Fossil Creek Wild and Scenic River Resource Assessment

Introduction

The purpose of this resource assessment is to determine and document which river values meet the standard for "Outstandingly Remarkable" in the Fossil Creek Wild and Scenic River corridor. This assessment documents the evaluation of resource conditions and river values at the time that Congress designated Fossil Creek as a wild and scenic river (March 2009), and updates these conditions and values to present condition (which varies by resource).

It is important to identify the outstandingly remarkable values (ORVs) because the Wild and Scenic Rivers Act (WSRA) requires the administering agency to "protect and enhance" the river's free-flowing condition, water quality and its outstandingly remarkable values. Protecting and enhancing the free-flow condition, water quality, and ORVs become the basis for managing the wild and scenic river corridor.

In late 2010, the Forest Service published a draft of this document and asked the public to comment on the significance of each resource and the preliminary findings. In response, the Forest Service received 19 letters representing 26 individuals or organizations. This revised resource assessment responds to those comments.

Background

On March 30, 2009, Congress designated approximately 16.8 miles (27 km) of Fossil Creek (Arizona) as a wild and scenic river (WSR) with the following segments and classification:

- The approximately 2.7-mile (4.3-km) segment from the confluence of Sand Rock and Calf Pen Canyons to the point where the segment exits the Fossil Spring Wilderness, as a wild river
- The approximately 7.5-mile (12-km) segment from where the segment exits the Fossil Creek Wilderness to the boundary of the Mazatzal Wilderness, as a recreational river
- The 6.6-mile (10.6-km) segment from the boundary of the Mazatzal Wilderness downstream to the confluence with the Verde River, as a wild river

Figure 1 - Arizona map with Fossil Creek location

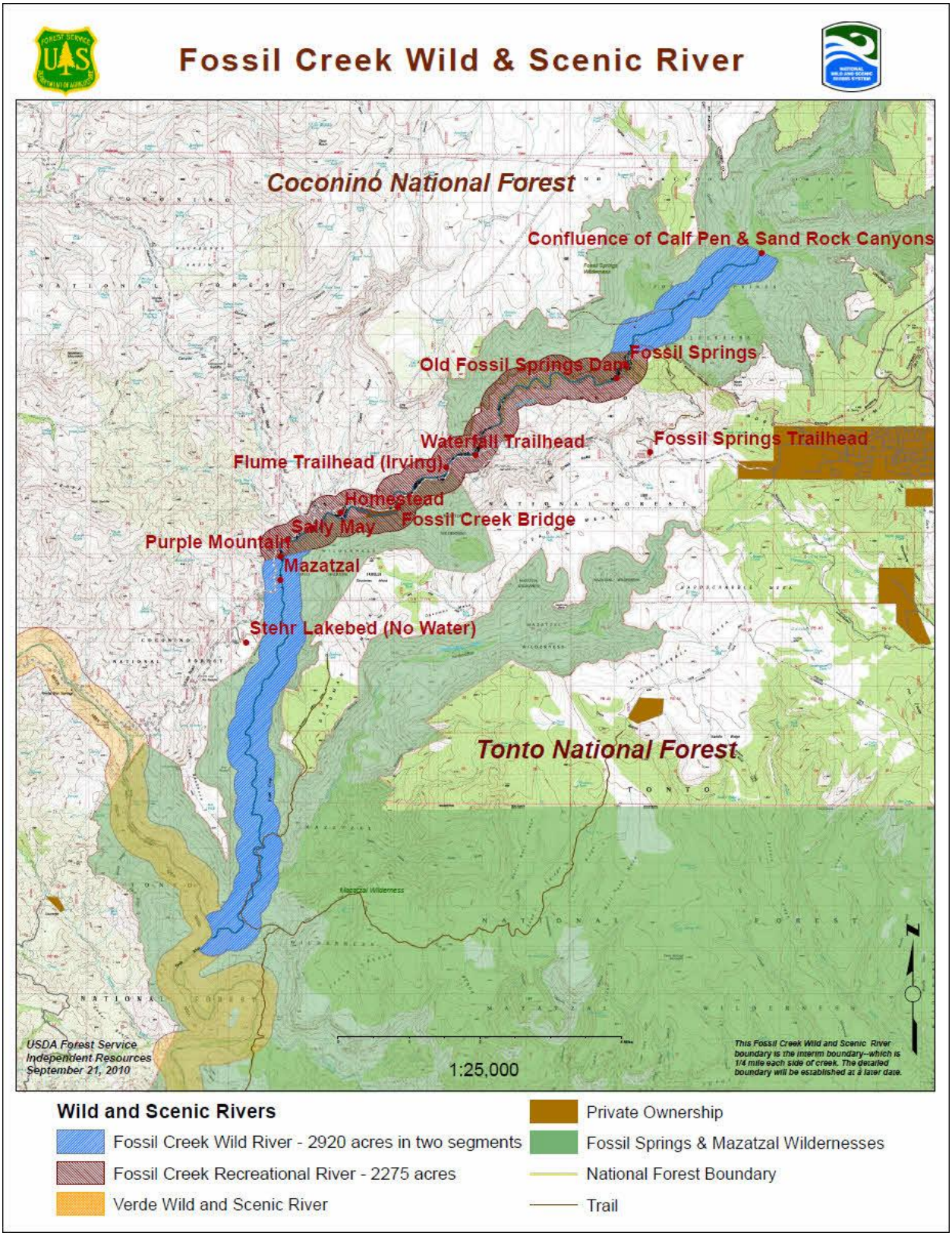

Figure 2 - Fossil Creek Wild and Scenic River Interim Corridor

Wild and Scenic Rivers Act Requirements

In order to be assessed as outstandingly remarkable, a river-related value must be a unique, rare, or exemplary feature that is significant at a comparative regional or national scale. Dictionary definitions of the words “unique” and “rare” indicate that such a value would be one that is a conspicuous example from among a number of similar values that are themselves uncommon or extraordinary.

While the spectrum of resources and opportunities that may be considered is broad, all values should be directly river-related. That is, they should:

1) Be located in the river or on its immediate shorelands (generally within 1/4 mile on either side of the river);

2) Contribute substantially to the functioning of the river ecosystem; and/or

3) Owe their location or existence to the presence of the river.

This resource assessment uses the criteria developed by the Interagency Wild and Scenic Rivers Coordinating Council and incorporated into agency policy (Forest Service Handbook 1909.12, Chapter 82.14) to evaluate Fossil Creek’s river values and determine the outstandingly remarkable values associated with the creek (Interagency Wild and Scenic Rivers Coordinating Council, 1999) and water (Interagency Wild and Scenic Rivers Coordinating Council, 2003). The Fossil Creek planning team developed similar criteria for those river values that the Coordinating Council did not address. The determination that a river area contains outstanding values is a professional judgment on the part of an interdisciplinary team, based on objective, scientific analysis. (USDA Forest Service, 2006)

Previous identification of Fossil Creek’s outstandingly remarkable values

In 1993, the Forest Service conducted studies of Arizona's free-flowing rivers and published its findings in a 300-page report (the "1993 Report"). The 1993 Report identified 57 rivers and streams as potentially eligible for inclusion in the National Wild and Scenic Rivers System. The Forest Service concluded that the portion of Fossil Creek below the Fossil Springs dam met the eligibility criteria: free-flowing and possessing outstandingly remarkable geology, fish, wildlife, history, ecology, and riparian community values (USDA Forest Service, 1993).

In the early 2000’s, the Forest Service proposed management changes for the Fossil Creek area to provide more effective resource protection and improved recreation quality, and in response to the expected decommissioning of the Arizona Public Service’s (APS) Childs/Irving power plants and removal of the Fossil Springs dam. Although this planning process was not completed, the proposal published on the Forest Service website included an analysis of the eligibility of Fossil Creek as a wild and scenic river from the Fossil Springs to the Verde River in anticipation of restoration of flows. The river’s outstandingly remarkable values were identified as scenery, geology, fish, wildlife, history, and botany (Coconino National Forest, 2002).

In 2003, the Arizona Wilderness Coalition published a report titled Fossil Creek Wild and Scenic River Proposal. This report also evaluated resources of Fossil Creek from the Fossil Springs to the Verde River to determine outstandingly remarkable values. Using criteria consistent with those developed by the Interagency Wild and Scenic River Coordinating Council, they found that the following resources met the outstandingly remarkable value criteria: scenery, geology, fish, wildlife, cultural resources, and ecology (Arizona Wilderness Coalition, 2003).

Table 1. Previous evaluations of outstandingly remarkable values for Fossil Creek

	1993 report	Early 2000's Forest Service Planning	2003 Arizona Wilderness Coalition
Length Studied	From just below Fossil Springs dam to the Verde River (~13.5 miles or 21.7 km)	From Fossil Springs to the Verde River (~14 miles or 22.5 km)	From Fossil Springs to the Verde River (~14 miles or 22.5 km)
ORVs identified	• Geology • Fish • Wildlife • History • Ecology • Riparian Community	• Scenery • Geology • Fish • Wildlife • History • Botany	• Scenery • Geology • Fish • Wildlife • Cultural Resources • Ecology

Changed Conditions since previous ORV Assessments

Since these assessments, several changes have occurred that have influenced findings of outstandingly remarkable.

- In 2004-2005, several agencies partnered to build a fish barrier in the lower part of Fossil Creek, remove non-native fish above the barrier, and return native fish above the barrier to restore a native-only fish population to Fossil Creek;
- In 2005, Arizona Public Service removed the top 14 feet (4.3 meters) of the Fossil Springs dam, removed the diversion structure, and natural flow was restored in Fossil Creek;
- In 2009, Congress included approximately 2.8 additional miles (4.5 km) as a wild and scenic river than had been previously studied;
- The Arizona Game and Fish Department and the US Fish and Wildlife Service stocked multiple endangered/threatened fish species in Fossil Creek;
- After natural flow was restored to the creek, recreation use increased exponentially.

River Value Descriptions, Evaluations and Findings

River Values Evaluated (updated in 2015)

Review of Forest Service Policy indicates that river values should include free flowing character, water quality as well as outstandingly remarkable values (Interagency Wild and Scenic Rivers Coordinating Council 2003). Long term protection of the river values are critical objectives found in the Wild and Scenic Rivers Act, specifically Section 13(c) creates a federal reserved water right for Wild and Scenic Rivers (WSR), and Section 1(b) establishes protection of water quality a one of the threefold purposes of the act. The Coconino NF has chosen to carry free flowing character and water quality (including quantity) as river values throughout the assessment and planning, in addition to the outstandingly remarkable values of biological, geology, Apache and Yavapai Traditional and Contemporary Cultural Values, and recreation.

