (WUI) (55 to 70% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 55 to 70 percent of the treatment area. Accompanied by prescribed fire.	2,224
Paired Watershed Study	2,300 acres of control watersheds and infrastructure (50’ high towers with no guy lines, snow pillows, 12 flumes and 12 weather stations and associated instrumentation) to evaluate how restoration affects water yield and carbon. No fire treatments for 5 to 7 years in control watersheds.	Up to 3

Alternative D

Alternative D responds to Issue 2 (prescribed fire emissions) by decreasing prescribed fire acres by 30 percent when compared to alternative B (proposed action). A select number of MSO PACs would be mechanically treated but would not be treated with prescribed fire. All other components of the alternative are the same as described in alternative B.

The Coconino and Kaibab NFs would conduct restoration activities on approximately 563,407 acres over a period of 10 years or until objectives are met. On average, 45,000 acres of vegetation would be mechanically treated annually. Restoration activities would:

- Mechanically cut trees on approximately 384,966 acres. This includes: (1) mechanically treating up to 16-inch dbh within 18 Mexican spotted owl protected activity centers, and, (2) disposing of slash through various methods including chipping, shredding, mastication, and removal of biomass off-site
- Utilize prescribed fire only on approximately 178,441 acres. On average, 40,000 acres of prescribed fire would be implemented annually across the Forests (within the treatment area). Two prescribed fires would occur over the 10-year treatment period.
- Construct 520 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed).
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 726 miles of existing system and unauthorized roads on the Coconino NF.
- Decommission 134 miles of unauthorized roads on the Kaibab NF.
- Restore 74 springs and construct up to 4 miles of protective fencing.
- Restore 39 miles of ephemeral channels.
- Construct up to 82 miles of protective (aspen) fencing.
- Allocate/manage as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF, and manage 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF.

Three non-significant forest plan amendments would be required on the Coconino NF to implement alternative D:

Amendment 1 (Coconino) would add language to allow mechanical treatments up to 16-inch dbh to improve habitat structure (nesting and roosting habitat) in 18 MSO PACs. The amendment would remove language that limits PAC treatments in the recovery unit to 10 percent increments and language that requires the selection of an equal number of untreated PACs as controls. The amendment would remove language referencing monitoring (pre- and post-treatment, population, and habitat). Replacement language would defer final project design and monitoring to the FWS biological opinion specific to MSO for the project. Definitions of target and threshold habitat would be added.

Amendment 2 (Coconino) would add the desired percentage of interspace within uneven-aged stands to facilitate restoration in goshawk habitat (excluding nest areas), add the interspace distance between tree groups, add language clarifying where canopy cover is and is not measured, allow 28,952 acres to be managed for an open reference condition, and add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.

Amendment 3 (Coconino) would remove the cultural resource standard that requires achieving a “no effect” determination and would add the words “or no adverse effect” to the remaining standard. In effect, management would strive to achieve a “no effect” or “no adverse effect” determination.

Table 15. Alternative D mechanical and prescribed fire treatment descriptions and acres

Treatment Type	Treatment Description/Objective	Acres
Aspen	Mechanical treatment that removes post-settlement conifers within 100 feet of aspen clone; stimulates suckering.	1,227
Prescribed Fire Only	Prescribed fire would be applied exclusively to move treated areas towards desired vegetation conditions.	178,441

Treatment Type	Treatment Description/Objective	Acres
Grassland Restoration	Mechanical treatment that remove encroaching post-settlement conifers and manages for up to 90 percent of the treatment area as grass/forb/shrub using pre-settlement tree evidence as guidance.	11,185
Intermediate Thin (IT) 10 (10 to 25% interspace)	Mechanical treatment that thins tree groups and establishes interspace adjacent to tree groups to an average of 70 to 90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe; Interspace would occupy 10 to 55 percent of the treatment area, respectively.	7,565
Intermediate Thin (IT) 25 (25 to 40% interspace)		11,871
Intermediate Thin (IT) 40 (40 to 55% interspace)		38,712
MSO Threshold	Same as MSO Target (below)	1,894
MSO Target	Intermediate thinning (IT) designed to improve forest health, reduce fire risk, and meet forest density, structure, and species composition requirements.	6,497
MSO Restricted	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, irregular tree spacing, a mosaic of interspaces and tree groups of varying sizes.	64,065
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk.	10,284
Pine-sage	Mechanical treatment that restores pre-settlement tree density and pattern using pre-settlement tree evidence as guidance.	5,261
Savanna (70 to 90 % interspace)	Mechanical treatment that restores pre-settlement tree density and pattern and manages for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individual trees using pre-settlement tree evidence as guidance.	45,405
Stand Improvement (SI) 10 (10 to 25% interspace)	Mechanical treatment that establishes tree groups and interspace adjacent to tree groups and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees within each group; Interspace would occupy 10 to 55 percent of the treatment area, respectively.	1,914
Stand Improvement (SI) 25 (25 to 40% interspace)		6,618
Stand Improvement (SI) 40 (40 to 55% interspace)		12,303
Uneven-aged (UEA) 10 (10 to 25% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 10 to 25 percent of the treatment area.	18,082
Uneven-aged (UEA) 25 (25 to 40% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 25 to 40 percent of the treatment area.	39,190
Uneven-aged (UEA) 40 (40 to 55% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 40 to 55 percent of the treatment area.	100,133
Wildland Urban Interface (WUI) Pinyon-Juniper	Mechanical treatment around the community of Tusayan designed to reduce fire risk and meet Community Wildfire Protection Plan (CWPP) objectives.	535
Wildland Urban Interface (WUI) (55 to 70% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 55 to 70 percent of the treatment area.	2,224

Alternative E

Alternative E responds to Issue 5 by removing all forest plan amendments. Eighteen MSO PACs would be mechanically treated to 9-inch dbh. No prescribed fire would be utilized within MSO PAC core areas. No acres would be managed for an open reference condition[2]. No treatments would occur within the proposed Garland Prairie RNA. MSO population and habitat monitoring would follow current forest plan direction and the FWS biological opinion. Watershed research would occur.

The Coconino and Kaibab NFs would conduct restoration activities on approximately 581,301 acres over a period of 10 years or until objectives are met. On average, 45,000 acres of vegetation would be mechanically treated annually. Restoration activities would:

- Mechanically cut trees on approximately 403,500 acres. This includes: (1) mechanically treating up to 9-inch dbh within 18 Mexican spotted owl protected activity centers and, (2) disposing of slash through various methods including chipping, shredding, mastication, and removal of biomass off-site.
- Utilize prescribed fire only on approximately 177,801 acres. On average, 40,000 acres of prescribed fire would be implemented annually across the Forests (within the treatment area). Two prescribed fires would occur over the 10-year treatment period.
- Construct 520 miles of temporary roads for haul access and decommission when treatments are complete (no new permanent roads would be constructed).
- Reconstruct up to 40 miles of existing, open roads for resource and safety concerns (no new permanent roads would be constructed). Of these miles, approximately 30 miles would be improved to allow for haul (primarily widening corners to improve turn radiuses) and about 10 miles of road would be relocated out of stream bottoms. Relocated roads would include rehabilitation of the moved road segment.
- Decommission 726 miles of existing system and unauthorized roads on the Coconino NF.
- Decommission 134 miles of unauthorized roads on the Kaibab NF.
- Restore 74 springs and construct up to 4 miles of protective fencing.
- Restore 39 miles of ephemeral channels.
- Construct up to 82 miles of protective (aspen) fencing.
- Construct up to 12 flumes and 12 weather stations and associated instrumentation (up to 3 total acres of soil disturbance) to support the Paired Watershed Study research.
- Allocate/manage as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF, and manage 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF.

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[2] Open Reference Condition is defined as forested ponderosa pine areas with mollic integrade soils to be managed as a relatively open forest with trees typically aggregated in small groups within a grass/forb/shrub matrix.

Table 16. Alternative E Mechanical and Prescribed Fire Treatment Descriptions and Acres

Treatment Type	Treatment Description/Objective	Acres
Aspen	Mechanical treatment that removes post-settlement conifers within 100 feet of aspen clone; stimulates suckering.	1,227
Prescribed Fire Only	Prescribed fire would be applied exclusively to move treated areas towards desired vegetation conditions.	177,801
AZ Game & Fish Research	Mechanical treatment designed to create groups of various sizes ranging from 1 to 15 acres in size. Accompanied by prescribed fire.	4,837
Grassland Mechanical	Mechanical treatment in grassland vegetation types. Accompanied by prescribed fire.	47,880
Intermediate Thin (IT) 10 (10 to 25% interspace)	Mechanical treatment that thins tree groups and establishes interspace adjacent to tree groups to an average of 70 to 90 square feet of basal area and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees with the least amount of mistletoe; Interspace would occupy 10 to 55 percent of the treatment area, respectively.	7,565
Intermediate Thin (IT) 25 (25 to 40% interspace)		11,871
Intermediate Thin (IT) 40 (40 to 55% interspace)		40,272
MSO Threshold	Same as MSO Target (below)	1,892
MSO Target	Intermediate thinning (IT) designed to improve forest health, reduce fire risk, and meet forest density, structure, and species composition requirements.	7,059
MSO Restricted	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, irregular tree spacing, a mosaic of interspaces and tree groups of varying sizes.	62,222
MSO PAC	Mechanical treatment designed to increase tree vigor and health and create canopy gaps to reduce fire risk.	10,284
MSO PAC Grassland Mechanical	Mechanical treatment designed to re-establish the historic meadow edge as defined by the current forest structure of young trees encroaching around the meadow edge; Retain large trees with long-lived characteristics. Accompanied by prescribed fire.	35
Pine-sage	Mechanical treatment that restores pre-settlement tree density and pattern using pre-settlement tree evidence as guidance.	5,261
Stand Improvement (SI) 10 (10 to 25% interspace)	Mechanical treatment that establishes tree groups and interspace adjacent to tree groups and manages for improved tree vigor and growth by retaining the best growing dominant and co-dominant trees within each group; Interspace would occupy 10 to 55 percent of the treatment area, respectively.	1,914
Stand Improvement (SI) 25 (25 to 40% interspace)		6,618
Stand Improvement (SI) 40 (40 to 55% interspace)		13,595
Uneven-aged (UEA) 10 (10 to 25% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 10 to 25 percent of the treatment area.	17,865
Uneven-aged (UEA) 25 (25 to 40% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 25 to 40 percent of the treatment area.	38,492
Uneven-aged (UEA) 40 (40 to 55% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 40 to 55 percent of the treatment area.	121,570

Treatment Type	Treatment Description/Objective	Acres
Wildland Urban Interface (WUI) Pinyon-Juniper	Mechanical treatment around the community of Tusayan designed to reduce fire risk and meet Community Wildfire Protection Plan (CWPP) objectives.	535
Wildland Urban Interface (WUI) (55 to 70% interspace)	Uneven-aged (UEA) mechanical treatment designed to develop uneven-aged structure, and a mosaic of interspaces and tree groups of varying sizes. Interspace would occupy 55 to 70 percent of the treatment area.	2,224
Paired Watershed Study	2,300 acres of control watersheds and infrastructure (50’ high towers with no guy lines, snow pillows, 12 flumes and 12 weather stations and associated instrumentation) to evaluate how restoration affects water yield and carbon. No fire treatments for 5 to 7 years in control watersheds.	Up to 3

Comparison of Alternatives

Table 17 provides a summary of the alternatives. Information in this table focuses on effects related to the purpose and need for the project. See chapter 3 for detailed discussion of the effects and the specialists' reports for the complete analysis.

Table 17. Comparison of Alternatives

Proposed Activity Activity	Alternative A (No Action)	Alternative B (Proposed Action)	Alternative C (Preferred)	Alternative D	Alternative E
Vegetation Mechanical Treatment (acres)	0	**384,966**	**431,049**	**384,966**	**403,500**
Prescribed Fire (acres)*	0	**583,330**	**586,110**	**178,441**	**581,301**
MSO PAC Habitat Treatments	N/A	Mechanically treat up to 16-inch dbh in 18 PACs (excluding core areas) Utilize prescribed fire in **70 MSO PACs** (excluding core areas)	Mechanically treat up to 17.9-inch dbh in 18 PACs Utilize prescribed fire in 54 MSO PACs (including core areas) Utilize prescribed fire in 16 MSO PACs (excluding core areas)	Mechanically treat up to 16-inch dbh in 18 PACs (excluding core areas) Utilize prescribed fire in **70 MSO PACs** (excluding core areas)	Mechanically treat up to 9-inch dbh in 18 PACs (excluding core areas) Utilize prescribed fire in **70 MSO PACs** (excluding core areas)
Springs Restored (number)	0	74	Same as alternative B		
Springs Protective Fence Construction (miles)	0	Up to 4	Same as alternative B		
Aspen Protective Fencing (miles)		Up to 82	Same as alternative B		
Ephemeral Stream Restoration (miles)	0	39	Same as alternative B		
Temporary Road Construction and Decommission	0	**520**	Same as alternative B		

Proposed Activity Activity	Alternative A (No Action)	Alternative B (Proposed Action)	Alternative C (Preferred)	Alternative D	Alternative E
(miles)					
Road Reconstruction/ Improvement (miles)	N/A	Up to 30	Same as alternative B		
Road Relocation (miles)	N/A	Up to 10	Same as alternative B		
Existing Road Decommission (miles)	N/A	**726**	Same as alternative B		
Unauthorized Route Decommission (miles)	N/A	134	Same as alternative B		

*On those acres proposed for prescribed fire, two fires would be conducted over the 10- year period.

Affected Environment

Restoration Units and Subunits

1-1: This treatment area includes portions of four 6th Code HUC watersheds, but only one perennial stretch of stream, a portion of Rio de Flag. This subunit does not contain any proposed spring restoration areas, but several stream channel restorations are proposed, including portions of Fay Canyon1, Skunk Canyon, and Cherry Canyon.

Fish that may be present in Rio de Flag include Largemouth Bass, Channel Catfish and Smallmouth Bass. Native fish that may be present include Speckled Dace. There are no listed or sensitive fish or macroinvertebrates documented in this streamcourse.

Nearby water bodies include Lower Lake Mary and Marshall Lake, but both are upstream of the treatment area. All other streamcourses and water bodies in or near this subunit are ephemeral and therefore do not contain permanent populations of fish or macroinvertebrates.

1-2: There is no perennial water in this subunit, thus permanent populations of fish and macroinvertebrates are absent. Spring restoration is proposed for Sedge Spring. Mormon Lake is nearby and downhill from a portion of the subunit, but water in this natural lake is ephemeral, and thus any fish species present are the result of opportunistic stocking by the Arizona Game and Fish Department.

Mormon Lake went dry in the fall of 2009 and currently has no fish living in the lake. The final Environmental Assessment for sportfish stocking in Arizona (USDI 2011) eliminated both Mormon Lake and Stoneman Lake from all future stocking of sportfish in order to protect populations of Northern leopard frog.

1-3: This treatment area includes portions of three 6th Code HUC watersheds, including Walnut Creek-Upper Lake Mary, Walnut Creek-Lower Lake Mary, and Pumphouse Wash. There are no perennial streams in this treatment area, but Walnut Creek fills both Upper and Lower Lake Mary, which hold water through most if not all of the year. Local runoff fills Marshall Lake, which occasionally holds enough water to support seasonal Rainbow Trout stocking. Stream channels in this treatment area also include Schoolhouse Draw, Pumphouse Wash, Kelly Canyon, James Canyon, Priest Draw, Howard Draw, and Newman Canyon. Proposed spring restoration in this subunit includes Thomas Spring, Hogworth Spring, Clarks Well, Babbit Spring, and Welmer Spring. Stream channel restoration projects are proposed for portions of Schoolhouse Wash, Pumphouse Wash, James Canyon, Priest Draw, Howard Draw, and Newman Canyon, in this subunit.

1-4: This treatment unit includes portions of five 6th Code HUC watersheds, including Yeager Draw, Kinnikinick Canyon, Grapevine Canyon, Sawmill Wash, and Long Lake-Chaves Pass Ditch. This restoration subunit includes only one stretch of perennial stream, the upper portion of Sawmill Wash. Proposed spring restoration includes Mint Spring and Dove Springs in Kinnikinick Canyon. The only proposed stream channel restoration is a small stretch of Sawmill Wash, downstream from perennial streamflow.

Macroinvertebrates are found in the ephemeral streamcourses when water is flowing, and year-round in the perennial portion of Sawmill Wash.

1-5: This treatment unit includes portions of seven 6th Code HUC watersheds, including Munds Canyon, Mormon Lake, Lower Woods Canyon, Upper Woods Canyon, Bar M Canyon, Rattlesnake Canyon, and

Double Canyon Park-Jacks Canyon. Perennial streams near this treatment unit include a portion of Sawmill Wash and Munds Creek, downstream from Odell Lake. Six stream channel restoration projects are proposed along unnamed stream channels. Eighteen proposed spring restoration projects include Willard Spring, Howard Spring, Mud Spring, Dairy Spring, Double Springs, Smith Spring, Munds Spring, Sheep Spring, Bootlegger Spring, Bristow Spring, Rock Top Springs, Tree Spring, Railroad Spring, Lee Spring, Van Deren Spring, Tinney Spring, Broken Spring, and Seven Anchor Spring.

Odell Lake is located near Munds Park. Fish in this artificial lake include Northern Pike, Yellow Perch, and Fathead Minnow. Flood events apparently wash fish from this lake downstream into the intermittent portions of Munds Canyon (M. Childs, USFS, pers. obs., 2010). Macroinvertebrates are present in the stream when water is present, and in Odell Lake.

3-1: This treatment unit includes portions of eleven 6th Code HUC watersheds, including Cataract Creek Headwaters, Dogtown Wash, Johnson Creek, Meath Wash, Devil Dog Canyon, Upper Hell Canyon, Rattlesnake Wash, Grindstone Wash, MC Canyon, Bear Canyon, and Government Canyon. There are no perennial streams in this treatment unit, but ephemeral flows provide water to three lakes that usually contain water: City, Dogtown, and Santa Fe Reservoirs. Thirteen streamcourses are located within this subunit. One stream channel restoration project is proposed, along an unnamed stream channel in the Johnson Creek watershed. No spring restoration projects are proposed for this subunit.

The lakes contain populations of macroinvertebrates. Ephemeral streamcourses in the subunit may occasionally contain macroinvertebrates, depending on flows.

3-2: This treatment unit includes portions of seven 6th Code HUC watersheds: Big Spring Canyon, Pitman Valley-Scholz Lake, Sawmill Tank, Garland Prairie, Government Prairie, Volunteer Wash, and Telephone Tank. There are no perennial streams in this treatment unit, but Scholz Lake usually contains water, with ephemeral flows from Frenchy Canyon. There are five ephemeral streamcourses within this subunit. No stream channel or spring restoration projects are proposed for this subunit.

Macroinvertebrate populations in this subunit are not permanent residents, as there is no perennial water. Ephemeral populations, however, occur in Scholz Lake and Perkins Tank, and some streamcourses.

3-3: This treatment unit includes portions of seven 6th Code HUC watersheds: Tule Canyon, Cedar Creek, Upper, Middle, and Lower Sycamore Creek, Little Lo Spring Canyon, and Volunteer Canyon. Perennial water occurs in upper Sycamore Creek, and in nearby West Fork of Oak Creek, which is SE of the Little Lo Spring Canyon watershed. Eleven stream courses occur within this treatment subunit, including Lee Canyon, Tule Tank Wash, Government Canyon, Jacks Canyon, Dam Wash, Colcord Canyon, Sycamore Creek, Volunteer Canyon, Little Lo Spring Canyon, Railroad Draw, and Sinclair Wash. Streamcourse restoration is proposed for several unnamed streamcourses, and for portions of Volunteer Canyon and Railroad Draw. Spring restoration is proposed for Upper and Lower Hull Spring, Poison Spring, and Railroad Spring.

Fish present in Sycamore Creek include Yellow Bullhead, Western Mosquitofish, Green Sunfish, and Smallmouth Bass (D. Weedman, AGFD, pers. comm.). Native fish that have been collected from Sycamore Creek include Sonora Sucker, Desert Sucker, Spikedace, Roundtail Chub, Longfin Dace, and Speckled Dace.

Macroinvertebrate populations occur in the perennial portion of upper Sycamore Creek and in nearby West Fork of Oak Creek.

3-4: This treatment unit includes portions of three 6th Code HUC watersheds: Upper Rio de Flag, Sinclair Wash, and Pumphouse Wash. Perennial water occurs in Pumphouse Wash and nearby Oak Creek. Five streamcourses occur within this treatment subunit, including Sinclair Wash, Woody Wash, Pumphouse Wash, Kelly Canyon, and James Canyon. No streamcourse restoration is proposed for this treatment subunit, but two spring restoration projects (Griffiths Spring, Scott Spring) are proposed.

Fish in this subunit are found in Pumphouse Wash (Rainbow Trout, Brown Trout, Speckled Dace) and in nearby Oak Creek (see below). Cold water macroinvertebrate populations exist in both of these perennial streams.

3-5: The Turkey Butte/Barney Pasture Restoration Project removed a substantial portion of the SW portion of this treatment area. This treatment subunit includes portions of seven 6th Code HUC watersheds: Fry Canyon, West Fork Oak Creek, Upper Oak Creek, Munds Canyon, Middle Oak Creek, Lower Woods Canyon, and Upper Woods Canyon. Perennial water occurs in West Fork Oak Creek, Oak Creek, and Munds Canyon. Eleven streamcourses occur within this treatment subunit, including Casner Cabin Draw, Fry Canyon, Sterling Canyon, West Fork Oak Creek, Cookstove Draw, Surveyor Canyon, Crazy Park Canyon, Bee Canyon, Munds Canyon, Casner Canyon 1, and Woods Canyon. Oak Creek (Upper Oak Creek watershed) flows near the treatment subunit. Foxboro Lake is a small ephemeral lake in the Munds Canyon watershed. Eight streamcourse restoration projects are proposed in unnamed streamcourses, and two springs (Lockwood and Ritter Springs) are proposed for restoration.

Fish in this subunit are found in Oak Creek (Rainbow Trout, Brown Trout, Speckled Dace, Roundtail Chub, Sonora Sucker, and Desert Sucker), in West Fork Oak Creek (Rainbow Trout, Brown Trout, Speckled Dace, Sonora Sucker, Desert Sucker, and Gila Trout[3]), and in the perennial portion of Munds Canyon (Northern Pike, Yellow Perch, Fathead Minnow, Green Sunfish, and Rock Bass). Macroinvertebrate populations occur in each of the perennial streams.

Oak Creek extends from the Mogollon Rim to its confluence with the Verde River near Cornville. Oak Creek survey data indicates a mixture of cold and warm water fish species (Table 18; C. Benedict, pers. comm.).

[3] West Fork Oak Creek represents historic habitat for Gila trout.

Table 18. Summary of past AGFD survey data from Oak Creek, (1991 through 2007; AGFD unpublished data).

Species*	Total Captured
Desert Sucker	235
Sonora Sucker	93
Speckled Dace	805
Smallmouth Bass	59
Channel Catfish	1
Brown Trout	681
Green Sunfish	80
Red Shiner	1
Common Carp	1
Rock Bass	13
Flathead Catfish	1
Rainbow Trout	239
Bullhead catfish	37

*Note that Roundtail Chub was not captured in Oak Creek in any AGFD surveys between 1991 and 2007.

In 2007 (Rinker 2007), the fish assemblage in Oak Creek upstream of the Grasshopper Point recreation site included Rainbow Trout (stocked and wild spawned), Speckled Dace, Brown Trout (wild spawned), Sonora Sucker and Desert Sucker. The fish assemblage downstream of the Grasshopper Point recreation site in 2007 included Rock Bass, Green Sunfish, Smallmouth Bass, Channel Catfish, Bullhead Catfish, Common Carp, Rainbow Trout (stocked), Sonora Sucker, Speckled Dace and Desert Sucker.

Roundtail Chub are known from Oak Creek as far upstream as the city of Sedona, but were likely present throughout perennial portions of the stream historically.

The West Fork of Oak Creek is a tributary of Oak Creek located near Sedona, Arizona in the Coconino National Forest. Sampling in 2003 and 2010 (Rinker 2010) indicated that the fish community is composed primarily of Speckled Dace with a few Rainbow Trout and Desert Sucker. Speckled Dace comprised the majority of the total catch at 98.5% with Rainbow Trout making up the other 1.5% (6 individuals). Although not collected, small numbers of “suckers” (*Catostomus* spp) were also observed during the survey in deep pools close to the confluence with Oak Creek. Both Desert and Sonora Sucker are likely present. Gila Trout was present historically.

Cold water macroinvertebrate populations exist in both Oak Creek and West Fork of Oak Creek.

4-2: This treatment subunit includes portions of five 6th Code HUC watersheds: Upper Cataract Canyon, Cataract Creek Headwaters, Dogtown Wash, Johnson Creek, and Juan Tank Canyon. There are no perennial streams within this treatment unit, but ephemeral streamcourses include Johnson Creek, K4 Draw, West Cataract Creek, Cataract Creek, Pine Creek, and Dogtown Wash. Water bodies in this treatment area include Cataract Lake, Gonzales Lake, Three Mile Lake, Kaibab Lake, and nearby Holden Tank. No streamcourse or spring restoration projects are proposed for this subunit.

Native fish are not present in this subunit. Macroinvertebrates occur in the ephemeral waters, when water is present.

4-3: This treatment subunit includes portions of three 6th Code HUC watersheds: Middle Spring Valley Wash, Smoot Lake, and Upper Red Lake Wash. There are no perennial streams within this treatment subunit. Ephemeral stream courses include Spring Valley Wash and Red Lake Wash. Four streamcourse restoration projects are proposed in the Middle Spring Valley Wash watershed, and two are proposed in the Upper Red Lake Wash watershed. No spring restoration projects are proposed.

No permanent fish or macroinvertebrate populations occur within this subunit.

4-4: This treatment subunit includes portions of seven 6th Code HUC watersheds: Pitman Valley-Scholz Lake, Sawmill Tank, Garland Prairie, Upper Spring Valley Wash, Government Prairie, Volunteer Wash, and Telephone Tank. There are no perennial streams within this treatment subunit. Ephemeral streamcourses include Spring Valley Wash, McDermit Canyon, and Volunteer Wash. Ephemeral water bodies include Dry Lake, Davenport Lake North, Duck Lake, Fay Lake, Raymond Lake, and Moritz Lake. No streamcourse or spring restoration projects are proposed for this subunit.

No permanent fish or macroinvertebrate populations occur within this subunit.

4-5: This treatment subunit includes portions of two 6th Code HUC watersheds: Upper Rio de Flag and Sinclair Wash. There is no perennial water in this subunit. Ephemeral streamcourses include Rio de Flag and Sinclair Wash. No streamcourse or spring restoration projects are proposed for this subunit.

Frances Short Pond is stocked for fishing by AGFD. Rainbow Trout are provided for the local fishing community. Macroinvertebrate populations occur within Frances Short Pond and within the ephemeral portions of Rio de Flag when the streamcourse is flowing.

5-1: This treatment subunit includes portions of eight 6th Code HUC watersheds: Upper Deadman Wash, Babbit Lake, Upper Spring Valley Wash, Government Prairie, Volunteer Wash, Upper Rio de Flag, Lower Rio de Flag, and Sinclair Wash. Perennial water in the treatment subunit can be found in a portion of Rio de Flag (Lower Rio de Flag watershed). Streamcourses within the subunit include: Deadman Wash, White Horse Canyon, Abineau Canyon, Reese Canyon, Volunteer Wash, Rio de Flag, Schultz Creek, Sinclair Wash, and Switzer Canyon. Two unnamed streamcourse restoration projects are proposed, and two spring restoration projects (Pat Spring and Chimney Spring) are proposed.

Native fish in the perennial portions of Rio de Flag may include Speckled Dace, but no recent surveys have been conducted. Macroinvertebrate populations exist year-round in this perennial water.

5-2: This treatment subunit includes portions of seven 6th Code HUC watersheds: Middle Deadman Wash, Bear Jaw Canyon, Lower Deadman Wash, Upper Kana-a Wash, Doney Park, Upper San Francisco Wash, and Cinder Basin. There is no perennial water within this treatment subunit. There are only two ephemeral streamcourses in this subunit, Bear Jaw Canyon and Weatherford Canyon. Two unnamed streamcourse restoration projects are proposed, and one spring restoration project (Little Elden Spring) is proposed.

No permanent fish or macroinvertebrate populations occur within this subunit.

6-2: This treatment subunit includes portions of three 6th Code HUC watersheds: Rain Tank Wash, Little Red Horse Wash, and Curley Wallace Tank. No perennial streams occur in this treatment subunit, and only one ephemeral streamcourse (Rain Tank Wash) is present. No streamcourse or spring restoration projects are proposed for this subunit.

No permanent fish or macroinvertebrate populations occur within this subunit.

6-3: This treatment subunit includes portions of two 6th Code HUC watersheds: Coconino Wash Headwaters and Red Horse Wash Headwaters, and their ephemeral streamcourses. No perennial water occurs within this subunit. Two unnamed streamcourse restoration projects are proposed in the Coconino Wash Headwaters watershed, but no spring restoration projects are proposed.

No permanent fish or macroinvertebrate populations occur within this subunit.

