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Fisheries 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Analysis of effects on aquatic habitat and species included compilation of unpublished sampling data from Arizona Game and Fish Department (C. Benedict, pers. comm.), Forest Service reports and unpublished records, GIS analysis of perennial, intermittent, and ephemeral stream courses in the project area and downstream from the project area, proposed burn areas and associated slope, and use of the effects analyses in the Soils Report (Steinke 2013) and Riparian and Water Report (MacDonald 2012) for this project.

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

A century ago the pine forests were dominated by widely-spaced large trees with a more open, herbaceous forest floor (Cooper 1960). Typical historic tree group/patch size ranged from 0.1 to 0.75 acres in size, (2 to >40 trees) (White 1985). This historic range of variability condition for trees per acre on the Fort Valley Experimental Forest, near Flagstaff, Arizona, is estimated to average 23 to 56 trees per acre (Covington 1993).

Fires burned on a frequency ranging from 2 to 21 years (Weaver 1951; Cooper 1960; Fule 2003; Heinlein et al. 2005; Diggins 2010; Swetnam and Baisan 1996; Fule et al. 1997), with the majority of acres burning with low-to-moderate severity surface fire. The herbaceous understory fueled frequent fires started by lightning, and thinned and/or eliminated thickets of small trees keeping the forest open and park-like (Allen et al. 2002). This created a mosaic of grass, forbs, shrubs and trees. Under these conditions, the forest maintained its diversity and resiliency to fire and other natural disturbances. Today, human factors have led to a lack of re-occurring fire, which has resulted in a landscape that is highly departed from historic reference conditions. The desired condition is to restore tree density and pattern to the natural range of variability, while meeting forest plan requirements for Mexican spotted owl (hereafter referred to as MSO) protected and target/threshold habitat and goshawk nest stands. There is a need to move towards the forest structural reference conditions that were typical when natural disturbances were intact.

Canopy Openings

The ponderosa pine forests on the Kaibab are much denser than historic conditions, with 79 percent of the stands in a “closed” state (>32% canopy cover). Historically there were spaces between clumps of trees that are now either smaller or nonexistent. Only 19 percent of the ponderosa potential natural vegetation type (PNVT) is currently in the historic condition, which was all a mature to old forest with various-sized patches of young regenerating forest (USDA 2008). Likewise on the Coconino NF, there have been significant shifts to a closed medium aged forest with loss of herbaceous understory and tree age diversity with a trend away from reference conditions. Currently 76% of young and young to mid aged forests have cover greater than 30 percent. (USDA 2009).

As noted earlier, a century ago the pine forests had widely-spaced large trees with a more open, herbaceous forest floor (Cooper 1960). Typical historic tree group/patch size ranged from 0.5 to 0.75 acres in size, (2- 40+ trees) (Cooper 1961; White 1985; Pearson 1950). In contrast to having a ponderosa pine ecosystem consisting of groups of trees with an open tree canopy density mixed with interspaces (Woolsey 1911), approximately 75 percent of the ponderosa pine forest type within the project area has a moderately closed to closed tree canopy density (Table 1). This indicates a continuous tree canopy with few canopy gaps and openings. An open tree canopy mixed with interspaces which mimic historical spatial patterns and provide for tree regeneration and the development of grass and forbs are lacking. There is a direct relationship between canopy openings and understory vegetation. About 99 percent of the vegetation diversity in Southwest ponderosa pine forests occurs as understory species (Laughlin and Abella 2007). Abella and Springer (2008) concluded that tree thinning was a viable management technique for increasing the vigor and richness of understory.

Table 1 displays the departure from the historic range of variability across the project area using canopy density as the analysis metric to estimate the continuity of the tree canopy. At the fine scale, the desired condition is a ponderosa pine ecosystem consisting of groups of trees that typically range in size from 0.1 acre to 1.0 acre in size with an open tree canopy density mixed with interspaces. There is a need to use management strategies that promote tree regeneration and understory vegetation. There is a need to move towards the historic range of variability for tree canopy density and patterns of tree groups and interspaces.

Table 1. Current percent of ponderosa pine in project area by tree canopy density classification

Tree Canopy Density Classification	Percent of Project Area (%)
Open: 10% to 39%	22
Moderately Closed: 40% to 59%	30
Closed: 60%+	45
Unknown	3

Age and Size Class Diversity

Forest resiliency and diversity is dependent on the distribution of age and size classes. A balance of age and size classes across the landscape allows for a sustainable balance of regeneration, growth, mortality and decomposition (Oliver and Larsen 1990; Franklin et al. 2002; Thomas et al. 1979). Currently, over 50 percent of the project area lacks age and size class diversity and is in an even-aged structure. A lack of age and size class diversity results in a homogenous landscape with reduced resiliency (i.e. much higher risk of high intensity and severity fire, density-related mortality, and dwarf mistletoe spread and intensification) and diversity (i.e. reduced herbaceous productivity and tree-related wildlife habitat). The desired condition is to have a forest structure that represents all age classes necessary for a sustainable balance of regeneration, growth, mortality and decomposition (USDA 1987, as amended; USDA 1988, as amended). There is a need to implement un-even aged management strategies where appropriate.

Forest Structure in goshawk and MSO habitat

The Coconino NF and Kaibab NF forest plans include standards and guidelines that, once implemented, will move treated areas towards a forest structure with all age and size classes represented for all goshawk and MSO habitat types (USDA 1987, as amended; USDA 1988, as amended). Vegetation Structural Stage (VSS) is the metric used to describe existing and desired age and size classes. Table 2 displays the acres of goshawk and MSO habitat within the project area.

Table 2. Goshawk and MSO habitat within project area

Habitat Type	Acres
Goshawk Protected Fledgling Family Area (PFA), Dispersal PFA and nest stands	30,600
Goshawk non-PFA	369,033
Goshawk habitat total acres	399,633
MSO Protected Activity Area (PAC)	36,455
MSO Restricted	67,378
MSO Target/Threshold	8,713
MSO habitat total	112,546
Total Acres of goshawk and MSO habitat	512,178

Specific to the northern goshawk, forest plan guidelines incorporate direction for maximizing sustainable landscapes of old forest (USDA 1987, as amended; USDA 1988, as amended). The guidelines were designed to sustain a long-term (250 years or more) intermix of vegetation structural stages (VSS), ranging from newly regenerated to old-aged trees and forests. Reynolds et al. (1992) determined this is best accomplished with about 20 percent of a landscape in VSS 1 and VSS 2 (grass/forb, seedlings/saplings), 20 percent in VSS 3 (young forest), 20 percent in VSS 4 (mid-aged forest), 20 percent in VSS 5 (mature forest), and 20 percent in VSS 6 (old forest). Each VSS can vary by 3 percent (plus or minus). These proportions reflect forest development from cohort establishment through canopy closure to old forests.

Reynolds et al. (1992) based the VSS recommendations on the needs of goshawks and 14 key prey species. No single prey species is likely to be abundant enough to support goshawks, especially during winter and extreme weather. Providing the habitat conditions necessary to support 14 key species is expected to provide for goshawks regardless of what may be happening to any one individual prey species at any given time. Prey populations within goshawk foraging areas are expected to be abundant and sustainable when the mix of VSS classes is achieved along with interspaces, understory vegetation development and the maintenance of snags and logs.

Tables 3 and table 4 display the existing and desired forest structure within goshawk non-PFA habitat. The project area has approximately 369,633 acres of goshawk non-PFA habitat. Even-aged stand conditions (Table 3) apply to 56 percent of the foraging habitat within the project area. This condition is only desirable in nesting stands. Approximately 44 percent of the foraging habitat is an uneven-aged stand condition (Table 4). Of the even-aged stands, 56 percent is mid-aged to mature (VSS 4+) and 36 percent is young (VSS 3). Approximately 76 percent of all ponderosa pine stands in goshawk non-PFA habitat are VSS 3 and VSS 4. This means the project area is deficit of mature and old forest (VSS 5 and 6) as well as seedlings and saplings (VSS 2).

Table 3. Goshawk foraging habitat even-aged stands in the project area (2010)

Vegetation Structural Stage (VSS)	Tree Diameter (dbh)	Even-Aged Existing % of Area	Forest Plan Desired %Distribution[1]
1 – Grass/Forb/Shrubs	0.0 – 0.9”	8	Uneven-aged in all VSS Classes
2 – Seedling/Sapling	1.0 – 4.9”	0	
3 – Young Forest	5.0 – 12”	36	
4 – Mid-age Forest	12.0 – 17.9”	47	
5 – Mature Forest	18.0 – 23.9”	8	
6 – Old Forest	24”+	1	

Table 4 compares the existing VSS to the desired condition of 20 percent of a landscape in VSS 1 and VSS 2 (grass/forb, seedlings/saplings), 20 percent in VSS 3 (young forest), 20 percent in VSS 4 (mid-aged forest), 20 percent in VSS 5 (mature forest), and 20 percent in VSS 6 (old forest). The table illustrates that the existing uneven-aged forest structure does not represent a balance of VSS classes. As a result, habitat components such as an intermix of vegetation structural stages are lacking or limited in most stands. VSS 3 (35 percent) and VSS 4 (32 percent) are over-represented and VSS 1 (0 percent), VSS 2 (2 percent), VSS 5 (14 percent) and VSS 6 (17 percent) are deficit relative to a balanced age/structure uneven-aged condition.

[1] The forest plan standards and guidelines do not describe desired even-aged stand conditions for goshawk foraging area habitat. The desired condition is to convert all foraging area even-aged stands to the uneven-aged structural conditions shown in table 4 and convert all goshawk PFA/nest stands to the desired uneven-aged structural conditions shown in table 5.

Table 4. Goshawk foraging habitat uneven-aged stands in the project area (2010)

Vegetation Structural Stage (VSS)	Tree Diameter (dbh)	Existing % of Area	Forest Plan Desired Distribution (%)
1 – Grass/Forb/Shrubs	0.0 – 0.9”	0	10
2 – Seedling/Sapling	1.0 – 4.9”	2	10
3 – Young Forest	5.0 – 12”	35	20
4 – Mid-age Forest	12.0 – 17.9”	32	20
5 – Mature Forest	18.0 – 23.9”	14	20
6 – Old Forest	24”+	17	20

Within the project area there is approximately 30,600 acres of goshawk PFA, dispersal PFA and nest (includes replacement nest stands) habitat. The forest plan desired distribution of VSS in PFAs is the same as described above (table 4) for foraging habitat. The desired conditions for goshawk nest and replacement nest stands is to have a forest structure dominated by mature and old forest structure (VSS 5, 6) with a canopy cover of 50 percent or higher. Table 5 displays conditions similar to those found in foraging habitat. VSS 3 and 4 are over-represented and VSS 1, 2, 5 and 6 are deficit relative to a balanced age/structure uneven-aged condition. In terms of landscape ecology, these elements represent specific habitat components that are needed for goshawk prey species. An imbalance in these habitat components potentially decreases the ability of goshawks to maintain their numbers over time. There is a need to manage for a balanced interspersion of age classes in goshawk foraging and PFA/nest stand habitat.

Table 5. Forest structure in goshawk PFA/nest stands in the project area (2010)

Vegetation Structural Stage (VSS)	Tree Diameter (dbh)	Existing % of Area	Forest Plan Desired %Distribution
1 – Grass/Forb/Shrubs	0.0 – 0.9”	2	10
2 – Seedling/Sapling	1.0 – 4.9”	1	10
3 – Young Forest	5.0 – 12”	34	20
4 – Mid-age Forest	12.0 – 17.9”	46	20
5 – Mature Forest	18.0 – 23.9”	11	20
6 – Old Forest	24”+	6	20

Forest structure for MSO pine-oak habitat is evaluated by comparing the percent stand density index (SDI) by size class to the desired percent of SDI by size class and trees per acre >18” dbh . SDI is a metric used to rate the potential for density related tree mortality. Table 6 displays that MSO habitat has an excess of the smaller size classes (12” to 18”) and is deficit in trees 18” to 24” dbh in restricted habitat and in target/threshold, a component of restricted habitat. MSO habitat is at least 50 percent deficit in the 24” + category. There is a need to implement uneven-aged management strategies and manage for high-density, relatively uneven-aged stands in MSO restricted habitat, including target/threshold habitats to meet forest plan and MSO Recovery Plan requirements.

Table 6. Percent of the total existing stand density index (SDI) and trees per acre in MSO habitat (2010)

Stand Density Index (SDI) by dbh and Trees per Acre ≥18” dbh class	Existing Percent (%) SDI in MSO restricted habitat		Desired Percent (%) SDI and Trees Per Acre ≥ 18” dbh class
	Target/Threshold	Restricted (non-target/threshold)	
SDI – 12” to 18”	30	32	15
SDI – 18” to 24”	16	13	15
SDI – 24”+	6	6	15
TPA ≥ 18”	17.9	11.8	20

In addition to the need to improve habitat quality, both goshawk and MSO habitats are at risk from passive and active crown fire and the severe effects that accompany crown fire. Approximately 47 percent of MSO restricted habitat is at risk of crown fire. This increases to 50 percent in protected habitat and to 51 percent in target/threshold habitat. In goshawk habitat, 39 percent of post-fledgling family areas (PFA), dispersal PFA, and nest stands are at risk. The risk in landscapes outside of PFAs is 36 percent. There is a need to reduce the risk of crown fire which can impair or remove habitat, function, and move towards habitat conditions that are resilient to disturbances such as fire.

Old Growth

The forest plans define old growth as a condition of the forest having structural attributes based on the number of large trees per acre, basal area, canopy cover percent, dead standing trees, and down logs (USDA 1987, as amended) (USDA 1988, as amended). Ponderosa pine and pinyon juniper are the species identified for allocating old growth in this analysis.

Forest plan old growth standards state, “Until the forest plan is revised, allocate no less than 20 percent of each forested EMA to old growth” and, “Allocations will consist of landscape percentages meeting old growth conditions and not specific acres”. Old growth guidelines for both forests state, “All analyses should be at multiple scales - one scale above and one scale below the ecosystem management areas (USDA 1987, as amended; USDA 1988, as amended).”

Four scales of analysis have been developed given the size of this project. The smallest scale is represented at the stand level with stands averaging 100 acres in size. The EMA is considered to be 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. The fourth scale for ponderosa pine type is the 512,178 acres of ponderosa pine within the project area. For pinyon-juniper type, it is the 23,316 acres of pinyon-juniper within the project area.