Table 2 lists the values described and evaluated in this document and summarizes the findings for outstandingly remarkable and river values. For some values, there is a change from a previous finding to the present one. This is due to changed conditions since the previous evaluations and/or the extra rigor in this analysis compared to previous ones. For example, fish, aquatic species and wildlife have been combined into a Biological ORV. Habitat and population of each of these three values have been evaluated and deemed outstandingly remarkable and can be found at the end of this document. Combining into one river value does not in any way reduce the value of the individual parts, but will reduce redundancy in subsequent environmental analysis. History has been identified in all analyses, but has been refined to the Apache and Yavapai Tribes as the single thread relating historic events, and continuing into the future. Free flowing character and water quality is included in the river values assessment and remarkable characteristics are identified. These will remain separate from the outstandingly remarkable values, but retain the same status for protection.

Table 2 – River Values Evaluated and Findings

River Value	Finding
Recreation	Outstandingly remarkable
Geology	Outstandingly remarkable
Biological	Outstandingly remarkable
Apache and Yavapai Traditional and Contemporary Cultural Values	Outstandingly remarkable
Water	River Value
Scenery	Not outstandingly remarkable
Pre-History	Not outstandingly remarkable
Riparian Communities and Botany	Not outstandingly remarkable

Public Input

In September of 2010, the Forest Service conducted two workshops to give the public a chance to describe what they value about Fossil Creek. In addition, during Labor Day weekend and the week before that, a team of Forest Service employees interviewed visitors at Fossil Creek to

hear what they value about Fossil Creek. The subject matter specialists considered all of these perspectives when evaluating the river values, but because these citizens were not provided the criteria to evaluate ORVs, in many instances these views represent a local perspective rather than a broader regional or national one.

Region of Comparison

In general, the region of comparison is the Central Highlands Planning Area (CHPA), one of seven planning areas identified by the Arizona Department of Water Resources in Arizona (Figure 2). It encompasses about 13,900 square miles (36000 km2) and includes the Agua Fria, Salt River, Tonto Creek, Upper Hassayampa, and Verde River Basins. Most of the Fossil Creek WSR corridor lies within the Central Highlands Physiographic Province, which is a transition zone between the Basin and Range lowlands to the south and west and the Plateau Uplands to the north and east.

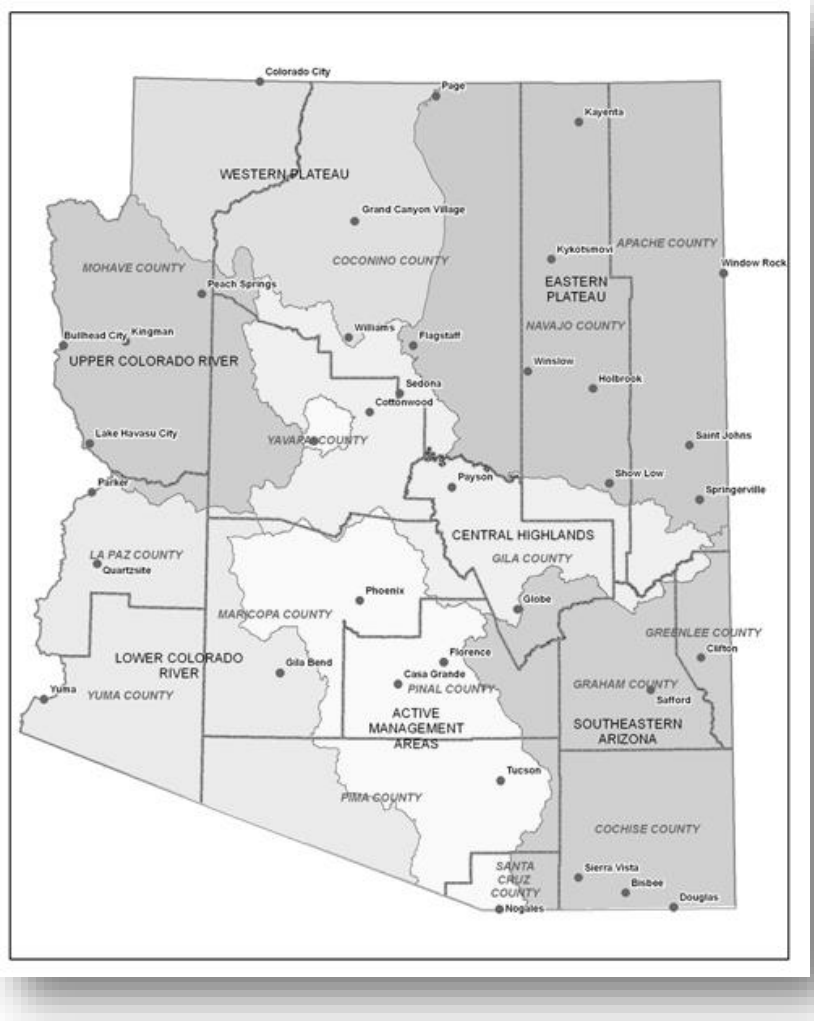

Figure 3 – Arizona Planning Areas (ADWR, 2009) including the Central Highlands Planning area (region of comparison for this evaluation)

Organization of the rest of this assessment

The final section of this resource assessment examines each river value to determine its significance. First, it provides the criterion used to judge the significance of a particular value. This assessment uses the criteria developed by the Interagency Wild and Scenic Rivers Coordinating Council and incorporated into agency policy (Forest Service Handbook 1909.12, Chapter 82.14). The Fossil Creek planning team developed similar criteria for those resources that the Coordinating Council did not address. Following the criterion is a narrative description of the resource, which addresses the factors in the criterion. The final part of each resource section is a finding as to whether or not a value is unique, rare, or exemplary at a regional or national scale and whether or not it is outstandingly remarkable.

Evaluation and Recommendations

Scenery

Criteria for Outstandingly Remarkable

The landscape elements of landform, vegetation, water, color and related factors result in notable or exemplary visual features and/or attractions within the region. When analyzing scenic values, additional factors—such as seasonal variations in vegetation, scale of cultural modifications, and the length of time negative intrusions are viewed may be considered. Scenery and visual attractions may be highly diverse over the majority of the river or river segment.

Scenery Description

Fossil Creek is a perennial stream that meanders through a remarkable canyon bottom. Expansive views from the stream expose a variety of dramatic landforms and colors enhancing the encounter with nature. Within the canyon are striking steep, red-rock cliffs and bedrock gorges. Crystal-clear water reveals the vigorous aquatic life and reflects the surrounding flourishing vegetation with seasonal variations. There is a striking contrast between the green canopies billowing from the riparian forest and the surrounding arid environment. The character of the creek displays a variety of water features including brilliant blue-green colored water; still, clear pools; waterfalls, and whitewater as the channel varies. The relative absence of negative intrusions by human modifications on adjacent lands has maintained its natural character and sense of remoteness.

In the upper part of the WSR corridor, the creek meanders over red rocks and one can glance up to the steep red rock canyon dotted with pinyon and juniper trees. During the summer, the creek can become totally dry here. As one travels downstream, water bubbles out of the ground from the perennial springs. The creek area changes from a low water or dry riverbed to a lush, green environment. One particularly interesting area is called the hanging garden – where springs burst out of the side of the creek and bright green ferns and other plants hang from the creek bank.

Going downstream, springs continue to add water to the creek. Because the springs discharge water into Fossil Creek at a constant and relatively high rate compared to other nearby rivers, visitors can depend on a well-watered river with many reflection pools. The springs also contribute calcium carbonate to the water, which causes the bright blue-green color of the water. The calcium carbonate also is deposited as travertine formations that resemble bones or fossils (and why the creek is named Fossil Creek). The travertine deposits have also contributed to a variety of river features such as waterfalls and small dams.

Traveling farther downstream, the creek is accessible by road for about 4 miles (6.4 km). Many deep, clear, pools are found in this section. In autumn, the deciduous riparian vegetation transforms to deep yellows and browns. Downstream of the road-accessible portion of the creek, it continues the deep, continuous water flow, but the travertine formations are no longer pronounced.

In addition to the natural features, two power lines run through the WSR corridor and visually impact the scenery. One is a large 345 KV line, which passes through the WSR corridor in the road-accessible portion of the corridor. The other is a 69 KV line, which runs from a substation at Childs to Irving, crosses the creek near Irving, then runs up the canyon to Strawberry.

Other rivers in the Central Highlands planning area also contain striking scenery. Both Beaver Creek and Oak Creek have magnificent red rock formations above with water gliding over red, water-ground rocks below. West Clear Creek also contains red rock canyons. Tonto Creek has a waterfall and a canyon. Tonto Natural Bridge State Park contains the largest natural travertine bridge in the world. Within Arizona, the Sedona red rocks and the Grand Canyon are world-renowned.

Finding

Although the scenery on Fossil Creek is diverse over the majority of the creek, scenery is also striking in other rivers and areas within the region and the state. In addition, the two power lines impact the scenery within the corridor. The scenery at Fossil Creek is not unique or rare within the region, so does not rise to the level of outstandingly remarkable.

Recreation

Criteria for Outstandingly Remarkable

Recreational opportunities are, or have the potential to be, popular enough to attract visitors from throughout or beyond the region of comparison or are unique or rare within the region. Visitors are willing to travel long distances to use the river resources for recreational purposes. River-related opportunities could include, but are not limited to, sightseeing, wildlife observation, camping, photography, hiking, fishing, hunting, and boating.

Interpretive opportunities may be exceptional and attract, or have the potential to attract, visitors from outside the region of comparison.

The river may provide, or have the potential to provide, settings for national or regional usage or competitive events.

Recreation Description

Fossil Creek provides outstanding opportunities for a variety of recreational activities and it attracts numerous visitors, many of whom return year after year. This freshwater source provides essential relief from the desert heat. Visitors enjoy the shade and cooler temperatures from the dense riparian canopy and there is an abundance of deep, clear pools in which to wade, swim, and snorkel. The springs that form Fossil Creek keep the water flow constant throughout the year, which is an uncommon and welcome attribute for visitors in the desert southwest. Calcium carbonate dissolved in the water gives it a beautiful blue-green color, which adds to the enjoyment of the area.

Other attractions and opportunities include the 70° F. (21° C.) warm springs, camping, hiking, wilderness appreciation, fishing, wildlife and nature observation, photography, bird watching, and potential cultural and historical site interpretation. Visitors typically access Fossil Creek along the 4 miles (6.4 km) of road that parallel the creek, by hiking northeast of the road along Fossil Creek to a waterfall, and by hiking or backpacking using the Fossil Springs Trail.

Where do visitors come from?

Data collected in the summer of 2009, 2010 and 2011show that on average, 55% of Fossil Creek visitors were from the Phoenix-Metro area. . However, data collected in 2013 indicates that an even larger percentage of visitors came from the Phoenix-Metro area at 79%. A distant second in all years were residents from Chino and Prescott Valleys (11 to 19%). Residents from the communities closest to Fossil Creek, the Verde Valley and the Rim Country (Strawberry, Pine and Payson), made up only 16% of visitors in 2009, and 11% of visitors in 2013- a relatively small segment of visitor use. None of the visitors contacted during the summer of 2009 claimed any residence outside the state of Arizona (Rotert A. M., 2009), but in 2013, 3% of visitors were from out of state (Rotert A.M., 2013).

