Arizona Water Protection Fund
FY 2009 Grant Application Review

Application # WPF 0370 **Applicant:** U.S. FOREST SERVICE

Title of Project: MIDDLE FOSSIL CREEK RIPARIAN HABITAT PROTECTION AND RESTORATION

Additional materials were submitted with this application that could not be reproduced and distributed for review. These materials may be reviewed in person at the Arizona Water Protection Fund offices at (3550 N. Central Avenue, 4th Floor, Phoenix). The additional materials available are the following:

__________ **Maps**
__________ **Photographs**
__________ **Disk**
___✓___ **Other**

• FOSSIL CREEK STATE OF THE WATERSHED REPORT

COPY

Arizona Water Protection Fund
Application Cover Page
FY 2009

WPF0370

Title of Project: Middle Fossil Creek Riparian Habitat Protection and Restoration

Type of Project:	**Stream Type:**	**Your level of commitment to maintenance of project benefits and capital improvements:**
☒ Capital or Other ☐ Water Conservation ☐ Research	☒ Perennial ☐ Intermittent ☐ Ephemeral	☐ < 5 years ☐ 5-10 years ☐ 11-15 years ☒ 16-20 years

Applicant Information:	**Inside an AMA:** Yes ☐ No ☒
Name/Organization: U.S. Forest Service Address 1: Address 2: City: State: ZIP Code: Phone: Fax: Tax ID No.:	**If yes, which AMA:** ☐ Phoenix ☐ Tucson ☐ Prescott ☐ Pinal ☐ Santa Cruz **Type of Application:** ☒ New ☐ Continuation

Contact Person:	**Any Previous AWPF Grants:**
Name: Heather C. Provencio Title: District Ranger, Red Rock Ranger District Phone: Fax: e-mail:	☒Yes ☐No **If yes, please provide Grant #(s):** 08-159WPF, Coconino NF, Hoxworth Springs Stream Channel Restoration Project

Arizona Water Protection Fund Grant Amount Requested:

$250,348.00

If the application is funded, will the Grantee intend to request an advance:
☒**Yes** ☐**No**

Matching Funds Obtained and Secured:

Applicant/Agency/Organization:	Amount ($):
1. Applicant	63,516.00
2. Friends of the Forest	27,840.00
3. ADEQ	89,500.00
Total:	183,853.00

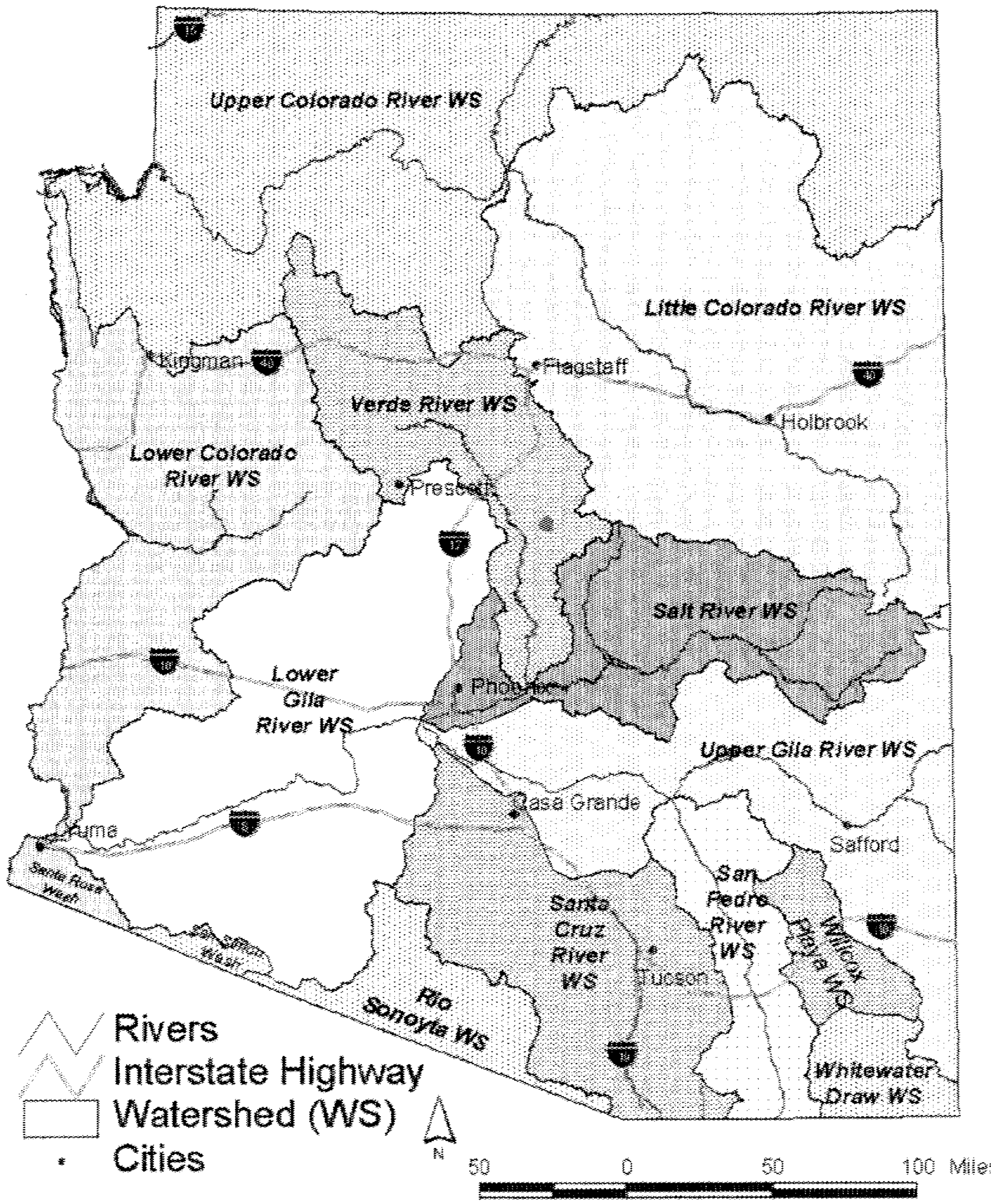
Has your legal counsel or contracting authority reviewed and accepted the Grant Award Contract General Provisions?
☒Yes ☐No ☐N/A

Signature of the undersigned certifies understanding and compliance with all terms, conditions and specifications in the attached application. Additionally, signature certifies that all information provided by the applicant is true and accurate. The undersigned acknowledges that intentional presentation of any false or fraudulent information, or knowingly concealing a material fact regarding this application is subject to criminal penalties as provided in A.R.S. Title 13. The Arizona Water Protection Fund Commission may approve Grant Awards with modifications to scope items, methodology, schedule, final products and/or budget.

See previously approved Special Provisions (attached)

Typed Name of Applicant or Applicant's Authorized Representative	**Title and Telephone Number**
Nora B. Rasure	Forest Supervisor
Nora B Rasure	6-5-08
Signature	**Date Signed**

Arizona Watershed Map
FY 2009



Title of Project: Middle Fossil Creek Riparian Habitat Protection and Restoration

Project Location & Environmental Contaminant Information
FY 2009

Project Location Information			
1. County: Coconino	2. Section: 29,30,31,36 (21,28)	3. Township: 12N (12N)	4. Range: 6 1/2E (7E)

5. Watershed: Verde River

6. Name of USGS Topographic Map where project area is located: Hackberry (and Strawberry)

7. State Legislative District: 1 & 2

(Information available at http://156.42.40.10/mapping/default2.asp?tname=Interim.2004.Legislative.Map)

8. Land ownership of project area: Federal, U.S. Forest Service

9. Current land use of project area: recreation, livestock grazing, research

10. Size of project area (in acres): 170

11. Stream Name: Fossil Creek

12. Length of stream through project area: 4.6

13. Miles of stream benefited: 9 miles

14. Acres of riparian habitat: 110 acres will be:

- ☒ Enhanced
- ☐ Maintained
- ☒ Restored
- ☐ Created

15. Provide directions to the project site from the nearest city or town. List any special access requirements:

From Flagstaff, travel south on Forest Highway 2 (FH3; Lake Mary Road). In the town of Strawberry, turn right (west) on Fossil Creek Road. This road turns into a steep dirt road (Forest Service Road 502). A high clearance vehicle is recommended, but not required. At the botton of this road, one will see Fossil Creek running adjacent to the road near the site of the historic Irving Power Plant. The north end of the project area is just upstream of Irving at the location where the second spring is noted on the map. The project area follows the creek downstream for approximately 4.6 miles.

Environmental Contaminant Location Information

1. Does your project site contain known environmental contaminants? ☐YES ☒NO If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:
   -
2. Are there known environmental contaminants in the project vicinity? ☐YES ☒NO If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:
   -
3. Are you asking for Arizona Water Protection Fund monies to identify whether or not environmental contaminants are present? ☐YES ☒NO

STATE HISTORIC PRESERVATION OFFICE
Review Form

In accordance with the State Historic Preservation Act (SHPO), A.R.S. 41-861 *et seq*, effective July 24, 1982, each State agency must consider the potential of activities or projects to impact significant cultural resources. Also, each State agency is required to consult with the State Historic Preservation Officer with regard to those activities or projects that may impact cultural resources. Therefore, it is understood that **recipients of state funds are required to comply with this law** throughout the project period. All projects that affect the ground-surface that are funded by AWPF require SHPO clearance, **including those on private and federal lands.**

The State Historic Preservation Office (SHPO) must review each grant application recommended for funding in order to determine the effect, if any, a proposed project may have on archaeological or cultural resources. To assist the SHPO in this review, the following information MUST be submitted with each application for funding assistance:

- A completed copy of this form, and
- A United States Geological Survey (USGS) 7.5 minute map
- A copy of the cultural resources survey report if a survey of the property has been conducted, and
- A copy of any comments of the land managing agency/landowner (i.e., state, federal, county, municipal) on potential impacts of the project on historic properties.
  NOTE: If a federal agency is involved, the agency must consult with SHPO pursuant to the National Historic Preservation Act (NHPA); a state agency must consult with SHPO pursuant to the State Historic Preservation Act (SHPA),
  OR
- A copy of SHPO comments if the survey report has already been reviewed by SHPO.

Please answer the following questions:

1. Grant Program: Arizona Water Protection Fund

2. Project Title: Middle Fossil Creek Riparian Habitat Protection and Restoration

3. Applicant Name and Address: Coconino National Forest, 1824 S. Thompson St., Flagstaff, AZ 86001

4. Current Land Owner/Manager(s): U.S. Forest Service

5. Project Location, including Township, Range, Section: Middle Fossil Creek: T12N, R6 1/2 E, sections 29,30,31,36 and T12N, R7E, sections 21, 28.

6. Total Project Area in Acres (or total miles if trail): 170

7. Does the proposed project have the potential to disturb the surface and/or subsurface of the ground?
   ☒ YES ☐ NO

8. Please provide a brief description of the proposed project and specifically identify any surface or subsurface impacts that are expected: A goal of this work is to protect and improve riparian vegetation and maintain and improve habitat for the recently restored native fishery and terrestrial riparian obligate species. This work will assist in preventing soil erosion and loss from these sites and will improve the water quality of Fossil Creek. Existing campsites located within the riparian area of Middle Fossil Creek will be removed and rehabilitated. Camping locations outside the riparian area will be created. In order to

ensure that visitors do not use the former campsites located within the riparian zone, the Forest Service will delineate 6-10 camping areas outside of the riparian zone within the middle reach of Fossil Creek. These camping areas will be designated at least 100 feet from Fossil Creek and outside of riparian habitat. Within these camp areas, with a total of between 62 and 90 campsites, occupying up to 40 acres, will be delineated. These camping areas will be delineated with a post marker and campers will be required to camp within a certain distance of this marker (usually 15-20 feet). Access roads and parking areas (outside of the riparian zone) will be designated for each site and unused roads will be closed and rehabilitated (through ripping and seeding) to prevent erosion into Fossil Creek where archeological concerns are not present. All access roads and parking will be located outside of the riparian zone. Kiosks will be installed and boulders may be used to delineate parking areas outside riparian areas.

9.

10. Describe the condition of the current ground surface within the entire project boundary area (for example, is the ground in a natural undisturbed condition, or has it been bladed, paved, graded, etc.). Estimate horizontal and vertical extent of existing disturbance. Also, attach photographs of project area to document condition: The condition of the ground surface is primarily disturbed due to recreational impact (human trails, camping site compaction, some dirt roads and spurs.

11. Are there any known prehistoric and/or historic archaeological sites in or near the project area? ☒ YES ☐ NO

12. Has the project area been previously surveyed for cultural resources by a qualified archaeologist? ☒ YES ☐ NO ☐ UNKOWN

If YES, submit a copy of the survey report. Please attach any comments on the survey report made by the managing agency and/or SHPO

13. Are there any buildings or structures (including mines, bridges, dams, canals, etc.), which are 50-years or older in or adjacent to the project area? ☐ YES ☒ NO

If YES, complete an Arizona Historic Property Inventory Form for each building or structure, attach it to this form and submit it with your application.

14. Is your project area within or near a historic district? ☐YES ☒ NO

If YES, name of the district:

Please sign on the line below certifying all information provided for this application is accurate to the best of your knowledge.

Nora B Rasure 6-5-08 Nora B. Rasure

Applicant Signature /Date Applicant Printed Name

FOR SHPO USE ONLY

SHPO Finding: ☐ Funding this project will not affect historic properties. ☐ Survey necessary – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*) ☐ Cultural resources present – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*)
SHPO Comments
For State Historic Preservation Office: Date:

STATE OF ARIZONA
HISTORIC PROPERTY INVENTORY FORM

Please type or print clearly. Fill out each applicable space accurately and with as much information as is known about the property.

PROPERTY IDENTIFICATION

For properties identified through survey: Site No. ______ Survey Area: ______

Historic Names (*enter the name(s), if any that best reflect the property's historic importance*): ______

Address: ______

City or Town: ______ ☐ Vicinity County: ______ Tax Parcel No.: ______

Township: ______ Range: ______ Section: ______ Quarters: ______ Acreage: ______

Block: ______ Lot(s): ______ Plat (Addition): ______ Year of plat (addition): ______

UTM Reference – Zone: ______ Easting: ______ Northing: ______

USGS 7.5' quadrangle map: ______

ARCHITECT: ______ ☐ not determined ☐ known Source: ______

BUILDER: ______ ☐ not determined ☐ known Source: ______

CONSTRUCTION DATE: ______ ☐ known ☐ estimated Source: ______

STRUCTURAL CONDITION

☐ Good (*well maintained; no serious problems apparent*)
☐ Fair (*some problems apparent*) Describe: ______
☐ Poor (*major problems; imminent threat*) Describe: ______
☐ Ruin/Uninhabitable

USES/FUNCTIONS

Describe how the property has been used over time, beginning with the original use: ______

Sources: ______

PHOTO INFORMATION

Date of photo: ______
View Direction (looking towards): ______

Attach a recent photograph of property in this space.
Additional photographs may be appended.

SIGNIFICANCE
To be eligible for the National Register, a property must represent an important part of the history or architecture of an area. The significance of a property is evaluated within its historic context, which are those patterns, themes, or trends in history by which a property occurred or gained importance. Describe the historic and architectural contexts of the property that may make it worthy of preservation.

A. HISTORIC EVENTS/TRENDS – *Describe any historic events/trends associated with the property:* ______

B. PERSONS – *List and describe persons with an important association with the building:* ______

C. ARCHITECTURE – Style: ______ ☐ no style

Stories: ______ ☐ Basement Roof Form: ______

Describe other character-defining features of its massing, size and scale: ______

INTEGRITY
To be eligible for the National Register, a property must have integrity (i.e. it must be able to visually convey its importance). The outline below lists some important aspects of integrity. Fill in the blanks with as detailed a description of the property as possible.

Location - ☐ Original Site ☐ Moved: Date: ______ Original Site: ______

DESIGN
Describe alterations from the original design, including dates: ______

MATERIALS
Describe the materials used in the following elements of the property:

Walls (structure): ______

Walls (sheathing): ______

Windows: ______

Roof: ______

Foundation: ______

SETTING
Describe the natural and/or built environment around the property: ______

How has the environment changed since the property was constructed? ______

WORKMANSHIP
Describe the distinctive elements, if any, of craftsmanship or method of construction: ______

NATIONAL REGISTER STATUS ***(if listed, check the appropriate box)***
☐ Individually Listed; ☐ Contributor; ☐ Non-contributor to ______ Historic District

Date Listed: ______ ☐ Determined eligible by Keeper of National Register (date: ______)

RECOMMENDATIONS ON NATIONAL REGISTER ELIGIBILITY (opinion of SHPO staff or survey consultant)

Property ☐ is ☐ is not eligible individually.

Property ☐ is ☐ is not eligible as a contributor to a listed or potential historic district.

☐ More information needed to evaluate.

If not considered eligible, state reason: ______

ARIZONA WATER PROTECTION FUND
GRANT AWARD CONTRACT AMENDMENT

SPECIAL PROVISIONS

The following Special Provision alter the General Provisions:

1. Section 2a. of the GENERAL REQUIREMENTS shall be changed to read:

   a. This agreement shall be interpreted in accordance with applicable Arizona or federal law.

2. Section 4. INDEMNIFICATION shall be changed to read:

   The USFS has willingly entered into this Agreement and will discharge its obligations as an independent entity. Neither party to this Agreement agrees to indemnify the other party. Each party is responsible for its own negligence.

3. Section 5. RESOLUTION OF DIFFERENCES shall be changed to read:

   a. Disputes arising from the performance of this Agreement will be resolved to the maximum extent possible through cooperation and coordination of the USFS, Staff and Commission.

   b. Disputes arising out of this Agreement are subject to non-binding arbitration.

   c. Disputes arising out of this Agreement are subject to the court of appropriate jurisdiction.

4. Section 8. NON-DISCRIMINATION shall be changed to read:

   The Grantee shall comply with all applicable federal and state laws, rules and regulations, including the Americans with Disabilities Act.

5. Section 11. RECOUPMENT OF GRANT PAYMENTS shall not apply to Agreement.

6. Section 16b. of ASSIGNMENTS shall be changed to read:

   b. In the event the USFS transfers control or access to the Property during the term of this Agreement through sale, lease, or other alienation of title, the USFS shall provide prior written notice to the Commission. To the extent allowable by federal law, responsibility for completion of operation and maintenance responsibilities shall be assigned to the person, entity or organization purchasing or leasing the Property if such person, entity, or organization is willing to accept any remaining operation and maintenance responsibilities under this Agreement.

ARIZONA WATER PROTECTION FUND
GRANT AWARD CONTRACT AMENDMENT

The following additional Special Provision shall also apply to this Agreement:

5. The Commission and the United States Forest Service (USFS) acknowledge that the USFS can comply with the terms of this Agreement only from appropriated funds legally available for such purpose. Nothing in this Agreement shall be construed or interpreted as a requirement that the USFS obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. § 1341, or any other applicable provision of law.

Middle Fossil Creek Riparian Habitat Protection and Restoration

Executive Summary

Fossil Creek, a tributary to the Verde River, is a perennial stream located in central Arizona. Fossil Creek is one of Arizona's rare warm water streams. The abundant water, outstanding scenery and wildlife offered by Fossil Creek have created a demand for recreation in the area. However, there is currently a lack of basic recreation facilities, management and public information and interpretation. Dispersed camping in this area has denuded and compacted soils and damaged archeological sites in some places. More than 200 dispersed campsites have been inventoried in the immediate Fossil Creek area. Campsite condition surveys show large areas of denuded soils, tree damage and poor sanitation. Recreational use is highest in the Middle Fossil Creek area. This area is accessible to visitors along Forest Service roads (502 and 708). Currently, there are many dispersed campsites, social trails and roads within the riparian zone in this area.

Visitation to Fossil Creek has historically been high. Since the restoration of full flows in June 2005, recreational use has increased every year. This is likely the result of increased knowledge by the public about Fossil Creek due to publicity related to the decommissioning of the Childs and Irving power plants and the return of the full flow of water to Fossil Creek after diversion for the last 100 years. The Childs Power Plant was built in 1909 on the banks of the Verde River and was one of the first hydroelectric power plants in the West. The Irving Power Plant was built in 1916 at Fossil Creek. Power for these plants came from diverting almost the entire discharge of the Fossil Springs complex—nearly 46 cubic feet per second. In an historic settlement agreement, Arizona Public Service (APS) and conservation groups agreed to the surrender of the hydropower license for both power plants, removal of the majority of the project facilities by early 2010, and the restoration of full flow.

Fossil Creek riparian habitat has been assessed to be in proper functioning condition except for the Middle Reach of approximately 2.5 miles. This area has unstable stream banks and sedimentation as a result of recreational impacts and grazing. There is considerable need to address the impacts to riparian habitat and water quality in Middle Fossil Creek. The objectives of this project are to protect and restore native riparian vegetation in Middle Fossil Creek, prevent soil sedimentation into Fossil Creek, minimize disturbance to aquatic and riparian obligate species, minimize damage and loss of cultural resources in this area, and educate visitors about the importance of the riparian resources provided by Fossil Creek.

Fossil Creek provides habitat for nine native fish species and many state species of concern including the lowland leopard frog and common black hawk. Four Federally listed native fish species have been introduced into Fossil Creek in the last year (Razorback Sucker, Loach Minnow, Spikedace, and Gila Topminnow), and there are plans to introduce Desert Pupfish in June 2008.

This project proposal outlines 7 tasks that address these objectives. The project focuses on restoring riparian habitat, and thereby reducing sediment and improving water quality through the permanent removal of high-use dispersed campsites located within the

riparian zone, and the completion of NEPA in order to implement this project on Forest Service lands. We are applying for matching funds from ADEQ for 50% of the costs to complete the NEPA for this project.

Project Overview

With more than 60 springs located along a 1,000-foot reach, discharging at a near-constant temperature of 72 degrees F, Fossil Creek, one of Arizona's rare warm water streams, has the greatest spring-water discharge in the Mogollon Rim region. The water contains high concentrations of calcium carbonate and dissolved carbon dioxide, resulting in travertine precipitating on rocks, leaves, and other objects in the channel. Fossil Creek provides outstanding riparian and aquatic habitat for a variety of fish and wildlife. Fossil Creek has one of the few reproducing populations of the sensitive Lowland Leopard Frog and is one of the few streams in Arizona retaining viable populations of five native fish species: Headwater Chub, Roundtail Chub, Speckled Dace, Sonora Sucker, and Desert Sucker. The Headwater Chub was added to the U.S. Fish and Wildlife Service's Candidate Species list in November 2008.

The Arizona Game and Fish Department and the U.S. Fish and Wildlife Service have introduced four Federally threatened and endangered fish species into Fossil Creek in late 2007 and early 2008 (Razorback Sucker, Loach Minnow, Spikedace, and Gila topminnow). The Desert Pupfish will likely be introduced in June 2008. See Table 1 for a list of threatened, endangered, and sensitive fishes and their habitat located within the Fossil Creek 5th order watershed.

Common Black Hawks nest in the riparian habitat at Fossil Creek and nesting habitat is present for the Western Yellow-billed Cuckoo, Bald Eagle, Southwestern Willow Flycatcher, and Yuma Clapper Rail. Fossil Creek also provides valuable nesting and migration habitat for many neotropical migrant birds. Habitat in Fossil Creek is considered suitable for the Southwestern River Otter now that full flows have been returned and river otter sign was observed at Fossil Creek in 2007. Other mammals include 22 species of bats that may occur in the Fossil Creek area, including the Western Red Bat, California Leaf-nosed Bat, Spotted Bat, Allen's Big-eared Bat, and Townsend's Big-eared Bat. See Table 2 for a complete list of threatened, endangered, sensitive, and management indicator species (MIS) for the Fossil Creek area (terrestrial species).

Table 1. Threatened, endangered, or sensitive fishes and / or their habitat expected to occur in the Fossil Creek 5th Order Watershed (NAU 2005;updated 5/2008).

Species	Status[1]	Occurrence[2]
razorback sucker	Endangered, WC, FS-S, T-S	O & Critical habitat (Verde River)
Gila topminnow	Endangered, WC, FS-S, T-S	O
loach minnow	Threatened, WC, FS-S, T-S	O & critical habitat
spikedace	Threatened, WC, FS-S, T-S	O & critical habitat
roundtail chub	WC, FS-S, T-S	O
headwater chub	WC, Candidate (FWS) FS-S, T-S	O
longfin dace	T-S, T+	O
desert sucker	T-S, T+	O
Sonora sucker	T-S	O
speckled dace	T-S	O
desert pupfish	Endangered, WC, FS-S	O

[1]**Status:**
T-S=Tonto NF Sensitive Species (USFS 2000)
T+=Tonto NF S&G emphasis species (USFS 1985, as amended)
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 July 1999)
[2]**Occurrence:**
O=Species known to occur in the project area, or in the general vicinity of the area.
H=Species not known to occur in the project area, but whose suitable or potential habitat does.
*****=Species have historically been known to occur in project area, no recent confirmation of presence.

Table 2. Threatened, endangered, sensitive, and management indicator species (MIS) for the Fossil Creek area (terrestrial species) (NAU 2005, updated May 2008).

Common Name	Scientific Name	Status
Federally Listed (End, Thr, Proposed) (5)		
Bald Eagle	*Haliaetus leucocephalus*	T,WC,Sen,MIS
Mexican Spotted Owl	*Strix occidentalis lucida*	T,WC,Sen,MIS
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	E, WC,Sen
Yuma Clapper Rail	*Rallus longirostris yumanensis*	E, WC,Sen
Chiricahua Leopard Frog	*Rana chiricahuensis*	T, WC,Sen
Razorback Sucker	*Xyrauchen texanus*	E
Loach Minnow	*Rhinichthys cobitis*	T
Spikedace	*Meda fulgida*	T
Gila Topminnow	*Poeciliopsis occidentalis occidentalis*	E
Desert Pupfish	*Cyprinodon macularius*	E
Sensitive Mammals (6)		
Southwestern River Otter	*Lutra canadensis sonora*	SC, WC,Sen
Western Red Bat	*Lasiurus blossevillii*	WC, HP
California Leaf-nosed Bat	*Macrotus californicus*	WC, HP
Spotted Bat	*Euderma maculatum*	WC, HP
Allen's Big-eared Bat	*Idionycteris phyllotis*	HP
Townsend's Big-eared Bat	*Corynorhinus townsendii* (formerly *Plecotus*)	HP
Sensitive Birds (4)		
American Peregrine Falcon	*Falco peregrinus anatum*	WC, Sen
Common Black Hawk	*Buteogallus anthracinus*	WC, Sen, MIS
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	C, WC, Sen
Bell's Vireo	*Vireo bellii*	Sen, MIS
Sensitive Amphibians (2)		
Lowland Leopard Frog	*Rana yavapaiensis*	SC, WC, Sen
Arizona Toad	*Bufo microscaphus microscaphus*	SC, Sen
Sensitive Reptiles (3)		
Narrow-headed Garter Snake	*Thamnophis rufipunctatus*	SC, WC, Sen
Mexican Garter Snake	*Thamnophis eques megalops*	SC, WC, Sen
Arizona Night Lizard	*Xantusia vigilis arizonae*	Sen
Sensitive Snails (1)		
Fossil Springsnail	*Pyrgulopsis simplex*	SC, Sen
Sensitive Invertebrates (14)		
Maricopa Tiger Beetle	*Cicindela oregona maricopa*	SC, Sen
Tiger Beetle	*Cicindela hirticollis corpuscular*	Sen
Freeman's Agave Borer	*Agathymus baueri freemani*	Sen
Neumogen's Giant Skipper	*Agathymus neumoegeni*	Sen
Aryxna Giant Skipper	*Agathymus aryxna*	Sen
Blue-black Silverspot Butterfly	*Speyeria nokomis nokomis*	SC, Sen
Mountain Silverspot Butterfly	*Speyeria nokomis nitocris*	Sen
Obsolete Viceroy Butterfly	*Limenitis archippus obsolete*	Sen
Early Elfin	*Incisalia fotis*	Sen
Comstock's Hairstreak	*Callophrys comstocki*	Sen
Spotted Skipperling	*Piruna polingii*	Sen
Netwing Midge	*Agathon arizonicus*	Sen

Common Name	Scientific Name	Status
Hoary Skimmer	*Libelula nodisticta*	Sen
Arizona Snaketail	*Ophiogomphus arizonicus*	Sen
Other Management Indicator Species (10)		
Yellow-breasted Chat	*Icteria virens*	MIS
Cinnamon Teal	*Anas cyanoptera*	MIS
Lucy's Warbler	*Vermivora luciae*	MIS
Lincoln's Sparrow	*Melospiza lincolnii*	MIS
Summer Tanager	*Piranga rubra*	MIS
Hooded Oriole	*Icterus cucullatus*	MIS
Hairy Woodpecker	*Picoides pubescens*	MIS
Warbling Vireo	*Vireo gilvus*	MIS
Western Wood Pewee	*Contopus sordidulus*	MIS
Arizona Gray Squirrel	*Sciurus arizonensis*	MIS

Table Legend

E = Federally listed as Endangered under Endangered Species Act (ESA)
EXNE = Federally Endangered, Experimental, Non-essential
T = Federally listed as Threatened under ESA
P = Federally Proposed for listing under the ESA
C = Federally designated as Candidate for listing
WC = Wildlife of Special Concern in Arizona (AGFD in prep. 1996)
Sen = On Regional Forester's Sensitive Species List (7/21/99)
HP = High Priority Species; "at high risk of imperilment" (Western Bat Species Regional Priority Matrix (1998)
MIS = Tonto and Coconino Management Indicator Species from the Respective Forest Plans

SC = Federal Species of Concern (former C2 species)

The overall goal of the Middle Fossil Creek Riparian Habitat Protection and Restoration project is to implement specific, on-the-ground actions that prevent continued resource damage to riparian habitat and improve water quality. Objectives of this project are:

1) Protect and restore native riparian vegetation and habitat in the Middle Fossil Creek area;
2) Prevent soil sedimentation into Fossil Creek resulting from recreational use in the riparian zone;
3) Minimize direct and indirect disturbance to aquatic and riparian obligate species and habitat;
4) Minimize damage to, and loss of, cultural resources;
5) Educate visitors about the importance of the unique riparian resources provided by Fossil Creek.

Fossil Creek riparian habitat has been assessed to be in proper functioning condition except for the Middle Reach of approximately 2.5 miles. This area has unstable stream banks and sedimentation as a result of recreational impacts and grazing. Dispersed recreational uses and activities have resulted in damage and removal of stream bank vegetation. Grazing activities in the uplands have resulted in accelerated runoff and sedimentation that adds to impacts on stream banks and riparian plants.

Vehicle and foot traffic have caused significant vegetative damage in popular streamside areas. Vegetation has been completely eliminated in locations used frequently for camping, leaving bare, compacted soil and infestations of invasive weeds. Entire trees or branches are regularly cut illegally by campers for firewood. There is an abundance of user-created roads and trails at Fossil Creek. These non-maintained, non-engineered tracks have contributed to impaired watershed conditions in the middle portion of Fossil Creek. User-created access and increased visitation to cliff and hilltop archeological ruins and sensitive wildlife habitat has resulted in damage to these sites. Creekside recreation is causing damage to aquatic and riparian wildlife habitats. Campsite surveys show that toilet paper and human feces are regularly left by recreationists, particularly in high-use camping areas. These items detract from aesthetic value, may pose health and safely hazards, and may be causing water contamination.

With the return of full flows to Fossil Creek in June 2005, travertine deposition has increased and travertine dams are expected to increase in both size and number (NAU 2007). This in turn is stimulating the creation of new wildlife and fish habitat, vegetative growth, and other ecosystem changes. Deeper, swifter, more abundant water is spawning additional recreational opportunities, including kayaking. These changes underscore the need for proactive and protective management within the Fossil Creek riparian area.

Senators John McCain introduced legislation (S. 86 and H.R 199) on July 28, 2006 to designate Fossil Creek in the National Wild & Scenic Rivers System. The bill is co-sponsored by Senator Jon Kyl and Representatives Trent Franks and Raul Grijalva. Designation would protect the free-flowing condition and "outstanding remarkable values" of Fossil Creek. Congressional hearings on the bill were held in November 2007. On April 10, 2008, the bill was placed on the Senate Legislative Calendar. If and when this legislation is passed, the completion of a comprehensive management plan for Fossil Creek will be required. The comprehensive plan will address watershed and recreation issues. That plan will require the completion of a companion Environmental Impact Statement (EIS).

However, the Forest Service is concerned about how long the above described planning process will take once adequate funding is secured. The resource damage and need to manage camping at Fossil Creek, particularly in the Middle section, is significant. The work that needs to be completed at Fossil Creek is not currently funded by the Forest Service; this situation is not expected to change in the near future. Priority work for the Red Rock District is focused on completing the Coconino National Forest Plan and the Travel Management Rule. The Coconino National Forest anticipates completion of the Forest Plan in March 2009. The Travel Management Rule is anticipated to be completed in September 2009.

There is a great need to address the impacts to riparian habitat and water quality in Middle Fossil Creek. The Forest Service began to address these issues in 2002 and 2003 with the writing of a "Draft Environmental Impact Statement for Fossil Creek Management Planning." However, due to changing priorities within the Forest Service, this draft EIS was never completed and a Final EIS was never issued. Without the completion of the necessary NEPA analysis, and funding to allow that as well as project implementation, the Forest Service has been unable to begin to address impacts to riparian resources in the middle reach of Fossil Creek. While the Draft EIS outlines a suite of actions proposed for the watershed, the project outlined in this proposal seeks to implement a subset of specific actions outlined in the draft EIS; it focuses only on the Middle Reach of Fossil Creek because this is where riparian impacts caused by recreationists are currently considered to be most severe and the Forest Service believes there is a desperate need to address impacts to riparian resources in this area.

The need to address recreational impacts in this area was also stressed in an April 22, 2008 editorial in Flagstaff's Arizona Daily Sun. The editorial suggested designating primitive camping areas well back from the creek. This proposed project does just that.

This project will have both immediate, short-term resource benefits to the Middle Reach of Fossil Creek, as well as long-term benefits to the riparian and aquatic ecosystem in this area. This project addresses the immediate need to remove direct riparian resource impacts and restore riparian habitat, and in so doing, will result in long-term benefits to the ecosystem. The permanent removal of camping sites and their associated user-created roads from the riparian zone will improve riparian habitat and benefit the vegetative, aquatic, and terrestrial species that rely upon them. We anticipate that the benefits of this project will be measurable and visible within 2-3 years of completion. These benefits will be in place for the foreseeable future (more than 50 years). The capital improvements made in this project will be maintained by the Forest Service in perpetuity.

Scope of Work

Task 1: Permit, Authorizations, Clearances and Agreements

Task Description: The Grantee shall obtain all permits, authorizations, environmental clearances, and agreements necessary to complete the tasks listed in the Scope of Work. These include but are not limited to:

- National Environmental Policy Act (NEPA) compliance
- State Historic Preservation Office (SHPO) clearance
- Section 7 Endangered Species Act consultation (if required)
- Subcontract agreement between U.S. Forest Service, Red Rock Ranger District, and Northern Arizona University.

Task Purpose: To comply with all local, state and federal permit requirements and environmental laws such as NEPA, archeological laws, and the Endangered Species Act. We plan to have the NEPA portion of this task be completed by a private environmental consulting firm composed of NEPA experts. For your information, we have included a copy of an estimate for the full NEPA costs associated with hiring an environmental consulting firm; we have not yet determined if this consulting firm will be hired, but we believe this estimate provides a reasonable approximation of this service. In the budget for this proposal, we have requested 50% of the full costs associated with this Task, including those of the consulting firm. We will be applying for matching dollars for 50% of the total cost of this Task from ADEQ this fall.

Deliverable Description: Copies of the draft and final NEPA documents, SHPO clearance, Endangered Species Act consultation, and the subcontract agreement with NAU.

Deliverable Due Date: Prior to any ground disturbing activities. SHPO clearance and Endangered Species Act consultation (if required) will be completed during the NEPA process. NEPA is expected to be completed by June 30, 2010.

Task Cost: $88,610

Task 2: Protect and Restore the Riparian Zone of Middle Fossil Creek through Closure of Dispersed Campsites Currently in Riparian Zone and Delineation of Camping Areas Outside of the Riparian Zone

Task Description: The riparian zone of Middle Fossil Creek is severely impacted by human visitors. Human use is high and camping is particularly impacting riparian vegetation, increasing sediment into Fossil Creek and affecting water quality. Existing dispersed camping sites are present in approximately 12 clusters in the project area, with each cluster composed of multiple sites. We estimate that there are approximately 100 campsites located within the riparian zone (within approximately 300 feet of the streambed) in this reach. Some sites are located just outside the riparian zone with access roads within the riparian zone. All campsites and access roads within the riparian zone will be rehabilitated in such a way so that they are not easily recognizable as campsites. Access roads, if present, will be obliterated by ripping and reseeding where no archeological concerns are present. Where archeological concerns are present, these camping areas will be allowed to rehabilitate naturally.

A goal of this work is to protect and improve riparian vegetation and maintain and improve habitat for the recently restored native fishery and terrestrial riparian obligate species. This work will assist in preventing soil erosion and loss from these sites and will improve the water quality of Fossil Creek. These actions will benefit state-listed species of special concern as well as federally listed species.

Campsites cannot be removed from the riparian area of Fossil Creek without providing camping locations nearby to meet the needs of visitors. The recreational use at Fossil Creek is currently very high. It is expected to increase as the Fossil Creek area gains popularity through word of mouth due to increased recreational attraction and the fact that there are more recreational opportunities present since the return of full flows, as well as with the predicted increase in Arizona's population. In order to ensure that recreationists do not use the former campsites located within the riparian zone, the Forest Service will delineate 6-10 camping areas outside of the riparian zone within the middle reach of Fossil Creek. These camping areas will be designated at least 100 feet from Fossil Creek and outside of riparian habitat. Within these camp areas, with a total of between 62 and 90 campsites, occupying up to 40 acres, will be delineated. These camping areas will be delineated with a post marker and campers will be required to camp within a certain distance of this marker (usually 15-20 feet). Access roads and parking areas (outside of the riparian zone) will be designated for each site and unused roads will be closed and rehabilitated (through ripping and seeding) to prevent erosion into Fossil Creek where archeological concerns are not present. All access roads and parking will be located outside of the riparian zone. Kiosks will be installed and boulders may be used to delineate parking areas outside riparian areas.

Task Purpose: The protection and restoration of the riparian zone of Middle Fossil Creek. The closure and rehabilitation of dispersed campsites in the riparian zone will ensure that dispersed camping no longer takes place in riparian habitat; this will protect riparian plant species as well as the integrity of the stream banks and associated aquatic habitat. The creation of delineated campsites outside of the riparian zone will ensure that recreationists have a place in which to camp and can do so in such a way as to prevent further resource damage in riparian habitat.

Deliverable Description: A report that summarizes the work completed for this task, photographs and a map of all designated campsites will be provided.

Deliverable Due Date: September 30, 2011

Task Cost: $46,346

Task 3: Development of a Monitoring Plan

Task Description: The motivating force behind Task 2 is to improve the condition of the riparian and stream ecosystem in the Middle Fossil Creek area that receives very high visitation. In year one of the grant we will design a monitoring plan to evaluate how removal of campsites from the riparian zone improves the health of the riparian and stream ecosystem. The monitoring plan will target two major areas where we anticipate to measure improvements in ecosystem health: riparian vegetation and water quality.

Component 1 will focus on riparian vegetation, as well as (likely) bank and soil integrity. We will determine indicators of recovery and methods to directly measure riparian vegetation before and after campsites are relocated to document if and how this component improves over time. In addition to monitoring native plant recruitment and recovery, we will also focus on exotic plants to ensure that management actions are not making conditions more conducive for exotic plants. If necessary we will develop a weed removal plan during the initial years of this project to increase the likelihood that the newly recovered riparian zone is dominated by native plants.

The second component will focus on water quality. We will measure a suite of water quality parameters before and after campsite removal, including fecal coliform, nutrients, temperature, pH, and conductivity. We are very interested in measuring fecal coliform, which is a good indicator of whether waters are being contaminated by human feces.

We have determined that monitoring of sediment reduction as a direct result of the removal of campsites from the riparian zone and have determined that the best way to measure the reduction in sediment loads related to removing campsites would be indirectly through measuring vegetation recovery in the riparian zone. In discussions with an expert in the sediment field, it was determined that the project area is too small to measure reduced sediment loads in relation to the riparian restoration work (pers. comm. Dr. Charles Schlinger, NAU).

We will also explore the inclusion of bank stability and soil integrity monitoring in the monitoring plan we will develop. We would like to contact soil experts, visit the site, and determine how best to measure these parameters and determine if it is possible to see results in the project time frame.

Task Purpose: Development of a monitoring plan that clearly indicates if the project outlined in Task 2 improved riparian vegetation and the water quality of Fossil Creek.

Deliverable Description: A copy of the complete monitoring plan.

Deliverable Due Date: December 2009

Task Cost: $7,174

Task 4: Implementation of Monitoring Plan

Task Description: using the Monitoring Plan developed in year 1 (Task 3) we will begin to implement the monitoring prior to on-the-ground implementation of Task 2 so that we can have adequate baseline (before data) to evaluate how campsite relocation is affecting riparian health and water quality. Monitoring will be conducted by qualified individuals, likely through subcontracting with Northern Arizona University. We anticipate that the Monitoring Plan will require that monitoring take place a minimum of two times per year for the vegetation analysis. We anticipate that the monitoring plan will outline a schedule to measure water quality more intensively during the summer and early fall when visitation is highest and when monsoons occur. Water quality monitoring should begin immediately and continue throughout the project implementation as well as post-implementation (5 years). Purchase of fecal coliform monitoring equipment will likely be necessary. NAU has expressed interest in including the water quality monitoring as part of a graduate student's research. Vegetative Monitoring will need to take place between 1-2 years after the completion of on-the-ground activities outlined in Task 2. Because of the risk of high flow events which may affect regeneration in the riparian zone, we anticipate that post-project monitoring will need to take place in 2012 and 2013.

Task Purpose: To implement the Monitoring Plan as produced in Task 3 to determine if the project outlined in Task 2 improved riparian vegetation and water quality.

Deliverable Description: A copy of the final Monitoring Plan Implementation Report.

Deliverable Due Date: March 2014

Task Cost: $83,770

<u>Task 5: Interpretation and Education about Fossil Creek Riparian and Aquatic Habitat</u>

Task Description: Interpretive signs will be created and posted in Middle Fossil Creek to educate visitors about the unique value of the riparian and aquatic habitat of Fossil Creek. The signs will be posed on kiosks located at each delineated camp area; an extra sign will be created to allow for replacement due to any vandalism that may occur. This interpretive sign will be created by the Project Coordinator (a NAU employee), who has experience in graphic design and created an interpretive sign for Forest Service use at Fossil Creek in 2006. Signs will be made of fiberglass with an imbedded image. These signs have ultraviolet protection (thus, they do not fade in the sun) and the imbedded image prevents destruction of the sign by scratching or spray paint. The interpretive sign will follow the design of already existing interpretive signs and will utilize the same artist's drawings.

Task Purpose: To ensure that the visiting public understands the value of and uniqueness of Fossil Creek riparian and aquatic habitat. The interpretive sign will be created in such a way as to provide ecological information in an interesting and eye-catching manner using language that the average person understands. Photographs or line drawings will be used to illustrate the variety of biological life that inhabits Fossil Creek, and the importance of conserving these attributes through responsible stewardship will be emphasized.

Deliverable Description: A paper copy of the interpretive sign design will be provided, as well as photographs of the installed signs placed on the kiosks.

Deliverable Due Date: April 1, 2012.

Task Cost: $15,698

<u>Task 6: Project Coordination and Monitoring</u>

Task Description: The Project Coordinator (a NAU employee) will produce a progress report for the Arizona Water Protection Fund every six months. In addition, the Project Coordinator will provide oversight on the projects' outlined tasks, monitor progress, conduct site visits, and oversee the project. The Project Coordinator will also be responsible for tracking financial aspects of the project.

Task Purpose: To ensure project progress, monitor progress, resolve issues that may arise, coordinate and communicate with Arizona Water Protection Fund personnel, ensure proper expenditure of funds, and to ensure deliverable completion and reporting.

Deliverable Description: Progress reports will be produced every 6 months and communication with the Arizona Water Protection Fund personnel will take place regularly and as needed to ensure proper project function and oversight.

Deliverable Due Date: Ongoing throughout life of project, with progress reports due every six months.

Task Cost: $6,746

Task 7: Preparation of a Final Project Report to Arizona Water Protection Fund

Task Description: A final project report will be prepared and presented to AWPF within three months of project completion. This report will detail all actions undertaken as outlined in this proposal and as agreed upon during project implementation and will present a final expenditure summary. It will include a copy of all of the deliverables required for each Task in this proposal, and it will include any additional information requested by AWPF personnel. The final project report will be prepared by the applicant and the Project Coordinator.

Task Purpose: To ensure that a complete record of the project is prepared and presented to AWPF.

Deliverable Description: A final report as described above will be provided to AWPF at the completion of the project.

Deliverable Due Date: Within 3 months of the completion of the Tasks 1-7, or by December 31, 2013.

Task Cost: $2,006

Detailed Budget

Middle Fossil Creek Riparian Habitat Protection and Restoration

TASK 1: Permits, Authorizations, Permits and Agreements	
(50% of total anticipated expenses for this task)	
Direct Labor Costs	
Salary for NEPA compliance (includes benefits) (FS, District personnel)	
Janie Agyagos (2.5 days@ $334/day*)	835
Bill Stafford (2.5 days @ $319/day*)	798
Subcontract Agreement between FS & NAU, FS costs (1 day @ $339/day*)	339
Subtotal:	1,972

* Fiscal Year 2008 salary costs; FY 2009 figures not yet available, but are expected to be slightly higher due to cost of living increases.