Allocations to old growth consist of landscape percentages meeting old growth conditions and not specific areas. The allocations for this project are independent of previous allocations that were part of other projects/analyses that overlap this project area. This is due to changes in forest conditions since the previous analyses and updates to the MSO and goshawk habitat classifications.

A review of stand data and habitat classifications within the project area indicates there are approximately 512,178 acres of ponderosa pine in the project area. Of this total, 194,804 acres meet old growth conditions. Old growth allocations are based on current conditions within the project area along with forest plan specific management direction. Currently, all restoration units meet or exceed the 20 percent minimum percentage requirement. Table 7 displays existing ponderosa pine old growth allocations by restoration unit and forest.

For ponderosa pine, the old growth allocation acreage/percentage includes: 100 percent of MSO protected habitat; 100 percent of MSO target/threshold; 40 percent of MSO restricted habitat that is uneven-aged with low dwarf mistletoe infection; 80 percent of MSO restricted habitat that is even-aged, mid-aged to old with low dwarf mistletoe infection; 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, mid-aged to old with low dwarf mistletoe infection. Most sites currently do not fully meet the minimum criteria for ponderosa pine old growth conditions as listed in the forest plans. However, the habitat types noted above are closest to meeting old growth conditions. Where management occurs within the ponderosa pine cover type, there is a need to maintain the old growth characteristics within the sites allocated as old growth.

Table 7. Ponderosa pine old growth allocation acres and percent by restoration unit

Restoration Unit	Ponderosa Pine Total Acres		Ponderosa Pine Old Growth Acres		Old Growth Percent (%)	
	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF
1	145,793	0	65,189	0	45	0
3	58,327	70,898	21,341	25,177	37	36
4	56,981	77,320	17,718	30,342	31	39
5	61,671	0	24,745	0	40	0
6	0	41,188	0	10,291	0	25
Total	**322,722**	**189,407**	**128,994**	**65,810**	**40**	**35**

There are approximately 23,316 acres of pinyon-juniper within the project area (Table 8). These acres were selected because they best meet the minimum criteria for old growth conditions (per the forest plan). The old growth allocation includes all sites that are classified within the mid-aged to old vegetation structural stages. Most sites currently do not fully meet the minimum criteria. Where management occurs within the pinyon-juniper cover type, there is a need to maintain the old growth characteristics within the sites allocated as old growth.

Table 8. Pinyon-juniper old growth allocation acres and percent by forest.

Restoration Unit	Pinyon-juniper total acres		Pinyon-juniper old growth acres		Pinyon-juniper old growth percent (%)	
	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF	Coconino NF	Kaibab NF
1	1,141	0	611	0	54	0
3	832	3,201	356	1,747	43	55
4	42	7,123	42	4,116	100	58
5	8,771	0	7,302	0	83	0
6	0	2,206	0	1,452	0	66
Total	**10,786**	**12,530**	**8,311**	**7,315**	**70**	**59**

Forest Health - Stand Density

Forest health is defined by the vigor and condition of the forest stands and the presence of insects and disease that affect the sustainability of the forest. In the project area, dense stands of young to mid-aged trees (see table 4) have reduced tree growth and health to the point there is a high risk of tree mortality in the larger size classes. The potential for density-related mortality is measured through stand density index (SDI) (Long 1985) and basal area (BA). Table 9 displays the existing and desired percent maximum SDI and BA within goshawk and MSO habitat in the project area. The table also displays existing and desired conditions for snags and course woody debris, two key components of wildlife habitat.

Table 9. Existing and desired condition for stand density, snags and course woody debris (CWD) by habitat stratum

Habitat Stratum	Existing Acres	Existing Condition BA Average	Desired Condition BA Range	Existing Condition SDI % of Maximum	Desired Condition SDI % of Maximum	Existing Snags 12"-18" per Acre	Existing Snags 18"+ per Acre	Desired Snags 18" + Per Acre	Existing CWD Tons Per Acre	Desired CWD Tons Per Acre
Goshawk										
PFA (including nest stands)	30,600	124	70-80	52	25-40	N/A	0.42	2.0	4.20	5-7
Non-PFA	369,033	116	50-70	51	15-35	N/A	0.35	2.0	3.30	5-7
MSO - Ponderosa Pine-oak										
Protected	36,455	156	NA	76	NA	2.91	0.62	2.0+	5.48	5-7
Target/ Threshhold	8,713	161	150-170	84	NA	2.37	0.59	2.0+	5.39	5-7
Restricted	67,378	137	70-90	70	25-40	1.85	0.43	2.0	3.92	5-7

Note: table doesn't have DC for snags 12 to 18". Table 9 displays that the desired density conditions are not being met in a majority of the project area[2]. In goshawk habitat, stand conditions are on a trajectory towards density-related mortality. In MSO habitat, the existing stand density is well above desired conditions. In all habitat types, large snags are deficit from forest plan desired conditions. These are key elements necessary to maintain a suite of prey species for MSO. In addition, over 75 species of birds, mammals, reptiles, amphibians and many invertebrate species use snags and course woody debris as nesting, rooting, feeding, loafing and catching sites. The desired condition is to improve forest health by reducing the potential for density related mortality and move towards forest plan desired conditions for snags and course woody debris. There is a need to reduce stand densities in all habitats except MSO restricted and target threshold.

[2] SDI calculation excludes MSO protected and restricted threshold and target threshold habitat for a total of 45,387 acres where SDI is not applicable.

Insect and Disease

Ponderosa pine is attacked and killed by several different bark beetles in the genera *Dendroctonus* and *Ips*. It can be difficult to discern what species initiated the attack. In the project area, bark beetle activity in ponderosa pine currently appears to be at endemic levels.

Dwarf mistletoe infection in ponderosa pine is common throughout the project area. Mistletoe infected trees slowly weaken, experience growth loss, and eventually die (Lynch et al. 2008). Inventory data and previous incidence reviews (Hessburg and Beatty 1985) indicates approximately 25 to 35 percent of the project area has some level of infection ranging from light to extreme. The desired condition is move towards forest composition, structure and pattern historic reference conditions that would allow dwarf mistletoe and beetles to function at endemic or historic levels There is a need to manage insect and disease in a manner that reduces but does not eliminate dwarf mistletoe in order to provide nesting, resting, foraging and catching sites for birds and mammals including Abert's squirrels.

Vegetation Diversity and Composition

Vegetation diversity throughout the project area has declined (USDA 2009a; USDA 2009b). 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, which ultimately caused increased stand densities, has allowed Gambel oak to become overtopped by fast growing ponderosa pine (Abella and Fule 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 (Brown 1958; Kruse 1992; Rosenstock 1998; Abella and Springer 2008; Abella 2008a; Neff and others 1979). There is a need to stimulate new growth and maintain growth in large-diameter trees and use management strategies that provide for a variety of shapes and sizes across the landscape.

There are approximately 7,744 acres of aspen in the project area. Aspen is an early seral component of the ponderosa pine ecosystem and a species that provides for habitat diversity. Aspen is dying or rapidly declining on both forests due to the combined effects of conifer encroachment, browsing, insect, disease, severe weather events, and lack of fire disturbance (Lynch 2008; USDA 2009) (USDA 2008; USDA 2009). A study by Fairweather et al. (2007) on the Coconino NF indicates that aspen on low-elevation dry sites (<7500 ft) 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. 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.

There are approximately 72,106 acres of grasslands (which includes wet and dry meadows) within the project area. Grasslands provide valuable habitat to many wildlife species including pronghorn antelope, birds, and small mammals. Historically (late 1800's), grassland communities had less than 10 percent tree cover until past actions such as grazing, logging and fire suppression reduced or eliminated the vegetation necessary to carry low intensity fires. This altered the natural fire regimes and allowed uncharacteristically high invasion by conifers to take place (USDA 2008).

Many grassland acres across the Coconino and Kaibab NF have become encroached with trees and converted to forest (USDA 2008; USDA 2009). An ecological sustainability assessment completed in 2009 for forest plan revision purposes found that grasslands on the Coconino have decreased. Historically, only 2 percent of the Great Basin grasslands were comprised of very large shrubs, closed canopy and some very large trees. Since reference conditions, this percentage has increased by 17percent (USDA 2009). Within montane subalpine grasslands, the percentage has increased from 0 to 33 percent (USDA 2009). On the Kaibab NF, the ecological sustainability assessment found that at least 8percent of the montane, subalpine and Great Basin grasslands have been invaded by conifers (USDA 2008). The desired condition is to move towards the historic range of variability. Tree canopy cover would range from 0 to 9 percent and grasses and forbs would dominate. The fire return interval would less than 35 years (USDA 2008). Fire would function as a natural disturbance across the landscape without causing loss to ecosystem function or to human safety, lives, and values. When fire did occur, vegetation would return close to pre-fire conditions within a few years (Johnson 1998) and would typically replace less than 75 percent of the overstory (USDA 2009). There is a need to reduce (and in some cases remove) tree encroachment which has reduced the size and function of landscapes that were historically grasslands.

Big sage and ponderosa pine co-occur on approximately 16,000 acres of the Tusayan district (Kaibab NF, RU 6) portion of the project area. Pine-sage provides valuable habitat for several species of wildlife including migratory birds. Shrub species that occur with sage and provide further diversity include Fendler's ceanothus, mountain mahogany, snakeweed, bitter brush, Oregon boxleaf and Gambel oak. Sage cover under ponderosa pine varies from 0 percent cover, where it burned with moderate to high intensity surface fire or the pine has overtopped and shaded out the sage, to well over 35 percent cover in areas where fire has been excluded or the pine density is more open. The desired condition for the sage component of the pine/sage community is to have a shifting mosaic of sagebrush with a mix of age classes. The mosaic pattern would be largely regulated by fires.

Fire Ecology

The potential for crown fire and high-intensity surface fires from unnaturally high surface fuel loads is the trajectory of most of the project area. Wildland Urban Interface (WUI) areas are spread across the project area and include the communities of Flagstaff (RU 1, 3,4,5), Williams (RU 3,4), Tusayan (RU 6), Parks (RU 3,4), Belmont (RU 3,4) and scattered developments such as Doney Park (RU 5), Munds Park (RU 1), and Kachina Village (RU 3) that are within or adjacent to the project area. Although fuel treatments have been implemented in WUI closest to the major population centers, much of the landscape is still vulnerable to fire or to second order fire effects such as flooding, erosion, weed infestations, and, damaged infrastructure. In addition to WUI, areas at risk include water resources, such as the Lake Mary watershed. The Lake Mary watershed is a source of water for the city of Flagstaff. Other resources at risk from crown fire include a diverse assemblage of wildlife that are known to occur or have habitat within or adjacent to the project area.

At the project (landscape) scale, approximately 34 percent of the area has the potential to sustain crown fire. Of the 34 percent, 29 percent would be active crown fire and 10 percent would be passive crown fire. About 62 percent of the project area has the potential for surface fire and 4 percent has no fire potential. At the restoration unit (RU) scale, the risk of crown fire varies, ranging from 28 percent RU 6 (Tusayan District, Kaibab NF) to 42 percent in RU 1. At a finer scale that reflects habitats for threatened and endangered species such as Mexican spotted owl, crown fire risk increases up to 51 percent.

Crown fire generally produces 100 percent mortality in ponderosa pine by consuming the crowns of trees. Crown fire can be active or passive. Active crown fire advances from crown to crown in the tops of trees or shrubs (NWCG 2008). A passive crown fire is a fire in the crowns of trees, but only individual trees or groups of trees torch. Passive crown fire that is ignited in forests with interlocking crowns and/or low crown base heights may readily become active crown fire in more extreme weather situations. With a delay of more than 20 years between fires or treatments (a delay in the fire-return interval), areas of passive crown fire may transition to having the potential for active crown fire. The current fire-return interval is approximately 43 years, about four times longer than the desired historic fire-return interval which is between 2 and 21 years (Weaver 1951; Cooper 1960; Fule 2003; Heinlein et al.2005).

Canopy bulk density and canopy base height are forest structure parameters used to measure the potential for crown fire. Canopy bulk density is defined as the mass of available canopy fuel per unit volume (Scott and Reinhardt 2001). The harder it is to see the sky though the canopy when you are looking up through it, the denser (higher) the canopy bulk density. Higher canopy bulk densities means that fire can easily move through the crowns of trees. In addition, higher canopy bulk densities mean there are more fuels to burn. With more fuels, fire intensity would be influenced. Currently, canopy bulk density in the ponderosa pine of the project area averages 0.63 kilograms per cubic meter (kg/m3). Approximately 61 percent of the pine has a canopy bulk density rating that is greater than .05 kg/m^3. The desired condition is to have canopy bulk density below .05 kg/m^3 in ponderosa pine.

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 propagate fire vertically into the canopy (Scott and Reinhardt, 2001). The lower the canopy base height, the easier it is for crown fire to initiate (Van Wagner 1977). Currently, canopy base heights in the project area average approximately 15 feet. The desired condition is to have average stand canopy base height above 18 feet. It takes only one tree with a low crown base height to initiate a crown fire in a stand.

Even without crown fire, a high intensity surface fire (62 percent of the project area) burning though this area could scorch the canopy sufficiently to cause widespread mortality (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). When crown fire does occur, it should be mostly passive crown fire, occurring in single trees, groups, or clumps, or areas where there had been mortality (wind throw, insects, etc.) Fire would 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 wildfire and prescribed 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 and the potential for high intensity surface fire (in the more productive forested areas where canopy bulk density will be greater). Table 10 summarizes existing and desired conditions for fire risk.

Table 10. Existing and desired fire potential in 4FRI ponderosa pine project area

Evaluation Criteria	Existing Condition	Desired Conditions
Potential crown fire (%)	34	Up to 10
Canopy Base Height (ft)	15	>18
Canopy Bulk Density (kg/m3)	0.028 to 0.35	<0.05
Potential surface fire (%)	62	Up to 90

Fire Regime Condition Class

Fire Regime/Condition Class (FRCC) is a coarse-scale evaluation protocol that was developed to support planning and risk assessments (Schmidt et al. 2002; Hann et al. 2004). FRCC assessments determine how departed a landscape's fire regime is from its historic fire regime. Across the entire analysis area, 59 percent is currently rated as in condition class 3. This indicates the fire regime is significantly departed from historical ranges (Table 11). In a condition class 3, the risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by multiple return intervals resulting in dramatic alterations to fire size, intensity, severity, landscape patterns, and/or vegetation attributes. The desired condition is to have 99 percent of the project area in FRCC 1. The remaining 1percent of the area is represented by parking areas, administrative sites, road rights-of-ways and other features which can be in FRCC 3. In FRCC 1, fire regimes would be within historical ranges, and the risk of losing key ecosystem components would be low. Vegetation, fuels, and natural disturbances would be intact and functioning within historical ranges. There is a need to reduce the percent of area in FRCC 3 and move the fire regimes towards FRCC 1.