Fossil Creek has the potential to attract national and international visitors. As stated later in the Geology section, only three travertine systems larger than Fossil Creek exist in the United States, all of which are partially or wholly contained within National Parks. These systems include Havasu Creek (Havasupai Indian Reservation and Grand Canyon National Park), Blue

Springs of the Little Colorado (Navajo Reservation, and Grand Canyon National Park), and Mammoth Hot Springs (Yellowstone National Park). In addition, sites similar to Fossil Creek in Mexico (Agua Azul) and Croatia (Plitvice) are important enough to be protected in National Parks (Overby & Malusa, 2002).

River-related Recreation Opportunities

Swimming

Fossil Creek has numerous swimming holes and waterfalls now that the dam has been removed and natural flows have returned. Visitors swim, wade, dive off cliffs, snorkel, and float down riffles and short waterfalls. The constant 70° F. (21 C.) water temperature makes taking a dip enjoyable during most seasons. Swimming was reported as the most popular activity in Fossil Creek (Rotert A. M., 2009, 2010, 2011).

Camping

Dispersed camping is also a popular form of recreation at Fossil Creek. In 2009, visitors used nearly 160 dispersed and undeveloped campsites along the 4 miles (6.4 km) of road that parallel the creek, near swimming holes, and around the springs (Rotert A. , 2010). In 2010, the Forest Service placed restrictions on camping within the riparian areas and on the Tonto National Forest in the wild and scenic river corridor, so the number of campsites diminished significantly. The Forest Service continued to implement the camping restriction in subsequent years, which resulted in further (minor) decreases in the number of campsites and total denuded area.

Hiking

The trail system within the Fossil Creek WSR corridor provides hiking and backpacking opportunities into the area including the Mazatzal Wilderness, Fossil Springs Wilderness, the Verde Wild and Scenic River, and the Fossil Springs Botanical Area. Portions of four designated trails are present in the Fossil Creek WSR corridor: the Flume-Irving Trail (#154), the Fossil Springs Trail (#18), the Mail Trail (#84), and the Deadman Mesa Trail (#17). The Fossil Springs trail receives the most use of these four trails.

Throughout the Fossil Creek area, a number of dispersed social trails (non-designated trails created by continuous use) provide access to the creek at various locations. These dispersed trails are close to the Fossil Creek Road (Forest Road 708), the Childs Road (Forest Road 502), the Flume Road/Trail (Forest Road 154), and dispersed campsites.

Kayaking

Since the return of natural flows to Fossil Creek, kayakers have discovered the waterfalls of Fossil Creek. They enjoy kayaking in the creek all year long – a rare opportunity as most streams in the warm desert run dry in summer and are too cold in winter in other areas.

Wilderness

Fossil Creek borders and is surrounded by the Mazatzal and Fossil Springs Wildernesses. Due to the remote nature of Fossil Creek, the rugged, steep-walled lower canyon, and the springs,

these wildernesses offer exceptional opportunities for experienced hikers and backpackers to venture into the remote areas, explore primitive nature, and have a true wilderness experience.

Cultural Attractions

The Childs and Irving power plants are designated a National Register Historic District. The History and Traditional Uses section of this resource assessment describes these resources more fully. Previous surveys and predictive models suggest that prehistoric ruins are present in extremely high densities throughout the planning area. All alluvial flats currently used for dispersed camping and picnicking are likely to contain prehistoric resources. Opportunities exist to interpret these cultural resources.

Fishing

After dam removal, the return of natural water flows, and the restoration of native fish species in Fossil Creek, the Arizona Game and Fish Commission approved a catch-and-release-only seasonal roundtail chub and headwater chub fishery along a portion of Fossil Creek starting in October of 2009. Many anglers enjoy fishing for native species in their native habitat, an opportunity that is rare in Arizona where most native fisheries have been depleted.

Finding

Recreation is an outstandingly remarkable value in Fossil Creek. The overwhelming majority of visitors to Fossil Creek come from outside the Arizona Central Highlands region (the region of comparison) and an even larger percentage came from outside in region in 2013 than in 2009. Although it is common for Phoenix residents to dominate recreation areas in Arizona, Fossil Creek has the potential to attract both national and international visitors because of the rare and unique travertine formations. The wild and scenic river corridor contains exceptional opportunities to swim, wade, hike, view wildlife and native fish, appreciate the history of the area, and it is rare that all of these opportunities exist in one place.

Geology

Criteria for Outstandingly Remarkable

The river, or the area within the river corridor, contains one or more examples of a geologic feature, process or phenomenon that is unique or rare within the region of comparison. The feature(s) may be in an unusually active stage of development, represent a "textbook" example, and/or represent a unique or rare combination of geologic features (erosional, volcanic, glacial or other geologic structures).

Geology Description

Early visitors to the area described travertine formations in Fossil Creek. Charles F. Lummis (1891) and F.W. Chamberlain (1904) documented the existence of a series of extraordinary travertine dams that extended for some distance downstream from the spring sources that water Fossil Creek (as cited in Malusa et al., 2003). These large natural dams created a number of impressive pools.

In 1909, a 26 foot (8 m) high dam was built across Fossil Creek and the entire baseflow was diverted through a flume system primarily for hydropower generation at the Childs power plant on the Verde River and later at the Irving power plant next to Fossil Creek. After diversion of the baseflow, the in-channel travertine structures were breached and largely destroyed by episodic floods and debris flows. The decommissioning of the hydroelectric project and return of full flows to Fossil Creek have triggered rapid regrowth of travertine dams (Fuller et al., 2010).

The American Geological Institute defines travertine as "Biotically and/or abiotically precipitated calcium carbonate (predominately calcite and aragonite) from spring-fed, heated and/or ambient-temperature waters" (American Geological Institute). Travertine is chemically identical to the mineral calcite, which is distinguished from other forms of calcium carbonate by its banded and often porous structure resulting from its mode of deposition. A rare combination of natural processes is required for the calcium carbonate-rich spring water to form travertine dams (Overby & Malusa, 2002).

Springs emitting water supersaturated with calcium carbonate have the potential to create travertine structures that dramatically alter stream morphology. These structures form when water interacts with the soil zone, carbonate aquifers, organic material, or regional geothermal activity to produce H_2CO_3 . The H_2CO_3 increases dissolution of carbonate rocks resulting in elevated dissolved CO_2 concentrations in the water. The concentration gradient between atmospheric CO_2 and dissolved CO_2 in water emerging from an aquifer initiates outgassing. As CO_2 concentrations move toward equilibrium through outgassing, the water becomes supersaturated with $CaCO_3$, eventually reaching a critical level. When this critical level is exceeded, a kinetic barrier is surpassed and $CaCO_3$ precipitates to form travertine deposits (Malusa et al., 2003).

Malusa (1997) and Malusa, Overby, and Parnell (2003) quantified calcite (travertine) precipitation at full flows and seepage flows in the natural channel, and documented the

approximate number of remnant travertine dams located in the historic travertine reach within Fossil Creek. Within months of restoration of natural flows in Fossil Creek in 2005, hundreds of new travertine dams started to form within the stretch of river 10 km downstream of the old dam (Fuller et al., 2010).

Overby and Malusa (2002) state that in all of North America, there are only three travertine systems larger (with respect to water discharge and mineral deposition potential) than Fossil Creek, all of which are partially or wholly contained within National Parks and are considered scenic park treasures. These systems include Havasu Creek (Havasupai Indian Reservation and Grand Canyon National Park), Blue Springs of the Little Colorado (Navajo Reservation, and Grand Canyon National Park), and Mammoth Hot Springs (Yellowstone National Park). In addition, sites similar to Fossil Creek in Mexico (Agua Azul) and Croatia (Plitvice), are protected in National Parks.

Historical accounts, remnant dam buttresses, geochemical data, and the rapid regrowth of travertine dams after flows were restored in 2005 all provide evidence that Fossil Creek definitively has the potential to quickly rebuild a huge travertine system (Fuller et al., 2010).

Finding

The travertine formations in Fossil Creek are the fourth largest in North America and the potential to quickly rebuild a huge travertine system is a rare feature. The geology of Fossil Creek is outstandingly remarkable.

Biological (Fish and Aquatic Resources)

Criteria for Outstandingly Remarkable

Fish and aquatic values may be judged on the relative merits of either populations or habitat, or a combination of these river-related conditions.

Populations - The river is nationally or regionally an important producer of resident and/or anadromous fish or aquatic species. Of particular significance is the presence of wild stocks and/or federal or state listed (or candidate) threatened, endangered or sensitive species. Diversity of species is an important aspect of this ORV.

Habitat - The river provides exceptionally high quality habitat for fish or aquatic species indigenous to the region. Of particular significance is habitat for wild stocks and/or federal or state listed (or candidate) threatened, endangered or sensitive species. Diversity of habitats is an important consideration and could, in itself, lead to a determination of outstandingly remarkable.

Fish and Aquatic Resources Description

Populations:

The Fossil Creek renovation created a pure native fish community in over 16.5 km of stream above the barrier (Weedman et al. 2005). Nine federally listed or Forest Service sensitive fish species either are present or have suitable habitat in the Fossil Creek CRMP analysis area (Table 3). Seven species are federally listed or candidate for listing. Four of the nine fish species are on the Southwestern Regional Forester's sensitive species list as of 2013. Fossil Creek is presently home to the largest number of native fish species protected from nonnative fish impacts in Arizona. Native fish (Table 3) include headwater chub (*Gila nigra*), roundtail chub (*Gila robusta*), speckled dace (*Rhinichthys osculus*), longfin dace (*Agosia chrysogaster*), Sonora sucker (*Catostomus insignis*), and desert sucker (*Pantosteus clarki*). Recently (2007-2011) Arizona Game and Fish Department and U.S. Fish and Wildlife Service repatriated spikedace (*Meda fulgida*), loach minnow (*Tiaroga cobitis*), Gila topminnow (*Poeciliopsis occidentalis occidentalis*), and razorback sucker (*Xyrauchen texanus*) to the stream. Longfin dace (Tangle Creek, AZ lineage), although already present in Fossil Creek, was also stocked to augment the native Fossil Creek population.

In addition, three Forest Service sensitive macroinvertebrates are present or have suitable habitat in the Fossil Creek CRMP analysis area (Table 3). Fossil springsnail (*Pyrgulopsis simplex*) is endemic to the Fossil Creek basin. Limited surveys for springsnails have occurred in the Fossil Creek watershed. Northern Arizona University conducted surveys between 2002 and 2006 and documented springsnails in six out of eight springs surveyed (Marks et al., 2009). Fossil springsnail is present in several springs in the Fossil Creek watershed, but research by Martinez and Hedwall (2013) indicates that several of these documented sites have desiccated. Fossil Creek contains a high diversity of macroinvertebrates compared to other southwestern streams, with well over 100 macroinvertebrate species (Northern Arizona University, 2005). Suitable habitat also exists for two other Forest Sensitive macroinvertebrate species (Table 3).