Outside Services	
Salary for completion of NEPA, Biological Assessment and SHPO Consultation (see attached budget proposal for total estimated expenses, Logan Simpson Design*)	80,447
Salary for Project Coordinator (NAU) ($25/hr for 30 hrs)	750
Benefits for Project Coordinator (NAU) (18%)	135
Subtotal:	81,332
Other Direct Costs	
Per diem ($34/day*), field work (consulting firm)	187
Vehicle/gas*, field work	400
B/W copies	308
Color copies and CD production	116
Public meeting displays	75
Subtotal	1,086
Administrative Costs (5%)	4,220

* Fiscal Year 2008 salary costs; FY 2009 figures not yet available, but are expected to be slightly higher due to cost of living increases and increases in fuel costs

TOTAL REQUEST:	**88,610**
Anticipated matching funds to be requested from ADEQ	89,500
Total costs for completion of this Task	179,000

TASK 2: Protect and Restore Riparian Zone through Closure of Dispersed Campsites Currently in Riparian Zone and Delineation of Camping Areas Outside of the Riparian Zone

Direct Labor Costs	
Salary for FS employees (includes benefits)-riparian restoration	
Janie Agygos (1 day/site=6 days @$343/day*)	2,058
Bill Stafford (3 days @$328/day*)	984
Salary for FS employees (includes benefits)-relocation of campsites	
GS-5 (5 days/site x10 sites=50 days@ $116/day*)	5,800

GS-5 (2 days/site x 10 campsite clusters=20 days@$116/day*) for heavy equipment operation	2,320
2 GS-5s for hauling heavy equipment (2 days each @ $116/day*)	464
Bill Stafford (1 day/site x 10 sites=10 days @$328/day*)	3,280
GS-5 for sign installation (2 days/sitex10 sites) @$116/day*)	2,320
Boulder purchase and delivery	5,500
Subtotal	22,726
Outside Services	
Salary for Project Coordinator (NAU) ($25/hr for 200 hrs)	5,000
Benefits for Project Coordinator (NAU) (18%)	900
Subtotal	5,900
Other Direct Costs	
Supplies (NAU)	100
Signs (total for 90 small signs = $900; 2 lg. signs/site X 10 sites=$8,400)	9,300
Sign posts	1,000
Travel (NAU)	
10 trips @ 200 miles/trip @ $0.15/mile + $35/day	650
Public Relations (FS)	
Connie Birkland, PR specialist (5 days @ 327/day*)	1,635
Subtotal	12,685
Capital Outlay and Equipment Costs	
Equipment (backhoe, etc.) cost for gas, grease	400
Equipment transport (FS)	0
2 GS-5s for 4 days/each (total 8 worker days @ $116/day*)	928
Native seed (20 acres)	1,500
Subtotal	2,828
Administrative Costs (5%)	2,207
* Fiscal Year 2008 salary costs; FY 2009 figures not yet available, but are expected to be slightly higher due to cost of living increases	
TOTAL	**46,346**

TASK 3: Development of Monitoring Plan

Direct Labor Costs	
Salary for FS employees	0
Input and Review of developed monitoring plan (5 days@$343/day*)	1,715
Subtotal	1,715
Outside Services	
Salary for expert to develop vegetation monitoring section ($35/hr for 25 hrs)	875
Benefits (32%)	280
Salary for expert to develop water quality monitoring section ($35/hr for 25 hrs)	875
Benefits (32%)	280

Salary for Project Coordinator (NAU) -coordinate and compile plan ($25/hr for 75 hrs)	1,875
Benefits for Project Coordinator (NAU) (18%)	338
Subtotal	4,523
Other Direct Costs	
Supplies (copies, etc).-NAU	
Categories of supplies:	
Copies of background info relevant to prep of plan (100*$0.08)	8
Phone calls	25
Copies of draft monitoring plan for review (250*$0.08)	20
Copies of FS and NAU paperwork necessary for AWPF reporting	12
Miscellaneous mailing costs associated with this task	10
Small desktop printer and ink (in combo with supplies item in Task 1)	125
Total Supplies for Task 3	200
Travel (monitoring experts and Coordinator) 3 trips @200 miles/trip @$0.15/mile + $35/day)	195
Subtotal	595
Capital Outlay and Equipment Costs	
Subtotal	0
Administrative Costs (5%)	342
* Fiscal Year 2008 salary costs; FY 2009 figures not yet available, but are expected to be slightly higher due to cost of living increases	
TOTAL	**7,174**

TASK 4: Implementation of Monitoring Plan (rough estimate only;will be refined after development of Montoring Plan

Direct Labor Costs	
Subtotal	0
Outside Services	
Salary for vegetation monitoring (1 days/area=12 days @ $200/day) x 3 years	7,200
Benefits (32%)	2,304
Salary for water quality monitoring field work (16 days @ $200/day) x 5 years	16,000
Benefits (32%)	5,120
Per diem for monitoring personnel (two) (51 days @ $34/day (NAU rate))	1,734
Salary for NAU graduate student (water quality) for 5 years @ $3,000/year	15,000
Salary for NAU faculty oversight (Jane Marks) of water quality monitoring for 2 weeks @ $3171 for 5 yrs	15,855
Benefits for faculty ($508 for 5 years)	2,540
Salary for Project Coordinator (NAU) ($25/hr for 25 hrs)	625
Benefits for Project Coordinator (NAU) (18%)	113
Subtotal	66,491

Other Direct Costs

Supplies for veg. monitoring (this is a rough estimate supplies necessary for implementing the plan)	300
Water quality testing at lab (for all components except coliform ($25/sample, 16/year for 5 years)	2,000
Fecal coliform monitoring equipment	3,000
Travel (vegetative monitoring crew + coordinator) (12 trips over 3 years using current NAU travel costs: 12 trips@200 miles/trip@$0.15/mile + $35/day)	3,000
Travel (water quality monitoring) (16 trips/year for 5 years using current NAU travel costs: 16 trips@200 miles/trip@$0.15/mile + $35/day)	4,240
Subtotal	12,540
Capital Outlay and Equipment Costs	
Equipment (to implement the monitoring plan; a rough estimate only)	750
Subtotal	750
Administrative Costs (5%)	3,989
* Fiscal Year 2008 salary costs; FY 2009 figures not yet available, but are expected to be slightly higher due to cost of living increases	
TOTAL	**83,770**

TASK 5: Interpretation and Education

Direct Labor Costs	
Subtotal	0
Outside Services	
Salary for Project Coordinator (NAU) ($25/hr for 150 hrs)	3,750
Benefits for Project Coordinator (NAU) (18%)	675
Artist to render line drawings for use on interpretive sign	1,000
Subtotal	5,425
Other Direct Costs	
Supplies (NAU): for the following:	
DVDs on which to store images for the interpretive sign	10
Color copies for interpretive sign design (draft and final) for review	60
Purchase of images from photographers for use in interpretive sign	100
Photographs and color copies of sign for AWPF requirements	15
Mailing costs (estimate)	15
Travel (NAU) 5 trips @200 miles/trip@ $0.15/mile+$35/day)	325
Subtotal	525
Capital Outlay and Equipment Costs	
Signs ($450 each x 10 signs + 10 replacement signs)	9,000
Subtotal	9,000
Administrative Costs (5%)	748

TOTAL	**15,698**

TASK 6: Project Coordination and Monitoring

Direct Labor Costs	
Subtotal	0
Outside Services	
Salary for Project Coordinator (NAU) ($25/hr for 200 hrs)	5,000
Benefits for Project Coordinator (NAU) (18%)	900
Subtotal	5,900
Other Direct Costs	
Supplies	200
Travel (NAU) (5 trip @200 miles/trip@$0.15/mile+$35/day)	325
Subtotal	525
Administrative Costs (5%)	321
TOTAL	**6,746**

TASK 7: Final Project Report

Direct Labor Costs	
Subtotal	0
Outside Services	
Salary for Project Coordinator (NAU) ($25/hr for 60 hrs)	1,500
Benefits for Project Coordinator (NAU) (18%)	270
Subtotal	1,770
Other Direct Costs	
Supplies	75
Travel (NAU) (1 trip@200 miles/trip@$0.15/mile+$35/day)	65
Subtotal	140
Administrative Costs (5%)	96
TOTAL	**2,006**
PROJECT TOTAL:	**250,348**

Detailed Matching Funds Breakdown

USFS	
SHPO Clearance (5 days @$328/day)	$1,640
Section 7 ESA Compliance (2 days@$343/day)	$686
Patrol and clean-up (6 days/month for 5 years@ 116/day)	$41,760
Travel to site (Task 2) (60 days@$150/trip)	$15,000
Equipment rental for Task 2	$1,000
Coordination and review of interpretation and education materials developed by Project Coordinator (5 days@$343/day)	$1,715
Assisting Project Coordinator with preparation/review of Final Report (5 days@$343/day)	$1,715
Total Forest Service matching	$63,516
Outside Matching Support	
ADEQ matching funds for 50% of NEPA costs (attempting to secure in next cycle of funding process starting in fall 2008)	$89,500
Friends of the Forest patrol and clean-up (4 days/month for 5 years @$116/day)	$27,840
NAU (Marks Lab) educational material development for Fossil Creek	$3,000
Total non-Forest Service matching	$120,340
Total matching	**$183,856**

Supplemental Information

Key Personnel (Forest Service employees do not have available resumes; additional biographical information can be provided upon request.)

Heather Provencio, District Ranger, Red Rock Ranger District

Heather Provencio was born and raised in southern Illinois and grew up in a Forest Service family. She moved to Arizona in 1982 to attend Northern Arizona University and pursue a Bachelor's degree in archaeology and anthropology. In 1998, she attended NAU again and received her Master's degree in Anthropology. Her Master's work focused on volunteerism in archaeology. Her first job with the Forest Service was in 1985 as a firefighter on the Apache-Sitgreaves National Forest in northern Arizona. Later, on that same Forest, she went on to become a trail crew foreman, work in human resources, was a recreation planner and finally, an archaeologist. Prior to coming to the Red Rock District she worked as an archaeologist and tribal liaison on the Coconino National Forest on the Peaks and Mormon Lake Ranger Districts in Flagstaff. She now serves as the District Ranger for the Red Rock Ranger District of the Coconino National Forest.

Janie Agyagos, District Wildlife Biologist, Red Rock Ranger District

Janie Agyagos is a wildlife biologist with the United States Forest Service. She currently works on the Red Rock Ranger District of the Coconino National Forest, where she has served as district wildlife biologist since 1994. Janie graduated in 1993 from Arizona State University with a bachelor's degree in Wildlife and Fisheries Management. Janie began her career with the Forest Service in 1989 working as a firefighter on the Tonto National Forest and has worked as a biologist on numerous Ranger Districts in Arizona since 1992. Janie's main duties as wildlife biologist include inventorying and monitoring special status plant, fish and wildlife species, designing and implementing habitat improvement projects, managing area closures for the protection of fish, wildlife and plant species and/or their habitat, conducting project effect analyses and consultations for over 50 rare species, coordinating with multiple agencies in the management of plant, fish, and wildlife species and their habitat, maintenance of the district herbarium, and conducting risk analyses and treatments for invasive weeds.

Bill Stafford, District Recreation Planner, Red Rock Ranger District

I am a native of New Mexico, my wife Laurie and I reside in Lake Montezuma. We have a son, Zach (29). His wife Crystal and our two grandchildren live in Prescott Valley, Arizona. Our grandchildren names are Lilly (3) and Savannah (1). We have a daughter Keli (26). She resides in Bay City, Oregon with her husband Ryan who is in the Coast Guard. Zach is an electrician and Keli is a librarian in an elementary school. My wife Laurie works in the emergency room of both the Sedona Medical Center and the Verde Valley Medical Center.

I attended the University of New Mexico and enrolled in the Northern Arizona University College of Forestry in the fall semester of 1968. I worked on wildland fire crews, tree planting crews and fence construction crews while attending Forestry School at NAU. My first seasonal job with the Forest Service was on the Big Fork District of the Flathead National Forest in Big Fork, Montana in 1970. My job there was to perform silvicultural compartment exams on timber stands mainly in clear cut areas. I graduated in 1971 and went to work as a Forestry Technician (timber) in Grangeville, Idaho on the Nez Perce National Forest. I performed compartment exams, worked on a tree thinning crew and on a fire crew during my time in Grangeville.

I took a job as an Assistant District Forester for the New Mexico Department of State Forestry in Sept. 1971 on the Magdalena District. I was then promoted to District Forester in 1972 and transferred to the Las Vegas District at Storrie Lake, New Mexico and then back to Magdalena. I worked there until 1976 and then took a job with the Forest Service as Fire Management Officer for the Crown King District of the Prescott National Forest in Crown King, Arizona. We lived there until Oct. 1977 and then I took a job as the Assistant Recreation and Lands Staff Officer on the Cloudcroft Ranger District of the Lincoln National Forest. In 1979 we moved to Beaver Creek Ranger Station where I worked as the Recreation and Lands Staff Officer until 1988 when I transferred to the Sedona District as the Recreation and Lands Staff Officer. I have worked on the Red Rock Ranger District since then as Recreation and Lands Staff and Recreation Staff.

Michele James, Fossil Creek Project Coordinator, Northern Arizona University

Ms. James is a wildlife biologist and she has over 20 years of experience working with Federal and State land management agencies in the western U.S. Ms. James came to Arizona over 13 years ago to work for the U.S. Fish and Wildlife Service. As part of her work with the Service to ensure the implementation of the Endangered Species Act, she worked with native fish and bald eagle issues on the Verde River, as well as with forest species on the Coconino NF. Ms. James began working at NAU in May 2004 as the Project Coordinator for Fossil Creek research. In this capacity, she has worked closely with NAU researchers as well as agency personnel, conservation groups, and a private corporation to determine and attempt to solve the management issues present in the Fossil Creek watershed. In this capacity, she has produced abundant outreach material, including an interpretive sign about the decommissioning at Fossil Creek. She has also developed a web site to disseminate information about research and management activities at Fossil Creek. In 2006, Michele began to learn graphic design and is currently pursuing a visual communications degree at NAU. These skills, as well as her ability to work well with a variety of state and federal agencies and conservation groups, will help to ensure that project management will be successful.

Michele A. James
Northern Arizona University
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Flagstaff, Arizona 86011
(928) 523-2995

EDUCATION

Master of Arts, Sustainable Communities
Thesis title: "Envisioning a Memorial for Extinct Species," with a focus on the Colorado Plateau
Northern Arizona University, Flagstaff, Arizona
Graduated "with distinction" (GPA 4.0)
May 2003

B.S. Wildlife Biology, second major in Technical Journalism
Colorado State University, Fort Collins, Colorado
December 1990

EXPERIENCE

Project Coordinator, Fossil Creek, Northern Arizona University
Flagstaff, Arizona **May 2004 – present**

Coordinate research and monitoring associated with the decommissioning of the hydropower facilities at Fossil Creek and associated research. Facilitate communication between four NAU departments and the involved federal and state agencies. Organize and participate in multi-agency stakeholder and public meetings. Identify funding opportunities and develop grant proposals. Develop an outreach plan for the project. Ensure and facilitate ongoing communication between participants. Participate in project planning, quality control, and agency relations. Coordinate with federal, state, and conservation agencies/organizations to ensure comprehensive and high-quality monitoring and research. Develop a comprehensive monitoring plan and write and edit a "state of the watershed" report. Develop and outreach kiosk poster detailing the restoration and decommissioning of Fossil Creek. Develop and manage a public web site for the project.

Wildlife Biologist for Grand Canyon National Park
Flagstaff, Arizona **July 2004 – March 2008**

Conduct research, analysis, and write the Biological Assessments determining impacts to threatened and endangered species and their habitat for the Colorado River Management Plan (CRMP), and Grand Canyon Overflights. Determine potential impacts to wildlife, fish, and their habitats. Consult with experts internally and with federal and state agencies and academia regarding potential impacts of the proposed action. Formulate recommendations to mitigate negative impacts to wildlife, fish, and their habitats. Outcome is a comprehensive written biological assessment for use by the National Park Service for Endangered Species Act section 7 consultation with the U.S. Fish and Wildlife Service. Work is conducted on an as-needed basis.

Research Program Coordinator, Ecological Monitoring and Assessment Program, Northern Arizona University, Flagstaff, Arizona **November 2004 – June 2007**

Coordinate science-based research and monitoring projects for the Program. Serve as principal investigator on research and monitoring projects. Coordinate the Science Advisory Panel. Conduct outreach related to research project as well as broad-based Program outreach. Complete publications on completed and on-going research subjects. Coordinate and ensure quality information is used to populate the GIS-based Southwest Ecological Information System; supervise students hired to assist with this work. Identify funding opportunities for the Program and Foundation and complete grant proposals. Conduct Program management including planning and funding. Facilitate communication between NAU faculty, staff, and students, and outside agencies and organizations.

Species Conservation Program Manager for Grand Canyon Trust
Flagstaff, Arizona **January 2002 – June 2004**

Led the Coconino County Comprehensive Plan Wildlife Workgroup and wrote significant sections of the *Wildlife Reference Document* (December 2003) that detailed focal wildlife species habitat and movement areas in seven distinct communities, and made recommendations for inclusion in the Comprehensive Plan. Supervised GIS specialist and ensured accurate digitizing of detailed maps that accompanied this effort.

Completed comprehensive comments on management proposals and NEPA documents for such actions as Forest Service forest restoration projects, recreational trails, ski area improvements, and native fish restoration at Fossil Creek. Comments were prepared after significant coordination with action agency and other agencies/organizations and emphasized minimizing harm to imperiled species and rare habitats, and providing opportunities for restoration.

Participated as an active member of the Greater Flagstaff Forests Partnership Advisory Board and worked collaboratively with other Partners and the Forest Service to complete forest restoration in the urban interface surrounding Flagstaff. Participated as a member of the Partnership Project Team and addressed site-specific issues related to restoration projects.

Researched and wrote the focal, sensitive, and listed species sections of a draft conservation alternative for the three southern Utah Forest Management Plan Amendments (Dixie, Fishlake, and Manti-La Sal National Forests). Worked with a coalition of scientists and interested publics to craft an alternative that provided for sustainable human uses of the forests while providing for the needs of native species. Worked with contractor to complete "least cost path" GIS modeling for Utah for the black bear and gray wolf.

Fish and Wildlife Biologist (endangered species) for the U.S. Fish and Wildlife Service
Flagstaff and Phoenix, Arizona **January 1994 – January 2002**

Analyzed complex management actions including the U.S. Forest Service's Southwestern Region Forest Plan and Amendments, Sedona Forest Plan Amendment, Kachina Wilderness Prescribed Natural Fire Plan, timber sales, thinning and restoration, prescribed burns, road building, grazing allotment management plans, overflights, and communication towers. Conducted field review of project areas in order to gain full understanding of proposed actions. Negotiated and resolved conflicts where possible to ensure protection of wildlife species and their habitats.

Researched, analyzed, negotiated, and wrote comprehensive biological opinions outlining the effects of specific proposed management actions and forest plans to threatened, endangered, and candidate species and critical habitat pursuant to the Endangered Species Act. Primary species included the Mexican spotted owl, peregrine falcon, bald eagle, southwestern willow flycatcher, Little Colorado spinedace, spikedace, loach minnow, and Arizona cliffrose.

Reviewed proposed federal projects and evaluated potential negative and positive effects to imperiled species and their habitats; conducted field reviews of project areas and negotiated with land management agencies and others to resolve conflicts and determine appropriate means to mitigate for negative effects; served on Forest Service interdisciplinary teams where appropriate.

Wildlife Biologist for the U.S. Forest Service, Deschutes National Forest
Sisters, Oregon **summers 1987-1990/ full time January 1991- December 1993**

Researched and wrote biological assessments analyzing effects of timber harvest and other forest activities on threatened, endangered, sensitive, and Category 2 animal and plant species. Served as leader and member of interdisciplinary teams representing wildlife concerns related to proposed actions. Provided alternatives for NEPA analysis and wrote sections of Environmental Assessments. Conducted field surveys and monitoring of threatened, endangered, and sensitive species including northern spotted owl, northern goshawk, bald eagle, bull trout, spotted frog, tailed frog, and *Penstemon peckii*.

Existing Plans/Reports/Information

Copies of the following documents have been included in the proposal package. Due to limited funding, we are only able to provide one copy of the State of the Watershed Report.

- Archeological Survey and Cultural Resources Clearance Report (USFS)
- Draft Environmental Impact Statement (EIS), in draft form (USFS)
- State of the Fossil Creek Watershed (NAU) (1 copy)
- Field Review of Middle Fossil Campsites, March 31, 2003 (USFS)
- Fossil Creek, Lower Verde River Watershed Condition Assessment (U.S. Forest Service, Coconino National Forest
- Short- and Long-Term Management, Stewardship, and Education/Outreach Needs for Fossil Creek, Notes from Fossil Creek Stewardship Meeting, October 2005 (NAU)
- EcoNotes from Fossil Creek: Volume I: Before Decommissioning (NAU)
- Fossil Creek Econotes: A Summary of Current Research Results, June 2007
- Fossil Creek Ecosystem Studies Group Newsletter, Spring 2006 (NAU)
- Editorial on Fossil Creek, Arizona Daily Sun, April 22, 2008
- Fossil Creek Stakeholders Draft Meeting Notes, May 22, 2008
- Cost estimate for NEPA, Logan-Simpson Design, May 2008

Evidence of Control and Tenure of Land

N/A

Evidence of Physical and Legal Availability of Water

N/A

Literature Cited

Northern Arizona University, 2007. Fossil Creek Econotes: A Summary of Current Research Results, Draft, April 2007.

Northern Arizona University, 2005. Fossil Creek State of the Watershed Report: Current Conditions of the Fossil Creek Watershed Prior to Return of Full Flows and Other Decommissioning Activities. July.

Project Site Photographs

Dispersed campsite in riparian zone (Campsite Conditions Inventory, NAU)

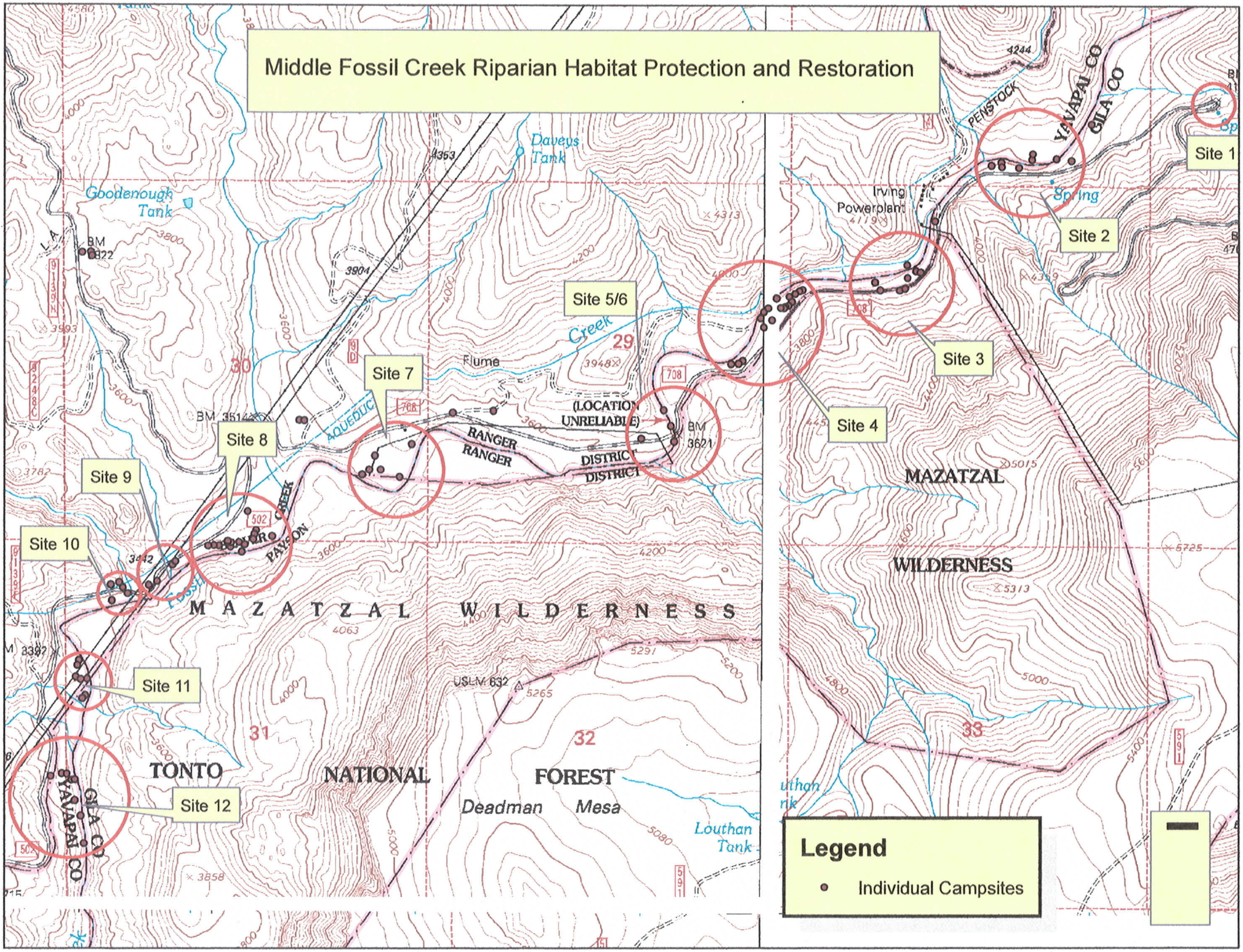
Social road in riparian zone (FS)

Large dispersed campsite (FS)

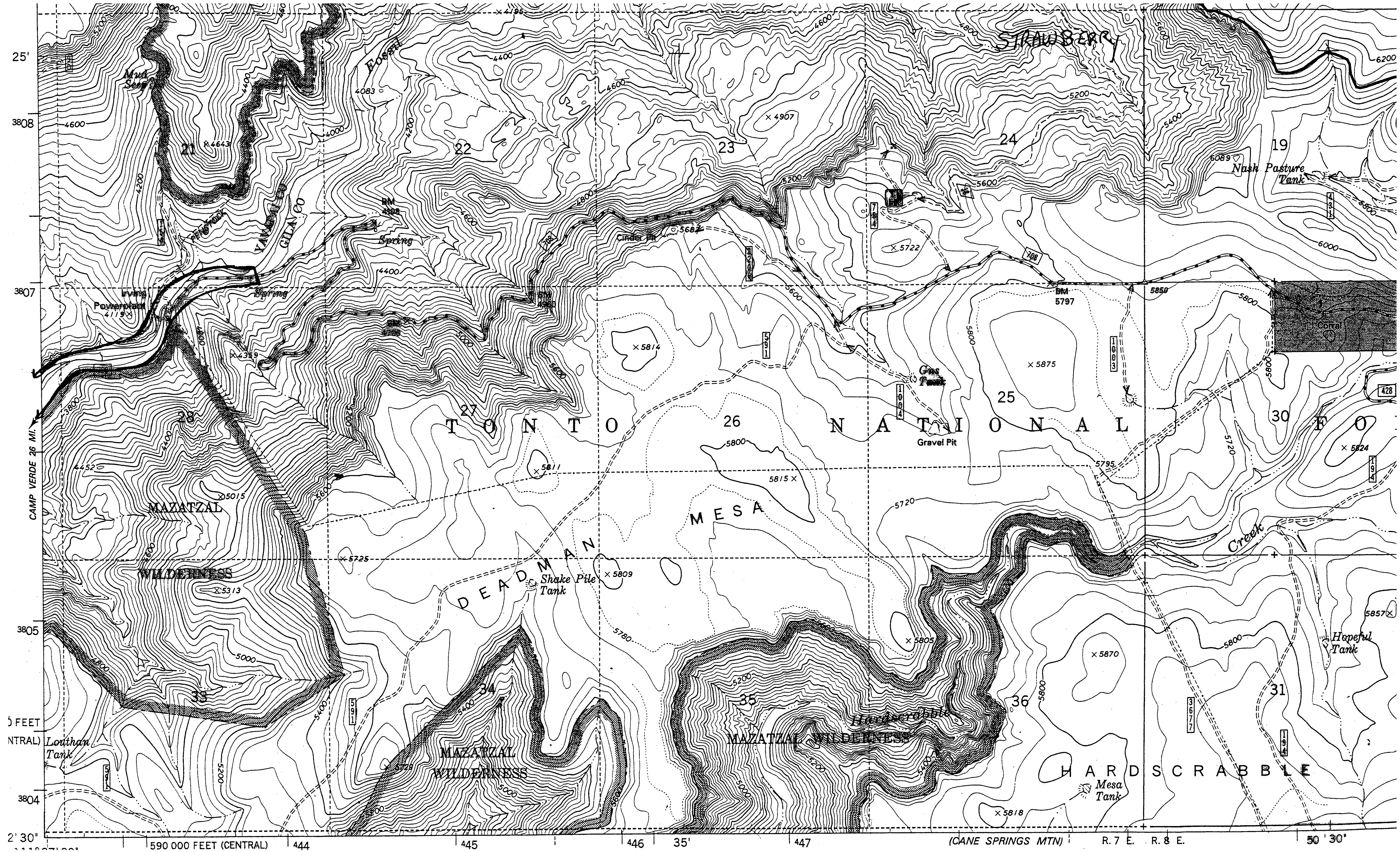

Dispersed campsite on bank of Fossil Creek just upstream of bridge (May 2008, NAU)


Trash in riparian zone at Fossil Creek (FS)

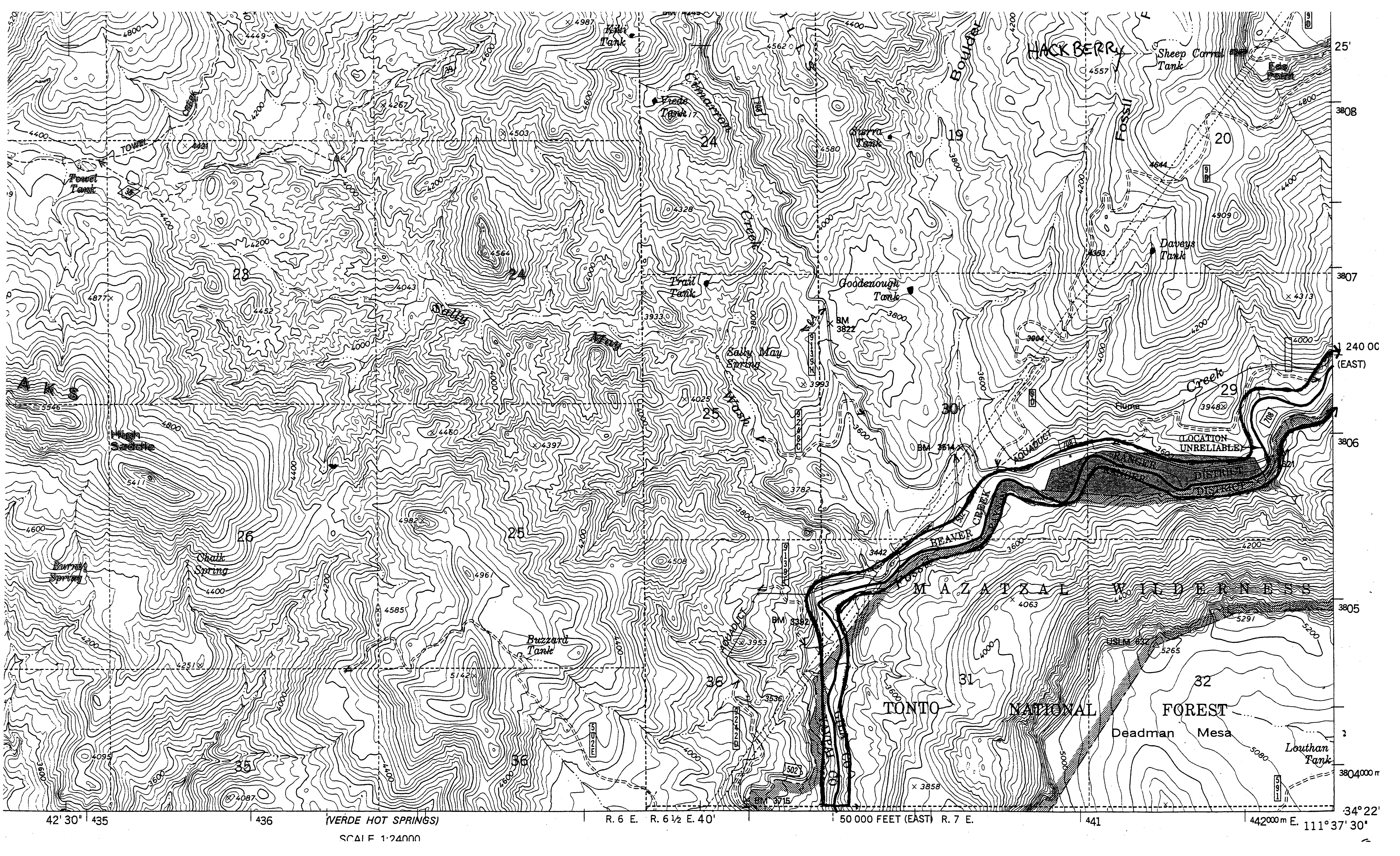

Trash in riparian zone at Fossil Creek (FS)



Middle Fossil Creek Riparian Habitat Protection and Restoration
Site 1
Site 2
Site 3
Site 4
Site 5/6
Site 7
Site 8
Site 9
Site 10
Site 11
Site 12
Legend
Individual Campsites
MAZATZAL WILDERNESS
MAZATZAL
WILDERNESS
TONTO NATIONAL FOREST
Deadman Mesa
YAVAPAI CO
GILA CO
Irving Powerplant
PENSTOCK
Spring
Daveys Tank
Goodenough Tank
Louthan Tank
Creek
Fossil
Flume
AQUEDUCT
RANGER
DISTRICT
(LOCATION UNRELIABLE)
PAYSON
CREEK
29
30
31
32
33



STRAWBERRY
TONTO NATIONAL FO
DEADMAN MESA
HARDSCRABBLE
MAZATZAL WILDERNESS
Hardscrabble
Creek
Fossil
Mud Seep
Irving Powerplant
Spring
Cinder Pit
Gravel Pit
Gus Tank
Nash Pasture Tank
Shake Pile Tank
Hopeful Tank
Mesa Tank
Louthan Tank
Corral
CAMP VERDE 26 MI.
(CANE SPRINGS MTN)
R. 7 E.
R. 8 E.
590 000 FEET (CENTRAL)
25'
2' 30"
50' 30"
35'
3808
3807
3805
3804
444
445
446
447


HACKBERRY
Boulder
Fossil
Sheep Corral Tank
Eds Point
Kiki Tank
Verde Tank
Cimarron
Creek
Sierra Tank
Daveys Tank
Goodenough Tank
Trail Tank
Sally May Spring
Sally
May
Wash
Towel Tank
TOWEL
High Saddle
Chalk Spring
Burro Spring
Buzzard Tank
Flume
Creek
(LOCATION UNRELIABLE)
AQUADUCT
RANGER DISTRICT
BEAVER CREEK
MAZATZAL WILDERNESS
TONTO NATIONAL FOREST
Deadman Mesa
Louthan Tank
(VERDE HOT SPRINGS)
SCALE 1:24000
R. 6 E.
R. 6 1/2 E.
R. 7 E.
50 000 FEET (EAST)
1 240 000 (EAST)
42' 30"
40'
34°22'
111°37'30"

LETTERS OF SUPPORT

THE STATE OF ARIZONA
GAME AND FISH DEPARTMENT
5000 W. CAREFREE HIGHWAY
PHOENIX, AZ 85086-5000
(602) 942-3000 • WWW.AZGFD.GOV
REGION II, 3500 S. LAKE MARY ROAD, FLAGSTAFF, AZ 86001

June 2, 2008

Heather Provencio, District Ranger
Red Rock Ranger District, Coconino National Forest
P.O. Box 20249
Sedona, AZ 86341-0429

Dear Ms. Provencio:

I am writing to support the Forest Service's Arizona Water Protection Fund proposal entitled "Middle Fossil Creek Riparian Habitat Protection and Restoration." If funded, this project will begin to address a critical need to manage recreation in Fossil Creek. Currently, the middle Fossil Creek area is experiencing unacceptably high levels of impact due to unmanaged recreation. Given the recent investment in the restoration of the native fish community in Fossil Creek by our agencies and others, it is imperative we address recreation management challenges that threaten the area's wildlife resources. We fully support this and other efforts to protect riparian vegetation, reduce soil erosion, and improve water quality, to ensure we conserve native fish, leopard frogs, black hawks and other riparian obligates and their habitat in Fossil Creek.

Sincerely,

Susan MacVean
Nongame Specialist

:sm

United States Department of the Interior
U.S. Fish and Wildlife Service
Arizona Ecological Services Field Office
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
Telephone: (602) 242-0210 Fax: (602) 242-2513

In Reply Refer to:

AESO/SE
22410-2008-TA-0338

June 3, 2008

Ms. Heather C. Provencio
District Ranger
Red Rock Ranger District
Coconino National Forest
Post Office Box 20429
Sedona, Arizona 86341-0429

Dear Ms. Provencio:

The Fish and Wildlife Service is writing in support of the Forest Service's Arizona Water Protection Fund (AWPF) proposal entitled "Middle Fossil Creek Riparian Habitat Protection and Restoration." This project will implement much needed recreation management work in the middle reach of Fossil Creek, an area that receives extensive recreational impacts. The tasks outlined in the proposal will improve the riparian area by protecting and restoring riparian vegetation, reducing soil erosion, and improving water quality. These improvements will in turn result in improved habitat for the recently restored native fishery as well as riparian obligate species.

We have worked cooperatively with the Forest Service for many years in the decommissioning of the Arizona Public Service's Childs-Irving Hydropower Project and the subsequent native fish restoration project. In conjunction with the Arizona Game and Fish Department, it is our goal and intent to continue to assist with the creek's management and protection for listed and sensitive aquatic and riparian species. Though we have all worked diligently to protect Fossil Creek, the on-going recreational impacts to the creek are extensive and have increased dramatically since the return of full flows. Without intensive management, the immense recreation pressure that Fossil Creek is receiving may compromise the creek's ability to provide quality aquatic and riparian species habitat through decreased water quality and degraded streamside vegetation. The Forest Service inventoried more than 200 dispersed campsites in the immediate Fossil Creek area and campsite condition surveys show large areas of denuded soils, tree damage, and poor sanitation. We believe that if the Forest Service is successful in obtaining this AWPF grant that many of these impacts to Fossil Creek could be significantly reduced.

Friends of the Forest, Inc.

P. O. Box 2391
Sedona, Arizona 86339-2391

Helping to protect National Forest Lands

June 2, 2008

Heather Provencio, District Ranger
U.S. Forest Service, Red Rock Ranger District
P.O. Box 20249
Sedona, AZ 86341-0429

Dear Ms. Provencio:

As president representing Sedona's Friends of the Forest, I am writing of our organization's support of the Forest Service's Arizona Water Protection Fund proposal entitled "Middle Fossil Creek Riparian Habitat Protection and Restoration." This project will implement much-needed recreation management work in the middle reach of Fossil Creek, an area that receives extensive recreational impacts. The tasks outlined in the proposal, particularly funding to move dispersed campsites out of the riparian area in the middle reach of Fossil Creek and designate campsites outside the riparian. Managing dispersed campsites will improve the riparian area by protecting and restoring riparian vegetation, reducing soil erosion, and improving water quality. These improvements will in turn result in improved habitat for the recently restored native fishery as well as riparian obligate species.

As volunteers in service to the Red Rock Ranger District of the Coconino National Forest, we have been providing assistance to the ranger district in weekly trips to clean up the garbage and trash left by a few of the users of the distributed campsites at Fossil Springs and the trail heads that lead to Fossil Springs and Fossil Creek. In order to preserve the efforts of the many agencies that have worked to restore the Fossil Springs/Creek riparian area, it is obvious to us that a comprehensive recreation management strategy is needed. We applaud the efforts outlined in the Middle Fossil Creek Riparian Habitat Protection and Restoration plan to preserve and protect this wonderful natural area.

Sincerely,

Mike Ward, President,
Friends of the Forest

Northern Arizona AUDUBON SOCIETY
P.O. Box 1496
Sedona, Arizona 86339

June 4, 2008

Heather Provencio, District Ranger
U.S. Forest Service, Red Rock Ranger District
P.O. Box 20249
Sedona, AZ 86341-0429

Dear Ms. Provencio:

This letter documents the Northern Arizona Audubon Society's support of the Forest Service's Arizona Water Protection Fund proposal, "Middle Fossil Creek Riparian Habitat Protection and Restoration."

Fossil Creek is an important place to our many members, who enjoy birding, wildlife watching, camping, hiking, and simply experiencing wild places. As you know, Fossil Creek offers them a place to see such uncommon species as yellow-billed Cuckoos and Common Black-hawks, as well as a host of other riparian-dependent birds.

NAAS was closely involved in the decision to decommission the hydropower facilities at Fossil Creek, and we were very gratified to see the return of full flows to the creek nearly three years ago. But we have become alarmed at the lack of an effective recreation plan for the area, which now runs the risk of being "loved to death", especially through the presence of unregulated campsites within the riparian zone. By moving campsites to designated areas, the proposed project would protect and restore riparian vegetation, reduce soil erosion, and improve water quality.

Those improvements will result in improved habitat for birds and other wildlife, and in an improved recreational experience for birders and others who enjoy the area. We are also in strong support of the proposed monitoring plan, which will help the Forest Service and others assess the effects of management decisions.

This work is much needed, and NAAS strongly supports the overall project proposal.

Sincerely,

James P. Logan

James Logan
Conservation Chair

NORTHERN
ARIZONA
UNIVERSITY

Fossil Creek Ecosystem Studies Group
College of Engineering and Natural Sciences
Department of Biological Sciences
P.O. Box 5640
Flagstaff, Arizona 86011

Heather Provencio, District Ranger
U.S. Forest Service, Red Rock Ranger District
P.O. Box 20249
Sedona, AZ 86341-0429

May 29, 2008

Dear Ms. Provencio:

We are writing in support of the Forest Service's Arizona Water Protection Fund proposal entitled "Middle Fossil Creek Riparian Habitat Protection and Restoration." This proposal outlines the inclusion of Northern Arizona University as a subcontractor to implement specific tasks including project coordination and designing and implementing a monitoring plan. We are enthusiastic about this opportunity to assist the Forest Service with implementation of this much-needed recreation management work in the middle reach of Fossil Creek. We believe that the tasks outlined in the proposal will improve the riparian area by protecting and restoring riparian vegetation, reducing soil erosion, and improving water quality. These improvements will in turn result in improved habitat for the recently restored native fishery as well as riparian obligate species.

Members of NAU's Ecosystem Studies Group have been studying the human impacts and biological resources of Fossil Creek for nearly 10 years. The restoration of Fossil Creek has focused on increasing the amount and quality of stream habitat by both removing exotic fishes and restoring natural water flow to the river. The positive results that have been observed from this stream restoration work cannot be separated from the growing concern of human impacts at Fossil Creek. NAU researcher Marty Lee's work, in conjunction with the Forest Service, has shown the recreational impacts are significant and an ecological concern in the riparian zone. Because of the benefits that this project will have on riparian and water resources, the Ecosystem Studies Group strongly supports this proposal.

Sincerely,

/s/ Roderic Parnell, Geology
/s/ Jane Marks, Biological Sciences
/s/ Shelley Silbert, Center for Sustainable Environments
/s/ Martha Lee, School of Forestry
/s/ Michele James, Biological Sciences

USGS Southwest Biological Science Center
Colorado Plateau Research Station
Box 5614 Northern Arizona University
Flagstaff, AZ 86011

3 June 2008

Heather Provencio, District Ranger
U.S. Forest Service, Red Rock Ranger District
P.O. Box 20249
Sedona, AZ 86341-0429

Dear Ms. Provencio:

I am writing in support of the Forest Service's Arizona Water Protection Fund proposal entitled "Middle Fossil Creek Riparian Habitat Protection and Restoration." This project will implement much-needed recreation management work in the middle reach of Fossil Creek, an area that receives extensive recreational impacts. The tasks outlined in the proposal will improve the riparian area by protecting and restoring riparian vegetation, reducing soil erosion, and improving water quality. These improvements will in turn result in improved habitat for the recently restored native fishery as well as riparian obligate species such as herpetofauna.

This site is of particular interest to me due to its potential suitability as a reintroduction or repatriation site for the increasingly rare narrow-headed gartersnake, a species currently being studied by the USGS. Work on the species in Oak Creek, Arizona has shown that recruitment of this sensitive species can be negatively impacted by heavy recreation. For this reason, as well as existing gaps in our knowledge of the effects of recreation on the recovering Fossil Creek ecosystem, I strongly support the attached proposal.

I am on currently on travel without access to a printer but will send a hardcopy version of this letter when I return.

Sincerely,

/s/ Erika Nowak, Herpetologist

Existing Plans/Reports/Information Relevant to the Project

USDA FOREST SERVICE	REPORT NO.: 2001-74-A Coconino National Forest

INVENTORY STANDARDS AND ACCOUNTING

(Reference: FSM 2361)

1. REPORT NUMBER:	2. REPORT DATE:	3. ROUTING: Copies to
YEAR 2001 / FOREST 04 / NUMBER 74 / SERIES A	MONTH May / DAY 11, / YEAR 2005	___ D- _ SHPO ✓ XX D-6 : Janie Agyagos, Jack Norman X ARCH: Joe Garrotto __ Site Files: X GIS: Debbie Hom

4. AUTHOR(S): A. Quinn, James B. Blood, Sharynn-Marie GPS File Path name: (None)

PROJECT NAME/REPORT TITLE (Abbreviate if necessary):

Fossil Creek Dispersed Campsite Assessment

6. **ABSTRACT/SUMMARY of report and findings:** With the decommissioning of the Childs-Irving Hydroelectric Power Plant Facility, areas along Fossil Creek will be returned to the Tonto and Coconino National Forests and made available for public recreational use. A survey and assessment of the area was conducted as part of the Fossil Creek Area planning study to evaluate impacts caused by camping activities and vehicular access. Its focus is on the closure of social roads that access or effect Fossil Creek and the installation of information kiosks and signs at established camp sites about on-going efforts to restore native fish in Fossil Creek. Project activities include closing some campsites, removing trash and debris, removing a corral that is in disrepair, constructing information signs and kiosks, designating specific dispersed camping sites within larger camping areas, constructing variously sized parking areas to accommodate from one to 30 vehicles, closing roads, improving existing roads, and hand construction of trails between camping locations, parking areas, and Fossil Creek. Road closures will be made by placing boulders across the roads, bulldozing up 4-6 ft. high berms, constructing boulder-reinforced berms, filling road cuts with earth and other fill material, ripping roads with a bulldozer, mechanized and hand recontouring of areas disturbed by construction activities, and seeding. Five camping locations have been evaluated on the Coconino side of the creek. Six sites, a feature, one scatter, and one isolated artifact were found.

7. CONSULTATION/CLEARANCE

A. CONDITIONS OF CLEARANCE: _____ **NONE (No poten. eligible sites in project area)**
__X__ **AVOID sites specified** _____ **MONITOR sites specified below**
____ **REPORT new sites to Forest Archaeologist** ___ **OTHER/ADDITIONAL COMMENTS**

All sites will be marked and monitored to ensure they are avoided by all project activities. A monitoring report will be prepared at the end of the project to summarize monitoring activities. Any activities not specifically mentioned in this clearance must be reviewed by the District and Forest archaeologists to determine if they require a separate cultural resources clearance.

B. ____ **ADDITIONAL FIELD WORK REQUIRED** ____ **EVALUATE SITES SPECIFIED BELOW** ______ **OTHER**

C. REPORT ACCEPTED: _X_ **YES** ____ **NO**
D. CLEARANCE RECOMMENDED: _X_ **YES** ____ **NO** ___ **N/A**

[signature] **FOREST ARCHAEOLOGIST** — **August 8, 2006** **DATE**

E. EFFECT ON CULTURAL RESOURCES:
_X_ **No Effect** ______ **No Adverse** _____ **Adverse** ____ **N/A** _____ **Beneficial**

F. TRANSMITTAL TO SHPO: Consultation for:
____ **Effect** __ __ **Eligibility** ____ **Info Only**
_X_ **N/A, as per PMOA**

[signature] **FOREST SUPERVISOR** — 8-8-6 **DATE**

G. **SHPO CONCURRENCE:** ____ YES ____ YES, per comment below ____NO
Comments: (_____ Additional comments attached)

_X_ **Case by case concurrence not required as per Programmatic Agreement and/or SHPO letter of Oct. 10, 2000**

N/A
S H P O **DATE**

H. **CLEARANCE APPROVED:** ____ YES ____ NO

for [signature] **FOREST SUPERVISOR** — 8-8-6 **DATE**

An Archaeological Survey and Cultural Resources Clearance Report for The Fossil Creek Dispersed Campsite Assessment Project Coconino National Forest, Arizona

By

James Quinn III, Archaeological Technician
and
Sharynn-Marie Blood, Red Rock District Archaeologist

May 11, 2006

INTRODUCTION

An archaeological survey was performed to determine if cultural resources were present that might be effected by the proposed activities for the Fossil Creek Dispersed Campsite Assessment Project. The assessment was done in anticipation of public recreational opportunities that will result from the decommissioning of the Childs-Irving Hydroelectric System by Arizona Public Service Co. and the relinquishment of areas formerly used by the system to the Tonto and Coconino National Forests. The decommissioning project will allow cultural and natural resource protection and recreation improvements in the existing dispersed camping areas along the middle section of Fossil Creek.