6-4: This treatment subunit includes portions of the Upper Lee Canyon 6^{th} Code HUC watershed. There is no perennial water within this subunit, but the ephemeral Lee Canyon is located along the NE border of the treatment area. Also, just downstream from the treatment subunit is Trash Dam, which holds water ephemerally as well. No streamcourse or spring restoration is proposed for this treatment subunit. No permanent fish or macroinvertebrate populations occur within this subunit.

Special Status Fish Species' Natural History and Occurrence

Five endangered, one candidate, and three Forest Sensitive fish and/or their habitat were considered in this analysis because of their potential occurrence within the project Analysis Area (Table 19). Three Forest Sensitive macroinvertebrates or their habitat also occur within the Analysis Area. Finally, macroinvertebrates (Forest-wide Management Indicator Species) occur in perennial waters within the Analysis Area.

Table 19. Threatened, endangered, or sensitive fishes and/or their habitat expected to occur in the Four Forest Restoration Initiative project area.

Common Name	Scientific Name	Status[1]	Occurrence[2]	Coconino Forest-wide Habitat (mi)	Potential Habitat in Affected Environment (mi)	Occupied Habitat in Affected Environment (mi)
Fish						
Gila Chub	*Gila intermedia*	E, WC	**Δ**	13.3[4]	0	0
Roundtail Chub	*Gila robusta*	C, WC, FS-S	O	350.9	77.9	77.9
Spikedace	*Meda fulgida*	E, WC	**Δ**	134.3[4]	36.8[4]	0
Colorado Pikeminnow	*Ptychocheilus lucius*	E[3], WC	**Δ**	55.6	0	0
Loach Minnow	*Tiaroga cobitis*	E, WC	H	95.8[4]	36.8[4]	0
Razorback Sucker	*Xyrauchen texanus*	E, WC	**Δ**	55.6[4]	0	0
Desert Sucker	*Catostomus clarki*	WC, FS-S	O	236.7	77.9	77.9
Sonora Sucker	*Catostomus insignis*	WC, FS-S	O	236.7	77.9	77.9
Macroinvertebrates						
California Floater	*Anodonta californiensis*	FS-S	H	368.6	77.9	0
A Caddisfly	*Lepidostoma knulli*	FS-S	O	ca. 13 mi	13	Unknown
A Mayfly	*Moribaetis mimbresaurus*	FS-S	O	ca. 13 mi	13	Unknown

[1] **Status:**

- **T** = Federally listed as Threatened
- **E** = Federally listed as Endangered
- C = Candidate for Federal listing as Threatened or Endangered
- **WC** = Wildlife of Special Concern in Arizona (1996 Arizona Game & Fish Department classification pending revision to Article 4 of the State Regulations)
- **FS-S** = Forest Service Sensitive Species

[2] **Occurrence:**

- **O** = Species known to occur in the project area, or in the general vicinity of the area.
- **Δ** = Species occurs downstream of project area
- **H** = Species occurred historically in project area

[3] Colorado Pikeminnow is listed as endangered; the species is listed as “experimental non-essential” in Arizona.

[4] All habitat is also critical habitat

Threatened and Endangered Species

The Threatened, Endangered and Sensitive Species (TES) List for the Coconino and Kaibab National Forests were reviewed and a list of TES species was created for this project based on known occurrence or, in the absence of survey data, the presence of suitable habitat. The following is a description of the species their habitat, and an analysis of the effects of implementation of each alternative on each species.

Three species (Gila Chub, Razorback Sucker, and Colorado Pikeminnow) were eliminated from further analysis because these species do not have critical habitat, potential habitat, or occupied habitat in the analysis area. Gila Trout was eliminated from further analysis because this species does not have occupied habitat in the analysis area.

Spikedace

Spikedace was federally listed as threatened under the Endangered Species Act on July 1, 1986 (USDI 1986b) and listed as endangered on February 23, 2012 (USDI 2012). U.S. Fish and Wildlife Service approval of the species' recovery plan came in September 1991 (USDI 1991b).

Spikedace can live up to 24 months in the wild, although few survive more than 13 months (USDI 2007). Reproduction occurs primarily in one-year-old fish (USDI 2007). Spawning extends from mid-March into June and occurs in shallow (less than 15 cm [5.9 in] deep) riffles with gravel and sand bottoms and moderate flow (USDI 2007). By mid-May, most spawning has occurred, although in years of high water flows, spawning may continue into late May or early June (USDI 2007).

Reproduction is apparently initiated in response to a combination of declining stream discharge and increasing water temperature (USDI 2007). The ova are adhesive and demersal and adhere to the substrate. The number of eggs produced varies from 100 to over 800, depending on the size of the individual. The young grow rapidly, attaining a length of 1.4-1.6 in. (35-40 mm) by November of the year spawned.

Spikedace feed primarily on aquatic and terrestrial insects (USDI 2007). In addition, Barber et al. (1970) reported that Spikedace feed on food items in the drift including some fish fry. Diet composition is largely determined by type of habitat and time of year (Minckley 1973).

Spikedace occupy mid-water habitats usually less than 1 m deep, with slow to moderate water velocities over sand, gravel, or cobble substrates (USDI 2007). Adults often aggregate 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 (USDI 2007). The preferred habitat of the Spikedace varies seasonally and with maturation (USDI 2007). In winter, the species congregates along stream margins with cobble substrates. The erratic flow patterns of southwestern streams that include periodic spates and recurrent flooding are essential to the feeding and reproduction of the spikedace by scouring the sands and keeping gravels clean (USDI 2007). 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. The young typically occupy stream margin habitats, where the water velocity is less than 0.16 ft/sec (5 cm/sec) and the depth is less than 1.96 in (5 cm).

Historically, the Spikedace was common and locally abundant throughout the upper Gila River Basin of Arizona and New Mexico. Its distribution was widespread in large and moderate-sized rivers and streams in Arizona, including the Gila, Salt, and Verde Rivers and their major tributaries. In the Verde River

Basin, Spikedace has been recorded in the lower end of West Clear Creek, in Wet Beaver Creek at the confluence with the Verde River, and within the Montezuma Castle National Monument. The most recent occurrences of Spikedace have been recorded in the upper Verde River from the headwaters downstream to the confluence with Sycamore Creek (Minckley 1993).

Spikedace was collected in Beaver Creek in 1937 and 1938 (Girmendonk and Young 1997). No other reported collections from Beaver Creek contained Spikedace. Aside from Spikedace occurrences in the upper Verde River (upstream from Sycamore Canyon), this species has not been collected at any other locations along the Verde River in the recent past.

Spikedace may be extirpated from the Verde River Basin (excluding Fossil Creek). Until recently, Spikedace was thought to persist in the upper reaches of the Verde River; however, formal monitoring surveys over the past several years have failed to collect Spikedace. During a 1999 survey (other than the formal monitoring mentioned above), a single Spikedace was collected from a location along the upper Verde River.

Spikedace now occurs in Fossil Creek as a result of recent repatriation efforts. Critical habitat for Spikedace (USDI 2012) on the CNF includes the Verde River from Sycamore Canyon downstream to the confluence with Fossil Creek, and the lower portions of Oak Creek, Beaver/Wet Beaver Creeks, West Clear Creek, and Fossil Creek. Effects to critical habitat in Oak Creek are analyzed below

Habitat in the Analysis Area
There are 134.3 miles of Spikedace critical habitat within the Coconino Forest boundary. Within the analysis area, the species has 36.8 miles of critical habitat, in middle and lower Oak Creek (Table 19). Although unoccupied, this habitat will be analyzed for potential effects from the proposed alternatives.

Loach Minnow

Loach Minnow was federally listed as a threatened species, under the Endangered Species Act, on October 28, 1986 (USDI 1986a), and listed as endangered on February 23, 2012 (USDI 2012). U.S. Fish and Wildlife Service approval of the species’ recovery plan came in September 1991 (USDI 1991a).

The first spawn of Loach Minnow generally occurs in their second year, primarily from March through May (USDI 1991a). 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 cobbles that form the roof of a small cavity in the substrate. The number of eggs per cobble ranges from 5 to more than 250, with an average of 52-63 (USDI 1991a). Eggs incubated at 18-20 °C hatch in 5-6 days. Male Loach Minnow guard the nest during spawning and egg incubation (M. Childs, pers. obs.). Longevity in the wild is typically 15 months to 2 years, although Loach Minnow can live as long as 3 years (USDI 1991a).

Loach Minnow feed exclusively on aquatic insects. Loach Minnow are opportunistic benthic insectivores, feeding primarily on riffle-dwelling larval ephemeropterans, and simulid and chironomid dipterans. They actively seek their food on bottom substrates, rather than pursuing food items in the drift (USDI 1991a).

The Loach Minnow is found in turbulent, rocky riffles of rivers and tributaries up to about 2,200 m (7,200 ft) in elevation. Loach Minnow are bottom-dwelling inhabitants of shallow, swift waters flowing over gravel, cobble, and rubble substrates in mainstream rivers and tributaries (USDI 1991a). Most growth occurs during the first summer. Loach Minnow uses the spaces between and in the lee of larger substrates for resting and spawning (USDI 1991a). The species is rare or absent from habitats where fine sediments fill the interstitial spaces (Propst and Bestgen 1991).

Historically, Loach Minnow was locally common throughout much of the Gila River Basin of Arizona and New Mexico. Loach Minnow distribution in Arizona included the Gila, Salt, and Verde Rivers and their major tributaries. Historic (non-introduced) Loach Minnow populations are considered to be extirpated from the Verde River Basin (Minckley 1993). The last recorded collections of Loach Minnow from within the Verde River Basin were in 1938. These 1938 collections came from the Verde River above Camp Verde and from Beaver Creek near its confluence with the Verde River (Minckley 1993). Currently, the only known Loach Minnow populations are in the Salt, San Pedro, Gila, and San Francisco River Basins, and now the reintroduced population in Fossil Creek.

Since 1987, the Arizona Game and Fish Department has conducted extensive surveys of the Verde River mainstem. In addition, since 1994 research fisheries biologists from the Rocky Mountain Research Station have monitored seven sites on the upper Verde River. Neither of these efforts has resulted in detection of Loach Minnow.

Critical habitat for Loach Minnow (USDI 2012) includes the Verde River from Sullivan Dam downstream to the confluence with Beaver/Wet Beaver Creek, and the lower portions of Oak Creek, Beaver/Wet Beaver Creeks, and Fossil Creek. Effects to critical habitat in Oak Creek are analyzed below.

Habitat in the Analysis Area

There are 95.8 miles of Loach Minnow critical habitat within the Coconino Forest boundary. Within the analysis area, the species has 36.8 miles of critical habitat, in middle and lower Oak Creek (Table 19). Although unoccupied, this habitat will be analyzed for potential effects from the proposed alternatives.

Candidate Species

Roundtail Chub

Roundtail Chub (*Gila robusta*) is a candidate species under the ESA but has been precluded from listing now due to higher priority actions to amend current species lists (USDI 2006; USDI 2009). Roundtail Chub was included on the Regional Foresters' sensitive species list (USDA 2013).

Roundtail Chub is a moderately streamlined member of the minnow family (Cyprinidae); they have a slender caudal peduncle and a deeply forked, relatively large caudal fin. Coloration of adults is silvery shading dorsally to dusky yellow or light green. Both sexes have orange-red coloration of the ventrolateral surface and on all fins except the dorsal. Both males and females possess breeding tubercles to a highly variable degree. Adult Roundtail Chub can attain 20 inches (51 cm) in length and two pounds (0.9 kg) in weight, while adult headwater chub generally do not grow as large.

Roundtail Chub is widespread in moderate to large rivers of the Colorado River Basin. In Arizona, it still occurs in the mainstem and tributaries to the Verde and Salt Rivers. Roundtail Chub are also still thought to occur in the Upper Clear Creek watershed. Populations have declined considerably during the past few decades. This report will analyze effects to Roundtail Chub and its habitat, as it is present in Oak Creek and Sycamore Creek.

Roundtail Chub occupy cool to warm water, mid-elevation streams, and rivers where typical adult microhabitat consists of pools up to eight feet deep adjacent to swifter riffles and runs. Cover is usually present and consists of large boulders, tree rootwads, submerged large trees and branches, undercut cliff walls, or deep water. Smaller chub generally occupy shallower, low velocity water adjacent to overhead bank cover. Roundtail Chub appear to be very selective in their choice of pools, as they are commonly found to congregate in certain pools, and are not found in similar, nearby pools. Spawning takes place over gravel substrate. Tolerated water temperatures approach 80°F.

Young chub feed on small insects, crustaceans, and algal films, while older chub move into moderate velocity pools and runs to feed on both terrestrial and aquatic insects along with filamentous algae. Large Roundtail Chub take small fish, and even terrestrial animals such as lizards that fall into the water.

Roundtail Chub breed in early summer, often in habitats associated with beds of submergent vegetation or other kinds of cover such as fallen trees and brush, as spring runoff is subsiding. Fertilized eggs are randomly scattered over gravel substrate with no parental care.

Habitat in the Analysis Area

There are 350.9 miles of potential Roundtail Chub habitat within the Coconino Forest boundary. Within the analysis area, the species occupies 77.9 miles (22.2%) of perennial stream (Table 19), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. This habitat will be analyzed for potential effects from the proposed alternatives.

Forest Service Sensitive Species

Desert Sucker

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 (AGFD 2002a). 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. 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 (AGFD 2002a). As an adult 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 Sucker spawns 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.

Habitat in the Analysis Area

There are 236.7 miles of potential Desert Sucker habitat within the Coconino Forest boundary. Within the analysis area, the species occupies 77.9 miles (32.9%) of perennial stream (Table 19), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. This habitat will be analyzed for potential effects from the proposed alternatives.

Sonora Sucker

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 (AGFD 2002b). 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 (AGFD 2002b). Information on age and growth has not been developed.

Habitat in the Analysis Area

There are 236.7 miles of potential Sonora Sucker habitat within the Coconino Forest boundary. Within the analysis area, the species occupies 77.9 miles (32.9%) of perennial stream (Table 19), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. This habitat will be analyzed for potential effects from the proposed alternatives.

California Floater

California floater (*Anodonta californiensis*) is a mussel that lives in the shallow areas of clean, clear lakes, ponds and large rivers. It prefers lower elevations and soft, silty substrate to burrow into. Its common name is derived from the tendency of *Anodonta* species to float to the surface of the water after death, which is a result of gas build-up behind their thin shells. The life cycle of California floater includes a parasitic larval stage (called a glochidium), during which it is dependent upon a host fish, usually a member of the *Gila* genus, for food and dispersal. Larval California floaters have two hook-like projections within their shells which they use to attach to the fins of certain species of native fish. The fish hosts form cysts around the glochidia, but remain unharmed. After it reaches a certain size, the glochidium releases itself from its host, undergoes metamorphosis and begins its adult life as a sedentary filter-feeder, straining bacteria, plankton and detritus from the surrounding currents with its gills. Adults begin to reproduce after reaching 6 to 12 years of age. Although a female floater may release several million larvae during the course of one year, survivorship is extremely low due to the specific requirements of finding and attaching to an appropriate fish host. The decline of native host fish species has been identified as a likely cause of decline in populations of this species. Other factors that continue to heavily impact populations of California floaters include pollution, sedimentation due to excess logging and grazing, predation by introduced fish species, and dam-building. Dams, in particular, have changed the physical, chemical, and biological environment of a large number of streams to the point that approximately 30% to 60% of the mussel fauna within those streams has been destroyed.

Freshwater mussels were an important food source for Native Americans, who also used them for building tools and for decorative purposes. Today, the mussel is still highly regarded commercially by the cultured pearl industry, which uses the shells for seed pearl production. Many species of freshwater mussels have declined to the point of being listed as endangered, threatened or species of special concern. It is of particular concern that so many populations of these bivalves are ailing because of their special status as indicators of aquatic environmental health.

California floater used to range from southern British Columbia south to northern Baja California, and east to Wisconsin. Today, however, 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.

Habitat in the Analysis Area

There are 368.6 miles of potential California floater habitat within the Coconino Forest boundary. Within the analysis area, there are 77.9 miles (21.1%) of potential perennial stream habitat (Table 19), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. This habitat will be analyzed for potential effects from the proposed alternatives.

A Caddisfly

The caddisfly *Lepidostoma knulli* is listed as imperiled (G2) by NatureServe (2013). It is rare in Oak Creek, and has been found primarily in the upper portions of the stream (Sedona to Pumphouse Wash; Blinn and Ruiter 2009). Adults are likely short-lived and do not feed (Stevens and Ledbetter 2012).

Habitat in the Analysis Area

Lepidostoma larvae occupy cool water springs, streams, and rivers, and occasionally occur in lacustrine habitats (Holzenthal et al. 2007). Blinn and Ruiter (2006, 2009) noted that the species occurred in cool stream segments with generally swift-flowing water, dominated by large cobbles with low embeddedness of interstitial gravels. Houghton (2001) found this species in two sites in Apache National Forest, eastern Arizona. Moulton et al. (1994) lists two sites in Apache and Coconino Counties, Arizona. In Coconino County, the species was collected in Oak Creek Canyon, Manzanita Recreation Area, 1993.

A Mayfly

The mayfly *Moribaetis mimbresaurus* is a large baetid mayfly listed as critically imperiled (G1) by NatureServe (2013). It was collected from Oak Creek at Pumphouse Wash in 1984, and is believed to be a disjunct population from known Mexican and Central American populations. This species has a relictual distribution in Arizona and probably was much more widespread in Mexico and Central America at one time (McCafferty 2007). Larvae of the species have not yet been collected.

Habitat in the Analysis Area

The species is poorly known in Arizona, but the holotype male was collected from Oak Creek at the confluence of Pump House Wash in 1984 (McCafferty 2007). Larvae of this genus are splash-zone dwellers that are frequently found exposed on wet surfaces above the water line, on the surfaces of rocks in fast water, at the bases of waterfalls, or rocks along the shoreline of fast-water areas (Waltz and McCafferty 1983).

Management Indicator Species

Macroinvertebrates and Their Habitat

As a group, aquatic macroinvertebrates are identified in the Coconino National Forest Land and Resource Management Plan (as amended) as management indicator species for late seral, high and low elevation riparian areas. Perennial stream miles provide an accurate measure of available macroinvertebrate habitat on the Forest because many miles of riparian forest do not have above-ground perennial water, and thus no permanent macroinvertebrate populations (USDA 2013). All references to aquatic macroinvertebrates and their habitat as management indicators in this report are specific to the Coconino NF.

Monitoring macroinvertebrates provides a method for assessing the health of aquatic systems. The riparian ecosystems targeted for monitoring are those associated with lotic or flowing water conditions. Perennial stream miles provide an accurate measure of available macroinvertebrate habitat on the Coconino NF because many miles of riparian forest do not have above-ground perennial water, and thus no permanent macroinvertebrate populations. The MIS Status Report for the Coconino NF, version 2 (USDA 2013) describes the ways aquatic insects can be used to monitor stream conditions and the development of population and habitat trends. The Arizona Department of Environmental Quality (ADEQ) has consistently collected macroinvertebrate data at the same locations on and near the Coconino NF over a time scale that allows for trend analysis. Data can be summarized by using macroinvertebrate community characteristics. The Environmental Protection Agency developed an Index of Biological Integrity (IBI) using Rapid Bioassessment Protocols. This approach combines macroinvertebrate community characteristics into an index that can then be compared between monitoring sites to assess insect abundance and richness and aids in determining whether sites are attaining environmental objectives or whether they are impaired. The IBI's are calculated using the metrics described in Table 20.

Table 20. Metric used in the calculation of overall Index of Biological Integrity (IBI).

Category	Metric	Definition	Expected Response to Disturbance	Warm Water Index	Coldwater Index
Richness	Total Taxa	Total taxa of all orders	Decrease	X	X
	Ephemeroptera Taxa	Total mayfly species	Decrease	X	
	Trichoptera Taxa	Total caddisfly species	Decrease	X	
	Diptera Taxa	Total true fly species	Decrease	X	X

Category	Metric	Definition	Expected Response to Disturbance	Warm Water Index	Coldwater Index
	Intolerant Taxa	Total Taxa that are susceptible to disturbance/pollution	Decrease		X
Composition Measures	Percent Dominant taxa	Percent of total comprised of dominant	Increase	X	
	Percent Ephemeroptera	Percent of total that are mayfly species	Decrease	X	
	Percent Plecoptera	Percent of total that are stoneflies	Decrease		X
Tolerance Measure	Hilsenhoff Biotic Index (HBI)	Uses tolerance values to weight abundance in an estimate of overall pollution.	Increase	X	X
Trophic Measures	Scraper Taxa	Total species that feed by scraping algae off of rocks	Decrease	X	X
	Percent Scraper	Percent of total comprised of scrapers	Decrease	X	X

Table 21 illustrates the numeric IBI groupings and their respective assessment categories and interpretive descriptions as determined by ADEQ (ADEQ 2005). It states that if the site scores greater than the 25th percentile of reference condition, the site is attaining some designated uses for either warm water aquatic communities (below 5,000 feet elevation) or cold water aquatic communities (above 5,000 feet elevation). If the IBI is between the 10th and 25th percentile the sites are inconclusive, and below the 10th percentile of reference, they are impaired for one or more designated uses.

Table 21. Index of Biological Integrity numerical groupings and their respective narrative assessment categories and category descriptions.

Macroinvertebrate Bioassessment Result	Index of Biological Integrity		Assessment
	Coldwater	Warm water	
Greater than the 25th percentile of reference condition	≥52	≥50	Attaining
Between the 10th and 25th percentile of reference condition	46-51	40-49	Inconclusive
Less than the 10th percentile of reference condition	≤45	≤39	Impaired

Macroinvertebrate Population Trends

As of spring 2011, macroinvertebrate sampling on streams either on or close to the Coconino National Forest by ADEQ spans a 19-year time frame from 1992 to 2011. The analysis presented here uses only samples taken from riffles during spring (to meet ADEQ biocriteria standards). This analysis examined 39 streams (Table 22), twelve cold water, and twenty-seven warm water.

Table 22. Most recent macroinvertebrate bioassessment ratings for streams monitored by ADEQ for both cold and warm water systems.

Stream Course	Last Assessment Date	Bioassessment Rating	Cold or Warm Water Stream
Beaver Creek	1999	Attaining	Warm
Fossil Creek at Headwaters	2008	Attaining	Warm
Oak Creek above Page Springs	1995	Inconclusive	Warm
Oak Creek at Chavez Crossing	1995	Attaining	Warm
Oak Creek at Grasshopper Point	1995	Attaining	Warm
Oak Creek at Mormon Crossing	2011	Attaining	Warm
Oak Creek at Red Rock State Park	1999	Attaining	Warm
Oak Creek Below Manzanita Campground	2011	Attaining	Warm
Oak Creek Below Page Springs	1999	Attaining	Warm
Spring Creek Below Mormon Crossing	1997	Attaining	Warm
Spring Creek Below Oak Creek Valley Community Bridge	1997	Attaining	Warm
Spring Creek Near Road Crossing	2004	Attaining	Warm
Sycamore Creek Near Summers Springs	2008	Attaining	Warm
Tangle Creek Above Verde River Confluence	1995	Attaining	Warm
Verde River Above Bridgeport Bridge	1999	Attaining	Warm
Verde River Above Confluence with West Clear Creek	1999	Attaining	Warm
Verde River Above Perkinsville Bridge	2011	Attaining	Warm
Verde River at Beasley Flat Recreation Area	1995	Inconclusive	Warm
Verde River Below Perkinsville Bridge	2005	Attaining	Warm
West Clear Creek Above Bull Pen Ranch	1999	Attaining	Warm
West Clear Creek at Campground	2008	Inconclusive	Warm
West Clear Creek Near Camp Verde	2011	Attaining	Warm
Wet Beaver Creek Above USGS Gage	2008	Attaining	Warm
Wet Beaver Creek at Campground	1999	Attaining	Warm

Stream Course	Last Assessment Date	Bioassessment Rating	Cold or Warm Water Stream
Wet Beaver Creek at Montezuma Well	1995	Inconclusive	Warm
Wet Beaver Creek at USGS Gage Near Rimrock	2004	Attaining	Warm
Wet Beaver Creek Below Montezuma Road	2008	Inconclusive	Warm
Barbershop Canyon Creek below Merritt Draw	2007	Impaired	Cold
Buck Springs Canyon Creek	1995	Impaired	Cold
East Clear Creek 3/4 mi upstream from Kinder Crossing	2007	Impaired	Cold
East Clear Creek above confluence with Yeager Canyon	2001	Impaired	Cold
East Clear Creek above Mack's Crossing	2010	Impaired	Cold
East Clear Creek just east of FH95 and FR 396 intersection	2007	Impaired	Cold
Oak Creek above Slide Rock Campground	2011	Inconclusive	Cold
Oak Creek Below Cave Springs Campground	1998	Inconclusive	Cold
Oak Creek Below Pine Flat Campground	2004	Impaired	Cold
Oak Creek Below Pine Flats Subdivision	2008	Impaired	Cold
West Clear Creek at Callaway Butte	1995	Inconclusive	Cold
West Clear Creek at Maxwell Trail, Upper	1997	Impaired	Cold

Using simple linear regression, examination of IBI scores at sites that had been sampled in at least three different years found that across the Forest, trend was upward (positive slope) at four sites and downward at eight sites (Table 23; Figures 12 and 13). The r^2 values for several streams were quite low, indicating that variation in IBI scores was not well-explained by sampling year, and thus the confidence in estimated trend for these streams is low. This, however, is the best-available data for macroinvertebrate trend analysis.

Table 23. Sample location and trend determination

Stream	Last Assessed	Equation*	r^{2**}	F-value	P-value
Barbershop Canyon Above ECC	2007	y = 0.0137x + 18.3	0.0001	0.0003	0.988
Barbershop Canyon Below Merritt Draw	2007	y = -0.8687x + 1789.0	0.4481	2.4361	0.216
East Clear Creek Above Confluence with Yeager	2001	y = 0.4119x - 779.9	0.1691	0.4071	0.589
Oak Creek Below Cave Springs	1998	y= 0.878x - 1711,6	0.0145	0.0148	0.923
Spring Creek Near Road Crossing	2004	y = -1.4289x + 2919.7	0.9497	18.8616	0.144
Sycamore Creek Near Summer Springs	2008	y = -0.1894x + 4333.8	0.0071	0.0286	0.874
Verde River Above Perkinsville Bridge	2011	y = -0.8195x + 1703.0	0.5013	5.0267	0.075
Verde River Below Perkinsville Bridge	2005	y = -1.4881x + 3038.5	0.116	0.5429	0.509
West Clear Creek Above Bull Pen	1999	y = -0.0313x + 123.0	0.0001	0.0004	0.986
West Clear Creek at	2008	y = 0.004x + 44.8	0.00003	0.0000	0.999

Stream	Last Assessed	Equation*	r^{2**}	F-value	P-value
Campground					
West Clear Creek at Maxwell Trail	1997	y = -2.091x + 4219.0	0.3622	2.2714	0.206
Wet Beaver Creek Above USGS Gage	2008	y = -0.2454x + 549.8	0.0389	0.0000	0.999

*** Simple linear regression of the IBI value as the response value, and year as the independent value; positive equations indicate upward trends and negative values downward trends.**

**** The r^2 statistic measures how well the regression line fits the data; it is the percent of variation in the response variable explained by the independent variable.**

P-value is the probability of a higher F-value. P-values over 0.05 are not significant, meaning that the slope of the fitted line is not significantly different from zero, and thus trend cannot be accurately determined.

Sample sites have had high amounts of variation in IBI scores over the sample period. This variation could have a variety of causes, from changing environmental factors such as flooding and drought cycles, microhabitat variation between collections, and contributing upland condition and the associated runoff effects to water quality.

The MIS Status Report for the Coconino NF, version 2 (USDA 2013) reported the forest-wide IBI trend is stable. None of the trend line slopes were significantly different than zero, therefore, the trends displayed in Table 22 and Figures 12 and 13 are not significant.

Macroinvertebrate Habitat Trends

The MIS Status Report for the Coconino NF, version 2 (USDA 2013) reported habitat trends by habitat type. The high elevation riparian habitat trend is stable, but a majority is highly departed from reference conditions. Low elevation riparian habitat appears to be improving, but there is not adequate data to make a quantitative determination. Wetlands, open water, and cienega habitats are stable to improving.

The boundary for the 4FRI includes or intercepts several 5th code HUC watersheds that contain perennial water (Table 24). About 28% of the perennial streams on the Forest are within the cumulative effects boundary. Thus, about 28% of potential macroinvertebrate habitat and associated populations on the Coconino National Forest is within the Affected Environment boundary.

Table 24. Perennial waters within 5th code watersheds within or overlapping the project boundary.