Table 11. Existing and desired fire regime/condition class

Fire Regime Condition Class (FRCC)	Existing Condition (% of total area)	Desired Condition (% of total area)
FRCC 1	14	99
FRCC 2	27	0
FRCC 3	59	1

Ecological Processes and Function

Springs and Seeps

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).

On the Coconino NF, reference conditions are largely unknown. However, springs are well represented throughout all the major watersheds on the forest. Spring function within the project area has been adversely affected 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 downward trends or static-degraded conditions (MacDonald 2011). Excessive disturbance can also result in these features becoming non-functional (USDA 2009). Forty-seven (47) developed springs on the Coconino NF are functioning below potential. On the Kaibab NF, 27 springs have reduced function (USDA 2008).

Figure 1 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 impaired function is displayed by 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.

Figure 1. Degraded Babbitt Spring on the Coconino NF

Figure 2 displays Hoxworth Spring that is located approximately 3 miles upstream from Babbitt Spring in a restored condition. This figure provides an example of successfully meeting restoration desired conditions. Vegetative composition and springs outflow has improved. Bank headcutting in the spring's outflow has been addressed and tree encroachment that affected spring function has been removed. The purpose of Figure 3 is to display protective measures (fencing) that have been successfully used in the past to attain restoration desired conditions.

Figure 2. Restored Hoxworth Spring (Coconino NF)

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 1986, USDA 1987, USDA 2008, USDA 2009). 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 3. Hoxworth Spring Restoration with Protective Fencing (Coconino NF)

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 can be categorized being 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

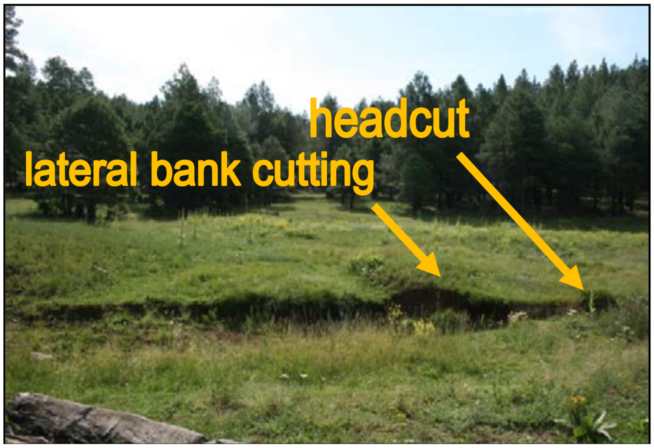

Figure 4. Degraded Ephemeral/Riparian Stream in the Hoxswoth Spring Drainage (Coconino NF)

7 miles of degraded non-riparian streams. Figure 4 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 1986, USDA 1987, USDA 2008, USDA 2009). On some streams, there is a need to maintain and promote existing vegetation. On others, there is a need to reduce tree encroachment, the presence of 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 5. Restored Hoxworth Spring Drainage Immediately Post Treatment (Photo on Left) and 1-Year Post-Treatment (Photo on the Right)

The left-hand side of shows the channel immediately after re-contouring. The purpose of Figure 5 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 forest-wide transportation analyses). The TMR process identified a need to decommission approximately 770 miles[3] 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. Road decommissioning includes applying various treatments, including 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 culverts, reestablished drainages, 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 5) other methods designed to meet the specific condition associated with the unneeded roads.

[3] The original proposed action that was scoped in March of 2011 had a total of 941 miles of road needed for decommissioning on the Coconino and 170 miles of decommissioning on the Kaibab. These mileages were changed to 770 miles needed on the Coconino and 134 miles on the Kaibab. See the transportation specialist report for rationale for the change.

The desired condition is to restore road prisms to their natural condition (USDA 1986, USDA 1987). 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 2,820 miles of road would be needed to implement the project. Of this total, approximately 2,297 miles are existing, open roads. However, portions of these existing roads have resource concerns, which require maintenance 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. Road improvement is any activity that results in an increase of an existing road's traffic service level, expansion of its capacity, or a change in its original design function. Activities include, but are not limited to, reconstruction of bridges and major culverts, placing bar ditches, subgrade repairs, shoulder widening, lane widening, ditch widening, roadway prism widening, horizontal and vertical alignment changes, curve widening, and improving site distance at road intersections. Vegetation will likely be removed with these activities. This is estimated at 30 miles across the landscape and will occur in very small, discrete areas (.1-.5 miles at a stretch). This will occur primarily with widening curves, adding turnouts to improve safety, and rarely, changing road alignment to reduce slope.

Road relocation includes activities that moves all or parts of the horizontal and vertical alignment of a road to a new location and decommissioning the old alignment. Generally realignments are for the purpose of moving the road location to more suitable areas to mitigate impacts to streams, critical habitat, and other natural or cultural resources. This activity includes creating a new road alignment in an upland position, installing the proper drainage features, signage, and surfacing on the new road alignment and the decommissioning of the old road alignment. The new road alignment will require the removal of vegetation at the new alignment site. This is estimated at 10 miles across the landscape. For additional information, see the transportation inventory in the project record.

There is a need to have adequate access to the project area for implementation. Adequate access includes utilizing existing roads that have no resource or health and human safety concerns and temporarily creating roads that can be returned to their natural state at the completion of project activities. Road maintenance techniques include , but not limited to, road blading, draining maintenance, culvert installation, culvert replacement, spot surfacing and resurfacing, removal of slides and slumps, removal of danger trees, removal of road side vegetation for improved site distance on the roads, dust abatement, and removal of overhanging vegetation to allow for access and installation of signs.. Maintenance 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 or D), 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, and (6) whether the forest plans will be amended as proposed.

Relationship to the Forest Plans

The Coconino NF and Kaibab NF Land and Resource Management Plans (hereafter referred to as "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. Desired conditions also reflect the use of the best available science that is being used to inform forest plan revision. The analysis tiers to each forest's Final Environmental Impact Statement (USDA 1987) (USDA 1988), as encouraged by 40 CFR 1502.20.

Management Direction

The project area includes 23 management areas (MA) as described in the Coconino NF forest plan (pp. 46 to 206-113). The MAs located within the project area, forest plan MA emphasis, and the relationship between MA total acreage to the project is displayed in Table 12. Because the Flagstaff/Lake Mary Ecosystem Analysis Area (FLEA) MA incorporates 10 MAs, the location-specific direction in the various MAs was utilized (per forest plan direction).

On the Kaibab NF, the project area includes five geographic areas (GAs) and one land use zone (LUZ). Approximately 183,729 acres of GA 2 (Williams forestland) and 41,012 acres of GA 10, (Tusayan forestland) is proposed for treatment in the project area. About 8,353 acres of treatment are proposed within GA 1 (Western Williams Woodland), 3 (North Williams Woodland), and GA 8 (Tusayan Woodland). Treatments are proposed within about 1,049 acres of LUZ 21, existing developed recreation sites. Table 12 displays the acreage associated with the predominant MAs and GAs in the project area where the majority of restoration actions are proposed.

For additional information, see chapter 4 of the forest plans (Coconino NF forest plan, pp. 21 to 206-118), Kaibab NF forest plan (pp. 16 to 114) where detailed descriptions of forest-wide resource direction specific to the management or geographic areas can be found.

Table 12. Predominant forest plan management areas (MA) and geographic areas (GA) within the project area

Forest Plan Management Areas (MA) and Geographic Areas (GA) within the project area*	Description	Forest Plan Emphasis	Forest-wide MA and GA acres	MA and GA acres within project area	Acres/Percent (%) of forest-wide 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	190,763/37
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	37,801/60
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	14,023/35
MA 36	Schultz	Reduce wildfire risk, maintain watershed health and water quality	21,289	21,130	7,069/33
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
MA 4	Ponderosa pine and MC above 40%	Wildlife habitat, watershed condition, and dispersed recreation	46,382	11,793	8,107/18
MA 32	Deadman Wash	Grasslands, un-roaded landscape,	58,133	11,659	11,380/20

Forest Plan Management Areas (MA) and Geographic Areas (GA) within the project area*	**Description**	**Forest Plan Emphasis**	**Forest-wide MA and GA acres**	**MA and GA acres within project area**	**Acres/Percent (%) of forest-wide MA/GA proposed for treatment**
		grazing, hunting			
MA 31	Craters	Restore natural grasslands, re-establish or maintain fire in pinyon-juniper woodland	29,940	8,969	8,969/15
MA 10	Transition Grassland/Sparse PJ above Mogollon Rim	Range management, watershed condition, and wildlife habitat	160,494	8,544	8,012/5
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	273,815	3,206	3,203/1
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 stand-replacing wildfire, recreation, scenic quality	1,781	1,675	1,460/82
MA 18	Elden Environmental Study Area	Visual resource management, watershed condition, manage for low fire potential with fire re-established	1,577	1,611	337/21
MA 12	Riparian and Open Water	Wildlife habitat, visual quality, fish habitat, watershed condition on the wetlands, riparian forest, and riparian scrub, dispersed	20,490	653	609/3

Forest Plan Management Areas (MA) and Geographic Areas (GA) within the project area*	Description	Forest Plan Emphasis	Forest-wide MA and GA acres	MA and GA acres within project area	Acres/Percent (%) of forest-wide MA/GA proposed for treatment
		recreation on the open water portions			
MA 7	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
		Kaibab National Forest			
GA 2	Williams Forestland	Suitable timberland, recreation, grazing, wildlife habitat	308,394	299,842	181,371/59
GA 10	Tusayan Forestland	Wildlife habitat, recreation, grazing	86,250	43,559	41,012/48
GA 1	Western Williams Woodland	Wildlife habitat, sandstone products, scenic routes and features, grazing, wild burro territory	169,041	4,807	3,360/2
GA 3	Northern Williams Woodland	Winter wildlife habitat, scenic routes and features, grazing	65,533	3,485	3,475/5
GA 8	Tusayan Woodland	Wildlife habitat, scenic routes and features, grasslands, grazing	195,118	1,518	1,518/1
LUZ 21	Existing Developed Recreation Sites	Existing public and private sector Developed recreation sites and other smaller sites (trailheads, interpretive sites, etc.)	1,556	1,049	1,049/67

*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 management area 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 addressed through the various MAs that make up FLEA.

Alternatives

The Forest Service developed four alternatives, including the no action (alternative A), the final proposed action (alternative B) and two additional alternatives (alternative C and D) that respond to recommendations and issues raised by the public.

Alternative A – No Action

As required by 40 CFR 1502.14(c) the no action alternative (alternative A) has been analyzed to contrast the impacts of the action alternatives with the current condition and expected future condition if the proposed action were not implemented. Approximately 82,592 acres of 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).

This alternative proposes no restoration treatments including those for vegetation, prescribed fire, springs, seeps, ephemeral channels, and road decommissioning in the project area. Alternative A would not increase forest resiliency to natural disturbances and would not improve function. It does not meet the purpose and need for the project as it would not move the project area towards forest plan vegetation (forest structure, forest health, composition, and diversity), fire behavior (percent of the landscape with the potential for uncharacteristic fire behavior and effects), soils (soil function/productivity and understory species), and watershed (riparian ecosystem and channel function) desired conditions.

Alternative B – Proposed Action

The Coconino and Kaibab NFs propose to conduct approximately 587,923 acres of restoration activities over approximately 10 years or until objectives are met. Up to 45,000 acres of vegetation would be mechanically treated annually. Up to 40,000 acres of prescribed fire would be implemented annually across the forests. Two prescribed fires[4] 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 388,489 acres. This includes: (1) mechanically treating up to 16-inch dbh within 18 Mexican spotted owl protected activity centers, (2) cutting 99 acres of trees by hand on slopes greater than 40 percent, and, (3) using low-severity prescribed fire within 72 MSO PACs (excluding core areas)
- Utilize prescribed fire-only on approximately 199,435 acres
- Construct 517 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

[4] The first prescribed fire may include pile burning followed by a broadcast burn.

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 770 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 as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF and 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF

Three non-significant forest plan amendments (see appendix C) would be required on the Coconino NF to implement the proposed action:

- Amendment 1 would allow the use of mechanical treatments to improve habitat structure and allow for mechanical treatment up to 16-inch dbh within 18 MSO PACs to improve nesting and roosting habitat. All Mexican spotted owl monitoring would defer to the project's Biological Opinion issued by US Fish and Wildlife Service.
- Amendment 2 would : 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 29,017 acres to be managed for an open reference condition, which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 3 would allow for managing to achieve a "No Adverse Effect" determination for significant, or potentially significant, inventoried heritage sites.

Two non-significant forest plan amendment (see appendix C) would be required on the Kaibab NF to implement the proposed action.

- Amendment 1 would 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 27,637 acres to be managed for an open reference condition, which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 2 would defer all Mexican spotted owl monitoring to the project's Biological Opinion issued by US Fish and Wildlife Service.

Alternative C (Preferred Alternative)

Alternative C 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 RNA on the Kaibab NF. It proposes mechanically treating up to 18-inch dbh in 18 MSO PACs and includes low-severity prescribed fire within 72 MSO PACs, including 56 core areas. It includes an implementation plan and a monitoring and adaptive management plan.

The Coconino and Kaibab NFs would conduct restoration activities on approximately 593,211 acres over a period of 10 years or until objectives are met. Up to 45,000 acres of vegetation would be mechanically treated annually. Up to 40,000 acres of prescribed fire would be implemented annually across the forests. Two prescribed fires[5] would be conducted on all acres proposed for treatment over the 10-year period. Restoration activities would:

- Mechanically cut trees on approximately 434,001 acres. This includes: (1) mechanically treating up to 18-inch dbh within 18 Mexican spotted owl protected activity centers, (2) cutting trees by hand on 99 acres on slopes greater than 40 percent, and, (3) using low-severity prescribed fire within 72 Mexican spotted owl protected activity areas (including 56 core areas).
- Utilize prescribed fire-only on approximately 159,211 acres
- Construct 517 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 770 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 15 weirs and 20 weather stations (up to 3 total acres of disturbance) to support watershed research
- Allocate as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF and 35 percent of ponderosa pine and 58 percent of pinyon-juniper woodland on the Kaibab NF

Three non-significant forest plan amendments (see appendix C) would be required on the Coconino NF to implement alternative C:

- Amendment 1 would: (1) allow the use mechanical treatments to improve habitat structure and mechanically treat up to 18-inch dbh within 18 MSO PACs, (2) allow the use of low-intensity prescribed fire within 56 PAC core areas, and (4) allow for managing 8,410 acres of restricted target and threshold habitat for a minimum range of 110 to 150 basal area, and, (5) would defer all Mexican spotted owl monitoring to the project's Biological Opinion issued by the US Fish and Wildife Service.
- Amendment 2 would: 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 29,017 acres to be managed for an open reference condition, which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.