The project will include closing some road segments, improving various existing roads, closing some campsites, cleaning up trash and dispersed debris, providing specific dispersed camping sites within larger camping areas, providing portable toilet locations, and barricading access in specific locations to provide natural resource rehabilitation and cultural resource protection. Similar activities will take place on the Tonto National Forest as part of their response to decommissioning; however, this clearance only pertains to activities on the Coconino National Forest. The project is located in T 11 ½ N, R 6 ½ E, Sec. 31 and 36 and T 12 N, R 7 E, Sec. 21, 28, 29, and 30 on the Red Rock Ranger District of the Coconino National Forest (Figures 1).

FOSSIL CREEK DISPERSED CAMPSITE PROJECT ACTIVITIES

The project focus is on the closure or improvement of dispersed camping spots, parking areas, and social roads that are causing negative effects on soil and water quality, cultural resources, and plant and animal life. Interpretation of on-going efforts to restore the natural environment and re-introduce native fish populations along Fossil Creek will be provided by installing signs and information kiosks at established camp sites. The project involves five campsites on the Coconino National Forest - Campsites 5, 6, 8, 11, and 12 (Figure 1).

Campsites 5 & 6 – Bridge

One road to the creek was closed when the QWestfiber optic line was installed in 2003 (Hasbargen 2003). However, road rehabilitation will be improved by filling the closed road with 6 to 8 in. of rocks and soil and then ripping and seeding it. Parking currently exists for three-to-four cars but will be expanded here and at another site nearby to accommodate up to 30 cars. An interpretive kiosk will also be installed in the parking area.

Campsite 8 –Corral Removal

Corrals at this location are in gross disrepair and will be removed. A social road that presently accesses Fossil Creek is proposed for closing with a berm and boulder construction. In addition, 6-12 in. of fill material and soil will be laid down in the road bed, rocks adjacent to the road will be pulled back over the road bed, and the filled-in road bed seeded and mulched. A trail will then be delineated within the rehabilitated roadway to allow access to Fossil Creek. Dispersed camping in the upper area along the existing pull-through road will continue and kiosks will be installed along the middle portion of the newly created trail or at each end where it connects to Forest Road 502 (FR 502).

Campsite 11 – Second to Last Access to Fossil Creek

Two social roads that access Fossil Creek here are proposed for closing. The first road would be closed by digging holes in the road bed and setting large boulders in them. The road will be filled, rehabilitated with mulch and seed, and converted into a trail. An informal parking area for two-to-three vehicles at the top of this road will be enlarged to accommodate five vehicles.

The second road will be closed and rehabilitated in a similar fashion, beginning at the narrow point located after the established turn around. Small kiosks will be constructed here and along FR 502 before the main social road splits into the two roads that will be closed .

Campsite 12 – Last Access to Fossil Creek

The social road here does not directly access Fossil Creek, but is causing water quality problems, and will be closed near FR 502. Only walk-in access will be provided to this camp site and Fossil Creek. Access will be from Camp Site 11 and/or a parking area that will be constructed adjacent to FR 502 .

PREVIOUS SURVEYS

Four previous surveys, covering 31.5 acres, have been conducted within the Fossil Creek project area, as shown below:

Report	Title	Author	Acres
1977-12	Fossil Creek – Ike's Backbone Fence	Pilles	7.4
1984-32	Fossil Creek Gabion Construction Project	Pope/Pilles	0.5
1987-202	ADOT Arizona Vehicular Bridge National Register Study	Fraser	9
1988-052	Fossil Creek Cattle Guard	Webber	9
1990-135	Stehr Lake and Childs Area Borrow pits project	Larson	5.6

THE SURVEY

The most recent survey was conducted on September 20-24 and 27-30, 2004 by Sharynn-Marie Blood, Red Rock District Archaeologist, and James Quinn III, Red Rock District Archaeological Technician, by walking a series of parallel transects spaced 60 ft. apart over the project area. The project area measures 558 by 23,760 ft. (187 acres), all of which was surveyed.

Two new sites, four previously recorded sites, one feature, one scatter, and one isolated artifact were located.

PREVIOUSLY RECORDED SITES

AR-03-04-01-1134 - The site consists of a large sherd and lithic scatter on the first and second terraces above Fossil Creek. At least three artifact concentrations and a roasting feature are present as well as a sparse scatter of historic artifacts throughout the site area. The site has poor overall integrity as the area has been disturbed by a road cut, a siphon pipe, a 345 kV power line, a corral, and use of the location for dispersed camping activities. The site continues to be impacted by dispersed camping.

AR-03-04-01-1135 – This site has a field house, a possible agricultural field, and a sparse artifact scatter on the first two benches above Fossil Creek. Additionally, there is a low density historic artifact scatter across both benches that is probably associated with the "Sally May" house (AR-03-04-01-1136) located across Sally May Wash from the site. Impacts from dispersed camping and other recreational activities are minimal.

AR-03-04-01-1136 – This is the "Sally May" house that was occupied by an APS employee who patrolled transmission lines in the area. The frame house was torn down in the 1950's and the area bladed flat. Trash dumps are east and south of the general house location, outside the bladed area. Additionally, a low density scatter of historic and prehistoric artifacts was noted throughout the general site area. One quartzite projectile point fragment was collected. Impacts from dispersed camping and other recreational activities are minimal.

AR-03-04-01-1138 – The site consists of the remains of three structures and a sparse scatter of historic artifacts across the entire site area. In addition, a corral, trash dump, and segment of an old road are present. Two of the structures consist only of foundations. The third structure is semi-subterranean and constructed of unmodified rocks cemented together. Wood roof beams and two window frames are also present.

Historic records of The Arizona Power Co. (TAPCO) indicate this site is the Purple Mountain work camp, built between 1908-1910 during the construction of the Childs flume system. Structures associated with the camp included a boarding house, one or more warehouses, and a hospital. After the flume was constructed, each structure was removed and reused to construct new buildings elsewhere. Historic records indicate the camp was occupied for only one or two years; however, artifacts suggest the site was reoccupied between 1930 and 1960, perhaps by APS or local ranchers. The survey inspection found the site is generally as described in earlier documentation. The foundations, trash dump, and old road segment appears to be largely intact and impacts from dispersed camping and other recreational activities are minimal.

NEW SITES

AR-03-04-01-1177 - A Southern Sinagua two-room field house, associated with a rock-cleared area and a petroglyph, is located at the edge of a terrace above Fossil Creek Artifacts are scattered throughout the site. The terrace is broad and could have provided a large area for dry farming.

AR-03-04-01-1178 - This site is located within a large dispersed camping area consists of two concentrations of historic trash on a terrace above Fossil Creek. It appears to be a trash dump from the early 1900's and is likely associated with construction activities and/or labor camps of the Child's-Irving Hydroelectric System.

ISOLATED OCCURRENCES

Feature

A trash dump composed of cans, sheet metal, auto parts, nails, oil cans, springs, ceramic toilet tank and bowl, and glass jars with screw caps is located behind the trailhead kiosk at the Flume Trailhead. The main concentration of trash is confined to a 20 m. diameter location on the terrace edge above the creek.

Artifact Scatter

A sparse scatter of prehistoric artifacts that includes 20+ basalt flakes and 5-10 Verde Brown sherds is located at the west end of the Flume Trailhead parking area.

Isolated Artifact

One isolated artifact, a Kaibab chert biface, was found and collected.

TRIBAL CONSULTATION

The following Native American Indian groups were notified of the project in the Coconino National Forest Annual Consultation letters dated June 5, 2003, August 13, 2004, and Feb. 28, 2006 as well as the Forest's Schedule of Proposed Actions and quarterly updates since 2004: Dine' Medicine Man's Association, Fort McDowell Yavapai Nation, Hopi Tribe, Hualapai Tribe, Havasupai Tribe, Navajo Nation, Pueblo of Zuni, San Carlos Apache Tribe, San Juan Southern Paiute Tribe, Tonto Apache Tribe, Yavapai-Apache Nation, Yavapai-Prescott Tribe, and White Mountain Apache Tribe. No replies or tribal concerns about this project were received. Fossil Creek, however, has been identified as a traditional cultural property by the Yavapai-Apache Nation. Locations of areas proposed for modification or construction were inspected by representatives of the Nation, APS, the Tonto National Forest, and the Coconino National Forest on December 16, 2002, and no concerns were identified.

CLEARANCE RECOMMENDATIONS

The latest Forest Service listings of the National Register of Historic Places have been consulted, and no sites on or nominated to the Register are known to be in the project area.

Sites AR-03-04-01-1134, -1135, -1136, -1138, -1177, and -1178 are considered eligible for NHPA Section 106 purposes for this project under Criterion D. They will be protected pursuant to FSM 2361.1(2) and FSM R-3 2361.21(2) until testing or additional information is available that would allow formal determinations of eligibility to be made. The sites will be flagged and avoided by all project activities.

The Isolated Occurrences are not considered significant and require no further protection, as per the Amended U.S.D.A., Forest Service, Region 3, Programmatic Agreement regarding cultural property protection and responsibilities, dated December 24, 2003.

The Red Rock Ranger District is responsible for notifying the Zone or Forest Archaeologist before initiating any activities as part of this project to ensure the proposed activities have cultural resources clearance and that project personnel are aware of the conditions of this clearance.

The project is to be periodically monitored by the District to ensure sites are avoided. A summary monitoring report will be prepared at the end of the project and will include dates, personnel, sites monitored, and condition of sites when the project was monitored.

Should any additional prehistoric or historic archaeological sites be encountered during the course of the project, they are to be avoided and reported to the Zone or Forest Archaeologist.

If these recommendations are followed, there will be No Effect to historic properties by the proposed project.

This report is submitted in compliance with the provisions of the Historic Preservation Act of 1966, as amended.

Cultural Resources Clearance for the Fossil Creek Dispersed Campsite Assessment Project is recommended.

REFERENCES CITED

Fraser, Clayton

1987 Arizona Bridge Inventory: A Historical Inventory for the Arizona Department of Transportation (CNF Report 1987-202). Fraser Design, Loveland, Colorado.

Hasbargen, Jim

2003 Cultural Resources Survey for a QWest Fiber Optic Line Along Fossil Creek Road. (CNF Report 2003-59). MS on file, Coconino National Forest Supervisor's Office, Flagstaff.

Larson, Skip

1991 An Archaeological Survey of the Stehr Lake and Childs Area Borrow Pits. (CNF Project 1990-135). MS on file, Coconino National Forest Supervisor's Office, Flagstaff.

Pilles, Peter J., Jr.

1977 An Archaeological Survey of the Fossil Creek Allotment, Ike's Backbone Fence (CNF Project 1977-12). MS on file, Coconino National Forest Supervisor's Office, Flagstaff.

Pope, Ralph, and Peter J. Pilles, Jr.

1984 An Archaeological Survey of the Fossil Creek Gabion Construction Project (CNF Project 1984-32). MS on file, Coconino National Forest Supervisor's Office, Flagstaff.

Webber, Paul

1988 An Archaeological Survey of the Fossil Creek Cattle Guard Installation (CNF Project 1988-52). MS on file, Coconino National Forest Supervisor's Office, Flagstaff.

The Fossil Creek Dispersed Camping Assessment Project (Project No. 2001-74-A)

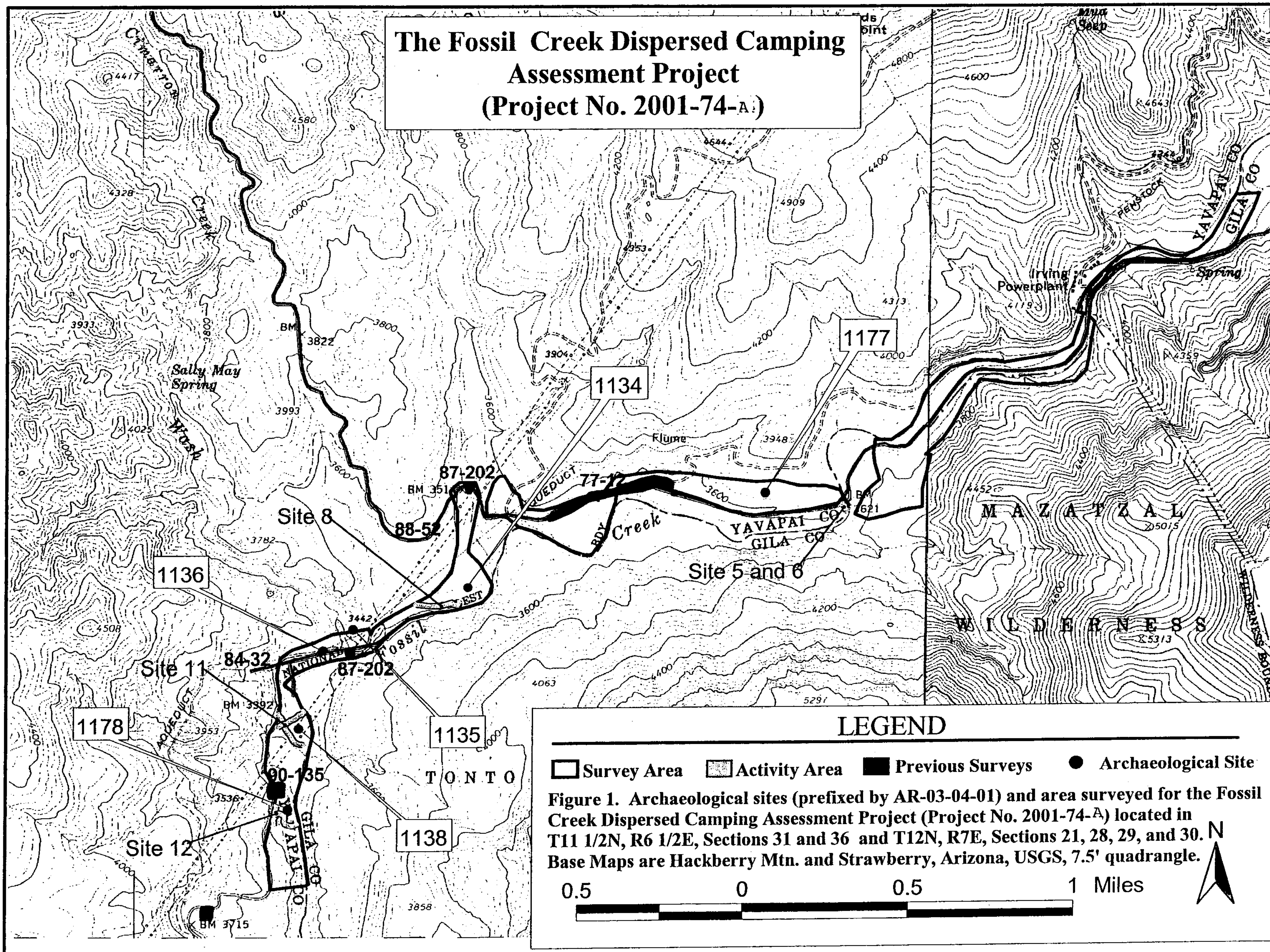


Figure 1. Archaeological sites (prefixed by AR-03-04-01) and area surveyed for the Fossil Creek Dispersed Camping Assessment Project (Project No. 2001-74-A) located in T11 1/2N, R6 1/2E, Sections 31 and 36 and T12N, R7E, Sections 21, 28, 29, and 30. Base Maps are Hackberry Mtn. and Strawberry, Arizona, USGS, 7.5' quadrangle.

United States
Department of
Agriculture

Forest
Service

**Southwestern
Region**

Draft Environmental Impact Statement for Fossil Creek Management Planning

Coconino and Tonto National Forests, Red Rock and Payson Ranger Districts

Environmental Impact Statement For XXX

Coconino and Tonto National Forests
Coconino, Gila and Yavapai Counties, Arizona

Lead Agency:	USDA Forest Service
Responsible Officials:	Karl Siderits, Forest Supervisor, Tonto NF 2324 E. McDowell Rd, Phoenix, AZ 85006
	Nora B. Rasure, Forest Supervisor, Coconino NF 2323 Greenlaw Ln, Flagstaff, AZ 86001
For Information Contact:	Judy Adams, Lands Staff Officer, Coconino NF Red Rock RD, PO Box 300, Sedona AZ 86339 928.282.4119

Abstract:

The Coconino and Tonto National Forests propose to [summarize proposal]. The area affected by the proposal includes [briefly describe affected environment]. This action is needed, because [summarize the need for action].

[Describe the background leading up to the proposal, public involvement efforts, and major issues raised.]

These issues led the agency to develop alternatives to the proposed action including:

[Briefly describe each alternative.

Major conclusions include:

[Briefly explain or display conclusions as related to impacts.]

Based upon the effects of the alternatives, the responsible official will decide [insert brief description of decision to be made].

Reviewers should provide the Forest Service with their comments during the review period of the draft environmental impact statement. This will enable the Forest Service to analyze and respond to the comments at one time and to use information acquired in the preparation of the final environmental impact statement, thus avoiding undue delay in the decision making process. Reviewers have an obligation to structure their participation in the National Environmental Policy Act process so that it is meaningful and alerts the agency to the reviewers' position and contentions. Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519, 553 (1978). Environmental objections that could have been raised at the draft stage may be waived if not raised until after completion of the final environmental impact statement. City of Angoon v. Hodel (9th Circuit, 1986) and Wisconsin Heritages, Inc. v. Harris, 490 F. Supp. 1334, 1338 (E.D. Wis. 1980). Comments on the draft environmental impact statement should be specific and should address the adequacy of the statement and the merits of the alternatives discussed (40 CFR 1503.3).

Send Comments to: Judy Adams, Lands Staff Officer, Coconino NF
Red Rock RD, PO Box 300, Sedona AZ 86339

Date Comments Must Be Received: Date

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Chapter 1. Purpose of and Need for Action

Document Organization

The Forest Service (FS) has prepared this Environmental Impact Statement in compliance with the National Environmental Policy Act (NEPA) and other relevant Federal and State laws and regulations. This Environmental Impact Statement discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives. The document is organized into four chapters:

Chapter 1. Purpose and Need for Action: The chapter includes information on the history of the project proposal, the purpose of and need for the project, and the agency's proposal for achieving that purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.

Chapter 2. Alternatives: This chapter provides a more detailed description of the agency's proposed action as well as alternative methods for achieving the stated purpose. These alternatives were developed based on significant issues raised by the public and other agencies. This discussion also includes mitigation measures. Finally, this section provides a summary table of the environmental consequences associated with each alternative.

Chapter 3. Affected Environment and Environmental Consequences: This chapter describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by [insert topic (i.e., resource area, significant issues, environmental component)].

Chapter 4. Consultation and Coordination: This chapter provides a list of preparers and agencies consulted during the development of the environmental impact statement.

Appendices: The appendices provide more detailed information to support the analyses presented in the environmental impact statement such as the record index, public comments and responses, etc.

Index: The index provides page numbers by document topic

Additional documentation, including more detailed analyses of project-area resources, may be found in the project planning record located on the Coconino National Forest, Red Rock Ranger District, Sedona, Arizona.

Purpose and Need for Action

The purpose of this initiative is to develop and begin implementation of management changes within the Fossil Creek analysis area. These changes will be designed to address several management concerns; particularly 1) the need for lasting protection of Fossil Creek's uncommon resources, 2) an increasing public demand for high quality water based recreation, 3) the anticipated decommissioning of the Childs/Irving power plant facilities and 4) creating management consistency between national forests. These changes also respond to the Coconino and Tonto National Forest Plans, and help move the analysis area toward the desired conditions described in these plans. The greater goals and objectives of the Forest Plans are to improve forest and ecosystem health, while still meeting the needs and desires of present and future generations. Actions undertaken by this project would assist in achieving specific management goals and standards for soil and water quality, riparian areas, cultural resources, wilderness management, wildlife habitat, dispersed recreation, road and trail access and management, law enforcement and administrative facilities.

Fossil Creek is one of Arizona's rare perennial streams, flowing from Fossil Springs southwest to the Verde River. The neighboring landscape is rich in unique resources. Native fish and wildlife species, such as roundtail chub, common blackhawk and lowland leopard frog inhabit the area. Cultural resources in the form of rock art, roasting pits and historic buildings and facilities abound. Crystal clear springs, Wilderness areas and abundant riparian vegetation are present as well. With the anticipated decommissioning of the Childs/Irving power plants and the restoration of full flows to Fossil Creek, travertine dams (created when calcium carbonate - saturated waters deposit the minerals in the creek bed) are expected to recreate a unique system of pools and waterfalls, resulting in new and varied fish and wildlife habitat, more diverse vegetation and protection of scenic quality. These travertine forming mineral deposits occur in only two other locations in the state, making this a rare and important resource.

The Fossil Creek analysis area receives an exceptional amount of annual visitation. Hiking, picnicking, swimming, wildlife watching, camping and other recreational opportunities attract visitors from Arizona and the southwest, drawing even larger crowds during holidays. Recent Forest Service inventories of conditions along Fossil Creek show that such high recreation pressures are negatively impacting the area's natural and cultural resources. Some resource concerns include:

1. **Proliferation of user created roads and trails.**

   Hiking and off-highway vehicle use along certain routes has resulted in the development of user-created roads and trails. The abundance of these unmaintained, unengineered tracks has contributed to impaired watershed conditions in the middle portion of Fossil Creek. User-created access and increased visitation to cliff and hilltop archaeological ruins, sensitive wildlife habitats and other areas has resulted in damage to these sites.

2. **Vegetative damage in riparian areas.**

   Vehicle and foot traffic have caused prominent vegetative damage in popular streamside areas. Vegetation has been completely eliminated in locations used frequently for camping, leaving behind bare, compacted soil and infestations of invasive weeds (Larson 1996). Entire trees or branches are often cut illegally by campers for firewood. More than 211 campsites have been inventoried in the planning area.

3. **Damage to/loss of cultural resources**

   Ground disturbing activities such as cross-country hiking and off-road vehicle use damage cultural resources. Site impacts include looting, vandalism, erosion, alteration of site context, disturbance from management and maintenance activities and damage to tribal values.

4. **Disturbance to wildlife and habitat**

   Creekside recreation is causing damage to aquatic and riparian wildlife habitats. Activities such as camping, off-road vehicle and day use activities often create visual and noise disturbance to wildlife species.

5. **Sanitation.**

Campsite surveys show that toilet paper and human feces are often left by recreationists, particularly in high use camping areas. These items detract from the aesthetic value of the area and may pose health and safety hazards.

The current location and intensity of recreational activities in the planning area serves to lower the scenic, cultural, and natural values. An important purpose of management changes is to restore and better protect these sensitive and unique resources, while continuing to offer access to outdoor recreation opportunities.

Trends in population growth and recreation use are also pertinent to planning for the area. In a 1998 study, Cordell et al. state that projected increases in population and income will lead to a corresponding growth in recreation. In Arizona, participation in activities such as hiking, developed camping, backpacking and swimming is expected to increase at a rate equal to or greater than increases in population growth. Proximity to growing populations in the Verde Valley and Phoenix is expected to increase the demand for fishing, swimming, wildlife viewing and hiking. The population of the Verde River Basin doubled between 1980 and 1994. This trend is projected to continue with some forecasts estimating a 128 percent increase in population between 1994 and 2040 for the Verde Valley (ADWR 2000 Verde River Watershed Study). The rising numbers of recreationists will likely exceed the capacity of recreation areas and resources to comfortably accommodate them ( ).

In January 2005, APS (Arizona Public Service) is expected to begin the decommissioning of the Childs/Irving hydroelectric facilities, located in the Fossil Creek area. Following installation of these plants in the early 1900s, all waters were diverted from the creek channel through a system of flumes and pipes to the power plants for use in generating electricity. In the last ten years, some flows have been returned, with over 80% of water still diverted. Upon decommissioning, all flows would be returned to the creek for the first time in nearly 90 years. Consequently, the FOREST SERVICE anticipates even greater public interest in Fossil Creek. With the return of full flows, travertine dams are expected to increase in both size and number. This in turn will stimulate the creation of new wildlife and fish habitat, vegetative growth and other ecosystem changes. Deeper, swifter, more abundant waters will likely spawn additional recreational opportunities. These imminent changes have established a need for proactive management planning within the Fossil Creek riparian corridor.

Relationship to Forest Plans

This EIS will amend the Coconino and Tonto Forest Plans. National forest planning occurs at national, regional, forest and project levels. The Fossil Creek Management Planning EIS is a project-level analysis. The scope of the EIS is confined to addressing the significant issues and possible environmental consequences of this particular project. It does not attempt to address decisions made at higher levels. It does, however, implement direction provided at those higher levels. In addition, this EIS will not attempt to address decisions made by other agencies. However, it will address the cumulative effects these decisions may have on actions undertaken within the Fossil Creek area.

(add that there are many issues that are already dealt with (with standards and guidelines) in forest plans, such as range, cultural issues, etc. and will not be specifically dealt with. these guidelines and direction will be followed)

The Forest Plans embody the provisions of the National Forest Management Act (NFMA), its implementing regulations, and other guiding documents. The Forest Plans set forth, in detail, direction for managing the land and resources of the Coconino and Tonto National Forests. When appropriate, the Fossil Creek Management Planning EIS will tier to the final EISs of the Forest Plans, as encouraged by 40 CFR 1502.20.

The Forest Plans use management areas to guide the management of national forest lands within the Coconino and Tonto National Forests. Each management area provides for a unique combination of activities, practices and uses. The Fossil Creek Planning area includes several management areas. Goals, objectives and desired future conditions of each of these management areas are described in the Forest Plans and subsequent amendments. In addition, the Forest Plans contain a description of each management area.

The analysis area lies within the administrative boundaries of the Coconino and Tonto National Forests (NFs), in Coconino, Gila and Yavapai Counties in central Arizona, USA. Refer to the attached site location map. On the Coconino NF, the planning area includes the Fossil Springs Wilderness, Fossil Creek Botanical area (as described in the Coconino NF Land and Resource Management Plan) and portions of the Hackberry and Boulder Canyon inventoried roadless areas. The Tonto NF portion contains the proposed Fossil Creek State Natural area and a segment of the Mazatzal Wilderness (as described in the Tonto NF Land and Resource Management Plan). The planning area lies entirely within the Verde River - Fossil Creek 5th code watershed.

Proposed Action

Management actions proposed by the Forest Service to meet the purpose and need are summarized in the following table:

	Road Access	Trail Access	Camping and Campfires
Management Actions	FR708 and 502 would remain open to public at Maintenance Level 3. A road access system would be designed and created in the Middle Fossil area. Two day-use parking areas would be created. Some social trails and vehicle tracks would be retained and converted to trails. Unneeded user created tracks would be closed. FR502E would be decommissioned. FR502A, which provides access to Stehr Lake, would remain open to the public.	The Flume Road and trail would be closed and restored. Footbridge would be removed. New trails would be constructed in the Middle Fossil area. A creekside trail may be constructed in the Middle Fossil area. Some social trails and vehicle tracks would be retained and converted to trails. Unneeded user created trails would be closed.	The area of Fossil Springs, downstream to Irving would be day use only. Designated, dispersed camping and campfires would be allowed at former Irving housing area and downstream through Middle Fossil area. Dispersed camping, campfires, and day use would be allowed in the vicinity of Stehr Lake. The first recreation area off of FR 708 from Strawberry would be closed (1.0 acre and 0.25 miles of track).

This action would result in an amendment to both the Coconino and Tonto National Forest plans. Please see Chapter 2 (Alternatives) for a complete description of the proposed action and all other alternatives.

Decision Framework

The Coconino and Tonto National Forest Supervisors are the officials responsible for making programmatic decisions that will amend the two forest plans. Considering the purpose and need, these officials will review the proposed action, the other alternatives, and environmental consequences in order to make decisions, including: management area changes; measures for the protection and enhancement of fish and wildlife habitat, riparian values, scenic values, and historic and cultural values; and determining the character, type and location of recreation opportunities, roads, trails, and facilities.

Public Involvement

The Council on Environmental Quality (CEQ) defines scoping as "...an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a Proposed Action" (40 CFR 1501.7). The scoping process is used to invite public participation, to help identify issues and to obtain public comment at various stages of analysis. Public participation should begin early; however, scoping is an iterative process that continues until a decision is made. In response to scoping efforts put forth by the Coconino and Tonto NFs, approximately 57 letters and over 340 substantive comments concerning this analysis have been received to date. The public has been invited to participate in the Fossil Creek Planning process in the following ways:

Public Mailings: On October 11, 2002, the Forest Service began the initial scoping process by mailing a letter providing information and soliciting public comments to approximately ___ individuals and groups. This included state and federal agencies, Native American groups, municipal offices, businesses, interest groups and individuals.

Notice of Intent (NOI): A Notice of Intent to prepare an EIS was published in the Federal Register on _________, 2003.

Public Meetings: A public open house was held in Pine, Arizona on December 4, 2002. Forest Service staff officers conducted a question and answer session with interested public groups in Phoenix, AZ on January 23, 2003. These gatherings were used to provide project area information and discuss local concerns and interests that should be addressed within the Fossil Creek Management Planning analysis. Approximately ______ individuals attended these meetings.

Local News Media: Announcements regarding this project were printed in the ___________ on ____________.

Issues

Public comment was summarized and issues were identified. An issue is defined as a point of debate. The Forest Service separated the issues into two groups: significant and non-significant. Significant issues were defined as points of debate regarding the proposed action. Non-significant issues were identified as those that are: 1) outside the scope of the proposed action; 2) already decided by law, regulation, Forest Plan, or other higher level decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence. CEQ (Council on Environmental Quality) NEPA (National Environmental Policy Act) regulations explain this delineation in Sec. 1501.7, "…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)…". A list of non-significant issues and reasons regarding their categorization as non-significant may be found at [X] in the record.

For significant issues, the Forest Service identified the following primary issue during scoping:

> *While there is a large amount of agreement regarding protection of the natural and cultural values associated with the Fossil Creek area, there is disagreement about the amount, type and location of recreation and access that should be*

permitted within the area. Some people believe that current levels and locations of recreation and access should remain, including all roads and trails and no camping or campfire restrictions. Others suggest that recreation and access should be substantially reduced to best meet protection goals, in particular a reduction in both recreation and access along the riparian corridor.

The following sub-issues were also identified:

- *Current levels of access and recreational activity could adversely impact soil, water, cultural resources, wildlife, vegetation and travertine.*
- *Limitations on access and recreational activity could adversely impact the quality and quantity of recreational experiences.*

Other Related Planning Efforts

In addition to this management planning analysis, there are a number of other planning processes currently underway in the Fossil Creek area. These include:

1) FERC/APS decommissioning

   The Childs/Irving project, owned by the Arizona Public Service Company (APS), is an existing hydroelectric facility located on Forest Service lands in Fossil Creek. The project consists of two developments, Childs and Irving that generate hydroelectric power for the towns of Strawberry and Pine, AZ by diverting water from a 14 mile length of Fossil Creek. Since the early 1900s, APS has maintained a license to continue these operations through the Federal Energy Regulatory Commission (FERC). In September 2000, APS signed a settlement agreement with a number of special interest groups, providing for the cessation of power generation and restoration of all flows back to Fossil Creek no later than December 31st, 2004. In April 2002, APS filed an application with FERC to surrender the project license. On June 4, 2003 FERC published and made available for comment a draft environmental assessment for the decommissioning of the Childs/Irving facilities.

2) Verde Wild and Scenic River Comprehensive Management Planning

   The Tonto, Prescott, and Coconino NFs are working together to develop a plan for management of the Verde Wild and Scenic River. The Childs Campground and Verde Hot springs area are within the Verde Wild and Scenic River planning area. Decisions related to camping and recreation use in this area will be made in this process. Decisions are expected in June 2004.

3) Bureau of Reclamation (BOR)/Forest Service Native Fish Restoration

   The BOR and the FS are proposing to construct a concrete fish barrier and renovate a segment of Fossil Creek. The purpose of the project is to restore and allow a native fish assemblage to persist in as much of Fossil Creek as possible. The barrier is intended to impede fish movement upstream, as well as prevent invasion of nonnative aquatic species from downstream sites. Stream renovation would involve eradicating populations of nonnative fishes. Native fishes would be reintroduced into treated areas. The time frame for this project is being driven by the FERC/APS decommissioning project (see above). Native fish restoration work would need to be completed before full flows are returned to the creek. A draft environmental assessment is scheduled for release in late summer/early autumn 2003.

4) Qwest/Fossil Fiber Optic Line

Qwest has proposed constructing a buried fiber optic line within the Fossil Creek road service from Camp Verde to Strawberry. This line will provide additional service for central Arizona customers. An Environmental Assessment is expected to be published for review in July 2003. A decision is expected in late August or September 2003.

5) Mail Trail

The historical Mail Trail was a 53 mile route between Camp Verde and Payson, used by mail carriers on horseback during the late 1880s and early 1900s to provide delivery service between the two towns. The Coconino NF, in cooperation with the Camp Verde Cavalry, the Yavapai-Apache Nation, and the Payson and Camp Verde Historical Societies, has proposed to designate approximately 8 miles of the historic trail for recreational use, and add this segment to the FS trail system. Environmental analysis for this trail is currently underway. The project is located both within and adjacent to the Fossil Creek project boundary.

6) Cross Country Travel EIS

Five national forests across the state of Arizona, including the Coconino and Tonto NFs, are jointly proposing to limit/restrict motorized cross-country vehicle travel on lands administered by them. The purpose of this proposal is to avoid future resource impacts likely to result from the increasing use of off-highway vehicles (OHVs), and to provide direction for future motorized recreation planning efforts. A draft EIS for this project was released for public comment in April 2003.

7) Range Allotment Management Planning

Allotment management plans are to be completed on active allotments (Fossil Creek, Pivot Rock and Hackberry) in the Fossil Creek area within the next few years. Only small portions of these allotments are within the planning area.

Chapter 2. Alternatives

Introduction

This chapter describes and compares all alternatives considered for the Fossil Creek Management Planning analysis. It includes a detailed description of each alternative considered, and mitigation measures associated with these alternatives. This section also presents the alternatives in comparative form, describing the differences between each alternative and providing a basis for choice among options by decision makers and the public. Some of the information used to compare alternatives is based upon the design of the alternative (i.e., day use versus overnight use), while some information is based upon the environmental, social and economic effects of implementing each alternative (i.e., the intensity of wildlife disturbance caused by day use versus overnight use). Alternatives are also compared based on how well the components of each helps to improve conditions stated in the purpose and need.

Alternatives Considered in Detail

Based on information from public scoping, along with internal management and resource concerns, the Forest Service formulated several alternatives to the proposed action. Five alternatives, including No Action and Proposed Action, were developed for analysis (See Figure 2.1). Alternatives were crafted to provide a variety of responses to the significant primary issue and subissues described in Chapter 1. Alternatives were developed through intensive interdisciplinary evaluation of current and desired conditions. Alternatives are also designed to meet the stated purpose and need for the Fossil Creek Planning project and the project specific desired future conditions. One alternative may respond to multiple issues. Each alternative addresses the issues differently and meets the project purpose and need to a greater or lesser degree.

Figure 2.1 Alternative Themes

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Theme	Proposed Action	No Action	Camping Emphasis	Resource Emphasis	Day use Emphasis

Items Common to All Action Alternatives

Many items included in the Proposed Action (Alternative A) occur in all other action alternatives as well. The following action items are common to all alternatives (with the exception of Alternative B - No Action):

1. **Trail Access**

- 0.5 miles of trail would be added to the Forest Service trail system to extend the Fossil Springs Trail through to the Fossil Springs APS diversion dam site.

- 0.3 miles of social trails would be closed and 0.2 miles of social trail would be retained for creek access in the Middle Fossil Creek area.

2. **Road Access**

- FR9206W (to Quail Tank) and 9248C (to Sally Mae Wash) would be decommissioned.

3. Camping and Campfires

➢ Dispersed camping, campfires, and day use may be allowed in the Stehr Lake area (but with different road systems for each alternative as described, below).

➢ Camping and campfires would be permitted downstream of the existing Irving powerplant facility in locations consistent with riparian resource protection.

4. Other

➢ Cross-country travel would be prohibited; roads would be considered closed unless posted open. Off-highway vehicle use in the planning area would be consistent with decisions adopted in the "Cross-country Use of Motorized Vehicles in Five Arizona Forests" EIS that is currently in progress.

➢ Guidelines for preventing the introduction and spread of invasive plants would be added to both forest plans, including language such as:

- prevent the further spread of existing weeds and future introductions of new populations
- remove sources of weed seed
- minimize the creation of conditions that promote the establishment of invasive weeds

➢ Interpretation would occur outside of Wilderness in order to encourage appreciation and stewardship for Fossil Creek's resources. Two primary interpretive themes would be native fish conservation and cultural landscape history. Interpretation and education would occur mostly at higher use areas such as Irving, Middle Fossil Creek and at trailheads.

➢ Sanitation facilities may be installed in the Middle Fossil and/or Irving areas.

In addition to the specific items listed above, management actions proposed under all alternatives would adhere to existing Coconino and Tonto National Forest Plan standards and guidelines, and applicable mitigation measures. This is the application of both National Forest plans and subsequent amendments, including guidelines for Management Indicator Species, Best Management Practices and archaeological site protection.

The above action items are not restated in the alternative descriptions below. Please reference this "Items Included in all Alternatives" section as well as individual alternative descriptions for a complete account of <u>all</u> management actions proposed for each alternative.

Alternative Descriptions

In this section, management actions proposed for each alternative are summarized in a matrix (see Figures 2.2 - 2.6). Each matrix is followed by a detailed explanation of the summarized actions as well as additional actions, along with rationale for inclusion of these actions in the alternative.

Refer to "Items included in all Alternatives" section above for additional management actions proposed for all alternatives.

Alternative A

Proposed Action

Under Alternative A unnecessary roads and trails would be closed, while maintaining, and, in some locations, creating, adequate parking, camping and creekside access. Camping in the Middle Fossil Creek area would be limited to designated areas to control impacts to soil and vegetation.

Figure 2.2. Summary of proposed management actions in Alternative A (Proposed Action).

	Alternative A Proposed Action		
	Road Access	**Trail Access**	**Camping and Campfires**
Management Actions	FR708 and 502 would remain open to public at Maintenance Level 3. A road access system would be designed and created in the Middle Fossil area to facilitate public parking and creek access. Two day-use parking areas would be created for access to Irving and the FR708 bridge area. Some social trails and vehicle tracks would be retained and converted to trails. Unneeded user created tracks would be closed. In the Middle Fossil area approximately 3 miles of tracks would be closed to motor vehicles and restored. FR502E (and any associated user-created roads) would be decommissioned. FR502A, which provides access to Stehr Lake, would remain open to the public.	Area trails would include the Mail Trail, Fossil Springs Trail, two connector trails near Irving and FR708 Bridge area. The Flume Road and trail would be closed and restored. Footbridge would be removed. A creekside trail may be constructed in the Middle Fossil area. Some social trails and vehicle tracks would be retained and converted to trails. Unneeded user created trails would be closed.	The Fossil Springs Botanical Area, downstream to Irving would be day use only. Designated dispersed camping and campfires would be allowed at former Irving housing area and downstream through Middle Fossil area. Including Irving, 10 camping areas would be designated outside the riparian area, occupying approximately 40 acres. Within these camp areas, an estimated 90 campsites would be available. Dispersed camping, campfires, and day use would be allowed in the vicinity of Stehr Lake. The first recreation area off of FR 708 from Strawberry would be closed (1.0 acre and 0.25 miles of track).

The proposed action calls for adding approximately 2.5 miles of maintenance level 2 roads to the forest system. This includes converting approximately 2.3 miles of user created tracks in the Middle Fossil area to official roads, along with the construction of 0.2 miles of new roads. The Middle Fossil road access system would facilitate public parking and creek access in several locations. Approximately 0.4 miles of user created tracks would be converted to nonmotorized trail to facilitate creek access.

Two day use parking areas associated with Irving and the FR708 bridge would each accommodate up to 25 vehicles and affect ½ acre (50 vehicle capacity, 1.0 acre total).

Other Management Actions include:

1. **Forest Plan Land Management Area Changes**

   A portion of Management Area (MA) 11 (Verde Valley) on the Coconino NF would be converted to MA 12 (Riparian). The Fossil Springs Botanical Area would remain unchanged. On the Tonto NF, the proposed State Natural Area would be expanded to include the creekside downstream to Irving and the Mazatzal wilderness boundary.

2. **Recreation Development (Recreation Opportunity Spectrum - ROS)**

   ROS of Roaded Natural along FR708 and including Irving and Middle Fossil area. Development could include such elements as vault toilets, informational and interpretive signs, trails, and vehicle barriers. Management presence would be frequent.

Alternative B

No Action

Alternative B proposes no future management changes within the analysis area at this time. Current direction given in forest plans and other applicable documents would continue to guide management of the project area. All activities currently occurring would continue in the same manner, at the same levels of intensity, duration, etc. Resource concerns such as vegetative damage, soil compaction and loss of cultural sites would persist.

The Council on Environmental Quality (CEQ) regulations (40 CFR 1502.14d) require that a "No Action" alternative be analyzed. This alternative does not preclude activities in other areas at this time or from the project area at some time in the future. Alternative 2 represents the existing condition against which all other alternatives are compared. Taking no management action would not meet the purpose and need of this project.

Figure XX. Summary of proposed management actions in Alternative B (No Action).

	Alternative B No Action		
	Road Access	**Trail Access**	**Camping and Campfires**
Management Actions	FR708 and 502 would remain open to the public at Maintenance Level 3. FR502E, 9206W and 9248C would remain open to the public. All "tracks" would remain available for public motor vehicle use.	Trails include the Fossil Springs Trail, Mail Trail and Flume Trail. The footbridge at Irving would remain as per the FERC decision.	Dispersed camping and campfires would be allowed throughout the analysis area.

Alternative C
Camping Emphasis

Alternative C was designed to maintain the existing camping capacity, while controlling damage to sensitive resources. While camping would be allowed throughout most of the project area, it would be moved away from the sensitive streamside. Camping and creekside access would be maintained and/or created through the design of roads and trails. Unnecessary user created roads and trails would be closed.

Figure XX. Summary of proposed management actions for Alternative C .

	Alternative C Camping Emphasis		
	Road Access	**Trail Access**	**Camping and Campfires**
Management Actions	FR708 and 502 would remain open to the public at Maintenance Level 3. A road access system would be designed and created in the Middle Fossil area to facilitate public parking and creek access. Two day-use parking areas would be created for access to Irving and the FR708 bridge area. Some social trails and vehicle tracks would be retained and converted to trails. Unneeded user created tracks would be closed. In the Middle Fossil area approximately 3 miles of tracks would be closed to motor vehicles and restored. FR502E would remain open to the public at Maintenance Level 2 to Buzzard Tank. FR502A, to Stehr Lake, would remain open to the public.	Area trails would include the Mail Trail, Fossil Springs Trail, two connector trails near Irving and FR708 Bridge area. The Flume Road would be narrowed and converted to a NF system trail. The footbridge would remain as per the FERC decision. A creekside trail may be constructed in the Middle Fossil area. Some social trails and vehicle tracks would be retained and converted to trails. Unneeded user created trails would be closed.	Camping would be allowed above the junction of the Mail and Fossil Springs trails, 100 feet from the drainage and trails. Campfires would be prohibited in this vicinity. In the Fossil Springs vicinity, camping would be allowed at 4 designated sites located outside the riparian area, occupying approximately 2 acres. Dispersed camping and campfires would be allowed at former Irving housing area and downstream throughout Middle Fossil area. Including Irving, 10 camping areas would be designated outside the riparian area, occupying approximately 40 acres. Within these camping areas, an estimated 90 campsites would be available. Dispersed camping would be prohibited between Irving and the Fossil Springs APS Diversion Dam. Dispersed camping, campfires, and day use would be allowed in the vicinity of Stehr Lake. The first recreation area off of FR708 from Strawberry would be closed (1.0 acre and 0.25 miles of track).

Alternative C calls for adding approximately 2.5 miles of maintenance level 2 roads to the forest road system. This includes converting approximately 2.3 miles of user created tracks in the Middle Fossil area to roads, along with the construction of 0.2 miles of new roads. The Middle Fossil road access system would facilitate public parking and creek access in several locations. Approximately 0.4 miles of user created tracks would be converted to nonmotorized trail to facilitate creek access.

In addition to FR502A, an APS administrative road would provide access to Stehr Lake. A loop would be created between these two roads. Beyond Buzzard Tank, FR502E would be gated, with access limited to administrative and range permittee use. The road would end at Chalk Springs.

Other Management Actions include:

1. **Forest Plan Land Management Area Changes**

   A portion of Management Area (MA) 11 (Verde Valley) on the Coconino NF would be changed to MA 12 (Riparian). Fossil Springs Botanical Area would remain unchanged. On the Tonto NF, the proposed State Natural Area would be expanded to include the creekside downstream to Irving and the Mazatzal wilderness boundary.

2. **Recreation Development (Recreation Opportunity Spectrum - ROS)**

   ROS of Roaded Natural along FR708 and including Irving and Middle Fossil area. Development could include such elements as vault toilets, information signs, trails, and vehicle barriers. Management presence would be frequent.

Alternative D

Resource Emphasis

Of all the alternatives, Alternative D places the most control on recreational activities, and offers the most protection to cultural and natural resources. A minimal amount of access would be provided in the Middle Fossil Creek area, with unneeded roads or trails closed and restored. In general, the analysis area would be managed for maximum resource protection while still providing both single and multi-day recreational opportunities.

Figure XX. Summary of proposed management actions in Alternative D

	Alternative D Resource Emphasis		
	Road Access	**Trail Access**	**Camping and Campfires**
Management Actions	FR 708 would remain open to public motor vehicle access at Maintenance Level 3 except for a section located between the rim (approximately ¼ mile north of the junction with the Deadmans Mesa Road (FR391), and the bridge south of Irving. An estimated 3 miles of FR708 would be decommissioned and converted to a non-motorized recreation trail. A minimal road access system would be created in the Middle Fossil area to facilitate public parking and creek access. Two day-use parking areas would be created for access to Irving and the	The Flume Trail and Road would be closed and restored as needed to meet watershed protection. The footbridge would be removed. Approximately 0.3 mile of vehicle track would be converted to non-motorized trails in Middle Fossil area to link parking/camping with the creek. No creek side trail would be constructed in Middle Fossil. Approximately 0.5 mile of trail would be added to the FS trail	Camping would be allowed above the junction of the Mail and Fossil Springs trails, 100 feet from the drainage and trails. Campfires would be prohibited in this vicinity. The Fossil Springs area, downstream to and including Irving would be day use only. Dispersed camping and campfires would be allowed in 6 designated areas occupying approximately 30.5 acres, outside the riparian area throughout Middle Fossil Creek. An estimated 62 campsites would be available within these designated camp areas.

	FR708 bridge area. Some social trails and vehicle tracks would be retained and converted to trails. Unneeded user created tracks would be closed. In the Middle Fossil area an estimated 4.3 miles of tracks would be closed to motor vehicles and restored. FR9206W (and associated user-created road network), 502E, 9248C and all roads accessing Stehr Lake would be decommissioned.	system to extend the Fossil Springs Trail through to the Fossil Springs APS Diversion Dam site. 0.3 miles of social trails would be closed and 0.2 miles of social trails would be retained for access to the creek.	Dispersed camping, campfires and day use would be allowed in the vicinity of Stehr Lake. The first recreation area off of FR 708 from Strawberry would be closed (1.0 acre and 0.25 miles of track).

A scenic viewpoint would be created to overlook Fossil Creek at the site of closure for FR708.

A new road access system in the Middle Fossil area would include converting an estimated 1.0 mile of existing tracks to forest system roads. Approximately 1 acre of vehicle parking would be established adjacent to FR708 and FR502, with walk-in camping at 3 camp areas serving approximately 40 sites.