Stream	Miles of Perennial
Munds Canyon	4.06
Oak Creek	51.72
Pumphouse Wash	0.64
Rio de Flag	5.00
Sawmill Wash	0.80
Sterling Canyon1	0.19
Sycamore Canyon1	5.34
West Fork Oak Creek	15.98
Total Project	**83.73 (28%)**
Total Forest	**296.4**

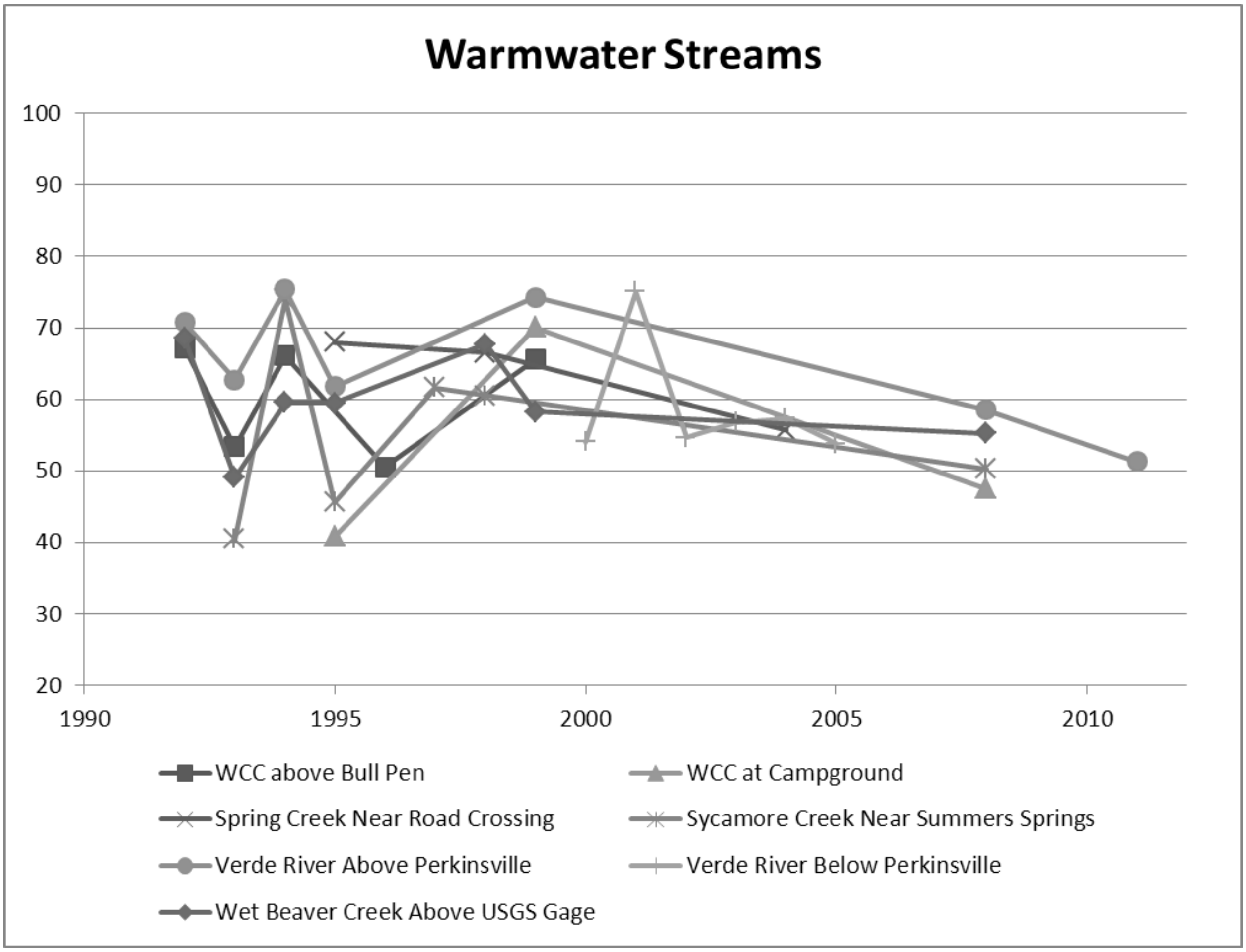


Figure 12. ADEQ macroinvertebrate IBI scores (Y-axis) for warmwater reaches on the Coconino National Forest with at least three sample years.

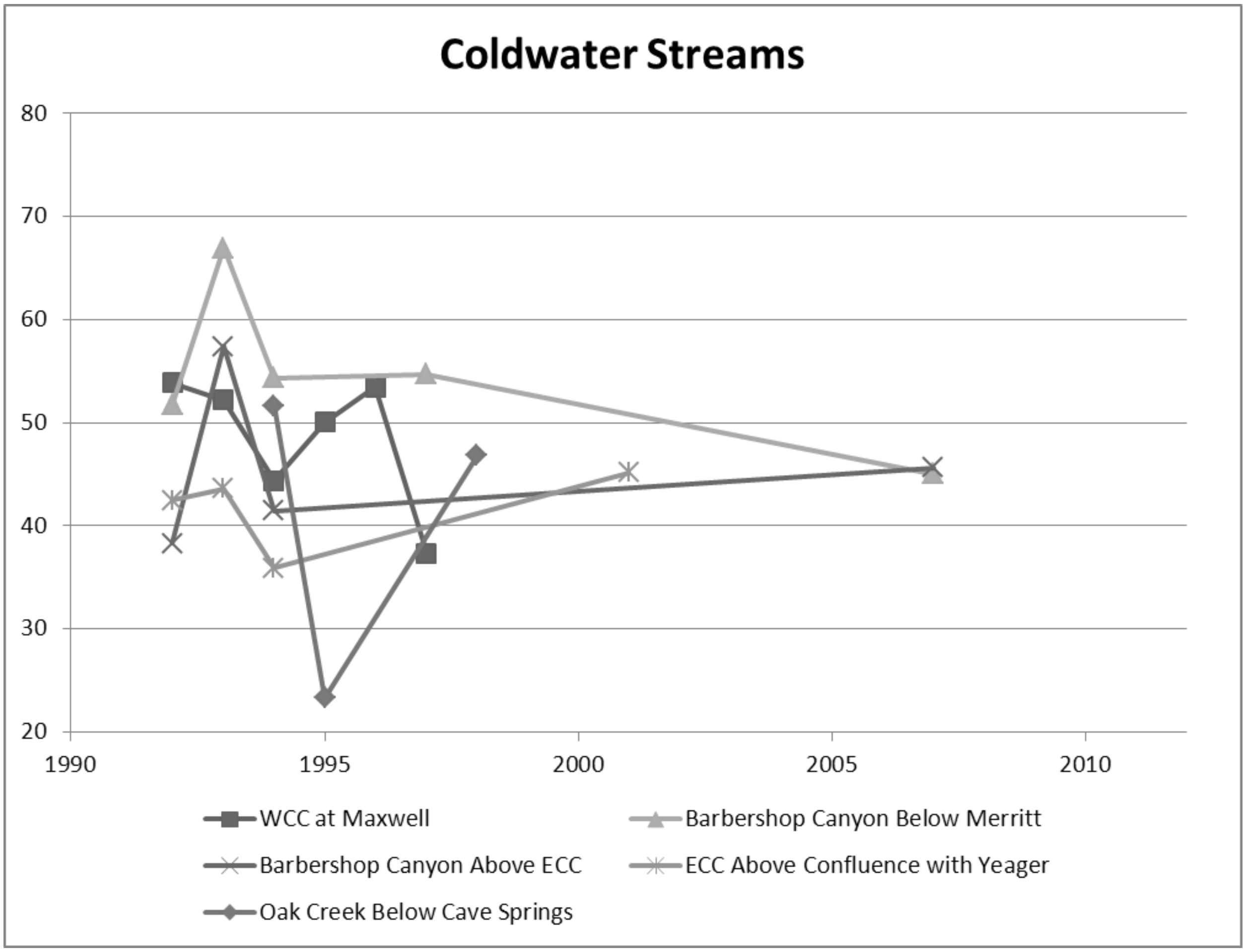


Figure 13. ADEQ macroinvertebrate IBI scores (Y-axis) for coldwater reaches on the Coconino National Forest with at least three sample years.

Environmental Consequences

Units of Measure

The primary environmental consequence to aquatic habitat and associated species from timber and vegetation treatments is increased ground disturbance which has the potential to increase the rate of soil erosion over natural background levels. Therefore this report will focus on the predicted ground disturbance and its effect in regards to the following:

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

- Macroinvertebrate assemblage - alteration in channel morphology or increases in sediment can alter the macroinvertebrate assemblage.

Alternative A – No Action

Direct and Indirect Effects (incorporated from MacDonald 2014; edited by MRC)

Because no activities are proposed under Alternative A, there would be no direct effects to aquatic species or their habitat as a result of this Alternative. However, indirect effects of the No Action Alternative are likely.

Much of the ponderosa pine forest is in Vegetation Condition Class 3 and trends indicate that fuel loading would continue to increase in both living biomass and woody detritus through natural forest ingrowth and tree encroachment into existing openings, resulting in increased risk of high severity wildfire. Ingrown understories can create 'ladder fuels' which allow ground fires to ascend and spread quickly as crown fires. Fine and coarse woody debris are expected to increase over time as small, medium, and large diameter material falls to soil surfaces and begins to decay. While the increased organic matter would improve soil quality in some regards (organic matter accumulation in subsurface horizons, microhabitat for soil organisms, increased short-term water holding capacity, improved nutrient status) it can also result in decreased herbaceous plant productivity and soil nutrient cycling and an increased risk of high severity wildfires where fuel loading becomes excessive. A dense forest litter layer (i.e., duff) displaces herbaceous vegetation (McConnell and Smith, 1970). Vegetative ground cover provides greater benefits to soil ecological function than forest litter alone through improved nutrient cycling due to fine root turnover, increased fine litter, improved soil porosity and aggregate stability, increased water holding capacity, increased infiltration, and decreased runoff. The location, size and intensity of future wildfires cannot be predicted with reasonable accuracy, although some generalizations can be made. High intensity wildfires tend to occur in areas where fuel loading and fuel distributions are sufficient to carry a fire. Typically, uncontrolled wildfires occur during the drier times of the year, yielding higher severity fires than would occur under prescribed fire conditions. The adverse effects of a high severity fire to water quality and riparian areas such as soil erosion above tolerance thresholds, sediment delivery to connected streamcourses, increased stream bedload, stream channel incision and bank failure, increased water turbidity, and downstream flooding would be more widespread in an uncontrolled wildfire situation than under prescribed fire conditions where the size and intensity of the fire can generally be controlled. Soil erosion models indicate that approximately 24% of all soils left untreated could be subject to soil erosion above tolerable levels from severe wildfires if all soils burned under condition of high burn severity.

Uncharacteristic fires on the Coconino National Forest historically have ranged from about 20-45% of the burn acreage resulting in high severity fire. While large stand-replacing fires on the Kaibab National Forest historically have 10-25% of the burn acreage exhibiting high severity fire conditions. Lata (2014) suggests that, for fires managed primarily for suppression in extreme burning conditions, about 33% of ponderosa pine forests in Arizona burn with high burn severity. Therefore, if a 10,000 acre wildfire (being managed primarily for suppression in extreme burning conditions) were to occur within the analysis area, approximately 1,000 to 3,000 acres of high severity fire would be expected to adversely affect water quality and riparian conditions.

There have been many examples of recent stand-replacing wildfires occurring in the southwestern United States in areas that were originally open, fire-maintained forests (e.g., Rodeo-Chediski, Schultz, Horseshoe 2, Wallow, Las Conchas, Tres Lagunas, Jaroso, Thompson Ridge, Whitewater-Baldy, Slide, etc.). Such events can have profound negative effects to water quality and riparian conditions including: a) increased soil hydrophobic conditions (i.e. the inability of soils to absorb water following precipitation resulting in increased overland flow, b) increased sediment, ash, debris, and nutrient delivery to water bodies, and c) downstream flooding resulting in changes to stream geomorphology (e.g. increased bedloads, channel downcutting/incision, and channel aggradation).

A high-severity fire is not certain to occur within the project area during any given timeframe. However, the occurrence of a high-severity wildfire would have an increased potential for profound adverse impacts to hydrologic systems in project area watersheds and downstream locations. As previously discussed in this report, such a fire event would likely result in increased runoff and potential for soil erosion and sediment delivery to streamcourses as a result of loss of forest interception of rainfall, reduced soil water infiltration rates, and the reduction of effective ground cover at the soil surface. The infrequent nature of ephemeral stream flow results in the potential for sediment and ash to be stored within these stream channels and then transported during surface runoff events. This, in turn, could pose detrimental effects to surface water quality and water storage capacity, including impoundments that are the sources of municipal water supplies for the Cities of Flagstaff and Williams.

Other potential detrimental effects to hydrologic conditions in the project area and downstream locations could include the destabilization of the geomorphic conditions of stream channels due to excessive sediment delivery and debris loading, increased peak flows, and overall increases in average annual water yield resulting from loss of upslope interception, infiltration, and evapotranspiration. Ephemeral stream channels within high burn severity areas would lose their ability to buffer runoff from large rainfall events, resulting in increased channel scour and incision caused by accelerated runoff and erosion from severely burned watershed areas. Increased bedloads in stream channels effectively raises the elevation of stream bottoms, causing flood flows to exceed channel capacities, resulting in overland flooding. These conditions could result in increased flooding risk within the 100-year floodplains.

Another effect is sediment and ash deposition in downstream roads, stock tanks and meadows, even if such areas may not have burned. In addition, sediment and ash-laden overland flows may damage low lying roads by eroding road traveled ways and filling culverts and low water crossings with sediment and debris. These are examples of why post-wildfire watershed conditions are significantly different from pre-fire or low-severity prescribed fire conditions.

Soil hydrophobicity occurs naturally in soils (DeBano 1981, Doerr et al. 2000). It is the result of leaching of hydrophobic compounds, such as aliphatic hydrocarbons, from the litter and humus layers. Under unburned conditions, soil hydrophobicity below the soil surface is commonly associated with fungal mycelia (Savage et al. 1969). However, high fire intensity can volatize hydrophobic compounds in the litter, humus, and soil organic matter (DeBano et al. 1966). These compounds can then enter the soil atmosphere and condense on cooler soil particles at or below the soil surface (DeBano 1981). The condensation of these compounds forms a hydrophobic layer on the soil particles (DeBano and Krammes 1966, Savage 1974).

The formation of a strong hydrophobic layer after natural or prescribed fires can inhibit infiltration (Scott and van Wyk 1990). When ash and soil above a hydrophobic layer become saturated, any additional precipitation will become runoff. The rate of runoff from forested areas can therefore increase dramatically after burning if a hydrophobic layer is present; and this surface runoff, when combined with the loss of a protective litter layer, can cause even larger increases in surface erosion and sediment yields (e.g. Helvey 1980, Scott and van Wyk 1990).

Sediment yields in the first year after a wildfire can range from very low in relatively flat topography with minimal rainfall to extreme on steep landscapes affected by high-intensity thunderstorms (Robichaud et al. 2000). Hendricks and Johnson (1944) observed wildfire induced sediment yields ranging from 71Mg per ha per year on 42 percent slopes to 202 Mg per ha per year on 66 percent slopes, and 370 Mg per ha per year on 78 percent slopes in Upper Pocket Creek in central Arizona. Following the North 25 Fire in in 1998, Robichaud and others (2006) observed first year mean erosion rates of 16 Mg per ha, with most erosion occurring during short duration, moderate intensity summer storms.

The physical, chemical and biological characteristics of surface water can be adversely affected by post fire conditions. MacDonald (2014) focused on the physical and chemical changes to surface water resulting from fire. Biological effects are therefore inferred from the changes in the physical and chemical properties of surface waters following fire.

Increased sediment loads are the primary physical impacts to surface waters following fire. Sedimentation of impoundments can decrease their effective life, resulting in a need for dredging and other mitigation measures. Biological pathogens are easily adsorbed to sediment and ash, which can overload public drinking water treatment facilities, increasing the cost of water treatment. Metals such as Mercury and Iron and other chemical constituents in surface runoff can adsorb to clay particles in sediments, further adversely affecting water quality. The large quantities of post-fire sediment can overwhelm the biological habitats of aquatic organisms such as fish, as well as organisms that depend on water for some life stage, such as amphibians and invertebrates.

Altered solute and debris content in surface waters following wildfire can also change nutrient dynamics, light, and temperature regimes (Betts and Jones 2009). When riparian vegetation is removed by fire or other means, the stream surface is exposed to direct solar radiation, and stream temperatures increase (Neary et al. 2005). Reduced concentrations of dissolved oxygen (O_2) that can occur as a result of increased surface water temperatures can result in fish mortality.

Elevated pH values of soils following wildfires have been shown to increase pH values in streamflow (DeBano et al. 1998, Landsberg and Tiedemann 2000). The combustion process releases bound nutrients, many in elemental form. Some cations (i.e., positive ions), are stable at typical combustion temperatures and remain onsite after burning. They subsequently infiltrate into the soil or are transported in runoff where they exchange with H^+ ions; the resulting decrease in H+ ions in solution increases the pH. Nutrient availability is related to soil acidity (c.f., Tisdale and Nelson, 1975). Bicarbonates (HCO_3^-) and carbonates (CO_3^{2-}) may also contribute to increased surface water alkalinity.

Nitrate (NO_3^-), nitrite (NO_2^-), ammonium (NH_4^+) and ammonia (NH_3) are the forms of nitrogen that can be altered after fire. Values for nitrate generally increase after fire. Stream nitrate responses to prescribed fire are generally lower than for wildfire. In an undisturbed ponderosa pine and Gambel oak watershed in

Arizona, Gottfried and DeBano (1990) observed slight, but significant increases in nitrate in surface water following fire. The potential for increased NO_3^- in streamflow after fire is attributed mainly to increased mineralization and nitrification (Vitousek and Melillo 1979, Covington and Sackett 1986, DeBano and others 1998) and reduced plant demand (Vitousek and Melillo 1979). This increase is the result of the conversion of organic N to available forms, mineralization (Covington and Sackett 1992), or mobilization by microbial biomass through the fertilizing effect of ash nutrients and improved microclimate (Ojima et al. 1994). These post fire effects are usually short lived, lasting only a year or two (Kovacic et al. 1986, Monleon et al. 1997)

The mobility of phosphorus (P) increases after wildfires and to a lesser extent after prescribed fires, because phosphorus is easily adsorbed to sediment and ash and is therefore readily transported in runoff. Most of the increase in P concentrations in surface water is therefore due to higher post-fire erosion rates.

The introduction of weeds and unwanted flora following a wildfire could lead to increased competition between less desirable invasive and noxious weeds and desirable native vegetation. Weeds can increase erosion by reducing soil moisture and depleting nutrient levels (DiTomaso 2000), leading to a less vigorous native plant community, and therefore overall ground cover. The resulting erosion can degrade surface water quality and increase bedloads and channel scour in riparian areas.

Under the No Action alternative, there would be no obliteration and no relocation of roads that are currently contributing to loss of soil productivity and degradation of water quality. These roads would remain at risk of unauthorized use, further contributing to soil destabilization, loss of productivity, and adverse impacts to surface water quality. Ongoing road maintenance of ML-2 and ML-3 roads within the project area would continue as it has in the past.

Under the No Action Alternative, there would be no restoration of springs and no restoration of ephemeral channels. These areas would continue to exhibit downward trends in functional condition or remain in static condition for the foreseeable future.

This alternative would result in no additional acres of ground disturbance from mechanical vegetation treatments, piling of activity-related woody debris, construction and maintenance of temporary roads, road obliteration, fence construction, and the use of prescribed fire. Because these activities can have short-term adverse effects to water quality and riparian areas, Alternative A poses fewer short-term risks to water quality and riparian areas than the Action Alternatives. However, because uncharacteristic fire behavior would not be reduced or mitigated within the project area, long-term risk to water quality and riparian areas would be greatly increased under the No Action Alternative.

The No Action Alternative would not meet the purpose and need of forest restoration that would provide for more resilient forest conditions that would better protect forested ecosystems and watersheds from uncharacteristic fire behavior and improve ecosystem function in grassland vegetative communities, spring ecosystems, ephemeral streamcourses, and perennial waterbodies.

General Direct Effects of Vegetation Management and Prescribed Fire (Common to Alternatives B-E)

Direct effects of vegetation management on stream systems should be minor when Forest Service BMP's are followed (Region 3 FSH 2509.22). These include providing an adequate buffer from harvest operations, designation of all channel crossing locations by mechanized equipment, and designation of skid trails, to avoid crossing stream channels (ephemeral and intermittent). Limiting vegetation management activities from impacting stream courses should lead to minor or inconsequential direct effects to stream habitat and associated biota. While prescribed fire has the ability to have direct effects to stream channels, none of the action alternatives propose for ignitions to occur within riparian areas or along stream channels, but fire is allowed to back downslope into these areas. If fire burns riparian areas, there is the potential for some ash and localized erosion to occur; however, these effects should be minor in degree and extent.

General Indirect Effects of Vegetation Management and Prescribed Fire (Common to Alternatives B-E)

Most effects to aquatic habitat and biota are the result of upland terrestrial changes that result in changes to sediment and water transport in the watershed. The primary negative impacts to aquatic systems and their associated biota from vegetation treatment and prescribed fire come as indirect effects. These indirect effects include: increased sediment, loss of riparian vegetation, altered macroinvertebrate assemblages, lowering of groundwater tables and decreased perennial flows, increased stream temperature, larger peak flows, stock tank impacts, and changes in channel form (Bisson et al. 2003, Swank et al. 1989).

Sedimentation and erosion are natural processes and ecosystems have evolved to handle the natural background levels and the episodic events of fire (Bisson et al. 2003). However, when land management activities alter the natural levels in a watershed, deleterious effects to the habitat and biota can occur, and this can be compounded when a system's natural resiliency has been degraded by past activities, such as fire suppression, drought, road building, grazing, etc. Vegetation management can contribute to the deterioration of soil stability and porosity, increasing erosion and compaction. These factors can lead to increased sedimentation into streams and changes in the hydroperiod.

Sediment adversely impacts stream fishes directly through: changing fish behavior, altering fish physiology, impairing growth, shifting blood chemistry, inducing gill trauma, reducing disease resistance, increasing egg mortality, and direct mortality of juveniles and adults if strong enough (Anderson 1996, Argent and Flebbe 1999, Bisson and Bilby 1982). Sediment indirectly affects fish through behavior modifications, including increased frequency of the cough reflex, avoidance of suspended sediment, reduction in feeding, and temporary disruption of territoriality. The severity of changes in fish behavior is associated with the timing of disturbance, the level of stress, and the importance of the habitat that the fish may be excluded from (Anderson 1996, Bisson and Bilby 1982, Rice et al. 2001). Other indirect effects on stream fishes from sediment can occur by modifications to stream habitat. These changes include: altered channel morphology, loss of spawning habitat, loss of rearing habitat, changes in the food supply (macroinvertebrate assemblage), and decreased over-wintering habitat (Lisle 1989, Miller and Benda 2000, Wood and Armitage 1997).

Watershed hydroperiod can be altered by fire and cause vegetation removal causing accelerated soil erosion and loss of soil productivity, and contribute to increased soil compaction. Reductions in soil productivity can limit the vegetation potential resulting in less moisture that is taken up by plants. Increased soil compaction decreases the amount of water and organic material infiltration into the soil. Both of these factors compound to lead to higher surface runoff and higher flood pulses in stream channels (Swank et al. 1989, Ziemer et al. 1991). The erosive energy of floods can cause stream channel downcutting or incision causing water to drain from floodplains into the channel resulting in lower ground water tables (Agee and Skinner 2005, Lertzman et al. 1998, Ziemer et al. 1991). This results in a narrowing or loss of riparian vegetation because it is left in drier soils. Additionally, less water is stored upslope and less water is available for riparian soils to provide late season flows. Therefore, the higher flows during precipitation events are often followed by low or no flow during the drier weather periods (Rinne and Miller 2006).

The effects of hydroperiod alterations listed above can result in deleterious effects to aquatic biota. Lower water tables that reduce or eliminate riparian vegetation affect macroinvertebrate communities. Streamside vegetation provides both allochthonous (produced outside stream system) and autochthonous (produced within stream ecosystem) food sources for macroinvertebrates and the quantity and quality of these inputs plays a critical role in regulating the macroinvertebrate assemblage that is present in the system (Gregory et al. 1991). In turn, macroinvertebrates are a primary food source for aquatic vertebrates (icthyofauna and herpetofauna) and alterations to the food web at the lower levels will have repercussions to these higher-level consumers. Additionally, riparian plant communities with rooted plants retard streambank erosion, filter sediments out of the water, build and stabilize streambanks and streambeds, and provide shade and nutrients for aquatic species. Healthy riparian areas act as sponges during high water periods and raise water tables maintaining streamwater during dry seasons, resulting in more flow throughout the year (Elmore and Kauffman 1994, Kauffman et al. 1997). The loss of riparian vegetation therefore can result in a negative feedback loop where conditions continue to break down until active management is undertaken to repair degraded areas.

General Direct and Indirect Effects of Wildfire (Common to Alternatives B-E)

Effects of fire may be direct and immediate or indirect and sustained over time (Gresswell 1999). The cause of direct fire-related fish mortalities has not been clearly established. Fatalities are most likely during intense fires in small, headwater streams with low flows (less insulation and less water for dilution) (Gresswell 1999). In these situations, water temperatures can become elevated or changes in pH may cause immediate death (Cushing and Olson 1963). Spencer and Hauer (1991) documented 40-fold increases in ammonium concentrations during an intense fire in Montana. The inadvertent dropping of fire retardant in streams is another source of direct mortality during fires.

Indirect effects of fire include ash and debris flows, increases in water temperature, increased nutrient inputs, and sedimentation (Bozek and Young 1994, Gresswell 1999). Ash and debris flows can cause mortality months after fires occur when barren soils are eroded during monsoonal rain storms (Bozek and Young 1994, Brown et al. 2001). Fish can suffocate when their gills are coated with fine particulate matter, they can be physically injured by rocks and debris, or they can be displaced downstream below impassable barriers into habitat occupied by nonnative fish. Ash and debris flows or severe flash flooding can also decimate aquatic invertebrate populations that fish may depend on for food (Molles 1985, Rinne 1996). In larger streams, refugia are typically available where fish can withstand the short-term adverse conditions; small headwater streams are usually more confined, concentrating the force of water and debris (Pearsons et al. 1992, Brown et al. 2001).

Direct and Indirect Effects of Spring Restoration (Common to Alternatives B-E)

Spring conditions would improve for up to74 springs within the analysis area (Table 25). Initially, spring habitats would experience short-term increases in sediment production and transport as a result of restoration activities. As restored springs stabilize, however, springs would show increased surface flows and improved groundwater levels. Additionally, vegetation treatments at the watershed scale combined with prescribed burning could restore or improve hydrologic function of springs that currently have reduced discharge due to evapotranspiration losses of soil water that could otherwise recharge groundwater in perched or shallow aquifers (MacDonald 2013).

Table 25. Location of proposed spring restoration activities, by 5th HUC watershed and subunit.

5th HUC Name	Subunit	Spring Name
Beaver Creek	1-5	Bristow Spring
		Lee Spring
		Rock Top springs
		Seven Anchor Spring
		Tree Spring
		T-Six Spring
		Van Deren Spring
Canyon Diablo	1-4	Dove Springs
		Mint Spring
		Sawmill Springs
Cataract Creek	4-3	Fues Spring
Deadman Wash	5-1	Pat Spring
	5-2	Alto Spring
Hell Canyon	3-1	Andrews Spring
		Bear Springs
		Bill Williams Loop unnamed spring
		Hat Tank lower unnamed spring
		Hat Tank upper unnamed spring
		Stewart Spring
		Wild Horse Spring
Oak Creek	1-5	Bootlegger Spring
		Howard Spring
		Mud Spring
		Munds Spring
		Sheep Spring
		Willard Spring
	3-4	Griffiths Spring
		Scott Spring
	3-5	Lockwood Spring
		Ritter Spring
Rio de Flag	5-1	Chimney Springs
	5-2	Little Elden Spring
San Francisco Wash	1-2	Sedge Spring
Spring Valley Wash	4-4	Beale Spring
Sycamore Creek	3-2	Big Spring
		McDougal Spring

5th HUC Name	Subunit	Spring Name
		Mineral Spring
		Rosilda Spring
		Triangle Spring
		Willow Spring
	3-3	Lee Canyon upper unnamed spring
		Lower Hull Spring
		Poison Spring
		Railroad Spring
		Rocky Tule spring unnamed
		Upper Hull Spring
		weed unnamed spring
	4-4	Kaufman Spring
		Lower McDermit Spring
		NE Spring
		Sawmill Spring
		Spitz Spring lower
		Spitz Spring upper
		Upper McDermit Spring
		Wade Spring
Upper Cedar Wash	4-3	Curley Seep
		Howard Seep
		Kendrick Spring
		Lost Spring
Walnut Creek	1-3	Babbit Spring
		Clarks Well
		Hoxworth Springs
		Thomas Spring
		Weimer Spring
	1-5	Broken Spring
		Dairy Spring
		Double Springs
		Railroad Spring
		Smith Spring
		Tinny Spring
		(blank)

Direct and Indirect Effects of Stream Restoration (Common to Alternatives B-E)

Thirty-nine miles of ephemeral streamcourses (Table 26) would be treated to reduce channel and bank scour, downcutting, aggradation, and uncharacteristic levels of sediment transport. Initially, ephemeral streamcourse restoration would likely exhibit slight increases in short-term sediment production and transport since stream banks and channels would be disturbed during the reshaping and restoration process (MacDonald 2013). As restored areas stabilize, ephemeral streamcourse banks would have more gentle angles of repose that would support vegetative cover, more favorable floodplains to increase soil water storage, and reduced stream velocities; thus decreasing sediment transport, channel downcutting, and stream bank undercutting that results in bank failure.

Table 26. Location of proposed stream restoration activities, by 5th HUC watershed and subunit.