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[5] The first prescribed fire may include pile burning followed by a broadcast burn.

- Amendment 3 would allow for managing to achieve a “No Adverse Effect” determination for significant, or potentially significant, inventoried heritage sites.

Three non-significant forest plan amendments (see appendix C) would be required on the Kaibab NF to implement alternative C:

- Amendment 1 would: 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 27,675 acres to be managed for an open reference condition, which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 2 would allow for mechanically treating and prescribe burning approximately 400 acres in the proposed Garland Prairie RNA.
- Amendment 3 would defer all Mexican spotted owl monitoring to the project’s Biological Opinion issued by US Fish and Wildlife Service.

Alternative D

Alternative D responds to issue 2 (prescribed fire emissions) by decreasing the acres that would receive prescribed fire. All other components of the alternative are the same as described in alternative B (see pages 54 to 64).

The Coconino and Kaibab NFs would conduct restoration activities on approximately 567,279 acres over a period of 10 years or until objectives are met. Up to 45,000 acres of vegetation would be mechanically treated annually. Restoration activities would:

- Mechanically cut trees on approximately 388,489 acres. This includes: (1) mechanically treating up to 16-inch dbh within 18 Mexican spotted owl protected activity centers, (2) cutting 99 acres of trees by hand on slopes greater than 40 percent, and, (3) disposing of slash through various methods including chipping, shredding, mastication and removal of biomass off-site
- Utilize prescribed fire-only on approximately 178,790 acres. Up to 40,000 acres of prescribed fire would be implemented annually across the forests. Two prescribed fires would occur over the 10-year treatment period.
- Construct 517 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 770 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 as old growth 40 percent of ponderosa pine and 77 percent of pinyon-juniper woodland on the Coconino NF, and 35 percent of ponderosa pine and 58 percent of pinyon-juniper on the Kaibab NF

Three non-significant forest plan amendments (see Appendix C,) would be required on the Coconino NF to implement alternative D:

- Amendment 1 would: (1) allow the use of mechanical treatments to improve habitat structure, (2) allow for mechanical treatment up to 16-inch dbh within 18 MSO PACs to improve nesting and roosting habitat, and, .(5) would defer all Mexican spotted owl monitoring to the project's Biological Opinion issued by the US Fish and Wildlife Service.
- Amendment 2 would: 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 29,017 acres to be managed for an open reference condition, which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 3 would allow for managing to achieve a "No Adverse Effect" determination for significant, or potentially significant, inventoried heritage sites.

Two non-significant forest plan amendments (see appendix C) would be required on the Kaibab NF to implement the proposed action:

- Amendment 1 would: 1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration and defines interspace, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allows 27,637 acres to be managed for an open reference condition, which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees, and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.
- Amendment 2 would defer all Mexican spotted owl monitoring to the project's Biological Opinion issued by the US Fish and Wildlife Service.

Alternatives B-D are compared in Table 13.

Table 13. Comparison of Alternatives

Proposed Activity	Alternative A (No Action)	Alternative B (Proposed Action)	Alternative C	Alternative D
Vegetation Mechanical Treatment (acres)	0	388,489	434,001	388,489
Prescribed Fire (acres)*	0	587,923	593,211	178,790
Mexican spotted owl (MSO) protected activity centers (PACs) Habitat Treatments	N/A	Mechanically treat up to 16-inch dbh in 18 PACs (excluding core areas) Utilize prescribed fire in 72 MSO PACs (excluding core areas)	Mechanically treat up to 18-inch dbh in 18 PACs Utilize prescribed fire in 56 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 72 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 (miles)	0	517	Same as Alternative B	
Road Reconstruction-Improvement (miles)	N/A	Up to 30	Same as Alternative B	

Proposed Activity	Alternative A (No Action)	Alternative B (Proposed Action)	Alternative C	Alternative D
Road Relocation (miles)	N/A	Up to 10	Same as Alternative B	
Existing Road Decommission (miles)	N/A	770	Same as Alternative B	
Unauthorized Route Decommission (miles)	N/A	134	Same as Alternative B	

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 14, the Effectiveness column is included to give the reader an idea of how well these mitigation measures work from past experiences and/or research. The numbers correspond to the following results:

1. Almost always reduces impacts significantly. Almost always done in this situation.
2. Usually reduces significant impacts. Often done in this situation.
3. Effectiveness monitoring will be conducted during project implementation & other appropriate times.

BMP's referenced within the mitigation text are BMP's outlined in the Region 3 USFS Soil and Conservation Handbook ((R3) FSH 2509.22.

Table 14: 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	To minimize the spread of non-native species

BMP #	Mitigation	Why
	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 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	To protect surface and subsurface

BMP #	Mitigation	Why
	approved camp and suitable sanitation facilities must be provided.	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 #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	To minimize sediment and/or ash delivery into drainages and maintain water quality.

BMP #	Mitigation	Why
	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.	
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 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.	To minimize soil erosion and minimize noxious weed spread and mitigate severe erosion hazard.
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 #	Mitigation	Why
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 #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	On areas that have had roads previously obliterated	To add surface roughness a To

BMP #	Mitigation	Why
#20	and the remaining roadbed will be removed, add slash/or erosion mat and seed to the disturbed areas.	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 #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	To maintain long-term soil productivity on slopes with severe erosion hazard potential

BMP #	Mitigation	Why
	harvesting can occur up to 40% slopes.	
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	Filtering sediment and/or providing bank stability on all streamcourses

BMP #	Mitigation	Why
	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. 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.	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 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)	To minimize and mitigate impacts from activities that compact sites and to restore long-term soil productivity and to minimize impacts on .severe

BMP #	Mitigation	Why
	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	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.

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.

Affected Environment

Restoration Units and Subunits

1-1: Appendix 1 page 1 shows streamcourses and water bodies found within Restoration Unit 1, Subunit 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: Appendix 1 page 2 shows streamcourses and water bodies located within Restoration Unit 1, Subunit 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: Appendix 1 page 3 shows streamcourses and water bodies located within Restoration Unit 1, Subunit 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: Appendix 1, page 4 shows streamcourses and water bodies located within Restoration Unit 1, Subunit 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: Appendix 1, page 5 shows streamcourses and water bodies located within Restoration Unit 1, Subunit 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. Non-native sport fish in this artificial lake include northern pike, yellow perch, and fathead minnow. Flood events apparently wash fish from this lake downstream into the perennial portions of Munds Canyon (M. Childs, USFS, pers. obs., 2010), which otherwise would likely support one or several native fish species. Macroinvertebrates are present in the perennial stream, and in Odell Lake.

3-1: Appendix 1, page 6 shows streamcourses and water bodies located within Restoration Unit 3, Subunit 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: Appendix 1, page 7 shows streamcourses and water bodies located within Restoration Unit 3, Subunit 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: Appendix 1, page 8 shows streamcourses and water bodies located within Restoration Unit 3, Subunit 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.

Sportfish 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: Appendix 1, page 9 shows streamcourses and water bodies located within Restoration Unit 3, Subunit 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: Appendix 1, page 10 shows streamcourses and water bodies located within Restoration Unit 3, Subunit 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[6]), 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 15; C. Benedict, pers. comm.).

Table 15. Summary of past AGFD survey data (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

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

Species*	Total Captured
Common carp	1
Rock bass	13
Flathead catfish	1
Rainbow trout	239
Bullhead catfish	37

*Note that roundtail chub were not captured in Oak Creek in any AGFD surveys between 1991 and 2007.

In 2007, (Rinker et al 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 were present historically.

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

4-2: Appendix 1, page 11 shows streamcourses and water bodies located within Restoration Unit 4, Subunit 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: Appendix 1, page 12 shows streamcourses and water bodies located within Restoration Unit 4, Subunit 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: Appendix 1, page 13 shows streamcourses and water bodies located within Restoration Unit 4, Subunit 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: Appendix 1, page 14 shows streamcourses and water bodies located within Restoration Unit 4, Subunit 5. This treatment subunit includes portions of two 6^{th} 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.

Macroinvertebrate populations occur within Frances Short Pond and within the ephemeral portions of Rio de Flag when the streamcourse is flowing.

5-1: Appendix 1, page 15 shows streamcourses and water bodies located within Restoration Unit 5, Subunit 1. This treatment subunit includes portions of eight 6^{th} 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: Appendix 1, page 16 shows streamcourses and water bodies located within Restoration Unit 5, Subunit 2. This treatment subunit includes portions of seven 6^{th} 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: Appendix 1, page 17 shows streamcourses and water bodies located within Restoration Unit 6, Subunit 2. This treatment subunit includes portions of three 6^{th} 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: Appendix 1, page 18 shows streamcourses and water bodies located within Restoration Unit 6, Subunit 3. This treatment subunit includes portions of two 6^{th} 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: Appendix 1, page 19 shows streamcourses and water bodies located within Restoration Unit 6, Subunit 4. This treatment subunit includes portions of the Upper Lee Canyon 6th 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 four Forest Sensitive fish and/or their habitat were considered in this analysis because of their potential occurence within the project Analysis Area (Table 16). Two Forest Sensitive macroinvertebrates also occur within the Analysis Area. Finally, macroinvertebrates (Forest-wide Management Indicator Species) occur in perennial waters within the Analysis Area.

Table 16. 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
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
Roundtail chub	*Gila robusta*	C, WC, FS-S	O, **Δ**	350.9	77.9	77.9
Longfin dace	*Agosia chrysogaster*	WC, FS-S	O, **Δ**	236.7	77.9	77.9
Desert sucker	*Catostomus clarki*	WC, FS-S	O, **Δ**	236.7	77.9	77.9
Sonora sucker	*Catostomus insignis*	WC, FS-S	O, **Δ**	236.7	77.9	77.9
Macroinvertebrates						
California floater	*Anodonta californiensis*	FS-S	H	368.6	77.9	0
A. mayfly	*Homoleptohyphes quercus*	FS-S	O	77.7	72.6	72.6

[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 National Forest was 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, and because this species will not be reintroduced into any waters in the analysis area in the foreseeable future.

Spikedace

Spikedace (*Meda fulgida*) is historic to the Verde River. However the species has not been detected for years in this system, and may be extirpated. Spikedace now occur 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.

Spikedace was federally listed as threatened under the Endangered Species Act on July 1, 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 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.

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 16). Although unoccupied, this habitat will be analyzed for potential effects from the proposed alternatives.

Loach Minnow

Loach minnow (*Tiaroga cobitis*) is historic to the Verde River, and critical habitat for the 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.

The 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 (Marsh 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 (Marsh1991a). Most growth occurs during the first summer. Loach minnow use the spaces between and in the lee of larger substrates for resting and spawning (Marsh 1991a). The species is rare or absent from habitats where fine sediments fill the interstitial spaces (Propst and Bestgen 1991).

Historically, loach minnow were 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.

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 16). 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 and has been precluded from listing now due to higher priority actions to amend current species lists (USDI 2006; USDI 2009). The roundtail chub was included on the Regional Foresters' (USDA Forest Service – Southwestern Region) 1-October, 2007 sensitive species list.

Roundtail chub are moderately streamlined members 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 16), 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

Longfin Dace

The longfin dace (*Agosia chrysogaster*) is a small, silvery minnow (Family: Cyprinidae) that seldom exceeds 100 mm in length. Its mouth is slightly subterminal, and there is a minute barbel present on each side of the upper lip. Coloration is usually dark gray above and white below. Sides are sometimes silvery, or with a dark lateral band terminating in a black spot at the base of the caudal fin. Breeding males develop nuptial tubercles on the head and fins, and may have some yellowing of lower parts and bases of paired fins.

Longfin dace ranges from low, hot, sandy-bottomed desert streams to clear, cooler brooks in the lower reaches of the conifer zones. It is rarely abundant in larger streams, or at elevations above 5,000 feet (AGFD 2006). This report will analyze effects to longfin dace and its habitat, as it is present in Oak Creek and Sycamore Creek.

It is usually found in waters less than 0.6 feet deep, with moderate velocities (1.1 feet/second) over pebble/gravel/sand substrate. Water flow is typically smooth and laminar. It has a tendency to remain in open, shallow areas throughout much of the day.

The fish is highly opportunistic, moving rapidly into flowing water during periods of high precipitation and runoff to travel amazing distances in relatively short periods. During desiccating conditions, longfin dace persist beneath moist debris and algal mats throughout the day, then become active at night when meager flow returns. Adults tend to congregate in shaded, deep areas when water temperatures exceed 75°F. Thermal mortalities of longfin dace have rarely been observed.

Longfin dace is an opportunistic omnivore, consuming primarily insects when the preferred taxon (baetid mayflies) is abundant, but consuming primarily algae when mayfly abundance is low. Other foods include detritus and zooplankton.

Most individuals become sexually mature within the first year. Spawning occurs from December through July, and perhaps to September (AGFD 2006). Saucer-shaped depressions in sandy bottom streams are used as nests, and are located along shorelines and on sandbars at depths of less than 0.6 feet. Nests sometimes are concentrated, with as many as 20 per square yard. Incubation requires about 4 days at temperatures higher than 75° F (AGFD 2006). The life span is rarely longer than three years.

Habitat in the Analysis Area

There are 236.7 miles of potential longfin dace habitat within the Coconino Forest boundary. Within the analysis area, the species occupies 77.9 miles (32.9%) of perennial stream (Table 16), 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.

Desert Sucker

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

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

Desert sucker is found in rapids and flowing pools of streams, primarily over bottoms of gravel-rubble with sandy silt in the interstices (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. The desert sucker is highly adaptive to a wide range of temperatures, tolerating water temperatures as high as 90°F. It may be able to tolerate lower oxygen levels than other native stream fishes.

Chironomid larvae (midges) are the primary food of juveniles (AGFD 2002a). As an adult, the desert sucker is primarily herbivorous, scraping filamentous algae from stones as well as ingesting plant detritus, aquatic insect larvae, and other invertebrates. Individuals often turn completely upside-down as they glean food off surfaces of stones.