Two day use parking areas associated with Irving and the FR708 bridge would each accommodate up to 15 vehicles and affect ½ acre (30 vehicles, 1.0 acre total).

Other Management Actions include:

1. **Forest Plan Land Management Area Changes**

   An expansion of the Fossil Springs Wilderness on both the Tonto and Coconino NFs would be recommended to include Fossil Springs Botanical Area on the Coconino NF and the proposed State Natural Area on the Tonto, downstream along the creek to upstream of Irving and FR708. The Irving vicinity and downstream (outside of the Mazatzal wilderness) would be changed to the Fossil Creek Conservation MA with a boundary generally be ¼ mile on either side of the creek.

2. **Recreation Development (Recreation Opportunity Spectrum - ROS)**

   ROS would be Roaded Natural, but with a more semi-primitive character along Fossil Creek. Signs of management presence would be infrequent.

3. **Special Resource Protection Measures**

   A special closure area would be established along Fossil Creek from just upstream of Irving north to the Fossil Springs APS Diversion Dam. Public access would not be allowed within the closure in order to protect unique riparian and wildlife habitat.

Alternative E

Day Use Emphasis

Alternative E provides resource protection and maintains recreational opportunities by emphasizing day use activities While camping would be permitted throughout most of the analysis area, it would be in designated areas away from the sensitive creekside. The Fossil Springs area would be day use only. Unnecessary user created roads and trails would be closed.

Figure XX. Summary of proposed management actions in Alternative E

	Alternative E Day Use Emphasis		
	Road Access	**Trail Access**	**Camping and Campfires**
Management Actions	FR708 and 502 would remain open to public at Maintenance Level 3. A road access system would be designed and created in the Middle Fossil area to facilitate public parking and creek access. Two day-use parking areas would be created for access to Irving and the FR708 bridge area. Some social trails and vehicle tracks would be retained and converted to trails. Unneeded user created tracks would be closed. In the Middle Fossil area approximately 3 miles of tracks would be closed to motor vehicles and restored. FR502A, to Stehr Lake, would remain open to the public. FR502E would be narrowed and converted to a public trail, open to motorized vehicles less than 50 inches wide. The road would end at Chalk Springs.	Area trails would include the Mail Trail, Fossil Springs Trail, two connector trails near Irving and FR708 Bridge area. The Flume Road would remain a NF trail and be narrowed. The footbridge would remain. A creekside trail may be constructed in the Middle Fossil area. Some social trails and vehicle tracks would be retained and converted to trails. Unneeded user created trails would be closed.	Camping would be allowed above the junction of the Mail and Fossil Springs trails, 100 feet from the drainage and trails. Campfires would be prohibited in this vicinity. The Fossil Springs area, downstream to and including Irving, would be day use only. Dispersed camping and campfires would be allowed in 9 designated areas occupying approximately 35 acres, outside the riparian area throughout Middle Fossil Creek. An estimated 75 campsites would be available within these designated camp areas. Dispersed camping, campfires and day use would be allowed in the vicinity of Stehr Lake. The first recreation area off of FR 708 from Strawberry would be closed (1.0 acre and 0.25 miles of track).

Like the proposed action, this alternative calls for adding approximately 2.5 miles of maintenance level 2 roads to the forest system. This includes converting approximately 2.3 miles of user created tracks in the Middle Fossil area to roads, along with the construction of 0.2 miles of new roads. The Middle Fossil road access system would facilitate public parking and creek access in several locations. Approximately 0.4 miles of user created tracks would be converted to nonmotorized trail to facilitate creek access.

Two day use parking areas associated with Irving and the FR708 bridge would each accommodate up to 25 vehicles and affect ½ acre (1.0 acre total).

In addition to FR502A, an APS administrative road would provide access to Stehr Lake. A loop would be created between these two roads.

Other Management Actions include:

1. **Forest Plan Land Management Area Changes**

   A new Fossil Creek Conservation MA would be created to include Fossil Springs Botanical Area, the proposed State Natural Area and ¼ mile on either side of Fossil Creek downstream to and including the area near the junction of FR708 and FR502, but not wilderness.

2. **Recreation Development (Recreation Opportunity Spectrum - ROS)**

   ROS of Roaded Natural along FR708 and including Irving and Middle Fossil area. Development could include such elements as vault toilets, information signs, trails, and vehicle barriers. Management presence would be frequent.

Mitigation Actions Common to All Alternatives

The following mitigation measures are part of all of the action alternatives.

#	Mitigation	Rationale
	Prior to all project specific implementation activities archaeological survey and cultural resource clearances will be completed.	The current level of archaeological survey is inadequate and not up to current standards
	Visitation to cliff dwellings will be discouraged.	Reduce impacts to archaeological sites, as well as to bats roosting inside
	Construction activities involving heavy machinery or other loud activities (i.e. blasting) near riparian areas will occur only between September 1st and March 15th.	Reduce impacts to nesting bird species
	System tracks and trails will be well signed.	Minimize the creation of new social trails.
	No camping or campfires within the riparian/flood zone (including springs).	Reduce impacts to vegetation, wildlife, fish, soils and water.
	With the exception of Irving, no campsites will be designated on the __________ side of Fossil Creek.	Reduce disturbance to wildlife species.
	Any creekside trail created in the future will be located on the _____________ side of Fossil Creek.	Reduce disturbance to wildlife species.

BMPs (best management practices under the Federal Water Pollution Control Act, Clean Water Act), would be applied to any ground disturbing or construction activities. Possible BMPs are listed in Appendix X. Prior to ground disturbing activities and implementation, specific BMP's would be identified in an implementation plan. Many of these best management practices apply to fisheries, wildlife and other resources, as well as soils and water.

required mitigation - for other disciplines (weeds, veg and wildlife, cultural, fisheries [interpretive signing for angling]

Alternatives Considered but Eliminated from Detailed Study

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). Public comments received in response to the Proposed Action provided suggestions for alternative methods for achieving the purpose and need. Some of these alternatives may have been outside the scope of the analysis, duplicative of alternatives already considered in detail, or determined to be components that would cause unnecessary environmental harm. Therefore, a number of alternatives were considered, but dismissed from detailed consideration as discussed below.

(alt from 4-9-03 meeting notes??)

Comparison of Alternatives

This section provides a summary of the outcomes of implementing each alternative. Information in Figure XX (the first table) is focused on activities and effects where different levels of outputs/outcomes can be distinguished quantitatively or qualitatively among alternatives. Alternatives are also compared in Figure XX (the second table) based on how well the components of each helps to improve conditions stated in the purpose and need.

Alternative **A - Proposed Action**
Alternative **B - No Action**
Alternative **C - Camping Emphasis**
Alternative **D - Resource Emphasis**
Alternative **E - Day Use Emphasis**

Table XX. Comparison of Alternatives Based on Outputs/Outcomes

Middle Fossil Camping Overview	**A**	**B**	**C**	**D**	**E**
#Camp Areas	10	13	10	6	9
#Campsites	90	90	90	62	75
#Acres Allocated to Camping	40	38	40	30.5	35
Irving and Fossil: Camping Allowed					
Former Irving Housing Area	Y	N	Y	N	N
Fossil Springs Botanical Area	N	N	Y	N	N
Above Junction of Mail and Fossil Springs Trails	Y	Y	Y	Y	Y

Middle Fossil Camping Overview	A	B	C	D	E
Irving and Fossil: Campfires Allowed					
Former Irving Housing Area	Y	Y	N	N	N
Fossil Springs Botanical Area	N	Y	N	N	N
Above Junction of Mail and Fossil Springs Trails	N	Y	N	N	N
Flume Trail	N	Y	Y	N	Y
Miles of Road Decommissioned	9.4	0	7.0	14.1	5.0

Table XX. Comparison of Alternatives Based on Improving Conditions Stated in the Purpose and Need

Purpose and Need	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Reduce the propagation of user created roads and trails	Well signed system trails and tracks will help reduce the creation of social trails.	No reduction in user created roads and trails. Does not meet purpose & need.	Well signed system trails and tracks will help reduce the creation of social trails.	Well signed system trails and tracks will help reduce the creation of social trails.	Well signed system trails and tracks will help reduce the creation of social trails.
Reduce vegetative damage		No reduction in vegetative damage. Does not meet purpose & need.		Largest reduction in vegetative damage due to largest number of campsites closed and creation of special closure area	
Reduce damage to/loss of cultural sites and resources		No reduction in cultural resource damage. Does not meet purpose & need.		Best meets need with interpretation and by eliminating/reducing camping in many areas, and creating special closure area	
Continue to provide a diverse range of recreational opportunities in Fossil Creek	13.5 miles of roads and trail closed; 7.5 acres of camping area closed.	Most diverse range of recreational opportunity. No roads, trails or camping areas closed.	XX% fewer miles of roads/trails closed, XX% fewer acres of camping areas closed than Alt. 1. Small/moderate reduction in recreational opportunity	Least diverse range of recreational opportunity. Moderate/large reduction in recreational opportunity	XX% fewer miles of roads/trails closed, XX% fewer acres of camping areas closed than Alt. 1. Small/moderate reduction in recreational opportunity
Reduce disturbance to wildlife, fish and habitat	Meets need with interpretation and by eliminating/reducing camping in fewer areas	No reduction in wildlife, fish or habitat disturbance. Does not meet purpose & need.	Meets need with interpretation and by eliminating/reducing camping in fewer areas	Best meets need with interpretation and by eliminating/reducing camping in many areas, and creating special closure area	Meets need with interpretation and by eliminating/reducing camping in fewer areas

Create strategies for managing increased numbers of recreationists	Meets need by developing parking areas, managing access and other proposed actions.	No management strategy created. Does not meet purpose and need.	Meets need by developing parking areas, managing access and other proposed actions.	Meets need by developing parking areas, managing access and other proposed actions.	Meets need by developing parking areas, managing access and other proposed actions.
Proactively prepare for the anticipated decommissioning of Childs/Irving powerplant facilities	Meets need by developing revised management strategies	No preparation for anticipated decommissioning. Does not meet purpose & need.	Meets need by developing revised management strategies	Meets need by developing revised management strategies	Meets need by developing revised management strategies

Chapter 3. Affected Environment and Environmental Consequences

Introduction

This Chapter summarizes the physical, biological, social, and economic environments of the project area and the effects of implementing each alternative on that environment. It also presents the scientific and analytical basis for the comparison of alternatives presented in the Chapter 2.

(need to define "adverse effect")

Vegetation

Affected Environment

Riparian Vegetation

Fossil Creek has been largely dewatered in the lower reach (below Irving) since the construction of the Childs power plant in 1909, and in the upper reach since construction of Fossil Springs dam and the Irving facility in 1916. Some seepage (approximately 1.5 to 2.0 cfs) from Fossil Springs dam has been occurring over the last 10 years. Likewise, approximately 5.5 to 6.0 cfs or more has been released into the natural channel at the Irving facility over the last 10 years. In addition Fossil Creek from Irving downstream to at least Hardscrabble Creek is a gaining system due to the presence of springs. These flows have allowed a riparian community to persist in Fossil Creek, despite diversion of almost all flows. Due to the dramatic reduction in the amount of water flowing in Fossil Creek, existing riparian conditions are undoubtedly different than before pre-European settlement, both above the diversion structure at Fossil Springs and below (Monroe 2000, Sayers 1998, Medina 1998). The significant reduction in base flow in the Creek may limit vegetative abundance and diversity, exacerbating the impacts of episodic floods on the Verde River (Sullivan and Richardson 1993).

In the uppermost portion of Fossil Creek, above the influence of Fossil Springs, riparian trees are sparse and low in species diversity. Sycamore is the dominant species, with good age class diversity overall. The understory is sparse and comprised of upland species. In 2002 Fossil Creek riparian habitat was assessed using the 'Process for Assessing Proper Functioning Condition' (U.S.D.I., 1993). In this portion of the analysis area, Fossil Creek was assessed to be in 'proper functioning condition' (PFC). (add PFC to definitions page)

A diverse, well-developed riparian area approximately 23 acres in size is associated with Fossil Springs (Goodwin 1980). From the springs down to the diversion dam, basal area, crown density, and species diversity of riparian tree species are high, with good age class representation (Goodwin 1980, Burbridge and Story 1974a, Sayers 1998). Compared to below the dam (from the dam downstream to the Irving powerplant facility), the area near the springs has a higher proportion of understory vegetation, including grasses, ferns, and shrubs (Sayers 1998). Based on a recent assessment, the riparian habitat in this area is well developed and in proper functioning condition.

The upper reach of Fossil Creek was historically a travertine-dominated system. The water from the Fossil Springs is rich in calcium carbonate, which, under certain conditions of flows and turbulence, precipitates out to form travertine structures, or dams, in the stream channel. Due to diversion of the majority of flows from the natural channel, little travertine is being actively deposited. With minimal base flows, and little to no travertine deposition, floods are currently the dominant process influencing riparian habitat (Malusa 1997).

From the dam downstream to the Irving hydroelectric plant, there is little soil to support understory vegetation. The overstory is dominated by Arizona sycamore (*Platanus wrightii*). A variety of habitat assessments in this section show a change in age class distribution where mature trees represent the majority of the cover type and shrubs species are few to absent (Goodwin 1980, Sayers 1998, USDA 1989). Norman (personal observation 2002), however, reports that this section has well-developed riparian vegetation (where not limited by bedrock) and is in proper functioning condition. In 1996, Overby and Neary observed 81 distinct sets of travertine dams in this reach, and that is some instances, multiple terraces had developed within the riparian zone of the creek. Travertine dams will impound sediments, forming these terraces that allow for establishment of herbaceous, emergent, and shrubby habitat components, which are extremely limited in the creek system between Irving and the Fossil Springs diversion dam (Arizona Public Service Company 1992, Sayers 1998, Medina 1998).

Between Irving and the Narrows (a narrow canyon with sheer wall and little to no stream bank), riparian vegetation is quite sparse (Goodwin 1980); in this reach, well-developed riparian vegetation exists only in concentrated areas in association with springs. Small, localized areas with sand bars support abundant cottonwood reproduction (Goodwin 1980). Existing large woody vegetation in this reach is likely supported by groundwater rather than stream flows (Medina 1998). Travertine deposition has been observed to occur to some degree just below Irving, where a small amount of flow is released into the natural channel. Dam monitoring points along the stream edge have been inundated and are no longer accessible, indicating the stream channel has widened, and cattails and other vegetation have colonized some of the stream edges (C. Overby, personal observation).

In 1980, Goodwin documented a poorly developed riparian community from the Narrows downstream to the confluence of Fossil Creek and the Verde River. The overstory was described as sparse, with depauperate riparian vegetation in the area approaching the Verde River (Goodwin 1980). In 1993, Sullivan and Richardson reported a restriction in herbaceous and emergent species growth adjacent to the stream channel in the confluence area. A more recent assessment in 2002 by _____ stated that riparian habitat in this reach was well-developed, and Fossil Creek was determined to be in proper functioning condition. The discrepancies between present and past habitat evaluations may be attributed to the return of some flows to Fossil Creek within the last decade, resulting in improved riparian conditions and, consequently, a healthier, more productive riparian community.

Overall, understory components, such as emergents, herbaceous species and shrubs, are limited in Fossil Creek from below Fossil Springs downstream to the Verde River confluence (Arizona Public Service Company 1992, Sayers 1998, Medina 1998, Sullivan and Richardson 1993). Tree species diversity is good throughout, with differences in overstory dominant species are found (Goodwin 1980, Sayers 1998).

Seedlings are the most common vegetative age class in Fossil Creek, and are concentrated in a very narrow band directly adjacent to the stream (Arizona Public Service Company 1992). The number of riparian plants decreases with horizontal distance from the stream, which is related to the lack of available soil moisture away from the stream channel (Arizona Public Service

Company 1992). Current base flows do not provide moisture to adjacent riparian terraces, disconnecting the active stream channel with creek banks. Although abundant regeneration occurs in the narrow band adjacent to the stream channel, floods and lack of soil moisture on adjacent terraces will likely limit long-term survival and growth to maturity.

Fossil Springs Botanical Area

Fossil Springs Botanical Area is located in the stream reach between Fossil Springs and the diversion dam. The area is approximately 32 acres in size (12 acres on the Coconino, and 20 acres on the Tonto) and consists of both riparian and upland vegetation. A total of 166 species of plants have been recorded in the Botanical Area. Refer to Appendix XX for a list of these species.

Stehr Lake

Stehr Lake is a regulating reservoir, historically used by APS to maintain a 3-day supply of water for the Childs development in the event that the Irving powerhouse or flume had to be closed for repairs (Federal Energy Regulatory Commission and USDA Forest Service 1997). Original surface area of water was 23 acres, but has been reduced to 3 acres due to sediment accumulation and dense growth of emergent vegetation (Federal Energy Regulatory Commission and USDA Forest Service 1997). Cattails occupy 13 acres of the lake, bordered by Torrey's rush, but cattails in the northeast part of the lake are dying and being replaced by drier riparian species (Federal Energy Regulatory Commission and USDA Forest Service 1997). Overall, deciduous hardwoods are scattered (Burbridge and Story 1974b). The lake is surrounded by a variety of vegetation, including grass, willow, ash, mesquite, cottonwoods, walnut, and several shrub species (Burbridge and Story 1974b, Federal Energy Regulatory Commission and USDA Forest Service 1997). Many of the mature deciduous riparian trees located on the north end of the lake are dead or are dying (J.Agyagos, pers. obs).

Secondary Streams, Springs and Tanks

In addition to Fossil Creek and the Verde River, there are other riparian areas within the planning area. Riparian Area Survey and Evaluation System (RASES) data show riparian vegetation (primarily deciduous tree species) along lower Calf Pen Canyon, Sandrock Canyon, Tin Can Draw, Mud Tanks Draw, Boulder Canyon, Sally May Wash, Stehr Lake Wash, and Hardscabble Creek. Refer to Appendix XX Map XX (or specialist report??) for locations of these riparian areas.

There are 13 springs located within the uplands of the planning area. Ten of these springs have been assessed for riparian condition. Of the ten springs assessed, 6 support riparian vegetation and 6 have perennial flow. Refer Table XX in Appendix XX (or specialist report??) for a summary of these springs, and Appendix XX, Map XX (or specialist report??) for the location of these springs in the planning area.

The analysis area contains 22 tanks, whose primary purpose are to water permitted livestock. Many of these tanks are dry at certain times of the year. Recently, only Stehr, Buzzard, and Quail Tanks have held water year round. Refer to Appendix XX, Map XX (or specialist report??) for the locations of all tanks within the planning area.

Upland Vegetation

Eight broad vegetative, or biotic, communities are present within the Fossil Creek area (Table Two). In the northeast portion of the planning area where Calf Pen and Sandrock Canyons occur, the upland vegetation is dominated by mixed conifer, ponderosa pine, and ponderosa pine/Gambel oak. The upland slopes in the Fossil Springs area are predominately pinyon-juniper, with inclusions of chaparral (Goodwin 1980, TES mapping results). Below Irving, the vegetation on the slopes changes to a mixed grassland/desert scrub community (Goodwin 1980, TES mapping results). The Fossil Creek database (located in the wildlife files on the Coconino NF, Red Rock Ranger District) documents 300 plant species that have been found in surveys of riparian and upland areas associated with the planning area. Refer to Appendix XX for a list of these species. To date, a complete and systematic inventory of the plant species in the Fossil Creek planning area has not been conducted.

Terrestrial Ecosystem Survey (TES) data was used to determine the acres of the different biotic communities within both the 5th code Fossil Creek watershed and the planning area boundary. Refer to Appendix XX, Maps XX and XX (or specialist report?) for a display of the various biotic communities by 5th code watershed and planning area, respectively. Refer to Table XX in Appendix XX (or specialist report?) for a summary of these acreage figures.

Invasive Plants

No formal inventories for invasive plant species have been conducted within the analysis area. However, a query of the Fossil Creek database shows documentation of six species of invasive plants in the Fossil Creek area. Refer to Table XX in Appendix XX (or specialist report?) for a list of these species and the localities in which they have been observed. It is anticipated that additional weed species such as Dalmatian toadflax, bull thistle, yellow-star thistle, and diffuse knapweed are present within the Fossil Creek planning area.

Wildlife

Introduction

Fossil Creek canyon and the surrounding habitat support over 146 known vertebrate wildlife (excluding fish species), and 30 known species of invertebrates (Fossil Creek Database). These numbers are based on actual sightings of species within the Fossil Creek area. There are many more species that potentially, and likely, occur in the area but have not been documented. In addition to actual observations, the Fossil Creek database tracks species that various sources have listed as hypothetically occurring in the area. A query of this database shows that 298 species of mammals, birds, reptiles and amphibians may occur but have not yet been documented in the Fossil Creek area. Refer to Appendix XX, XX, XX and XX for a list known and hypothetical occurrences of birds, mammals, herp, and invertebrate species in the Fossil Creek planning area.

Rare wildlife species that are known to occur, or have existing or potential habitat within the project area include five Federally listed or proposed species: Bald eagle (*Haliaeetus leucocephalus*), Mexican spotted owl (*Strix occidentalis lucida*), Southwestern willow flycatcher (*Empidonax traillii*), Yuma clapper rail (*Rallus longirostris yumanensis*), and Chiricahua leopard frog (*Rana chiricahuensis*).

Other rare wildlife species that are known to occur, or have existing or potential habitat include 34 Forest Service sensitive species, five bat species at high risk of imperilment, and 14 Forest Service Management Indicator Species (MIS), four of which are also listed or sensitive species (Table Four).

ADD SPECIES TABLE

Bald Eagle, *Haliaeetus leucocephalus* (Threatened)

Affected Environment

Nesting

Bald eagles in central Arizona prefer to nest on cliff ledges, pinnacles or in tall trees (USFWS 1982). Foraging for waterfowl and fish occurs along major streams; however, hunting for small mammal species takes place in upland areas, especially during winter. Nesting eagles are known from both the Coconino and Tonto NFs. Two bald eagle breeding areas occur on the Verde River in the project area vicinity, approximately .21 and .75 miles respectively, outside the project area boundary. No bald eagle nest sites are known to occur in the Fossil Creek planning area. Refer to Appendix G, Map 4 (or specialist report?) for locations of bald eagle nest sites near the planning area.

Research shows that eagles from at least one of these nearby breeding areas have historically foraged for spawning suckers and used hunting perches along Fossil Creek. Hunt et al. (1992) state that Fossil Creek is an important Verde River tributary to protect to ensure maintenance of fish populations and riparian communities utilized by bald eagles. These birds are not known to use Stehr Lake, although the lake and its shoreline may provide foraging and nesting habitat. Due to infill and vegetation encroachment, Stehr Lake, originally 23 acres in size, had been reduced to approximately 3 acres. This affects the quality of this habitat for eagles, and its potential suitability for nesting or foraging.

Wintering

The fishery currently supported by Fossil Creek provides limited foraging habitat for wintering eagles. Stehr Lake provides potential foraging and roosting habitat, although eagles are not known to use the lake and habitat may be marginal. Given the flat topography, small size and the presence of better roosting habitat in Fossil Creek, Stehr Lake's use as a winter roosting area is questionable.

Within the planning area, there is over 5,500 acres of mixed conifer, ponderosa pine, and pine/oak vegetation in the Sand Rock and Calf Pen Canyons. Communal roosting may potentially occur in these vegetation types where suitable conditions such as steep slopes, wind protection, open canopy and larger trees occur. Grubb and Kennedy (1982) document Fossil Springs as an area where there was either historic or reported use. Due to the presence of large trees protected from the wind by adjacent slopes along portions of the creek, potential roosting habitat occurs along Fossil Creek. Although potential roosting habitat occurs, no bald eagle winter roosts are known to occur in the planning area.

Mexican Spotted Owl, *Strix occidentalis lucida* (Threatened)

Affected Environment

In general, Mexican spotted owls (MSOs) on the Coconino NF (what about the Tonto?) occupy mixed conifer and ponderosa pine/gambel oak vegetation types, usually characterized by high canopy closure, high stem density, multi-layered canopies within the stand, numerous snags, and downed woody material. Suitable nesting and roosting habitat is often located on steep slopes or in canyons with rocky cliffs, where cool moist, microhabitats are provided by dense vegetation, crevices or caves. Because owls use canyon bottoms extensively, it is important to preserve and increase the quality of these habitats (USDI Fish and Wildlife Service 1995). Increasing the quantity and distribution of riparian habitats such as Fossil Creek provides the potential for increasing spotted owl habitat (USDI Fish and Wildlife Service 1995).

Three Mexican spotted owl protected activity centers (PACs) are found in the Fossil Creek vicinity. These PACs occur primarily in mixed conifer and ponderosa pine/oak vegetation located in the northeastern portion of the planning area. Refer to Appendix XX, Map XX (or specialist report?) for PAC locations. Table XX shows the reproductive status of owls inhabiting these three PACs.

Table XX: Reproductive History of Mexican Spotted Owls (by PAC) in the Fossil Creek Area

PAC Name	PAC #	00	91	92	93	94	95	96	97	98	99	01
Sandrock	040103	NI	NI	NI	1Y	M,NU	NI	NI	M,NU	NI	M	S
Calf Pen	040421	O,NU	F,NU	O,NU	NI	O,NY	NI	NI	NI	NI	NI	NI
Horse	040444	NI	NI	NI	NI	NI	NI	NI	NI	NI	O,2Y	NI

O = Pair Occupancy
S = Single detected (sex unknown)
M = Male detected
F = Female detected
Y = Number of young fledged
NU = Nesting status unknown
NY = No young produced
NI = No Information (unsurveyed)

Surveys have not been conducted for Mexican spotted owls in the riparian portions of the planning area. According to the MSO recovery plan (USDI Fish and Wildlife Service 1995), the riparian area along Fossil Creek qualifies as restricted MSO habitat, and lands within Wilderness boundaries and the Fossil Springs Botanical Area qualify as protected MSO habitat. To date, no MSO surveys in Fossil Creek riparian habitats have been conducted; however, there is little to no suitable nesting habitat within the project area. Several small patches of habitat occur along the creek at Fossil Springs and in association with other small seeps and springs, but the small size and fragmented nature of these areas likely preclude their use by nesting owls. Overall, the majority of the riparian forest along Fossil creek is too sparse, and/or lacks the complex structure necessary to provide nesting habitat.

Southwestern Willow Flycatcher, *Empidonax traillii extimus* (Endangered)

Affected Environment

Nesting southwestern willow flycatchers prefer dense riparian thickets in areas where perennial flow, surface water, or saturated soil is present from April through September. Canopy cover is high, typically greater than 90% (Spencer et al. 1996). In the Verde Valley, nesting willow flycatchers occur in tamarisk (Tamarix sp.) and mixed riparian habitats.

In 1994, USFS personnel conducted surveys at Fossil Springs and along Fossil Creek approximately six miles below the dam. Three additional sites along Fossil Creek were surveyed in 1998. Compared with occupied sites in the Verde Valley, the narrow corridors of riparian habitat and open mid and understory layers of vegetation of the planning area have little potential for supporting nesting willow flycatchers. No southwestern willow flycatchers were detected in 1994 or 1998 surveys. Currently, neither Fossil Creek nor Stehr Lake support nesting willow flycatchers (what is the rationale for saying that Stehr Lake habitat is not suitable?).

Yuma Clapper Rail, Rallus longirostris yumanensis (Endangered)

Affected Environment

Yuma Clapper Rails live and nest in freshwater marshes where moist to wet soil and dense vegetation occur (Todd 1986, Eddleman and Conway 1998). Flooded areas are important, but generally areas of shallow water near shore are used. Most studies of Yuma clapper rails have indicated a preference for areas dominated by cattails and bulrush (Anderson and Ohmart 1985, Conway and others 1993, Eddleman 1989, Smith 1975, Todd 1986).

Currently there is no nesting habitat for Yuma Clapper rails along Fossil Creek. Increased flows into Fossil Creek may provide adequate size patches of emergent vegetation suitable for nesting, however, spring flows from snow melt and spring precipitation would likely result in fluctuating water levels that could inundate Yuma clapper rail nests. Suitable habitat occurs at Stehr Lake. Surveys conducted in the area in 1998 failed to detect nesting rails.

Yellow-Billed Cuckoo, Coccyzus americanus occidentalis (Candidate)

Affected Environment

The yellow-billed cuckoo is a late migrant associated with large tracts of undisturbed riparian deciduous forest where willow, cottonwood, sycamore, or alder occur. Yellow-billed cuckoos in higher elevations may be found in mesquite and tamarisk. The yellow-billed cuckoo feeds almost entirely on large insects, and if food stressed, may also feed on berries and fruit. A query of the Fossil Creek database shows that a yellow-billed cuckoo was detected in the Fossil Creek riparian area by Coconino biologist Cathy Taylor. AGFD conducted a survey for the cuckoo at Verde Hot Springs along the Verde River however no cuckoos were detected. Yellow-billed cuckoos could potentially occur in Fossil Creek from Fossil Springs down to the Verde confluence and more surveys need to be conducted.

Lowland Leopard Frog, *Rana yavapaiensis* (Sensitive)

Affected Environment

Lowland leopard frogs prefer permanent stream pools, springs, stock tanks, and side channels of major rivers, most commonly at low elevations. Surveys for this species have been conducted in Fossil Springs, Fossil Creek, and nearby stock tanks. All life stages of lowland leopard frogs have been observed in abundance above the Fossil Springs dam (Appendix XX, Map X). Surveys conducted below the dam in 1985, 1990, 1992 and 1995 failed to detect the species. An additional 1998 survey conducted from the bridge to the Irving Power Plant and further upstream to ca 3,840 ft also failed to detect lowland leopard frogs. Numerous tadpoles were observed from a spring throughout the aquatic channel upstream to the dam (??). Immature individuals were observed just upstream of the Verde River confluence.

Based on all known surveys, the lowland leopard frog population above the dam in the Fossil Springs area constitutes over two thirds of the total number of lowland leopard frogs on the Coconino National Forest. While habitat in varying degrees of suitability occurs below the dam in Fossil Creek, no adults have been detected in that area, only tadpoles. The presence of predacious crayfish and non-native fish species, as well as a lack of hiding cover contribute to the absence of lowland leopard frogs below the Fossil Springs dam.

Common Black-hawk, *Buteogallus anthracinus* (AZ Wildlife Species of Concern, Sensitive, MIS)

Affected Environment

Common black-hawks inhabit low elevation riparian areas. The species is dependent upon mature, relatively undisturbed habitat supported by a permanent flowing stream. Groves of tall trees must be present along the stream course for nesting.

In Fossil Creek, common black-hawks have been observed in all reaches except the lower reach below Irving. There have been no observations of black-hawks at Stehr Lake. Suitable nesting habitat currently occurs from Fossil Springs downstream to the Irving power plant, and in areas where significant springs provide for tall trees and foraging habitat.

Aquatics

Affected Environment

Introduction

Fish species and their habitats combine to form the affected environment of the fisheries resource. Rare fish species that are known to occur, or have existing or potential habitat within the project area include five Federally listed species: Colorado pikeminnow (*Ptychocheilus lucius*), Razorback sucker (*Xyrauchen texanus*), Gila topminnow (*Poeciliposis occidentalis occidentalis*), Loach minnow (*Tiaroga cobitis*) and Spikedace (*Meda fulgida*). Other notable fish species that are known to occur, or have existing or potential habitat include six sensitive and/or management emphasis species, including roundtail chub, headwater chub, longfin dace, desert sucker, Sonora sucker and speckled dace (Table XX).

Also included as an integral part of the aquatics resource are the macroinvertebrate fauna associated with the Fossil Creek aquatic ecosystem. The Environmental Protection Agency (EPA 1991) defines macroinvertebrates as those organisms that lack a backbone, are visible by the naked eye, are greater than .5 millimeter in size, and which require a watered environment to persist and/or complete their life cycle.). "A wide variety of taxonomic groups are found in freshwater environments, and these include annelids, crustaceans, flatworms, mollusks, and insects." As a group, macroinvertebrates are identified in the Coconino National Forest Land and Resource Management Plan (USDA 1987a) as a management indicator [species] (MIS) for high and low elevation riparian areas. The presence and/or absence of macroinvertebrates provide a natural barometer for determining the health of an aquatic system. For all practical purposes, the evaluation of effects to the aquatic and/or fisheries resource, described in this document, implies an evaluation of macroinvertebrate habitat as well.

Fish Species

Colorado Pikeminnow, *Ptychocheilus lucius*
Endangered

Colorado pikeminnow is characterized as a "big river" generalist species, occurring in deep, turbid, strongly flowing waters. Larvae and other small individuals often occur in shallow backwater areas. The species can make long migrations to spawn in very specific canyon-like habitats.

Since 1985, extensive reintroductions of hatchery-raised Colorado pikeminnow have been made into the Verde River systems. Colorado pikeminnow, although stocked annually in the Verde River near Childs, have never been captured in Fossil Creek, although in theory the species could enter lower reaches if a suitable native fish prey base is reestablished. Returns from stocking efforts have been poor (Hendrickson 1993).

Razorback Sucker, *Xyrauchen texanus*
Endangered

This species tends to occupy strong, uniform currents over sandy bottoms, eddies and backwaters, sometimes concentrating near cut banks or fallen trees. Habitat needs of young and juvenile razorback suckers in the wild are largely unknown.

Razorback suckers have been stocked in numerous locations in the Verde River Basin in an attempt to recover the species. Early stocking sites included Fossil Creek and the Verde River below Camp Verde. Returns from these reintroduction efforts were poor. Razorback suckers were stocked above the Fossil Springs diversion dam in 1989 and survived for several years, but no longer occur in Fossil Creek (Barrett 1992, Hendrickson 1992, 1993 in USDI 2002).

Gila Topminnow, *Poeciliopsis occidentalis occidentalis*
Endangered

Gila topminnow inhabit a wide variety of water types, including springs, marshes, permanent or interrupted streams, and formerly along large rivers below 4,500 feet in elevation. Habitat requirements are fairly broad; shallow, warm and fairly quiet waters are preferred, but the species can adjust to a wide range of conditions. Preferred habitat contains dense mats of algae and debris.

Gila topminnow populations have been declining for over 100 years. Recovery of the species has included introductions into approximately 175 historic and non-historic habitats across Arizona. Fossil Creek was included as a non-historic introduction site, and was stocked with Gila topminnows in 1967 and 1969. This stocking has been deemed unsuccessful (Bagley et al. 1991 in undated paper by T. Cain).

Loach Minnow, *Tiaroga cobitis*
Threatened

Loach minnow inhabit turbulent, rocky riffles on mainstem rivers and tributaries up to 7,200 feet in elevation. Most habitat occupied by loach minnow is relatively shallow, with moderate to swiftly flowing waters.

A recovery plan for loach minnow was approved in 1991 (USDI 1991b). Critical habitat is designated along Fossil Creek, extending upstream from the Fossil Creek/Verde River confluence for approximately 4.7 miles. This stretch is contiguous with additional critical habitat designated along the Verde River (USDI 2000). Loach minnow populations are considered to be extirpated from the entire Verde River basin (Minckley 1993, USDI 2000), including Fossil Creek.

Spikedace, *Meda fulgida*
Threatened

Spikedace inhabit riffles and runs in shallow flowing waters. Larval spikedace most commonly occupy slow-velocity waters near stream margins over sandy substrates. Spawning occurs in shallow riffles. Research has indicated that the greatest determining factor in spikedace occurrence was water velocity (Neary et al.199X)

A recovery plan for spikedace was approved in 1991 (USDI 1991b). Critical habitat is designated along Fossil Creek, extending upstream from the Fossil Creek/Verde River confluence for approximately 4.7 miles. This stretch is contiguous with additional critical habitat designated along the Verde River (USDI 2000). Spikedace populations are considered to be extirpated from the entire Verde River basin (Minckley 1993, USDI 2000), including Fossil Creek.

Roundtail Chub (*Gila robusta*) and Headwater Chub (*Gila nigra*)
Forest Service Sensitive Species

Roundtail chub occupy pools in mid-elevation streams and rivers. Cover is usually present. Smaller chubs generally occupy shallower, low velocity waters. Roundtail chub appear to be very selective in their choice of pools, as they are commonly found to congregate in certain pools, and are not found in similar, nearby pools. Headwater chub typically use similar habitats, but exist in headwater reaches using pools with less depth than those preferred by roundtail chubs.

Taxonomic classification between roundtail and headwater chub was made very recently (Minckley and DeMarais 2000). Roundtail chub are included on the Regional Forester's sensitive species list, and although headwater chub are not, their close relationship and similar status warrant the same special consideration. Both species currently occupy Fossil Creek: roundtail chubs inhabit the portion of the creek downstream of the Irving Power Plant, while headwater chubs are typically found upstream of this area. Roundtail chub populations have declined over the past few decades, while headwater chub are restricted in overall range to headwater reaches of Verde River tributaries.

Longfin Dace, *Agosia chrysogaster*
Tonto NF Sensitive Species

Longfin dace occur naturally throughout the Gila River drainage. The species is found in shallow waters, and is rarely abundant in larger streams, or at elevations above 5,000 feet. Sandy substrates are necessary for spawning.

Desert Sucker, *Catostomus clarki*
Tonto NF Sensitive Species

This species is found in rapids and flowing pools of streams. Adults inhabit pools by day, moving at night to swift riffles and runs. Young inhabit riffles throughout the day.

Desert suckers occur in the Verde River drainage, and are fairly common throughout their entire range. Water development remains a continued threat, casting uncertainty on the future status of the species.

Sonora Sucker, *Catostomus insignis*
Tonto NF Sensitive Species

Sonora suckers are characteristic of gravelly or rocky pools of creeks and rivers. The species can be found in a variety of habitats from warm water rivers to trout streams.

Sonora suckers are widely distributed and common between 1,000 and 6,500 feet elevation in the Verde River basin. Dams and diversions of free-flowing streams, water pollution, and sedimentation of streams have diminished its range. The status of the species is uncertain.

Speckled Dace, *Rhinichthys osculus*
Tonto NF Sensitive Species

Speckled dace prefer small, headwater streams, often occurring in waters isolated for miles from larger streams by dry streambeds. Individuals can persist for long amounts of time in intermittent pools. This species is presently rare below 5,000 feet elevation.

Speckled dace is the most ubiquitous freshwater fish in the western US, and occurs in all of Arizona's major drainages.

Macroinvertebrates

Fossil Springsnail, *Pyrgulopsis simplex*
Federal Species of Concern, Sensitive

Springsnails require perennially flowing waters with moderate current year round. The tiny Fossil Springsnail is typically found only in the headspring and upper sections of outflows at the various Fossil Springs (Appendix G, Map 4). Physiological requirements limit suitable habitat to headwaters. This species has experienced no apparent reduction in range or abundance as a result of activities in the Fossil Creek watershed during the past two decades.

Soils

Affected Environment

Soils in the Fossil Creek planning area can be summarized into eight ecological categories, based on the type of vegetation they produce - streamside, semi-desert grasslands, desert and semi-desert shrubland; juniper/semi-desert grasslands, juniper/semi-desert shrublands, pinyon-juniper woodlands, ponderosa pine/ juniper oak, and mixed conifer. Soil condition for each of these ecological categories is summarized below. The Terrestrial Ecosystem Survey (TES) for both the Coconino National Forest (USDA 1995) and the Tonto National Forest (1985) form the basis of the assessment of soil condition. Soil condition is described with various terms; unsatisfactory, satisfactory-inherently unstable, impaired, and satisfactory (see glossary). Additional information on soil condition within the planning area can be found in the Fossil Creek Planning Area Existing Condition Soils Report (Steinke 2002).

Streamside Vegetation

Soils found along streamsides (1,085 acres) occur on slopes less than 10 percent and have formed in alluvium from mixed sources. These soils are subject to flooding. Historical and present day camping and day recreation use has typically occurred on these soils along Fossil Creek. Based on TES, there are areas with impaired and unsatisfactory soil conditions on both forests. Roads located in or near stream channels, as well as those located in the uplands in areas of naturally erosive soils found on steep slopes, provide an avenue from which surface runoff may carry sediment laden water and deliver it into a stream or an intermittent channel that eventually drains into downstream perennial waters.

Current vegetative ground cover ranges from about 10 to 25 % with natural cover projected at about 25 to 35 % by the Forest TES. Recent data indicate where current canopy cover of trees and shrubs far exceeds natural canopy covers as listed in the TES, the herbaceous understory component is low resulting in decreased effective vegetative ground cover and increased susceptibility to sheet and rill erosion.

Semi-Desert Grasslands

Soils in semi-desert grasslands (950 acres) occur on gently sloping elevated plains to steep sloped hills (0-40% slopes); however most slopes are less than 15%. Soils have primarily formed from old alluvium derived from limestone and basalt and are mostly greater than 20 inches in depth. Overall, soil condition as identified by the Forests TES is impaired and unsatisfactory with small areas of satisfactory-inherently unstable soils on steeper slopes. Slopes less than 15% are typically compacted as a result of high levels of current and historic livestock grazing and are in unsatisfactory condition. Many soils on steeper slopes have excessive sheet and rill erosion.

Existing effective vegetative ground cover area ranges from about 10 to 30%. Vegetative ground cover under natural conditions is projected to be about 30% by the Forest TES.

Desert & Semi-Desert Shrubland

This soil type comprises 684 acres within the planning area. Soils occur on steep to very steep mountains and escarpments and are formed from mixed sources. Many areas include rock outcrop. Soil depths are variable ranging from about 10 inches to greater than 40 inches.

Due to the steep slopes present, most of this soil type has not been as heavily impacted by livestock grazing as others. Soil condition is generally satisfactory but inherently unstable. Soils are typically found on south facing slopes. Vegetative ground cover under current conditions is around 10%, nearly equivalent to the ground cover under climax conditions.

Juniper/Semi-Desert Grassland and Juniper/Semi-Desert Shrubland

Soils in juniper/semi desert grassland (2566 acres) and juniper/semi-desert shrubland (2,187 acres) occur on gently sloping plains to steep sloped hills (0-40%), however, most slopes are less than 15%. Soils have primarily formed from old alluvium.

Soil condition as identified by the Tonto National Forest TES include satisfactory, satisfactory-inherently unstable, satisfactory and impaired, impaired, and unsatisfactory, with the largest acreage as impaired. Soil condition as identified by the Coconino National Forest TES is primarily unsatisfactory. On both Forests, slopes less than 15% are typically compacted as result of high levels of current and historic livestock grazing and are in unsatisfactory condition. Many soils on steeper slopes have moderate sheet and rill erosion. Existing effective vegetative ground cover area ranges from about 10 to 35%. Vegetative ground cover under natural conditions is projected to be about 25 to 35% by the Forest TES.

Pinyon-Juniper Woodlands
Soils in pinyon-juniper woodlands (23,307 acres) occur on steep and very steep (25 – 120% slopes) mountains and escarpments and have formed from residual sources including limestone, basalt, and other metamorphic rocks. Because of steep slopes, most of this type has minimal impact from livestock grazing. However, on accessible footslopes (less than 50%) high levels of current and historic livestock grazing have impaired soil condition with a reduction in plant composition and diversity.

Soil condition on a majority of the steep and very steep slopes is satisfactory-inherently unstable. Vegetative ground cover under current conditions ranges from about 20 to 25% and is nearly equal to vegetative ground cover under natural conditions.

Mixed Conifer
Soils in mixed conifer (4,306 acres) occur on steep escarpments, typically on north facing slopes. Soil condition is satisfactory on both forests.

Ponderosa pine-Juniper-Oak
Soils in ponderosa pine-juniper-oak (1,251 acres) occur on scarp slopes of plains and elevated plains, and have formed from residual sources including sandstone, limestone, and basalt. Soil condition on both forests is satisfactory for all soil units except one.

Environmental Consequences

Unpaved roads, cut and fill slopes, roadside ditches, and embankments are areas of surface disturbance that are subject to elevated rates of erosion. Additional soil erosion occurs when concentrated water in roadside ditches is discharged onto adjacent erodible areas or comes into contact with side drainages. Soil loss through erosion results in a reduction in soil productivity.

Alternative A - Proposed Action

Road Access
FR502 and FR708 would remain open for access at maintenance level 3. Soil erosion and movement is occurring as a result of these roads, particularly in the vicinity of FR502's intersection with Fossil Creek, approximately ¼ mile below its confluence with Sally May Wash.

An estimated 2.3 miles of user created roads in the middle Fossil area would be converted to Forest maintenance level 2 roads for campsite access. An additional 0.2 miles of new road would be constructed to complete road loops back to FR708. An estimated 0.4 miles of track at 6 locations directly connected to the riparian area would be blocked and converted to trails for creek access. The remaining user created road segments in the planning area, approximately 10.1 miles, would be closed to motor vehicles and restored.

Closing and converting .04 miles of track to trail would result in a reduction in soil erosion and sediment movement to the creek as these roads naturally rehabilitate over time. The conversion to Forest maintenance level 2 roads and the closure and restoration of the remaining user created roads would result in substantial reductions in present soil erosion and loss as rehabilitation occurs.

FR9206W, 502E, and 9248C, totaling approximately 6 miles, would be closed to motor vehicles and decommissioned. Decommissioning would include blocking road access, reestablishing cross drainages and allowing the road beds to rehabilitate naturally over time. With protection from additional disturbance, natural rehabilitation would proceed. Soil erosion with resultant soil loss would decrease and would become minimal over time as rehabilitation occurs.

Trail Access

Under this alternative, the Fossil Springs and Mail Trails would remain open. The Flume road and trail would be closed and restored. The present soil erosion and loss generated from this road would decrease over time as the road track rehabilitates.

Approximately 1.0 mile of new trail would be constructed to extend the Fossil Springs Trail and to connect the parking areas at Irving and the FR708 bridge. These trails would be constructed to Forest standards and would have minimal effect on soils.

Approximately 0.5 miles of social trails lead from the terrace (what terrace?) into the riparian area along Fossil Creek. At present, these trails are eroding and delivering sediment into the riparian area. A total of approximately 0.3 miles of trail would be closed and allowed to rehabilitate naturally. The remaining 0.2 miles would be retained for access to the creek. The retained trails would be modified with erosion control structures to reduce present soil erosion. The closure and trail modification of 0.5 miles of trail leading into Fossil Creek would substantially reduce present rates of soil erosion and sediment delivery into the riparian area.

Camping and Campfires

The area of Fossil Springs downstream to Irving would be converted to day use only. The closed campsites located in riparian areas along Fossil Creek would rehabilitate naturally. Over time soil erosion and loss from these sites would decrease.

In the middle Fossil area (including Irving) there would be 10 camping areas including 90 campsites designated for use outside of the riparian area. Campsites closed in riparian areas and on floodplains along Fossil Creek would rehabilitate naturally. Over time soil erosion and loss from these sites would decrease.

The first recreation area off FR708 from Strawberry would be closed, including 1.0 acre of disturbed area and 0.25 miles of track. With natural rehabilitation, soil erosion and loss from these sites would decrease over time.

Alternative B – No Action

Road Access

FR502 and FR708 would remain open for access at maintenance level 3. Soil erosion and movement is occurring as a result of these roads, particularly in the vicinity of FR502's intersection with Fossil Creek, approximately ¼ mile below its confluence with Sally May Wash.

A total of 12.8 miles of user created roads would remain open in this alternative. Of these, 5.3 miles located in the middle Fossil area are used by recreationists to access campsites and the creek. These 5.3 miles are located on terraces adjacent to the creek of which an estimated 0.4 miles of track at 6 locations directly connects to the riparian area of Fossil Creek.

All of these tracks have been randomly established without proper road design or engineering, and have never received maintenance. They are compacted areas of disturbed surface soils. These soils have eroded and will continue to erode at accelerated rates. They have and will continue to erode at accelerated rates of soil erosion. Water received on these compacted tracks runs off onto adjacent undisturbed soils resulting in additional erosion and soil loss. Soil loss would result in a reduction in soil productivity at these affected sites.