5th HUC Name	Streamcourse	Subunit	Miles
Beaver Creek	Unnamed	1-5	0.21
Canyon Diablo	Sawmill Wash	1-4	0.33
Cataract Creek	Unnamed	4-3	0.63
Deadman Wash	Unnamed	5-1	0.46
Heather Wash	Coconino Wash	6-3	0.10
	Unnamed	6-3	0.30
Oak Creek	James Canyon	1-3	0.02
	Pumphouse Wash	1-3	0.83
	Schoolhouse Draw	1-3	0.61
	Unnamed	1-3	2.52
	Unnamed	1-5	1.66
	Unnamed	3-4	0.02
	Unnamed	3-5	4.51
Rio de Flag	Unnamed	5-1	0.39
	Unnamed	5-2	1.53
Spring Valley Wash	Unnamed	4-3	4.43
Sycamore Creek	Railroad Draw1	3-3	0.13
	Volunteer Canyon	3-3	1.09
	Volunteer Wash	3-3	0.00
	Unnamed	3-3	1.68
Walnut Creek	Fay Canyon1	1-1	0.69
	Howard Draw	1-3	2.16
	Newman Canyon	1-3	3.48
	Priest Draw	1-3	0.31
	Skunk Canyon	1-1	0.29
	Unnamed	1-1	3.43
	Unnamed	1-3	6.55
	Unnamed	1-5	0.49
Grand Total			**38.84**

Direct and Indirect Effects of Road Restoration and Decommissioning (Common to Alternatives B-E)

Runoff from road surfaces can detach and transport the fine material from road prisms and ditches. Sediment delivery directly from road surfaces to water courses is difficult to estimate since it occurs as non-point source runoff. Sediments delivered to streams from roadside ditches may have originated from sheet or rill erosion prior to entering road surfaces or drainage ditches (MacDonald 2013). In the absence of vehicle traffic, sediment concentrations in road runoff decreases over time. However, vehicle traffic, particularly trucks, can pulverize road surface aggregates, resulting in more fine particles that are easily transported in runoff. Additionally, the pressure of vehicular tires on saturated road surfaces can force fine particles from below the surface to move upward to the surface. Road proximity and connectivity to drainages can strongly influence sediment delivery to watercourses and peak flows in streams. Roads within the project area intersect numerous ephemeral drainages. These points of intersection occur as both culverted crossings and low-water crossings. Road-stream intersections are the primary location where sediments are delivered to stream courses.

A total of approximately 860 miles of existing system roads and unauthorized roads would be decommissioned under all Action Alternatives. Road decommissioning would entail obliteration whereby road surfaces could be ripped and seeded or mulched, inside ditches would be filled, road prisms outsloped, culverts and fill materials removed, stream crossings re-contoured, unstable sidecast or cutslopes removed or stabilized, and entrances blocked to prevent future access (MacDonald 2013). These activities would return unproductive acreage to a more stable, productive status over the long term by improving water infiltration, naturalizing water flow, increasing vegetative ground cover and reducing erosion (MacDonald 2013). Upon completion of road decommissioning activities, long term erosion rates for decommissioned roads are expected to approach natural erosion rates for TEUs where these roads occur. With implementation of appropriate BMPs as outlined in Table 27, water quality and riparian ecosystem conditions would be improved.

Approximately 40 miles of roads would be reconstructed to reduce adverse effects to surface water quality. These legacy roads are located in close proximity to, or within streamcourses. By relocating these roads to upland locations, sediment delivery directly to streamcourses would be minimized.

Approximately 520 miles of temporary roads would be necessary to conduct vegetation treatments. These roads would be constructed using BMPs as outlined in Table 27, thus minimizing adverse impacts to surface water quality. No riparian areas would be adversely affected by temporary road construction as none are proposed within riparian areas.

Direct and Indirect Effects of Dust Abatement (Common to Alternatives B-E)

Road-related operations would include dust abatement treatments. An expert panel, sponsored by the U.S. Environmental Protection Agency, conducted a literature review of dust suppressants (Piechota et al. 2004). Magnesium chloride ($MgCl_2$) is the most widely used salt for suppressing dust. Salts move through soil easily with water and, in areas near the application, could potentially have negative impacts on plant growth near application sites. Chloride concentrations as low as 40 ppm have been found to be toxic to trout. Salt concentrations greater than 1,800 mg/L have been found to kill daphnia and crustaceans (Sanders and Addo 1993), and 920 mg/L of calcium chloride has been found to be toxic to daphnia (Anderson 1950). A mortality of 50% was achieved for Rainbow Trout exposed to 2,500 mg/L ligninsulfonate for 275 hours. Lignin has been found to cause weight gain and colon ulcers in lab testing of rodents. It did not prevent seed germination in field trials and may be the most environmentally compatible dust suppressant (Piechota et al. 2004).

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

Resource Protection Measures

Resource protection measures listed below include references to the standard contract clauses (BT and CT) Forest Service Timber Sale Contract (TSC) and to Best Management Practices (BMP's) the Soil and Watershed Conservation Practices Handbook (USDA, 1990). Resource protection measures are put in place to minimize nonpoint source pollution as outlined in the intergovernmental agreement between the Arizona Department of Environmental Quality and the Southwestern Region of the Forest Service (ADEQ, 2008).

In Table 27, BMP's referenced within the mitigation text are BMP's outlined in the Region 3 USFS Soil and Conservation Handbook ((R3) FSH 2509.22. Additional BMP's (BMP 37 and 38) were added to address potential effects from the Slide Fire.

Table 27: Resource Protection Measures Required for All Action Alternatives.

BMP #	Mitigation	Why
BMP #1	Implement Best Management Practices prior to project implementation.	To minimize impacts to soil and water resources from project implementation, to minimize non-point source pollution, to adhere to the Clean Water Act, and to adhere to the intergovernmental agreement between Region 3 of the Forest Service and the Arizona Department of Environmental Quality.
BMP #2	Minimize mechanical operations when ground conditions are such that soil compaction can occur. All activities should be limited/restricted to when soils are dry or frozen. If compaction occurs, mitigate through ripping, seeding and covering compacted areas with slash.	To minimize soil compaction, soil detachment & sediment transport. To maintain long-term soil productivity.
BMP #3	All fueling of vehicles will be done on a designated protected, upland site. If more than 1320 of gallons of petroleum products are to be stored on site above ground or if a single container exceeds 660 gallons, then a spill prevention control and countermeasures plan (SPCC) will be prepared as per 40 CFR 112).	To prevent contamination of waters from accidental spills.
BMP #4	The following applies to any personnel implementing ground-disturbing actions: Prior to moving off-road equipment onto a project area, contractor shall identify the location of the equipment's most recent operation. Contractor shall not move any off-road equipment that last operated in an area infested with one or more invasive species of concern onto sale area without having cleaned such equipment of seeds, soil, vegetative matter, and other debris that could contain or hold seeds, and having notified Forest Service, as provided in (iii). If the location of prior operation cannot be identified, then contractor shall	To minimize the spread of non-native species

BMP #	Mitigation	Why
	assume that the location is infested with invasive species of concern. If the contractor has worked in areas where potential chytrid fungus could occur, contractor shall assume chytrid fungus is present and must disinfect equipment prior to work adjacent to water bodies. (i – intentionally omitted) (ii) Prior to moving Off-road equipment from a cutting unit or cutting area that is shown on contract area or sale area map to be infested with invasive species of concern to, or through any other area that is shown as being free of invasive species of concern, or infested with a different invasive species, contractor shall clean such equipment of seeds, soil, vegetative matter, and other debris that could contain or hold seeds and/or disinfect as necessary, and shall notify the Forest Service, as provided in (iii). (iii) Prior to moving any off-road equipment subject to the cleaning and disinfecting requirements set forth above, contractor, shall advise Forest Service of its cleaning measures and make the equipment available for inspection. Forest Service shall have 2 days, excluding weekends and Federal holidays, to inspect equipment after it has been made available. After satisfactory inspection or after such 2 day period, contractor may move the equipment as planned. Equipment shall be considered clean when a visual inspection does not disclose seeds, soil, vegetative matter, and other debris that could contain or hold seeds. Contractor shall not be required to disassemble equipment unless so directed by the Forest Service after inspection. (iv) If contractor desires to clean off-road equipment on National Forest land, such as at the end of a project or prior to moving to, or through an area that is free of invasive species of concern, contractor shall obtain prior approval from contracting officer as to the location for such cleaning and measures, if any, for controlling impacts.	
BMP #5	If construction crews are to live on-site, then an approved camp and suitable sanitation facilities must be provided.	To protect surface and subsurface water from unacceptable levels of bacteria, nutrients and chemical pollutants.
Prescribed burning and managed fires		
BMP #6	On areas to be prescribed burned, fire prescriptions should be designed to minimize soil temperatures over the entire area. High intensity fire should occur on 10% or less of the entire area. Fire prescriptions should be designed so that soil and fuel moisture temperatures are such that fire intensity is minimized and soil health and productivity are maintained. If containment lines are put in place, rehabilitate lines after use by either rolling berm back over the entire fireline, spreading slash across the fireline or waterbar the fireline. If line is only to be waterbarred, disguise the first 400 feet of line to discourage use as a trail.	To maintain long-term soil productivity and minimize sediment delivery from containment lines.

BMP #	Mitigation	Why
BMP #7	On areas to be prescribed burned, manage for 5-7 tons/acre of course woody debris in ponderosa pine be left on-site after the prescribed burns to maintain long-term soil productivity on areas to be burned outside of the buffers around private land in. Within the pinyon-juniper cover type, snags would be managed for 1 per acre over 75% of the area and coarse woody debris (CWD) would be managed for an after treatment average of 1 to 3 tons per acre. Where available, a portion of the CWD would include two logs ≥10" and ≥10' in length.	To maintain long-term soil productivity.
BMP #8	On areas to be prescribed burned, establish filter strips (also known as streamside management zones. These stream reaches will be designated as protected streamcourses. The following are recommendations to protect streamcourses. **Riparian streamcourse:** Severe erosion hazard: 120 feet on each side of streamcourse. Moderate erosion hazard: 100 feet on each side of streamcourse. Slight erosion hazard: 70 feet on each side of streamcourse. **Non-riparian streamcourse:** Severe erosion hazard: 100 feet on each side of streamcourse. Moderate erosion hazard: 70 feet on each side of streamcourse. Slight erosion hazard: 35 feet on each side of streamcourse. Do not ignite fuels within this buffer area. Some creep may occur into the buffer.	To minimize sediment and/or ash delivery into drainages and maintain water quality.
BMP #9	All burning will be coordinated daily with the Arizona Department of Environmental Quality (ADEQ). Burning will not take place on any portion of the project without prior approval from ADEQ. Coordination with ADEQ will take place through the Kaibab and Coconino National Forest Zone Dispatch Center and the Prescribed Burning Boss.	To ensure that smoke management objectives are met.
Road Reconstruction and Channel Restoration		
BMP #10	Complete all required permitting (404 permits) and Water Quality Certification (if necessary), prior to project implementation.	To comply with Clean Water Act provisions.
BMP #11	Site rehabilitation on upland sites for stream channel and road reconstruction projects where ground disturbance occurs: Seed at 5 pounds/acre with native, certified weed	To minimize soil erosion and minimize noxious weed spread and mitigate severe erosion hazard.

BMP #	Mitigation	Why
	free seed mix. Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized. Where feasible, protect site with slash spread across the disturbed area to create microclimates and protect from grazing ungulates.	
BMP #12	Site rehabilitation on riparian sites for stream channel and road rehabilitation projects where ground disturbance occurs: Seed at 5 pounds/acre with certified weed free native seed mix to rehabilitate the site and minimize impacts of noxious weeds. Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized. Where feasible, protect site with a variety of methods (e.g ungulate proof fence, spreading slash etc).	To comply with State and Federal water quality standards by minimizing soil erosion through the stabilizing influence of vegetation ground cover. Minimize noxious weed spread.
BMP #13	Install silt fences and/or waddles downstream from ground-disturbing activities in stream channels to minimize the chance of sediment being lost downstream during construction and until revegetation is completed.	To comply with State and Federal water quality standards by minimizing sediment delivery to drainages.
BMP #14	Provide site protection on newly disturbed soils (e.g. hydromulch, erosion mat, spread slash etc) in channel restoration and road reconstruction sites on all sites as needed and where feasible.	To comply with State and Federal water quality standards by minimizing sediment delivery to drainages, minimize impacts on severe erosion hazard soils, and to create microclimate for regeneration of grass/forb community and minimize noxious weed spread.
BMP #15	Bring rock material from a local upland site to any headcut drop structures that may be installed in channel restoration projects.	To minimize disturbance in drainage systems and minimize sediment production within channel.
BMP #16	Site rehabilitation on disturbed sites at and stream channel shaping on previously obliterated roads: Site rehabilitation consists of several revegetation methods, such as, but not limited to: 1) Store sod removed from the initial ground disturbance and replace the sod from the top of the bank on the disturbed site; 2) Seed with a native seed mix (see BMP's above) 3) Protect site with slash spread across the disturbed area to create microclimates and protect from grazing ungulates. Slash placement will be limited to the upper 2/3 of the bank to limit transport downstream of woody material; 4) Fence out ungulates for 1 to 2 years (or until the site has re-established); 5) use mycorhizal inoculum on severely disturbed sites where no topsoil is left, 6) install erosion mat.	To comply with State and Federal water quality standards by minimizing soil erosion through the stabilizing influence of vegetation ground cover. Minimize noxious weed spread.
BMP #17	Do not borrow road fill or embankment materials from the stream channel or meadow surface on road maintenance projects. End-load all material hauled on-site and compact fill.	To minimize disturbance in drainage systems and minimize sediment production within channel.

BMP #	Mitigation	Why
BMP #18	Where feasible, relocate roads out of filter strips into an upland position. If this is not feasible, use riprap or velocity checks to stabilize or disperse outfall on road maintenance projects when roads are located within filter strips.	To minimize sediment delivery into drainage and to minimize disturbance in drainage systems and minimize sediment production within channel.
BMP #19	At riparian stream reach restoration sites, restore riparian dependent grasses through 1) seeding of native species, 2) planting plugs of rushes, sedges, and spike rushes to improve success of regeneration efforts. Fence with ungulate proof fencing for 1 to 2 years (or until plants are established) if grazing is inhibiting regeneration efforts.	To comply with State and Federal water quality standards by minimizing soil erosion through stabilization of ground cover. Minimize noxious weed spread.
BMP #20	On areas that have had roads previously obliterated and the remaining roadbed will be removed, add slash/or erosion mat and seed to the disturbed areas.	To add surface roughness a To comply with State and Federal water quality standards by minimizing soil erosion through stabilization of ground cover and to diminish the impact of the first rain event and to speed recovery of the site.
Springs and seeps		
BMP #21	At spring restoration sites, restore riparian dependent species through 1) seeding of native species, 2) planting plugs/cuttings of native plants to improve success of regeneration efforts. Fence with ungulate proof fencing for 1 to 2 years (or until plants are established) if grazing is inhibiting regeneration efforts.	To comply with State and Federal water quality standards by minimizing soil erosion through stabilization of ground cover. Minimize noxious weed spread.
Harvesting operations		
BMP #22	Do not blade roads when the road surface is too dry. If the road surface is too dry, a water truck can apply water, or the project can be scheduled for when adequate moisture occurs to complete the project.	To minimize sediment detachment and to minimize impacts on .severe erosion soils
BMP #23	In grassland restoration sites, limit skidding and designate skid trails if wood is to be removed. Where material is not to be removed, do not skid logs in meadows and lop and scatter is the preferred method of treating slash. Do not machine pile within meadows. If skidding has to occur across a riparian or non-riparian streamcourse, designate any crossing prior to skidding.	To minimize impacts to streams and soils in meadows from tree harvesting operations.
BMP #24	Skid trails and obliterated roads will have slash placed on the trail or cross-ditched (waterbarred) to break the energy flow of water. Placing slash on skid trails is the preferred method to dissipate the energy flow of water. Waterbars are only to be implemented with equipment with an articulating blade (no skidders) or by hand.	To minimize soil erosion and maintain soil productivity. and to minimize impacts on severe erosion soils
BMP #25	Landing locations will be in upland positions and out of meadows, riparian and non-riparian filter strips.	To minimize sediment delivery into drainage. and to minimize impacts on .severe erosion soils

BMP #	Mitigation	Why
BMP #26	Mechanical harvest or mechanical fuel treatment are only allowed on Cinder Cones greater than 25% slope with designated skid trails and slash mats placed on the skid trails. On other sites, mechanized harvesting can occur up to 40% slopes.	To maintain long-term soil productivity on slopes with severe erosion hazard potential
BMP #27	Designated skid trails and log landings will be required within the Integrated Resource Service Contract (**BMP 24.18 in FSH 2509.22**) on all cutting units. Skid trail design should not have long, straight skid trails that would direct water flow. Skid trails should also be located out of filter strips (exceptions are at approved crossings).	To minimize the number of acres disturbed and to minimize impacts on severe erosion soils .
BMP #28	Felling to the lead will be required within the Integrated Resource Service Contract (IRSC) to minimize ground disturbance from skidding operations (**BMP 24.18**).	Felling of timber should be done to minimize ground disturbance from skidding operations and to minimize impacts on .severe erosion soils .
BMP #29	The IRSC outlines the timing and application of erosion control methods to minimize soil loss and sedimentation of streamcourses. Seed mix can include any of the following certified weed free native species at a minimum of 5 lbs/acre pure live seed: Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized. Corresponding BMP's from FSH 2509.22 to minimize soil loss and sedimentation of include **24.13, 24.21, 24.22, 24.23, 24.24, and 24.25**. The preferred erosion control method on the skid trails in the harvest areas will be by spreading slash. Other acceptable erosion control measures include, but are not limited to, waterbarring (waterbars should not be more than two feet deep and need at least a ten foot leadout. Waterbars are only to be implemented with equipment with an articulating blade (no skidders) or by hand.), removing berms, seeding, mulching and cross-ripping. Erosion control after skidding operations must be timely to minimize the effects of log skidding.	Minimize soil loss and sedimentation of streamcourses from skidding operations and to minimize noxious weed spread and re-establish native vegetation and to minimize impacts on severe erosion soils
BMP #30	Road drainage is controlled by a variety of methods (**BMP 41.14**), including rolling the grade, insloping outsloping, crowning, water spreading ditches, an contour trenching. Sediment loads at drainage structures can be reduced by installing sediment filters, rock and vegetative energy dissipaters, and settling ponds. Design of roads is included in the transportation plan of the IRSC and T-specs.	To minimize soil movement and maintain water quality and to minimize impacts on .severe erosion soils.
BMP #31	Road maintenance (**BMP 41.25)** through the IRSC should require prehaul and post haul maintenance on all roads to be used for haul.	To minimize soil movement and maintain water quality. and to minimize impacts on .severe erosion soils
BMP #32	The designation of filter strips (also known as streamside management zones) minimizes on-site soil movement from timber harvest activities along streamcourses (**BMP 24.16**). These stream reaches will be designated as protected streamcourses. Locations of protected streamcourses are included in the individual **Task Order Maps** and will be designated with a protected streamcourse designation.	Filtering sediment and/or providing bank stability on all streamcourses and to minimize impacts on .severe erosion soils . To implement the Oak Creek *E. Coli* TMDL and Lake Mary Region Mercury TMDL and to filter sediment and/or

BMP #	Mitigation	Why
	The following are recommendations to protect streamcourses within the proposed tree harvest units in relation to riparian and non-riparian streamcourses. The guidelines for filter strip designation are as follows: **Riparian streamcourse:** Severe erosion hazard: 120 feet on each side of streamcourse. Moderate erosion hazard: 100 feet on each side of streamcourse. Slight erosion hazard: 70 feet on each side of streamcourse. **Non-riparian streamcourse:** Severe erosion hazard: 100 feet on each side of streamcourse. Moderate erosion hazard: 70 feet on each side of streamcourse. Slight erosion hazard: 35 feet on each side of streamcourse. Accepted harvest activities within riparian and non-riparian filter strips include mechanical and conventional tree felling and limited skidding on designated skid trails and not across streamcourses. Landings, decking areas, machine piles, and roads (except at designated crossings) are planned outside of riparian and non-riparian filter strips.	provide bank stability.
BMP #33	Manage for a minimum of 5 to 7 tons per acre in ponderosa pine sites that will be left on-site on all cutting unit sites.	To promote long-term soil productivity.
BMP #34	Mechanical crushing of lopped slash can only occur on 0-25% slopes**.**	To incorporate slash into the soil to promote long-term soil productivity.
BMP #35	Identify landings, staging area for heavy equipment and sites for any in woods processing sites outside of filter strips and meadows. Sites will be rehabilitated after use by methods such as, but not limited to: 1) ripping to remove compaction, 2) seeding with certified weed free native seed to 5 lbs per acre. Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized; and 3)spreading of slash to disguise the site and provide for a mulch for seeds	To minimize and mitigate impacts from activities that compact sites and to restore long-term soil productivity and to minimize impacts on .severe erosion soils .
BMP #36	Manage for a minimum of 1 to 3 tons per acre in pinyon-juniper sites that will be left on-site on all cutting unit sites. Where available, a portion would include two logs greater than or equal to 10 inches and 10 feet in length.	To promote long-term soil productivity.
Slide fire		
BMP	Defer mechanical thinning and prescribed fire activities	To minimize impacts to the water quality

BMP #	Mitigation	Why
#37	within the Slide Fire perimeter until 5 years after the signed decision, at the earliest.	of West Fork of Oak Creek and Oak Creek (Arizona Unique Water) from sediment. The BMP will allow for adequate post-fire recovery of soil and vegetation resources and minimize the cumulative effects from the fire.
BMP #38	Defer mechanical thinning and prescribed fire activities within the Slide Fire perimeter until adequate vegetative ground cover (plant litter, duff and basal area) is present (minimum of about 60% in ponderosa pine vegetation types) to filter and reduce sediment delivery into streamcourse.	To minimize impacts to the water quality of West Fork of Oak Creek and Oak Creek (Arizona Unique Water) from sediment. The BMP will assure streamside management zone is capable of filtering into connected perennial waters downstream.

Cumulative Effects

Alt A (No Action)

The geographic setting and boundary for this cumulative effects analysis will be all 82 6th HUC watersheds within or intersecting the project boundary for a total of about 2,032,080 acres. Cumulative effects includes past timber sales and their associated roads, hazardous fuel and prescribed burning projects that can affect the acres of soil disturbance, primarily through fuel treatments, as well as past burning and wildfires, range allotments, roads, private land, power corridors and recreation activities. Recreation activities are dispersed across the cumulative effects boundary area and are not quantifiable.

Baseline Activities

Roads, private land, grazing allotments, and powerline corridors are baseline disturbance area acres for the project area. Baseline activities are ground disturbance constants. For this analysis, roads and powerline corridors are synonymous because the area of powerline corridors that contains baseline ground disturbance is the access road. Grazing allotments occur across about 1,692,900 acres of the cumulative effects area on allotments on the Coconino, Kaibab, Prescott National Forests and State and Private lands. Ground disturbance from cattle grazing is difficult to quantify; however, ground disturbance does occur from grazing where cattle congregate, which are typically associated watering sites. For this analysis, I will use the baseline disturbance for grazing as an area adjacent to stock tanks (1/8 mile buffer). For this analysis, there are approximately 1,100 acres of disturbance from grazing.

There are approximately 7,170 miles of roads within the analysis area according to three forest Geographic Information System (GIS) data layers. These data layers did not differentiate between open and closed roads, so for this analysis, I assumed that all roads are open; therefore the actual acres of current ground disturbance is probably overstated for the cumulative effects analysis area. The 7,170 miles of road equate to approximately 13,030 acres of disturbance from roads.

There are 101,461 acres of private land within the cumulative effects boundary area. Of these acres, there are variable levels of development ranging from municipal development in areas such as Flagstaff, Williams, Tusayan, and Sedona, to completely undeveloped. For this analysis, each private land parcel was classified as either having high or low development by examining each parcel with air photos to determine the level of development. For areas of high development, a disturbance factor of 70% was applied (this is the equivalent disturbed area factor used on the Apache-Sitgreaves Equivalent Disturbed Area process for high development). For areas of low development, a 10% disturbance factor was applied after examining aerial photos (the Apache-Sitgreaves Equivalent Disturbed Area process for low development applies a 20% disturbance factor and after reviewing parcels by air photo this factor was too high because there is a general lack of any development on many of the parcels). The total ground disturbance for private land is calculated at about 30,900 acres.

The total baseline ground disturbance is about 45,040 acres for the cumulative effects area, or about 2% of the entire cumulative effects area. There are four 6^{th} code watersheds where urban development has a large impact on ground disturbance areas—Cataract Creek Headwaters (11% baseline ground disturbance) associated with the City of Williams, Sinclair Wash (25%) and Lower Rio de Flag (18%) associated with the City of Flagstaff, Middle Oak Creek (11%) associated with Sedona and private land developed adjacent to Oak Creek.

Past Actions and Present Actions

The timeframe for past actions is 2-3 years, based on vegetative and course woody debris recovery of the site. Vegetative recovery after fuel treatments is generally very rapid, with erosion rates typically dropping to pre-fire levels within 1 to 2 years (Elliot et al 2010: 93). Therefore, protective vegetative ground cover that may have been disturbed in past timber sales, hazardous fuel and prescribed burning projects older than about 2-3 years is likely recovered enough to protect against accelerated erosion, and does not contribute to adverse cumulative effects to the soil and therefore, soil productivity is now maintained. This translates directly to protection of aquatic habitat, because sediment erosion and associated sedimentation of surface waters will be reduced. The acres used for the analysis are a summary of projects that were reported in the FACTS activity layer from 2009 to the present.

For the cumulative effects boundary area, there are approximately 154,720 of total treatment acres of past and current projects within the cumulative effects boundary (about 7% of the cumulative effects area). Assuming a 15% disturbance factor for treatments, there are a total of approximately 27,380 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1% of the cumulative effects boundary area.

Vegetative ground cover in more recent projects (within the last 2 years) is in the process of recovery. Soil disturbance and erosion is less than the 4-FRI proposed action and smaller in extent and magnitude because fewer acres were treated (and therefore less than the 3.0% that would be generated from the 4-FRI proposed action). The magnitude of soil erosion above tolerable soil loss is believed to be similar in proportion to the 4-FRI proposed action, very minor in magnitude because similar harvesting techniques and BMPs were employed mitigating negative effects to soil and water. The combination of past and ongoing projects regarding soil disturbance is limited in extent and magnitude and amount to about 1% within the cumulative effects boundary.

Reasonably Foreseeable Future Actions

Recreational activities include: hiking, viewing wildlife, hunting, dispersed car-camping, backpack camping, orienteering, horseback riding, caving, rock climbing, photography, picnicking, taking scenic drives, ORV/ATV use, bicycling, shooting, and gathering in family or social groups. Snowmobile use and cross-country skiing are increasing as popular uses in the area. During normal winters, snowmobiles are the only vehicles that access the area.

Other potential uses within the project area include firewood cutting, post and pole cutting, collecting boughs and cones, collecting and transplanting wildlings, gathering antlers, collecting food and medicinal resources such as berries, nuts, mushrooms, and bracken fern, and collecting biological specimens for research. These activities are unquantifiable.

Fuels reduction related projects are expected to occur within the cumulative effects project boundary. For the cumulative effects boundary area, there are approximately 157,500 acres of future and foreseeable treatment acres within the cumulative effects boundary (about 8% of the cumulative effects area). Assuming a 15% disturbance factor for treatments, there are a total of approximately 23,667 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1% of the cumulative effects boundary area.

Table 28: Summary of cumulative effects-Alternative A

	Baseline	Future Foreseeable		Current/Ongoing		PROJECT TOTAL	
TOTAL CUM EFFECTS Analysis Area 6th Code Acres	BASELINE Ground Disturb	TOTAL Treat Acres	TOTAL Ground Disturb	TOTAL Treat Acres	TOTAL Ground Disturb	TOTAL CUM EFFECTS Ground Disturb	TOTAL CUM EFFECTS % Ground Disturb
2,032,080	45,041	157,772	23,666	154,720	27,380	96,087	4.7%

Alt B (Proposed Action)

The geographic setting and boundary for the cumulative effects analysis will be all 82 6th HUC watersheds within or intersecting the project boundary for a total of about 2,032,080 acres. Cumulative effects includes past timber sales and their associated roads, hazardous fuel and prescribed burning projects that can affect the acres of soil disturbance, primarily through fuel treatments, as well as past burning and wildfires, range allotments, roads, private land, power corridors and recreation activities. Recreation activities are dispersed across the cumulative effects boundary area and are not quantifiable.

Baseline Activities

Roads, private land, grazing allotments, and powerline corridors are baseline disturbance area acres for the project area. Baseline activities are ground disturbance constants. For this analysis, roads and powerline corridors are synonymous because the area of powerline corridors that contains baseline ground disturbance is the access road. Grazing allotments occur across about 1,692,900 acres of the cumulative effects area on allotments on the Coconino, Kaibab, Prescott National Forests and State and Private lands. Ground disturbance from cattle grazing is difficult to quantify; however, ground disturbance does occur from grazing where cattle congregate, which are typically associated watering sites. For this analysis, we will use the baseline disturbance for grazing as an area adjacent to stock tanks (1/8 mile buffer). For this analysis, there are approximately 1,100 acres of disturbance from grazing.