Table 3. Threatened, endangered, and sensitive fishes and macroinvertebrates expected to occur in the Fossil CRMP analysis area.

Species	Status[1]	Occurrence[2]
Fish		
Colorado pikeminnow *Ptychocheilus lucius*	Endangered, WC Experimental, Non-Essential	O
Razorback sucker *Xyrauchen texanus*	Endangered, WC	O, Δ, CH
Loach minnow *Tiaroga cobitis*	Endangered, WC	O, Δ, CH
Spikedace *Meda fulgida*	Endangered, WC	O, Δ, CH
Gila topminnow *Poeciliopsis occidentalis*	Endangered, WC	O**,** Δ
Roundtail chub *Gila robusta*	Candidate, WC, FS-S	O
Headwater chub *Gila nigra*	Candidate, WC, FS-S	O
Desert sucker *Pantosteus clarki*	FS-S	O
Sonora sucker *Catostomus insignis*	FS-S	O
Macroinvertebrates		
Fossil springsnail *Pyrgulopsis simplex*	FS-S	O
California Floater *Anodonta californiensis*	FS-S	H
A caddisfly *Wormaldia planae*	FS-S	O

[1]Status:

- 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 (USFS, Southwestern Region, Regional Forester's List – 21 September 2007, and updated October 2007)

[2]Occurrence:

- O = Species known to be extant, or occur in the general vicinity.
- H = Species not known to occur in Fossil Creek, but whose suitable or potential habitat does.
- Δ = Species recently stocked into Fossil Creek
- CH = Species has critical habitat in or immediately downstream of project area.

Populations of native aquatic species in Fossil Creek continue to adjust to the predator-free and natural flow environment and have not reached equilibrium since dam removal and installation of the downstream fish barrier. Since restoration, however, there was a 50 fold increase in the relative abundance of native fish (Marks et al 2010). These numbers appear to be declining somewhat (Marsh et al 2010). There is a steep decrease in relative abundance of native fish at two sites that are less than a half kilometer downstream from the Purple Mountain site (M.

O'Neill and D. Petersen, Arizona Game and Fish Department, unpublished data). The cause of this decline is unknown.

Prior to renovation, nonnative green sunfish (*Lepomis cyanellus*) invaded Fossil Creek from the Verde River or were illegally released into the stream. Nonnative smallmouth bass (*Micropterus dolomieu*) also invaded Fossil Creek and were present from the Verde confluence upstream to a large waterfall acting as a fish barrier located about 5 km below the old Fossil Springs Diversion Dam. There are records of yellow bullhead (*Ameiurus natalis*) downstream of Sally May Wash (AGFD unpublished data), plus several other nonnative fishes that occasionally enter lower Fossil Creek from the Verde River.

Fishing

After dam removal, the return of natural water flows, and the restoration of native fish species in Fossil Creek, the Arizona Game and Fish Commission approved creating the country's first-ever blue ribbon catch-and-release-only seasonal roundtail chub fishery along four miles of Fossil Creek starting in October of 2009 (season is the first Saturday in October through April 30th). Although the fishery is somewhat controversial, many anglers enjoy fishing for native species in their native habitat, an opportunity that is rare in Arizona where most native fisheries have been depleted.

PAOT (People at one Time)

High numbers of recreationists can have direct negative impacts to aquatic species and their habitat in several ways. Fish can be displaced from favored habitats as a result of recreational swimming and diving. Higher numbers of recreationists can also increase the likelihood of introduction of non-native invasive species, which are highly detrimental to native southwestern fish species.

The Visitor Use Data Collection Project (Rotert 2012) indicates that 56% of the visitors to the Fossil Creek Wild and Scenic Corridor go there to swim. Based on available parking, the number of people that are presently able to access the corridor is estimated at 1100 PAOT. This means that, under current conditions and at any given time, as many as 616 people may be swimming in Fossil Creek. This undoubtedly has a negative impact on native fish in the creek, especially the larger species (chub and suckers) which prefer deeper pools, and is where swimmers are more likely to be.

Temporary Barrier

During the winter of 2009/2010 an unusually large flood deposited a slug of boulders, cobbles, and other sediments on the downstream side of the fish barrier and removed a natural abutment. This event was exacerbated by unstable channel conditions resulting from the return of flows to a stream that had been dewatered for over 90 years. The loss of the abutment and the deposited slug of boulders and sediment reduced the effective drop of the fish barrier. Monitoring by the Coconino National Forest and Arizona Game and Fish Department (AGFD) at the end of July 2011 resulted in the detection of smallmouth bass in Fossil Creek, mostly just upstream of the barrier, but an individual was detected as far upstream as 1/8 mile downstream of Sally May Wash.

A temporary barrier was quickly installed upstream to contain the nonnative fish. Following that, the estimated 80 ton-slug of boulders and sediment below the barrier was removed using a specialized Wilderness crew from the Gallatin National Forest. Methods employed were entirely non-motorized and non-mechanized and included breaking up large boulders with blasting as well as sledge hammers and star bit drills, and redistributing boulders and sediment away from the barrier using grip hoists and rock bars. Except for replacing a natural boulder in the barrier that was lost during flooding, the effective drop of the barrier was restored by removing this sediment.

In September of 2012, AGFD, FWS, and FS successfully salvaged and treated the infested reach. Prior to treatment, a salvage operation was employed to relocate target native fish (certain age classes) from the reach to be moved above the temporary fish barrier. Native fish were salvaged using baited hoopnets, trammel nets, minnow traps, electro-fishing and angling. The piscicide treatment (using rotenone) was conducted using rotenone-coated sand for pools, backpack sprayers for slack water, and drip buckets for riffles. The rotenone treatment was stopped by detoxification using sodium permanganate at the bottom end of the treated reach. Due to the amount and weight of chemicals, an MRDG analysis was completed and approved in May 2012 that recommended the use of a helicopter for sling load delivery of concrete, equipment, and supplies and some use of motorized tools. NEPA was also completed.

In March of 2013, the BOR and a contract construction crew repaired the permanent fish barrier by constructing a concrete boulder in the gap left when a natural boulder was blown out by floods. This concrete work effectively restored the four foot drop required to prevent non-native fish from moving upstream.

In April of 2013, the BOR, USFWS, USFS, and a contract crew deconstructed the temporary fish barrier over a period of 5 days. The temporary barrier remained in place until the permanent fish barrier was repaired. It was subsequently removed.

Habitat

Fossil Creek is located in the Mazatzal Mountains of central Arizona, and forms the boundary between Yavapai and Gila Counties, as well as the Tonto and Coconino National Forests over most of its course. Fossil Creek is one of Arizona's rare warm water perennial streams, flowing from a complex of springs, known as Fossil Springs, 23 km through rugged and isolated terrain before entering the Verde River.

Base flows from Fossil Springs are about 43 cfs (Weedman et al. 2005). For nearly a century, however, flows in Fossil Creek were diverted for hydropower generation, and nonnative fish invaded a large portion of the stream. In 2004, a multi-partner fisheries restoration project was initiated. A fish barrier was constructed on the lower portion of Fossil Creek (4.5 miles (7.2 km) above the confluence with the Verde River), and nonnative fish species were removed from Fossil Creek (Weedman et al. 2005). The fish barrier was constructed to prevent upstream incursion of nonnative species from the Verde River. Full flow was restored to Fossil Creek in 2005 after decommissioning the Childs-Irving Power Plant.

Carter (2007) and other cooperators conducted a visual survey of aquatic habitat in Fossil Creek during fall 2007. The goal of this work was to find suitable habitat for native fish species that were to be repatriated into the stream (spikedace, loach minnow, Gila topminnow, desert pupfish, and razorback sucker). Fossil Creek upstream from the fish barrier was surveyed. The stream was divided into three reaches. The lower reach (from the barrier upstream to the lowest road access point) was described as being canyon-bound with a steep gradient, turbulent riffles, boulder-cobble substrate, deep pools, and deep runs. Fine sediment was also present, likely generated from a nearby dirt road (Carter 2007). Habitat in this reach appeared best suited for razorback sucker, but not the other fish species proposed for repatriation. This reach supports sizeable populations of roundtail chub, desert sucker, Sonora sucker, and longfin dace; speckled dace is present in low abundance.

The middle reach (from the lowest road access point upstream to the former Irving power plant) was dominated in 2007 by travertine formation. There was a larger diversity of habitat in this reach, with some loach minnow habitat offered by shallow riffles. Towards the upper end of this reach, more habitat typical of Gila topminnow and desert pupfish was available (Carter 2007) with an increase in abundance of backwaters and vegetated stream margins. The middle reach supports all five native fishes that were present pre-renovation.

The upper reach (Irving power plant upstream to the Fossil Springs dam and a small stretch of stream between the diversion dam and Fossil Springs) contained yet more habitat complexity, with variable gradient, current, depth, and substrates. Travertine formation continues upstream from the former Irving power plant to about 1.25 miles (2 km) downstream from the old diversion dam. Findings in 2007 for each species were as follows: 10 stretches of riffle habitat suitable for loach minnow; 10 stretches of glide-run habitat for spikedace; three backwaters suitable for Gila topminnow and desert pupfish, and two springs suitable for topminnow. From the diversion dam to the springs, there was no travertine formation, and Fossil Creek appeared more typical of other nearby streams (Carter 2007). More riffle habitat for loach minnow, run-glide habitat for spikedace, and a few more spring sites and backwaters were also found, and appeared appropriate for topminnow and pupfish repatriation. The upper reach supports four native fishes present pre-renovation; longfin dace is present in low abundance.

The stream sustained extreme winter flooding in 2008 and 2010 and it appears that the only repatriated fish species (see above) to established itself in Fossil Creek is Gila topminnow. It is too early to determine if this species will survive in Fossil Creek in the future. Initial observations indicate that the flooding that occurred in January of 2010 redistributed stream substrates and destroyed many of the travertine dams throughout the system, changing or removing many pool and side-channel habitats (including riparian vegetation) that had developed behind them (Marsh et al. 2010). The system is dynamic, much as it was prior to the early 1900s. Far from being a detriment to native aquatic species, natural flooding and related habitat changes are generally beneficial, removing substrate embeddedness, and redistributing both sediments and nutrients into the riparian zone and downstream. Recent habitat changes in Fossil Creek do not appear to have harmed the previously established native fish species

(Marsh et al. 2010), providing further evidence that native Gila basin fish are well-adapted to flooding (Meffe and Minckley 1987).

Finding

Fish and aquatic resources are outstandingly remarkable in Fossil Creek. Fossil Creek is home to a diverse native fish community, presently comprised of 9 endangered, threatened, candidate or Forest sensitive species. This diverse community is unique in Arizona, and presently flourishes because of the removal of nonnative fish from the system. High quality and diverse habitats for native fish contribute to the finding of outstandingly remarkable.

High water quality and a wide diversity of habitat types also support a wide diversity of macroinvertebrates species. Macroinvertebrates provide the food base for many native fish, and the wide diversity of these species in the system is unique in its own right. The interdependence among Fossil Creek native fish, invertebrates, and their ever-changing habitat, certainly contributes to the finding of outstandingly remarkable.