In the middle Fossil area, nearly all the sediment generated off the 0.4 miles of track directly connected with the riparian area would enter the creek. Water and sediment moving down slope off other user-created tracks have a high potential to enter the creek.

FR9206W, 502E, and 9248C would remain open to motor vehicle use. Combined, these total approximately 6 miles of road, of which about 50% is connected to Fossil Creek by Stehr, Buzzard, Sally May, and an unnamed wash. The remaining road segments are connected to the Verde watershed. In most cases, these roads were constructed in erosive soils located on steep to very steep mountainsides. Their associated drainage structures have silted in, and road beds are actively eroding. Water moves down slope off these road segments, causing additional erosion of adjacent soil areas. The areas subject to erosion are large due to the steep gradient of these adjacent slopes. Detached soil particles have the potential to move large distances down slope particularly during high energy rain events.

Trail Access

The Fossil Springs, Mail and Flume Trails would remain open. The Flume road track would remain open to foot traffic only. Soil erosion and loss would decrease over time as the Flume road track stabilizes into a trail.

The approximate 0.5 miles of social trails accessing the creek would remain in use. These trails are eroding and delivering sediment to riparian areas.

Camping and Campfires

Dispersed camping and campfires would continue to be allowed in the planning area. This alternative would maintain the existing level of impact to soils. With increased recreational use expected over time impacts would likely increase.

Many of the 211 inventoried campsites are located in riparian areas and on floodplains along Fossil Creek. Continued, repetitive use of these campsites typically results in bare, compacted soils. The soil erosion generated from these camping areas and adjacent down slope areas would be deposited as sediment into the riparian areas along Fossil Creek.

Alternative C - Camping Emphasis

Road Access

Same as Alternative A except:

FR502E, approximately 4 miles in length, would remain open to motor vehicle use. About 50% of this distance is connected to Fossil Creek by Stehr, Buzzard, Sally May, and an unnamed wash. The remaining road segment is connected to the Verde watershed. This road was constructed in erosive soils that, in most cases, are located on steep to very steep mountainsides. The associated drainage structures have silted in and the road bed is actively eroding. Water moves down slope off these road segments, causing additional erosion of adjacent soil areas. The areas subject to erosion are large due to the steep gradient of these adjacent slopes. Detached soil particles have the potential to move large distances down slope particularly during high energy rain events.

Trail Access

Same as Alternative A except:

The Flume Road would be converted to a trail. The road track would rehabilitate over time as a bench on the side slope in Alternative A, whereas in Alternative C this bench would be used as a trail. There would be no significant difference in the amount of soil movement generated from either alternative.

Camping and Campfires

The area around Fossil Springs downstream to Irving would be converted to day use only. However, camping would be allowed at 4 designated areas outside of the riparian area in the vicinity of the springs. The closed campsites located in riparian areas along Fossil Creek would rehabilitate naturally. Over time soil erosion and loss from these sites would decrease.

In the middle Fossil area (including Irving) there would be 10 camping areas including 90 campsites designated for use outside of the riparian area. Campsites closed in riparian areas and on floodplains along Fossil Creek would rehabilitate naturally. Over time soil erosion and loss from these sites would decrease.

The first recreation area off FR708 from Strawberry would be closed, including 1.0 acre of disturbed area and 0.25 miles of track. With natural rehabilitation, soil erosion andloss from this site would decrease over time.

Alternative D - Resource Emphasis

Road Access

FR502 and 708 would remain open at maintenance level 3 except for a 3 mile section of FR708 from just below the rim to the trailhead parking at Irving. This road segment would be converted to a non-motorized trail. In the past, there have been road instability concerns with this segment, as it was originally constructed with switchbacks along a very steep mountainside. As a result, some reconstruction along with additional maintenance has been required. Closing this road segment would result in reduced rates of soil erosion and loss over time as this road stabilizes into a trail.

Soil erosion and movement is occurring as a result of these roads, particularly in the vicinity of FR502's intersection with Fossil Creek, approximately ¼ mile below its confluence with Sally May Wash.

An estimated 1.0 mile of user created roads in the middle Fossil area would be converted to Forest maintenance level 2 roads for campsite access. An estimated 0.3 mile of track at 4 locations directly connected to the riparian area would be blocked and converted to trails for creek access. The remaining user created road segments in the planning area, approximately 11.5 miles, would be closed to motor vehicles and restored.

Closing and converting .04 miles of track to trail would result in a reduction in soil erosion and sediment movement to the creek as these roads naturally rehabilitate over time. The conversion to Forest maintenance level 2 roads and the closure and restoration of the remaining user created roads would result in substantial reductions in present soil erosion and loss as rehabilitation occurs.

FR9206W, 502E, and 9248C, totaling approximately 6 miles, would be closed to motor vehicles and decommissioned. Decommissioning would include blocking road access, reestablishing cross drainages and allowing the road beds to rehabilitate naturally over time. With protection from additional disturbance, natural rehabilitation would proceed. Soil erosion with resultant soil loss would decrease as rehabilitation takes place and would become minimal over time.

Trail Access
The Fossil Springs and Mail Trails would remain open. The Flume road and trail would be closed and restored. The present soil erosion and loss generated from this road would decrease over time as the road track rehabilitates.

Approximately 1.0 mile of new trail would be constructed to extend the Fossil Springs Trail and to connect the parking areas at Irving and the FR708 bridge. These trails would be constructed to Forest standards and have minimal effect on soils.

Approximately 0.5 miles of social trails lead from the terrace (What terrace?) into the riparian area along Fossil Creek. At present these trails eroding and delivering sediment into the riparian area. Approximately 0.3 miles of trail would be closed and allowed to rehabilitate naturally. The remaining 0.2 miles would be retained for access to the creek. The retained trails would be modified with erosion control structures to reduce present soil erosion. Closure and modification of 0.5 miles of trail leading into Fossil Creek would substantially reduce present rates of soil erosion and sediment delivery into the riparian area.

Camping and Campfires
The area around Fossil Springs downstream to Irving would be converted to day use only. The closed campsites located in riparian areas along Fossil Creek would rehabilitate naturally. Over time soil erosion and loss from these sites would decrease.

In the middle Fossil area (including Irving) there would be 6 camping areas including 62 campsites designated for use outside of the riparian area. Campsites closed in riparian areas and on floodplains along Fossil Creek would rehabilitate naturally. Overtime soil erosion and loss from these sites would decrease.

The first recreation area off FR708 from Strawberry would be closed, including 1.0 acre of disturbed area and 0.25 miles of track. With natural rehabilitation, soil erosion and loss from this site would decrease over time.

Alternative E - Day Use Emphasis

Road Access
Same as Alternative A except:

FR502E would be narrowed and converted to a public motorized trail open to vehicles less than 50 inches in width. The conversion to ATV use in lieu of motor vehicles would lessen the amount of disturbance, due primarily to size of smaller vehicle size and the width of track. Decreased soil disturbance would result in less soil erosion and loss.

Trail Access
Same as Alternative C.

Camping and Campfires
The area around Fossil Springs downstream to Irving would be converted to day use only. The closed campsites located in riparian areas along Fossil Creek would rehabilitate naturally. Over time soil erosion and loss from these sites would decrease.

In the middle Fossil area (including Irving) there would be 9 camping areas including 75 campsites designated for use outside of the riparian area. Campsites closed in riparian areas and on floodplains along Fossil Creek would rehabilitate naturally. Over time soil erosion and loss from these sites would decrease.

The first recreation area off FR708 from Strawberry would be closed, including 1.0 acre of disturbed area and 0.25 miles of track. With natural rehabilitation, soil erosion andloss from this site would decrease over time.

Cumulative Effects

The upland soils in the planning area vary in soil condition as described in the Fossil Planning Area Existing Condition Soils Report (Steinke, 2002). Most are on very steep slopes greater than 40% and are inherently unstable. Soils in the middle Fossil area below 40% in slope are typically impaired or unsatisfactory. The degraded soil conditions have resulted primarily from intense historic livestock grazing as well as continued grazing practices.

The current rate of upland soil erosion in the middle and lower Fossil areas exceeds tolerable limits. A combination of vegetation removal, soil compaction, and soil crust removal has resulted in increased runoff during rain events. Additional runoff would cause accelerated erosion down slope on terraces and the floodplain of Fossil Creek, adding to the impact of management changes proposed in the alternatives.

A prescribed burn was conducted in the Stehr Tank basin area within the past several years. A portion of the burn area was located on steep slopes just above and to the north of the basin. Accelerated rates of erosion have occurred, resulting in soil loss and movement down slope toward Fossil Creek.

Water

Air Quality

Affected Environment

In general, air quality within the planning area is very good, with few exceptions. In the fall and winter, inversions may occur, trapping pollutants from wood burning and other local activities in the Verde Valley. During the summer months, industrial pollutants from the Phoenix vicinity drift over the Verde Valley as well.

The Fossil Creek project area includes portions of the Mazatzal and Fossil Springs Wildernesses. The Mazatzal Wilderness in the southern portion of the planning area is a Class I Airshed. The Fossil Springs Wilderness in the northern portion of the planning area is a Class II Airshed. Both are targeted for air quality protection under the Clean Air Act and Forest Service policy. (cite regs where these targets are found) (define airshed, class I and II, and inversions)

Environmental Consequences

Alternative A - Proposed Action

Under this alternative, two day use parking areas, 1.0 mile of new trail and up to 0.2 miles of new level 2 roads will be constructed within the planning area. Areas of construction result in soil disturbance. Airborne dust may be generated in localized areas of construction. The dust generated would result in short term impacts to air quality, increasing levels of particulate matter.

FR9206W, 502E, 9248C and other unnecessary user-created tracks in the planning area would be closed and rehabilitated over time. As rehabilitation occurs, the localized areas of airborne dust generated from these disturbances would decrease over time.

Alternative B - No Action

Under this alternative, current standards of air quality would be maintained. Areas of disturbance, including roads and campsites, would continue to generate airborne dust in localized areas within the planning area.

Alternative C - Camping Emphasis

Impacts from this alternative would be similar to those associated with Alternative A. However, FR502E would remain open to vehicular travel, generating a minimal amount of airborne dust in a localized area for brief periods of time.

Alternative D - Resource Emphasis

Under this alternative, three pull in parking areas, two day use parking areas and 1.0 mile of new trail will be constructed within the planning area. Areas of construction result in soil disturbance. Airborne dust may be generated in localized areas of construction. The dust generated would result in short term impacts to air quality, increasing levels of particulate matter.

FR9206W, 502E, 9248C and other unnecessary user-created tracks in the planning area would be closed and rehabilitated over time. As rehabilitation occurs, the localized areas of airborne dust generated from these disturbances would decrease over time.

Alternative E - Day Use Emphasis

Impacts from this alternative would be similar to those associated with Alternative A. However, FR502E would be narrowed and converted to a trail, generating a minimal amount of airborne dust in a localized area for brief periods of time.

Historic and Cultural Resources

Introduction

The historic and cultural resources of the Fossil Creek Planning Area consist of those prehistoric and historic archaeological sites and structures within and immediately adjacent to the planning area. This includes those areas identified as having traditional or religious significance by Native American tribes who lived there in the past.

Archaeological investigations were first conducted in the Verde Valley and the Fossil Creek drainage in 1890, 1891 and 1928. These initial surveys were neither complete, nor comprehensive, and could not be considered any more than preliminary reconnaissance. Since the 1970s, periodic surveys by Tonto and Coconino National Forest archaeologists in support of trail work, fence construction, and other small scale activities have added to the inventory. These archaeologists have also made occasional condition inspections of sites within the planning area, focusing on several of the better known and accessible sites.

Since then, the primary archaeological survey of the project area was conducted by Archaeological Consulting Services (ACS) to provide specific planning information for the continued operation of the Child's-Irving Hydroelectric power project (Macnider, Effland and Howard 1991). An important result of this survey was the nomination and listing on the National Register of Historic Places of the Childs-Irving Hydroelectric power project. The listing acknowledges the importance and significance of the hydropower facilities, not only the elements included as contributing as well as the entire historic landscape that dominates the Fossil Creek corridor.

Although it provided comprehensive information about sites along the flume corridor, the ACS inventory did not provide sufficient information to adequately inform management decisions regarding land use within the entire Fossil Creek Planning Area. To remedy this, the FS contracted an archaeological and ethnohistorical study that included an archival review of existing literature, interviews with tribal cultural specialists, and field inspections.. Additionally, an interpretive plan for the hydropower facilities as well as the prehistoric sites within the planning area is being prepared.

Affected Environment

Archaeological evidence of the occupation, agricultural use and modification of floodplains, terraces, and hill slopes by people of the prehistoric Southern Sinagua cultural traditions exists throughout the planning area. This use occurred over a period of at least 600 years. The planning area may also contain sites of human use and occupation from as long ago as 8,000 to 10,000 years.

The planning area is also expected to contain a number of pre-European contact and historic sites reflecting use by Yavapai and Apache hunters, gatherers, and farmers, as well as European, Mexican and Euro-American stockmen who raised or drove livestock throughout the area. It also contains a significantl part of the industrial history of Arizona, as it contains the site of the earliest hydroelectric generating system in the State at the small settlements of Childs and Irving, currently still occupied. The significance of the Childs and Irving power plants has already been recognized by listing the sites in the National Register of Historic Places and the American Society of Mechanical Engineers who recognized the system's historic engineering and construction significance by selecting it as the 11th National Historical Mechanical Engineering Landmark.

Archaeological surveys, including an assessment of the Childs-Irving Hydroelectric System (Macnider, Effland and Howard 1991) have identified a wide range of features embedded in the planning area landscape. These include nearly invisible scatters of discarded artifacts and trash, collapsed and buried pit houses, intact cliff dwellings and ruins exceeding 20 rooms in size, and buildings collapsed into masonry rubble piles up to two meters high. The great majority of these features are prehistoric in date and consist most frequently of collapsed stone masonry structures of various sizes, stone-built water control devices, pit ovens for preparing plant and animal foods, and rock art hammered into the surfaces of boulders and basalt outcrops (Macnider, Effland and Howard 1991).

No specifically located ethnographic resources, traditional cultural properties, native plant gathering areas, sacred sites, or other significant Tribal places have been securely identified within the planning area (Neal 2003). Nevertheless, portions of the Fossil Creek planning area fall within the traditional territories of the Bald Mountain and Fossil Creek Bands of the Tonto Apache, as well as different groups of Yavapai. Several clans may have originated in the Fossil Creek drainage. Although specific sites with evidence of Apache or Yavapai occupation are fairly well represented in the current inventory, they can be expected to be found in greater numbers with additional survey and closer inspection of known sites. Likewise, as additional information can be gathered through interviews with tribal elders, specific locations may yet be identified that correspond to historic farms and camps.

Condition of the Historic and Cultural Resource Inventory of Fossil Creek

In general, it can be said that archaeological knowledge of the cultural resources within the planning area are poorly understood. Less than 3% of the area has been inventoried to current standards.

One hundred sixty-eight (168) archaeological and/or historic sites have been recorded or reported within or immediately adjacent to the Fossil Creek analysis area. Twenty-seven of the 168 archaeological sites (16%) are now noted as permanent prehistoric residential settlements, ranging in size from small homesteads to large masonry room blocks and outliers containing as many as 40 contiguous rooms. At least six of these are large, early pit house settlements. Another 42 (25%) are said to have been temporary prehistoric residential sites, usually one room structures known as "field houses".

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[1] Section 106 of the National Historic Preservation Act, as amended 1992, establishes the basis for determining effects to cultural and historic sites as eligibility for inclusion in the National Register of Historic Places. Significance, the level of importance a site has in local or national culture or history, is a central concern in the evaluation of such eligibility and is determined by applying the National Register Criteria for Evaluation as defined in 36 CFR Part 60.

Twenty-three prehistoric artifact scatters without masonry, visible surface features or indications of subsurface pit houses are recorded. Only nine prehistoric sites are described as defensive in either architecture or location. There are also a variety of prehistoric agricultural features associated with many residential sites.

There are 38 historic sites, all related to hydroelectric power generation, roads, trails, or ranching. With the exception of one hydropower related site and a few of the prehistoric agricultural sites, all of the historical and cultural sites inventoried in the analysis area are located outside the zone of riparian vegetation and scouring floods on the terraces, ridges, and hills overlooking the creek.

Site condition throughout the analysis area is highly variable. All of the large prehistoric pueblo sites could be characterized as having more than half of their recognizable features vandalized. Site impacts include looting, vandalism, erosion, alteration of site context, disturbance from recreation, maintenance and management activities, damage to tribal values and disturbance from stock grazing. Overall impressions of the remainder of the inventoried sites suggest that they are generally in good condition. Given the high level of site integrity and the significance of the settlement history of this area, all inventoried sites within the planning area are considered eligible for the National Register of Historic Places, pending further evaluation.

Environmental Consequences

Impacts to historic and cultural resources can be generally defined as anything that results in the removal, displacement of, or damage to artifacts, structural features, and/or stratigraphic deposits of cultural material. For historic and cultural resources considered eligible for the National Register of Historic Places, this can also include alteration of a site's setting or context. In the case of ethnographic resources and places having traditional, historical, or religious significance to Native American tribes, additional considerations may include alterations to geological formations, closure or restriction of access routes, or changes in the presence or availability of particular plant species.

Issue: Access

Visiting archaeological sites on National Forest lands is a popular recreational activity in Arizona. Many people enjoy this activity for the insight it gives them to the land and the people who once lived here. Others enjoy it for the sense of mystery and adventure that accompanies discovering obscure traces of past civilizations in what is now considered "wild" country. Reducing the number of access points to Fossil Creek may deny some people the opportunity to visit and enjoy the creek's historic and cultural resources.

The Forest Service is required by law and regulation (cite them) to protect and preserve historic and cultural resources from damage, excessive deterioration, vandalism, looting, and the alteration of site context. The primary causes of impacts to historic and cultural resources in the Fossil Creek planning area are vandalism and looting. Damage from recreational activities is another potential source of impact that may be related to management decisions for the Fossil Creek Planning Area.

Reducing vehicular access to portions of the planning area may also reduce the ability of Forest Service personnel and volunteer Site Stewards to monitor the condition of sites within the planning area and to enforce laws protecting them from vandalism and looting. Reduction of access would also result in reduced visitation in general, resulting in fewer potential observers of all kinds. Finally, reduction in vehicular accessibility increases law enforcement response time and costs.

Issue: Levels of Recreation Use

High levels of recreation use may affect the integrity of historic and cultural resources as visitors expand use areas outside established campgrounds and access points. Informal camping areas within site boundaries can impact site integrity through the introduction of modern trash, removal of architectural materials to construct fire rings, and the digging of holes for waste disposal. Other direct effects of camping on sites include the casual collection and displacement of surface artifacts and the establishment of informal trails that can initiate destructive gullying erosion. Indirect effects of camping on sites may include increased vandalism encouraged by the presence of fire rings and trash as an indicator that the sites might not be closely monitored or maintained.

Developing or improving creek access points and recreation areas will provide additional opportunities for visitation to archaeological sites. It would also provide opportunities for interpreting these resources, as well as educating visitors regarding rules of conduct when visiting historic and cultural sites and the laws and regulations protecting them. Better access would improve opportunities for patrol and monitoring, and also facilitate visitation by site stewards, thus improving the effectiveness of historic and cultural resource law enforcement in the area.

Alternative A – Proposed Action

Alternative A attempts to strike a balance between resource protection and recreational use. Unnecessary roads and trails would be closed, while maintaining and occasionally creating adequate parking, camping, and creek side access.

Alternative A also calls for management and the development of an interpretive plan for the historic and prehistoric resources of the hydropower facilities at Childs, the Irving area and trailheads. This would provide increased opportunities for public interpretation and education, increasing the effectiveness of other protective activities in the area.

Designating dispersed camping areas would allow avoidance of cultural resources should current recreational campsites be impacting archaeological sites. Under the proposed action, the upper Fossil area would be limited to day use only. This action would reduce the number of camping areas, lessening the impacts caused by camping and campfires toany archaeological resources in the area. This alternative would result in minor to moderate direct adverse effects, and would provide increased levels of protection and enhancement for the historic and cultural resource over what is currently provided. However, site protection and law enforcement in the upper Fossil Springs area would be the most difficult, least effective, and most expensive under this alternative. This is due to the closure of the Flume Road, increased difficulty and expense of site monitoring, and by increased law enforcement response time.

Alternative B—No Action

Under this alternative, existing roads and trails accessing the creek would remain open and maintained under current standards. Public visitation of historic and cultural resources would continue at current levels, likely increasing over time in proportion to regional population growth, and concentrated in those areas having the highest motorized access or most recreational facilities. Accessibility for patrol, monitoring, and other law enforcement activities would remain limited to existing roads and would continue to concentrate in the areas of highest recreational day use. Access to the more remote portions of the planning area would remain minimal. Direct minor to moderate adverse effects from vandalism and looting would remain at current levels, with a reduction over time commensurate with management intensity and monitoring frequency.

With no change in the number and type of recreational facilities, opportunities for public interpretation and education would remain limited to Childs and Irving, although no interpretive developments are currently in place or planned at either location. Reduction of vandalism and looting impacts resulting from visitor education would be minimal to nonexistent.

As in all alternatives, current levels of protection of historic and cultural resources provided by Federal laws and regulations would continue. By continuing existing, unrestricted access for monitoring and law enforcement this alternative would have no effect on the level of protection currently afforded historic and cultural resources. It would not provide any form of enhancement. This alternative does not instigate changes in management that would affect historic properties, but implementation would allow adverse impacts to the resource to continue.

Alternative C – Camping Emphasis

Alternative C was designed to maximize camping and other recreational opportunities, while preventing future damage to resources. Dispersed and/or designated dispersed camping would be allowed throughout most of the project area. Management actions would be the same as Alternative A except:

This Alternative would provide increased levels of protection and enhancement for the historic and cultural resource over what is currently provided, however site protection and law enforcement would be difficult under this alternative due to the conversion of the Flume Road to a non-motorized trail and increasing the difficulty and expense of site monitoring and by increasing law enforcement response time. This alternative also calls for management and the development of an interpretive plan for the historic and prehistoric resources of the hydropower facilities at Childs, the Irving area and trailheads. This would provide increased opportunities for public interpretation and education, increasing the effectiveness of other protective activities in the area. Designating dispersed camping areas would allow avoidance of cultural resources should current recreational campsites be impacting archaeological sites. . This alternative would have negligible direct effects on the prehistoric and historic resources within the Fossil Creek Planning Area.

Alternative D – Resource Emphasis

Alternative D places the most stringent restrictions on recreation activities, while offering the most protection to cultural and natural resources.

This alternative would provide increased levels of protection and enhancement for the historic and cultural resource over what is currently provided, through limitations on camping and campfires and the reduction of vehicle access to campsites in the Middle Fossil area. Site protection and law enforcement in the upper Fossil area would be difficult under this alternative due to the conversion of the Flume Road to a non-motorized trail and increasing the difficulty and expense of site monitoring and by increasing law enforcement response time. This alternative also calls for management and the development of an interpretive plan for the historic and prehistoric resources of the hydropower facilities at Childs, the Irving area and trailheads. This would provide increased opportunities for public interpretation and education, increasing the effectiveness of other protective activities in the area.

Designating dispersed camping areas would allow avoidance of cultural resources should current recreational campsites be impacting archaeological sites. Limiting the upper Fossil area to day use only would reduce the number of camping areas and lessen the impacts caused by camping and campfires to any archaeological resources in the area. This alternative would have negligible direct effects on the prehistoric and historic resources within the Fossil Creek Planning Area.

Alternative E – Day Use Emphasis

Alternative E provides resource protection and maintains recreational opportunities by emphasizing day use activities.

This Alternative would provide increased levels of protection and enhancement for the historic and cultural resource over what is currently provided by providing for no camping in the Fossil Springs area and decreased camping activities in the Middle Fossil area. Site protection in the upper Fossil area would be difficult due to conversion of the Flume Road to a non-motorized trail increasing the difficulty and expense of monitoring and by increasing law enforcement response time. This alternative also calls for management and the development of an interpretive plan for the historic and prehistoric resources of the hydropower facilities at Childs, the Irving area and trailheads. This would provide increased opportunities for public interpretation and education, increasing the effectiveness of other protective activities in the area.

Designating dispersed camping areas would allow avoidance of cultural resources should current recreational campsites be impacting archaeological sites. Limiting the upper Fossil area to day use only would reduce the number of camping areas and lessen the impacts caused by camping and campfires to any archaeological resources in the area This alternative would have negligible direct effects on the prehistoric and historic resources within the Fossil Creek Planning Area.

Cumulative Effects

Cumulative impacts to prehistoric, historic, and ethnographic resources are based on analysis of past, present, and reasonably foreseeable future actions in the Fossil Creek Planning Area, in combination with the potential effects of the different alternatives.

In general, the cultural resources within the Fossil Creek area are the result of thousands of years of human occupation. Development of facilities within the area, including the construction, operation, and maintenance of the Childs/Irving Hydropower facilities, has disturbed or destroyed numerous cultural resources and compromised the integrity of others, which has led to an adverse cumulative effect. (???)

Reasonably foreseeable future actions proposed for the area that could have an adverse cumulative effect on cultural resources in the Fossil Creek area include the activities proposed in each alternative, hydropower maintenance, operation, and decommissioning; maintenance of utility lines; road maintenance; livestock grazing; and maintenance of livestock grazing allotment structures. Primary disturbance and ecological restoration associated with these projects could disturb cultural resources in the creek corridor. The Forest Service would follow FSM 2360, and the Region 3 Programmatic Agreement guidelines to avoid adverse effects to cultural resources as often as possible.

Recreation

Affected Environment

Environmental Consequences

Alternative A – Proposed Action

Motor Vehicle Road access: Under this alternative there would be reduced vehicle access over what exists currently as an estimated 10 miles of user created tracks are closed, cross-country travel is prohibited, and FR9206W, FR502E, and FR9248C are closed. Stehr Lake would remain available for camping and day use activities, with motor vehicle access via FR502A.

Most user created "tracks" that currently access creek side areas would be closed or converted to non-motorized trails. This may impact persons with disabilities as they will be less able to access the Fossil Creek riparian area by motor vehicle.

Non-motorized Trail access: Under this alternative it is not expected that creek foot-trail access would be substantially reduced over the existing condition. Trails within the planning area under this alternative may include the Fossil Springs Trail to Fossil Springs and the diversion dam area, the Mail Trail and creek access trails in the Middle Fossil area. Persons wishing to access the Irving area would have to ford the creek or cross at the FR708 bridge and walk upstream to Irving, once the footbridge is removed.

Recreation Opportunity Spectrum/ Wilderness Opportunity Spectrum: This alternative would allow for modest development in the Middle fossil creek area, including at Irving, primarily for camping and day use activities, consistent with Roaded Natural ROS. Visitors would see signs, vehicle barriers, toilets, designated trails, camp areas, and management presence.

It is likely that the ROS character regarding human contact may become more of an "Urban" setting than the current "roaded natural" setting. Frequency of overall crowding and contact between groups is expected to increase substantially, especially during holidays and weekends.

Because the Mazatzal Wilderness boundary is adjacent to the creek and FR708 within the Middle Fossil area, this part of the Wilderness is likely to have continued impacts from crowding, trampled vegetation, compacted soils, noise and human waste. These impacts would increase over time as demand for water based recreation/access increases, consistent with a WOSIII adjacent to the creek.

Outside of the Middle Fossil Creek area, the amount of human use is expected to gradually increase but be consistent with current ROS classifications except during holidays and weekends.

The Fossil Springs Botanical Area would continue to have a semi-primitive, non-motorized character during most of the year. It is not likely that closing the Flume Trail and converting the springs area to day use only would result in substantially less crowding, or fewer contacts. An estimated 75% of use at the Springs is currently day use from the Fossil Springs Trailhead. This would be expected to increase over time.

Opportunities for solitude and primitive recreation would continue to exist in areas designated Semi-primitive, both motorized and non-motorized in areas located away from Middle Fossil and Fossil Springs.

Camping and Campfires: People who enjoy camping in an undeveloped motorized setting would continue to have access to numerous sites within the planning area. However, camping would be limited to 10 designated camp areas and an estimated 98 camp sites within the popular Middle Fossil area. This capacity is not different than the current camping capacity for the area, however, the designated camping areas are generally not as close to the creek, and are located in dryer, hotter, less desired juniper and mesquite terraces. This may result in reduced summer camping. The area affected by these designated camp areas is estimated at 45 acres to allow for parking and privacy screening.

The capacity of the Middle Fossil area will likely continue to be inadequate to meet camping and picnicking demand during popular weekends and holidays in spring and summer. "Overflow" camping areas are located outside of the Middle fossil area. The creation of established vehicle and camp areas in Middle fossil is expected to improve the appearance of the area as camping and vehicle impacts are more confined and moved out of the riparian area.

Camping would not be allowed within the area of Fossil Springs Botanical Area downstream to just above Irving. This would close an estimated 30 campsites near Fossil Springs to overnight use, which may affect as many as 6000 backpackers/year (SOURCE?). Displacement of traditional backpacking at Fossil Springs may have the effect of moving backcountry camping into the Fossil Springs and Mazatzal wildernesses. This may result in direct and indirect adverse effects on wilderness values in some locations, including ecological conditions. Solitude, primitive recreation opportunities, and managerial presence. (???)

The former Irving housing area (after decommissioning) would offer a sense of remoteness and semi-primitive camping character due to the difficulty of access without a foot bridge. The lack of direct vehicle access will appeal to visitors seeking a semi-primitive non-motorized camp experience near Fossil Creek.

In the remainder of the planning area, over 80 dispersed campsites will remain open and accessible by motor vehicle, including areas at Stehr Lake.

Although toilets may be installed at some clustered camp areas, it is likely that garbage, human waste and charcoal from campfire pits will still be associated with camp areas throughout the planning area.

Alternative B – No Action

Motor Vehicle Road access: Under this alternative an estimated 12 miles of user created tracks would remain open for vehicle travel, however, cross-country travel would be prohibited consistent with decisions made under the 5-forest cross-country travel EIS, currently underway. Persons with disabilities who access areas by motor vehicle would experience minor change over existing conditions. Stehr Lake would remain available for camping and day use activities, with motor vehicle access via existing roads.

Non-motorized Trail access: Under this alternative, no new trails would be added to the FS system to facilitate creek access or consolidate social trails. Visitors to the Fossil Springs Botanical Area and along Fossil Creek would still be able to follow dozens of user created trails within the riparian creek side. FS system trails within the area would include the Flume Trail (footbridge removed), Mail Trail, and Fossil Springs Trail. The Flume Trail could continue to be accessed via the Irving footbridge.

Recreation Opportunity Spectrum/ Wilderness Opportunity Spectrum: In the Middle Fossil area, recreation characteristics would remain consistent with Roaded Natural ROS. With increased population and demand for water-based recreation, contact levels and crowding are expected to increase.

Because the Mazatzal Wilderness boundary is adjacent to both the creek and the road within the Middle fossil area, this part of the Wilderness will likely have continued impacts from crowding, trampled vegetation, compacted soils, noise and human waste.

The area of Fossil Springs would continue to have a semi-primitive, non-motorized character during most of the year, except holidays and weekends when currently the contact frequencies in the area are consistent with a Roaded Natural ROS.

Opportunities for solitude and primitive recreation would continue to exist in areas designated motorized semi-primitive and non-motorized semi-primitive. This includes areas located away from Middle Fossil and Fossil Springs, such as Fossil Springs Wilderness, Fossil Creek within the Mazatzal Wilderness downstream of Stehr Lake, Deadmans Mesa and Chalk Springs.

Camping and Campfires: People who enjoy camping in an undeveloped motorized setting would continue to have access to numerous sites with virtually no restrictions. The current 98 inventoried campsites within the popular Middle Fossil area near the creek would expand as more people visit the area.

The lack of established vehicle and camp areas in Middle Fossil would lead to an increase in impacted area, as well as an increase in degraded appearance from trash, compacted soils, damaged vegetation and a proliferation of user-created roads.

Continued camping within the Fossil Springs Botanical Area would contribute to a degraded appearance and impacts from trash, human waste, compacted soils, damaged vegetation, and numerous social trails.

At the former Irving housing area campsites would not be designated and campfires would be allowed. This would create more extensive impacted areas near the creek than under any other alternative.

It is likely that the number of campsites and associated impacts will increase substantially near the creek over the next decade.

Alternative C – Camping Emphasis

Motor Vehicle Road access: Under this alternative FR9206W, FR9248C and an estimated 10 miles of user created tracks would be closed. Cross-country travel would be prohibited. Motor vehicle access for hunters, OHV users and other recreationists would be reduced. Stehr Lake would continue to be accessible by public motor vehicle via existing roads.

Persons with disabilities would be less able to access the riparian area by motor vehicle as most user created "tracks" that currently access creek side areas would be closed or converted to non-motorized trails.

Non-motorized Trail access: Non-motorized creek side hiking and access would likely be enhanced by this alternative. This would include an extension of the Fossil Springs Trail (1 mile), and several short trails to connect camping/parking areas in the Middle Fossil area with the creek (1 mile). The Flume Trail would be accessible by fording the creek.

Recreation Opportunity Spectrum/ Wilderness Opportunity Spectrum: This alternative would allow for modest development in the Middle fossil creek area (including Irving), primarily for camping and day use activities. Any development would be consistent with a Roaded Natural ROS. Visitors would see signs, vehicle barriers, toilets, designated trails, camp areas and management presence.

The ROS character regarding human contact may become more characteristic of an "Urban" setting as overall crowding and contact between groups increases, especially during holidays and weekends.

Because the Mazatzal Wilderness boundary is adjacent to both the creek and the road within the Middle fossil area, this part of the Wilderness will likely have continued impacts from crowding, trampled vegetation, compacted soils, noise and human waste.

The area of Fossil Springs Botanical Area would continue to have a semi-primitive, non-motorized character during most of the year. It is not likely that limiting camping to 4 areas would result in substantially less crowding, or fewer contacts. During weekends and holidays the contact frequencies would be more consistent with a Roaded Natural ROS classification within the Fossil Springs vicinity.

Camping and Campfires: People who enjoy camping in an undeveloped motorized setting would continue to have access to numerous sites within the planning area. The designated camping areas are generally not as close to the creek, and are located in dryer, hotter, less desired juniper and mesquite terraces. This may result in reduced summer camping. The area affected by these designated camp areas is estimated at 45 acres to allow for parking and privacy screening. The creation of established vehicle and camp areas in Middle Fossil is expected to improve the appearance of the area as camping and vehicle impacts are more confined and removed from the riparian area.

The capacity of the Middle Fossil area will likely continue to be inadequate to meet camping and picnicking demand during popular weekends and holidays in spring and summer.

The limitation of camping at Fossil Springs Botanical Area to 4 areas would relieve some impacts. However, this will not meet the demand for camping in this area. This action would require more active management.

The former Irving housing area (after decommissioning) would offer a sense of remoteness and semi-primitive camping character due to the difficulty of access without a bridge. The lack of direct vehicle access will appeal to visitors seeking a semi-primitive non-motorized camp experience near Fossil Creek. Designated campsites and a prohibition on fires would result in less extensive areas of impact and less degradation to the area's appearance.

In the remainder of the planning area, over 80 dispersed campsites will remain open and accessible by motor vehicle, including areas at Stehr Lake. Although toilets may be installed at some clustered camp areas, it is likely that garbage, human waste and charcoal from campfire pits will still be associated with camp areas throughout the planning area.

Alternative D - Resource Emphasis

Motor Vehicle Road access: Under this alternative there would be reduced vehicle access from what exists currently as an estimated 11 miles of user created tracks are closed, cross-country travel is prohibited, and FR9206W, FR502E, FR502A, FR9248C and a three mile portion of FR708 are closed.

A three mile section of FR708 would be converted to a non-motorized trail between Irving and an overlook on the rim. This would be expected to substantially change patterns of motorized access into the planning area. Access from Strawberry and Payson to areas of the Verde River such as Childs campground, river launch, and Verde Hot Springs, or to areas downstream of Irving would be more difficult and may substantially reduce the number of recreationists within Fossil Creek. An estimated average of 110 vehicles per day access FR708 from Strawberry. Based on these counts, this may affect an estimated 87,000 persons (at 3 people per car) annually who would otherwise access the Fossil Creek area from Strawberry (SOURCE?).

Vehicle access to designated camping areas would be provided by adding some user created tracks to the Forest Road system within the Middle Fossil area. Under this alternative most camper vehicle parking would occur immediately adjacent to FR708 and 502, with walk-in camping to designated camp areas.

With FR502A closed, Stehr Lake would no longer be accessible by public motor vehicle.

Persons with disabilities would be less able to access the riparian area by motor vehicle as most user created "tracks" that currently access creek side areas would be closed or converted to non-motorized trails.

Non-motorized Trail access: Under this alternative, creek foot-trail access would be reduced. Trails would include the Mail Trail, the Fossil Springs Trail and a 1 mile extension of the Fossil Springs Trail to the Fossil Springs APS diversion dam. In addition, several creek access trails within the Middle Fossil area would be developed to link camp and parking areas with the creek (approximately 1 mile).

Recreation Opportunity Spectrum/ Wilderness Opportunity Spectrum: This alternative would allow for modest development in the Middle Fossil Creek area (including Irving), primarily for camping and day use activities, consistent with a Roaded Natural ROS. Visitors would see signs, vehicle barriers, toilets, designated trails, camp areas and management presence.

With increased population and demand for water-based recreation, contact levels and crowding are expected to increase and ROS to become more characteristic of an "Urban" setting, particularly during holidays and weekends.

Because the Mazatzal Wilderness boundary is adjacent to both the creek and the road within the Middle fossil area, this part of the Wilderness will likely have continued impacts from crowding, trampled vegetation, compacted soils, noise and human waste.

The area of Fossil Springs Botanical Area would continue to have a semi-primitive, non-motorized character during most of the year. It is not likely that prohibiting camping would result in substantially less crowding, or fewer contacts. Day use would be expected to continue and increase over time, particularly between the months of April and October, when contact frequencies would be more consistent with a Roaded Natural ROS classification in the Fossil Springs vicinity.

Camping and Campfires: Camping capacity in the Middle Fossil would be reduced. Designated camping areas would be set back from the creek, and located in dryer, hotter, less desired juniper and mesquite terraces. The area affected by these designated camp areas is estimated at 36 acres to allow for parking and privacy screening. The creation of established vehicle and camp areas in Middle Fossil is expected to improve the appearance of the area as camping and vehicle impacts are confined and removed from the riparian area.

The capacity of the Middle Fossil area will likely continue to be inadequate to meet camping and picnicking demand during popular weekends and holidays in spring and summer.

Day use only restrictions at Fossil Springs Botanical Area would relieve some impacts. However, this will not satisfy the high demand for camping in this area. Displacement of traditional backpacking at Fossil Springs may have the effect of moving backcountry camping into the Fossil Springs and Mazatzal wildernesses. This may have direct and indirect adverse effects on wilderness values in some locations, including ecological conditions. Solitude, primitive recreation opportunities, and managerial presence. (???)

The former Irving housing area (after decommissioning) would offer a sense of remoteness and semi-primitive day use character due to the difficulty of access without a bridge. The lack of direct vehicle access will appeal to visitors seeking a semi-primitive non-motorized day use experience near Fossil Creek.

In the remainder of the planning area, over 80 dispersed campsites will remain open and accessible by motor vehicle.

Closing the area upstream of Irving to the dam site to public access would not affect a substantial number of recreationists. This area is relatively inaccessible and little used.

While toilets may be installed in at some clustered camp areas, garbage, human waste and charcoal from campfire pits will likely be associated with camp areas throughout the planning area.

Alternative E – Day-Use Emphasis

Motor Vehicle Road access: Under this alternative an estimated 10 miles of user created tracks are closed, cross-country travel is prohibited, and FR9206W and FR9248C are closed, resulting in reduced vehicle access. Vehicle access to camping would be provided by the conversion of some user created tracks onto the Forest Road system within the "Middle Fossil Creek" area to access designated camping areas. Stehr Lake would be accessible by public motor vehicle on existing roads.

Persons with disabilities would be less able to access riparian areas by motor vehicle as most user created tracks that currently access creek side areas would be closed or converted to non-motorized trails.

Non-motorized Trail access: Under this alternative creek side hiking would be enhanced through an extension of the Fossil Springs Trail and several short trails that will connect camping/parking areas with the creek.

Recreation Opportunity Spectrum/ Wilderness Opportunity Spectrum: This alternative would allow for modest development in the Middle Fossil Creek area (including Irving), primarily for camping and day use activities, consistent with a Roaded Natural ROS. Visitors would see signs, vehicle barriers, toilets, designated trails, camp areas and management presence.

With increased population and demand for water-based recreation, contact levels and crowding are likely to increase. ROS character regarding human contact may become more characteristic of an Urban setting than the current ROS of Roaded Natural, particularly during holidays and weekends.

Because the Mazatzal Wilderness boundary is adjacent to both the creek and the road within the Middle fossil area, this part of the Wilderness will likely have continued impacts from crowding, trampled vegetation, compacted soils, noise and human waste.

The former Irving housing area (after decommissioning) would offer day use recreational opportunities, and would likely be extremely popular. The area would be easily accessed by the existing footbridge, and meet a Roaded Natural ROS.

The Fossil Springs Botanical Area would continue to have a semi-primitive, non-motorized character during most of the year. Day use would be expected to continue and increase over time, particularly during weekends and holidays, when contact frequencies would be more consistent with a Roaded Natural ROS classification in the Fossil Springs vicinity.

Camping and Campfires: People who enjoy camping in an undeveloped motorized setting would continue to have access to numerous sites within the planning area. In the Middle Fossil area, designated camping areas set back from the creek and are in dryer, hotter, less desired juniper and mesquite terraces. The area affected by these designated camp areas is estimated at 40 acres to allow for parking and privacy screening. The creation of established vehicle and camping areas in Middle Fossil is expected to improve the appearance of the area as camping and vehicle impacts are confined and removed from the riparian area. The capacity of the Middle Fossil area will likely continue to be inadequate to meet camping and picnicking demand during popular weekends and holidays in spring and summer.

Day use only restrictions at Fossil Springs Botanical Area would relieve some impacts. However, this will not satisfy the demand for camping in this area. Displacement of traditional backpacking at Fossil Springs may have the effect of moving backcountry camping into the Fossil Springs and Mazatzal wildernesses. This may have direct and indirect adverse effects on wilderness values in some locations, including ecological conditions. Solitude, primitive recreation opportunities, and managerial presence. (???)

In the remainder of the planning area, over 80 dispersed campsites will remain open and accessible by motor vehicle, including areas at Stehr Lake.

While toilets may be installed in at some clustered camp areas, garbage, human waste and charcoal from campfire pits will likely be associated with camp areas throughout the planning area.

Scenery

Environmental Justice

The issue of environmental equity and justice in natural resource allocation and decision making is receiving increasing political and social attention. Following President Clinton's Executive Order 12898 (Federal Register, February 1994) all Federal land management agencies have been mandated to address environmental justice in non-white and /or low income populations, with the goal of achieving environmental protection for all communities regardless of their racial and economic composition.

Alternatives A, B, C, D and E have been reviewed in accordance with Executive Order 12898. None of the alternatives analyzed will result in significant or disproportionate effect on low income or minority populations.

Short-term Uses and Long-term Productivity

NEPA requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). As declared by the Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101).

Unavoidable Adverse Effects

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. Irretrievable commitments are those that are lost for a period of time such as the temporary loss of timber productivity in forested areas that are kept clear for use as a power line rights-of-way or road.

Other Required Disclosures

NEPA at 40 CFR 1502.25(a) directs "to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with other environmental review laws and executive orders."

Chapter 4. Consultation and Coordination

Preparers and Contributors

The Forest Service consulted the following individuals, Federal, State, and local agencies, tribes and non-Forest Service persons during the development of this environmental assessment:

ID TEAM MEMBERS:
Rory Steinke - Team Soil and Water Specialist, Coconino National Forest. Rory serves as Forest Watershed Program Manager. He has a B.S. in Soil Science from the University of Wisconsin Stevens Point, and is an ARCPAC Certified Soil Scientist. Rory has more than 23 years of experience in soil survey, soil conservation, and watershed management with the Natural Resource Conservation Service, BLM, US Peace Corps and the Forest Service.

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Judith B. Adams - Co-Interdisciplinary Team Leader, Coconino National Forest - Judy functions as the Red Rock Ranger District Lands and Minerals Staff. She has a BS in Forestry from Michigan Technological University and has 15 years of experience with the Forest Service.

Kermit Johansson - (title? forest?) Kermit is a Forest Service Landscape Architect with a BS in Landscape Architecture and a MS in Environmental Planning. He has 25 years in the varied practice of Forest Service landscape design and visual management and 7 years in private practice landscape design.

David M. Whitney (Mark) – Forest Fisheries Biologist, Coconino National Forest. Mark obtained a Bachelor of Science Degree in Zoology from Colorado State University; and has post-graduate course work from Northern Arizona University, Utah State University, and Virginia Polytechnic Institute and State University. He has 25 years of experience with the Forest Service as a fish and wildlife field biologist.

Cavetta G. Green - Cavetta received a Bachelor of Science degree in Wildlife Biology from Tuskegee University. She has 3 years of experience with the Forest Service as wildlife biologist.

CONSULTANTS:

FEDERAL, STATE, AND LOCAL AGENCIES:
[Insert names]

TRIBES:
[Insert names]

OTHERS:
[Insert names]

List of Agencies, Organizations and Person to Whom Copies of the DEIS, Supplement and FEIS Were Sent

This environmental impact statement has been distributed to individuals who specifically requested a copy of the document [(**for final environmental impact statements only**) and those who submitted substantive comments on the draft environmental impact statement]. In addition, copies have been sent to the following Federal agencies, federally recognized tribes, Sate and local governments, and organizations representing a wide range of views regarding [Insert purpose].

[Insert names of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved and any appropriate Federal, State. or local agency authorized to develop and enforce environmental standards; any person, organization, or agency requesting the entire environmental impact statement; and in the case of a final environmental impact statement any person, organization, or agency which submitted substantive comments.]

Index

[Insert an index]

Appendix A - xxx

[Insert any material that is essential to the understanding of the environmental impact statement.]

Appendix B – Public Comments and Responses [for FEIS only]

[Insert response to public]

Short- and Long-Term Management, Stewardship, and Education/Outreach Needs for Fossil Creek

Fossil Creek Stewardship Meeting
October 26, 2005
Southwestern Academy
Rimrock, AZ

Compiled by

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December 2005

NORTHERN ARIZONA UNIVERSITY

Fossil Creek Stewardship Meeting

Introduction and Methods

The Fossil Creek dam decommissioning in July 2005 was the beginning of a new chapter for the Fossil Creek ecosystem. The Fossil Creek Stewardship meeting held on October 26, 2005 was designed to bring together managers, researchers, environmentalists, tribal leaders, and interested citizens to talk about future management of Fossil Creek, specifically the short- and long-term management, stewardship, and education/outreach needs for Fossil Creek.

Forty-two people were invited to attend the meeting organized by the NAU Fossil Creek Ecosystem Studies Group. Attendees were sent an e-mail inviting them to participate in a discussion of Fossil Creek short- (1-3 years) and long-term needs for Fossil Creek. We asked them to think about three questions we would discuss at the meeting:

1. What are the short- and long-term management needs for Fossil Creek? Management in this context has to do with actions by agencies responsible for managing Fossil Creek and its resources.

2. What are the short- and long-term stewardship needs for Fossil Creek? Stewardship has to do with broadly defined actions and commitments to care for and protect Fossil Creek that include individuals and communities.

3. What are the short- and long-term education and outreach needs for Fossil Creek?

Invitees were subsequently sent a letter reminding them of the meeting along with a map and directions to the Southwestern Academy where the meeting was held. Those that responded that they were not able to come to the meeting were asked to provide written responses to the questions. One individual sent written responses to the questions and those are included at the end of the meeting responses.