There are approximately 7,170 miles of roads within the analysis area according to three forest Geographic Information System (GIS) data layers. These data layers did not differentiate between open and closed roads, so for this analysis, we assumed that all roads are open; therefore the actual acres of current ground disturbance is probably overstated for the cumulative effects analysis area. The 7,170 miles of road equate to approximately 13,030 acres of disturbance from roads.

There are 101,461 acres of private land within the cumulative effects boundary area. Of these acres, there are variable levels of development ranging from municipal development in areas such as Flagstaff, Williams, Tusayan, and Sedona to completely undeveloped. For this analysis, each private land parcel was classified as either having high or low development by examining each parcel with air photos to determine the level of development. For areas of high development, a disturbance factor of 70% was applied (this is the equivalent disturbed area factor used on the Apache-Sitgreaves Equivalent Disturbed

Area process for high development). For areas of low development, a 10% disturbance factor was applied after examining aerial photos (the Apache-Sitgreaves Equivalent Disturbed Area process for low development applies a 20% disturbance factor and after reviewing parcels by air photo this factor was too high because there is a general lack of any development on many of the parcels). The total ground disturbance for private land is calculated at about 30,900 acres.

The total baseline ground disturbance is about 45,040 acres for the cumulative effects area, or about 2% of the entire cumulative effects area. There are four 6th code watersheds where urban development has a large impact on ground disturbance areas—Cataract Creek Headwaters (11% baseline ground disturbance) associated with the City of Williams, Sinclair Wash (25%) and Lower Rio de Flag (18%) associated with the City of Flagstaff, Middle Oak Creek (11%) associated with Sedona and private land developed adjacent to Oak Creek.

Past Actions and Present Actions

The timeframe for past actions is 2-3 years, based on vegetative and course woody debris recovery of the site. Vegetative recovery after fuel treatments is generally very rapid, with erosion rates typically dropping to pre-fire levels within 1 to 2 years (Elliot et al 2010: 93). Therefore, protective vegetative ground cover that may have been disturbed in past timber sales, hazardous fuel and prescribed burning projects older than about 2-3 years is likely recovered enough to protect against accelerated erosion, and does not contribute to adverse cumulative effects to the soil and therefore, soil productivity is now maintained. The acres used for the analysis are a summary of projects that were reported in the FACTS activity layer from 2009 to the present.

For the cumulative effects boundary area, there are approximately 154,720 of total treatment acres of past and current projects within the cumulative effects boundary (about 7% of the cumulative effects area). Assuming a 15% disturbance factor for treatments, there are a total of approximately 27,380 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1% of the cumulative effects boundary area.

Vegetative ground cover in more recent projects (within the last 2 years) is in the process of recovery. Soil disturbance and erosion is less than the 4-FRI proposed action and smaller in extent and magnitude because fewer acres were treated (and therefore less than the 3.0% that would be generated from the 4-FRI proposed action). The magnitude of soil erosion above tolerable soil loss is believed to be similar in proportion to the 4-FRI proposed action, very minor in magnitude because similar harvesting techniques and BMPs were employed mitigating negative effects to soil and water. The combination of past and ongoing projects soil disturbance is limited in extent and magnitude and amount to about 1% within the cumulative effects boundary.

Reasonably Foreseeable Future Actions

Recreational activities include: hiking, viewing wildlife, hunting, dispersed car-camping, backpack camping, orienteering, horseback riding, caving, rock climbing, photography, picnicking, taking scenic drives, ORV/ATV use, bicycling, shooting, and gathering in family or social groups. Snowmobile use and cross-country skiing are increasing as popular uses in the area. During normal winters, snowmobiles are the only vehicles that access the area.

Other potential uses within the project area include firewood cutting, post and pole cutting, collecting boughs and cones, collecting and transplanting wildlings, gathering antlers, collecting food and medicinal resources such as berries, nuts, mushrooms, and bracken fern, and collecting biological specimens for research. These activities are unquantifiable.

Fuels reduction related projects are expected to occur within the cumulative effects project boundary. For the cumulative effects boundary area, there are approximately 157,500 acres of future and foreseeable treatment acres within the cumulative effects boundary (about 8% of the cumulative effects area). Assuming a 15% disturbance factor for treatments, there are a total of approximately 23,667 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1% of the cumulative effects boundary area.

Summary of Cumulative Effects

There are about 45,000 acres of baseline ground disturbance from roads, private land, grazing allotments, and powerline corridors that occur across the cumulative effects analysis area. The total acres of past, present are future and foreseeable treatment acres within the cumulative effects project area are roughly 312,780 acres (154,720 past and present projects and 158,000 acres of future, foreseeable projects) or about 15% of the cumulative boundary area. Of these treatment acres, we are assuming that about 15% of these acres will have ground disturbance, or about 43,700 acres, or just under 2% of the cumulative effects analysis area. The 4FRI EIS will add an additional 66,000 acres of ground disturbance for a total acreage of ground disturbance across the cumulative effects analysis area of 162,200 acres, or about 8% of the cumulative effects boundary area (Table 29).

There are six 6th code watersheds where urban development has a large impact on ground disturbance areas. This project, plus current and future foreseeable projects impacts these watersheds in the following manner. In the Cataract Creek Headwaters watershed there was a 9% baseline ground disturbance prior to any activities. This percent of ground disturbance increases to 15% total cumulative ground disturbance. In the Sinclair Wash watershed, there was an 12% baseline ground disturbance prior to any activities. This percent of ground disturbance increases to 26% total cumulative ground disturbance with all current and foreseeable projects. In the Lower Rio de Flag watershed there was an 8% baseline ground disturbance that increases to 21% total cumulative ground disturbance. In the Middle Oak Creek watershed, there was a 7% baseline ground disturbance that increases to 11% total cumulative ground disturbance. Pumphouse Wash watershed has about 11% contributions from past, present and future projects and about 6% from 4FRI. Upper Rio de Flag watershed has about 14 percent contribution from past, present and future projects and extra about 3 percent from 4FRI. Implementation of BMP's would minimize any impacts to watersheds, and would be especially important in the watersheds that have a high urban impact already existing.

Implementation of BMP's will minimize any impacts to watersheds, and will be especially important in the watersheds that have a high urban impact already existing.

A discussion of cumulative effects resulting from the Slide Fire is found at the end of the analysis for each Alternative.

Table 29: Summary of cumulative effects-Alternative B

	EIS		Baseline	Future Foreseeable		Current/Ongoing		PROJECT TOTAL	
TOTAL CUM EFFECTS Analysis Area 6th Code Acres	TOTAL EIS Ground Disturb	TOTAL EIS % 6th Code Ground Disturb	BASELINE Ground Disturb	TOTAL Treat Acres	TOTAL Ground Disturb	TOTAL Treat Acres	TOTAL Ground Disturb	TOTAL CUM EFFECTS Ground Disturb	TOTAL CUM EFFECTS % Ground Disturb
2,032,080	66,155	3.3%	45,041	157,772	23,666	154,720	27,380	162,241	8.0%

Executive Summary of Cumulative Effects

For past, present and reasonably foreseeable actions including the 4-FRI proposed action, the extent (about 162,250 acres or 8.0 percent, up from 7.6% to include recent disturbance predicted from the Slide Fire) and magnitude of soil disturbance, would not be exceeded with this project within the cumulative effects boundary. Further protection of soil resources is provided by the use of Best Management Practices that minimize the potential for soil disturbance. Identified and implemented BMP's are expected to reduce the risk on accelerated erosion, sediment delivery and nonpoint source pollution to connected streamcourses and maintain water quality in all watersheds. In addition to the use of BMP's, the completion and implementation of the Travel Management EIS will further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, this alternative would not provide a detrimental cumulative effect to soil resources within the cumulative effects boundary.

A discussion of cumulative effects resulting from the Slide Fire is found at the end of the analysis for each Alternative.

Alt C (Preferred Alternative)

The geographic setting, boundary and potential projects are the same as Alternative B.

Baseline Activities

Baseline activities and effects are the same as alternative B. The total baseline ground disturbance is about 45,040 acres for the cumulative effects area, or about 2 percent of the entire cumulative effects area. There are six, 6th code watersheds where urban development has a large impact on ground disturbance areas—Cataract Creek Headwaters (11 percent baseline ground disturbance) associated with the City of Williams, Sinclair Wash (25 percent) and Lower and Upper Rio de Flag (18 percent), Pumphouse Wash associated with the City of Flagstaff, Middle Oak Creek (11 percent) associated with Sedona and private land developed adjacent to Oak Creek.

Past Actions and Present Actions

Past and present activities and timeframe thereof and effects are the same as alternative B. The acres used for the analysis are a summary of projects that were report in the FACTS activity layer from 2009 to the present and are the same as alternative B. For the cumulative effects boundary area, there are approximately 154,720 of total treatment acres of past and current projects within the cumulative effects boundary (about 7 percent of the cumulative effects area). Assuming a 15 percent disturbance factor for treatments, there are a total of approximately 27,380 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1 percent of the cumulative effects boundary area.

Reasonably Foreseeable Future Actions

The activities and acreages of reasonably foreseeable future actions are the same as alternative B. Ground disturbing actions will implement BMPs to mitigate non-point source pollution to connected streamcourses. For the cumulative effects boundary area, there are approximately 157,500 acres of future and foreseeable treatment acres within the cumulative effects boundary (about 7.7 percent of the cumulative effects area). Assuming a 15 percent disturbance factor for treatments, there are a total of approximately 23,500 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1 percent of the cumulative effects boundary area. Ground disturbing actions will implement BMPs to mitigate non-point source pollution to connected streamcourses.

Summary of Cumulative Effects

There are about 45,000 acres of baseline ground disturbance from roads, private land, grazing allotments, and powerline corridors that occur across the cumulative effects analysis area. The total acres of past, present and future and foreseeable treatment acres within the cumulative effects project area are roughly 312,720 acres (154,720 past and present projects and 158,000 acres of future, foreseeable projects) or about 14 percent of the cumulative boundary area. Of these treatment acres, we are assuming that there would be about 15 percent of these acres will have ground disturbance, or about 43,700 acres, or just about 2 percent of the cumulative effects analysis area are expected to have ground disturbance from past, present and future or foreseeable projects. The 4FRI EIS would add an additional about 71,300 acres of ground disturbance for a total acreage of ground disturbance across the cumulative effects analysis area, for a total acreage of disturbed ground of nearly 167,500 acres, or about 8.2 percent of the cumulative effects boundary area (see Table 30 below).

There are six 6th code watersheds where urban development has a large impact on ground disturbance areas. This project, plus current and future foreseeable projects impacts these watersheds in the following manner. In the Cataract Creek Headwaters watershed there was a 9 percent past, present and future project generated ground disturbance prior to any activities. This percent of ground disturbance increases to 15 percent total cumulative ground disturbance. In the Sinclair Wash watershed, there was a 12 percent past, present and future ground disturbance prior to any activities. This percent of ground disturbance increases to 26 percent total cumulative ground disturbance with all projects, current and foreseeable projects. In the Lower Rio de Flag watershed there was an 8 percent past, present and future project generated ground disturbance that increases to 21 percent total cumulative ground disturbance. In the Middle Oak Creek watershed, there was 7 percent past, present and future project generated ground disturbance that increases to 11 percent total cumulative ground disturbance. Pumphouse Wash watershed has about 11% contributions from past, present and future projects and about 6% from 4FRI. Upper Rio de Flag watershed has about 14 percent contribution from past, present and future projects and extra about 3 percent from 4FRI. Implementation of BMP’s would minimize any impacts to watersheds, and would be especially important in the watersheds that have a high urban impact already existing.

A discussion of cumulative effects resulting from the Slide Fire can be found at the end of the analysis of Alternatives.

Table 30: Summary of cumulative effects-Alternative C

	EIS		Baseline	Future Foreseeable		Current/Ongoing		PROJECT TOTAL	
TOTAL CUM EFFECTS Analysis Area 6th Code Acres	TOTAL EIS Ground Disturb	TOTAL EIS % 6th Code Ground Disturb	BASELINE Ground Disturb	TOTAL Treat Acres	TOTAL Ground Disturb	TOTAL Treat Acres	TOTAL Ground Disturb	TOTAL CUM EFFECTS Ground Disturb	TOTAL CUM EFFECTS % Ground Disturb
2,032,080	71,371	3.5%	45,041	157,772	23,666	154,720	27,380	167,458	8.2%

Executive Summary of Cumulative Effects

Alternative C protection of soil resources is provided by the use of Best Management Practices that minimize the potential for soil disturbance. Identified and implemented BMP's are expected to reduce the risk on accelerated erosion, sediment delivery and nonpoint source pollution to connected streamcourses and maintain water quality in all watersheds. In addition to the use of BMP's, the completion and implementation of the Travel Management EIS would further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, this Alternative would not provide a detrimental cumulative effect to soil resources within the cumulative effects boundary.

Alt D

The geographic setting, boundary and potential projects are the same as Alternative B.

Baseline Activities

Baseline activities are the same as alternative B. The total baseline ground disturbance is about 45,040 acres for the cumulative effects area, or about 2 percent of the entire cumulative effects area. There are six, 6th code watersheds where urban development has a large impact on ground disturbance areas—Cataract Creek Headwaters (11 percent baseline ground disturbance) associated with the City of Williams, Sinclair Wash (25 percent) and Lower and Upper Rio de Flag (18 percent), Pumphouse Wash associated with the City of Flagstaff, Middle Oak Creek (11 percent) associated with Sedona and private land developed adjacent to Oak Creek.

Past Actions and Present Actions

Past and present activities and timeframe thereof, are the same as alternative B. The acres used for the analysis are a summary of projects that were reported in the FACTS activity layer from 2009 to the present and are the same as alternative B. For the cumulative effects boundary area, there are approximately 157,772 of total treatment acres of past and current projects within the cumulative effects boundary (about 7 percent of the cumulative effects area). Assuming a 15 percent disturbance factor for treatments, there are a total of approximately 27,380 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1 percent of the cumulative effects boundary area.

Reasonably Foreseeable Future Actions

The activities and acreages of reasonably foreseeable future actions are the same as alternative B. Ground disturbing actions will implement BMPs to mitigate non-point source pollution to connected streamcourses. For the cumulative effects boundary area, there are approximately 157,700 acres of future and foreseeable treatment acres within the cumulative effects boundary (about 7.7 percent of the cumulative effects area). Assuming a 15 percent disturbance factor for treatments, there are a total of approximately 23,667 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1 percent of the cumulative effects boundary area.

Summary of Cumulative Effects

There are about 45,000 acres of baseline ground disturbance from roads, private land, grazing allotments, and powerline corridors that occur across the cumulative effects analysis area. The total acres of past, present and future and foreseeable treatment acres within the cumulative effects project area are roughly 312,720 acres (157,772 past and present projects and 158,000 acres of future, foreseeable projects) or about 14 percent of the cumulative boundary area. Of these treatment acres, we are assuming that there would be about 15 percent of these acres will have ground disturbance, or about 43,700 acres, or just about 2 percent of the cumulative effects analysis area are expected to have ground disturbance from past, present and future or foreseeable projects. The 4FRI EIS would add an additional about 57,937 acres of ground disturbance for a total acreage of ground disturbance across the cumulative effects analysis area, for a total acreage of disturbed ground of nearly 154,000 acres, or about **7.6** percent of the cumulative effects boundary area (see Table 31 below).

There are six 6th code watersheds where urban development has a large impact on ground disturbance areas. This project, plus current and future foreseeable projects impacts these watersheds in the following manner. In the Cataract Creek Headwaters watershed there was a 9 percent past, present and future project generated ground disturbance prior to any activities. This percent of ground disturbance increases to 15 percent total cumulative ground disturbance. In the Sinclair Wash watershed, there was a 12 percent past, present and future ground disturbance prior to any activities. This percent of ground disturbance increases to 26 percent total cumulative ground disturbance with all projects, current and foreseeable projects. In the Lower Rio de Flag watershed there was an 8 percent past, present and future project generated ground disturbance that increases to 21 percent total cumulative ground disturbance. In the Middle Oak Creek watershed, there was 7 percent past, present and future project generated ground disturbance that increases to 11 percent total cumulative ground disturbance. Pumphouse Wash watershed has about 11% contributions from past, present and future projects and about 6% from 4FRI. Upper Rio de Flag watershed has about 14 percent contribution from past, present and future projects and extra about 3 percent from 4FRI. Implementation of BMP's would minimize any impacts to watersheds, and would be especially important in the watersheds that have a high urban impact already existing.

A discussion of cumulative effects resulting from the Slide Fire is found at the end of the analysis by Alternative.

Table 31: Summary of cumulative effects-Alternative D

	EIS		Baseline	Future Foreseeable		Current/Ongoing		PROJECT TOTAL	
TOTAL CUM EFFECTS Analysis Area 6th Code Acres	TOTAL EIS Ground Disturb	TOTAL EIS % 6th Code Ground Disturb	BASELINE Ground Disturb	TOTAL Treat Acres	TOTAL Ground Disturb	TOTAL Treat Acres	TOTAL Ground Disturb	TOTAL CUM EFFECTS Ground Disturb	TOTAL CUM EFFECTS % Ground Disturb
2,032,080	57,937	2.9%	45,041	157,772	23,666	157,772	27,380	154,023	7.6%

Executive Summary of Cumulative Effects

Alternative D protection of soil resources is provided by the use of Best Management Practices that minimize the potential for soil disturbance. Identified and implemented BMP's are expected to reduce the risk of accelerated erosion, sediment delivery and nonpoint source pollution to connected streamcourses and maintain water quality in all watersheds. However, the absence of prescribed fire puts the soil resource at risk of adverse effects of high severity wildfire similar but slightly less due to lower fuel loading to those described for Alternative A. Identified and implemented BMP's are expected to reduce the risk on accelerated erosion, sediment delivery and nonpoint source pollution to connected streamcourses and maintain water quality in all watersheds. In addition to the use of BMP's, the completion and implementation of the Travel Management EIS will further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, this Alternative would not provide a detrimental cumulative effect to soil resources within the Cumulative Effects boundary.

Alt E

The geographic setting, boundary and potential projects are the same as Alternative B.

Baseline Activities

Baseline activities are the same as alternative B. The total baseline ground disturbance is about 45,040 acres for the cumulative effects area, or about 2 percent of the entire cumulative effects area. There are six, 6^{th} code watersheds where urban development has a large impact on ground disturbance areas—Cataract Creek Headwaters (11 percent baseline ground disturbance) associated with the City of Williams, Sinclair Wash (25 percent) and Lower and Upper Rio de Flag (18 percent), Pumphouse Wash associated with the City of Flagstaff, Middle Oak Creek (11 percent) associated with Sedona and private land developed adjacent to Oak Creek.

Past Actions and Present Actions

Past and present activities and timeframe thereof, are the same as alternative B. The acres used for the analysis are a summary of projects that were report in the FACTS activity layer from 2009 to the present and are the same as alternative B. These acres are summarized in Attachment #1. For the cumulative effects boundary area, there are approximately 154,720 (table 32 and Attachment #1) of total treatment acres of past and current projects within the cumulative effects boundary (about 7 percent of the cumulative effects area). Assuming a 15 percent disturbance factor for treatments, there are a total of approximately 27,380 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1 percent of the cumulative effects boundary area.

Reasonably Foreseeable Future Actions

The activities and acreages of reasonably foreseeable future actions are the same as alternative B. Ground disturbing actions will implement BMPs to mitigate non-point source pollution to connected streamcourses. For the cumulative effects boundary area, there are approximately 157,500 acres of future and foreseeable treatment acres within the cumulative effects boundary (about 7.7 percent of the cumulative effects area). Assuming a 15 percent disturbance factor for treatments, there are a total of approximately 23,667 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1 percent of the cumulative effects boundary area.

Summary of Cumulative Effects

For past, present and reasonably foreseeable actions including the 4-FRI proposed action, the extent of soil disturbance equals about 7.9 percent and the overall 15% soil disturbance threshold would not be exceeded with this project within the cumulative effects boundary. The contribution and magnitude of soil disturbance from 4FRI treatments would be short-term (about 2-3 years) and equal about 3.2% at the watershed scale. Further protection of soil resources is provided by the use of Best Management Practices that minimize the potential for soil disturbance. Identified and implemented BMP's are expected to reduce the risk on accelerated erosion, sediment delivery and nonpoint source pollution to connected streamcourses and maintain water quality in all watersheds. In addition to the use of BMP's, the completion and implementation of the Travel Management EIS would further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, this alternative would not provide a detrimental cumulative effect to soil resources within the cumulative effects boundary.

As stated above in the baseline disturbance assessment, there are six 6th code watersheds where urban development has a large impact on ground disturbance areas. This project, plus current and future foreseeable projects impacts these watersheds in the following manner. In the Cataract Creek Headwaters watershed there was a 9 percent past, present and future project generated ground disturbance prior to any activities. This percent of ground disturbance increases to 15 percent total cumulative ground disturbance. In the Sinclair Wash watershed, there was a 12 percent past, present and future ground disturbance prior to any activities. This percent of ground disturbance increases to 26 percent total cumulative ground disturbance with all projects, current and foreseeable projects. In the Lower Rio de Flag watershed there was an 8 percent past, present and future project generated ground disturbance that increases to 21 percent total cumulative ground disturbance. In the Middle Oak Creek watershed, there was 7 percent past, present and future project generated ground disturbance that increases to 11 percent total cumulative ground disturbance. Pumphouse Wash watershed has about 11% contributions from past, present and future projects and about 6% from 4FRI. Upper Rio de Flag watershed has about 14 percent contribution from past, present and future projects and extra about 3 percent from 4FRI. Implementation of BMP's would minimize any impacts to watersheds, and would be especially important in the watersheds that have a high urban impact already existing.

In addition the use of BMP's, the completion and implementation of the Travel Management EIS would further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, this alternative would not provide a detrimental cumulative effect to soil resources within the cumulative effects boundary.

Table 32: Summary of cumulative effects-Alternative E

	EIS		Baseline	Future Foreseeable		Current/Ongoing		PROJECT TOTAL	
TOTAL CUM EFFECTS Analysis Area 6th Code Acres	TOTAL EIS Ground Disturb	TOTAL EIS % 6th Code Ground Disturb	BASELINE Ground Disturb	TOTAL Treat Acres	TOTAL Ground Disturb	TOTAL Treat Acres	TOTAL Ground Disturb	TOTAL CUM EFFECTS Ground Disturb	TOTAL CUM EFFECTS % Ground Disturb
2,032,080	64,252	3.2%	45,041	157,772	23,666	154,720	27,380	160,338	7.9%

Executive Summary of Cumulative Effects

Alternative E protection of soil resources is provided by the use of Best Management Practices that minimize the potential for soil disturbance. Identified and implemented BMP's are expected to reduce the risk of accelerated erosion, sediment delivery and nonpoint source pollution to connected streamcourses and maintain water quality in all watersheds. In addition to the use of BMP's, the completion and implementation of the Travel Management EIS will further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, this alternative would not provide a detrimental cumulative effect to soil resources within the Cumulative Effects boundary.

Cumulative Effects Slide Fire

The Slide Fire started on May 20th, 2014, was human caused and burned over 7,800 acres in the 4FRI project area footprint including areas of moderate and high burn severity. Protective vegetative ground cover in areas of high burn severity is nearly totally consumed while mostly consumed (estimated about 66%) in areas of moderate burn severity. The remainder of the fire burned in low or unburned mosaic with adequate protective vegetative ground cover except there are very minor areas (<5%) that have either moderate or high burn patches within. Slide Fire total ground disturbance was calculated based on low severity (2% of acres disturbance), moderate severity (62%) high severity (90%) for a total of about 7,455 acres.

The Burned Areas Emergency Response team assessed burn severity, values at risk and recommended emergency stabilization treatments including seeding and helimulching to improve the immediate ground cover and reduce the amount of runoff, erosion and sediment delivery into connected streamcourses on over 2,175 acres of moderate and high burn severity.

The fire resulted in disturbances to 3 watersheds that cumulatively exceed the 15% ground disturbance threshold. They include Upper Oak Creek with a total of 4,362 acres or 20.6% of the watershed, West Fork of Oak Creek with a total of 16,432 acres or 30.1% of the watershed, and Pumphouse Wash with 11,423 acres or 18.2% of the watershed. The fire burned in portions of Fry Canyon and Dry Creek but cumulative ground disturbance totaled less than 10%.

To adequately protect soil productivity, water quality and watershed function, additional soil and water BMPs are now identified (Table 27) that should allow adequate time (minimum of 5 years) for protective vegetative ground cover recovery in uplands and streamside management zones so that sediment will be trapped in the vegetative ground cover and not contribute excessive sediment into streamcourses. Research indicates that vegetative ground cover recovery occurs within about 5 years, sufficient to be similar to pre-fire conditions at levels that prevent erosion above tolerable limits after which treatments can be considered (Steinke 2014) USDA 2014 (BAER).

The combined cumulative effects of post fire soil disturbance plus 4FRI treatments are not expected to disturb more than about 15% of the soil and do not pose risk to soil productivity or water quality when implementing Slide Fire BMPs (Table 27). Treatments will be deferred for at least 5 years, and this will assure adequate vegetative ground cover establishment in streamside management zones. Soil productivity is expected to be maintained and water quality is expected to meet designated beneficial uses and meet state water quality standards.

Alternative C and E Management of Canopy Cover

In response to comments on the DEIS, approximately 38, 256 acres would be treated less intensively (from the proposed savanna treatment). The soils and watershed report (Steinke 2014) found reducing treatment intensity on these acres would not directly or indirectly pose risk to soil productivity, water quality or watershed function. With the implementation of identified soil and water BMPs, soil disturbance direct effects associated with all proposed treatments has already been shown not to exceed the 15 percent established soil productivity threshold. Therefore, reduced treatment intensity would not exceed this threshold. For these reasons, there would be no measurable impact on aquatic habitat or aquatic species including threatened and endangered, candidate, Forest Service sensitive and Coconino NF management indicator species.

Effects of Forest Plan Amendments on Aquatic Species and Habitat

All proposed amendments are specific, one-time variances for the Coconino and Kaibab restoration project. The language proposed does not apply to any other forest project. The amendments would be authorized per direction in the National Forest Management Act of 1976 (NFMA) and its implementing regulations found in 36 CFR 219 (1982).

Alternatives B and D

CNF Amendments 1 and 2

These proposed Plan amendments are specific to Mexican spotted owl and Northern goshawk habitat. They would not result in measurable effects to aquatic species or their habitat compared to the general direct, indirect, and cumulative effects presented above for vegetation management and prescribed fire. Therefore, it is my determination that these amendments would have "No Effect" on aquatic species or their habitat.

CNF Amendment 3

Amendment 3, which allows for management to achieve a "No Adverse Effect" determination for significant, or potentially significant, inventoried heritage sites, would not have a measurable effect on aquatic species or their habitat. Although heritage sites are often located in or near riparian areas and the consequence of this amendment would be to eliminate activities that could cause surface erosion around these sites, the number and size of inventoried heritage sites in riparian areas is insignificant compared to the proposed treatment area. Therefore, it is my determination that these amendments would have "No Effect" on aquatic species or their habitat.

Alternative C

CNF Amendments 1 and 2

These proposed Plan amendments are specific to Mexican spotted owl and Northern goshawk habitat. They would not result in measurable effects to aquatic species or their habitat compared to the general direct, indirect, and cumulative effects presented above for vegetation management and prescribed fire. Therefore, it is my determination that these amendments would have "No Effect" on aquatic species or their habitat.

CNF Amendment 3

Amendment 3, which allows for management to achieve a "No Adverse Effect" determination for significant, or potentially significant, inventoried heritage sites, would not have a measurable effect on aquatic species or their habitat. Although heritage sites are often located in or near riparian areas and the consequence of this amendment would be to eliminate activities that could cause surface erosion around these sites, the number and size of inventoried heritage sites in riparian areas is insignificant compared to the proposed treatment area. Therefore, it is my determination that these amendments would have “No Effect” on aquatic species or their habitat.

Effects of Alternatives on Aquatic Habitat

Alternative A (No Action)

Alternative A is the no action alternative. The effects of no action for all perennial streams in the project area are similar and have been grouped together to avoid repetition. Under this alternative, crown fire potential would remain unchanged in the project area. None of the management actions including tree removal, burning, spring restoration, channel restoration, aspen restoration or actions related to road reconstruction or decommissioning would occur. There would be no direct effects from management actions to stream habitat.

Increased likelihood of high severity fire from overgrown forests, and unnaturally high surface fuel loads are some of the inevitable results of the current trajectory of most of the project area. Approximately 34% of the project area has crown fire potential and 64% has potential for surface fire (VanWagner 1973). A high intensity surface fire has high flame lengths and, particularly when combined with closed, dense canopy fuels, can produce sufficient damage to kill trees with a combination of needle scorch, root damage, and cambium damage. Overall, the desired condition is to have fire, as a disturbance process, maintain a mosaic of diverse native plant communities. No more than 10 percent of the project area should be prone to crown fire (Swetnam and Baison 1996; Roccaforte et al. 2008). The current fire-return interval is approximately 40 years, about four times longer than the desired historic fire-return interval which is between 2 and 21 years (Cooper 1960; Fulé et al. 2003; Heinlein et al.2005).