Biological (Wildlife)

Criteria for Outstandingly Remarkable

Populations - The river or area within the river corridor contains nationally or regionally important populations of indigenous wildlife species. Of particular significance are species considered to be unique and/or populations of federal or state listed (or candidate) threatened, endangered or sensitive species. Diversity of species is an important aspect of this ORV.

Habitat – The river, or area within the river corridor, provides exceptionally high quality habitat for wildlife of national or regional significance, and/or may provide unique habitat or a critical link in habitat conditions for federal or state listed (or candidate) threatened, endangered, or sensitive species. Contiguous habitat conditions are such that the biological needs of the species are met. Diversity of habitats is an important consideration and could, in itself, lead to a determination of "outstandingly remarkable".

Wildlife Description

The following wildlife evaluations are based on comparisons with other wildlife and habitat in the Central Highlands Planning Area and are greatly summarized here.

Populations:

A high diversity of indigenous wildlife is present in Fossil Creek. Based on actual observations during limited wildlife surveys, Fossil Creek and its associated riparian habitat support roughly 200 known bird, mammal, reptile, and amphibian species. There is potential for an additional 300 species of mammals, birds, reptiles, and amphibians to be present along Fossil Creek based on the diverse habitat available.

There are about eighty special status species that are present or potentially present within the Fossil Creek drainage. Special status species include federally-listed or proposed species, Forest Service sensitive species, Forest Service Locally Important Species, Forest Service management indicator species, and federal and state identified neotropical migratory birds. Special status wildlife species that are known to occur, or have existing or potential habitat, include six federally-listed or proposed species (Mexican spotted owl, southwestern willow flycatcher, western yellow-billed cuckoo, northern Mexican gartersnake, narrow-headed gartersnake, and Chiricahua leopard frog), 17 Forest Service sensitive species (Table 4), 27 Forest Service management indicator species (Table 5), and 27 neotropical migratory birds (Table 6).

Birds

A number of bird species of regional significance occur near or along Fossil Creek. Common black-hawks, a Forest Service management indicator species, nest all along Fossil Creek. The Common black-hawk is a riparian obligate and is considered a species of concern throughout much of its range in the southwestern United States, in part due to human-caused threats to riparian habitat. Previous studies indicated that native fish and amphibians were important prey delivered to nestlings, but these prey have undergone significant declines in many riparian systems. In 2008 and 2009, a study documented prey delivery to 18 nests in four tributaries of the Verde River drainage in central Arizona (Etzel, 2010). In Fossil Creek, fish dominated the composition of prey brought to nests and this distinguished nests in this drainage from the

other three (Oak Creek, Wet Beaver Creek, Red Tank Draw). In 2005, a large-scale aquatic restoration in Fossil Creek removed non-native fish and increased water flow (Weedman et al., 2005). Since the restoration, an increase in native fish populations of fifty-fold has been documented (Marks et al., 2010). The restoration of Fossil Creek may have created a scenario where diets of nesting black-hawks in Fossil Creek were more similar to historical diets due to an increase in native fish abundances.

While Mexican spotted owls are only known to nest just outside of the Fossil WSR corridor, they historically nested in the riparian area, likely use the corridor for foraging during the breeding season, and may spend considerable time in the corridor during the winter. The Fossil corridor is considered recovery riparian habitat for the Mexican spotted owl.

Suitable habitat for both the Southwestern willow flycatcher and yellow-billed cuckoo exists in Fossil Creek. Limited surveys have failed to result in detections of these two species, however surveys efforts continue. Fossil Creek is capable of supporting populations of cuckoos and flycatchers, especially as these species recover and reoccupy their historic range.

Other special status birds in the Fossil WSR corridor include bald and golden eagles, zone-tailed hawk, American dipper, Bell's vireo, Lucy's warbler, belted kingfisher, peregrine falcon, and Costa's hummingbird, Other uncommon or special status birds observed in Fossil Creek WSR corridor include osprey, Gila and Lewis' woodpeckers, yellow warbler, hairy woodpecker, violet-green swallow, western bluebird, western wood and greater pewees, juniper titmouse, Ash-throated flycatcher, gray vireo, Townsend's solitaire, northern flicker, spotted towhee, black-chinned and black-throated sparrows, canyon and spotted towhees, yellow-breasted chat, summer tanager, hooded oriole, Cordilleran flycatcher, gray vireo, black-throated gray warbler, loggerhead shrike, Costa's hummingbird, Crissal thrasher, phainopepla, olive warbler, Grace's warbler, Virginia's warbler, flammulated owl, purple martin, pinyon jay, gray flycatcher, black-throated gray warbler, band-tailed pigeon, loggerhead shrike, sage sparrow, Bendire's thrasher, Lawrence's goldfinch, elf owl, and American bittern.

Mammals

Mammal species of significance known to occur in the Fossil corridor include Arizona gray squirrel, a high diversity of bat species, beaver, river otter, ring-tailed cat, coatimundi, and various game species.

Arizona gray squirrels are riparian obligates and their populations have declined concurrent with the loss of southwest riparian woodlands. They are uncommon and only occur in limited canyons within Central and Southern Arizona where water, walnuts, and acorns are available. Arizona gray squirrels occur in all reaches of Fossil Creek. Their warning calls are often heard before they are seen foraging on the ground or hopping through the canopy of riparian trees.

Bat surveys in Fossil Creek have documented 16 of the 28 species found in Arizona. The dominant species captured were Mexican free-tailed bat, pallid bat, and California myotis. Forest Service Sensitive species captured included Allen's lappet-browed, Townsend's big-eared, and red bats. Other interesting species captured included cave myotis, big free-tailed bat and pocketed free-tail bat. A fascinating finding from a 2011 effort was the dominance of

reproductive females; 90% of the 105 females captured were pregnant, lactating, or post-lactating. Despite few bat roost inspections, several occupied bat roosts are known to occur in cliff dwellings. However, other roosts likely occur in natural structures such as underneath loose bark on snags, in tree and snag cavities, under rocks, in the cracks and crevices of cliffs, and in man-made structures such as bridges, buildings, and flume tunnels. Water sources such as earthen stock tanks, springs, seeps, and streams are important for bat drinking (lactating females lose a third of the their body weight during each 12 hour roosting period) and for foraging (due to the abundance of insects originating from or flying above the stream).

Beaver are important for their role in creating dams; the resulting pools create wetland habitat capable of supporting even more aquatic and terrestrial species than a purely riverine system. Another riparian obligate, the Southwestern river otter likely occurred in Fossil Creek, since they occurred in the Verde River, but they are thought to now be extirpated. While otter are currently present in Fossil, it is likely they are the Louisiana subspecies of otter introduced into the Verde River in the 1980's rather than the native southwestern river otter that is considered extinct.

While not all are special status species, there are many game mammals in Fossil Creek. Rocky mountain bighorn were introduced into the West Clear Creek area in 2006. Since then populations have established in various portions of the Fossil W&S corridor. The Fossil area is popular with hunters for hunting javelina, mountain lion, bear, mule deer and white-tailed deer. Other game species in the Fossil Creek area include elk, bobcat, gray fox, coyote, raccoon, cottontail and jackrabbits, squirrels, and raccoons.

Non-game mammal species include chipmunks, mice, rats, woodrats, skunks, ring-tailed cats, coatimundi, and numerous species of bats. Several species of skunks occur primarily within riparian and other vegetative zones within close proximity to riparian areas and are especially abundant in high use areas due to the presence of camp supplies and trash. Rock squirrels, cliff chipmunks, white-footed mouse, western harvest mouse, brush mouse, and white-throated woodrat are a few small mammal species that occur within the Fossil corridor.

Reptile and Amphibians

Reptile and amphibian species of significance in the Fossil corridor include several species of leopard frogs and garter snakes. The only viable population of lowland leopard frogs on the Coconino National Forest persists in Fossil Creek. Prior to the restoration of the native fishery in 2004 and restoration of full flows in 2005, lowland leopard frogs only persisted above the Fossil Springs dam and were at record low numbers. Since restoration efforts, these frogs are recovering and recolonizing below the historic Fossil Springs dam downstream below the large falls but not so much downstream of Irving. Due to restoration efforts, complex habitat, lack of non-native fish, and limited crayfish, the lowland leopard frog population within Fossil Creek is the most secure population in the entire region.

Chiricahua leopard frogs occur at higher elevations and are present within the upper watershed of Fossil Creek.

While narrow-headed garter snakes and northern Mexican garter snakes have not been detected in Fossil Creek, narrow-headed garter snakes have been detected along the Verde near Fossil confluence. It is unknown whether these two gartersnake species historically occurred in Fossil Creek because there were no herpetological surveys prior to hydropower operations (and the resulting changes in habitat due to dewatering) at the turn of the 20th century. The travertine-dominated portion of Fossil Creek with its dense aquatic vegetation, pools, and slower flows, provides optimal habitat, especially for the northern Mexican gartersnake.

Arizona toad historically occurred in Fossil but intensive herp surveys have not detected any juveniles or adults. Arizona toads hybridize with woodhouse toads resulting in swamped genetics. Toad tadpoles are frequently observed during surveys, but they are difficult to identify to species.

Gila monsters are relatively frequently sighted in the Fossil W&SR corridor as well as along the 708 road out to Hwy 260.

Other special status herp species observed in Fossil Creek WSR corridor include Arizona black rattlesnakes, Gila spotted whiptail lizard, and Sonora mud turtle.