Twenty-four people participated in the discussion groups. A list of participants is presented in Appendix A. We used a facilitated nominal group process to identify and rank responses to the questions. We broke participants into three groups with each having a mix of researchers and managers from the various land and wildlife management agencies, non-profit group members, tribal leaders, and interested citizens. Each group included a facilitator and a recorder. Facilitators included Marty Lee, Martha Hahn, and Shelley Silbert. Recorders included Paul Hancock, Alexis Mullen, and Nathan Schott.

The nominal group process included the following steps:

Step One: Ask the Question

- each group began with a different question
- groups began with approximately 4 minutes of "quiet time" to reflect on the question and to write down their ideas. Pads of paper and pencils were provided to participants if needed

Step Two: Collecting Ideas

- each group had two flip charts where short- and long-term needs were recorded separately
- an item could be listed as both a short- and long-term need
- ideas were gathered but no critiquing of others' ideas was allowed in this step
- approximately 30 minutes was allowed for this step

Step Three: Clarify Ideas and Vote

- items were clarified and combined if the entire group agreed
- group members were asked to vote for the items they felt were the most important. Participants were given colored dots—3 to 8 depending on the number of items generated. Short- and long-term needs were voted on separately.
- votes were tallied for each item

Each group worked independently through the three questions. Breaks were taken between questions. Two of the groups spent time discussing "The next step" after completing discussion of the three questions. The meeting ended after approximately three hours.

Results

A complete listing of the short- and long-term needs for Fossil Creek identified by the meeting participants are presented in the following sections. Short- and long-term needs for management, stewardship, and education/outreach are presented separately. A brief summary of needs identified by the groups as being most important are presented below.

Notable Highlights

Short-Term Management Needs

- recreation management to enhance experiences and reduce impacts
- collaborative, interagency management and monitoring
- protection of native fish (e.g., crayfish control, enforcing regulations, developing a monitoring plan)

Long-Term Management Needs

- maintain native fisheries (control of crayfish, non-natives)
- management of recreation infrastructure, including roads, trails, motorized access
- acquiring funding and additional human resources
- management presence/law enforcement

Short-Term Stewardship Needs

- formation of a stewardship group – Friends of Fossil Creek
- form relationships with other existing stewardship groups
- collaborative planning
- keep the area clean
- provide stewardship information to users

Long-Term Stewardship Needs

- Friends of Fossil Creek and agency interaction
- keep the area clean
- consider user fees
- law enforcement
- increase volunteerism (e.g., in local communities, school groups)

Short-Term Education/Outreach Needs

- On-site information sharing targeting users
  - media – kiosks, on-site hosts, displays
  - topics – Leave No Trace, stewardship, Fossil Creek story, preserving native fish
- Off-site information sharing – schools, communities, seek volunteers
- Share information within and among agencies

Long-Term Education/Outreach Needs

- education of visitors and locals about stewardship, ethics, Leave No Trace
- education on native fish to prevent reintroduction of non-natives
- gathering and sharing information on Fossil Creek research and management with the public via symposia, liaison, surveys

All items generated in the discussion groups, including the number of "importance" votes for each item, are presented in the tables below.

The Next Step

While the results of this meeting are largely intended to serve as recommendations—a proposal—to land managers responsible for the short- and long-term management of Fossil Creek, it was evident from the meeting that there are many other individuals and groups who would like to be part of the future of Fossil Creek. Collaboration and partnerships are strong elements of the Fossil Creek restoration effort and will undoubtedly continue as that future develops. A core working group, a "Friends of Fossil Creek" group are only two formal collaborations suggested at the meeting. Communication, sharing knowledge, partnering on projects were suggestions for less formalized collaboration. The message was clear—working together is critical.

Acknowledgements

We gratefully acknowledge the hospitality of the Southwestern Academy in hosting the meeting. They were extremely accommodating in helping set up for the meeting, providing refreshments, and helping clean up following the meeting. We were pleased to have several of their students sit in on the meeting.

Funding for the Stewardship Meeting is part of a grant from the Nina Mason Pulliam Charitable Trust. We appreciate their support of Fossil Creek research, particularly that of Bob Berger who attended the Stewardship Meeting.

SHORT-TERM MANAGEMENT NEEDS FOR FOSSIL CREEK

<table>
<tr><th>Group 1 (n=9)</th><th>Group 2 (n=8)</th><th>Group 3 (n=7)</th></tr>
<tr><td>1. Recreation management to enhance recreation experience. (6 votes)
2. Establish inter-agency management team involving tribes, stakeholders, and the public. (6 votes)
3. Apply for scenic status through DOI. (4 votes)
4. Look at infrastructure – access, trails, road maintenance, and location. (4 votes)
5. Maintain native fisheries. (3 votes)
6. Maintaining water quality – phosphates and nitrates. (3 votes)
7. Apply for outstanding water status from ADEQ. (3 votes)
8. Consider user fees. (3 votes)
9. Support Forest Service in-stream flow. (2 votes)
10. Source of funding? (2 votes)
11. Volunteer program for management. (2 votes)
12. Management of non-native fish species. (2 votes)
13. Management presence – safety and health, public safety. (1 vote)
14. Manage traffic to Childs. (1 vote)
15. Protection of cultural resources. (1 vote)
16. Identify and protect (prehistoric) traditional cultural resources. (1 vote)
17. Protect historic structures. (1 vote)
18. Ethnographic and ethnobotanic studies.
19. Fish rescue plan.</td><td>1. Engineering to reduce impacts, e.g., parking lots, designated use areas, erosion control. (4 votes)
2. Official presence – law enforcement, personnel. (3 votes)
3. Active crayfish control program. (3 votes)
4. Finish Fossil Creek watershed plan. (3 votes)
5. Security implementation of: illegal stockings, fish regulations, fire security, sampling pressure – do not duplicate, undue pressure and permits. (2 votes)
6. Develop financial and human resources. (2 votes)
7. Current check of access points and facilities – trail markers, improvements. (1 vote)
8. Research and review existing management plans – wilderness implementation, wild and scenic river, forest plan, recreation management plan. (1 vote)
9. Implementation of education and outreach needs. (1 vote)
10. Repatriation of other native fish to Fossil Creek. (1 vote)
11. Support research needs – financial, people.
12. Support deconstruction.</td><td>1. Recreation plan, interim. (3 votes)
2. Form a core working group to share information and coordinate monitoring research and management – lead agencies. (3 votes)
3. Develop partnerships. (3 votes)
4. Identify areas that are most threatened and form emergency response – inventory, USFS, APS. (2 votes)
5. Enforce existing fishing regulations – USFS, Game and Fish. (2 votes)
6. Management plan for OHV – USFS. (2 votes)
7. Implement dedicated monitoring plan for fish, frogs, non-natives, and water quality. (2 votes)
8. Comprehensive watershed plan. (1 vote)
9. Adequate presence in area – USFS, AZ Game and Fish. (1 vote)
10. Defer grazing until A.M.P. revision – USFS. (1 vote)
11. Wild and scenic designation, determine suitability – USFS. (1 vote)
12. Provide opportunities for public input into management plans especially to local public.
13. Develop and implement interim plan, educational and interpretive.</td></tr>
</table>

LONG-TERM MANAGEMENT NEEDS FOR FOSSIL CREEK

Group 1 (n=9)	Group 2 (n=8)	Group 3 (n=7)
1. Maintain native fisheries. (5 votes) 2. Management presence – health and safety. (4 votes) 3. Look at infrastructure growth – access, trails, maintenance, and location. (4 votes) 4. Consider user fees. (4 votes) 5. Recreation management to enhance/control recreation experience. (3 votes) 6. Source of funding? (3 votes) 7. Research to guide management – monitoring. (3 votes) 8. Incorporate volunteer program. (3 votes) 9. Restoration and protection of habitats outside of stream. (3 votes) 10. Management of non-native species. (3 votes) 11. Maintaining water-quality. – phosphates and nitrates. (2 votes) 12. Management direction as a result of ethnographic and ethnobotanic studies. (2 votes) 13. Protection of cultural resources. (2 votes) 14. Protect wilderness values. (2 votes) 15. Water quantity. (1 vote) 16. Fish rescue plan. (1 vote) 17. Continued protection of structures. 18. Look at upper watershed impacts. 19. Facility for holding fish in emergency.	1. Official presence – law enforcement, personnel. (4 votes) 2. Analysis of looking at closing the road from Strawberry and making it a trail – access/road management of 708. (4 votes) 3. Active crayfish control program. (3 votes) 4. Develop financial and human resources. (3 votes) 5. Increase designation for protection e.g., Wild and Scenic Act. (2 votes) 6. Implementation of education and outreach needs. (2 votes) 7. Security implementation of: illegal stockings, fish regulations, fire security, sampling pressure – do not duplicate, undue pressure and permits. (1 vote) 8. Repatriation of other fish to Fossil Creek. (1 vote) 9. Monitoring native and non-natives particularly sensitive species – aquatic. 10. Support research needs – financial, people.	1. Strategic plan for recreation – multi-forest plan – USFS. (5 votes) 2. Keep non-native species, nuisance species out – monitoring and removal, animal and plan – Game and Fish, USFWS, USFS. (5 votes) 3. Funding for agencies – planning, implementation, education and outreach. (3 votes) 4. Manage motorized access – conversion of roads to trails. (3 votes) 5. Revise the A.M.P. – USFS. (3 votes) 6. Forest plan revision – incorporate guideline specifics for Fossil Creek. (3 votes) 7. Adaptive management. (2 votes) 8. Develop partnerships for long-term stewardship. (2 votes) 9. Develop and implement a plan for educational and interpretive – USFS and stakeholders. (2 votes) 10. Reintroduce extirpated aquatic species, fish, snakes, and herbs. (2 votes) 11. Participating in local government planning for groundwater and in-stream flow protection – all. (2 votes) 12. Adequate presence in the area. (1 vote) 13. Develop and implement fishing regulations – Game and Fish. (1 vote) 14. Expand wilderness designation. (1 vote) 15. Complimentary ecological designation. (1 vote)

SHORT-TERM STEWARDSHIP NEEDS FOR FOSSIL CREEK

Group 1 (n=9)	Group 2 (n=8)**	Group 3 (n=7)
1. Form a planning committee like Friends of Fossil Creek, including a neighborhood watch group. (7 votes) 2. Information bulletin boards to make the public aware of their responsibilities. (5 votes) 3. Coordinate law enforcement with funding. (4 votes) 4. User fees? Explore and design concepts. (3 votes) 5. Quantify visitor use. (3 votes) 6. How to deal with the impacts of trash and human waste? (3 votes) 7. Establish baseline monitoring data across resources, i.e., photos. (1 vote) 8. Establish baseline water quality data. (1 vote) 9. Restrictions on glass bottles, etc.	1. Formation of a Friends of Fossil Creek – education, information on Fossil Creek, presence, grant seeking, advocate, time and labor, interface with agencies regarding conservation teams and recovery teams . 2. Find a champion(s) to form Friends group. 3. Involvement in stewardship by multiple groups, including agencies. 4. Outreach to other interest groups. 5. Learn the interests of local communities to understand the expectations for Fossil Creek. 6. Involve the public in planning. 7. Educate the existing users to reduce impacts to the land. ** All are of equal importance.	1. Keep clean. (6 votes) 2. Prevention of non-native nuisance species – pathogens, parasites, weeds. (4 votes) 3. Law enforcement support. (3 votes) 4. Work with APS on restoration of facility sites. (2 votes) 5. Money – financial contributions, donations. (2 votes) 6. Involvement in agency planning – local, state governments, and federal. (1 vote 7. Participate in active volunteer groups. (1 vote) 8. Respect and protect natural resources and ethics. (1 vote) 9. Protect designated wilderness areas. (1 vote) 10. Native fish protection. 11. Crayfish control – monitoring, research. 12. Protection of cultural resources – cultural and prehistoric.

LONG-TERM STEWARDSHIP NEEDS FOR FOSSIL CREEK

Group 1 (n=9)	Group 2 (n=8)	Group 3 (n=7)
1. Interaction between agencies responsible – like Friends of Fossil Creek. (7 votes) 2. Implement user fees. (5 votes) 3. Continue university research. (5 votes) 4. Involve school classes and community organizations within general vicinity. (4 votes) 5. Tribes' expertise for long-term stewardship. (4 votes) 6. Law enforcement. (2 votes) 7. Continuing restrictions of glass, etc. 8. Use citizens to help monitor water quality. 9. Recognize all stakeholders on information boards.	1. Formation of a Friends of Fossil Creek – education, information on Fossil Creek, presence, grant seeking, advocate, time and labor, interface with agencies regarding conservation teams and recovery teams . (Group members all agreed this was the important long-term stewardship need)	1. Keep clean – trash, human waste, cars. (6 votes) 2. Law enforcement support – public involvement. (3 votes) 3. Involvement in agency planning – local, state governments, and federal. (3 votes) 4. Participate in active volunteer groups. (3 votes) 5. Respect and protect ethics, natural resources. (3 votes) 6. Find funding for stewardship. (2 votes) 7. Water quantity – legal rights, groundwater, in-stream flow. (2 votes) 8. Adoption of areas – sites, trails. (2 votes) 9. Monitoring success of stewardship efforts – limits of acceptable change. (2 votes) 10. Native fish protection. (1 vote) 11. Crayfish control – regular treatment organized, monitoring and research. (1 vote) 12. Community buy-in and participation. (1 vote) 13. Protect designated wilderness. (1 vote) 14. Water quality – what are issues, number of visitors, monitoring. (1 vote) 15. Surveys – fish, frogs, etc. (1 vote) 16. Educational, bring and linking together – synthesis and distribution of information. (1 vote) 17. Control ATVs, pack animals, camping and day use – management plans to keep numbers down. (1 vote) 18. Committee of stakeholders – adaptive management. (1 vote) 19. Understanding of the resource by recreationists.

		20. Travertine – research, management, education, communication. 21. Active advocacy of voter legislation. 22. Watershed restoration and identification, and soil erosion – grazing, roads, trails, fire regimes. 23. Private development – conservation, purchasing, planning, easement. 24. Money – financial contributions, donations. 25. Complimentary ecological designations – wild and scenic rivers, botanical, bird areas, tribe designations. 26. Prevention of non-native nuisance species.

SHORT-TERM EDUCATION AND OUTREACH NEEDS FOR FOSSIL CREEK

Group 1 (n=9)	Group 2 (n=8)	Group 3 (n=7)
1. Develop various media resources to share information and tell the unique Fossil Creek story without attracting people. (7 votes) 2. Share knowledge within, before educating outside. (5 votes) 3. Invest in interpretive displays at hardened sites. (3 votes) 4. Expand current Fossil Creek curriculum in schools. (2 votes) 5. Have on-site/off-site hosts for visitor interaction. (2 votes) 6. Educate political leaders. (2 votes) 7. Create liaison with involved environmental groups. (1 vote) 8. Resource etiquette/information on-site. (1 vote) 9. Community website for Fossil Creek, including chat.	1. Information kiosks on: decommissioning process, recreation opportunities, what's the future? (4 votes) 2. Outreach for additional resources for managing Fossil Creek. (4 votes) 3. Outreach to local communities and response from them. (3 votes) 4. Need to educate public on stewardship – how to reduce their impacts. (2 votes) 5. Connect researchers with the local science teachers. (2 votes) 6. Need for a facilitator/catalyst for outreach. (2 votes) 7. Getting information out to the public – native and non-native species. (1 vote) 8. Benefits to recovery and conservation of natives – especially fish and aquatic species. (1 vote) 9. Identify level of education of public visiting. (1 vote) 10. Security regarding commission order 40 – fishing closure. (1 vote) 11. Community presentations on dam decommission – broader presentations as case studies. 12. Volunteer efforts in form of education/stewardship group. 13. Outreach to Boy Scouts. 14. Educate through programs – Leave No Trace.	1. Leave No Trace ethics – wilderness definition, low impact camping. (5 votes) 2. Prevention of non-native and nuisance species to local residents. (4 votes) 3. Unique values of Fossil Creek communicate to users – history, geology, cultural, biological. (4 votes) 4. On-site signage and kiosks. (3 votes) 5. Outreach to local residents – volunteering and agency process. (2 votes) 6. Native fisheries signage. (1 vote) 7. Learn about user values. (1 vote) 8. Educational messages for OHV users. (1 vote) 9. Identify available educational materials. 10. Definition of wilderness and interpretation of wilderness. 11. Law enforcement reporting mechanism – vandalism, etc. 12. Effectively communicating legal restrictions/regulations.

LONG-TERM EDUCATION AND OUTREACH NEEDS FOR FOSSIL CREEK

Group 1 (n=9)	Group 2 (n=8)	Group 3 (n=7)
1. Focus on Fossil Creek as a native fish refuge with emphasis on user education. (6 votes) 2. Have on-site/off-site hosts for visitor interaction. (5 votes) 3. Periodic symposia on Fossil Creek. (5 votes) 4. Resource etiquette/information on-site. (3 votes) 5. Education components using lessons learned from research. (2 votes) 6. Add Fossil Creek curriculum in schools. (2 votes) 7. Recognize Fossil Creek in Arizona Wildlife Viewing Guide. 8. Work with local communities.	1. Volunteer efforts in form of education/stewardship group. (4 votes) 2. Outreach for additional resources for managing Fossil Creek. (4 votes) 3. Need for a facilitator/catalyst for outreach. (3 votes) 4. Need to educate public on stewardship – how to reduce their impacts. (2 votes) 5. Themes for types of education for visitors and the people living there – wilderness, archaeological, native fish, riparian habitat. (2 votes) 6. Liaison between researchers and public educators. (2 votes) 7. Educate through programs – Leave No Trace. (2 votes) 8. Benefits to conservation and recovery of natives – especially fish and aquatic species. (1 vote) 9. Central entity responsible for education and stewardship, e.g., River Keeper. (1 vote) 10. Getting information out to the public – native and non-native species. 11. Volunteer efforts involved in long-term monitoring of crayfish. 12. Connect researchers with local science teachers. 13. Outreach to Boy Scouts.	1. Leave No Trace ethics/wilderness definition. (4 votes) 2. Prevention of non-natives to new users, youth, Chamber of Commerce, and tourists – education on how to and why. (2 votes) 3. Native species – media outreach, ecosystem approach. (2 votes) 4. Data on users – what they expect, surveys, how to give appropriate information. (2 votes) 5. Develop interpretive plan. (2 votes) 6. Promoting/reporting mechanism to law enforcement. (2 votes) 7. Communicate to users the values of Fossil Creek—on-site and off-site—interpretation of history/prehistory, geology, and culture. (2 votes) 8. Local school programs and field trips. (2 votes) 9. Feedback to convey success of programs – monitoring, press-releases, internet postings, and presentations. (2 votes) 10. Education messages for OHV users. (1 vote) 11. On-site signage and kiosks. 12. Effectively communicate legal regulations. 13. Helping other organization undergoing similar processes. 14. Working with other universities. 15. Funding.

THE NEXT STEP

Two of the three groups talked briefly about what the next step should be for Fossil Creek. There was no formal discussion or voting.

Group 2 (n=8)	Group 3 (n=7)
1. Proceed at a pace that the Forest Service can live with. 2. Let USFS wrestle with the suggestions – Forest Service will provide feedback re: timing, support. 3. Outline a timeline for priorities. 4. Agencies put suggestions in context – they talk about what can move forward, defer, etc. 5. Product equals proposed action plan – time, who.	1. Wild and scenic designation would provide framework under which this could all work. 2. Strategic plan for management of Fossil Creek. Inter-agency or at least an agency plan. 3. Form a core working group, with formal partnerships. 4. Realistically state and federal budgets are inadequate – volunteer groups should be formed. 5. Biggest threat is influx of people. Need management now, before it is too late. Before patterns of use are established.

These are responses made by a land manager who could not attend the meeting.

1. What are the short and long term stewardship needs for Fossil Creek?

To provide care and protection of soil, vegetation, wildlife, cultural resources and primitive recreation opportunities. This includes a balanced program of properly engineered facilities, an education program through signs and other means and the enforcement of regulations intended to protect resources and people.

Long term stewardship depends on a balanced program of engineering, education and enforcement. If any one of these is reduced the efficiency and effectiveness of the protection of resources and recreation opportunity is also reduced.

2. What are the short and long term management needs for Fossil Creek?

Short term management needs include: initiating management presence without the APS presence that has existed in the past; establishing an effective Leave No Trace Program including the seven principles of Plan Ahead and Prepare, Travel and Camp on Durable Surfaces, Dispose of Waste Properly, Leave what you Find, Minimize Campfire Impacts, Respect Wildlife and Be Considerate of Other Visitors. Short term needs for trash pickup, protection of riparian resources and aquatic species, reduction in damage from OHV's to soil and vegetation resources must be provided. Forest Service presence must be continuous at regular intervals to show visitors who manages the property and who is concerned about it. Too often recreationists just see a piece of land to have their way without attaching a purpose, value and identity of who the land management agency is.

Long term management needs are a sustainable ecosystem which has in place regular management. Long Term needs include sustainable resources to manage the Fossil Creek Mgt. Unit. This includes a model for the future for the area similar to the Sedona Ecosystem where only 29% of our budget comes from congressional funding. The remainder comes from grants, in-kind volunteer labor and fees (O/G retained fees or other fees). With congressional funding falling we need to look for other ways to get on the ground engineering (const.), education and enforcement (both preventative and actual law enforcement). Partnerships will make that happen, also. The long term desired condition for Fossil Creek should be that the Fossil Creek Area becomes a site where recreation activities, transportation facilities and their impacts work to enhance the wildlife/fisheries/wild and scenic river outstanding resource values/scenery mgt. system and human recreational benefits over the "Long Run".

APPENDIX A

Fossil Creek Stewardship Meeting **Attendees**		
25-Oct-05		
Name	**Title**	**Agency**
Janie Agyagos	District Wildlife Biologist	Red Rock Ranger District
Cecilia Overby	Forest Biologist	Coconino National Forest
Ken Anderson	District Ranger	Red Rock Ranger District
Ed Armenta	District Ranger	Payson Ranger District
Shaula Hedwall	Fish and Wildlife Biologist	U.S. Fish & Wildlife Service
Scott Reger		Arizona Game & Fish
Dave Weedman	Fish Biologist	Arizona Game & Fish
Susie MacVean	Non-game Specialist	Arizona Game & Fish
Dan Campbell		The Nature Conservancy
Tim Flood		
Jim Walters		
Allen Haden		NAU
Russell Vallelunga	Text Manager	Textbook Source of AZ
Chris Coder	Archaeologist	Yavapai-Apache Tribe
Vincent Randall		Yavapai-Apache Tribe
Heidi Kloepel	Biologist	Grand Canyon Wildlands Council
Chris Cantrell	Native Fish Biologist	Arizona Game & Fish Dept.
Jeff A. Sorensen	Native Fish and Invertebrates Program Manager	Arizona Game & Fish Dept.
Chuck Jenkins	President	Friends of the Forest
Walt Thole	Recreation Staff	Payson Ranger District
Amy Unthank	Regional Fish Biologist	U.S. Forest Service
Delvin Lopez	Group Leader for Public Service	Tonto National Forest
Mark Sensibaugh	Public Services Staff Officer	Coconino National Forest
Julie Meke		Arizona Game & Fish Dept.
Bob Berger		Nina Mason Pulliam Charitable Trust
Martha Hahn	Group Facilitator	The Sage Project
Shelley Silbert	Group Facilitator	Northern Arizona University
Marty Lee	Group Facilitator	Northern Arizona University
Paul Hancock	Group Recorder	Northern Arizona University
Alexis Mullen	Group Recorder	Northern Arizona University
Nathan Schott	Group Recorder	Northern Arizona University

Field Review of Middle Fossil Campsites
March 31, 2003

Attending: Bill Stafford, Christa Roughan, Sharyn Valdez, Peter Piles, Jack Norman, Walt Thole, Cavetta Green, and Janie Agyagos

Refer to attached map for campsite locations.

I) Overview

Only one area (Campsite 1) will be closed.

Some campsites are located only in riparian; since no camping allowed in riparian zone, these will be day use (Campsites 2, 5, and 6)

In order to control capacity and prevent camping in riparian areas, it was unanimously agreed upon that all campsites in the Middle Fossil area will be delineated with some kind of marker and camping will only be allowed where delineated.

Generally any roads that access the riparian area are to be blocked. Preferably, these roads will be rehabbed and most will be turned into a trail allowing for creek access. (Campsites 3, 4, 5, 8, 9a, 11, and 12).

For most campsites parking of one vehicle would be allowed right at campsite to allow for car camping (Campsites: 3?, 4a, 4b, 4c?, 7, 8, 9, 10). Concern was raised about parties with more than one vehicle. To accommodate additional vehicles, it was suggested that pull-in parking be delineated right off main road.

For some campsites with no road access or poor roads (2, 4c, 5, 6, 11, 12), the roads will be closed, parking will be available next to main road, and access will be by foot.

No glass containers allowed.

Campsite Number	Complete Closure	Dayuse Only	Close Roads to Riparian	Close all but one trail to creek	Road-side Parking with walk-in access	Car Camping Available
1	X					
2		X		X	X	
3			X	X		?
4a			X	X		X

Campsite Number	Complete Closure	Dayuse Only	Close Roads to Riparian	Close all but one trail to creek	Road-side Parking with walk-in access	Car Camping Available
4b				X		X
4c					X	If road extended from 4b
5		X	X		X	
6		X			X	
7						X
8			X			X
9a			X			X
9b						X
10						X
11			X	X	X	
12			X		X	

II) Above Irving

Campsite # 1:
The road into this camping area is steep, eroded, and crosses a spring channel before getting to the flat terrace. Since this area is within the upper third of Fossil and the tentative policy is day-use only, it was agreed that this site would be completely closed and the road rehabilitated.

Campsite # 2 (Flume trailhead):
Currently this a large, undefined parking area. The proposal is to tighten up the parking using boulders to delineate the general parking area. It was also agreed to obliterate all but one main trail which would allow access to the creek for dispersed day use. Flume trail users would have to access the Flume trail via the footbridge located just down the road (a trail would have to be created). Signage would clarify trail destinations to avoid confusion. The campsite across the road from this trailhead would be retained.

Footbridge above Irving:
It was agreed that the footbridge should be retained for access to the Irving area and the Flume trail. Also, since it will likely be necessary to get emergency and patrol vehicles over to the Irving side, there should be no parking allowed at the footbridge. Instead boulders and a locked gate would be installed along the main road. Flume trail users would be instructed to park at the trail head up the road. The gate on the footbridge will have to modified to allow walk-thru traffic.

III) Irving and Below

Campsite # 3:
Tonto folks requested that both roads down to the creek be closed, rehabbed, and one road converted to a trail accessing the creek. Parking is available across the road and will be left open for camping. The terrace will also be left open for camping.

Campsite # 4a:
The campsites and the portion of the road located on the terrace above the creek are OK to keep. However, the portion of the road to the creek should be closed and converted to a trail. Preferably, the road should be rehabbed.

Campsite # 4b (Abandoned truck):
Since no roads access the creek, all roads can be retained and used for dispersed camping. All but one trail to the creek will be obliterated. Each campsite will be delineated; one parking space allocated per campsite; pull-in parking for excess vehicles can be made available along main road.

Campsite # 4c:
Since the road accessing this area has drainage problems, the road would be closed and pull-in parking delineated along main road. Or, the road from 4b could be punched through to this area.

Campsite # 5 and 6 (Bridge):
On the upstream side of the bridge, there is now a road leading down the riparian area; this road would be closed and rehabilitated. The bridge area will be day-use only. Parking is limited along main road and there is need for a 20 to 30 car parking area. Need to determine private land status and explore for a suitable area for a parking lot.

Campsite # 7 (van and dog):
No problems with this site as it is up on terrace. Only concerns are that livestock are drawn to terraces and tend to make them totally undesirable for camping. This pushes folks down into the riparian area.

Campsite # 8:
The road here goes down to creek. This will be closed and converted to a trail. 15 campsites up on the terrace are OK.

Campsite # 9a (Sally May):
The road goes almost to the creek but mostly up on the terrace. Would have to close the very last portion of the road (where boulders currently occur and looked like a previous attempt at closure).

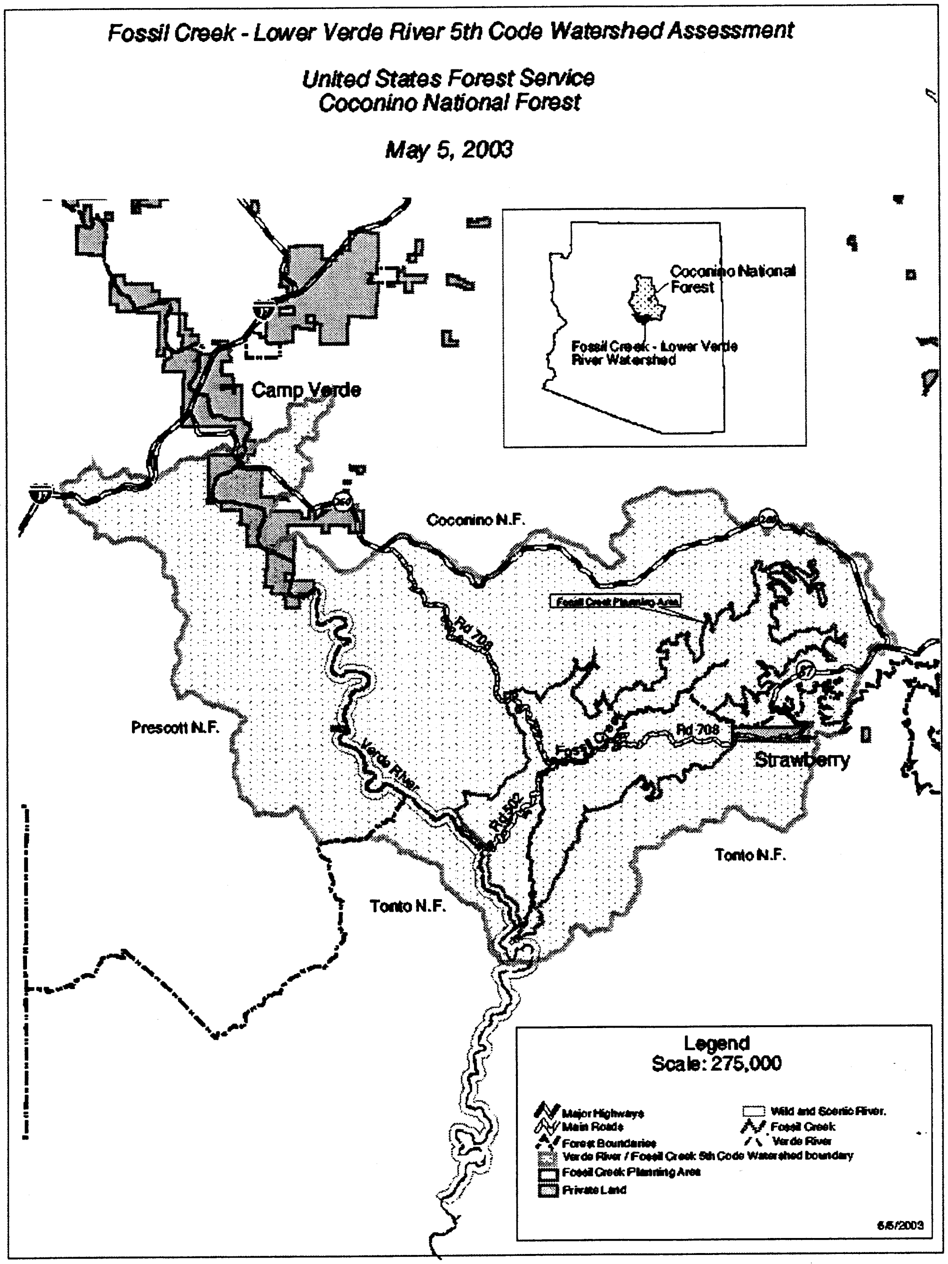
Campsite # 9b:

This campsite is located on the other side of the powerlines from 9a. The road is far up from the riparian and is OK as is.

Campsite # 10:
Repeat of 9b – up on terrace and no roads lead down into riparian.

Campsite # 11:
Since this road leads down into riparian, the road would be closed, converted to a trail, and users would have to hike in. Half of the campsites are located in the riparian and half out. Only designate those out of riparian.

Campsite # 12:
This campsite is located down a long road that winds along a hillside sloping into the creek. Need to close road where we parked or maybe up at 502. Walk-in camping allowed.



Fossil Creek, Lower Verde River Watershed Condition Assessment (U.S. Forest Service, Coconino National Forest

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The Purpose of the Watershed Condition Assessment (WCA)

To shift focus from species and sites to the ecosystems that support them in order to understand consequences of management actions before selecting a proposed action and implementation. The analysis enhances our ability to estimate direct, indirect, and cumulative effects of our management activities and guides the type, location and sequence of management activities within a watershed.

This analysis focuses on the physical and biological characteristics and processes within the watershed and human impacts affecting hydrologic and soil functions (aka watershed condition, FSM 2520). Detailed information about the physical, chemical and biologic conditions and functions of the soil, aquatic, and riparian systems are analyzed to assess watershed condition.

The Objectives of the WCA

- Identify and discuss existing and desired watershed condition (soil, riparian, aquatics)
- Allow a discussion of effects of management activities at the watershed level
- Prioritize at-risk areas needing restoration or rehabilitation
- Recommend management opportunities and alternative management Best Management Practices, (BMP's)
- Prioritize where subsequent finer detailed watershed analysis is needed
- Develop scientifically based information to assist in watershed-based riparian/open water management direction
- May incorporate assessment into Forest Plan revision process
- Use a consistent and scientific approach to assess watersheds (Unified Federal Policy Federal Register)
- Recognize watersheds in assessment and planning (COSR – Committee of Scientists Report NFMA)
- Use the results to guide planning and management activities (UFP-FR)
- Make maintenance and restoration of watershed health an overriding priority for future forest plans and provide measures for monitoring progress (USDA-FS Natural Resource Agenda)

Process Followed

This WCA uses the 6-step process as outlined in the Federal Guide for Watershed Analysis, version 2.2 or a Framework for Analyzing Hydrologic Condition of Watersheds. This process has been modified to meet our needs but is generally similar to the following 6 steps. Steps 5 and 6 have been combined in this assessment.

1) Characterize the watershed

2) Identify issues and key questions to analyze
3) List current conditions of watershed
4) List reference conditions
5) Synthesis and interpretation of data
6) List recommendations (management, BMP's, priorities, etc.)

A watershed level roads analysis is completed also and found in Appendix A.

Focus of the WCA

The Fossil Creek – Lower Verde River is a newly delineated 5th Hydrologic Unit Code Watershed. It now includes what was previously the entire Fossil Creek watershed and parts of the Verde River drainage basin. Previously, the Fossil Creek and portions of the Verde River drainage basin were not delineated together but recent direction mandated uniform watershed delineation protocol across the National Forest System and resulted in numerous changes in 5th code watershed delineations.

The Fossil Creek watershed is listed as one of the top 5-priority watersheds on the Coconino National Forest. The Verde River is one of the largest perennial rivers in Arizona and located in a growing population center resulting in increased water demand and impact both on the river and watershed.

The Coconino National Forest is attempting to restore full flows to Fossil Creek and its associated native fisheries following the perceived decommissioning of the Irving and Childs Power Plants. It is expected that full flows will bring about in increase in recreational use and impacts to the Fossil Creek area. Consequently, the Forest requested an assessment of the Fossil Creek Planning Area and a watershed-based assessment of current and desired conditions and recommended management opportunities to protect the natural resources in Fossil Creek and the watershed.

The focus of this assessment will be on watershed condition and function and vegetative conditions as they relate to physical, chemical and biologic conditions of the soil, aquatic and riparian systems. This WCA will focus on the Fossil Creek - Verde River 5th code watershed located on lands administered primarily by the Coconino National Forest including parts of the Prescott and Tonto National Forests.

Public Participation and other On-going Analysis

This assessment was being done in conjunction with the **Fossil Creek Planning Area Assessment**. The Fossil Creek Planning Area Assessment is often referred to in the watershed assessment. Although only limited public participation was developed for the assessment, substantial public participation is on going in the related Fossil Creek Planning Area Assessment. The Fossil Creek Planning Area Assessment targets the immediate area surrounding Fossil Creek. An interdisciplinary team was formed and made up of Wildlife and Fisheries Biologists, Soil Scientists, Hydrologists, Range

Conservationists, Fuels Specialists, Recreation and Land Use Specialists and Archaeologists primarily from the Coconino, Prescott and Tonto National Forests and included local Northern Arizona University Specialists and other government agencies as well.

For the Fossil Creek Planning Area Assessment, public meetings were held and are on-going in local communities and attended by individuals representing a large spectrum of interests.

In addition to the Fossil Creek Planning Area Assessment and the watershed assessment, three other planning processes are on going. The FERC is in the process of planning for the decommissioning of both the Childs and Irving power plants with anticipated full flows restored to Fossil Creek. The Bureau of Reclamation is planning for native fish restoration in Fossil Creek in anticipation of FERC decommissioning. The Verde River Comprehensive River Management Planning effort is also on going. These 4 processes and planning efforts are interconnected and have complex timing issues.

Format of the Report

This report is organized into a Contents section, Introduction section, and five Chapters followed by Appendix A (Roads Analysis), a List of tables, and List of figures, a List of contributors and a Reference section.

Each Chapter is divided into major headings electronically linked from the Table of Contents. The Table of Contents also provides links to Tables and Figures throughout the document.

CHAPTER 1 - CHARACTERIZATION OF THE WATERSHED

This chapter provides a brief overview of the Fossil Creek – Lower Verde River watershed in terms of the dominant physical, biological and human processes that affect watershed function and condition. These processes will be covered throughout this analysis.

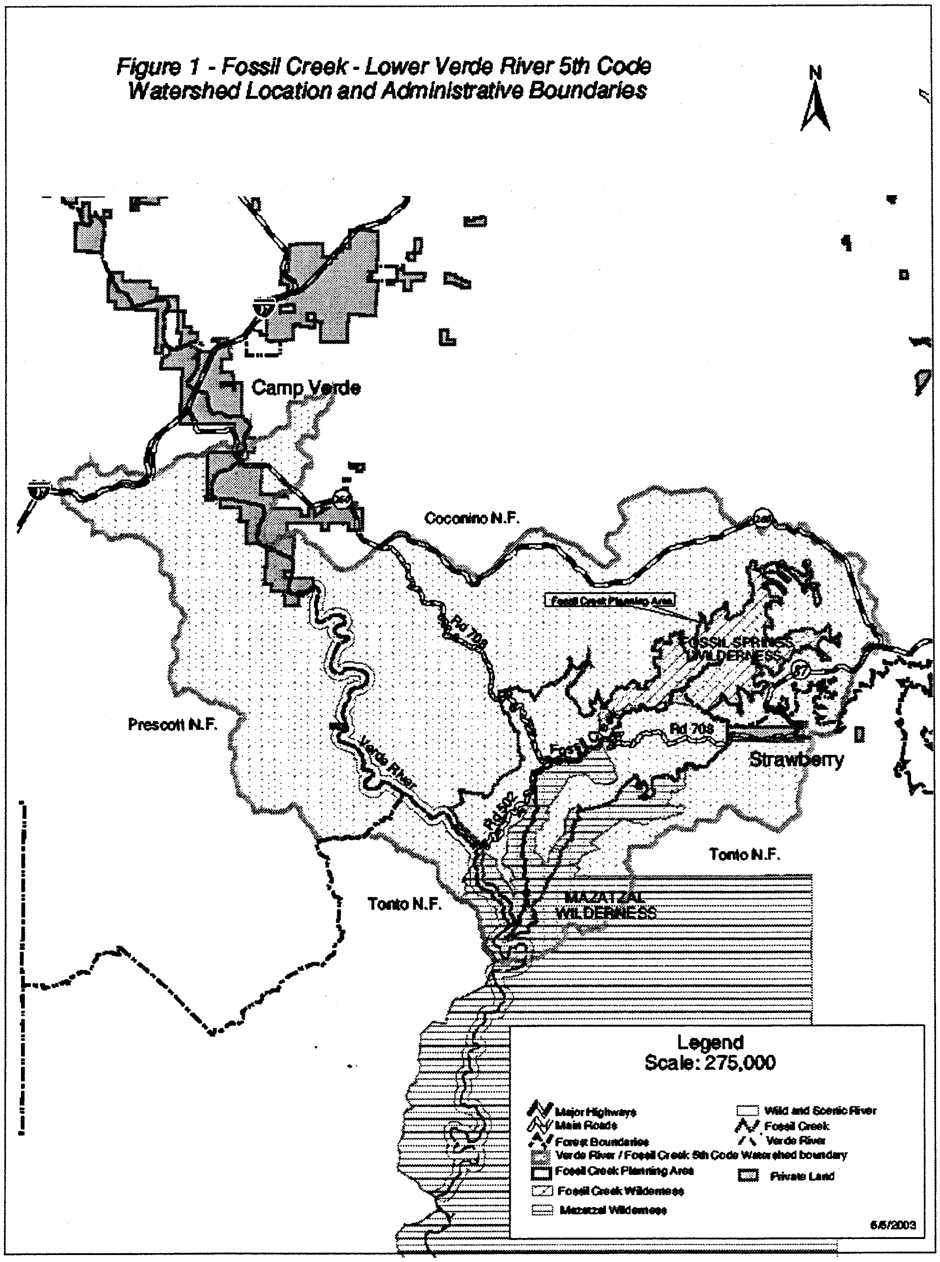
Physical Setting and Location

The Fossil Creek – Lower Verde River watershed is located in central Arizona (see Figure 1 below). It is a 5th hydrologic unit code (huc) watershed identified as huc number 1506020302. The watershed analysis area encompasses approximately 191,677 acres: 107,512 acres on the Coconino National Forest, 40, 030 acres on the Tonto National Forest, and 44,135 acres on the Prescott National Forest. Approximately 2897 acres of private lands fall within the watershed boundary but are not analyzed in detail. The majority of the watershed is located in Yavapai County and parts of Coconino County (generally above the Mogollon Rim) and Gila County adjoining the Tonto National Forest.

The entire watershed covers about 300 square miles and ranges in elevation from about 7350 feet above sea level along the southern boundary of the Colorado Plateau (the Mogollon Rim) to about 2550 feet below the confluence of the Verde River and Fossil Creek in the Transition Zone Province. Major perennial streams are the Verde River and Fossil Creek. The extreme downstream reach of West Clear Creek joins the Verde River in the northern part of the watershed. There are many other intermittent streams and riparian areas in the watershed.

The Forest Service manages almost the entire watershed. The Verde River is the boundary between the Coconino and Prescott National Forest to the south. Fossil Creek is the boundary between the Coconino and Tonto National Forest to the southeast. The upper part of the watershed was designated The Fossil Springs Wilderness Area in 1994 (USDA 1997). Closer to the Verde River, The Mazatzal Wilderness extends south from Fossil Creek.

Figure 1 – Watershed Location and Administrative Boundaries



Weather and Climate

The weather in the Mogollon Rim region is strongly influenced by jet stream activity coming from the southwest and can be extremely variable from year to year, and season to season. The watershed is located in a land of extremes. Within the watershed, the large elevational gradient produces a wide range of temperatures and amounts of precipitation (Monroe, 2002).

Annual precipitation is distributed bimodally with peaks in the winter and summer. Cold Pacific winter frontal storms can deliver large quantities of precipitation in the form of rain or snow depending on elevation. During summer months, monsoonal storms can produce locally large amounts of rain. The majority of the precipitation comes in winter months (October – April) usually followed by dry periods and low humidity from mid May though early July, which typically results in low fuel moistures and the highest threat of wildfire. Beginning in early July and usually lasting through early September, monsoonal thunderstorms with lightning contribute the second greatest amount of total, annual precipitation.

At elevations lower than about 6000 feet and below the Mogollon Rim and Ponderosa Pine zone, summers are usually hot with average high temperatures exceeding 95 degrees for June, July, and August (data for Montezuma Castle NM from the Western Regional Climate Center). Winters are typically mild at low elevations. At elevations above about 6000 feet, and above the Mogollon Rim, summers are warm and winters cold. Snow usually does not accumulate for more than a few days except at elevations above about 6000 feet where patchy snow may persist into the early summer. Rain on snow events occur in the Ponderosa Pine zone during the spring and may account for large peak flows downstream. Soils generally do not freeze for long periods at a time except in the Ponderosa Pine zone, which is minor in overall watershed acreage, and therefore frozen soils do not contribute significantly to accelerated runoff during storm events.

Precipitation and Air Temperature

Total Amount – 15 - 20" in semidesert grasslands and lower, 18-22" in pinyon-juniper woodlands and transitional areas, 21-25" in Ponderosa Pine vegetation types.

Childs NOAA weather station (located upstream of the confluence of Fossil Creek and the Verde River shows average precipitation from 1971-2000 of 19.5", and average minimum temperature of 47 degrees F, and average maximum temperature of 81 degrees F.

Beaver Creek Ranger Station NOAA weather station (station is located north of the watershed but may represent elevations where the vegetative type is pinyon-juniper and pinyon-juniper – semidesert grassland vegetation types) shows average precipitation from 1971-2000 of 19.9" and average minimum temperature of 31 degrees F. and average maximum temperature of 63 degrees F.

Payson NOAA weather station (located east of the watershed but may represent elevations where the vegetative type is ponderosa pine) shows average precipitation from 1971-2000 of 21.6", and average minimum temperature of 39 degrees F, and average maximum temperature of 73 degrees F.

Snow – average of 25 to about 50 inches or more in ponderosa pine vegetation types. Patchy snow in pinyon-juniper woodlands and with little to no accumulation and only trace amounts of snow with no accumulation in semidesert grasslands and below.
Duration/Intensity – winter precipitation from frontal systems is often of low to moderate intensity and of longer duration, and summer monsoon storms tend to be of short duration and high intensity.
Timing – bimodal, more than half during winter and the second most during summer monsoons with dry spring and fall seasons.

Geology and Landforms

The watershed lies along the Mogollon Rim Transitions Zone. List landforms and geology and subsections.

Natural erosion processes are sheet, and rill erosion and to a lesser extent, gully and wind erosion on calcareous soils. Steep slopes can produce debris slides especially when the soils are wet.

Vegetation Type and Elevational Ranges

The watershed is vegetatively diverse and ranges from Ponderosa Pine and small areas of mixed conifer at the highest elevations to semidesert grasslands at the lowest elevations. Table 2 summarizes vegetation type by elevational range.

Table 1 Vegetation Type and Elevational Range

Vegetation Type	Elevational Range
Ponderosa Pine/Mixed Conifer	6375 – 7350 feet
Pinyon-Juniper Woodlands	3280 - 6375
Juniper Shrubland	3400 - 4800
Chaparral	3280 - 6000
Juniper-Semidesert Grassland Transition	3400 - 4600
Semidesert Grassland/Grasslands	3100 - 4100
Semidesert and Desert Shrublands	2600 - 3250
Streamside Vegetation	2550 - 4950
Riparian Areas	2550 - 4900

Wildlife and Fish

Fossil Creek currently provides outstanding riparian and aquatic habitat for a wide variety of fish and wildlife. Fossil Creek provides critical habitat for several native fish including loachminnow and spinedace. Above Irving, the creek contains predominantly native fish. Below Irving, non-native species currently predominate.

Fossil Creek has the only reproducing population of the sensitive lowland leopard frogs on the Coconino NF and has the highest population density on the forest.

Impacts to wildlife are currently occurring from dispersed recreation (displacement and habitat modification), grazing and the invasion of non-native plants, fish, and crayfish.