Current and predicted soil erosion (Steinke 2014) was modeled for all alternatives using the Water Erosion Prediction Project disturbed model (WEPP). Disturbed WEPP is designed to predict runoff and sediment yield from undisturbed and harvested forests and prescribed and wildfires. Table 32 shows predicted soil erosion from a 10-year storm event, for the most representative soil in ponderosa pine ecosystems, by slope class. Tolerable soil loss values are 1-4 tons/acre depending on soil type. Cells shaded gray have erosion exceeding tolerable soil loss. Areas where soil loss exceeds tolerable amounts erode faster than they renew themselves, resulting in accelerated soil loss and loss of soil productivity, and also deliver high amounts of sediment to connected streamcourses. For Alternative A, it is predicted (Lata 2014) that up to 33% of soils could burn under high burn severity if left untreated, and the WEPP model predicts that slopes greater than 15% and under high burn severity would result in erosion above tolerable levels, risking erosion and loss of soil productivity.

Table 33. Predicted soil erosion from 10-year storm event (Steinke 2014).

Slope Class	Erosion in tons/acre/year	Sediment Leaving Profile in tons/acre/year	Threshold Values in Tons/Acre/Year
Alternative A (Undisturbed)			
0-15%	0	0	2-4
15-40%	0	0	2-4
40-120%	0	0	2-3

Slope Class	Erosion in tons/acre/year	Sediment Leaving Profile in tons/acre/year	Threshold Values in Tons/Acre/Year
High Burn Severity (Alt A Possible)			
0-15%	1.23	.40	2-4
15-40%	6.89	2.68	2-4
40-120%	15.89	6.23	2-3
Alternative B, C, D (Low Burn Severity, Prescribed Fire)			
0-15%	.04	.004	2-4
15-40%	.43	.14	2-4
40-120%	1.08	.37	2-3 (possible inclusions of 1 for some soils)
Alternative B, C, D (Mechanically Thinned Forests)			
0-15%	0	0	2-4
15-40%	0	.004	2-4
40-120%	.08	.009	2-3

Fifty-one developed springs on the Coconino NF are not functioning at or near potential. On the Kaibab NF, 27 springs have reduced function. Thirty-two miles of stream channels on the Coconino NF are heavily eroded with excessive bare ground, denuded vegetation, and head cuts. Of the total miles, approximately 6 miles are riparian streams and 26 miles are non-riparian streams. The Kaibab NF has approximately 7 miles of channels in this condition and all are non-riparian reaches.

A review of Coconino NF 2010 data indicated there is a need to decommission approximately 730 miles of existing system and unauthorized roads. Likewise, a review of Kaibab NF data indicates approximately 134 miles of unauthorized roads (often referred to as user-created routes) are recommended for decommissioning. There is a need to decommission the roads that have been identified by the forests and use management strategies and road maintenance techniques (including restoration of drainage features) that moves towards restoring road prisms (as much as practical) to their natural condition (USDA 1987).

Alternative A (no action) would result in no change in crown fire potential (as measured by canopy bulk density and canopy base height), nor in the highly departed fire-return interval (61% of the ponderosa pine is currently in VCC 3). In addition, no springs or stream channels would be restored, and no road decommissioning would occur. The result to stream courses and perennial streams, including their TES species and habitat, would likely be widespread stand-replacing crown fire, with effects similar to those observed following the Schultz Fire in 2010 (flooding, soil erosion, debris flows, channel re-alignment, destruction of riparian areas, sedimentation and embeddedness of stream substrates, etc.).

Implementation of Alternative A would not meet the projects purpose and need to improve and protect soil condition, productivity and watershed function nor move towards the desired condition of having soils in satisfactory condition and soil productivity maintained and watersheds properly functioning. It would not meet the projects purpose and need nor move towards the desired conditions of a resilient forest by reducing the potential for undesirable fire behavior and its effects and maintaining the mosaic of tree groups and interspaces with frequent, low-severity fire by having a forest structure that does not support wide-spread crown fire. Implementation of Alternative A would not increase forest resiliency to natural disturbances and would not improve or protect soil condition and soil productivity or watershed function as well as all other action alternatives. Implementation of Alternative A would put soils and watersheds at risk of continued uncharacteristic wildfires that could result in loss of soil productivity and sediment delivery to connected streamcourses.

Alternatives B, C, D, and E

The perennial streams within the project area that contain fish and/or macroinvertebrates are Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork Oak Creek (Figure 14).

As stated above, soil erosion risk was modeled for each alternative (Steinke 2014). Mechanical treatments generally do not have any appreciable impact on soil erosion (Table 29). However, a risk of erosion was identified for prescribed burning on slopes greater than 15% (Table 29). Approximately 2% of areas proposed for prescribed burning or managed fires could result in areas of high burn severity (Steinke 2014) where soil loss could be relatively high on slopes greater than 15%. However, these areas would likely be patchy in distribution. Excess sedimentation and ash flows from prescribed fires are primary threats that must be guarded against because sediment and ash can affect fisheries and macroinvertebrate resources both directly and indirectly (see discussion above). The BMPs presented in Table 27 are designed to mitigate these risks.

Three watersheds (Upper Oak Creek, West Fork of Oak Creek and Pumphouse Wash have predicted cumulative effects soil disturbance greater than 15% as a result of the May, 2014 Slide Fire (Steinke 2014). There are 22.7 stream miles of habitat for Desert Sucker, Sonora Sucker, A. Mayfly, and A. Caddisfly within the Slide fire perimeter. This includes about 6.6 miles along Oak Creek and 16.1 miles along the West Fork of Oak Creek. Flood waters have and will continue to carry ash and sediment into connected drainages and the two perennial streams. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill fish and macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Additional protective measures were added with BMPs #37 and #38 (Table 27) to protect habitat within and downstream of the Slide fire area.

Perennial streams included in this analysis (Figure 14) are further described by project units and subunits that may affect them (Figure 15). Potential effects to stream habitat are described in detail below for each perennial stream.

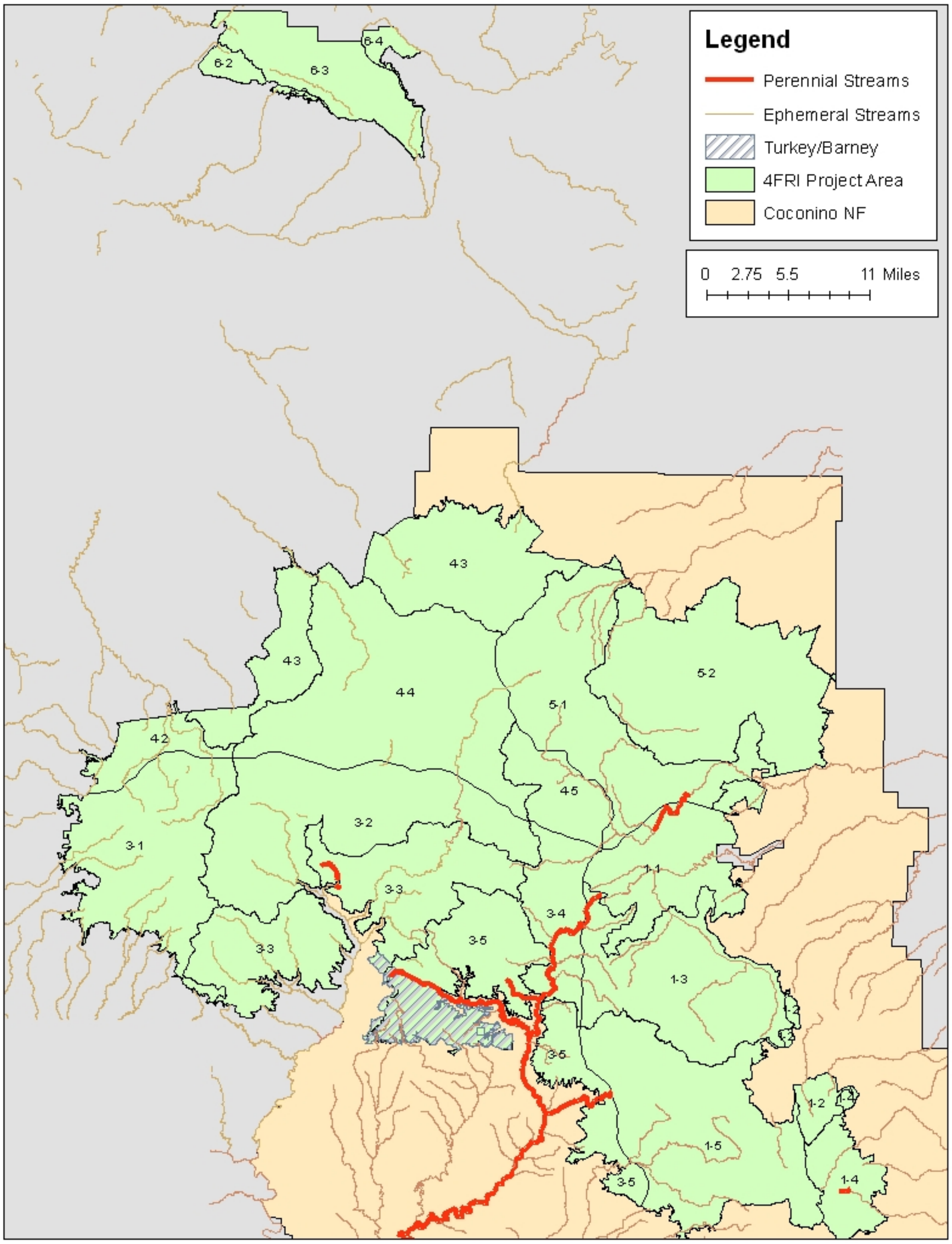
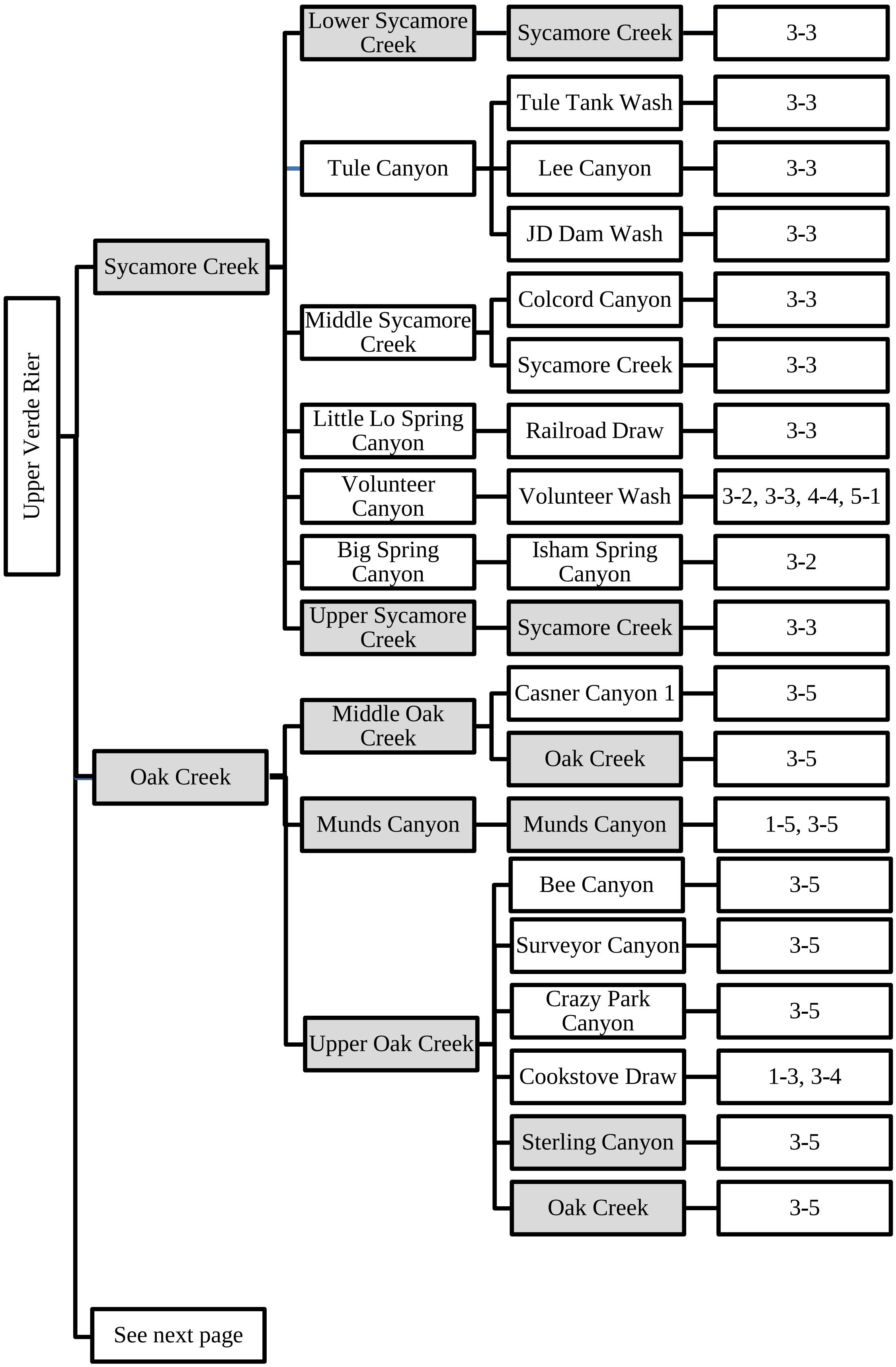


Figure 14. Four Forest Restoration Initiative Project Area showing perennial and ephemeral streams.

4th Code HUC	5th Code HUC	6th Code HUC	Stream	Subunit
Canyon Diablo	Rio de Flag	Lower Rio de Flag	Switzer Canyon	1-1, 5-1
			Rio de Flag	1-1, 5-1
		Sinclair Wash	Sinclair Wash	3-3, 3-4, 4-5, 5-1
		Upper Rio de Flag	Schultz Creek	5-1
	Canyon Diablo	Sawmill Wash	Sawmill Wash	1-4
Upper Verde River	Hell Canyon	Rattlesnake Wash	Rattlesnake Wash	3-1
		Upper Hell Canyon	Hell Canyon	3-1
		Devil Dog Canyon	Devil Dog Canyon	3-1
	Grindstone Wash Upper Verde	Bear Canyon	May Tank	3-1
			Wild Horse Canyon	3-1
			Bear Canyon	3-1
		MC Canyon	East Fork MC Canyon	3-1
			MC Canyon	3-1
		Grindstone Wash	Grindstone Wash	3-1
	See next page			


Upper Verde Rier
Sycamore Creek
Lower Sycamore Creek
Sycamore Creek
3-3
Tule Canyon
Tule Tank Wash
3-3
Lee Canyon
3-3
JD Dam Wash
3-3
Middle Sycamore Creek
Colcord Canyon
3-3
Sycamore Creek
3-3
Little Lo Spring Canyon
Railroad Draw
3-3
Volunteer Canyon
Volunteer Wash
3-2, 3-3, 4-4, 5-1
Big Spring Canyon
Isham Spring Canyon
3-2
Upper Sycamore Creek
Sycamore Creek
3-3
Oak Creek
Middle Oak Creek
Casner Canyon 1
3-5
Oak Creek
3-5
Munds Canyon
Munds Canyon
1-5, 3-5
Upper Oak Creek
Bee Canyon
3-5
Surveyor Canyon
3-5
Crazy Park Canyon
3-5
Cookstove Draw
1-3, 3-4
Sterling Canyon
3-5
Oak Creek
3-5
See next page

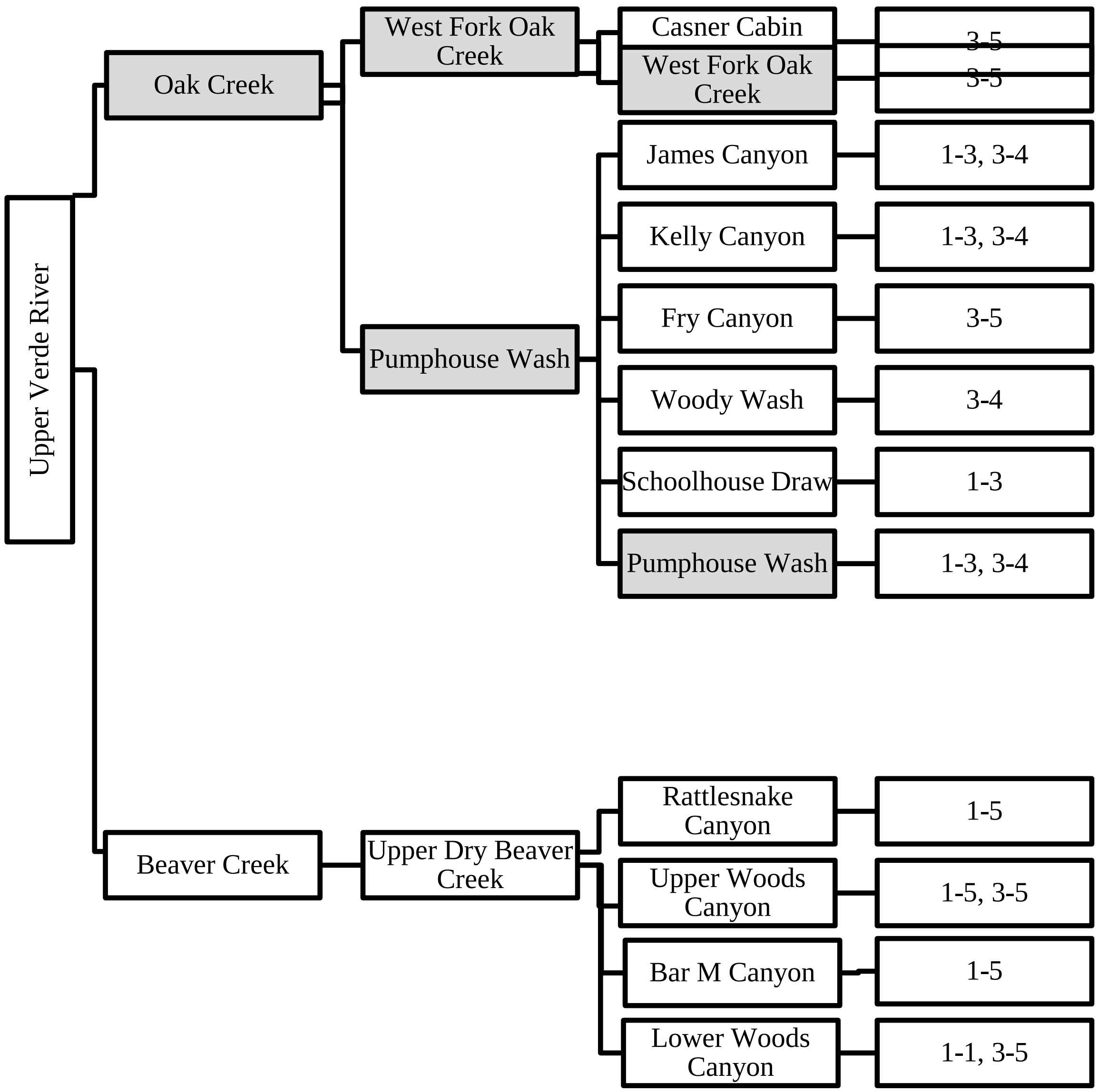


Figure 15. Perennial streams (shaded gray) in the analysis area, and the project subunits that may affect them.

Rio de Flag

Rio de Flag receives water from Lower Rio de Flag, Sinclair Wash, and Upper Rio de Flag 6th code HUC watersheds. The Lower Rio de Flag 6th Code HUC watershed overlaps portions of project subunits 1-1 and 5-1 and includes the Switzer Canyon streamcourse. There is no predicted sediment delivery to Switzer Canyon from any of the action alternatives, because prescribed burning is not proposed on slopes greater than 15% along this streamcourse.

The Sinclair Wash 6th Code HUC overlaps portions of project subunits 3-3, 3-4, 4-5, and 5-1. However, no prescribed burning on slopes greater than 15% is proposed under any of the action alternatives in this watershed, so there should be no appreciable sediment delivery to this streamcourse.

The Upper Rio de Flag 6th Code HUC watershed overlaps portions of subunit 5-1 and includes Schultz Creek. There are no differences among the action alternatives with regard to predicted sediment delivery to Schultz Creek, because there are no differences in proposed prescribed burning areas. Furthermore, proposed burning near Schultz Creek will not occur on slopes greater than 15%, so this streamcourse should not be affected by sediment or ash flow resulting from treatment.

Sawmill Wash

Sawmill Wash is part of the Canyon Diablo 4^{th} Code HUC watershed. Only a small portion of this stream is perennial, but it is important habitat for wildlife and macroinvertebrates (MIS). The Sawmill Wash 6^{th} Code HUC watershed overlaps a portion of subunit 1-4 Prescribed burning in subunit 1-4 would not differ among alternatives near Sawmill Wash, although Alternative D (reduced smoke alternative) does call for less burning in portions of this subunit. There would be no difference in sedimentation or ash effects to Sawmill Wash among the alternatives, although a buffer strip of at least 120 feet (BMP #8; Steinke 2014Steinke 2014) should be used to protect this streamcourse where prescribed burning does occur.

Sycamore Creek

Sycamore Creek receives water from seven 6^{th} Code HUC watersheds: Lower Sycamore Creek, Tule Canyon, Middle Sycamore Creek, Little Lo Spring Canyon, Volunteer Canyon, Big Spring Canyon, and Upper Sycamore Creek. These watersheds overlap portions of subunits 3-2, 3-3, 4-4, and 5-1.

Upper Sycamore Creek is perennial and supports macroinvertebrates. Prescribed burning would not affect this portion of the creek. Moving downstream, Big Spring Canyon 6^{th} Code HUC (subunit 3-2) contains two streamcourses, Isham Spring Canyon and Big Spring Canyon. There are few differences among the action alternatives with regard to prescribed burning in this watershed, but all propose prescribed burning on slopes greater than 15% along a portion of Big Spring Canyon, so this streamcourse should be protected with a buffer strip of at least 70 feet (BMP #8; Steinke 2014).

Volunteer Canyon 6^{th} Code HUC watershed contains Volunteer Wash, which drains a large area NE of Sycamore Creek including portions of subunits 3-2, 3-3, 4-4, and 5-1. The only location along Volunteer Wash where the action alternatives differ regarding proposed prescribed burning is in Volunteer Canyon, subunit 3-3, on slopes greater than 15%. At this location, and for about 1 mile of Volunteer Canyon, Alternative D does not propose prescribed burning while alternatives B, C, and E do. Thus, the risk of increased sedimentation and ash flow into Volunteer Wash is greater for Alternatives B, C, and E than for

Alternative D in this location. Volunteer Wash should be protected with a buffer strip of at least 70 feet (BMP #8; Steinke 2014) in this portion of Volunteer Canyon, if Alternative B, C or E is chosen.

Little Lo Spring Canyon 6th Code HUC watershed contains Railroad Draw (subunit 3-3). There are no differences among the action alternatives in areas of proposed prescribed burning. However, because prescribed burning is proposed along a substantial length of Railroad Draw on slopes greater than 15%, this streamcourse should also be protected with a buffer strip of at least 70 feet (BMP #8; Steinke 2014) to mitigate sediment and ash flow potential.

Middle Sycamore Creek 6th Code HUC watershed is mostly avoided by proposed project treatments, but does receive water from Colcord Canyon (subunit 3-3). No substantial differences in proposed prescribed burning occur among the action alternatives in this watershed, but all alternatives propose prescribed burning along Colcord Canyon on slopes greater than 15%, so this streamcourse should be protected with a buffer strip of at least 70 feet (BMP #8; Steinke 2014) to mitigate sediment and ash flow potential.

Tule Canyon 6th Code HUC watershed receives water from three streamcourses, Tule Tank Wash, Lee Canyon, and JD Dam Wash, all of which overlap with portions of subunit 3-3. There are no differences in proposed prescribed burning among the action alternatives. However, prescribed burning is proposed along portions of both Lee Canyon and Tule Tank Wash on slopes greater than 15%. Therefore, these streamcourses should be protected with a buffer strip of at least one chain to mitigate potential for sediment and ash flows.

Lower Sycamore Creek 6th Code HUC watershed is also perennial, and may be affected by prescribed burning within the upstream treatment subunits just discussed. Any effects that occur upstream would also impact this downstream-most portion of the creek. Lower Sycamore Creek contains both native fish and macroinvertebrates.

Oak Creek

Oak Creek receives water from five 6th Code HUC watersheds and about 18 different streamcourses. Many treatment subunits overlap with these streamcourses and watersheds, making the effects analysis quite complicated.

Effects from the Slide Fire will overwhelm all potential effects from Alternatives B-E (see above), with severe burn areas on slopes over 15% (Steinke 2014).

Pumphouse Wash

Starting at the upstream end, Oak Creek receives water from the Pumphouse 6th Code HUC watershed, which includes six different streamcourses. The Pumphouse Wash streamcourse runs through project subunits 1-3 and 3-4. There are no differences in proposed prescribed burning in subunit 1-3 for Pumphouse Wash, but Alternative D proposes substantially fewer acres of prescribed burning of slopes over 40% along this streamcourse in subunit 3-4 than Alternatives B, C, or E. The risk of increased sediment and ash flow would be greater for these alternatives than for Alternative D, and a buffer strip of at least 120 feet (BMP #8; Steinke 2014) would be used to protect this streamcourse in subunit 3-4, if Alternative B, C or E is chosen. Schoolhouse Draw also runs through project subunit 1-3, but none of the alternatives propose prescribed burning along this streamcourse. Woody Wash runs through project subunit 3-4, but none of the alternatives propose prescribed burning along this streamcourse either. Fry Canyon runs through subunit 3-5, but none of the alternatives propose prescribed burning along this streamcourse. Kelly Canyon runs through subunits 1-3 and 3-4. No prescribed burning is proposed along this streamcourse in subunit 1-3, but Alternative D proposes substantially fewer acres of prescribed burning of slopes greater than 40% along this streamcourse in subunit 3-4 than do Alternatives B, C, or E. The risk of increased sediment and ash flow will be greater for these alternatives than for Alternative D, and a buffer strip of at least 70 feet (BMP #8; Steinke 2014) should be used to protect this streamcourse if Alternative B, C or E is chosen. Likewise, James Canyon runs through subunits 1-3 and 3-4. Alternative D proposes substantially fewer acres of prescribed burning of slopes greater than 15% along this streamcourse in both subunits 1-3 and 3-4 than do Alternatives B, C, or E. Therefore, the risk of increased sediment and ash flow would be greater for these alternatives than for Alternative D, and a buffer strip of at least 70 feet (BMP #8; Steinke 2014) would be used to protect this streamcourse if Alternative B, C, or E is chosen.

Effects from the Slide Fire will overwhelm all potential effects from Alternatives B-E (see above), with severe burn areas on slopes over 15% (Steinke 2014).

West Fork Oak Creek

West Fork Oak Creek 6th Code HUC watershed receives runoff from one ephemeral tributary that runs through subunit 3-5, Casner Cabin Draw. All alternatives propose some prescribed burning on slopes greater than 15% near this streamcourse, so a buffer strip of at least 70 feet (BMP #8; Steinke 2014) should be maintained. Proposed prescribed burning within subunit 3-5 does differ among alternatives along the West Fork Oak Creek streamcourse, with Alternatives B, C, and E proposing prescribed burning on slopes greater than 40% along the upstream portion of West Fork Oak Creek, and Alternatives C and E proposing prescribed burning along a middle-section of the streamcourse, while Alternative D proposes no prescribed burning in these areas. Thus, Alternatives C and E would pose more risk than Alternative B, which would pose more risk than Alternative D, for sediment and ash flow into the streamcourse. Protective stream buffer strips of at least 120 feet (BMP #8; Steinke 2014) should be employed along the entire length of West Fork Oak Creek for Alternatives B, C, and E.

Effects from the Slide Fire will overwhelm all potential effects from Alternatives B-E (see above), with severe burn areas on slopes over 15% (Steinke 2014).

Upper Oak Creek

Oak Creek receives water in this 6th Code HUC watershed from four streamcourses that run through project subunit 3-5: Bee Canyon, Surveyor Canyon, Crazy Park Canyon, and Sterling Canyon. All four action alternatives propose prescribed burning near Bee Canyon, Surveyor Canyon and Crazy Park Canyon, but burning is excluded from slopes greater than 15% in these areas. However, lower Sterling Canyon has prescribed burning proposed on slopes greater than 15% for Alternatives B, C, and E, but not for Alternative D. Thus, there is a greater risk of sediment and ash flow to Sterling Canyon for these alternatives than for Alternative D. A buffer strip of at least 70 feet (BMP #8; Steinke 2014) along the Sterling Canyon streamcourse should be used if Alternative B, C or E is selected.

Effects from the Slide Fire will overwhelm all potential effects from Alternatives B-E (see above), with severe burn areas on slopes over 15% (Steinke 2014).

Munds Canyon

Munds Canyon runs through portions of subunits 1-5 and 3-5 (Figure 15). Alternatives B, C, and E propose far more acres of prescribed burning on slopes greater than 15% than does Alternative D in the Munds Canyon watershed. Thus, there is a greater risk of sediment and ash flow to the Munds Canyon streamcourse, and eventually to Oak Creek, for Alternatives B, C, and E than for Alternative D. Streamcourses are not well-defined in the Munds Canyon watershed. However, any low-lying areas that feed water to Odell Lake in subunit 1-5 should be protected with a buffer strip of at least 120 feet (BMP #8; Steinke 2014) to lessen the potential for sediment and ash to flow into Munds Canyon and Oak Creek.