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

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 16), 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 16), 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

The 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 16), 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. Mayfly

This species (*Homoleptohyphes quercus*) is poorly known and reported from only two counties (Coconino and Pinal) in Arizona (AGFD 2004a). The validity of the species is somewhat in doubt, and if current revisions being conducted on North American leptohyphids prove the species to be valid, they may also yield better information regarding its abundance and distribution. Although the current global ranking of this species is preliminary at this time, some attention to its habitat might be appropriate, especially in Oak Creek in Coconino County, Arizona, where another potentially imperiled species, *Baetodes arizonensis*, also occurs. Microhabitat is not reported, but the species is apparently restricted to certain isolated montane creeks in Arizona. This report will analyze effects to A. mayfly and its habitat, as it is present in Oak Creek, which is downstream of the project area.

Habitat in the Analysis Area

There are 77.7 miles of potential A. mayfly habitat within the Coconino Forest boundary. Within the analysis area, the species occupies 72.6 miles (93.4%) of perennial stream (Table 16), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, and West Fork of Oak Creek. This habitat will be analyzed for potential effects from the proposed alternatives.

Management Indicator Species

Macroinvertebrates

As a group, aquatic macroinvertebrates are identified in both the Coconino and the Kaibab National Forest Land and Resource Management Plans (as amended) as management indicator species for high and low elevation late-seral riparian areas. The project area for the Four Forest Restoration Initiative does not include any perennial streams on the Kaibab National Forest. Thus, there are no established populations of aquatic macroinvertebrates within the project area on the Kaibab. Therefore, all references to aquatic macroinvertebrates in this report will be concerned with macroinvertebrates and their habitat that occur on the Coconino National Forest.

The Monitoring Plan for the Coconino Forest Land and Resource Management Plan specifies monitoring with a systematic field sampling method (using a modified surber sampler) for aquatic macroinvertebrate species diversity and biomass on selected streams. The riparian ecosystems targeted for monitoring are those associated with lotic or flowing water conditions.

Aquatic macroinvertebrates are organisms that lack a backbone, are visible by the naked eye, and which require a watered environment to persist and/or complete their life cycle (Voshell 2002). Monitoring macroinvertebrates provides a method for assessing the health of aquatic systems. There are multiple approaches to using macroinvertebrates as indicators of stream health. One approach to characterizing benthic aquatic insects has been to group species according to trophic level or functional feeding groups; that is, shedders, collectors, scrapers, and predators (Cummins 1973). “Increases in the riparian canopy opening or the amount of organic material in the streams generally enhance aquatic insect populations. An increase in fine sediment usually has the opposite effect” (Gregory et al., 1987). Changes in the relative abundance of different functional feeding groups can indicate habitat change. For example, an increase in the number of scrapers as compared to shredders suggests an increase in the production of attached algae due to a reduction in the riparian canopy or an increase in stream width. Another approach is to look at the richness of taxa, usually examining the macroinvertebrate assemblage by order (Ephemeroptera, Trichoptera, Diptera, Plecoptera, etc.); use of total richness as an index provides information as richness of taxa generally declines following disturbances. An additional approach looks at the composition of taxa; following a disturbance a sample may be dominated by a single taxa, and decreases in abundance of certain taxa (Ephemeroptera or Plecoptera) is often a signal of past disturbance to the watershed. Finally, there are tolerance indices such as the commonly used Hilsenhoff Biotic Index that measures the amount of taxa that are tolerant to decreased water quality where on a scale of 1-10 a score of 10 indicates that the species present are pollution tolerant and usually is indicative of higher levels of pollutants in the system (Lawson 2005). Most monitoring indices incorporate many if not all of these different aspects into one combined metric or index.

The Coconino National Forest has collected macroinvertebrate data from several sources in the past, including USFS collections. However, the only source that has consistently collected macroinvertebrate data at the same locations over a time scale that allows for trend analysis is the Arizona Department of Environmental Quality (ADEQ).

ADEQ prepares a biennial Arizona Water Quality Assessment (ADEQ 2005). This report fulfills requirements under the federal Clean Water Act of 1987, section 305(b). In fulfilling these requirements, the 305(b) report includes such elements as water quality condition, water pollutants, and designated uses. The information provided in the report is based on accepted numeric and narrative standards, and assessment criteria. As part of a biocriteria evaluation, ADEQ uses a macroinvertebrate-based bioassessment to evaluate the health of aquatic communities. These bioassessments are generally used as supporting evidence of impairment or good water quality.

The macroinvertebrate-based bioassessment uses an index developed for the macroinvertebrate communities in Arizona. The index is known as the Index of Biological Integrity (IBI). This index was developed following the Environmental Protection Agency's 1999 Rapid Bioassessment Protocols guidance document. Through this approach, a set of macroinvertebrate community characteristics (metrics) have been measured at least-impacted or best available reference sites. These reference metrics are combined into an index and can then be compared to measurements taken at other monitoring sites to assess whether the Aquatic and Wildlife (A&W) designated use is attained.

The warm water Index of Biological Integrity (IBI) is applicable for wadeable, perennial streams below 5000 feet elevation, using macroinvertebrates collected in riffles during spring (April-June). The coldwater IBI is for perennial streams above 5000 feet elevation.

The IBI's are calculated using the metrics described in Table 17.

Table 17. 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
	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

To calculate the IBI for a location the metric score is calculated by dividing the location score by a threshold value and multiplying that by 100, except for dominant taxa and HBI where the sample value and threshold values are first subtracted from ten. The final score is the sum of all the metric scores divided by the number of metric scores (ADEQ 2005).

Table 18 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 25^{th} percentile of reference condition, the site is attaining some designated uses for either warm water aquatic communities or coldwater aquatic communities. If the IBI is between the 10^{th} and 25^{th} percentile the sites are inconclusive, and below the 10^{th} percentile of reference, they are impaired for one or more designated uses.

Table 18. 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 Forest Trend Analysis

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 19), twelve coldwater (above 5000 ft), and twenty-seven warmwater (below 5000 ft).

Table 19. 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 20; Figures 1 and 2). 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 20. 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

Stream	Last Assessed	Equation*	r^{2**}	F-value	P-value
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 Campground	2008	y = 0.004x + 44.8	0.00003	0.0000	0.999
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 (Heino et al. 2004), and contributing upland condition and the associated runoff effects to water quality.

Forest-wide IBI trend appears static because none of the trend line slopes were significantly different than zero. Although eight sites have downward trend and four sites have upward trend (Table 20; Figures 1 and 2), these values are not significant (Table 20) and thus trend cannot be accurately assessed. Addition data in the future may provide significant trend lines, or continue to show a static trend in IBI scores on the Forest.

The cumulative effects boundary for this project includes several 5th code HUC watersheds that contain perennial water (Table 21). As this table shows, only about 23% of the perennial streams on the Forest are within the cumulative effects boundary. Thus, about 23% of potential macroinvertebrate habitat on the Coconino National Forest is within the Affected Environment boundary.

Table 21. Perennial water within the cumulative effects 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 (22.7%)**
Total Forest	**368.6**

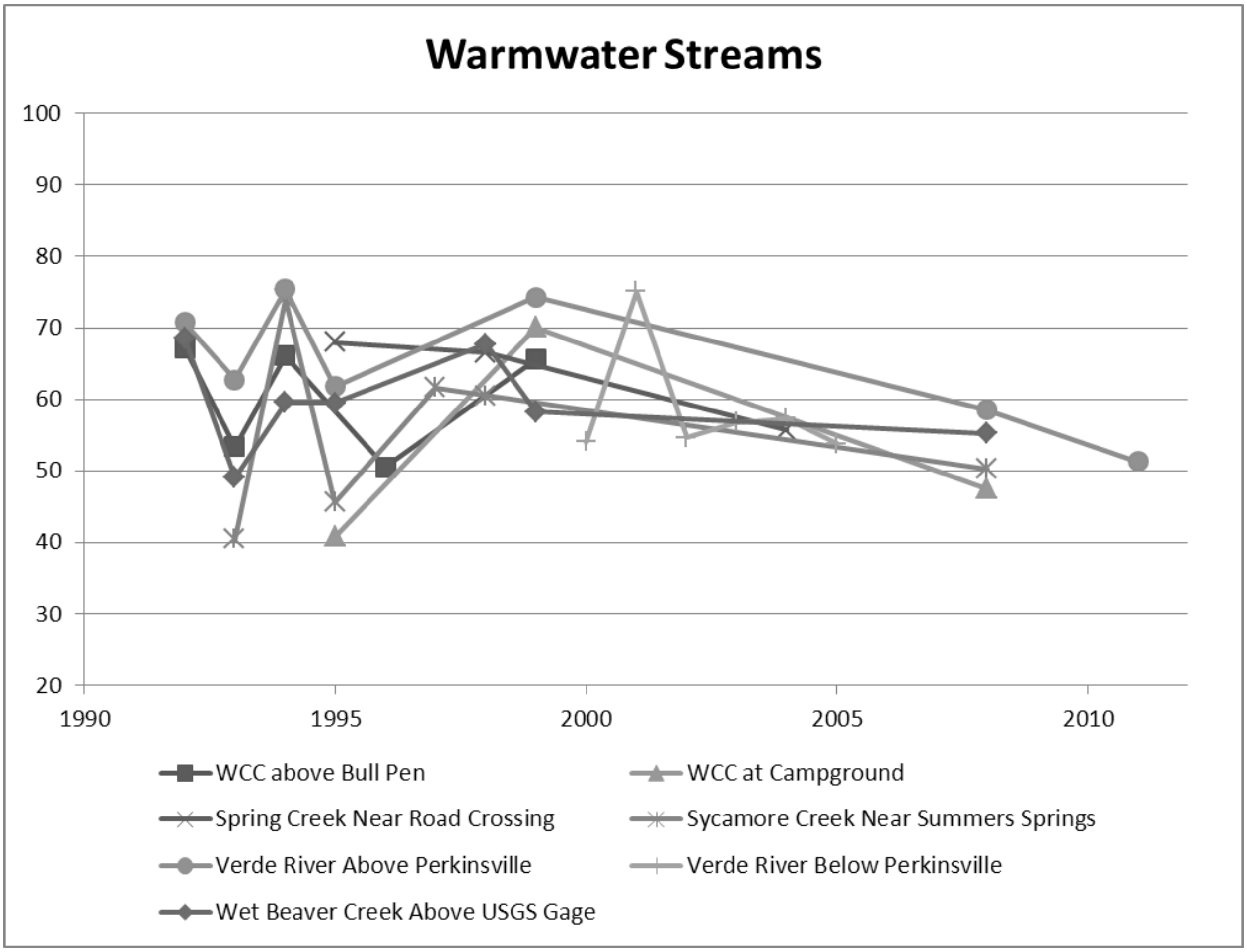


Figure 1. ADEQ macroinvertebrate data for warmwater reaches on the Coconino National Forest with at least three sample years.

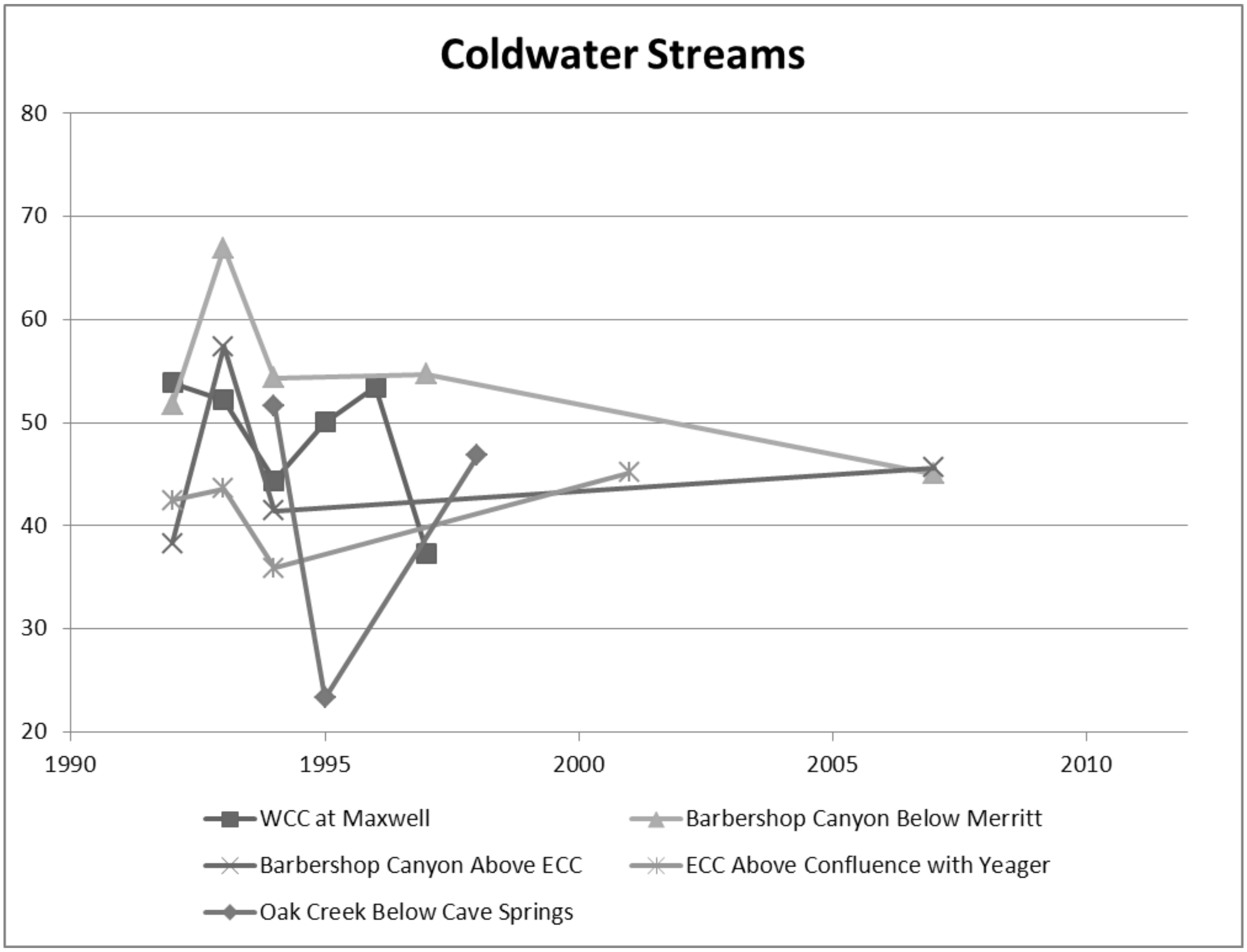


Figure 2. ADEQ macroinvertebrate data for coldwater reaches on the Coconino National Forest with at least three sample years.