Soils and Range

Several allotments and numerous pastures exist in the watershed. Soils located in Ponderosa Pine vegetative types are generally satisfactory. In other vegetation types, upland soil conditions on slopes less than 30 percent are typically degraded as a result of loss of effective ground cover, species composition changes, extent of bare and compacted soil resulting in local increases in erosion and runoff during high storm events.

Cattle gather on flat terraces adjacent to most perennial and intermittent streams. These same terraces are used by dispersed campers and also contain the remains of prehistoric ruins. Cattle gather at and drink from many natural springs. This has denuded riparian vegetation and affected invertebrates, amphibians and mammals. Some cattle tanks contain populations of Chiricahua Leopard frogs, which will soon be listed as Threatened and are potentially impacted by grazing practices.

Aquatic and Riparian Systems

Watershed and Riparian

Watershed conditions vary throughout the watershed as a result of historic and current grazing activity, recreation impacts, and roads. Numerous road segments (both system and non-system) contribute to a high "connected disturbed area" rating, especially near Fossil Creek and its tributaries. While grazing condition trends show improvement over past decades, there are large areas of unsatisfactory range. Most road culverts are not functioning properly.

Perennial and intermittent stream riparian condition is variable throughout the watershed. See Chapter 3.2 for detailed information.

Water Quality

Perennial stream water quality is assessed in Chapter 3.1. The important water quality parameters that most influence the beneficial uses are sediment and turbidity. Many reaches of the Verde River and Fossil Creek assessed in the ADEQ 2002 305 (b) Report are inconclusive due to a lack of sufficient samples and will be placed on the Planning List.

Fish Species and Aquatic Health

Aquatic habitat conditions and the associated fish communities vary along the length of the Verde River, Fossil Creek, and West Clear Creek. The fish community of the Verde River is dominated by non-natives but includes a few natives as well. Along Fossil Creek, the fish community changes above the Diversion dam and below. Please see Chapter 3 for a detailed discussion of current conditions.

The presence and/or absence of the macroinvertebrates provide a natural barometer for detecting the health of an aquatic system. Sampled habitat areas and a summary of the numbers of taxa for each sampled habitat area, and the numbers of unique, uncommon, rare, and special status species is detailed in Chapter 3.

Management Areas, Forest Plan Management Direction, and Land Allocations

The Coconino, Prescott and Tonto National Forests are divided into management areas. The LMP defines desired future conditions and management prescriptions within each management area. On the Coconino National Forest, The Verde River – Fossil Creek Watershed falls within the Management Areas listed in Table 1.1 below.

Table 1.1 Coconino National Forest Land Allocations in the Watershed

Management Areas	Acreage Extent
1 – Fossil Springs and Mazatzal Wilderness Areas	Medium
2 - Verde Wild & Scenic River	Low
3 - Ponderosa Pine/Mixed Conifer, < 40 % slopes	Very low
4 - Ponderosa Pine/Mixed Conifer, > 40 % slopes	Very low
6 - Unsuitable Timber Land	Very low
7 - Pinyon-Juniper Woodland, < 40 % slopes	Medium
8 - Pinyon-Juniper Woodland, > 40 % slopes	High
10 - Transition/Grassland/Sparse PJ, above rim	Low
11 - Verde Valley	High
12 - Riparian and Open Water	Very low

Wilderness

A portion of the Mazatzal Wilderness Area and the Fossil Springs Wilderness Area are within the watershed. Wilderness areas are managed according to the Wilderness Act of 1964, and regulations pursuant to those acts and the Forest Service Manual. The NFP and the Mazatzal Wilderness Area Implementation Plan directs management of the area.

The Verde Wild and Scenic River Area

The Verde River is designated as wild from about Beasley Flat to the Mazatzal Wilderness boundary and Scenic below. There are three separate designations on Wild and Scenic Rivers: recreation, scenic, and wild. Each designation carries a unique set of standards that regulate activities on federal lands within ¼ miles of the river.

Human Uses and Impacts

Communities

The communities of Camp Verde and Strawberry are within the influence of this watershed. The main industries are agriculture, ranching, service and tourism.

Transportation Systems

The transportation system is made up of roads and trails that provide access for motorized and non-motorized vehicles, livestock, and foot traffic. The road system consists of a state highway, county and Forest Service improved and unimproved roads and user crated roads. The major routes are Forest maintenance level 3 roads and are part of transportation network that links the watershed to either State Highway 260 or the Interstate 17. See Appendix A for detailed information on affected roads in the Roads Analysis.

Recreation Resources

Outdoor recreation in the area consists of a variety of opportunities, most of which occur along waterways including the Verde River, Fossil Creek, West Clear Creek and other riparian areas. These opportunities include dispersed and developed camping, fishing, rafting, sightseeing, hiking, hunting and OHV'ing. Verde River has a natural hot springs near Childs and Fossil Creek is home to the Fossil Springs Botanical Area and numerous travertine formations exist along portions of Fossil Creek below Fossil Springs. The outstanding scenery, abundant wildlife, and water offered have created increased demand for recreation especially along Fossil Creek.

CHAPTER 2 - ISSUES AND KEY QUESTIONS

The purpose of this chapter is to focus the analysis on key elements of the biophysical resources and human impacts that are most relevant to the management questions, and resource conditions within the watershed.

Seven issues and key questions critical to future management were identified by members of the Fossil Creek Planning Area IDT. These are not issues with any proposed action but are believed to be the most important biophysical elements where man may affect watershed condition. There is a need to know the difference between existing and desired conditions so that consequences of future management actions can be selected to meet desired conditions most effectively. The seven issues and related questions are:

Issue #1: Water Quality Condition
Issue #2: Health of Riparian Areas (Lotic and Lentic)
Issue #3: Aquatic and Native Fisheries Habitat Conditions
Issue #4: Health and Recovery of Upland Vegetation
Issue #5: Human Impacts to Watershed (Recreation, Grazing and OHV Activity)
Issue #6: Road and Stream Connectivity and Potential Sediment and Water Delivery to Fisheries and Aquatic Habitat ***(This issue is analyzed in the Roads Analysis located in Appendix A)***
Issue #7: Soil Condition, Erosion, Compaction, Nutrient Cycling, and Reduction of Soil Productivity, Hydrological and Watershed Condition

The following are key questions pertaining to each issue.

Issue #1: **Water Quality Condition**

Key Question

What are the current water quality conditions in terms of supporting the identified beneficial uses in perennial streams and how do they compare with the desired conditions within the watershed?

Outcome

Identify the beneficial uses on each perennial stream and determine if State water quality standards are met. Identify water quality desired conditions on perennial streams.

Key Question

Which management actions or human impacts may contribute to degraded water quality and what management actions might be taken to bring the stream reach into compliance with State water quality standards?

Outcome

Determine which State water quality standards are exceeded and which impacts are connected to impaired waters. Recommend management actions or best management practices (BMP's) that could improve water quality.

Issue #2: Health of Riparian Areas

Key Question

What are the existing and reference conditions of lotic and lentic riparian areas and are they functioning properly?

Outcome

Determine the existing and proper functional condition on riparian areas and identify their differences.

Key Question

What management actions or human impacts contribute to at-risk or dysfunctional riparian areas and what management actions or BMP's might be taken to improve riparian area function?

Issue #3: Aquatic and Native Fisheries Habitat Conditions

Key Question

What are the existing and reference aquatic and native fisheries habitat conditions?

Outcome

Identify and determine existing and reference conditions for both aquatic and fisheries habitat.

Key Question

What are the relative abundance and/or distribution of native and non-native fish and macro invertebrates in the watershed? What management practices might be considered to improve species distribution and aquatic habitat conditions?

Outcome

Determine the type of fish and aquatic macro invertebrates present and where they are found. Identify possible management practices or BMP's that could be considered to improve fish distribution and aquatic habitat.

Issue #4: Health and Recovery of Upland Vegetation

Key Question

What are the vegetation types and how do they differ from reference conditions?

Outcome

Identify, describe and compare the existing and potential vegetative types based on the TES.

Key Question

How have past and current grazing practices affected vegetative composition, diversity and productivity and what management practices or BMP's could be considered to help in vegetative recovery?

Outcome

Describe processes relating to grazing strategy and their affect on vegetative condition. Identify possible management practices or BMP's that could be considered to improve vegetative recovery.

Issue #5: Human Impacts to Riparian Areas (Recreation, Grazing, OHV Activity)

Key Question

What are the human impacts that have the most impact on the soil, riparian and aquatic systems in the watershed?

Outcome

Identify the human impacts having the most impact to soil, riparian and aquatic systems.

Key Question

What possible management practices or BMP's might be considered to mitigate the impact of human uses on the soil, riparian and aquatic systems in the watershed?

Outcome

Identify and recommend possible management practices or BMP's that could mitigate human impacts on the soil, riparian and aquatic systems in the watershed.

Issue #7: Road and Stream Connectivity and Potential Sediment and Water Delivery to Fisheries and Aquatic Habitat *(This issue is analyzed in the Roads Analysis located in Appendix A)*

Issue #8: Soil Condition, Erosion, Compaction, Nutrient Cycling, Reduction of Soil Productivity, Hydrological and Watershed Condition

Key Question

What are the existing and reference soil conditions in the watershed?

What erosional processes are occurring? Are there areas with high levels of soil compaction? Are there areas where nutrient cycling and soil productivity is impaired or reduced that may require improved management?

Outcome

Determine existing soil condition by evaluating the three primary soil functions: soil hydrologic function, soil stability and nutrient cycling.

Key Question

Is the soil functioning within its inherent physical and biological capability? Has a loss of soil function occurred? Does the soil have the ability to maintain resource values, sustain outputs or recover from impacts?

Outcome

Assess soil function processes and capabilities. Identify areas with unsatisfactory and impaired soil condition that require improved management activities.

Key Question

What is the soils sensitivity to erosion and how does it affect water quality and soil productivity? Are there areas with highly erosive soils that may contribute to increased risk of sedimentation to perennial streams?

Outcome

Identify soils with high erosion hazard and describe the processes that may affect water quality and soil productivity. Identify soils with high erosion hazard connected to a road that crosses a perennial stream within ¼ mile. This will be analyzed in the roads analysis

Key Question

What is the overall watershed condition?

Outcome

Determine the state of the watershed by comparing the physical, and biological characteristics and processes affecting hydrologic and soil functions. These biophysical characteristics include riparian, aquatic and soil conditions.

CHAPTER 3 – CURRENT CONDITIONS

This chapter describes the current conditions of the various biophysical elements and human uses in the watershed relevant to the identified issues and key questions described in Chapter 2. The information provided here will provide a more detailed analysis of the watershed than did the characterization given in Chapter 1.

Current Water Quality Conditions

Water quality is assessed using the Arizona Department of Environmental Quality (ADEQ), The status of water quality in Arizona – Clean Water Act Section 305(b) report 2000, EQR-00-03 and the 2002 ADEQ Surface Water Assessments, Impaired Waters, 303 (d) List Submission, and the Planning List Draft. Both the 2000 and 2002 reports are included in this assessment because significant differences occur in the evaluation protocol. Interpretations and recommendations are based on both reports.

The Arizona Department of Environmental Quality (ADEQ) prepares a biennial Arizona Water Quality Assessment. This report fulfills requirements under the federal Clean Water Act of 1987, section 305(b). In fulfilling these requirements, the 305(b) report includes such elements as water quality condition, water pollutants, and designated uses. The information provided in the report is based on accepted numeric and narrative standards, and assessment criteria.

Surface waters are classified with "designated use" identifiers, the "designated uses" are: aquatic and wildlife, full body contact, partial body contact, fish consumption, domestic water source, agriculture irrigation, and agriculture livestock watering. As part of a biocriteria evaluation, ADEQ uses a macro invertebrate-based bioassessment to evaluate the health of aquatic communities. These bioassessments are generally used as supporting evidence of impairment or good quality water.

Summary of ADEQ 2000 305 (b) Report:
Water quality assessments were completed for all reaches within and adjacent to the Coconino and Prescott National Forests for the Verde River, Fossil Creek, and West Clear Creek. Much of the Verde River was listed as water quality limited in past 305 (b) reports due to turbidity and arsenic (ADEQ 1998). The 2000 305 (b) Report has listed the portion of the Verde River in the 5th code watershed as in "full use support".

The aforementioned elements, from the State's 305(b) report, were used to aid in the evaluation of the affected stream courses associated with the watershed. A very brief summation of the 2000 305(b) report is presented below for fixed stations.

- Verde River (West Clear Creek to Fossil Creek), AZ15060203-025, is in full support of designated uses; warmwater fisheries due to change in arsenic standard. Turbidity standards exceeded in only 4 of 41 samples; therefore, in full support with designated used (<10% exceedence). 1995 macro invertebrate collections resulted in a "good" bioassessment rating. This reach has been identified as impaired for turbidity since the 1994 303 (d) list. Old and new data indicate this turbidity is not impairing designated uses. ADEQ recommends to delist this reach on the 2002 303 (d) list. In 2000, the Prescott and Coconino National Forests recommended to ADEQ, not to delist the Verde River because continued valley growth is expected to put added pressure and impacts to the river.

The bioassessment data are a measure of the aquatic and warmwater fishery designated use support and uses the Index of Biological Integrity. The macro invertebrate data indicates that the macro invertebrate community in this reach is healthy.

- Fossil Creek (headwaters to Verde River, 20 miles), AZ15060203-024) is in full support of designated uses; warmwater fisheries; no bioassessment data taken.

- Stehr Lake (21 acres), AZL15060202-1480, is in full support and monitored as part of the Clean Lakes Program 1996-1997. It is mesotrophic.

Table 3, 2002 ADEQ Surface Water Assessments, Impaired Waters, 303 (d) List Submission, and the Planning List

ADEQ 2002 Draft Assessment, Planning List, and 303 (d) Status Table 2 – Verde River - Fossil Creek Planning Area				
2002 Assessment Planning List & Designated Uses			303 (d) List	
Waterbody Name Segment Description Size Waterbody ID	Assessment 5-Past Listing Lake Trophic Status	Pollutants of Concern (Number of Samples Standard Exceeded)	Status of 1998 303 (d) List Pollutants (Designated Use Impaired)	Recommendations for 2002 303 (d) List
Fossil Creek Headwaters- Verde River 20 miles AZ 15060203- 024	A&Ww Inconclusive FC Inconclusive FBC Inconclusive AgL Inconclusive **Part 3 Inconclusive**	Add to Planning List due to insufficient sampling events.		
Verde River Beaver Creek- West Clear Ck. 6 miles AZ 15060203-	A&Ww Attaining FC Attaining FBC Inconclusive	Add to Planning List due to missing core parameter (bacteria).	**Turbidity (A&Ww)** – since 1994. Turbidity TMDL	**Delist Turbidity**. No exceedences in 6 samples. Older turbidity data exceeded standard in

ADEQ 2002 Draft Assessment, Planning List, and 303 (d) Status Table 2 – Verde River - Fossil Creek Planning Area

2002 Assessment Planning List & Designated Uses			303 (d) List	
Waterbody Name Segment Description Size Waterbody ID	Assessment 5-Past Listing Lake Trophic Status	Pollutants of Concern (Number of Samples Standard Exceeded)	Status of 1998 303 (d) List Pollutants (Designated Use Impaired)	Recommendations for 2002 303 (d) List
027	AgL Attaining AGI Attaining **Part 2– Attaining Some Uses**		approved by EPA in 2002.	only 3 samples out of 22. Both old and new data show that turbidity is not impairing designated uses.
Verde River W. Clear Ck.-Fossil Creek 24 miles AZ 15060203-025	A&Ww Inconclusive FC Attaining FBC Inconclusive AgL Attaining AGI Attaining **Part 2– Attaining Some Uses**	Add to Planning List due to: 1. Turbidity standard exceeded in 4 out of 9 samples. 2. Escherichia coli standard exceeded in 1 of 9 samples.		
West Clear Creek Headwaters-Verde River 65 miles AZ 15060203-026	A&Ww Attaining FC Attaining FBC Inconclusive AgL Attaining **Part 2– Attaining Some Uses**	Add to Planning List due to missing core parameter (bacteria).		
Stehr Lake 20 acres AZL 15060203-1480	A&Ww Inconclusive FC Attaining FBC Inconclusive AgL Attaining **Part 2– Attaining Some Uses** Trophic status not calculated	Add to Planning List due to missing bacteria samples. Note that decommissioning Fossil Ck. power plant, dam and flumes will result in loss of water to lake.		

Water Quality Assessments

Each designated use is assessed as follows:

Attaining – All surface water quality standards are being met based on a minimum of 3 monitoring events that provide seasonal representation and core parametric coverage.

Threatened – A surface water quality standard is currently being met, but a trend analysis indicates that the surface water is likely to be impaired before next assessment.

Impaired – A surface water quality standard is not being met based on sufficient number of samples to meet the test of impairment identified in the Impaired Waters Identification Rule.

Not Attaining – A designated use would be assessed as "impaired" except that a TMDL does not need to be completed form on of the following 3 reasons:

A. A TMDL has already been completed and approved by EPA.
B. Other pollution control requirements are reasonably expected to result in the attainment of standards by the next listing cycle.
C. The impairment is not related to a "pollutant" loading, but is caused by "pollution" (e.g. hydrologic modification).

Assessing the Surface Water

The individual designated use assessments are combined to provide an assessment of the surface water and each surface water is placed on one part of the 5-part assessment list as follows:

Attaining – A) All designated uses are assessed as "attaining" or B) At least one designated use is assessed as "attaining" **(Part 1)** and others are assessed as "inconclusive" or "threatened" **(Part 2)**.

Inconclusive – All designated used are assessed as "inconclusive" **(Part 3)**.

Not Attaining – One or more designated uses are assessed as "not attaining" and none are assesses as "impaired" **(Part 4)**.

Impaired – One or more designated uses is assessed as "impaired" **(Part 5).**

Not Assessed – Existing data is limited to one sample or data did not meet credible data requirements. In these cases, an assessment is not attempted and the surface water is added to the "Planning List: If standards were exceeded, the surface water and the parameters of concern are shown on table as **(Part 3).**

Designated Uses

Designated uses are specified form stream segments and lakes in the surface water rules (A>A>C> R18-11-104 and 105). Arizona's designated uses include:

Aquatic and Wildlife
Coldwater Fishery (A&Wc)
Warmwater Fishery (A&Ww)
Ephemeral Stream (A&We)

Full Body Contact (FBC) (i.e., swimming)
(AgL)
Partial Body Contact (PBC) (i.e., non-swimming recreation)

Fish Consumption (FC)

Domestic Water Source (DWS)

Agricultural Livestock (Agl)

Agricultural Livestock Watering

Core Parametric Coverage

The following parameters must have been monitored to assess a designated use as "attaining".

Aquatic and Wildlife: Dissolved oxygen, flow (if a stream) and depth (if a lake), pH, turbidity, total nitrogen[1], metals[2] (specifically dissolved copper, cadmium, chromium, and zinc) and hardness.

Fish Consumption: Metals[2] (specifically total mercury)

Full/Partial Body Contact: *Escherichia coli* (if FBC), pH, metals[2] (specifically total arsenic, beryllium, manganese).

Domestic Water Source: Nitrate/nitrite or nitrate, pH, fluorine (fluoride) and metals[2] (specifically total arsenic and barium).

Agriculture Irrigation: Boron, pH, and metals[2] (specifically total manganese).

Agriculture Livestock **Watering:** Metals[2] **(**specifically total copper and lead) and pH.

1. Nitrogen is required only in surface waters with nutrient standards.
2. Metals are required only at sites with current or historic mining activities in the drainage area.

Summary of Water Quality Conditions:

Aquatic Condition - Based on available ADEQ data from the **2000 305 (b)** report for Fossil Creek, West Clear Creek, Stehr Lake and portions of the Verde River in the 5th code watershed, we found aquatic conditions **to fully support designated uses** and where measured (Verde River) to have healthy macro invertebrate communities.

The Verde River reach identified as Beaver Creek to West Clear Creek was identified as impaired due to turbidity for warm water fisheries **(A&Ww)** in the 1994 EPA 303 (d) list. This reach was later recommended to be taken off of the 2002 303 (d) list due to new data show that turbidity is not impairing designated uses.

Based on the **draft 2002 ADEQ report** (assessment Planning List), affected reaches of the Verde River, West Clear Creek and Stehr Lake are inconclusive for one or more designated uses and are **attaining some uses** meaning limited data is available to formally list these reaches or assess them as attaining. These reaches will be added to the Planning List and further studied. All 4 reaches and Stehr Lake were inconclusive for Full Body Contact.

The affected Fossil Creek reach (headwaters to Verde River) is inconclusive for all designated used and therefore, not formally listed. This 20 miles reach will be added to the Planning List due to insufficient sampling events and further studied.

Current Riparian Areas and Functional Condition

Verde River

The Verde River originates in Big Chino Wash, north of Prescott, Arizona, at the confluence of Chino Wash and Granite Creek. The Verde River is a major tributary of the Salt River and serves the agricultural, recreational and drinking water needs of communities along the river including Camp Verde and ultimately, the Phoenix metropolitan area. The river flows for about 32 miles in a south-to-south easterly direction through the watershed. About 3.5 miles are located within Private lands in and adjacent to Camp Verde. The Verde River is free flowing through the watershed before being impounded by Horseshoe reservoir downstream of the watershed boundary. Chino Wash is a major source of fine-grained sediments (silt<2mm) while Granite Creek is considered a major contributor of coarse-grained sediments into the river (Girard, 2001).

The Verde River provides fish and wildlife habitat and recreational opportunities. It has been identified in the Department of Interior's National Rivers Inventory as one of the Nation's most significant free flowing rivers (Monroe, 2000).

The US Fish and Wildlife Service (USFWS) has designated the riparian corridor throughout the watershed as a Category 1 Resource. In accordance with this policy, the river is considered to be of high value for wildlife species and unique and irreplaceable on a national basis. In addition, the USFW mitigation policy indicates that no loss of existing habitat value is acceptable in areas within this category.

In 1984, 39.5 miles of the Verde River below Beasley Flat was designated as Wild and Scenic under authority of the 1968 Wild and Scenic Rivers Act. In 1991, American Rivers named the Verde River one of the 15 highly threatened rivers in the US.

Fossil Creek

Fossil Creek is a major perennial tributary to the Verde River, draining southwest from the Mogollon Rim between the major sub-basins of the East Verde River to the south and West Clear Creek to the north. Elevations at the Mogollon Rim are near 7,000 feet, and Fossil Creek enters the Verde River at an elevation of 2550 feet. Perennial flow arises from Fossil Springs at an elevation of 4,280 feet, and courses for 14.3 stream miles to the Verde River. In addition, there are several small springs above and below the Irving Hydroelectric Plant that produce minor flows. The lower stream and adjacent drainage lie within the Mazatzal Wilderness, an area dominated by remote, steep-canyon terrain. Virtually the entire Fossil Creek drainage area is public land under management by the Forest Service (USDI 2002).

Fossil Springs consists of a series of at least 7 major springs that emerge from the north stream bank and valley wall along a reach approximately 900 feet in length (Monroe 2000 in USDI 2002). This spring outflow contributes a constant base flow of approximately 43 cubic feet per second (cfs). Storm runoff and snowmelt from surrounding mountains can contribute to flows in excess of base flow throughout much of the winter and spring seasons. Intense, but brief and localized summer monsoon rainstorms produce infrequent, large volumes of runoff within the watershed that generates flashy flows and flooding. Significant floods that overflow the low flow channel and transport substantial quantities of sediment occur about every other year (Arizona Public Service 1998 in USDI 2002). Floods in excess of a 5-year recurrence have high peak flow velocities capable of transporting cobbles, small boulders and woody debris. Under current watershed conditions, the estimated peak flow of the 100-year flood event is approximately 13,530 cfs at Fossil Springs (Loomis 1994 in USDI 2002). However, Schlinger et al (2002) estimated a 100-year flood of 6743 cfs using the more current HEC-HMS model.

Most of the base flow is currently diverted by the Childs-Irving Hydroelectric Project at the Fossil Springs diversion dam, approximately 14 miles upstream from the Fossil Creek / Verde River confluence and just below Fossil Springs. The diversion dam (a 25-foot high concrete structure) removes most of the base flow discharged from Fossil Springs, leaving only approximately 1.5 cfs of seepage flow in the 3.8-mile stream reach between the dam and the Irving Power Plant. After passing through the Irving Power Plant, approximately 5.5 cfs of water is returned to the Fossil Creek stream channel, while an estimated 36 cfs of the spring discharge is diverted through another series of flumes and pipes to Stehr Lake, a regulating reservoir for the Childs Power Plant (pers. com. Jack Norman, Red Rock Ranger District). From Stehr Lake, the spring water is piped down to and through the Childs Power Plant and then discharged into the Verde River. The Childs Power Plant is situated adjacent to the Verde River approximately 3.5 miles upstream of the Fossil Creek/Verde River confluence. Flume and power plant maintenance allows for the periodic return of full base flow (~ 43 cfs) to Fossil Creek for short periods of time.

Under natural conditions, the ~ 43 cfs of baseflow discharged from Fossil Springs would account for an estimated 77% of the annual flow volume in Fossil Creek. If the ~ 43 cfs of base flow flowed within the Fossil Creek stream channel, then flood flows would not be considered to provide a significant percentage of the annual flow volume. However, given that the baseflow has been diverted from the Fossil Creek stream channel for the past 86 years, flood flows account for the majority of the annual flow volume. If floods represented 23% of the natural annual flow volume, they now represent 98% of the annual volume in the upper reach and 86% in the lower reaches (below Irving Power Plant) under the existing modified flow regime. In terms of annual flow volumes, Fossil Creek has shifted from a baseflow-dominated system to a flood flow dominated system. In terms of flow energies, the system has shifted from a predominantly stable flow regime, to an unstable flow regime characterized by very low and erosive and high flows (from a paper by T. Cain, former CNF Fisheries Biologist).

Fossil Spring water is saturated with calcium carbonate and dissolved carbon dioxide. Once exposed to the atmosphere, the partial pressure of carbon dioxide in the water equalizes with that of the atmosphere, a process referred to as "outgassing". When and if the carbon dioxide is outgassed, "the pH of the solution goes up and the equilibrium solubility with respects to calcium carbonate goes down. The solution becomes increasingly saturated with respect to calcium carbonate, and if this process continues to the point of supersaturation, precipitation of travertine[1] (calcite: calcium carbonate) will occur." (Mathews 1994) Outgassing of carbon dioxide is enhanced where turbulence is created in the water as it flows over obstructions and channel substrates. Algae also appear to provide a mechanism for outgassing through the consumption of carbon dioxide, and as a possible filter and attachment point for the travertine precipitant (Mathews 1994).

Prior to the diversion of the spring water for hydropower use in 1916, calcium carbonate precipitated out of solution (spring water) to form large travertine dams, terraces, and associated pools within the active channel. Today, only relic deposits remain in the stream channel, most having been lost through erosion from floods. These relic deposits typically exist as tall travertine abutments anchored into the sides of the stream channel. The drastic reduction in the natural baseflow over the last 86 years, and loss of associated travertine dams has rendered Fossil Creek to the scouring effects of flood flows. Exposure to the effects of flood flows has left Fossil Creek with completely altered channel morphology.

Riparian Condition and Definitions:

An important component of the watershed condition is the riparian condition. The 'Riparian Area Survey and Evaluation System' (RASES), (USDA, 1989) is a riparian survey conducted on perennial and intermittent streams within the watershed. This survey is used as baseline data for the current riparian condition assessment. The RASES provides a general description of the potential riparian vegetation and defines riparian reach breaks for both perennial and intermittent streams to be assessed. Also an identification number was developed in RASES for each riparian reach.

The existing riparian condition was assessed using the 'Process for Assessing Proper Functioning Condition for Lotic Systems' (USDI, 1993) and the 'Process for Assessing Proper Functioning Condition for Lentic Systems' (USDI, 1994). Lotic systems are running water systems and assessments will be made on riparian stream reaches as defined by RASES. Lentic systems are for upland springs within the watershed. The functioning condition of riparian-wetland areas is a result of interaction among geology, soil, water, and vegetation. A riparian assessment data sheet was completed in the field for each waterbody (Table 1) and for each spring source (Table 2). The ratings assigned were proper functioning condition (PFC), functional at risk (FAR), or nonfunctional

Existing riparian condition assessments in this report have been completed primarily on the Coconino National Forest with some work completed on the Tonto and the Prescott.

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[1] 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 (Mathews 1994).

Proper Functioning Condition - Riparian-wetland areas are functioning properly when adequate vegetation, landform, or large woody debris is present to dissipate energy associated with high flows, thereby reducing erosion and improving water quality; filter sediment, capture bedload, and aid floodplain development; improve flood-water retention and groundwater recharge; develop root masses that stabilize banks against cutting action; develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and support greater biodiversity.

Functional-At Risk - Riparian-wetland areas that are in functional condition but an existing soil, water, or vegetation attribute makes them susceptible to degradation.

Nonfunctional – Riparian-wetland areas that clearly are not providing adequate vegetation, landform, or large woody debris to dissipate energy associated with high flows and thus are not reducing erosion, improving water quality, etc., as listed above.

Table 3.1 Summary of Riparian Condition Assessments for Lotic Systems.

Waterbody	RASES #	Per/Int	Length/miles	Status
Verde River Private Lands	1506020000A001 1506020300A001 1506020391A001	Perennial	10.4	FAR
Verde River Forest Lands	1506020000A001 and non-mapped reach (3.5 miles)	Perennial	21.5	PFC
Fossil Creek – Reach 5	1506020392A001	Perennial	7.1	PFC
Fossil Creek – Reach 4	1506020392D001	Perennial	2.5	FAR
Fossil Creek – Reach 3	1506020392D002	Perennial	3.4	PFC
Fossil Creek – Reach 2	1506020392D003	Perennial	0.4	PFC
Fossil Creek – Reach 1	1506020392D004	Intermittent	2.6	PFC
Stehr Lake Wash	1506020392A002	Perennial	0.6	PFC
Sally May Wash	1506020392B001	Intermittent	1.1	FAR
L. Boulder Creek	1506020392C001	Intermittent	2.3	FAR
U. Boulder Creek	1506020392C002	Intermittent	1.6	
Mud Tanks Draw	1506020392E001	Intermittent	2.1	
Tin Can Draw	1506020392F001	Intermittent	1.4	
Sandrock Canyon	1506020392G001	Intermittent	3.7	
L. Calf Pen Canyon	1506020392H001	Intermittent	0.75	
U. Calf Pen Canyon	1506020392H002	Intermittent	1.2	
Hardscabble Creek		Intermittent		PFC
Towel Creek		Intermittent		FAR
Hackberry Canyon	1506020394E009	Intermittent		FAR
Sycamore Canyon- Reach above bridge		Intermittent		PFC

Sycamore Canyon-Reach below bridge		Intermittent		PFC
Total Miles Assessed			62.65	

Narrative Summary of Lotic Systems –

88.5 miles of lotic riparian areas are mapped and identified by the Riparian Area and Evaluation Survey (RASES) in the watershed (see Figure 2 below). About 62 .7 miles have been evaluated with the PFC assessment protocol including information gatherered from the Coconino National Forest and the Prescott National Forest (Watershed Condition Assessment for Select Verde River 5th Code Watershed, 4/30/30) and the (Verde River TMDL for Turbidity, ADEQ, January 2001).

The majority of assessed reaches rated out in proper functioning condition followed by functional at risk. All the reaches of Fossil Creek met the minimum standard of PFC except reach 4. This reach is near the center section of the creek adjacent to roads 807 and 502. The confluences of both Boulder Creek and Sally May Wash are within this reach. Historically this reach has received the most use from both livestock and recreationist. The reach is 'at risk' due to bank disturbance and sediment delivery from adjacent unsatisfactory upland soils.

Boulder Creek, Sally May Wash, and Hackberry Canyon were all rated 'at risk'. They all drain upland basins with high percentages of unsatisfactory soils. As result these drainages have received abnormally high peak flows and sediment delivery. The streams have experienced down-cutting and bank instability. The riparian hardwoods present are typically older with little recruitment.

According to data collected by the Prescott National Forest and documented in the Verde River TMDL For Turbidity, most affected reaches of the Verde River located in Private lands (about 3.5 miles) are functional at risk. Most reaches located on Forest system lands downstream are in PFC since cattle grazing has been removed from riparian areas. Some areas of the Verde River and other remote riparian systems have not been assessed to date for riparian condition.

Figure 2. Fossil Creek – Lower Verde River 5th Code Watershed Riparian Areas and Proper Functioning Condition

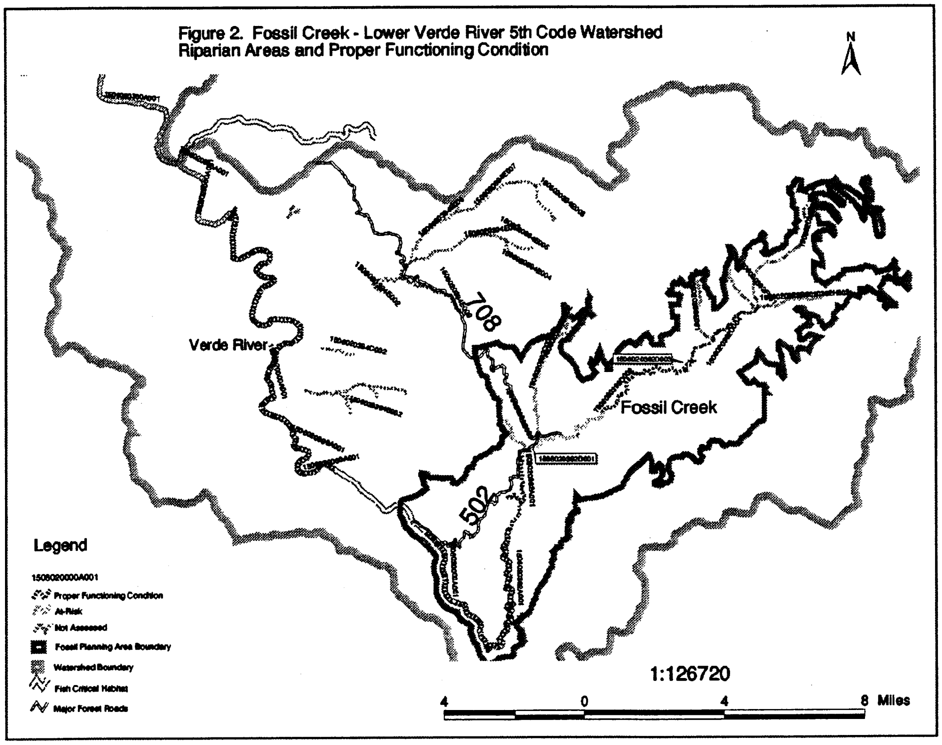


Table 3.2 Summary of Riparian Condition Assessments for Lentic Systems.

Spring Name	Riparian Habitat Area-Est. Acres	Perennial Water	Status
Unnamed (Flume) Springs (2)	Unknown	Unknown	Unknown
Mud Seep	0.5	Yes	PFC
Unnamed (Switchback) Spring	1.0	Yes	PFC
Unnamed (Tank) Springs (2)	0.5	Yes	NF
Unnamed (Irving) Spring	Unknown	Unknown	Unknown
Ed's Point Spring	0.25	Yes	NF
Cimarron Spring-Dry	0	No	NA
Sally May Spring	0.25	Yes	NF
Quail Spring	0.15	Yes	NF
Chalk Spring	0.5	Yes	NF
Shinbone Spring	Unknown	Unknown	Unknown
Kneecap #1 Spring	Unknown	Unknown	Unknown
Kneecap #2 Spring	Unknown	Unknown	Unknown
Unnamed (Childs) Spring-Dry	0	No	NA
Towel Spring-Dry *	0	No	NA
Wet Prong Spring	0.33	Yes	NF
Unnamed (L. Wet Prong) Spring	0.25	Yes	NF
Hackberry Springs (2)	0.5	Yes	FAR
Phroney Spring	0.25	Yes	NF
Dorans Defeat Spring	0.5	Yes	FAR
Willow Spring	0.33	Yes	FAR
Unnamed (Big Willow) Spring	0.5	Yes	NF
Cedar Spring	0.5	Yes	NF
Cottonwood/Mesquite Springs	5.0	Yes	PFC
Unnamed (Gate) Spring-Dry	0	No	NA

* - May not have found source.
NA – Non applicable.

Narrative Summary of Lentic Systems –

The springs listed in Table 2 are in the uplands of the watershed and are not directly associated with the Fossil Creek riparian zone. The Cottonwood/Mesquite springs are the only springs fenced for protection within the watershed and are in PFC. Mud Seep and Unnamed (Switchback) spring are in PFC and appear to not have been grazed in a long period.

There are 13 springs listed subject to livestock use that was rated as 'at risk' or nonfunctional. These springs are small and serve as water sources for livestock. Riparian impacts include riparian vegetation loss from grazing, soil compaction from trampling, degraded water quality, and bank instability and loss from erosion. Fencing for protection would be required to return these spring riparian habitats to proper functioning condition.

Unnamed (Tank), Quail, Chalk, Phroney, and Cedar springs of the above 13 have been developed with head boxes and all are rated as nonfunctional. Their potential riparian habitats have been dewatered and lost in proportion to the water-removed offsite.

There are 4 springs in the Table that were dry at the time of assessment and did not have perennial riparian vegetation present. The source of Towel Spring may not have been found and will be revisited in the future.

There are 5 springs listed as 'unknown' due to lack of data. They have not been assessed to date for riparian condition.

Aquatic and Native Fisheries Habitat Conditions (primarily from Whitney, 2002)

Fisheries Resource - Fossil Creek

Aquatic habitat conditions and the associated fish communities vary along the length of Fossil Creek. Variations in habitat conditions are the result of changes in gradient, stream discharge, and stream channel substrates. The differences in fish species composition is a function of the change in habitat conditions, the influence of the Verde River fishery, and both natural and man-made barriers. Personal observations and information obtained through a 2002 Forest Service stream habitat inventory provide the basis for the descriptions on fish habitat and associated species.

The lower reach has designated critical habitat for loachminnow and spikedace. Currently, loach minnow and spikedace may be extirpated from the Verde River Basin.

Aquatic habitat conditions from the springs downstream to the Fossil Springs diversion dam are fully influenced by, and a function of, the accumulated discharge of the numerous springs. Between the springs and the Fossil Springs diversion dam lies a combination of cobble / small boulder riffles, shallow runs, and moderately deep pools. The fishery consists of three, and only three, native cypriniforms[2]: desert suckers (***Catostomus clarki***), speckled dace (***Rhinichthys osculus***), and headwater chub (***Gila nigra***). All three species have been observed using the three prominent habitat types (run, riffle, pool), where the larger sized chubs are generally found in the pools. **Table 3.3** lists all the native fish known to have occurred, or which currently occupy habitat within Fossil Creek and the associated portion of the Verde River. This table also displays species special status, occurrence within the watershed, and designated critical habitat.

[2] Cypriniform: group of fish within the taxonomic order Cypriniformes that contains the taxonomic families Cyprinidae (minnow, chub, etc.) and Catostomidae (suckers).

From the Fossil Springs diversion dam downstream to the Irving Power Plant habitat conditions change rather dramatically. Diversion of virtually the entire ~43 cfs spring discharge leaves this stretch of Fossil Creek with only seepage flows. Seepage flow is estimated at approximately 1.5 cfs. A 22-foot high bedrock shelf in the stream channel creates a natural barrier (to upstream fish movement) approximately 1.4 miles upstream from the Irving Power Plant. This feature is approximately 2.4 miles downstream from spring diversion dam. Runs and pool / riffle complexes dominate the habitat types between the diversion dam and Irving. Cobble and boulder substrates are the dominant substrates found along the reach between the dam and the natural barrier. Bedrock lines the majority of the stream channel between the barrier and Irving. Historically, prior to the diversion of the spring flow, this length of the creek contained numerous travertine dams that formed very large and deep pool habitats. Today, only remnants of these travertine dams can be seen. Small travertine dams are present just downstream of the diversion dam. A calcite (travertine) layering covers and binds much of the gravel / cobble substrates along this length of creek, but travertine dams are virtually nonexistent. The fish community along this length of the creek is comprised of desert suckers, Sonora sucker (***Catostomus insignis***), headwater chub, speckled dace, and non-native green sunfish (***Lepomis cyanellus***). The natives (suckers, chub, and dace) comprise the greater majority of the fish numbers nearer the diversion dam; whereas, the sunfish are more dominate nearer to Irving.

An estimated 5.5 cfs is returned to the stream channel downstream of the Irving Power Plant. Combined with the ~1.5 cfs seepage flow in the stream channel upstream of the Irving Power Plant, the ~5.5 cfs flow returned from Irving brings the total flow downstream of Irving to ~7 cfs. This increased flow has resulted in the formation of travertine dams from Irving to about three-quarters of a mile downstream of the 708 Road crossing. Some of these travertine dams are three to four feet in height, and all of them form long runs / shallow pools that intermix with low gradient riffles and deep bedrock pools. The stream channel adjacent to the Irving Power Plant contains another bedrock shelf that drops an estimated 14 feet into a large pool below. This bedrock shelf (natural barrier) marks the upstream extension of the non-native smallmouth bass (***Micropterus dolomieui***), and is possibly the transition point between the upstream occurrence of the headwater chub and the downstream occurrence of the roundtail chub (***Gila robusta***). In addition to the bass and chub, the fish community includes the desert and Sonora suckers, and green sunfish. The larger bass, chub, suckers, and sunfish tend to inhabit the calmer waters found in the runs and deeper pools; whereas, the smaller sized bass and the mid to large size classes of the two suckers can typically be found using the riffles. The two suckers also make use of the plunge areas on the downstream side of the travertine dams. Smaller size classes of the native species are not usually found within this length of Fossil Creek.

From that point downstream of 708 Road crossing (mentioned above) to the Verde River confluence, stream habitat types are a mix of runs, riffles, and pools. The riffles tend to be medium to high gradient, and appear to comprise the greater majority of the length of this stretch of the creek. Several sizable pools are found, but only a few exceed depths of greater than six feet. It is suspected that the upstream end of this reach contains a greater abundance of the native fish species than the downstream end nearer the Verde River. The native longfin dace (***Agosia chrysogaster***), and the non-native piscivorous[3] flathead catfish (***Pylodictis olivaris***) and yellow bullhead (***Ameiurus natalis***) were collected during a 1994 through 1996 Arizona Game and Fish Department fish survey near the Verde River confluence (Roberson 1996). Continued existence of the longfin dace is questionable given occupancy by the catfish and bass species.

Table 3.3 - Threatened, Endangered, or Sensitive Fishes

Table 3.3. Threatened, endangered, or sensitive fishes and / or their habitat expected to occur in the Watershed.

Species	Status[1]	Occurrence[2]
Colorado pikeminnow	Endangered, WC, FS-S, T-S	O Experimental, nonessential
razorback sucker	Endangered, WC, FS-S, T-S	O Critical habitat (Verde River)
Gila topminnow	Endangered, WC, FS-S, T-S	H*
loach minnow	Threatened, WC, FS-S, T-S	H* critical habitat
spikedace	Threatened, WC, FS-S, T-S	H* critical habitat
roundtail chub	WC, FS-S, T-S	O
headwater chub	WC, FS-S, T-S	O
longfin dace	T-S, T+	O
desert sucker	T-S, T+	O
Sonora sucker	T-S	O
speckled dace	T-S	O

[1]**Status:**
- **T-S**=Tonto NF Sensitive Species (USFS 2000)
- **T+**=Tonto NF S&G emphasis species (USFS 1985, as amended)
- **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 July 1999)

[2]**Occurrence:**
- **O**=Species known to occur in the project area, or in the general vicinity of the area.
- **H**=Species not known to occur in the project area, but whose suitable or potential habitat does.
- *=Species have historically been known to occur in project area, no recent confirmation of presence.

Verde River and Fisheries Resource

Diversion of the flow from Fossil Springs through the Childs Power Plant augments flow by about 36 cfs in a 3.5-mile reach of the Verde River upstream of its confluence with Fossil Creek. At the nearest stream gauging station (Verde River near Camp Verde, approximately 14 miles upstream of Childs), mean monthly flows are between 84 cfs in June and 1,430 cfs in March. Aquatic habitats found in the Verde River are typically large deep runs with side-channel pools separated by short low to medium gradient riffles. Recent changes in grazing management has allowed encroachment of vegetation into the river resulting in more efficient processing of sediment, which in turn is enhancing diversity and complexity of aquatic habitats. Aquatic habitat at the outflow of the Childs Power Plant, into the Verde River, is diverse and complex. A secondary channel confined between dense banks of emergent vegetation is present, as are shallow

[3] piscivorous: fish-eating

water habitats used for spawning and feeding by the resident fishes. Downstream of the Verde River / Fossil Creek confluence, aquatic habitats are virtually the same as those described above for the river (USDA 2000).

The fish community of the Verde River is dominated by non-natives, which include channel (***Ictalurus punctatus***) and flathead catfish, largemouth (***Micropterus salmoides***) and smallmouth bass, bluegill (***Lepomis macrochirus***), green sunfish, yellow bullhead, common carp (***Cyprinus carpio***), and red shiners (***Cyprinella lutrensis***). The fish assemblage also includes a few native species as well. The native species list includes roundtail chub, Sonora and desert suckers, Colorado pikeminnow (***Ptychocheilus lucius***), and razorback suckers (***Xyrauchen texanus***). Arizona Game and Fish Department has stocked hundreds of pikeminnows and razorbacks, within the vicinity of the Childs Power Plant, over the last several years. In spite of these stockings, these two species comprise only a very small percentage of the overall collection made during monitoring surveys.

Affected reaches of The Verde River in this watershed have designated critical habitat for loachminnow, spikedace and razorback sucker. As with loach minnow, spikedace may be extirpated from the Verde River Basin.

Stehr Lake and Fisheries Resource

Stehr Lake is a regulating reservoir for power generation at the Childs Power Plant on the Verde River. Originally, this reservoir covered 23 surface acres, but through the gradual accumulation of sediment and subsequent eutrophication the reservoir has been reduced to 3 surface acres. Stehr Lake has been stocked with a variety of non-native fish over the years, including channel catfish, largemouth bass, bluegill, redear sunfish (***Lepomis microlophus***), green sunfish, and common carp (pers. comm. from J.Warnecke, AGFD to T.Cain, CNF). Presently, the non-native fishes appear to persist as self-sustaining populations (stocking no longer occurs). Angling pressure is light. Razorback suckers were stocked into Stehr Lake in the early 1980's (USDA 2000). Arizona Game and Fish Department personnel netted two very large razorback suckers from Stehr Lake during an October of 1999 survey.

Aquatic Health – Macroinvertebrates as Indicators

As part of a biocriteria evaluation, ADEQ uses a macro invertebrate-based bioassessment to evaluate the health of aquatic communities. These bioassessments are generally used as supporting evidence of impairment or good quality water.

The presence and/or absence of the macroinvertebrates provide a natural barometer for detecting the health of an aquatic system. Certain aquatic organisms possess a higher tolerance to stressors (water chemistry, siltation, riparian condition) than do others. Where stressors to a system reduce aquatic habitat conditions, then macroinvertebrate species diversity and abundance respond accordingly.

2001/2002 Macroinvertebrate Community in Fossil Creek

In May of 2001, the Forest entered into a Challenge Cost Share Agreement with Dr. Jane Marks of the Biological Department at Northern Arizona University to perform a qualitative sampling of the macroinvertebrate populations in Fossil Creek. In an August 2002 final report, Eric Dinger, M.Sc. and Dr. Marks supplied the following information.