Middle Oak Creek

The Middle Oak Creek watershed receives water from Casner Canyon 1, which runs through project subunit 3-5, and may be affected by the action alternatives. Prescribed burning is proposed for the upper reaches of Casner Cabin 1 on slopes greater than 15%, for all action alternatives. Therefore, a filter strip of at least 70 feet (BMP #8; Steinke 2014) should be used along the upper portion of this streamcourse to lessen the potential for sediment and ash flow into Oak Creek.

Effects Common to All Action Alternatives

None of the action alternatives would include treatments in riparian habitats associated with perennial streams. A series of BMPs have been developed for soil and water conservation (Soil and Water report and appendix C of the EIS). These include streamside management zones (also known as filter strips) with increasing widths for increasing soil erosion hazards. This is expected to minimize potential sediments reaching riparian areas.

On average, 40,000 to 60,000 acres of prescribed fire would be implemented annually across the forests (within the treatment area). The soils and water report (Steinke 2014) indicates that prescribed fire treatments could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation flow resulting from these treatments. However, BMPs would be in place to mitigate these risks. Prescribed fire ignitions would not occur inside the streamside management zones, but fire would be allowed to burn into riparian areas. BMPs also address soil health, retention of CWD, and to minimize sediment transport from upland operations (appendix C of the EIS). Implementation would be organized by task order. Task orders would typically be completed in about 3 years' time. If 4FRI implementation was completed in 10 years' time, on average 1/10 of the area would be treated in a given year. Because perennial water is limited on this landscape, most of the treated acres would not affect riparian or aquatic habitats. Most sediment is expected to remain on site due to the BMPs.

On average, 45,000 acres of vegetation would be mechanically treated annually. The Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 29). BMPs would be in place to address soil health, retention of CWD, and to minimize sediment transport from upland operations (appendix C of the EIS). Short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefits of restoration, including restoring the health of watersheds and the streams that represent macroinvertebrate habitat.

The restoration of 74 springs could improve ground water recharge, but this is not likely to lead to a measurable change in roundtail chub habitat. Stream restoration (39 miles) would only occur in ephemeral reaches. While this would reduce sediment delivery, it is also not likely to lead to a measurable change in roundtail chub habitat. Spring and stream restoration could also result in short-term increases in soil movement and sedimentation. BMPs would be in place to mitigate these short-term risks in order to realize long-term benefits from restored hydrologic function at spring sources, and reduced potential for severe flooding/sediment transport in restored ephemeral channels.

Slide Fire

It is very likely that Oak Creek and West Fork Oak Creek will exhibit impaired conditions for the foreseeable future (i.e., at least 3 years and likely longer) as a result of the 2014 Slide Fire. Within the fire perimeter, approximately 3,115 acres (14 percent) burned at high severity, 7,067 acres (32 percent) burned at moderate severity, 10,415 acres (48 percent) burned at low severity, and 1,293 acres (6 percent) were unburned or burned at very low severity. Burned areas are on steep slopes along the Mogollon Escarpment and canyons above Oak Creek and West Fork Oak Creek. It is likely that large amounts of sediment and ash will be deposited in these stream channels and their associated tributaries during and after monsoon storms and during snowmelt.

The post-Slide Fire landscape maintains potential to impact Roundtail Chub habitat (USDA 2014). Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation. The USDA BAER report (2014) described the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

All 4FRI treatments within the burned area would be deferred for a minimum of five years. This would provide an opportunity for recovery of affected soils and vegetation prior to implementing any actions that may cause additional disturbance. The proposed treatments would not change; however, prior to implementation, the area would be evaluated to ensure that treatments are still appropriate and would meet resource objectives.

Treatment-Related Disturbance

Mechanical treatments, prescribed burning, road construction and decommissioning, hauling of timber and other restoration activities would increase sedimentation potential. Increases in sedimentation would be localized, of short duration and low intensity. Along with project BMPs, this would not be expected to substantially interfere with riparian function. Up to 40,000 acres of prescribed burning and up to 45,000 acres of mechanical treatment would occur annually; however, these are short-term effects and would be minimized due to activities being spatially and temporally separated.

Road–Related Impacts

About 520 miles of temporary roads would be constructed and decommissioned when treatments are complete (no new permanent roads would be constructed). Reconstruction of up to 40 miles of existing, open roads would be done for resource and safety concerns. About 30 miles of this reconstruction would be roads improvements for hauling harvested materials (primarily widening corners to improve turn radiuses) and about 10 miles would consist of relocating roads out of stream bottoms. Relocated roads would include rehabilitation of the abandoned road segment.

Decommissioning 860 miles of roads would improve habitat quality along and adjacent to the roadways. Road decommissioning could include one or more of the following:

1. Reestablishing former drainage patterns, stabilizing slopes, and restoring vegetation;
2. Blocking the entrance to a road or installing water bars;
3. Removing unstable fills, pulling back road shoulders, and scattering slash on the roadbed;
4. Completely eliminating the roadbed by restoring natural contours and slopes; and/or
5. Other methods designed to meet specific conditions associated with unneeded roads.

The combination of the above actions would decrease the probability of off-site transportation of sediments. Not all acres would affect riparian habitat, but in general precipitation run-off would improve riparian habitat effectiveness at the site scale. This by itself would not have a discernible impact to habitat across the landscape.

Road-related operations would include dust abatement treatments. An expert panel, sponsored by the U.S. Environmental Protection Agency, conducted a literature review of dust suppressants (Batista et al. 2002). Lignin and magnesium chloride (MgCl2) are the most widely used dust suppressants. MgCl2 moves through soil easily with water. In lab tests, lignin was found to cause weight gain and colon ulcers in rodents, but may be the most environmentally compatible dust suppressant. However, the determination of effects must be based on assessing site-specific conditions. (Batista et al. 2002).

Dust abatement treatments would be limited in the 4FRI, occurring in selected areas where private landownership concerns could arise. Eight road sediments have been identified for dust abatement, totaling less than 7 miles in length. The average dust abatement treatment length would be about 0.9 miles, ranging from 0.3 to 2.5 miles. The effectiveness of MgCl2 is related to humidity levels (Batista et al. 2002). The higher the humidity the more effective it becomes. However, the drier the conditions, the more dust becomes an issue. Therefore, lignin would probably be used most often in the 4FRI landscape. Treatments would be temporary and only be used when hauling would occur on a particular road. None of the proposed treatment segments are near open water. Because of the limited application spatially and temporally, and because locations do not include sensitive areas such as open water, dust abatement is not expected to result in measurable effects to aquatic species or their habitat.

The action alternatives include improving springs and restoring the associated riparian habitat and ephemeral streams. There would be a short-term soil disturbance during implementation of restoration actions, but vegetation would be expected to be restored within a one to three year period (MacDonald 2014). Restoration would reduce the potential for sediments reaching perennial water in the long-term.

Forest Plan Amendments

Alternatives B - D include actions dependent on forest plan amendments. No forest plan amendments would be needed on the Kaibab NF. The proposed actions are consistent with forest plan objectives, desired conditions, and standards and guidelines (see forest plan consistency section). Three non-significant forest plan amendments would be required on the Coconino NF. Not incorporating the proposed amendments could affect downstream habitat for sensitive species in this report. The Mexican spotted owl amendments would allow managing for lower tree densities and basal area and creating canopy gaps. This would create and sustain habitat that includes more large pine and large oak trees. In the long-term, this would provide more large snags and logs and create a greater understory response. Not incorporating these amendments would lead to:

- uncharacteristically dense forest conditions with increased fire risk of high-severity wildfire in 18 Mexican spotted owl Protected Activity Centers (related to the proposed mechanical treatments in all action alternatives)
- uncharacteristically dense forest conditions with lower crown base height and increased fire risk in 70 PACs (related to the proposed prescribed fire treatments in alternative C only)
- BA values higher than those recommended in the revised Recovery Plan across all Protected Activity Centers, target, and threshold habitats (see Noble et al. 2014 for habitat definitions), i.e., this project would be maintaining tree densities greater than that called for in the revised Mexican spotted owl recovery plan (USDI 2012), i.e., alternative C would not use the best science available
- understory conditions would continue to decline across Mexican spotted owl habitat

While these amendments are Mexican spotted owl centric, they would affect surface conditions in those acres. Even limited thinning along with increasing large trees, snags, logs, and herbaceous ground cover would indirectly benefit the sensitive species analyzed. These actions would increase filtering of ground flow and reduce both sublimation and evapotranspiration, aiding in ground water recharge.

- About 28,952 acres of grassland, savanna, and meadows would not be restored. Grasslands are one of the most endangered terrestrial ecosystems in the nation, without a forest plan amendment these acres would continue to function as ponderosa pine forest, increasing canopy interception and sublimation to the detriment of ground water recharge.

Managing for open reference conditions within ponderosa pine forest would provide the rooting space between dense groups of trees. Simultaneously, forest densities would be reduced at the stand level, increasing the sustainability and resiliency of this habitat component in regards to high-severity wildfire and the synergistic interactions with climate change.

Group and gap forest structure would maintain closed canopy conditions while providing shrub and herbaceous vegetation, thereby increasing ground cover.

Species Effects

Threatened, endangered, and Forest Sensitive aquatic species in and adjacent to the project area are all located on the Coconino NF. Units and subunits (and relevant 6th Code HUC watersheds) that contain these species are: 1-3 (Pumphouse Wash), 1-4 (Sawmill Wash), 1-5 (Munds Canyon), 3-3 (Lower Sycamore Creek, Middle Sycamore Creek, Upper Sycamore Creek), 3-4 (Pumphouse Wash), 3-5 (Middle Oak Creek, Munds Canyon, Upper Oak Creek, West Fork Oak Creek), and 5-1 (Lower Rio de Flag). All other watersheds within the analysis area do not contain TES aquatic species habitat, and therefore are not considered further with respect to TES species effects.

Threatened, Endangered, and Candidate Species

Please refer to the following links, as they pertain to the No Action Alternative (Alt A) as well as the proposed Action Alternatives (B-E): ***Existing and Desired Conditions***
Alternatives Considered in Detail

Spikedace (Meda fulgida) and Loach Minnow (Tiaroga cobitis)

Alternative A

Species Determination

Spikedace and Loach Minnow are not currently present within the affected environment. Therefore, Alternative A would have ***No Effect*** on these species.

Critical Habitat (Spikedace critical habitat: Spikedace; Loach Minnow critical habitat: Loach Minnow)

Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. The effects of increased sedimentation on aquatic habitat have been described above. Ash flows produced from forest fires can negatively impact water quality by increasing pH and decreasing dissolved oxygen levels (Earl and Blinn 2003). Stream morphology can be changed by sediment deposition. Alternative A (no action) would not mitigate these potential negative impacts. However, it is difficult to compare the effects of the no action alternative with the potential effects of wildfire.

The Slide Fire (USDA 2014) could have a tremendous impact on existing Spikedace and Loach Minnow critical habitat (USDI 2012). Flood waters could carry ash and sediments into connected drainages which could reach West Fork of Oak Creek, and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Spikedace and Loach Minnow. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

The cumulative effects of the No Action Alternative (Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates, resulting from the Slide Fire on untreated landscapes.

Alternative A may impact Spikedace and Loach Minnow critical habitat, but considering direct, indirect, and cumulative effects, and BMPs, Alternative A ***May Affect but is Not Likely to Adversely Affect*** Spikedace or Loach Minnow critical habitat.

Alternative B

Species Determination

Spikedace and Loach Minnow are not currently present within the affected environment. Therefore, Alternative B would have ***No Effect*** on these species.

Critical Habitat

Within the analysis area, critical habitat for Spikedace (Spikedace) and Loach Minnow (Loach Minnow) exists in the middle and lower portions of Oak Creek (USDI 2012). Prescribed fire treatments in subunits connected to this watershed or its 6th HUC watersheds upstream could potentially lead to short-term increases in sedimentation and/or ash flow into Spikedace and Loach Minnow critical habitat.

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative B could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Spikedace and Loach Minnow live.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Spikedace or Loach Minnow critical habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on Spikedace or Loach Minnow critical habitat, as discussed above.

The Slide Fire (USDA 2014) could have an impact on existing Spikedace and Loach Minnow critical habitat (USDI 2012). Flood waters could carry ash and sediments into connected drainages which could reach West Fork of Oak Creek, and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Spikedace and Loach Minnow. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Additional protective measures were added with BMPs #37 and #38 (Table 27) to protect habitat within and downstream of the Slide Fire area.

The cumulative effects that may occur after the Slide Fire, resulting from an untreated environment (as described in Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates..

However, considering direct, indirect, and cumulative effects, and BMPs, Alternative B ***May Affect but is Not Likely to Adversely Affect*** Spikedace or Loach Minnow critical habitat.

Alternative C

Species Determination

Spikedace and Loach Minnow are not currently present within the affected environment. Therefore, Alternative C would have ***No Effect*** on these species.

Critical Habitat

Within the analysis area, critical habitat for Spikedace (Spikedace) and Loach Minnow (Loach Minnow) exists in the middle and lower portions of Oak Creek (USDI 2012). Prescribed fire treatments in subunits connected to this watershed or its 6th HUC watersheds upstream could potentially lead to short-term increases in sedimentation and/or ash flow into critical habitat.

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative C could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Spikedace and Loach Minnow live.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Spikedace or Loach Minnow critical habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on Spikedace or Loach Minnow critical habitat, as discussed above.

The Slide Fire (USDA 2014) could have an impact on existing Spikedace and Loach Minnow critical habitat (USDI 2012). Flood waters could carry ash and sediments into connected drainages which could reach West Fork of Oak Creek, and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Spikedace and Loach Minnow. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Additional protective measures were added with BMPs #37 and #38 (Table 27) to protect habitat within and downstream of the Slide Fire area.

The cumulative effects that may occur after the Slide Fire, resulting from an untreated environment (as described in Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates.

However, considering direct, indirect, and cumulative effects, and BMPs, Alternative C ***May Affect but is Not Likely to Adversely Affect*** Spikedace or Loach Minnow critical habitat.

Alternative D

Species Determination

Spikedace and Loach Minnow are not currently present within the affected environment. Therefore, Alternative D would have ***No Effect*** on these species.

Critical Habitat

Within the analysis area, critical habitat for Spikedace (Spikedace) and Loach Minnow (Loach Minnow) exists in the middle and lower portions of Oak Creek (USDI 2012). Prescribed fire treatments in subunits connected to this watershed or its 6th HUC watersheds upstream could potentially lead to short-term increases in sedimentation and/or ash flow into critical habitat.

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative D could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). Alternative D proposes far fewer acres of prescribed fire treatments than Alternative B, C, or E. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the Purpose and Need of the project, because the natural fire regime would not be returned to the landscape under this alternative.

BMPs (Table 27) would be in place to mitigate the risks of sedimentation and ash flow from prescribed fire, and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and reduced use of prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Spikedace live. Again, however, Alternative D would fail to meet the Purpose and Need of the project.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Spikedace or Loach Minnow critical habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on Spikedace or Loach Minnow critical habitat, as discussed above.

The Slide Fire (USDA 2014) could have an impact on existing Spikedace and Loach Minnow critical habitat (USDI 2012). Flood waters could carry ash and sediments into connected drainages which could reach West Fork of Oak Creek, and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Spikedace and Loach Minnow. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Additional protective measures were added with BMPs #37 and #38 (Table 27) to protect habitat within and downstream of the Slide Fire area.

The cumulative effects that may occur after the Slide Fire, resulting from an untreated environment (as described in Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates.

However, considering direct, indirect, and cumulative effects, and BMPs, Alternative D ***May Affect but is Not Likely to Adversely Affect*** Spikedace or Loach Minnow critical habitat. However, Alternative D would not meet the Purpose and Need of the project.

Alternative E

Species Determination

Spikedace and Loach Minnow are not currently present within the affected environment. Therefore, Alternative E would have ***No Effect*** on these species.

Critical Habitat

Within the analysis area, critical habitat for Spikedace (Spikedace) and Loach Minnow (Loach Minnow) exists in the middle and lower portions of Oak Creek (USDI 2012). Prescribed fire treatments in subunits connected to this watershed or its 6th HUC watersheds upstream could potentially lead to short-term increases in sedimentation and/or ash flow into Spikedace and Loach Minnow critical habitat.

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative E could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative E proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Spikedace and Loach Minnow live.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Spikedace or Loach Minnow critical habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on Spikedace or Loach Minnow critical habitat, as discussed above.

The Slide Fire (USDA 2014) could have an impact on existing Spikedace and Loach Minnow critical habitat (USDI 2012). Flood waters could carry ash and sediments into connected drainages which ultimately could reach West Fork and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Spikedace and Loach Minnow. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Additional protective measures were added with BMPs #37 and #38 (Table 27) to protect habitat within and downstream of the Slide Fire area.

The cumulative effects that may occur after the Slide Fire, resulting from an untreated environment (as described in Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates..

Therefore, considering direct, indirect, and cumulative effects, and BMPs, Alternative E ***May Affect but is Not Likely to Adversely Affect*** Spikedace or Loach Minnow critical habitat.

Candidate Species

Roundtail Chub (Gila robusta)

Within the analysis area, Roundtail Chub occupies 77.9 miles of perennial stream (22.2% of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.

Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. The effects of increased sedimentation on aquatic habitat have been described above. Ash flows produced from forest fires can negatively impact water quality by increasing pH and decreasing dissolved oxygen levels (Earl and Blinn 2003). Stream morphology can be changed by sediment deposition. Alternative A (no action) would not mitigate these potential negative impacts. However, it is difficult to compare the effects of the no action alternative with the potential effects of wildfire.

Alternative A

Species Determination

Under alternative A, projects would continue within the 4FRI footprint. Forest plan guidance and use of appropriate BMPs should continue moving forest vegetation towards healthier and more sustainable forest structure. However, the limited acres treated in typical projects combined with the current forest structure across the ponderosa pine forest would leave the forest trending away from desired conditions at the landscape scale. Dense forest conditions would still occur and the high fire hazard potential would persist. It is predicted that under alternative A up to 33% of soils could burn with high severity (Lata 2014). The WEPP model (Steinke 2014) predicts that slopes greater than 15% that burn with high severity would result in erosion above tolerable levels, risking loss of soil productivity and sediment transportation. The timing of future crown fire events and spatial configuration relative to sediment delivery cannot be determined, so it is assumed that the short-term cumulative effects would not change the current trends for aquatic macroinvertebrates and their habitat. Long-term effects from high-severity fire would be expected to maintain or change the forest-wide trends to decreasing for macroinvertebrate populations and their habitat.

The Slide Fire (USDA 2014) could have a tremendous impact on existing Roundtail Chub habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Roundtail Chub. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

The cumulative effects of the No Action Alternative (Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates, resulting from the Slide Fire on untreated landscapes.

Alternative A may impact Roundtail Chub habitat, but considering direct, indirect, and cumulative effects, and BMPs, Alternative A ***May Affect but is Not Likely to Adversely Affect*** Roundtail Chub or its habitat.

Alternative B

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative B could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Roundtail Chub live. Furthermore, Roundtail Chub is a long-lived species (adults live over 10 years), so the risk of short term effects to Roundtail Chub and its habitat is also mitigated by the fact that the species is adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Roundtail Chub or its habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on Roundtail Chub or its habitat, as discussed above.

The Slide Fire (USDA 2014) could have an impact on existing Roundtail Chub habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Roundtail Chub. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Additional protective measures were added with BMPs #37 and #38 (Table 27) to protect habitat within and downstream of the Slide Fire area.

The cumulative effects that may occur after the Slide Fire, resulting from an untreated environment (as described in Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates..

Therefore, considering direct, indirect, and cumulative effects, and BMPs, Alternative B ***May Affect but is Not Likely to Adversely Affect*** Roundtail Chub or its habitat.

Alternative C

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative C could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Roundtail Chub live. Furthermore, Roundtail Chub is a long-lived species (adults live over 10 years), so the risk of short term effects to Roundtail Chub and its habitat is also mitigated by the fact that the species is adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on roundtail chub or its habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on Roundtail Chub or its habitat, as discussed above.

The Slide Fire (USDA 2014) could have an impact on existing Roundtail Chub habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Roundtail Chub. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Additional protective measures were added with BMPs #37 and #38 (Table 27) to protect habitat within and downstream of the Slide Fire area.

The cumulative effects that may occur after the Slide Fire, resulting from an untreated environment (as described in Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates.

Therefore, considering direct, indirect, and cumulative effects, and BMPs, Alternative C ***May Affect but is Not Likely to Adversely Affect*** Roundtail Chub or its habitat.

Alternative D

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative D could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). Alternative D proposes far fewer acres of prescribed fire treatments than Alternatives B, C, or E. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the Purpose and Need of the project, because the natural fire regime would not be returned to the landscape under this alternative.

BMPs (Table 27) would be in place to mitigate the risks of sedimentation and ash flow from prescribed fire, and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and reduced use of prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Roundtail Chub live. Again, however, Alternative D would fail to meet the Purpose and Need of the project.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Roundtail Chub or its habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on Roundtail Chub or its habitat, as discussed above.

The Slide Fire (USDA 2014) could have an impact on existing Roundtail Chub habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Roundtail Chub. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Additional protective measures were added with BMPs #37 and #38 (Table 27) to protect habitat within and downstream of the Slide Fire area.

The cumulative effects that may occur after the Slide Fire, resulting from an untreated environment (as described in Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates.

Therefore, considering direct, indirect, and cumulative effects, and BMPs, Alternative D ***May Affect but is Not Likely to Adversely Affect*** Roundtail Chub or its habitat. However, Alternative D would not meet the Purpose and Need of the project.

Alternative E

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative E could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative E proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Roundtail Chub live. Furthermore, Roundtail Chub is a long-lived species (adults live over 10 years), so the risk of short term effects to Roundtail Chub and its habitat is also mitigated by the fact that the species is adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Roundtail Chub or its habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have an impact on existing Roundtail Chub habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Roundtail Chub. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Additional protective measures were added with BMPs #37 and #38 (Table 27) to protect habitat within and downstream of the Slide Fire area.

The cumulative effects that may occur after the Slide Fire, resulting from an untreated environment (as described in Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates.

Therefore, considering direct, indirect, and cumulative effects, Alternative E ***May Affect but is Not Likely to Adversely Affect*** Roundtail Chub or its habitat.

Forest Sensitive Species

The most recent Regional Forester's Sensitive Species list was transmitted to Forest Supervisor's on September 18, 2013 and is the basis for the species used for this analysis. If survey information was not available the assumption was made that potential habitat was occupied.

Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. The effects of increased sedimentation on aquatic habitat have been described above. Ash flows produced from forest fires can negatively impact water quality by increasing pH and decreasing dissolved oxygen levels (Earl and Blinn 2003). Stream morphology can be changed by sediment deposition. Alternative A (no action) would not mitigate these potential negative impacts. However, it is difficult to compare the effects of the no action alternative with the potential effects of wildfire.

Roundtail Chub (*Gila robusta*)

Within the analysis area, Roundtail Chub occupies 77.9 miles of perennial stream (22.2% of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.

Alternative A

Under alternative A, projects would continue within the 4FRI footprint. Forest plan guidance and use of appropriate BMPs should continue moving forest vegetation towards healthier and more sustainable forest structure. However, the limited acres treated in typical projects combined with the current forest structure across the ponderosa pine forest would leave the forest trending away from desired conditions at the landscape scale. Dense forest conditions would still occur and the high fire hazard potential would persist. It is predicted that under alternative A up to 33% of soils could burn with high severity (Lata 2014). The WEPP model (Steinke 2014) predicts that slopes greater than 15% that burn with high severity would result in erosion above tolerable levels, risking loss of soil productivity and sediment transportation. The timing of future crown fire events and spatial configuration relative to sediment delivery cannot be determined, so it is assumed that the short-term cumulative effects would not change the current trends for aquatic macroinvertebrates and their habitat. Long-term effects from high-severity fire would be expected to maintain or change the forest-wide trends to decreasing for macroinvertebrate populations and their habitat.

The Slide Fire (USDA 2014) could have an impact on existing Roundtail Chub habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Roundtail Chub. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

Potential sediment delivery from 74 springs, 39 miles of ephemeral channels, and 860 miles of existing or unauthorized roads proposed for decommissioning would continue for both the short- and long-term.

The cumulative effects of the No Action Alternative (Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates, resulting from the Slide Fire on untreated landscapes.

Species Determination

Alternative A may impact Roundtail Chub , but considering direct, indirect, and cumulative effects, and BMPs, Alternative A is ***not likely to cause a trend to federal listing or loss of viability.***

Alternative B

The soils and water report (Steinke 2014) indicates that prescribed fire treatments could result in soil erosion in areas where slope exceeds 15%. is a short-term risk (1-2 years) of sedimentation or ash flow reaching chub habitat as a result of these treatments (Table 33). However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so impacts would be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). The long-term effects of restoration, including restoring the health of watersheds and streams in which Roundtail Chub live, would be beneficial. Furthermore, Roundtail Chub is a long-lived species (adults live over 10 years), so the risk of short term effects to Roundtail Chub and its habitat is also mitigated by the fact that the species is adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Roundtail Chub or its habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on Roundtail Chub or its habitat, as discussed above.

The Slide Fire (USDA 2014) could have an impact on existing Roundtail Chub habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Roundtail Chub. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Additional protective measures were added with BMPs #37 and #38 (Table 27) to protect habitat within and downstream of the Slide Fire area.

The cumulative effects that may occur after the Slide Fire, resulting from an untreated environment (as described in Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates.

Species Determination

Considering direct, indirect, cumulative effects, and BMPs, Alternative B ***may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.***

Alternative C

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative C could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Roundtail Chub live. Furthermore, Roundtail Chub is a long-lived species (adults live over 10 years), so the risk of short term effects to Roundtail Chub and its habitat is also mitigated by the fact that the species is adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Roundtail Chub or its habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on Roundtail Chub or its habitat, as discussed above.

The Slide Fire (USDA 2014) could have a tremendous impact on existing Roundtail Chub habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Roundtail Chub. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Species Determination

Considering direct, indirect, cumulative effects, and BMPs, Alternative C ***may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.***

Alternative D

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative D could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 29). Alternative D proposes far fewer acres of prescribed fire treatments than does either Alternative B or Alternative C. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the Purpose and Need of the project, because the natural fire regime would not be returned to the landscape under this alternative.

BMPs (Table 27) would be in place to mitigate the risks of sedimentation and ash flow from prescribed fire, and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and reduced use of prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Roundtail Chub live. Again, however, Alternative D would fail to meet the Purpose and Need of the project.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Roundtail Chub or its habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on Roundtail Chub or its habitat, as discussed above.

The Slide Fire (USDA 2014) could have a tremendous impact on existing Roundtail Chub habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Roundtail Chub. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Species Determination

Considering direct, indirect, cumulative effects, and BMPs, Alternative D ***may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.*** However, Alternative D would not meet the Purpose and Need of the project.

Alternative E

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative E could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative E proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Roundtail Chub live. Furthermore, Roundtail Chub is a long-lived species (adults live over 10 years), so the risk of short term effects to Roundtail Chub and its habitat is also mitigated by the fact that the species is adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Roundtail Chub or its habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have a tremendous impact on existing Roundtail Chub habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are the food base for Roundtail Chub.

Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Species Determination

Considering direct, indirect, cumulative effects, and BMPs, Alternative E ***may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.***

Desert Sucker (Catostomus clarki) and Sonora Sucker (C. insignis)

Within the analysis area, Desert and Sonora Sucker occupy 77.9 miles of perennial stream (32.9% of their habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.

Alternative A

Alternative A (no action) would not mitigate the current high risk of high intensity wildfires. However, it is difficult to quantify the effects of the no action alternative as compared to the potential effects of wildfire. Perennial streams on the Coconino NF within and adjacent to the project area are currently at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. The effects of increased sedimentation on aquatic habitat have been described above. Ash flows produced from forest fires can negatively impact water quality by increasing pH and decreasing dissolved oxygen levels (Earl and Blinn 2003). Stream morphology can be changed by sediment deposition and erosion.

The Slide Fire (USDA 2014) could have a tremendous impact on existing sucker habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are one of the principal foods for juvenile suckers. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Alternative A may impact Desert and Sonora Sucker, but considering direct, indirect, and cumulative effects, and BMPs, Alternative A is ***not likely to cause a trend to federal listing or loss of viability.***

Alternative B

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative B could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which suckers live. Furthermore, Desert and Sonora suckers are long-lived species (adults live over 10 years), so the risk of short term effects to their habitat is also mitigated by the fact that these species are adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Desert or Sonora Sucker or their habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on suckers or their habitat, as discussed above.

The Slide Fire (USDA 2014) could have a tremendous impact on existing sucker habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach West Fork and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are one of the principal foods for juvenile suckers. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Species Determination

Considering direct, indirect, cumulative effects, and BMPs, Alternative B ***may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.***

Alternative C

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative C could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Desert and Sonora Sucker live. Furthermore, these species are long-lived (adults live over 10 years), so the risk of short term effects to habitat is also mitigated by the fact that these species are adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on sucker habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on these species or their habitat, as discussed above.