Table 4- Forest Service Sensitive Species List for Fossil Creek WSR Corridor

Common Name	Scientific Name
Mammals	
Western Red Bat	*Lasiurus blossevillii*
Spotted Bat	*Euderma maculatum*
Allen's lappet-browed Bat	*Idionycteris phyllotis*
Pale Townsend's Big-eared Bat	*Corynorhinus townsendii pallescens*
Birds	
Bald Eagle	*Haliaeetus leucocephalus*
American Peregrine Falcon	*Falco peregrinus anatum*
Common Black-hawk	*Buteogallus anthracinus*
Northern Goshawk	*Accipiter gentilis*
Abert's Towhee	*Pipilo aberti*
Reptiles and Amphibians	
Narrow-headed Gartersnake	*Thamnophis rufipunctatus*
Lowland Leopard Frog	*Lithobates yavapaiensis*
Northern Leopard Frog	*Lithobates pipiens*
Arizona Toad	*Bufo microscaphus microscaphus*
Reticulated Gila Monster	*Heloderma suspectum suspectum*
Invertebrates	
Nokomis Fritillary	*Speyeria nokomis nokomis*
Nitocris Fritillary	*Speyeria nokomis nitocris*
Four Spotted Skipperling	*Piruna polingii*

Table 5 - Management Indicator Species within Fossil Creek WSR Corridor

Species	Indicator Habitat
Abert squirrel	Early seral ponderosa pine
Northern goshawk	Late seral ponderosa pine and vertical diversity in p. pine.
Pygmy nuthatch	Late seral ponderosa pine
Turkey	Late seral ponderosa pine
Elk	Early seral ponderosa pine, mixed conifer, and spruce-fir
Hairy woodpecker	Snag component of ponderosa pine, mixed conifer, and spruce-fir
Violet-green Swallow	Cavity nesting habitat in ponderosa pine
Western bluebird	Forest openings in ponderosa pine
Mule deer	Early seral aspen and pinyon-juniper
Juniper (Plain) titmouse	Late seral and snag component of pinyon-juniper
Pronghorn	Early and late seral grasslands
Ash-throated flycatcher	Ground cover in pinyon-juniper
Gray vireo	Tree density in pinyon juniper
Townsend's solitaire	Juniper berry production
Northern Flicker	Snags in pinyon-juniper woodlands
Spotted Towhee	Successional stages of pinyon-juniper and shrub diversity in chaparral
Black-chinned sparrow	Shrub diversity in chaparral
Savannah sparrow	Grass species diversity in desert grassland
Black-throated sparrow	Shrub diversity in desert scrub
Canyon towhee	Ground cover in desert srub
Lucy's warbler	Low elevation riparian
Yellow-breasted Chat	Low elevation riparian
Bell's vireo	Well-developed riparian understory
Summer tanager	Tall mature riparian trees
Hooded oriole	Medium-sized riparian trees
Western wood pewee	Riparian
Common black-hawk	Low elevation riparian

Table 6 - Neotropical Migratory Birds within Fossil Creek WSR Corridor

Species	Relative Abundance	Status	Habitat Preference
Cordilleran Flycatcher	Uncommon	Summer	Ponderosa pine
Olive Warbler	Rare	Migrant	Ponderosa pine
Greater Pewee	Intermittent	Summer	Ponderosa pine
Grace's Warbler	Fairly Common	Summer	Ponderosa pine
Lewis' Woodpecker	Rare	Transient	Ponderosa pine
Flammulated Owl	Fairly Common	Summer	Ponderosa pine
Purple Martin	Uncommon	Summer	Ponderosa pine
Pinyon Jay	Fairly Common	Irregular	Pinyon-juniper
Gray Vireo	Rare	Summer	Pinyon-juniper
Gray Flycatcher	Uncommon	Summer	Pinyon-juniper
Black-throated Gray Warbler	Fairly Common	Summer	Pinyon-juniper
Band-tailed Pigeon	Fairly Common	Summer	Drainages in pinyon-juniper
Loggerhead Shrike	Fairly Common	Winter	Pinyon-juniper, chaparral, desert scrub, grasslands
Black-chinned Sparrow	Uncommon	Summer	Chaparral
Virginia's Warbler			Chaparral
Canyon Towhee	Fairly Common	Resident	Desert scrub
Costa's Hummingbird	Rare	Summer	Desert scrub
Crissal Thrasher	Fairly Common	Resident	Desert scrub
Sage Sparrow	Fairly Common	Winter	Desert scrub
Bendire's Thrasher	Rare	Summer	Desert scrub
Lawrence's Goldfinch	Intermittent	Migrant	Riparian, desert scrub, grasslands
Elf Owl (*whitneyi*)	Rare	Summer	Desert scrub, riparian
Bell's Vireo (*arizonae*)	Fairly Common	Summer	Riparian
Yellow Warbler (*sonorana)*	Common	Summer	Riparian
Gila Woodpecker	Common	Permanent	Riparian
Phainopepla	Common	Summer	Riparian
American bittern	Rare	Migrant	Riparian

Habitat

The conservation value of riparian areas is disproportionate to their spatial extent, particularly in arid and semi-arid environments (Miller et al., 2003). Riparian areas comprise less than 1% of the western landscape, but provide habitat for the majority of breeding bird species of the West. Less than one percent of the Coconino and Tonto National Forests are comprised of riparian areas, but riparian habitat is the most productive biotic community in the southwest. Riparian areas are a dwindling resource; in the Western U.S.; less than 20% of historic levels of riparian still exist (Belsky et al., 1999).

Confounding the loss of riparian habitat is the number of animals dependent either entirely or partly on riparian areas. Riparian areas harbor some of the most diverse avian assemblages in North America (Johnson et al., 1977) (Ohmart, 1994). Upwards of 80% of southwestern wildlife species (Chaney et al., 1990) and approximately 60 to 70 percent of western bird species completely depend on riparian areas (Ohmart, 1996). Breeding bird densities along the Verde River were found to be in excess of 800 pairs per 100 acres (Carothers et al., 1974). This

represents the highest avian population density per unit area ever recorded in North America (Johnson et al., 1977). Given that Fossil Creek is contiguous to the Verde River, and that the travertine in Fossil Creek supports even more complex habitat than the Verde River, it is very likely that breeding bird densities along Fossil Creek are similar to or even higher than those along the Verde River.

Riparian areas also provide critical resources for migrating birds (Stevens et al., 1977) (Knopf & Samson, 1994), (Skagen et al., 1998). Riparian corridors, in particular, facilitate faunal mixing on a broad, regional level (Knopf and Samson 1994), especially at the interface of different biomes or ecoregions (Sogge et al., 2005). When compared to other Verde tributaries (including the Verde River), Fossil Creek is the only intact perennial system with continuous flow without any water diversions in Arizona. Fossil Creek provides the only uninterrupted system between the Verde and the Mogollon Rim. This unfragmented system not only provides contiguous habitat for riparian obligates, it also provides a contiguous corridor for wildlife species moving through during dispersal or migration.

As stated in the fish and aquatic resources section, Fossil Creek's riparian area is unusual compared to most riparian areas because it is travertine-dominated. The deposition of travertine and creation of travertine dams has resulted in the impoundment of sediments and the formation of terraces that support a variety of submergent, floating, emergent, herbaceous, and shrubby habitat components. The floristic diversity of aquatic and riparian vegetation provides a variety of physical structures, which in turn supports a wider diversity of wildlife species. In addition to the floristic diversity, the presence of travertine has greatly increased the diversity of pools, riffles, glides, runs and backwaters, all of which provide a diverse array of habitat for numerous wildlife species.

In addition to the riparian habitat, where the floodplain widens, there are important areas of mesquite bosques adjacent to the riparian corridor. Mesquite bosques provide very critical nesting and foraging habitat for certain species such as yellow-billed cuckoo, Bell's vireo, Lucy's warbler, and verdin. While it is important to protect the riparian vegetation, it is also to maintain the adjacent mesquite bosques.

The presence of introduced plants and weeds from historic and ongoing human disturbance in Fossil Creek is evident in most sections of the creek from the springs down to the confluence of Fossil Creek with the Verde River. Even though the Coconino NF has continued to treat the high priority invasive species along the riparian corridor invasive weed populations continue to expand, even though the forest had increased survey and treatment efforts. There has been a similar increase in the number of individual populations of class A species mapped in the project area, indicating a rapid rate of spread.

Findings

Wildlife is outstandingly remarkable for both populations and habitat.

Populations

Although thorough surveys are limited, Fossil Creek and its associated riparian habitat is known to support roughly 200 bird, mammal, reptile, and amphibian species. There is potential for an

additional 300 species of to be present along Fossil Creek. There are roughly 80 special status species present or potentially present within the Fossil Creek drainage. The diverse habitat, along with portions free of non-native fish and crayfish, support regionally important populations of species such as the common black hawk and the lowland leopard frog. The high diversity and abundance of wildlife and rare species, and the regional importance of the riparian area for several rare species exemplify the outstandingly remarkable values offered by Fossil Creek.

Habitat

Fossil Creek is the only intact perennial system with continuous flow without any water diversions in Arizona. Fossil Creek provides the only uninterrupted system between the Verde and the Mogollon Rim, and spans and connects a number of biotic communities from upper Sonoran desert scrub up through ponderosa pine forests. This unfragmented system not only provides contiguous habitat for species that can only survive in riparian habitat, it also provides a contiguous corridor for wildlife species moving through during dispersal or migration. In the travertine-dominated reaches, the deposition of travertine and creation of travertine dams has resulted in the impoundment of sediments and the formation of terraces that support a variety of submergent, floating, emergent, herbaceous, and shrubby habitat components. The floristic diversity of aquatic and riparian vegetation provides a variety of physical structures, which in turn supports a wider diversity of wildlife species. In addition to the floristic diversity, the presence of travertine has greatly increased the diversity of pools, riffles, glides, runs and backwaters, all of which provide a diverse array of habitat for numerous wildlife species. The diversity of this unique habitat demonstrates the outstandingly remarkable wildlife habitat of Fossil Creek.

Pre-History

Criteria for Outstandingly Remarkable

The river or area within the river corridor contains a site(s) where there is evidence of occupation or use by Native Americans. Sites must have rare or unusual characteristics or exceptional human-interest value(s). Sites may have national or regional importance for interpreting prehistory; may be rare and represent an area where a culture or cultural period was first identified and described; may have been used concurrently by two or more cultural groups; or may have been used by cultural groups for rare or sacred purposes.

Pre-History Description

The Fossil Creek Wild and Scenic River corridor is known to contain archaeological evidence of the occupation and agricultural modification and use of the Fossil Creek floodplain, terraces, and hill slopes by people from prehistoric to modern times. There is evidence of the occupation of people related to the prehistoric Hohokam and Southern Sinagua cultural traditions over a period of at least 600 years, and there may be sites from as long ago as 10,000 to 12,000 years.

The bulk of the prehistoric material known from the Fossil Creek WSR corridor is ascribed to one or the other of two central Arizona archaeological traditions—Hohokam and Southern Sinagua. There have not been any formal archaeological excavations of any sites within the corridor, so it is difficult to assign sites from the early agricultural period to either of these cultures with any certainty. Eventually, a recognizable cultural boundary developed sometime around 1300 AD in roughly the same location as Fossil Creek. To the north, the settlements along the Verde River appear to have been tied, related, or allied with those in the Middle Verde Valley. For the most part, these sites are assigned to the Southern Sinagua cultural tradition. To the south, the sites appear to have been part of a cultural development that spread east and west on both sides of the Verde River from the Agua Fria River to the Tonto Creek divide, known informally as the “Verde Hohokam”.

Finding

Many of the sites within the Fossil Creek WSR corridor meet the criteria to be listed on the National Register of Historic Places. However, none of these sites is substantially different from numerous sites found in the Verde Valley and along the Mogollon Rim. The differences between the prehistoric sites inside and outside the corridor would not be obvious to the typical Fossil Creek WSR visitor. There is nothing known from the archaeological record indicating that Fossil Creek fostered any unique prehistoric cultural developments. Although clearly significant, the prehistory of Fossil Creek does not rise to the level of outstandingly remarkable.

Apache and Yavapai Traditional and Contemporary Cultural Values ORV

Criteria for Outstandingly Remarkable

The river or area within the river corridor contains a site(s) or feature(s) associated with a significant event, an important person, or a cultural activity of the past or present that was or is rare, unusual, or one-of-a-kind in the region. Many such sites are listed on the National Register for Historic Places, which is administered by the National Park Service. A historic site(s) and/or feature(s) in most cases is 50 years old or older. There may also be locations of exceptional cultural value or importance to Indian tribes.