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:

- <u>Changes in sediment and erosion</u>
- <u>Alterations to channel morphology</u> - increased sediment has the potential to alter stream channel morphology.
- <u>Changes to stream temperatures</u> - 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.
- <u>Effects on riparian vegetation</u> - loss of upland watershed vegetation can lead to flashier hydrographs which erode stream channels, lowering the water table impacting riparian vegetation.

- <u>Macroinvertebrate assemblage</u> **-** alteration in channel morphology or increases in sediment can alter the macroinvertebrate assemblage.

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

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-D)

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 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 since they are left in drier soils. Additionally, with less water entering upslope and riparian soils less water is available 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.

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

Spring conditions would improve for up to74 springs within the analysis area (Table 22). 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 return to a more natural state, with 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 evapotranspirational losses of soil water that could otherwise recharge groundwater in perched or shallow aquifers (MacDonald 2012).

Table 22. 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

5^{th} HUC Name	Subunit	Spring Name
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
		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

5th HUC Name	Subunit	Spring Name
		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-D)

Thirty-nine miles of ephemeral streamcourses (Table 23) would be returned to a more natural condition, thus reducing 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 2012). As restored areas stabilize, these ephemeral streamcourses would return to a more natural state with banks having 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 23. 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

5th HUC Name	Streamcourse	Subunit	Miles
	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-D)

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 2012). 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 (Truebe and Evans 1994). 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 904 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 2012). 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 2012). 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 14, 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 517 miles of temporary roads would be necessary to conduct vegetation treatments. These roads would be constructed using BMPs as outlined in Table 14, 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-D)

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.

Cumulative Effects

Alt A

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 2,032,000 acres. 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). Because no actions are proposed, no direct cumulative effects are created.

Alt B

The geographic setting and boundary for the cumulative effects analysis will be all 81 6th HUC watersheds within or intersecting the project boundary for a total of about 2,032,000 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 **133,000** 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 **19,900** 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 **150,000** acres of future and foreseeable treatment acres 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 **22,400** 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 282,400 acres (133,000 past and present projects and 150,000 acres of future, foreseeable projects) or about 14% of the cumulative boundary area. Of these treatment acres, we are assuming that about 15% of these acres will have ground disturbance, or about 42,400 acres, or just under 2% of the cumulative effects analysis area. The 4FRI EIS will add an additional 61,000 acres of ground disturbance for a total acreage of ground disturbance across the cumulative effects analysis area of nearly 148,396 acres, or about **7%** of the cumulative effects boundary area (see table below).

As stated above in the baseline disturbance assessment, there are four 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 an 11% baseline ground disturbance prior to any activities. This percent of ground disturbance increases to 14% total cumulative ground disturbance. In the Sinclair Wash watershed, there was an 25% baseline ground disturbance prior to any activities. This percent of ground disturbance increases slightly to 26% total cumulative ground disturbance with all current and foreseeable projects. In the Lower Rio de Flag watershed there was an 18% baseline ground disturbance that increases to 20% total cumulative ground disturbance. In the Middle Oak Creek watershed, there was an 11% baseline ground disturbance that increases to 13% total cumulative ground disturbance.

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.

Table 24: 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	60,995	3.0%	45,041	149,561	22,434	132,837	19,926	148,396	7.3%

Executive Summary of Cumulative Effects

For past, present and reasonably foreseeable actions including the 4-FRI proposed action, the extent (about 7%) 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 will not provide a detrimental cumulative effect to soil resources within the Cumulative Effects boundary.

Alt C

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% 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

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 133,000 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 19,900 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1% 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. Fuels reduction related projects are expected to occur within the cumulative effects project boundary. For the cumulative effects boundary area, there are approximately 150,000 acres of future and foreseeable treatment acres (about 7% of the cumulative effects area). Assuming a 15% disturbance factor for treatments, there are a total of approximately 22,400 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 282,400 acres, or about 14% of the cumulative boundary area. Of these treatment acres, we are assuming that about 15% of these acres will have ground disturbance, or about 42,400 acres, or just under 2% of the cumulative effects analysis area are expected to have ground disturbance from past, present and future or foreseeable projects. The 4FRI EIS Alternative C would add an additional 66,358 acres of ground disturbance for a total acreage of ground disturbance across the cumulative effects analysis area of nearly 153,759 acres, or about 8% of the cumulative effects boundary area (see table below).

As stated above in the baseline disturbance assessment, there are four 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 an 11% baseline ground disturbance prior to any activities. This percent of ground disturbance increases to 14% total cumulative ground disturbance. In the Sinclair Wash watershed, there was a 25% baseline ground disturbance prior to any activities. This percent of ground disturbance increases slightly to 26% total cumulative ground disturbance with all current and foreseeable projects. In the Lower Rio de Flag watershed there was an 18% baseline ground disturbance that increases to 20% total cumulative ground disturbance. In the Middle Oak Creek watershed, there was an 11% baseline ground disturbance that increases to 13% total cumulative ground disturbance.

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.

Table 25: 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	66,358	3.3%	45,041	149,561	22,434	132,837	19,926	153,759	7.6%

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 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.

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% 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

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 133,000 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 19,900 acres of ground disturbance from projects within the cumulative effects boundary area, or about 1% 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. Fuels reduction related projects are expected to occur within the cumulative effects project boundary. For the cumulative effects boundary area, there are approximately 150,000 acres of future and foreseeable treatment acres 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 22,400 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 282,400 acres, or about 14% of the cumulative boundary area. Of these treatment acres, we are assuming that about 15% of these acres will have ground disturbance, or about 42,400 acres, or just under 2% of the cumulative effects analysis area are expected to have ground disturbance from past, present and future or foreseeable projects. The 4FRI EIS Alternative D would add roughly an additional 52,800 acres of ground disturbance across the cumulative effects analysis area, for a total acreage of disturbed ground of nearly 140,200 acres, or about 7% of the cumulative effects boundary area (see table below) or very slightly less than B and C.

As stated above in the baseline disturbance assessment, there are four 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 an 11% baseline ground disturbance prior to any activities. This percent of ground disturbance increases to 14% total cumulative ground disturbance. In the Sinclair Wash watershed, there was a 25% baseline ground disturbance prior to any activities. This percent of ground disturbance increases slightly to 26% total cumulative ground disturbance with all current and foreseeable projects. In the Lower Rio de Flag watershed there was an 18% baseline ground disturbance that increases to 20% total cumulative ground disturbance. In the Middle Oak Creek watershed, there was an 11% baseline ground disturbance that increases to 13% total cumulative ground disturbance.

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.

Table 26: 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	52,814	2.6%	45,041	149,561	22,434	132,837	19,926	140,214	6.9%

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 on 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.

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.

KNF Amendment 1

This proposed Plan amendment is specific to Northern goshawk habitat. It 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 this amendment would have “No Effect” on aquatic species or their habitat.

KNF Amendment 2

Amendment 2 defers all Mexican spotted owl monitoring to the project’s Biological Opinion issued by the U.S. Fish and Wildlife Service. This Opinion will be issued when the Four Forest Restoration Initiative FEIS is completed. Monitoring of spotted owls should have no measurable effect on aquatic species or their habitat. Therefore, it is my determination that Amendment 2 for the KNF will 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.

KNF Amendment 1
This proposed Plan amendment is specific to Northern goshawk habitat. It 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 this amendment would have “No Effect” on aquatic species or their habitat.

KNF Amendment 2
Amendment 2 would allow for mechanically treating and prescribe burning approximately 400 acres in the proposed Garland Prairie RNA. The Garland Prairie 6th HUC watershed does not contain any perennial water, and thus does not contain any aquatic species or habitat. Therefore, it is my determination that this amendment would have “No Effect” on aquatic species or their habitat.

KNF Amendment 3
Amendment 3 defers all Mexican spotted owl monitoring to the project’s Biological Opinion issued by the U.S. Fish and Wildlife Service. This Opinion will be issued when the Four Forest Restoration Initiative FEIS is completed. Monitoring of spotted owls should have no measurable effect on aquatic species or their habitat. Therefore, it is my determination that Amendment 2 for the KNF will 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.

Canopy bulk density and canopy base height are forest structure parameters used to measure the potential for crown fire. Currently, canopy bulk density in the ponderosa pine of the project area averages 0.63kg/m^3. Approximately 61 percent of the pine has a canopy bulk density rating that is greater than 0.05 kg/m^3. The desired condition is to have canopy bulk density below 0.05 kg/m^3 in ponderosa pine. The lower the canopy base height, the easier it is for crown fire to initiate (Van Wagner 1977). Currently, canopy base heights in the project area average approximately 15 feet. The desired condition is to have average stand canopy base height above 18 feet. It takes only one tree with a low crown base height to initiate a crown fire in a stand.

Fire Regime/Condition Class (FRCC) is a coarse-scale evaluation protocol that was developed to support planning and risk assessments (Schmidt et al. 2002; Hann et al. 2004). FRCC assessments determine how departed a landscape's fire regime is from its historic fire regime. Across the entire analysis area, 59 percent is currently rated as in fire condition class 3. This indicates the fire regime is significantly departed from historical ranges. In a condition class 3, the risk of losing key ecosystem components is high. The desired condition is to have 99 percent of the project area in FRCC 1. In FRCC 1, fire regimes would be within historical ranges, and the risk of losing key ecosystem components would be low.

Stand replacing fire from overgrown forests, and high intensity surface fires from unnaturally high surface fuel loads are some of the inevitable results of the current trajectory of most of the project area. Approximately 34 % of project area has crown fire potential and 62% has potential for high intensity surface fire that could scorch the canopy sufficiently to cause widespread mortality (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 (Weaver 1951; Cooper 1960; Fule et al. 2003; Heinlein et al.2005).

Current and predicted soil erosion (Steinke 2013) 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 24 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 2012) 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 27. Predicted soil erosion from 10-year storm event (Steinke 2013).

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
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 & Managed 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 770 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 1986; 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 (59% of the Forests are in FRCC 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.).

Alternatives B, C, and D

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 6).

As stated above, soil erosion risk was modeled for each alternative (Steinke 2013). Mechanical treatments generally do not have any appreciable impact on soil erosion (Table 24). However, a risk of erosion was identified for prescribed burning on slopes greater than 15% (Table 24) a. Approximately 2% of areas proposed for prescribed burning or managed fires could result in areas of high burn severity (Steinke 2013) 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 14 are designed to mitigate these risks.

Perennial streams included in this analysis (Figure 3) are further described by project units and subunits that may affect them (Figure 4). Potential effects to stream habitat are described in detail below for each perennial stream.