The Slide Fire (USDA 2014) could have a tremendous impact on existing Desert and Sonora Sucker habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are one of the principal foods for juvenile suckers. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Species Determination

Considering direct, indirect, and cumulative effects, and BMPs, Alternative C ***may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.***

Alternative D

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative D could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). Alternative D proposes far fewer acres of prescribed fire treatments than does either Alternative B or Alternative C. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the Purpose and Need of the project, because the natural fire regime would not be returned to the landscape under this alternative.

BMPs (Table 27) would be in place to mitigate the risks of sedimentation and ash flow from prescribed fire, and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and reduced use of prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Desert and Sonora Sucker live. Again, however, Alternative D would fail to meet the Purpose and Need of the project.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Desert or Sonora Sucker habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on Desert or Sonora Sucker or its habitat, as discussed above.

The Slide Fire (USDA 2014) could have a tremendous impact on existing Desert and Sonora Sucker habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are one of the principal foods for juvenile suckers. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Considering direct, indirect, cumulative effects, and BMPs, Alternative D ***may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.*** However, Alternative D would not meet the Purpose and Need of the project.

Alternative E

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative E could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative E proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which Desert and Sonora Sucker live. Furthermore, these species are long-lived (adults live over 10 years), so the risk of short term effects to the suckers and their habitat is also mitigated by the fact that they are adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on Desert or Sonora Sucker or their habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have a tremendous impact on existing Desert and Sonora Sucker habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are one of the principal foods for juvenile suckers. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Considering direct, indirect, cumulative effects, and BMPs, Alternative E ***may impact individuals, but is not likely to cause a trend to federal listing or loss of viability.***

California Floater (Anodonta californiensis)

There are 368.6 miles of potential California floater habitat within the Coconino Forest boundary. Within the analysis area, there are 77.9 miles (21.1%) of potential perennial stream habitat (Table 18), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek.

Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. The effects of increased sedimentation on aquatic habitat have been described above. Ash flows produced from forest fires can negatively impact water quality by increasing pH and decreasing dissolved oxygen levels (Earl and Blinn 2003). Stream morphology can be changed by sediment deposition. Thinning and prescribed fire would occur at Alternative A (no action) would not mitigate these potential negative impacts. However, it is difficult to compare the effects of the no action alternative with the potential effects of wildfire.

Alternative A

Under alternative A, projects would continue within the 4FRI footprint. Forest plan guidance and use of appropriate BMPs should continue moving forest vegetation towards healthier and more sustainable forest structure. However, the limited acres treated in typical projects combined with the current forest structure across the ponderosa pine forest would leave the forest trending away from desired conditions at the landscape scale. Dense forest conditions would still occur and the high fire hazard potential would persist. It is predicted that under alternative A up to 33% of soils could burn with high severity (Lata 2014). The WEPP model (Steinke 2014) predicts that slopes greater than 15% that burn with high severity would result in erosion above tolerable levels, risking loss of soil productivity and sediment transportation. The timing of future crown fire events and spatial configuration relative to sediment delivery cannot be determined, so it is assumed that the short-term cumulative effects would not change the current trends for aquatic macroinvertebrates and their habitat. Long-term effects from high-severity fire would be expected to maintain or change the forest-wide trends to decreasing for macroinvertebrate populations and their habitat.

Potential sediment delivery from 74 springs, 39 miles of ephemeral channels, and 860 miles of existing or unauthorized roads proposed for decommissioning would continue for both the short- and long-term.

The cumulative effects of the No Action Alternative (Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates, resulting from the Slide Fire on untreated landscapes.

The Slide Fire (USDA 2014) could have a tremendous impact on existing California floater habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill macroinvertebrates which are one of the principal foods for juvenile California floater. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Alternative A may impact California floater,but considering direct, indirect, and cumulative effects, and BMPs, Alternative A is ***not likely to cause a trend to federal listing or loss of viability.***

Alternative B

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative B could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams that represent historic California floater habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on California floater habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on California floater habitat, as discussed above.

The Slide Fire (USDA 2014) could have a tremendous impact on existing California floater habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill invertebrates which are one of the principal foods for California floater. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Considering direct, indirect, and cumulative effects, and BMPs, Alternative B ***is not likely to cause a trend to federal listing or loss of viability.***

Alternative C

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative C could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams that represent historic California floater habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on California floater habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on California floater habitat, as discussed above.

The Slide Fire (USDA 2014) could have a tremendous impact on existing California floater habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill invertebrates which are one of the principal foods for California floater. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Considering direct, indirect, and cumulative effects, Alternative C ***is not likely to cause a trend to federal listing or loss of viability.***

Alternative D

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative D could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). Alternative D proposes far fewer acres of prescribed fire treatments than does either Alternative B or Alternative C. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the Purpose and Need of the project, because the natural fire regime would not be returned to the landscape under this alternative.

BMPs (Table 27) would be in place to mitigate the risks of sedimentation and ash flow from prescribed fire, and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and reduced use of prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams that represent historic California floater habitat. Again, however, Alternative D would fail to meet the Purpose and Need of the project.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on California floater habitat, as no dust abatement treatments are proposed near open water.

Proposed Coconino Forest Plan amendments would not have measurable effects on California floater habitat, as discussed above.

The Slide Fire (USDA 2014) could have a tremendous impact on existing California floater habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill invertebrates which are one of the principal foods for California floater. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Therefore, considering direct, indirect, and cumulative effects, and BMPs, Alternative D ***is not likely to cause a trend to federal listing or loss of viability.*** However, Alternative D would not meet the Purpose and Need of the project.

Alternative E

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative E could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative E proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams that represent historic California floater habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on California floater habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have a tremendous impact on existing California floater habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water and can kill invertebrates which are one of the principal foods for California floater. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Considering direct, indirect, and cumulative effects, and BMPs, Alternative E ***is not likely to cause a trend to federal listing or loss of viability.***

A Caddisfly (Lepidostoma knulli)

There are about 13 miles of potential A. caddisfly habitat within the Coconino Forest boundary. Within the analysis area, the species may occupy all 13 miles of perennial Oak Creek above Sedona (Table 18). Blinn and Ruiter (2006, 2009) noted that the species occurred in cool stream segments with generally swift-flowing water, dominated by large cobbles with low embeddedness of interstitial gravels.

Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. The effects of increased sedimentation on aquatic habitat have been described above. Ash flows produced from forest fires can negatively impact water quality by increasing pH and decreasing dissolved oxygen levels (Earl and Blinn 2003). Stream morphology can be changed by sediment deposition. Thinning and prescribed fire would occur at Alternative A (no action) would not mitigate these potential negative impacts. However, it is difficult to compare the effects of the no action alternative with the potential effects of wildfire.

Alternative A

Species Determination

Under alternative A, projects would continue within the 4FRI footprint. Forest plan guidance and use of appropriate BMPs should continue moving forest vegetation towards healthier and more sustainable forest structure. However, the limited acres treated in typical projects combined with the current forest structure across the ponderosa pine forest would leave the forest trending away from desired conditions at the landscape scale. Dense forest conditions would still occur and the high fire hazard potential would persist. It is predicted that under alternative A up to 33% of soils could burn with high severity (Lata 2014). The WEPP model (Steinke 2014) predicts that slopes greater than 15% that burn with high severity would result in erosion above tolerable levels, risking loss of soil productivity and sediment transportation. The timing of future crown fire events and spatial configuration relative to sediment delivery cannot be determined, so it is assumed that the short-term cumulative effects would not change the current trends for aquatic macroinvertebrates and their habitat. Long-term effects from high-severity fire would be expected to maintain or change the forest-wide trends to decreasing for macroinvertebrate populations and their habitat.

Potential sediment delivery from 74 springs, 39 miles of ephemeral channels, and 860 miles of existing or unauthorized roads proposed for decommissioning would continue for both the short- and long-term.

The cumulative effects of the No Action Alternative (Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates, resulting from the Slide Fire on untreated landscapes.

The Slide Fire (USDA 2014) could have a tremendous impact on existing A. caddisfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Considering direct, indirect, and cumulative effects, and BMPs, Alternative A is ***not likely to cause a trend to federal listing or loss of viability.***

Alternative B

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative B could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds that represent A. caddisfly habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on A. caddisfly habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have a tremendous impact on existing A. caddisfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.
Finally, the proposed Coconino Forest Plan amendments would not have measurable effects on A. caddisfly habitat, as discussed above.

Considering direct, indirect, and cumulative effects, and BMPs, Alternative B ***is not likely to cause a trend to federal listing or loss of viability***

Alternative C

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative C could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds that represent A. caddisfly habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on A. caddisfly habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have a tremendous impact on existing A caddisfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Finally, the proposed Coconino Forest Plan amendments would not have measurable effects on A. caddisfly habitat, as discussed above.

Considering direct, indirect, and cumulative effects, and BMPs, Alternative C ***is not likely to cause a trend to federal listing or loss of viability.***

Alternative D

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative D could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). Alternative D proposes far fewer acres of prescribed fire treatments than does either Alternative B or Alternative C. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the Purpose and Need of the project, because the natural fire regime would not be returned to the landscape under this alternative.

BMPs (Table 27) would be in place to mitigate the risks of sedimentation and ash flow from prescribed fire, and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and reduced use of prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds that represent A. caddisfly habitat. Again, however, Alternative D would fail to meet the Purpose and Need of the project.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on A. caddisfly habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have a tremendous impact on existing A caddisfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Finally, the proposed Coconino Forest Plan amendments would not have measurable effects on A. caddisfly habitat, as discussed above.

Considering direct, indirect, and cumulative effects, and BMPs, Alternative D ***is not likely to cause a trend to federal listing or loss of viability.*** However, Alternative D would not meet the Purpose and Need of the project.

Alternative E

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative E could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative E proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds that represent A. caddisfly habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on A. caddisfly habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have a tremendous impact on existing A caddisfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Considering direct, indirect, and cumulative effects, and BMPs, Alternative E ***is not likely to cause a trend to federal listing or loss of viability.***

A Mayfly (Moribaetis mimbresaurus)

There are about 13 miles of potential A. mayfly habitat within the Coconino Forest boundary. Within the analysis area, the species may occupy all 13 miles of perennial Oak Creek above Sedona (Table 18). The species is poorly known, but larvae of this genus are splash-zone dwellers that are frequently found exposed on wet surfaces above the water line, on the surfaces of rocks in fast water, at the bases of waterfalls, or rocks along the shoreline of fast-water areas (Waltz and McCafferty 1983).

Perennial streams on the Coconino NF within and adjacent to the project area are at high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires. The effects of increased sedimentation on aquatic habitat have been described above. Ash flows produced from forest fires can negatively impact water quality by increasing pH and decreasing dissolved oxygen levels (Earl and Blinn 2003). Stream morphology can be changed by sediment deposition. Thinning and prescribed fire would occur at Alternative A (no action) would not mitigate these potential negative impacts. However, it is difficult to compare the effects of the no action alternative with the potential effects of wildfire.

Alternative A

Species Determination

Under alternative A, projects would continue within the 4FRI footprint. Forest plan guidance and use of appropriate BMPs should continue moving forest vegetation towards healthier and more sustainable forest structure. However, the limited acres treated in typical projects combined with the current forest structure across the ponderosa pine forest would leave the forest trending away from desired conditions at the landscape scale. Dense forest conditions would still occur and the high fire hazard potential would persist. It is predicted that under alternative A up to 33% of soils could burn with high severity (Lata 2014). The WEPP model (Steinke 2014) predicts that slopes greater than 15% that burn with high severity would result in erosion above tolerable levels, risking loss of soil productivity and sediment transportation. The timing of future crown fire events and spatial configuration relative to sediment delivery cannot be determined, so it is assumed that the short-term cumulative effects would not change the current trends for aquatic macroinvertebrates and their habitat. Long-term effects from high-severity fire would be expected to maintain or change the forest-wide trends to decreasing for macroinvertebrate populations and their habitat.

Potential sediment delivery from 74 springs, 39 miles of ephemeral channels, and 860 miles of existing or unauthorized roads proposed for decommissioning would continue for both the short- and long-term.

The cumulative effects of the No Action Alternative (Alternative A) demonstrate the potential for destructive effects to the forest terrestrial landscape, riparian zone, and aquatic habitat, for both terrestrial and aquatic wildlife, fish, and macroinvertebrates, resulting from the Slide Fire on untreated landscapes.

The Slide Fire (USDA 2014) could have a tremendous impact on existing A. mayfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Alternative A may impact individuals, but considering direct, indirect, and cumulative effects, and BMPs, Alternative A is ***not likely to cause a trend to federal listing or loss of viability.***

Alternative B

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative B could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds that represent A. mayfly habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on A. mayfly habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have a tremendous impact on existing A. mayfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Finally, the proposed Coconino Forest Plan amendments would not have measurable effects on A. mayfly habitat, as discussed above.

Considering direct, indirect, and cumulative effects, and BMPs, Alternative B ***is not likely to cause a trend to federal listing or loss of viability.***

Alternative C

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative C could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds that represent A. mayfly habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on A. mayfly habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have a tremendous impact on existing A. mayfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Finally, the proposed Coconino Forest Plan amendments would not have measurable effects on A. mayfly habitat, as discussed above.

Considering direct, indirect, and cumulative effects, and BMPs, Alternative C ***is not likely to cause a trend to federal listing or loss of viability.***

Alternative D

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative D could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). Alternative D proposes far fewer acres of prescribed fire treatments than does either Alternative B or Alternative C. However, while reducing the risk of sedimentation and ash flows, the proposed reduction in acres of prescribed fire would not meet the Purpose and Need of the project, because the natural fire regime would not be returned to the landscape under this alternative.

BMPs (Table 27) would be in place to mitigate the risks of sedimentation and ash flow from prescribed fire, and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and reduced use of prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds that represent A. mayfly habitat. Again, however, Alternative D would fail to meet the Purpose and Need of the project.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on A. mayfly habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have a tremendous impact on existing A. mayfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Finally, the proposed Coconino Forest Plan amendments would not have measurable effects on A. mayfly habitat, as discussed above.

Considering direct, indirect, and cumulative effects, and BMPs, Alternative D ***is not likely to cause a trend to federal listing or loss of viability.*** However, Alternative D would not meet the Purpose and Need of the project.

Alternative E

Species Determination

The soils and water report (Steinke 2014) indicates that prescribed fire treatments under Alternative E could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation or ash flow resulting from these treatments (Table 33). In addition, Alternative E proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 27) would be in place to mitigate these risks and proposed treatments would occur over a ten-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 33). Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds that represent A. mayfly habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. These proposed treatments are the same across all action alternatives. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on A. mayfly habitat, as no dust abatement treatments are proposed near open water.

The Slide Fire (USDA 2014) could have a tremendous impact on existing A. mayfly habitat. Flood waters could carry ash and sediments into connected drainages which ultimately could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

The USDA BAER report (2014) recommended and has implemented the following mitigation measures: 1) application of mulch (certified weed free straw); and 2) seed on moderate to high severity areas on slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery, especially on sites which have a high potential to flood or have a debris flow and connect directly to perennial water. The intent is to reduce sedimentation into connected waters.

Considering direct, indirect, and cumulative effects, and BMPs, Alternative E ***is not likely to cause a trend to federal listing or loss of viability.***

Management Indicator Species (Macroinvertebrates)

Alternative A

Determination

There are about 294 miles of potential macroinvertebrate habitat (perennial stream) within the Coconino Forest boundary. Within the analysis area, there are about 84 miles (about 28%) of potential perennial stream habitat (Table 23), including Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Details on direct and indirect effects of proposed actions under the 4FRI are described above.

Alternative A

Current and ongoing projects would proceed within the 4FRI project area footprint under the no action alternative. These projects are listed in appendix F of the EIS.

Alternative A would not result in an immediate change to the quantity or quality of riparian habitat. Few projects alter riparian habitat, so at the 4FRI project and forest level, little change would occur under this alternative. Mitigation measures have already been implemented in the vicinity of the Slide Fire to reduce sedimentation into connected waters, including: application of mulch (certified weed free straw) and seed on moderate to high severity areas with slopes < 40% to reduce soil loss, stabilize soils, and enhance habitat recovery. This work encompassed sites with high potential to flood, have debris flow, and are connect directly to perennial water.

The lack of landscape-scale restoration would maintain the current level of hydrologic function. Hydrologic function is currently reduced due to uncharacteristic tree densities. Evapotranspiration from trees pulls water from the soils that could otherwise recharge groundwater (MacDonald 2013). In the long-term, less groundwater recharge and reduced discharge could lead to decreased flow in perennial streams, particularly combined with the predicted effects of climate change.

Under alternative A, 520 miles of temporary roads associated with the 4FRI would not be created, potentially reducing sediment delivery. Similarly, 860 miles of road decommissioning associated with the 4FRI, including 726 miles on the Coconino NF, would not occur, maintaining current sediment levels. Spring and ephemeral channel restoration would not occur as proposed. Sedimentation and ground water recharge would continue under current conditions. Effects of sedimentation from these sources are not expected to be significant because few of these total acres are directly associated with perennial streams. However, individual roads, springs, and ephemeral channels could affect localized portions of streams.

Conifer encroachment into riparian habitat would continue. Increased shading would help maintain cooler water temperatures which can negatively affect macroinvertebrates (USDA 2013). Increased overstory shading in riparian areas would decrease riparian ground cover that can filter sediments. Conifer encroachment would also provide fuel connectivity, increasing the risk of high-severity fire burning up to or into riparian habitats. High-severity fire can result in loss of stream shading and delivery of high sedimentation and ash loads into aquatic habitats. The risk of these stand-replacing crown fires remains high on the Coconino NF and represents a threat to macroinvertebrate populations within the project area (effects of increased sedimentation on aquatic habitat is described above). The Slide Fire (USDA 2014) could cause large-scale impacts to existing macroinvertebrate populations and their habitat. Flood waters could deliver ash and sediments from connected drainages into the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of individual storm events. Multiple precipitation events could occur in a day or within a week and within different drainages within the same watershed and each could result in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation.

Alternative A would maintain the stable trend for macroinvertebrate populations and the stable to improving trends in riparian habitats in the short-term. Factors that could influence long-term trends include a consistent decrease in hydrologic function resulting from high tree densities. Alternately, uncharacteristic, high-severity fires could open forests, removing ground cover in the short-term and forest cover in the long-term. Increased run-off from burned areas would likely increase sedimentation and ash flow if this were to occur. Trends in both macroinvertebrate populations and their habitats would be negatively affected in the long-term.

Alternatives B - E

None of the action alternatives would include treatments in riparian habitats associated with perennial streams. A series of BMPs have been developed for soil and water conservation (Soil and Water report and appendix C of the EIS). These include streamside management zones (also known as filter strips) with increasing widths for increasing soil erosion hazards. This is expected to minimize potential sediments reaching riparian areas.

The soils and water report (Steinke 2014) indicates that prescribed fire treatments could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1-2 years) of sedimentation flow resulting from these treatments (Table 29). However, BMPs (Table 27) would be in place to mitigate these risks. Prescribed fire ignitions would not occur inside the streamside management zones, but fire would be allowed to burn into riparian areas. Additional BMPs would address soil health, retention of CWD, and to minimize sediment transport from upland operations (appendix C of the EIS). Implementation would be organized by task order. Task orders would typically be completed in about 3 years' time. If 4FRI implementation was completed in 10 years' time, on average 1/10 of the area would be treated in a given year. Because perennial water is limited on this landscape, most of the treated acres would not affect riparian or aquatic habitats. Most sediment is expected to remain on site due to the BMPs.

The Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 29). BMPs would be implemented to address soil health, retention of CWD, and to minimize sediment transport from upland operations (appendix C of the EIS). Short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and the streams that represent macroinvertebrate habitat.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. Again, BMPs would be in place to mitigate these short-term risks in order to realize long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads. Dust abatement would have no effect on macroinvertebrate habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino Forest Plan amendments would not have measurable effects on macroinvertebrate habitat, as discussed above.

While many of the proposed actions could lead to sediments reaching perennial waters, the likelihood of this happening depends on the distance from disturbed site to the stream, the intervening slope, vegetation, and BMPs, and the scale and timing of precipitation events. Effects would be expected to be limited and localized. Therefore, the action alternatives would not change the forest-wide trends for macroinvertebrates or the quality of their habitat in the short-term. The 5^{th} code watersheds within and intercepted by the 4FRI treatment area contain about 28% of the total 294 miles of perennial streams occurring on the forest (Table 24).

Therefore, the action alternatives could lead to limited and localized decreases in aquatic macroinvertebrate populations and riparian habitat due to sedimentation. Decreased water quality could also alter the species taxa relationships and/or decrease macroinvertebrate species diversity. In the short-term, the scale of these potential impacts would not affect the forest wide trends for macroinvertebrate populations or the quality of their habitat. Because the combined actions of the project would include moving forest structure towards the historical range of variation, decommissioning roads, moving road segments to reduce sedimentation impacts, and spring and ephemeral channel restoration would all lead to long-term improvements. This would maintain or improve the current forest-wide trends in riparian habitat (stable to improving) and in macroinvertebrate populations (stable).

Cumulative Effects for Management Indicator Species

The boundary for the 4FRI project area includes or overlaps several 5^{th} code HUC watersheds containing perennial waters (Table 24). The project boundary and associated stream miles within these 5^{th} code watersheds (about 84 miles) were used to evaluate cumulative effects.

Total past, current, and future foreseeable projects in the 4FRI area include about 166,520 acres of mechanical treatment (cumulative effects supplement for Aquatic Species, project record). About ¾ of the mechanical treatments consist of thinning in goshawk habitat outside of post-fledging family areas. Other main areas of mechanical treatments in cumulative effects includes thinning in: grasslands (about 11,500 acres); Mexican spotted owl protected activity areas (about 7,400 acres); pinyon-juniper (about 6,900 acres); and aspen regeneration (about 5,200 acres). In addition, about 3,550 acres of thinning would occur in mixed-conifer habitat managed for Mexican spotted owl. By following the goshawk guidelines as incorporated into the forest plan and conducting vegetation restoration, these actions would move treated areas towards the natural range of variation. Thinning would be expected to improve hydrologic function (Steinke 2014), potentially improving riparian conditions. Results would be limited in Mexican spotted owl habitat because treatment intensities are typically light for this species. The restoration of vegetation types encroached by ponderosa pine and creating interspace in formerly contiguous forest would also reduce the risk of large-scale high-severity fire. Improved forest resilience would also decrease drought and insect-caused tree mortality which could also reduce fire effects. The Soils and Water Report (Steinke 2014) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope, in the ponderosa pine vegetation type.

Total past, current, and future foreseeable projects in the 4FRI area include about 208,300 acres of prescribed fire (cumulative effects supplement for Aquatic Species, project record). About 82% of these acres occurred within goshawk habitat outside of post-fledging family areas (170,700 acres). Prescribed fire has also been conducted in: grasslands (about 6,550 acres); Mexican spotted owl protected activity areas (about 2,240 acres); and pinyon-juniper (about 3,425 acres). In addition, about 3,600 acres of thinning would occur in Mexican spotted owl mixed-conifer habitat. Prescribed fire reduces surface fuel loading and typically increases canopy base height. Torching can occur, burning individual trees or groups of trees. Combined with the post-fire nutrient pulse, these effects can increase understory response. Coarse woody debris and logs typically decrease after fire, but increases occur within a few years post-treatment (Lata 2014). Increased understory biomass and woody debris would aid in stabilizing soils and filtering sediments. Changes in vegetation structure resulting from prescribed fire should reduce the risk of surface fire transitioning into crown fire, decreasing the risk of uncharacteristic sediment loads and ash pulses reaching perennial streams. The short-term risk associated with prescribed fire can yield long-term benefits, including restoring the health of watersheds and the streams that represent macroinvertebrate habitat.

Some public commenters on the draft EIS stated the analysis had exaggerated the risk of large-scale high-severity fire in the 4FRI landscape. Since receiving those comments the Slide Fire burned over 21,000 acres in and adjacent to proposed 4FRI treatments, affecting about 15% of the watershed acres upstream of the City of Sedona (USDA 2014). Flood waters could carry ash and sediments into connected drainages which could reach the West Fork of Oak Creek and ultimately the Oak Creek mainstem. Flooding and sediment delivery is influenced by the size, duration, and location of each storm. Multiple precipitation events could occur in a day or within a week and within different drainages, each resulting in transport of ash. Ash changes the pH and oxygen levels of water which can kill macroinvertebrates. Flooding, landslides, and debris flows can alter stream channel characteristics, can cause debris dams which can subsequently breach and create a pulse flow, can scour drainages, and modify or remove riparian vegetation. Sedimentation, ash, and the subsequent effects to stream characteristics can directly impact macroinvertebrates and their habitat. The cumulative effects of thinning and prescribed fire should reduce the probability of other high-severity fires in the 4FR treatment area.

Past cumulative effects include 24 water developments. All the developments are on the Tusayan ranger district. Each development is designed for wildlife using municipal water. Naturally flowing water will not be affected. No perennial waters occur on this district. Hydrologically the district is connected to the Little Colorado River, not the Verde River. There would be no cumulative effects on aquatic macroinvertebrates or their habitat on the Coconino NF. One current project on the Coconino NF is incorporating channel restoration. Potential effects from this would be cumulative with the 39 miles of ephemeral stream restoration proposed in the 4FRI. This restoration work could create a short-term (1 season) sediment pulse if the timing of precipitation transported materials off-site. Long-term benefits would include an overall decrease of sediment delivery to streams.

Under alternative A, projects would continue within the 4FRI footprint. Following forest plan guidance and use of appropriate BMPs should continue moving forest vegetation towards healthier and more sustainable forest structure. However, the limited acres treated in typical projects combined with the current forest structure across the ponderosa pine forest would leave the forest trending away from desired conditions at the landscape scale (McCusker et al. 2014). Dense forest conditions would still occur and the high fire hazard potential would persist. It is predicted that under alternative A up to 33% of soils could burn with high severity (Lata 2014). The WEPP model (Steinke 2014) predicts that slopes greater than 15% that burn with high severity would result in erosion above tolerable levels, risking loss of soil productivity and sediment transportation. The timing of future crown fire events and spatial configuration relative to sediment delivery cannot be determined, so it is assumed that the short-term cumulative effects would not change the current trends for aquatic macroinvertebrates and their habitat. Long-term effects from high-severity fire would be expected to maintain or change the forest-wide trends to decreasing for macroinvertebrate populations and their habitat.

The action alternatives would cumulatively account for about 551,500 (alternatives B and D) to 597,600 (alternative C) acres of mechanical treatments. About 70% of these acres are accounted for by the 4FRI and have the objective of achieving or moving towards restoration. The limited erosion potential expected from mechanical treatments on this landscape, along with the BMPs commonly implemented for mechanical treatments, are expected to retain sediments on site.

The action alternatives would cumulatively account for about 790,600 (alternatives B and E) to about 794,400 (alternative C) acres of prescribed fire. The exception to these ranges is in alternative D where about 386,700 acres of prescribed fire would occur. Alternatives B, C, and E account for nearly ¾ of the cumulative acres of prescribed fire. Alternative D would account for about 54% of these acres. Prescribed fire would reduce litter, CWD, and logs in the short-term. This may allow some sediment to move off-site. However, the limited perennial water in the 4FRI project area means most acres treated would not be in immediate proximity to streams. Use of BMPs should further restrict effects of sedimentation. Woody debris and litter is expected to be within the recommended forest plan levels within a few years of implementation. Their replenishment would start shortly after completion of the burns.

Mechanical and prescribed fire treatments combined would decrease the probability of future surface fire transitioning into crown fire. Removal of ladder fuels, decreasing surface fuels, and creating canopy gaps, openings, and interspace would limit fire effects on forest overstory. These same changes would increase understory development and create sediment traps. Interrupting canopy connectivity would also limit the scale of crown fire and torching. The amount of high severity burning in future fires should be reduced relative to current conditions. Combined, this would limit the scale of run-off, sediment and ash flow entering streams after future fires. Flooding, landslides, and debris flows can alter stream channel characteristics, scour drainages, and modify or remove riparian vegetation.

The action alternatives combined with cumulative effects could lead to a short-term decrease in perennial stream habitat quality due to sedimentation. Although sediments reaching riparian areas should be minimal as described above, perennial streams near treated areas could be negatively affected. Therefore, the action alternatives could lead to localized, short-term decreases in aquatic macroinvertebrate populations and riparian habitat quality due to sedimentation. Decreased water quality could also alter the species taxa relationships and/or decrease macroinvertebrate species diversity. However, these potential short-term effects are not expected to change the forest-wide trends. In the long-term, moving forest structure towards the historical range of variation, decommissioning roads, moving specific road segments to reduce sedimentation impacts, and spring and ephemeral channel restoration would lead to long-term improvements. This would maintain or improve the current forest-wide trends in riparian habitat (stable to improving) and in macroinvertebrate populations (stable).

BACKGROUND

Education and Professional Experience

Master's Degree in Zoology from Oklahoma State University (1993), and Bachelors of Science degree in Wildlife and Fisheries Management from Arizona State University (1990). Professional experience includes over 20 years of field and laboratory fisheries work for the Arizona Game and Fish Department, U.S. Fish and Wildlife Service, and Forest Service. Specialized in Southwestern native fish conservation and recovery.

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