History and Traditional Cultural Uses Description

There were two notable concurrent historic occupations of Fossil Creek, one by the indigenous Apache and Yavapai and one by Anglo engineers and workers associated with hydropower generation.

Apache and Yavapai

The occupation of the Fossil Creek WSR corridor by the Apache and Yavapai began several millennia ago and extends into the 1950s. The archaeological evidence is not conclusive, but some researchers have suggested that the Yavapai entered the Verde Valley as early as the 13th Century (Pilles, 1981). The details surrounding the arrival of the Apache are equally uncertain, but the Apache likely had entered the area by 1500 AD (Gilpin et al., 2003) (KenCairn & Randall, 2007). Both groups have occupied Fossil Creek at least intermittently since their arrival in the Verde Valley. Certain Apache and, to a lesser extent, Yavapai clans consider Fossil Creek to have been a central part of their home territory from the beginning of memory (Randall et al., 2009). Although both the Yavapai and Apache lived a nomadic lifestyle, the Apache in particular developed farmland along Fossil Creek and would have returned seasonally to plant and harvest crops.

The Apache likely would have been in residence along Fossil Creek when the first Europeans made their way into what is now Arizona, although the early Spanish explorers never set foot in Fossil Creek. The rough terrain surrounding Fossil Creek initially would have insulated the WSR corridor from the incursion of Anglo settlers that began streaming into the Verde Valley in the 1860s. Life along Fossil Creek probably remained largely unchanged until the late 1860s and 1870s, when the U.S. Cavalry pursued an active campaign against the Yavapai and Apache throughout Central and Southern Arizona.

Then everything changed in just a few short years. By 1873, only a few families were living in secrecy along Fossil Creek, remaining hidden from government troops. Some of these families survived through the entire Reservation Period (approximately 1871 until 1900) without ever being sent to San Carlos (Pilles, 1981) (Randall et al., 2009). These few individuals provided an unbroken cultural continuum between the people whose traditional religious practices predated contact with Anglo settlers and those who were either forced or born onto reservations and subjected to practices aimed at erasing their traditions during the roughly 30 years of incarceration. It would be impossible to measure the import of the individuals who

spent this period living isolated along Fossil Creek in renewing the traditional culture among those who eventually returned from San Carlos.

Once the threat of Indian raids had been eliminated, settlers started to explore Fossil Creek. However, the geology of Fossil Creek provides little arable land, and there is scant evidence that non-Indians spent much time along Fossil Creek in the 1800s. An isolated parcel of land was homesteaded in 1906, but very little is known about how the homesteaders fit into the larger history of Fossil Creek.

The seclusion of Fossil Creek changed in 1900. This is the year Lew Turner filed for water rights in Fossil Creek. This set the stage for the long process that eventually resulted in the development of the Childs-Irving Power System (Effland & Macnider, 1991). The rough topography of the area has always made Fossil Creek an isolated place, even to this day, but the construction of the power plant brought with it the bustle of activity that would continue for more than a century.

The construction of Childs-Irving played a critical role in the return of the Yavapai and Apache to Fossil Creek. Both the Yavapai and Apache were beginning to leave the reservations at San Carlos, Fort McDowell, and elsewhere in the early 1900s. Many returned to familiar places along the Verde River and the Mogollon Rim, only to find that settlers had taken over their traditional homelands. Others left the reservations in search of wage jobs. This sudden flood of Indians in need of employment and space where they would be allowed to set up camps for their families coincided with the need for huge amounts of manual labor to construct the Childs-Irving system. Many Apache and Yavapai found jobs working along Fossil Creek. Some of them brought their families and stayed, either doing maintenance on the power generating system after initial construction was completed or farming along Fossil Creek.

The construction of the power system provided employment for a large number of Apache and Yavapai who were just moving off the reservation at San Carlos and trying to make new lives in the face of huge changes that had occurred on their traditional lands during their 30-year absence. It provided an economic support system located within a familiar landscape filled with spiritual meaning for these families to rebuild their lives after decades spent on reservations. Whether they worked for the power company or not, the families newly returned from the reservations would have reconnected with the individuals who managed to survive along Fossil Creek through the Reservation Period. The return of people to their traditional territory, rich with mythical significance, and a reconnection with traditional practitioners who escaped the effects of reservation life likely reinvigorated traditional religious practices.

By the mid 1950s, much of the work in the power plants had been automated, and very few Indians remained on the payroll. Their farms had also been abandoned as families moved onto reservation lands in the Verde Valley or closer to towns where wage jobs were easier to find. The last of the Apache camps were bulldozed by APS in the early 1950s, thus ending the long history of Apache and Yavapai residential occupation of Fossil Creek forever (Randall et al., 2009). Traditional Apache camps left little permanent archaeological evidence, and the sites in the Fossil Creek WSR corridor are no exception. However, Fossil Creek continues to be

recognized as a place of special religious importance to many traditional Apache and Yavapai (KenCairn & Randall, 2007) (Krajl & Randall, 2009) (Randall et al., 2009).

Childs-Irving Hydroelectric Project

Fossil Creek was the site of the first hydrologic power system in Arizona, which facilitated the development of mines in the Prescott, Jerome, and Humboldt areas. These mines did much to drive the economy of Arizona, and the metals they produced helped the United States build a place for itself among the leading nations of the world. Childs-Irving was also supplying up to 70% of the power for Phoenix in 1920 (Effland & Macnider, 1991). The Childs-Irving system was listed on the National Register of Historic Places in 1991 to recognize both its accomplishment as an engineering and construction feat and its contribution to the economic development of Arizona.

The process of returning natural flows to Fossil Creek led to the dismantling and removal of much of the Childs-Irving power generating system over the past decade. There is scant evidence of this astonishing engineering accomplishment left on the landscape. Even the small communities that generations of plant workers and their families called home are hardly recognizable. There are still interpretive opportunities related to the power system, but the significance of the remaining features would not be obvious to the typical visitor without specific explanation.

Traditional and Contemporary Cultural Use

It is impossible to unravel the sacred from the secular when considering the traditional cultural use of any landscape by Indian tribes. However, Fossil Creek and the canyon it lies in clearly rise to the highest level of importance for tribes. The Apache and Yavapai occupied the Fossil Creek WSR corridor from sometime in prehistory through historic times. This area plays prominently in their mythologies. The Apache maintain many place names associated with features in and adjacent to the corridor (North, Senior, & Foster, 2002)(Vincent Randall and Chris Coder, personal communication, March 30, 2011). Fossil Creek plays a role in several Apache creation stories and other significant stories (Krajl & Randall, 2009) (Krajl & Randall, 2009). Apache elders have identified several locations within the corridor as being “holy” (significant beyond that connoted by “sacred”) (Vincent Randall and Chris Coder, personal communication, March 30, 2011; Bob Bear, personal communication, March 12, 2013). Apache elders with the Yavapai-Apache Nation have requested that the Coconino and Tonto National Forests assist them in nominating a portion of the Fossil Creek WSR corridor to the National Register of Historic Places as a Traditional Cultural Property. Both the Yavapai and Apache continue to conduct ritual visits to Fossil Creek. The tribes have clearly demonstrated that Fossil Creek has exceptional traditional cultural value to various Apache and Yavapai groups (Randall et al., 2009).

Finding

Fossil Creek played a significant role in two interconnected stories that were occurring in the first half of the 20th century. Unfortunately, there is very little visible evidence left to attest to the fascinating history of hydropower generation that has played out along Fossil Creek over

the past 100+ years. The interpretive opportunities that remain would certainly benefit visitors but are not outstandingly remarkable.

However, the corridor holds exceptional cultural value to several local tribes. Fossil Creek was a traditional territory of the Yavapai and Apache, and it was one of the first places that many families returned to after being allowed to leave distant reservations. The Yavapai-Apache Nation has provided oral evidence that Fossil Creek has in the past and continues to play an important role in their traditional practices and spiritual wellbeing. Thus, history, and traditional and contemporary cultural uses as it relates to past and modern tribal use is an outstandingly remarkable value.

Riparian Communities and Botany

Criteria for Outstandingly Remarkable

Populations - The river, or area within the river corridor, contains nationally or regionally important populations of indigenous plant species. Of particular significance are species considered to be unique and/or populations of federal or state listed (or candidate) threatened, endangered, or sensitive species. Diversity of species is an important consideration and could, in itself, lead to a determination of outstandingly remarkable.

Habitat - The river, or area within the river corridor, provides exceptionally high quality habitat for plant species indigenous to the region. Of particular significance is habitat for federal or state listed (or candidate) threatened, endangered or sensitive species. Diversity of habitats is an important consideration and could, in itself, lead to a determination of outstandingly remarkable.

Riparian Communities and Botany Description

The riparian community and associated botanical features are being assessed within the Central Highlands Planning Area. Streams and rivers used to provide comparisons to Fossil Creek riparian vegetation include Tonto Creek, Tangle Creek, East Verde River, Haigler Creek, Canyon Creek, West Clear Creek, Oak Creek, Wet Beaver Creek, Dry Beaver Creek, and Christopher Creek. Within the Central Highlands planning area, riparian vegetation is described as being composed of mixed broadleaf, cottonwood-willow, mesquite, and strand vegetation (riparian-obligate plants adapted to flood events).

At a broad scale, riparian areas in the western United States comprise less than one percent of the landscape, making them a unique feature in Arizona. Of that one percent, an estimated 95% of riparian habitat has been altered, degraded, or destroyed through a variety of human influences (Krueper, 1996). At this scale, Fossil Creek's riparian vegetation could be considered unique or rare because impacts to much of the vegetation have been minimal over the years (Smith & Bender, 1973), particularly above the Fossil Springs dam which dewatered a section of Fossil Creek for hydroelectric power generation. At the Central Highlands Planning Area scale, the dominant riparian communities present in most of Fossil Creek are typical of other streams and rivers within the planning area and would not be considered unique or rare.

Riparian vegetation in Fossil Creek is dominated by deciduous trees including Arizona sycamore (*Platanus wrightii*), Fremont cottonwood (Populus fremontii), willows (Salix spp.), Arizona alder (*Alnus oblongifolia*), velvet ash (*Fraxinus pennsylvanica* var *velutina*), and, to a lesser degree, mesquite (*Prosopis* spp.) and Arizona walnut (*Juglans major*). A wide variety of shrubs, forbs, grasses, mosses, and ferns occupy the understory along the banks and floodplains of the creek. Species diversity is rich, particularly around Fossil Springs and downstream to the diversion dam (Northern Arizona University, 2005). Below the dam, because of historic water diversion, diversity is less rich and tree species become less dominant as the creek approaches the Verde River. Age class diversity appears to follow a similar trend.

The richness of species diversity around Fossil Springs led to the creation of the Fossil Springs Botanical Area in 1987 (Wong, 1996). The Botanical Area is approximately 26 acres in size.