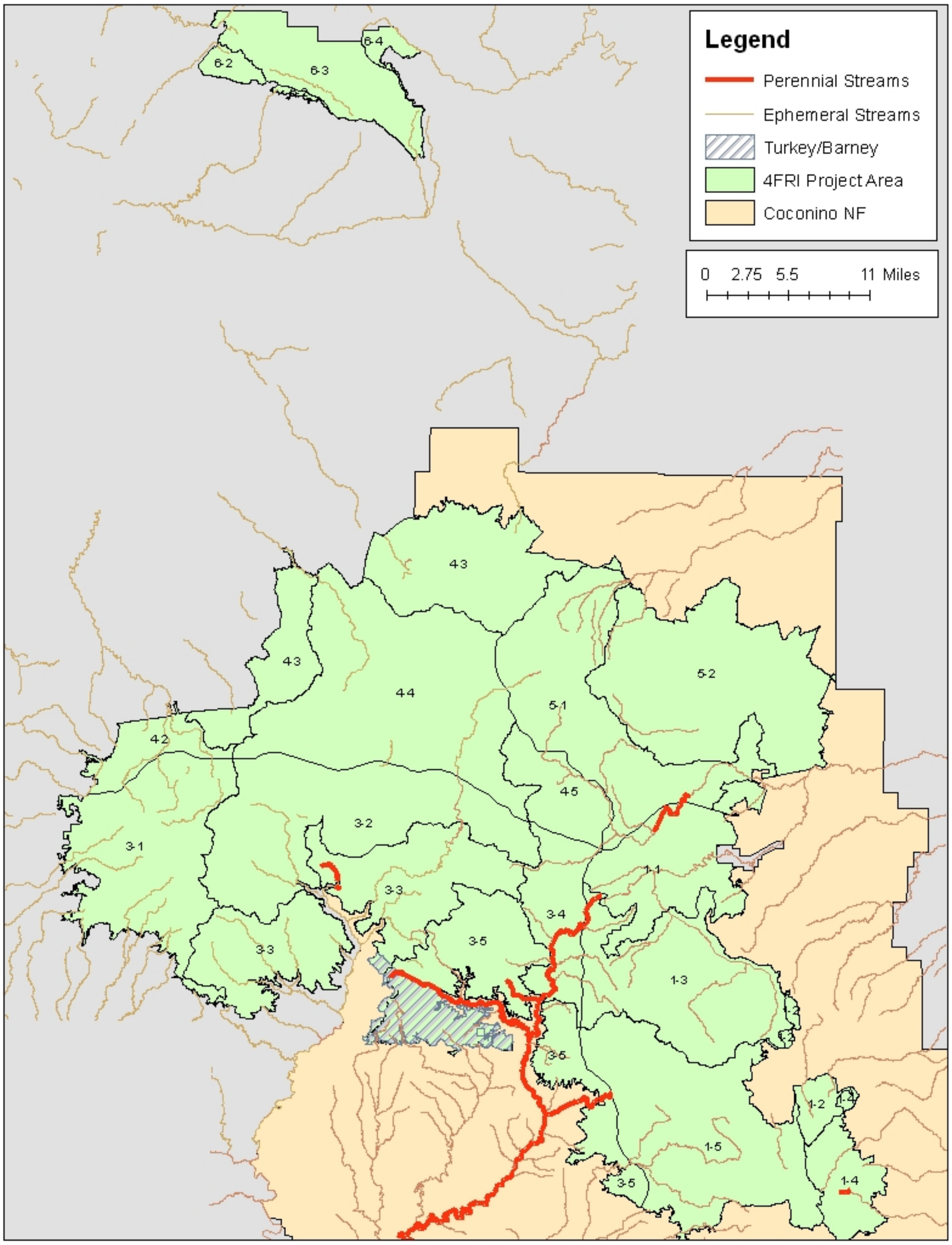
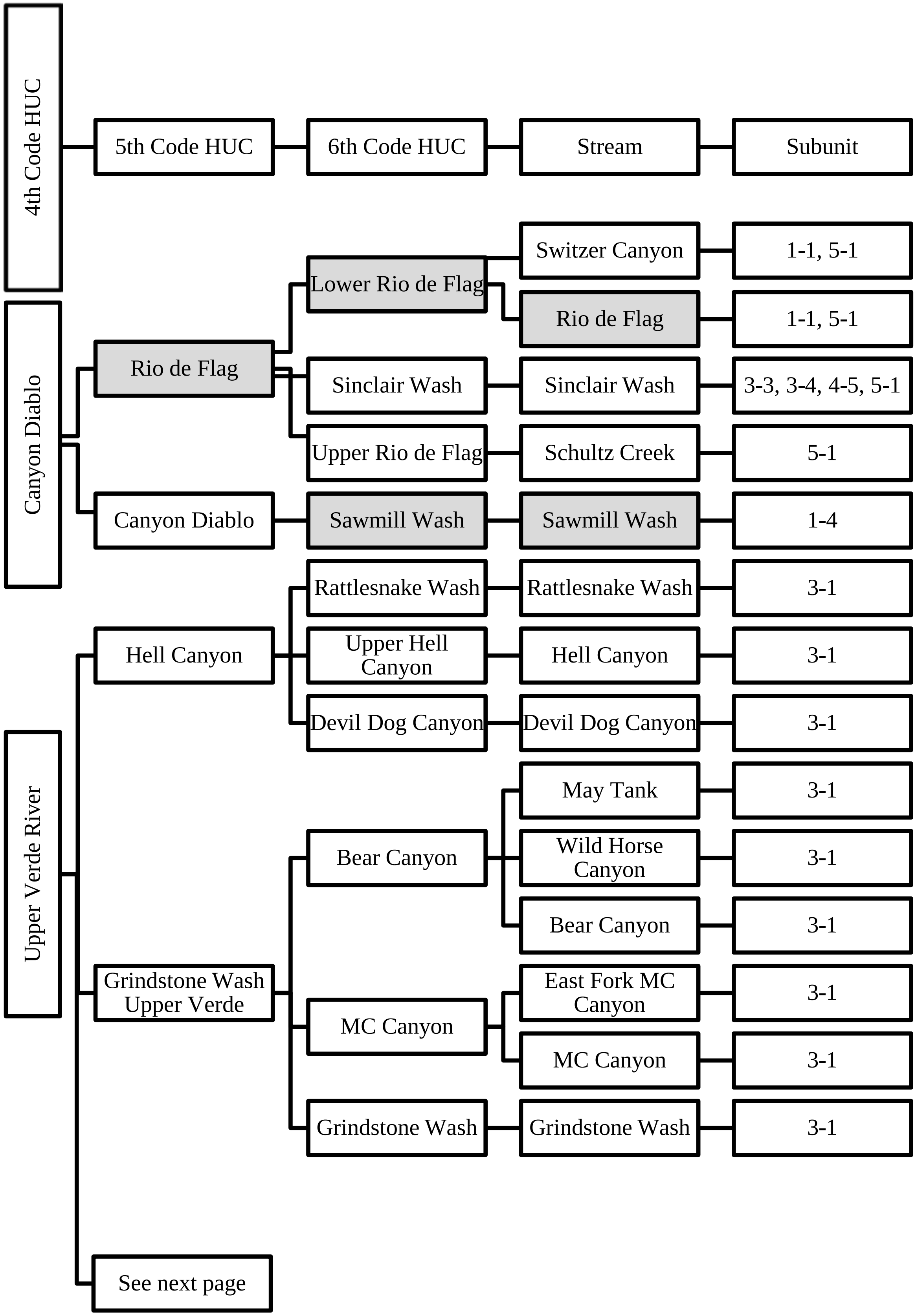
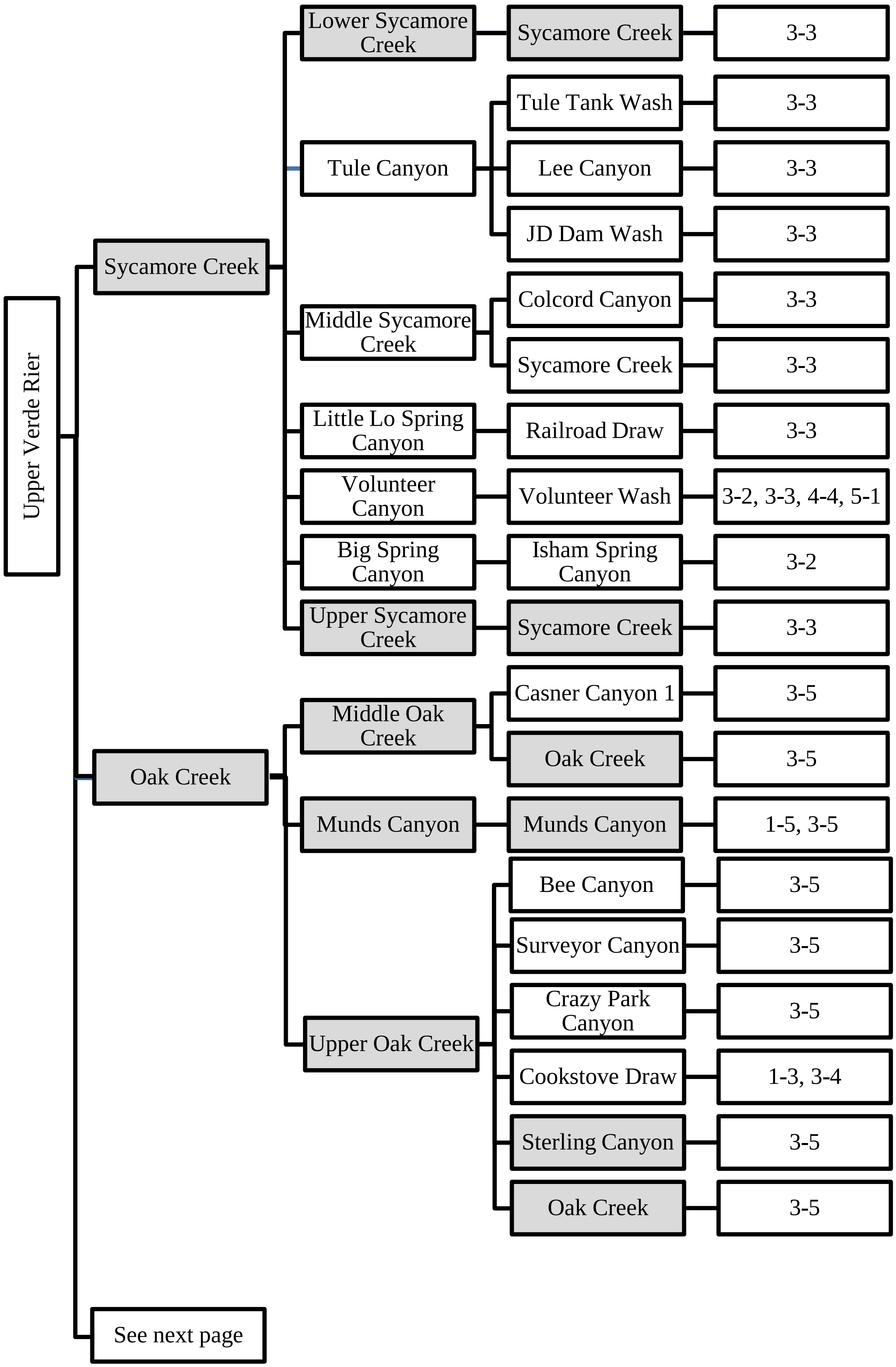


Figure 3. Four Forest Restoration Initiative Project Area showing perennial and ephemeral streams.



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

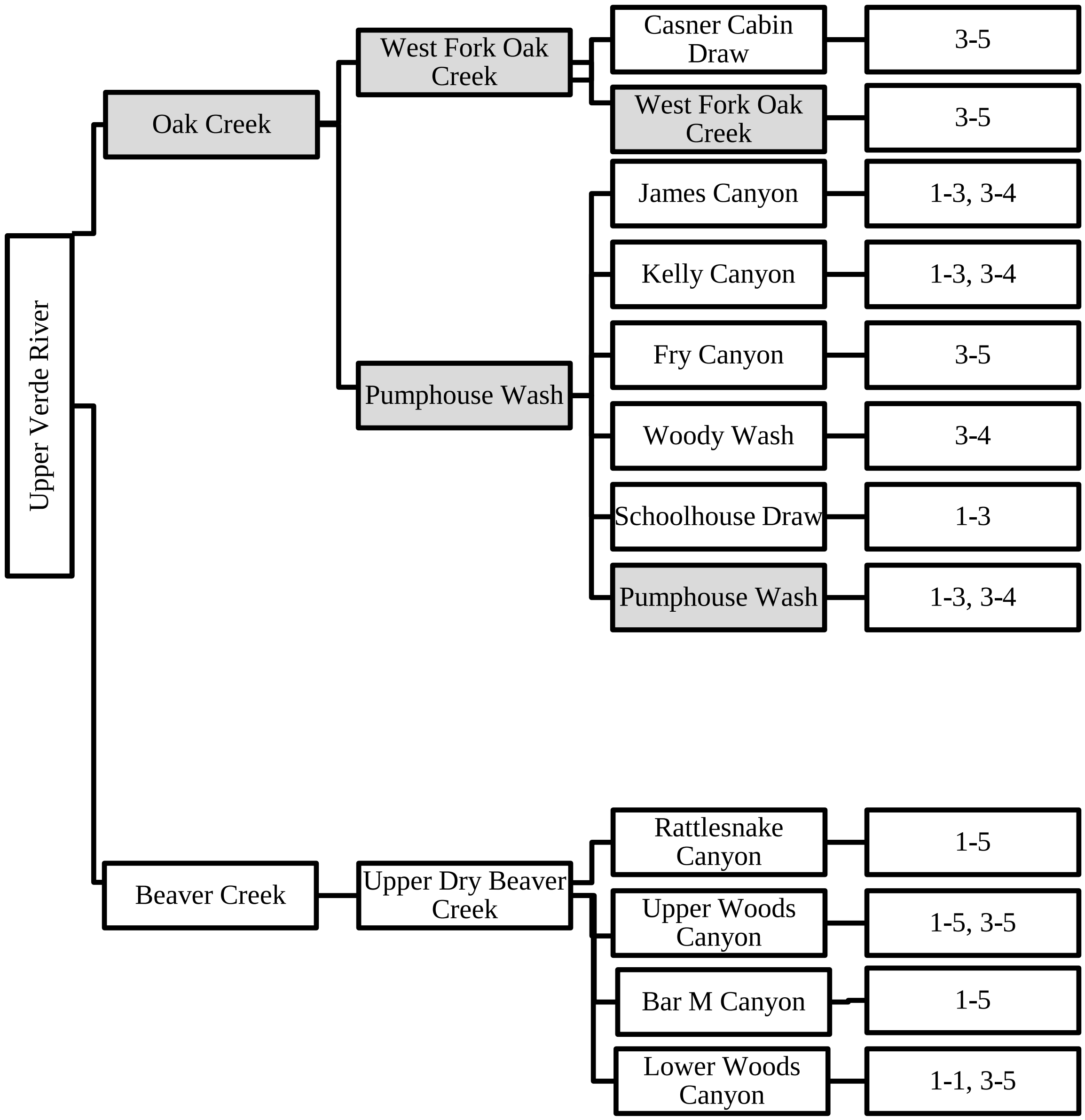


Figure 4. Perennial streams (shaded gray) in the analysis area, and the project subunits that may affect them.

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 (Appendix B).

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 (Appendix B). 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 4th 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 6th Code HUC watershed overlaps a portion of subunit 1-4 (Appendix B). 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 2013) should be used to protect this streamcourse where prescribed burning does occur.

Sycamore Creek

Sycamore Creek receives water from seven 6th 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 6th 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 2013).

Volunteer Canyon 6th 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 (Appendix B). 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 and C do. Thus, the risk of increased sedimentation and ash flow into Volunteer Wash is greater for Alternatives B and C than for Alternative D in this location. Volunteer Wash should be protected with a buffer strip of at least 70 feet (BMP #8; Steinke 2013) in this portion of Volunteer Canyon, if Alternative B or C 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 2013) 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 2013) 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 on 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.

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 (Appendix B). 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 do either Alternative B or C. The risk of increased sediment and ash flow would be greater for these two alternatives than for Alternative D, and a buffer strip of at least 120 feet (BMP #8; Steinke 2013) would be used to protect this streamcourse in subunit 3-4, if either Alternative B or C 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 either Alternatives B or C. The risk of increased sediment and ash flow will be greater for these two alternatives than for Alternative D, and a buffer strip of at least 70 feet (BMP #8; Steinke 2013) should be used to protect this streamcourse if either Alternative B or C 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 either Alternatives B or C. Therefore, the risk of increased sediment and ash flow would be greater for these two alternatives than for Alternative D, and a buffer strip of at least 70 feet (BMP #8; Steinke 2013) would be used to protect this streamcourse if either Alternative B or C is chosen.

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 (Appendix B). 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 2013) should be maintained along this streamcourse. Proposed prescribed burning within subunit 3-5 does differ among alternatives along the West Fork Oak Creek streamcourse, with Alternatives B and C proposing prescribed burning on slopes greater than 40% along the upstream portion of West Fork Oak Creek, and Alternative C proposing prescribed burning along a middle-section of the streamcourse, while Alternative D proposes no prescribed burning in these areas (Appendix B). Thus, Alternative C 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 2013) should be employed along the entire length of West Fork Oak Creek for both Alternatives B and C.

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 three 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 and C, 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 2013) along the Sterling Canyon streamcourse should be used if either Alternative B or C is selected.

Munds Canyon
Munds Canyon runs through portions of subunits 1-5 and 3-5 (Figure 5; Appendix B). Alternatives B and C 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 and C than for Alternative D. Unfortunately, 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 2013) 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 2013) should be used along the upper portion of this streamcourse to lessen the potential for sediment and ash flow into Oak Creek.

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

Spikedace (*Meda fulgida*)

Alternative A

Species Determination
Spikedace is not currently present within the affected environment. Therefore, Alternative A would have ***No Effect*** on spikedace.

Critical Habitat
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 known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to spikedace or its habitat from Alternative A, there can be no cumulative effects.

Therefore, Alternative A would have ***No Effect*** on spikedace critical habitat.

Alternative B

Species Determination
Spikedace is not currently present within the affected environment. Therefore, Alternative B would have ***No Effect*** on spikedace.

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

The soils and water report (Steinke 2013) 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 27). However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 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 critical habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on spikedace critical habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, Alternative B ***May Affect but is Not Likely to Adversely Affect*** spikedace critical habitat.

Alternative C

Species Determination
Spikedace is not currently present within the affected environment. Therefore, Alternative C would have ***No Effect*** on spikedace.

Critical Habitat
Within the analysis area, critical habitat for spikedace 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 critical habitat.

The soils and water report (Steinke 2013) 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 27). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 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 critical habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on spikedace critical habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, Alternative C ***May Affect but is Not Likely to Adversely Affect*** spikedace critical habitat.

Alternative D

Species Determination
Spikedace is not currently present within the affected environment. Therefore, Alternative C would have ***No Effect*** on spikedace.

Critical Habitat
Within the analysis area, critical habitat for spikedace 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 critical habitat.

The soils and water report (Steinke 2013) 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 27). 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 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 critical habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on spikedace critical habitat, as discussed above.

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

Loach minnow (*Tiaroga cobitis*)

Alternative A

Species Determination

Loach minnow is not currently present within the affected environment. Therefore, Alternative A would have ***No Effect*** on loach minnow.

Critical Habitat

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 known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to loach minnow or its habitat from Alternative A, there can be no cumulative effects.

Therefore, Alternative A would have ***No Effect*** on loach minnow critical habitat.

Alternative B

Species Determination
Loach minnow is not currently present within the affected environment. Therefore, Alternative B would have ***No Effect*** on loach minnow.

Critical Habitat
Within the analysis area, critical habitat for 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 loach minnow critical habitat.

The soils and water report (Steinke 2013) 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 27). However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 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 loach minnow critical habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on loach minnow critical habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, Alternative B ***May Affect but is Not Likely to Adversely Affect*** loach minnow critical habitat.

Alternative C

Species Determination
Loach minnow is not currently present within the affected environment. Therefore, Alternative C would have ***No Effect*** on loach minnow.

Critical Habitat
Within the analysis area, critical habitat for 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 loach minnow critical habitat.

The soils and water report (Steinke 2013) 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 27). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 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 loach minnow critical habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on loach minnow critical habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, Alternative C ***May Affect but is Not Likely to Adversely Affect*** loach minnow critical habitat.

Alternative D

Species Determination
Loach minnow is not currently present within the affected environment. Therefore, Alternative C would have ***No Effect*** on loach minnow.

Critical Habitat
Within the analysis area, critical habitat for 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 6^{th} HUC watersheds upstream could potentially lead to short-term increases in sedimentation and/or ash flow into loach minnow critical habitat.

The soils and water report (Steinke 2013) 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 27). 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 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 loach minnow 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 loach minnow critical habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on loach minnow critical habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, Alternative D ***May Affect but is Not Likely to Adversely Affect*** loach minnow critical habitat. However, Alternative D would not meet the Purpose and Need of the project.

Candidate Species

Roundtail Chub (*Gila robusta*)

Alternative A

Species Determination
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 known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to roundtail chub or its habitat from Alternative A, there can be no cumulative effects.

Therefore, Alternative A would have ***No Effect*** on roundtail chub or its habitat.

Alternative B

Species Determination
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. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into roundtail chub habitat.

The soils and water report (Steinke 2013) 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 27). However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on roundtail chub or its habitat, as discussed above.

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

Alternative C

Species Determination

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. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into roundtail chub habitat.

The soils and water report (Steinke 2013) 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 27). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on roundtail chub or its habitat, as discussed above.

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

Alternative D

Species Determination
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. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into roundtail chub habitat.

The soils and water report (Steinke 2013) 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 27). 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 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on roundtail chub or its habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, 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.

Forest Sensitive Species

Roundtail Chub (*Gila robusta*)

Alternative A

Species Determination
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 known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to roundtail chub or its habitat from Alternative A, there can be no cumulative effects.

Therefore, Alternative A is ***not likely to cause a trend to federal listing or loss of viability.***

Alternative B

Species Determination
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. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into roundtail chub habitat.

The soils and water report (Steinke 2013) 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 27). However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on roundtail chub or its habitat, as discussed above.

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

Alternative C

Species Determination
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. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into roundtail chub habitat.

The soils and water report (Steinke 2013) 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 27). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on roundtail chub or its habitat, as discussed above.

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

Alternative D

Species Determination
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. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into roundtail chub habitat.

The soils and water report (Steinke 2013) 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 27). 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 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on roundtail chub or its habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, 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.

Longfin Dace (*Agosia chrysogaster*)

Alternative A

Species Determination
Within the analysis area, longfin dace occupies 77.9 miles of perennial stream (32.9% 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 known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to longfin dace or its habitat from Alternative A, there can be no cumulative effects.

Therefore, Alternative A is ***not likely to cause a trend to federal listing or loss of viability.***

Alternative B

Species Determination
Within the analysis area, longfin dace occupies 77.9 miles of perennial stream (32.9% of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into longfin dace habitat.

The soils and water report (Steinke 2013) 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 27). However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 longfin dace live. Furthermore, longfin dace 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 longfin dace or its habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on longfin dace or its habitat, as discussed above.

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

Alternative C

Species Determination
Within the analysis area, longfin dace occupies 77.9 miles of perennial stream (32.9% of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into longfin dace habitat.

The soils and water report (Steinke 2013) 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 27). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 longfin dace live. Furthermore, longfin dace 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 longfin dace or its habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on longfin dace or its habitat, as discussed above.

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

Alternative D

Species Determination

Within the analysis area, longfin dace occupies 77.9 miles of perennial stream (32.9% of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into longfin dace habitat.

The soils and water report (Steinke 2013) 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 27). 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 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 longfin dace 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 longfin dace or its habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on longfin dace or its habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, 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.

Desert Sucker (*Catostomus clarki*)

Alternative A

Species Determination
Within the analysis area, desert sucker occupies 77.9 miles of perennial stream (32.9% 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 known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to desert sucker or its habitat from Alternative A, there can be no cumulative effects.

Therefore, Alternative A is ***not likely to cause a trend to federal listing or loss of viability.***

Alternative B

Species Determination
Within the analysis area, desert sucker occupies 77.9 miles of perennial stream (32.9% of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into desert sucker habitat.

The soils and water report (Steinke 2013) 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 27). However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 sucker live. Furthermore, desert sucker is a long-lived species (adults live over 10 years), so the risk of short term effects to desert sucker 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 desert sucker or its habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on desert sucker or its habitat, as discussed above.

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

Alternative C

Species Determination
Within the analysis area, desert sucker occupies 77.9 miles of perennial stream (32.9% of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into desert sucker habitat.

The soils and water report (Steinke 2013) 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 27). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 sucker live. Furthermore, desert sucker 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 desert sucker or its habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on desert sucker or its habitat, as discussed above.

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

Alternative D

Species Determination
Within the analysis area, desert sucker occupies 77.9 miles of perennial stream (32.9% of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into desert sucker habitat.

The soils and water report (Steinke 2013) 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 27). 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 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 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 sucker or its habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on desert sucker or its habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, 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.

Sonora Sucker (*C. insignis*)

Alternative A

Species Determination
Within the analysis area, Sonora sucker occupies 77.9 miles of perennial stream (32.9% 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 known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to Sonora sucker or its habitat from Alternative A, there can be no cumulative effects.

Therefore, Alternative A is ***not likely to cause a trend to federal listing or loss of viability.***

Alternative B

Species Determination
Within the analysis area, Sonora sucker occupies 77.9 miles of perennial stream (32.9% of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into Sonora sucker habitat.

The soils and water report (Steinke 2013) 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 27). However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 Sonora sucker live. Furthermore, Sonora sucker is a long-lived species (adults live over 10 years), so the risk of short term effects to Sonora sucker 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 Sonora sucker or its habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on Sonora sucker or its habitat, as discussed above.

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

Alternative C

Species Determination
Within the analysis area, Sonora sucker occupies 77.9 miles of perennial stream (32.9% of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into Sonora sucker habitat.

The soils and water report (Steinke 2013) 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 27). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 Sonora sucker live. Furthermore, Sonora sucker 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 Sonora sucker or its habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on Sonora sucker or its habitat, as discussed above.

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

Alternative D

Species Determination
Within the analysis area, Sonora sucker occupies 77.9 miles of perennial stream (32.9% of its habitat on the CNF), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into Sonora sucker habitat.

The soils and water report (Steinke 2013) 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 27). 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 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 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 Sonora sucker or its habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on Sonora sucker or its habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, 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.

California Floater (*Anodonta californiensis*)

Alternative A

Species Determination
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 16), 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 known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to California floater or its habitat from Alternative A, there can be no cumulative effects.

Therefore, Alternative A is ***not likely to cause a trend to federal listing or loss of viability.***

Alternative B

Species Determination

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 16), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into California floater habitat.

The soils and water report (Steinke 2013) 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 27). However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on California floater habitat, as discussed above.

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

Alternative C

Species Determination

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 16), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into California floater habitat.

The soils and water report (Steinke 2013) 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 27). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on California floater habitat, as discussed above.

Therefore, 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
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 16), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into California floater habitat.

The soils and water report (Steinke 2013) 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 27). 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 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on California floater habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, 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.

A. Mayfly (*Homoleptohyphes quercus*)

Alternative A

Species Determination
There are 77.7 miles of potential A. mayfly habitat within the Coconino Forest boundary. Within the analysis area, the species occupies 72.6 miles (93.4%) of perennial stream (Table 16), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, and West Fork of Oak Creek. It is often associated with silt, fine sand, gravel, and woody debris. It is not thought that sediment impairs this species or its habitat and there is no clear understanding as to why this species range has declined.

Since there are no direct or indirect effects to A. Mayfly from Alternative A, there can be no cumulative effects for A. Mayfly.

Therefore, Alternative A is ***not likely to cause a trend to federal listing or loss of viability.***

Alternatives B-D

Species Determination
There are 77.7 miles of potential A. mayfly habitat within the Coconino Forest boundary. Within the analysis area, the species occupies 72.6 miles (93.4%) of perennial stream (Table 16), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, and West Fork of Oak Creek. It is often associated with silt, fine sand, gravel, and woody debris. It is not thought that sediment impairs this species or its habitat and there is no clear understanding as to why this species range has declined.

Since there are no direct or indirect effects to A. Mayfly from Alternatives B-D, there can be no cumulative effects for A. Mayfly.

Therefore, Alternatives B-D are ***not likely to cause a trend to federal listing or loss of viability.***

Management Indicator Species (Macroinvertebrates)

Alternative A

Determination
There are 368.6 miles of potential macroinvertebrate habitat (perennial stream) within the Coconino Forest boundary. Within the analysis area, there are 83.7 miles (22.7%) of potential perennial stream habitat (Table 21), including Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill 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 known effects of the proposed action alternatives with the potential effects of hypothetical wildfire. Because there are no direct or indirect effects to macroinvertebrates or their habitat from Alternative A, there can be no cumulative effects.

Overall forest-wide riparian condition trend is mostly towards proper functioning condition, with some static areas (Steinke 2013). Overall trend in riparian acreage since 1987 is probably static to slightly upward with the addition of some riparian acreage in land exchanges (Steinke 2013). Macroinvertebrate population trends in high and low elevation streams on the Forest are static. Alternative A would not change macroinvertebrate habitat quality or quantity on the Forest, nor would it change current forest-wide trends.

Alternative B

Determination

There are 368.6 miles of potential macroinvertebrate habitat (perennial stream) within the Coconino Forest boundary. Within the analysis area, there are 83.7 miles (22.7%) of potential perennial stream habitat (Table 21), including Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into macroinvertebrate habitat.

The soils and water report (Steinke 2013) 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 27). However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 macroinvertebrate 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 macroinvertebrate habitat, as no dust abatement treatments are proposed near open water.

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

Overall forest-wide riparian condition trend is mostly towards proper functioning condition, with some static areas (Steinke 2013). Overall trend in riparian acreage since 1987 is probably static to slightly upward with the addition of some riparian acreage in land exchanges (Steinke 2013). Macroinvertebrate population trends in high and low elevation streams on the Forest are static. Alternative B would not change macroinvertebrate habitat quality or quantity on the Forest, nor would it change current forest-wide trends.

Alternative C

Determination

There are 368.6 miles of potential macroinvertebrate habitat (perennial stream) within the Coconino Forest boundary. Within the analysis area, there are 83.7 miles (22.7%) of potential perennial stream habitat (Table 21)\, including Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into macroinvertebrate habitat.

The soils and water report (Steinke 2013) 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 27). In addition, Alternative C proposes more acres of mechanical vegetation treatments than does Alternative B. However, BMPs (Table 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 macroinvertebrate 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 macroinvertebrate habitat, as no dust abatement treatments are proposed near open water.

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

Overall forest-wide riparian condition trend is mostly towards proper functioning condition, with some static areas (Steinke 2013). Overall trend in riparian acreage since 1987 is probably static to slightly upward with the addition of some riparian acreage in land exchanges (Steinke 2013). Macroinvertebrate population trends in high and low elevation streams on the Forest are static. Alternative C would not change macroinvertebrate habitat quality or quantity on the Forest, nor would it change current forest-wide trends.

Alternative D

Determination

There are 368.6 miles of potential macroinvertebrate habitat (perennial stream) within the Coconino Forest boundary. Within the analysis area, there are 83.7 miles (22.7%) of potential perennial stream habitat (Table 21), including Munds Canyon, Oak Creek, Pumphouse Wash, Rio de Flag, Sawmill Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into macroinvertebrate habitat.

The soils and water report (Steinke 2013) 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 27). 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 14) 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 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope (Table 27). 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 macroinvertebrate 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 macroinvertebrate habitat, as no dust abatement treatments are proposed near open water.

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

Overall forest-wide riparian condition trend is mostly towards proper functioning condition, with some static areas (Steinke 2013). Overall trend in riparian acreage since 1987 is probably static to slightly upward with the addition of some riparian acreage in land exchanges (Steinke 2013). Macroinvertebrate population trends in high and low elevation streams on the Forest are static. Alternative D would not change macroinvertebrate habitat quality or quantity on the Forest, nor would it change current forest-wide trends. However, Alternative D would not meet the Purpose and Need of the project.

BACKGROUND

Education and Professional Experience

I have a Master's Degree in Zoology from Oklahoma State University, and a Bachelors of Science degree in Wildlife and Fisheries Management from Arizona State University. My professional experience includes over 18 years of field and laboratory fisheries work for the Arizona Game and Fish Department, U.S. Fish and Wildlife Service, and Forest Service. I have specialized in Southwestern native fish conservation and recovery.

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