Many endemic species were identified within the Botanical Area in the proximate uplands as well as immediately adjacent the springs, and many of those endemic species were specific to individual springs and to the geology of the canyon containing Fossil Creek. In addition, the Botanical Area has experienced less human disturbance (grazing, farming, habitation, etc.) than other areas with similar riparian communities. As of 2003, 166 species of plants have been recorded in the Botanical Area. In the broader Fossil Creek planning area, 314 species of flowering plants and ferns have been documented. This is only a partial inventory of the 5th code watershed (Northern Arizona University, 2005).

The presence of threatened, endangered, or sensitive species in the Botanical Area has not been fully determined at this time. There have been numerous surveys over the years and several plant lists are available for the greater Fossil Creek planning area. The species listed below have been collected in Fossil Creek or identified as having potentially suitable habitat within the larger Fossil Creek Planning Area (Northern Arizona University, 2005).

Table 7 –Forest Sensitive and Rare Plant Species in the Fossil Creek Area

Species	Status
Aravaipa sage (*Salvia amissa*)	Forest sensitive, habitat
Arizona giant sedge (*Carex ultra*)	Forest sensitive, habitat
Gila rock daisy (*Perityle gilensis var. salensis*)	Forest sensitive, habitat
Hualapai milkwort (*Polygala rusbyi*)	Forest sensitive, habitat
Tonto Basin agave (*Agave delmateri*)	Forest sensitive, habitat
Metcalfe's ticktrefoil (*Desmodium metcalfei*)	Endemic, rare, collected
Fossil Hill Creek bedstraw (*Galium collomiae*)	Endemic, rare, collected
Ciliate rock daisy (*Perityle ciliate*)	Endemic, rare, collected

Riparian vegetation as a source of food for aquatic biota through decomposition during travertine formation in Fossil Creek has been documented by Marks et al. (2006). The importance of litter quality and species diversity has been linked to richer aquatic biota diversity (Leroy & Marks, 2006). It is difficult to separate the riparian community of Fossil Creek from the presence and diversity of native fish species and macro invertebrates that feed upon the vegetation as it is broken down through the development of travertine dams and take shelter in various components of the vegetation along the creek.

Finding

As stated above, the riparian communities along Fossil Creek are not unique within the Central Highland Planning Area. The botanical diversity of the riparian vegetation is important, but does not rise to the level of outstandingly remarkable. Although potentially suitable habitat exists within the Fossil Creek WSR corridor, threatened, endangered, or sensitive species have not yet been documented. Riparian communities and botanical resources are an important but not outstandingly remarkable value.

Free flowing Character and Water Quality (Quantity)

Criteria for River Value

The river may be known regionally or nationally for the magnitude of its spring-fed discharge.

The magnitude and uniformity of the river's baseflows may be unique, rare, or exemplary within the region or nation.

The river may have exceptional water quality characteristics including but not limited to the water's clarity, chemistry, and temperature. The river's water quality may be unique, rare, or exemplary within the region or nation.

Water Description

The Central Highlands Planning Area is the unit selected for assessing whether the water characteristics of Fossil Creek are significant at a regional scale.

Magnitude of discharge from Fossil Springs

Fossil Springs is one of the few unmanipulated major springs left in the West (Northern Arizona University, 2005). Fossil Springs emerges over a 100-foot (305-meter) reach of channel in a spring complex formed from more than 60 individual spring orifices that discharge from just a few liters per minute to more than 10 cfs (280 l/s). Continuous spring discharge data has not been collected, but monthly flow data collected by the Forest Service in support of an instream flow water right application recorded flows ranging from about 40 to 52 cfs (1130 to 1500 l/s) (Nelson, 2003). Discharge from the springs forming Fossil Creek is more than twice that of any other spring or spring complex in the Central Highlands Planning Area. In the State of Arizona, the only springs with discharge greater than that of Fossil Springs are Blue Springs which discharge into the Little Colorado River above the Grand Canyon at a rate of about 225 cfs (6370 l/s) (ADWR, 2009), and Havasu Spring that forms the beginning of perennial flow in Havasu Creek and flows at a rate of about 65 cfs (1840 l/s) (ADWR, 2009). Havasu Creek is internationally renowned where it flows over a series of waterfalls and pools on the Havasupai Indian Reservation. Tapeats Spring in the Grand Canyon is similar in size to Fossil Springs, flowing at a rate of about 42 cfs (1190 l/s) (ADWR, 2009).

Assessment:

The magnitude of the discharge from the springs represents a rare and exemplary feature at a regional scale and within the state as a whole.

Magnitude and Uniformity of Baseflows

Continuous flow measurements have not been collected for Fossil Creek and changes in stream flow as the creek flows in the downstream direction are not known. The US Geological Survey has recently installed a continuous recording flow gauge in Fossil Creek at the bridge, so our knowledge will increase I this area. Flow measurements collected from the springs are assumed to reflect baseflows in the creek and range from 40 to 52 cfs (1130 to 1500 l/s). These flows are greater than most of the major tributaries to the Salt and Verde Rivers, all of which have much larger contributing watershed areas than Fossil Creek. Only the Black River and

White River, which form the headwaters of the Salt River and the main-stems of the Salt and Verde Rivers, have greater baseflows than Fossil Creek.

The uniform nature of the discharge from the springs maintains a constant baseflow in Fossil Creek, which is an unusual characteristic of stream flow in the region. Early reports of Fossil Creek remarked on the uniformity of the discharge from Fossil Springs (Masson, 1910). The uniform nature of this discharge (as well as the magnitude of the discharge) was the characteristic that made Fossil Creek attractive as a hydroelectric power source.

Assessment:

The magnitude of baseflows in Fossil Creek is probably best described as uncommon on a regional basis but would probably not be unique, rare, or exemplary at a regional scale. The uniform nature of baseflows however is an exemplary feature of Fossil Creek and is significant on a regional scale

Water Quality Characteristics

Water quality in Fossil Creek is dominated by discharge from Fossil Springs during most of the year. Water infiltrating into the ground from recharge areas above the Mogollon Rim dissolves limestone as it percolates through the sedimentary formations below the rim. Carbon dioxide is dissolved into the water during the limestone dissolution process and emerges at Fossil Springs at pressures up to 150 times greater than atmospheric conditions (Malusa et al., 2003). Outgassing of the dissolved carbon dioxide, primarily in areas of turbulence, results in supersaturation with calcium carbonate. Once a critical level of supersaturation is exceeded, the CaCO3 precipitates to form travertine deposits. Travertine deposition is one of the unique features of Fossil Creek and is a contributing element for identifying other outstandingly remarkable values associated with the creek.

Fossil Creek is the only creek within the Central Highlands physiographic region that is dominated by travertine forming water chemistry. Tonto Natural Bridge on Pine Creek has actively building travertine deposits that form before discharge from the springs reaches Pine Creek. Havasu Creek in the Colorado Plateau region is well recognized for its travertine-forming characteristics and the beauty of its travertine-dominated waterfalls and pools have an international reputation.

The temperature of the water discharging from the springs is relatively warm, ranging from 67° to 72° F. (19° to 22° C.) in samples collected by Malusa et al. (2003). The relatively warm temperature of the water discharging from Fossil Springs is uncommon but not rare or unique for the region. Other springs discharging from the Mogollon Rim have similar water temperatures (Parker et al., 2004).

Water clarity is exceptionally clear during baseflow conditions and adds substantially to the scenic and recreational qualities of the creek.

The public has recognized the exceptional water quality characteristics of Fossil Creek and the state of Arizona has included the creek in the list of Outstanding Arizona Waters. Available water quality data suggests the creek has excellent water quality (ADEQ, 2008). The state of

Arizona has designated twenty-two stream reaches as Outstanding Arizona Waters. Ten other streams within the Central Highlands Planning Area have been designated. These include seven stream reaches on the Apache Sitgreaves National Forest on the far eastern end of the planning area and two stream reaches (Oak Creek and West Fork Oak Creek) in the Verde River basin in addition to Fossil Creek.

Assessment:

The Calcium Carbonate dominated water chemistry of Fossil Creek is a unique feature of the water of Fossil Creek within the physiographic region. The clarity of the water is unusual for the region. Recognition by the state as an Outstanding Arizona Water is significant at the regional scale. The combination of these factors results in a finding that the water quality characteristics of Fossil Creek are unique, rare, or exemplary at a comparative regional scale.

Finding

The water of Fossil Creek is a unique feature that is significant at a regional scale. This conclusion is based on the magnitude of discharge from the springs forming the perennial reach of Fossil Creek, the uncommon, magnitude and uniform nature, of baseflows in Fossil Creek, the water quality characteristics of Fossil Creek that are reflected in the unique nature of the supersaturation with respect to $CaCO_3$, the unusual clarity of the water, and the recognition of Fossil Creek as an Outstanding Arizona Water. Based on these findings, water is carried forward as a river value with the same standing as the outstandingly remarkable values of Fossil Creek.

Contributors to this Resource Assessment:

Name	Contribution	Location
Lynn Humphrey	Previous Fossil Creek CRMP Project Lead, Recreation	Forest Service, Independent Resources Enterprise Team
Paula Cote	NEPA Coordinator	Coconino National Forest, Supervisor's Office
Kim Vander Hoek	Scenery	Tonto National Forest
Jennifer Burns	Recreation	Coconino National Forest, Red Rock Ranger District
Larry Vogel	Recreation, Special Uses	Tonto National Forest, Payson Ranger District
Kyung Koh	Recreation	Southwestern Region, FS
Charlotte Minor	Recreation and Scenery, Project Lead	Coconino National Forest, Supervisor's Office
Mark Schwab	Geology	Southwestern Region, FS
Polly Haesig	Geology	Coconino National Forest, Mogollon Rim Ranger District
Mike Childs	Fish and Aquatic Resources	Coconino National Forest, Red Rock Ranger District
Janie Agyagos	Wildlife, Fish and Aquatic Resources	Coconino National Forest, Red Rock Ranger District
Travis Bone	Cultural Resources	Coconino National Forest, Red Rock Ranger District
Debbie Cress	Riparian and Botany	Tonto National Forest
Laura Moser	Botany and Invasive Species	Coconino National Forest, Supervisor's Office
Grant Loomis	Water	Tonto National Forest, Supervisor's Office
Amina Sena	Hydrologist	Coconino National Forest, Red Rock Ranger District
Rory Steinke	Soil Scientist/Hydrologist	Coconino National Forest, Supervisor's Office
Matt Johnson	Wildlife	Colorado Plateau Research Station
Christopher Calvo	Wildlife	Colorado Plateau Research Station
Shaula Hedwall	Wildlife, Fish and Aquatic Resources	U.S. Fish and Wildlife Service
Jane Marks	Fish and Aquatic Resources	Northern Arizona University
Jerry Stefferud	Fish and Aquatic Resources	Consultant, Retired USFS
Sally Stefferud	Fish and Aquatic Resources	Consultant, Retired USFWS

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