Table 3.4 provides a listing of the sampled habitat areas and their respective seasonal sampling periods. Certain invertebrate taxa were identified as "uncommon", "rare", or "unique" based on the frequency with which particular taxa was present in the combined samples for a specific habitat area (collection site). Invertebrates that were present in less than 10% of the samples were denoted as "uncommon", while those present in less than 5% of the samples were considered "rare". "Unique" taxa are those that occurred in only one specific habitat area. Invertebrate species of concern were identified through the use of the Arizona Game and Fish Department's Heritage Data Management System (HDMS). The HDMS includes species listed under the Endangered Species Act, Bureau of Land Management, U.S. Forest Service, and the Navajo Endangered Species List. The presence of non-insect aquatic invertebrates was also noted.

Table 3.4 - Fossil Creek habitat areas and macroinvertebrate sampling

Table 3.4: Fossil Creek habitat areas and seasonal periods from which macroinvertebrate samples were collected between July 2001 (summer) and June 2002 (spring).

Habitat Area (collection site)	Sampling Period
Ephemeral Pools (upstream of springs)	Summer, Fall, Winter, Spring
Spring Head (springs area)	Summer, Fall, Winter, Spring
Above Dam (Fossil Sprgs Diversion)	Fall, Winter, Spring
Dam Backwaters	Summer
Below Dam	Summer, Fall, Winter, Spring
Above Irving Power Plant	Fall, Winter, Spring
Below Irving Power Plant	Summer, Fall, Winter, Spring
1 KM Below Irving Power Plant	Summer
Confluence Reach (Below Bridge [708 Rd])	Summer
Confluence Reach (At Verde River)	Spring

- Table taken from Dinger and Marks 2002.

A total of 119 separate taxa were identified from all collection sites combined. Nine major orders of aquatic insects (Coleoptera, Diptera, Ephemeroptera, Hemiptera, Lepidoptera, Megaloptera, Odonata, Plecoptera, and Trichoptera) were represented in the taxa. Six non-insect orders (Acarina, Annelida, Amphipoda, Decapoda, Gastropoda, and Ostracoda) were also represented by identified taxa. The taxa with the highest species richness are Coleoptera (beetles), Diptera (flies), Trichoptera (caddisflies), and Hemiptera (true bugs) respectively.

Table 3.5 Aquatic invertebrate summary of species richness, and number of unique, uncommon, rare, and special concern species for all sample sites. Numbers in Parentheses are percent of species richness for that site. Diversity rank is based on Species Richness.

Site	Diversity Rank	Species Richness	Unique Taxa	Uncommon Taxa	Rare Taxa	Special Concern
Ephemeral Pools	4	43	21(49)	4(9)	24(56)	0(0)
Spring Head	4	43	3(7)	6(14)	5(12)	2(5)
Above Dam	5	36	1(3)	7(19)	6(17)	2(6)
Dam Backwaters	8	18	3(17)	2(11)	6(33)	0(0)
Below Dam	1	62	6(10)	11(18)	16(26)	1(2)
Above Irving Power Plant	3	44	3(7)	9(20)	9(20)	1(2)
Below Irving Power Plant	2	51	1(2)	8(16)	10(20)	0(0)
Confluence Reach (1 mi. below bridge)	7	21	0(0)	0(0)	1(5)	0(0)
Confluence Reach (At Verde River)	6	32	4(13)	5(16)	6(19)	1(3)

- Taken from Dinger and Marks 2002.
- Due to similarities in physical habitat and the invertebrate assemblage, the summer sample for the collection site one kilometer downstream of the Irving Power Plant were combined with the "Below Irving Power Plant" sample. Therefore, nine collection sites are shown instead of the ten sites listed in Table 2 (Dinger and Marks 2002).

Summary of Aquatic Health Indicators:

The greatest species diversity was located in the "Below Dam" habitat area (62 species) and in the "Below Irving Power Plant" habitat area (51 species). The lowest species diversity was found in the "Dam Backwaters" (18 species), and the area one mile downstream of the 708 Road Bridge (21 species).

The ephemeral pools, located upstream of the springs, produced the highest number of unique taxa, and contained the highest proportion of uncommon and rare taxa. A winter sampling at one of these ephemeral pools produced one of the only two stoneflies (Plecoptera: *Capnia sp.*) collected from the ten sites. The other stonefly, an unidentifiable member of the Perlodidae Family was collected from the "Above Irving Power Plant" site.

The results of this 2001 / 2002 sampling should be considered preliminary, since invertebrate distribution can vary from season to season, and from year to year.

Preliminary ordination analyses of relative abundance data suggest that most sites have different species composition than each other. More intensive sampling and analysis will be needed to determine the differences in species assemblages and whether there is a seasonal effect on the invertebrate species composition. This recent sampling of Fossil Creek should be considered as baseline information from which to compare future collections.

Summary of ADEQ 2000 305 (b) Report:

Water quality assessments were completed for all reaches within and adjacent to the Coconino and Prescott National Forests for the Verde River, Fossil Creek, and West Clear Creek. A brief summation of macro invertebrate collections of the 2000 305(b) report is presented below for fixed stations.

- Verde River (West Clear Creek to Fossil Creek), AZ15060203-025, is in full support of designated uses; warmwater fisheries due to change in arsenic standard. 1995 macro invertebrate collections resulted in a "good" bioassessment rating.

  The bioassessment data are a measure of the aquatic and warmwater fishery designated use support and uses the Index of Biological Integrity. The macro invertebrate data indicates that the macro invertebrate community in this reach is healthy.

- Fossil Creek (headwaters to Verde River, 20 miles), AZ15060203-024); no bioassessment data taken.

- Stehr Lake (21 acres), AZL15060202-1480, is in full support and monitored as part of the Clean Lakes Program 1996-1997. No bio assessment data was taken.

Upland Vegetation

There are 9 major vegetation types in the watershed (Table 3.6) and are based on aggregations of the TES for each Forest. Tables 3.8, 3.9, and 3.9.5 in Chapter 3 list the vegetation types and accompanying acres by TES ecological unit for each Forest. For a complete description of vegetation species, productivity and ground covers that would be found under the potential natural community (pnc) please refer to the individual Forest TES.

The TES includes current and potential vegetative ground covers, pnc, productivity potentials, current average and potential canopy cover of overstory species, potential canopy cover of shrubs, forbs and graminoids, soil classification and condition, hazards, and limitations for management activities.

TES information published in the manuscript for Coconino National Forest can be found by following the following link, http://alic.arid.arizona.edu/tes/tes.html.

Tables 3.8, 3.9, and 3.95 identify the soil condition of each vegetation type by TES unit. Generally, vegetation types associated with unsatisfactory or impaired soils currently have low species composition, diversity, and productivity relative to their potential natural community (pnc). In addition, effective vegetative ground cover is generally much less than what would be found in the potential natural community and may not be adequate to prevent accelerated sheet, and rill erosion.

Much of the following descriptive information is derived from each Forest TES and general knowledge of the analysis area.

Table 3.6 Vegetation Type, Acreage and Elevational Range

Vegetation Type	Elevational Range	Acreage	Relative Percent
Ponderosa Pine and Mixed Conifer	6375 – 7350 feet	52,215	27.4
Pinyon-Juniper Woodlands	3280 - 6375	87,550	45.6
Juniper Shrubland	3400 - 4800	6414	3.3
Chaparral	3280 - 6000	437	.2
Juniper-Semidesert Grassland Transition	3400 - 4600	10,534	5.5
Semidesert Grassland/Grasslands	3100 - 4100	24,676	12.9
Semidesert and Desert Shrubland	2600 - 3250	1812	1.0
Streamside Vegetation	2550 - 4950	2955	1.5
Riparian Areas	2550 - 4900	2159	1.1
Private and Stehr Lake	NA	2925	1.5

Current Ponderosa Pine and Mixed Conifer Conditions:

Generally, vegetative ground cover (litter and vegetative basal area) is currently adequate to prevent soil erosion and approximates potential natural community (pnc) conditions with the exception of areas identified in TES unit 530. Current tree canopy cover is somewhat higher than under the pnc and understory species composition, diversity and productivity is less than under pnc.

There are only 1266 acres of mixed conifer located on the Tonto National Forest. On the Coconino National Forest, TES unit 555 amounts to 5335 acres and is an association of pondersosa pine type on the south aspects and mixed conifer on the north. These areas are located on steep, inaccessible slopes and have current vegetative conditions near pnc.

Current Pinyon-Juniper Woodlands Conditions:

This vegetation type comprises the largest overall aerial extent (45.6 %) of the watershed. Vegetative ground cover and species composition vary according to slopes and ungulate access. Slopes greater than about 40 – 50 % have higher vegetative ground cover, and higher species composition, diversity and productivity than lesser slopes probably due to the inaccessibility to grazing ungulates. These slopes tend to have somewhat lower canopy covers of pinyon that what would be expected in the pnc. On slopes less than about 40 %, understory species composition, diversity and productivity is generally less than under pnc.

Consequently, slopes less than about 40 % are susceptible to accelerated erosion and loss of soil and vegetative productivity. Canopy cover varies but in general, approximates the pnc.

Current Juniper Shrublands Conditions:

This vegetation type is usually found on shallow soils (less than 20 inches to bedrock) or steep slopes. There is a high percentage of chaparral species including evergreen oaks and mountain mahogany and relatively low percentage of canopy cover of pinyon-juniper. See the Forest TES for information on current ground and overstory covers.

Current Chaparral Conditions:

Only .2 % of the watershed falls into this vegetative type. It is usually found on slopes grater than about 40 % and on soils less than about 20 inches to bedrock. This type has evolved under recurrent fire regimes and is necessary to maintain the chaparral character of the vegetation.

This type is similar to the Juniper Shrublands type except it is dominated by evergreen oaks, mountain mahogany and other shrubs and usually does not have more than 1-5 % canopy cover of pinyon or juniper. Vegetative ground cover usually approximates pnc. Species composition, diversity and productivity vary but generally are less than under pnc.

Current Juniper-Semidesert Grassland Transition Conditions:

his vegetation type exists in the ecotone between pinyon-juniper woodlands and semidesert grasslands. It is characterized by low canopy coverage of juniper and shrubs with variable grass and forb understory depending on level of disturbance. The majority of this type has been subject to high levels of historic grazing and is still grazed today. Most areas have unsatisfactory soil conditions as a result of ungulate grazing.

Consequently, vegetative ground cover has been reduced resulting in current and potential accelerated erosion and loss of soil and vegetative productivity.

Current vegetative ground cover, species composition, diversity and productivity are generally much less than what would be predicted in the pnc.

Current Semidesert Grassland and Other Grasslands Conditions:

Grassland types occupy 12.9 % of the watershed. The majority are semidesert grasslands but this category includes 1257 acres of converted grassland on the Coconino National Forest (TES unit 466) and 2528 acres of Juniper Savannah on the Tonto national Forest (TES unit 4140).

This type is characterized by low canopy cover of shrubs (5 – 25 %) and a variable understory comprised of perennial and annual grasses and forbs.

Vegetative conditions vary but generally; vegetative ground cover, species composition, diversity and productivity are less than what would be predicted in the pnc. The majority of this type has been subject to high levels of historic grazing and is grazed today. Consequently, vegetative ground cover has been reduced resulting in current and potential accelerated erosion and loss of soil and vegetative productivity.

Current Semidesert and Desert Shrublands Conditions:

This vegetation type occupies only 1% of the watershed. The majority occurs on the Tonto National Forest and is characterized by steep slopes greater than 40 % with inherently unstable soils. South aspects are dominated by Sonoran Desert species including giant Saguaro and paloverde. Vegetative ground cover, species composition, diversity and productivity are about what would be predicted in the pnc.

Desert Shrublands on the Coconino fall into TES unit 280 and are characterized by high canopy cover of creosotebush. High levels of historic grazing has reduced vegetative ground cover, species composition, diversity and soil productivity resulting in accelerated erosion and loss of soil and vegetative productivity.

Current Streamside and Riparian Area Conditions:

Although this vegetation type only occupies about 2.6% of the watershed, the vegetation and water present serve as very important corridors and lifelines for wildlife and fisheries habitat. The Streamside vegetation type does not have species associated with riparian areas but it is located in drainageways or on valley alluvium subject to flooding. Riparian areas include obligate plant species requiring water for growth and reproduction.

Fossil Creek has high vegetative species diversity, but in accessible areas, is even-aged and lacks seedling, sapling and pole sized cottonwood, willow, and Arizona Sycamore that would be present in the pnc. The Verde River has recently been excluded from grazing for the most part and is beginning to recruit cottonwood and willow seedlings and other riparian species.

Human Uses and Impacts

Recreation -

The outstanding scenery, abundant wildlife, and perennial water offered by Fossil Creek have created a demand for recreation in the area. However, there is a lack of management presence, basic recreation facilities, and public information and interpretation in key locations. Length of stay regulations and capacities are routinely exceeded at the Childs Campground on the Verde River. Hunting for turkey, elk, javelina, and deer is popular throughout the area. Difficult road access and creek access is perhaps the only factor that presently limits the numbers of recreationists.

12.8 miles of user-created road are located in the Fossil Creek drainage area alone resulting in numerous dispersed campsites. Many of these roads are in and along riparian areas. Dispersed sites have been mapped by the Coconino National Forest with GPS, and range from low to high impact. Dispersed camping along middle reaches of Fossil Creek, have denuded and compacted soils adjacent to Fossil Creek and created avenues for increased and concentrated water flow and sedimentation into Fossil Creek. Reaches above and below that stretch show light impacts from recreation. Accessible areas along the middle Fossil Creek reach between Irving and Stehr Lake tend to be the most highly impacted as a result of concentrated recreation use stemming from fuelwood gathering, soil rutting and scarification from off-road vehicles, human waste and litter.

The Childs area currently has a developed campground located adjacent to the Verde River and a hot springs. Recreation use has similarly impacted floodplains and riparian area habitat on the Verde River near Childs.

Fossil Springs and the Mazatzal Wilderness Area provide trailheads for day and backcountry hiking. Fossil Springs flows at about 43 cfs and is rich in CaCo3 forming unique travertine deposits downstream. Trail access to the springs is currently provided from the Childs area.

Current Grazing Strategy and Impacts

Current grazing strategy and related information is contained in the individual Allotment Management Plans and related Environmental Assessments to reauthorize grazing permits.

Verde River Access:

Livestock grazing has not been permitted on almost all of the Verde River for the past 6 years, and longer on some allotments. There are small areas where grazing continues and efforts are underway to limit access to the river by the installation of additional fences and cattleguards. Several livestock exclosures or riparian pasture fences have been built on major tributaries to the Verde River. The objectives of these fences and pastures are to eliminate livestock grazing from the riparian area, or to control the season of use to more effectively improve vegetation and soil condition. Streams where this management strategy has been implemented and should cumulatively improve riparian and aquatic habitat in the Verde River include, Oak Creek, West Clear Creek, Wet Beaver Creek, Copper Canyon Creek, Spring Creek and the Verde River.

Fossil Creek Planning Area:

Several allotments and numerous pastures exist in the planning area. Upland conditions on slopes less than 30 percent are degraded as a result of loss of effective ground cover, species composition changes, extent of bare and compacted soil and increase in runoff during storm events. This has impaired upland soils and impaired several tributaries that feed into the middle stretch of Fossil Creek.

Cattle gather on flat terraces adjacent to Fossil Creek. These same terraces are used by dispersed campers and also contain the remains of prehistoric ruins.

Cattle gather at and drink from natural springs. This has denuded riparian vegetation and affected invertebrates, amphibians and mammals. Some cattle tanks contain populations of Chiricahua Leapard frogs, which will soon be listed as Threatened and are potentially impacted by grazing practices.

Cattle currently get water from some leaky spots and flume releases along the APS flume and the flume road is used as a cattle drive. The water sources will no longer be available once decommissioning of the Irving Power Plant occurs.

Existing Soil, Hydrological and Watershed Condition

Overall watershed condition is based on evaluation of the soil, aquatic and riparian systems as prescribed by the watershed classes defined in Forest Service Manual 2520. A description of watershed condition and classes are found in Forest Service Manual 2520 (USDA 2000):

TES soils information published in the manuscript for Coconino National Forest can be found by following the following link, http://alic.arid.arizona.edu/tes/tes.html.

Soil Condition

An important component of watershed condition is soil condition. The Terrestrial Ecosystem Survey (TES) for the Coconino National Forest (USDA, 1995) and the Tonto National Forest were the basis for our soil condition assessment (USDA, 1985). The soil condition ratings are based on interpretations of the three primary soil functions: soil hydrologic function, soil stability and nutrient cycling. The Coconino and Tonto National Forests TES based soil condition primarily on quantitative on-site erosion rates (stability) measured and predicted by the Universal Soil Loss Equation, (USLE). Since its publication in 1995, a new approved soil condition protocol was developed in R3 (FSH 2509.18-99-1) assessing three soil functions including the ability of the soil to resist erosion, infiltrate water and recycle nutrients. Due to a lack of newer data, the assessment used in this analysis is based primarily on the ability of the soil to resist erosion, however, numerous refined on-site soil condition assessments were made primarily on slopes of less than 40 percent on the Coconino National Forest. On the Tonto National Forest, no on-site soil condition assessments were made and soil condition classes are based primarily on soil stability as predicted by the USLE, and professional judgment of the Forest Soil Scientist Norm Ambos.

Erosion and its consequence, sedimentation, are generally considered to be the number one problem associated with watershed management (Drinking Water from Forests and Grasslands, George E. Dissmeyer, GTR SRS-39, September, 2000).

The watershed project area encompasses acreage from the Coconino, Tonto and Prescott National Forests. Therefore, this report combines TES mapping from all forests. On the Coconino National Forest, we make one soil condition call per TES map unit except on map units 33 and 46 located in riparian areas where a dual class is used. In multi-component TES units (complexes) we used the more limiting component (in a reduced soil condition class) if the aerial percentage was 30 percent or more. The Tonto National Forest used dual classes where soil map unit design indicated more than one soil condition class exists.

A map unit is a collection of areas defined and named in terms of their soil/vegetation/climate components. Each map unit differs in some respects from all others in a survey but is comprised of each major component identified in the map unit legend. Soil condition may vary within the same map unit across the landscape due to differences in disturbance. It is important to recognize that the TES mapped ecological units across the landscape in a rather broad-brush approach. On-site investigation is recommended to validate soil condition or rate soil condition including all three-soil functions on a large-scale (small acreage basis).

Definitions:

Unsatisfactory: Indicators signify that a loss of soil function has occurred. Degradation of vital soil functions result in the inability of the soil to maintain resource values, sustain outputs or recover from impacts. Unsatisfactory soils are candidates for improved management practices or restoration designed to recover soil functions.

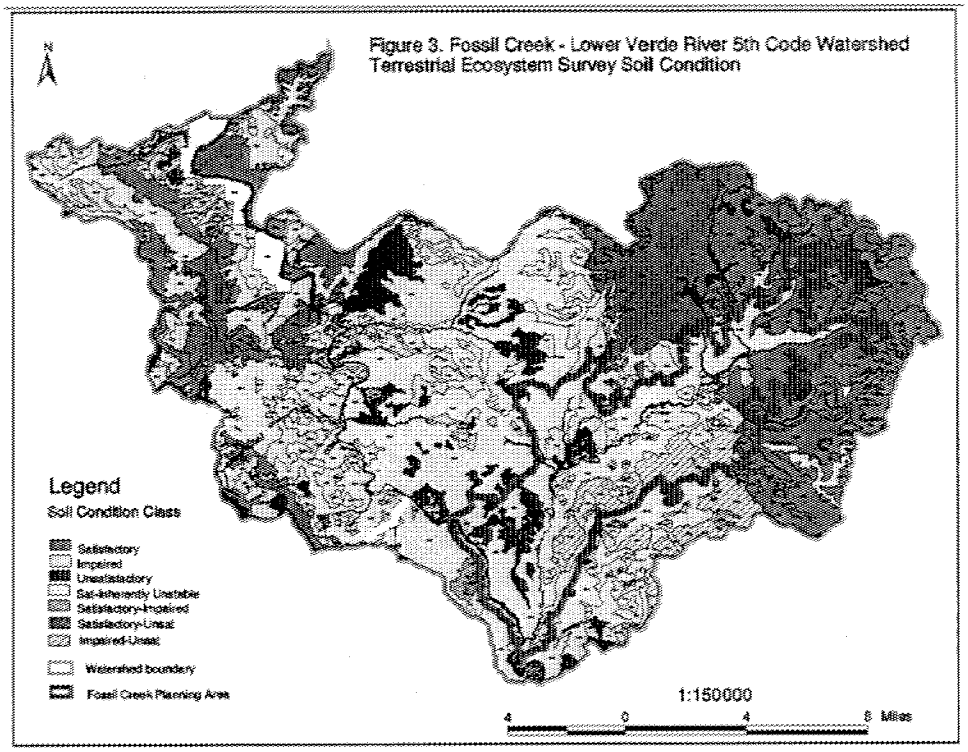
Impaired: Indicators signify a reduction in soil function. The ability of the soil to function properly and normally has been reduced and/or there exists an increased vulnerability to degradation. An impaired category indicates there is a need to investigate the ecosystem to determine the cause and degree of decline in soil functions. Changes in land management practices or other preventative measures may be appropriate.

Satisfactory: Indicators signify that soil function is being sustained and soil is functioning properly and normally. The ability of the soil to maintain resource values and sustain outputs is high

Table 3.7 - Soil Conditions Ratings in the Watershed

Table 3.7 Soil Condition in the Watershed		
Soil Condition Class	**Acres**	**Relative Percent**
Satisfactory	59,710	31.1
Satisfactory – Inherently Unstable	65,679	34.2
Satisfactory and Impaired	883	.5
Satisfactory and Unsatisfactory	1686	.9
Impaired	41,904	21.9
Impaired and Unsatisfactory	6666	3.5
Unsatisfactory	12,224	6.4
Private Lands	2897	1.5
Stehr Lake	28	< .02
TOTAL % (Acres):	191,677	100
See Figure 3 below for a layout of the soil condition class coverage by TES mapping unit within the watershed.		

Figure 3. Fossil Creek – Lower Verde River 5th Code Watershed Terrestrial Ecosystem Survey Soil Condition



Unsatisfactory Soil Condition

Table 3.8, 3.9, and 3.95 below lists soil condition by TES map units for each Forest.

Most of these soils are in accessible areas subject to grazing. Most of these soils have current erosion exceeding tolerable limits and overall amount to 12,224 or 6.4 percent of the watershed. A few soils are unsatisfactory as indicated by compacted soil surface horizons as a result of recreation and grazing impacts. Most of these soils are located in juniper-grassland transition zones. Indicators signify that a loss of soil function has occurred.

Most identified unsatisfactory soils result from high levels of historic grazing pressure and continued grazing probably beyond the carrying capacity of the land. Past grazing practices have contributed to accelerated erosion with detachment and transport of sediment resulting in a reduction of long-term soil productivity. A decrease in long-term soil productivity does not necessarily equate to sediment delivery into nearby drainage systems or downstream into areas of loachminnow and spinedace designated critical habitat. However, some sediment may be transported into ephemeral and intermittent streams, eventually connecting to perennial streams. Much of the sediment is redeposited on the uplands before reaching any drainage system and cannot be equated to sedimentation. The USLE is not intended to be a tool to determine sediment yield and delivery into streams. Sedimentation is a natural product of forestland, where in proper amounts, is essential to the well being of stream ecosystems. It provides a rooting medium for aquatic plants, spawning gravel for fish, shelter for small aquatic plants, and conveys nutrients into streams necessary by all biota (Patric 1982).

The Tonto National Forest identified a few areas with unsatisfactory soils in areas of designated critical habitat for loachminnow and spikedace adjacent to the Verde River. There are probably no unsatisfactory soils adjacent to Fossil Creek below Stehr Lake due to the inaccessible nature of this reach although no on-site data was collected.

There are small, isolated areas of unsatisfactory soils (TES units 33 and 46) adjacent to Fossil Creek, the Verde River and other perennial streams in the planning area. Where access is favorable to dispersed camping, recreation and grazing, these riparian areas tend to exhibit reduced vegetative ground cover (litter and basal vegetation) and increased soil compaction resulting in accelerated soil erosion and decreased soil productivity.

The northern and central portion of the watershed contains sizeable acreage of unsatisfactory soils. During high intensity storm events, it is possible that these upland areas may deposit sediment into both Sycamore Canyon and Cottonwood Creek neither of which are perennial streams. Another sizeable area with unsatisfactory soils occurs adjacent to Boulder Creek and middle reaches of Fossil Creek. Additional areas occur scattered throughout the watershed and planning area and may contribute a little more sediment downstream than would occur under areas with satisfactory soil condition. Following intense storms, peak flows probably are amplified and *short*-term increases in turbidity probably occurs downstream into areas of perennial streams and loachminnow and spinedace designated critical habitat.

Satisfactory-Inherently Unstable

TES map units 350, 430, 3236, 3339, 3712, 4176, 5368, 5452, 9239, 934, 9459, and 436 are rated as satisfactory-inherently unstable. These soils are located primarily in pinyon-juniper – chaparral vegetation types. These soils have natural erosion exceeding tolerable limits and overall amount to 65,679 acres or 34.2 percent in the planning area. Based on the Universal Soil Loss Equation (USLE) these soils are eroding faster than they are renewing themselves but are functioning properly and normally. Almost all acreage in this class occurs on slopes greater than 40 percent and is located in the central and western portions or the planning area. Due to the predominantly steep nature of the terrain, livestock are forced to graze on accessible areas with slopes ranging from 40 to 60 percent. Past and current grazing pressure in these areas may have caused accelerated soil erosion with a decrease in long-term soil productivity. It is not known how many acres are grazed or if grazing pressure has further impaired these soils.

Limited on-site soil condition refinement on TES map unit 430 indicates steep slopes where livestock access is prohibited generally have vegetative ground cover, and species composition similar to the potential plant community. However, based on estimates as predicted by the USLE, natural erosion rates are higher than tolerable indicating inherently unstable soil condition.

TES mapping includes up to 15 percent of other soils or lesser slopes in to the map unit design. Visual on-site investigations show slopes of less than 40 percent are common and in select areas, may include up to 25 percent of any one TES polygon. These areas typically have slopes ranging from 25 – 40 percent and are located on the footslopes of hills and mountains. These areas probably are not inherently unstable based on erosion as predicted by the USLE. Soil condition may be either unsatisfactory or impaired.

The processes of sediment delivery and effects to perennial streams and areas of designated critical habitat are similar to areas with unsatisfactory soil condition areas.

Impaired

Impaired soils account for about 41,904 acres or 21.9 percent of the watershed. Excessive livestock grazing may compact soil and reduce the soils ability to accept, hold, and infiltrate water. These soils have reduced ability to accept, hold, and release water and are generally caused by ungulate grazing and recreation use. On-site soil condition assessments were made and identified several TES units as impaired. It is not precisely known how many additional acres are impaired or unsatisfactory due to physical compaction or trampling by livestock in the planning area. It is likely that more impaired areas exist but would require additional on-site assessment to accurately display these numbers. Most identified impaired soils result from high levels of historic grazing pressure and continued grazing probably beyond the carrying capacity of the land. There are identified impaired soils adjacent to areas of perennial streams and critical habitat along Fossil Creek, and the Verde River.

Where impaired soils exist, they are found on plains and hillslopes slopes in pinyon-juniper woodlands, juniper-semi-desert grassland transition and semidesert grassland vegetation or creosote vegetation types. Since these soils are found on both flat slopes and moderately steep slopes, surface runoff varies from slow to fast and accelerated peak flows or reduced baseflows vary accordingly. It is unlikely that these soils significantly alter water quantity, and timing of flows sufficient to adversely affect riparian habitat vegetation, and fluvial geomorphology, as long as the streambanks are protected with adequate vegetation to withstand peak flows. Beyer (1997) has concluded that the Verde River is capable of handling sediment (indicating a certain level of stream stability) during large storm events.

Satisfactory Soil Condition

The majority of satisfactory soil conditions occurs in pinyon-juniper or ponderosa pine vegetative types and is commonly grazed on slopes less than about 40 percent. Approximately 59,710 acres or 31.1 percent of the planning area has satisfactory soil condition. Indicators signify that soil function is being sustained and soil is functioning properly and normally. For satisfactory soils, the ability of the soil to maintain resource values and sustain outputs is high.

Satisfactory and Unsatisfactory

Coconino National Forest TES units 33 and 46 are identified in this class and are located in riparian areas. They account for about 1686 acres or .9 percent of the watershed. There are small areas of unsatisfactory soils mixed with satisfactory soils (TES units 33 and 46) adjacent to Fossil Creek, the Verde River and other perennial streams in the planning area. Where access is favorable to dispersed camping, recreation and grazing, these riparian areas tend to exhibit reduced vegetative ground cover (litter and basal vegetation) and increased soil compaction resulting in accelerated soil erosion and decreased soil productivity.

Satisfactory and Impaired

TES map unit 3231 and 4161 on the Tonto National Forest fits this class and is very limited in extent (883 acres or .5 percent). These map units may have 2 major soil components and may have both soil condition classes present. On-site investigation should be conducted to validate the soil condition.

Impaired and Unsatisfactory

TES map units 3710 and 4140 are located on the Tonto National Forest in pinyon-juniper woodlands. This category amounts to about 6666 acres or 3.5 percent of the watershed.

These map units have either two major soil components with distinct soil loss tolerances and erosions rates resulting in impaired and unsatisfactory soil conditions or vary in soil condition throughout their range.

Table 3.8 Soil Condition by TES Map unit – Coconino National Forest

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TES Map unit Symbol	Acreage	Vegetation Type	Soil Condition Class
33	1284	Riparian	Satisfactory & Unsatisfactory
34	2137	Streamside	Satisfactory
45	112	Pinyon-juniper-evergreen oak in drainageways	Satisfactory
46	402	Riparian	Satisfactory & Unsatisfactory
280	1080	Desert Creosotebush	Impaired
350	2661	Semi-desert grassland	Sat. - Inherently Unstable
382	996	Semi-desert grassland	Impaired
383	1324	Semi-desert grassland	Satisfactory
385	1079	Semi-desert grassland	Satisfactory
401	2307	Juniper-semidesert grassland transition	Unsatisfactory
402	1192	Juniper-semidesert grassland transition	Unsatisfactory
403	907	Juniper-semidesert grassland transition	Impaired
404	511	Juniper-semidesert grassland transition	Unsatisfactory
417	668	Juniper-semidesert grassland transition	Impaired
420	4211	Juniper-semidesert grassland transition	Unsatisfactory
430	33,893	Pinyon-juniper-evergreen oak	Sat. - Inherently Unstable
457	257	Pinyon-juniper woodland	Impaired
458	343	Pinyon-juniper woodland	Impaired
462	5322	Pinyon-juniper woodland	Impaired
463	10,208	Pinyon-juniper woodland	Impaired
466	1257	PJ converted grassland	Satisfactory
492	14,032	Pinyon-juniper woodland and PJ converted grassland	Satisfactory
493	1122	Pinyon-juniper woodland	Satisfactory
495	176	Pinyon-juniper woodland	Satisfactory
520	133	Ponderosa pine-pinyon-juniper	Satisfactory

530	1660	Ponderosa pine-juniper-evergreen oak	Unsatisfactory
549	Trace	Ponderosa pine-gambel oak	Satisfactory
550	2732	Ponderosa pine-gambel oak	Satisfactory
555	5335	Mixed conifer	Satisfactory
567	2043	Ponderosa pine-juniper-gambel oak	Satisfactory
572	3866	Ponderosa pine-juniper-evergreen oak	Satisfactory
575	42	Ponderosa pine-gambel oak	Satisfactory
578	1691	Ponderosa pine-juniper-gambel oak	Satisfactory
579	93	Ponderosa pine-juniper-gambel oak	Satisfactory
582	1603	Ponderosa pine-gambel oak	Satisfactory
584	805	Ponderosa pine-gambel oak	Satisfactory
Lake	28		Satisfactory

Table 3.9 Soil Condition by TES Map unit – Tonto National Forest

TES Map unit Symbol	Acreage	Vegetation Type	Soil Condition Class
9	528	Streamside	Unsatisfactory
3050	389	Juniper-semidesert grassland transition	Satisfactory
3187	272	Juniper-semidesert grassland transition	Unsatisfactory
3231	633	Juniper shrubland	Satisfactory and Impaired
3236	3897	Juniper shrubland	Sat. - Inherently Unstable
3306	44	Semi-desert Grassland	Unsatisfactory
3339	3897	Juniper-semidesert grassland transition	Sat. - Inherently Unstable
3520	294	Juniper-semidesert grassland transition	Unsatisfactory
3521	3324	Juniper shrubland	Impaired

3710	4138	Pinyon-juniper woodland	Impaired and Unsatisfactory
3711	2432	Pinyon-juniper woodland	Impaired
3712	840	Pinyon-juniper –evergreen oak woodland	Sat. - Inherently Unstable
3770	126	Pinyon-juniper –evergreen oak woodland	Impaired
4140	2528	Juniper savanna	Impaired and Unsatisfactory
4161	250	Pinyon-juniper –evergreen oak woodland	Satisfactory and Impaired
4176	95	Pinyon-juniper –evergreen oak woodland	Sat. - Inherently Unstable
5250	29	Ponderosa pine-juniper-evergreen oak	Satisfactory
5251	123	Ponderosa pine-juniper-evergreen oak	Satisfactory
5368	10	Ponderosa pine-juniper-evergreen oak	Sat. - Inherently Unstable
5452	36	Ponderosa pine-juniper-evergreen oak	Sat. - Inherently Unstable
5550	4575	Ponderosa pine-juniper-evergreen oak	Satisfactory
5551	2046	Ponderosa pine-juniper-evergreen oak	Satisfactory
6405	1266	Mixed conifer	Satisfactory
9239	2634	Desert and semidesert shrubland	Sat. - Inherently Unstable
9349	8291	Juniper woodland	Sat. - Inherently Unstable
9459	166	Ponderosa pine-juniper-evergreen oak	Sat. - Inherently Unstable

Table 3.95 Soil Condition by TES Map unit – Prescott National Forest

TES Map unit Symbol	Acreage	Vegetation Type	Soil Condition Class
Private Land	2897	Not typed	Not rated
30	30	Riparian	Satisfactory
33	170	Riparian	Satisfactory
34	237	Streamside	Impaired
41	273	Riparian	Impaired
43	53	Streamside	Satisfactory
368	530	Semi-desert grassland	Unsatisfactory

373	446	Semi-desert grassland	Impaired
382	2027	Semi-desert grassland	Impaired
383	1726	Semi-desert grassland	Impaired
402	732	Juniper-semidesert grassland transition	Impaired
427	394	Juniper-semidesert grassland transition	Impaired
429	1850	Juniper shrubland	Impaired
430	12077	Pinyon-juniper – evergreen oak woodland	Satisfactory – Inherently Unstable
431	135	Juniper-semidesert grassland transition	Satisfactory
432	454	Juniper shrubland	Impaired
436	202	Chaparral	Satisfactory – Inherently Unstable
446	293	Pinyon-juniper woodland	Satisfactory
460	3921	Pinyon-juniper woodland	Satisfactory
461	1241	Pinyon-juniper woodland	Impaired
462	3589	Pinyon-juniper woodland	Impaired
464	189	Juniper shrubland	Impaired
466	2644	Pinyon-juniper woodland	Satisfactory
469	1490	Chaparral	Impaired
479	1334	Pinyon-juniper – evergreen oak woodland	Satisfactory
485	412	Pinyon-juniper woodland	Impaired
490	675	Juniper woodland	Unsatisfactory
491	1119	Juniper woodland	Impaired
551	2995	Chaparral	Satisfactory

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Summary of Soil Condition:

Upland soil conditions are variable, with the majority of the areas rating satisfactory – inherently unstable on slopes greater than about 40 percent. Satisfactory and satisfactory – inherently unstable soils account for about 65% of the watershed. Impaired soils account for about 22% and unsatisfactory soils account for about 6% with the remaining 7% in various mixed classes.

Watershed and Hydrologic Condition (Quality, Quantity and Timing of Flows)

Following Forest Service Manual 2520 definition, watershed condition is based on the physical and biological characteristics and processes affecting hydrologic and soil functions.

A description of watershed condition and classes are found in Forest Service Manual 2520 (USDA 2000) and listed below: This watershed assessment describes watershed condition based on evaluation of the soil, aquatic and riparian systems as prescribed by the following watershed classes.

Class I Condition. Watersheds exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. The drainage network is generally stable. Physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems are predominantly functional in terms of supporting beneficial uses.

Class II Condition. Watersheds exhibit moderate geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. Portions of the watershed may exhibit an unstable drainage network. Physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems are at risk in being able to support beneficial uses.

Class III Condition. Watersheds exhibit low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. A majority of the watershed may be unstable. Physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems do not support beneficial uses.

To place an overall state or condition class for the entire watershed is difficult and not very accurate. The physical, chemical and biological conditions of the soil, aquatic and riparian systems vary across the watershed and all three systems are integral in overall watershed condition.

Soil System:

In analyzing summary data for the soil system, it is evident that soil condition varies considerably across the watershed and is more variable than the aquatic and riparian systems.

As was noted in Chapter 3, satisfactory and satisfactory –inherently unstable soils account for about 65% of the watershed. Impaired soils account for about 22% and unsatisfactory soils account for about 6% with the remaining 7% in various mixed classes.

Given this data, it appears as though select areas of the soil system are not functioning within their capability and productivity and resiliency is reduced. Portions of the drainage network are unstable. However, the majority of the watershed has favorable soil conditions and the soil system is functioning within its capability and productivity is maintained. About ¼ of the watershed is functioning in a reduced condition.

Aquatic and Riparian System:
Physical, chemical and biologic conditions of aquatic systems are either inconclusive, or fully support beneficial or designated uses.

For riparian systems assessed, physical and biologic conditions vary from functional at risk to functional on lotic systems and are largely non-functional or functional at-risk for lentic systems.

Watershed Condition Class:
Physical and biologic conditions of the soil and riparian systems are variable throughout the watershed. Given this variability, watershed conditions in any given area range from Class I (predominantly functional with favorable conditions of water flow in terms of water quality, quantity and timing) to Class III (predominantly dysfunctional). The majority of the watershed exhibits moderate to high geomorphic, hydrologic, and biotic integrity relative to its natural potential condition. Portions of the watershed do exhibit unstable drainage networks. The soil, aquatic and riparian systems range from dysfunctional (smallest aerial extent) to predominantly functional (largest acreage extent) with significant areas at risk of being able to support beneficial uses.

Favorable conditions of water flow exist in many portions of the watershed. Many areas probably have increased peak flows and reduced base flows (in comparison to natural levels) following storm events and streams may have increased short-term sedimentation above state water quality standards.

CHAPTER 4 and STEP 4 – REFERENCE CONDITIONS

Water Quality by Reach

Fossil Creek Headwaters - Verde River 20 miles (AZ 15060203-024). ADEQ 2002 305(b) report shows assessment is inconclusive for all designated uses including, Aquatic and Wildlife Coldwater Fishery, Fish Consumption, Full body Contact, and Agricultural Livestock watering due to insufficient sampling events to meet the minimum requirements to assess as attaining all uses.

Affected reaches of the Verde River, West Clear Creek and Stehr are classified as "attaining some uses" due to insufficient samples taken for at least one parameter (see table 3.1).

It is possible that all designated uses are meeting minimum State Water Quality standards but insufficient sampling events have not been met under 2002 ADEQ protocol.

The reference or desired condition is all designated beneficial uses are attaining state Water Quality standards as detailed by the following parameters.

Aquatic and Wildlife: Dissolved oxygen, flow (if a stream) and depth (if a lake), pH, turbidity, total nitrogen[1], metals[2] (specifically dissolved copper, cadmium, chromium, and zinc) and hardness.

Fish Consumption: Metals[2] (specifically total mercury)

Full/Partial Body Contact: *Escherichia coli* (if FBC), pH, metals[2] (specifically total arsenic, beryllium, manganese).

Agriculture Irrigation: Boron, pH, and metals[2] (specifically total manganese).

Agriculture Livestock Watering: Metals[2] (specifically total copper and lead) and pH.

3. Nitrogen is required only in surface waters with nutrient standards.
Metals are required only at sites with current or historic mining activities in the drainage area

Riparian Areas

Riparian areas (lotic and lentic systems), springs and wetlands are functioning properly when adequate vegetation, landform, or large woody debris is present to:

- dissipate stream energy associated with high waterflows, thereby reducing erosion and maintaining or improving water quality
- filter sediment, capture bedload, and aid in floodplain development
- improve flood-water retention and ground water recharge
- develop root masses that stabilize streambanks against cutting action
- develop diverse ponding and channel characteristics to provide the habitat and water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses
- and support greater biodiversity

Aquatic and Native Fisheries Habitat Conditions

Riparian areas and wetlands have developed proper functioning channel characteristics that provide riparian vegetation, water depth, duration, temperature, and substrate necessary to support macroinvertebrates and native fisheries production. Threatened, endangered, or sensitive fishes and/or their habitat expected to occur in the watershed are sustained.

Macroinvertebrate species diversity, abundance, and richness are common to high in their range and the ADEQ biocriteria evaluation is good indicating healthy aquatic systems.

Native fisheries thrive in warmwater fisheries habitats and are self-sustaining.

Upland Vegetation

Assemblages of plant species express the greatest diversity, vigor and productivity of grasses, forbs, shrubs and trees and are sustainable.

Species composition, diversity, productivity and vegetative ground cover approximate what is predicted under the potential natural community for those TES map units aggregated in the vegetative type. Please refer to the individual TES map units and the Forest TES for detailed information on relative percentages.

Human Uses and Impacts

Impacts from developed and dispersed recreation are kept at a minimum and not located directly in or adjacent to riparian areas where connected roads or trails may deliver high amounts of water or sediment to intermittent or perennial streams.

Dispersed campsites are low impact sites with minimal vegetation, soil and site disturbance. Developed recreation sites are located on high stream terraces and uplands not connected to intermittent or perennial streams. Access is provided by Forest level 3 roads.

OHV use is confined to areas outside of riparian zones. User-created roads are not directly connected to intermittent or perennial streams. All other roads have low hydrologic connectivity to streams.

High value, low risk Forest level 1, 2, and 3 roads are maintained to provide safe travel and access to recreational and administrative sites. High value, high-risk roads are maintained to reduce environmental impacts. Low value and high-risk roads are put back into resource production, decommissioned, or improved so as not to cause environmental damage.

Grazing Strategy:

Authorized grazing is within the carrying capacity of the land. Individual Allotment Management Plans and strategies are followed whereas grazing does not reduce vegetative composition, diversity, productivity, vegetative ground cover or compact soils and cause accelerated soil erosion. Please consult individual Allotment Management Plan for detailed information on grazing strategy used.

Grazing along perennial streams only occurs in area not designated as critical and or occupied habitat for any wildlife or fish and only occurs on hardened streambanks whereas not to reduce the proper functioning riparian condition.

Soil, Hydrologic and Watershed Condition

Soil Condition and Productivity:

Indicators signify that soil function is being sustained and soil is functioning properly and normally. The soil has the ability to resist erosion. Soil litter, vascular plants, and biotic crusts provide adequate deterrents for water and wind erosion. The surface A horizon has lost less than about 25% of its thickness and maintains most of the original organic matter before disturbance. Soil hydrology is functioning properly by allowing for unimpaired infiltration of water. The soil has adequate structure, porosity and bulk density. Soil organic matter and litter provide a carbon and energy source for soil, microbes, and nematodes and provide nutrients needed for plant growth and nutrient cycling.

For satisfactory soil, the ability of the soil to maintain resource values and sustain outputs is high. For satisfactory-inherently unstable soils (naturally erodible soils generally on steep slopes), the soil is functioning properly and normally but may not have the ability to sustain high outputs.

Satisfactory and satisfactory-inherently unstable soils remain in that condition. Unsatisfactory and impaired soils are moving towards satisfactory condition. Impaired soils will become satisfactory faster than unsatisfactory soils. A few unsatisfactory soils will probably always remain unsatisfactory because the A horizon has been removed and may be impossible to improve significantly.

Hydrologic and Watershed Condition:

The physical, chemical and biological conditions of the soil, aquatic and riparian systems vary across the watershed and all three systems are present and integral to overall watershed condition.

Reference watershed condition should include a predominance of Class I condition and exhibit high geomorphic, hydrologic, and biotic integrity relative to natural potential conditions. The drainage network is generally stable. Physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems are predominantly functional in terms of supporting beneficial uses.

CHAPTER 5 and STEP 5 and 6 – CHANGES, INTERPRETATION, KEY FINDINGS and MANAGEMENT RECOMMENDTIONS and BEST MANAGEMENT PRACTICES (BMP's)

Water Quality, Riparian and Aquatic Systems and Fisheries

Changes in Water Quality, Aquatics and Fisheries:

Water Quality: Reference condition indicates a desire for all reaches to be attaining beneficial uses. Since most recent data is either fully supporting or inconclusive for existing condition, we cannot identify exact change or differences. However, it appears as though all affected reaches with the exception of Fossil Creek meet State Water Quality Standards for FC, AGL, and AGI, and varies for A& Wc and FBC. Fossil Creek is inconclusive for all beneficial uses.

Aquatic Systems and Fisheries: Bioassessment data from ADEQ are a measure of the aquatic and warmwater fishery designated use support and uses the Index of Biological Integrity. The macro invertebrate data indicates that the macro invertebrate community along the Verde River is healthy providing a healthy aquatic community, and not known for Fossil Creek and Stehr Lake. Therefore, changes cannot be determined.

Non-natives dominate the fish community of the Verde River. In Stehr Lake, non-native fishes appear to persist as self-sustaining populations (stocking no longer occurs).

Aquatic habitat conditions and the associated fish communities vary along the length of Fossil Creek. Above Irving, the creek contains predominantly native fish. Below Irving, non-native species currently predominate.

Interpretations/Key Findings for Water Quality, Aquatic Systems and Fisheries:

Water Quality: The ADEQ 2000 305 (b) report showed all reaches fully support designated uses and where measured (Verde River) to have healthy macro invertebrate communities except the Verde reach from Beaver Creek to West Clear Creek for turbidity. However, interpreting the ADEQ 2002 report, it appears as though all affected reaches with the exception of Fossil Creek are adequately managed to meet State Water Quality standards for the following beneficial uses, FC, AGL, and AGI. Fossil Creek may or may not be currently managed to adequately provide for clean water for identified beneficial uses. Further sampling by ADEQ will be necessary to accurately determine if State Water Quality standards are being met.

The switch back on FR 502 in the NE ¼ section 36, T 121/2 N R. 6E delivers high amounts of sediment into Fossil Creek. User-created roads, trails and dispersed campsites within or connected to riparian areas contribute higher than natural amounts of sediment and flows predominantly into the Verde River and Fossil Creek

Fisheries and Aquatics: Bioassessment data from ADEQ are a measure of the aquatic and warmwater fishery designated use support and uses the Index of Biological Integrity. The macro invertebrate data indicates that the macro invertebrate community along the Verde River is healthy providing a healthy aquatic community, and not known for Fossil Creek and Stehr Lake.

Non-native fish occupy native warmwater fishery habitats and are known predators on non-native fish and their habitat.

Fossil Creek currently provides outstanding riparian and aquatic habitat for a wide variety of fish and wildlife. Fossil Creek provides critical habitat for several native fish including loachminnow and spinedace. It is suspected that non-natives dominate downstream areas near the Verde River confluence.

Fossil Creek has the only reproducing population of the sensitive lowland leopard frogs and has the highest population density on the forest.

Affected reaches of The Verde River and Fossil Creek in this watershed have designated critical habitat for loachminnow, spikedace and razorback sucker (Verde River only). As with loach minnow, spikedace may be extirpated from the Verde River Basin.

Impacts to wildlife are currently occurring from dispersed recreation (displacement and habitat modification), grazing and the invasion of non-native plants, fish, and crayfish, especially in Fossil Creek.

Changes/Interpretations and Key Findings in Riparian Condition:

The majority of assessed reaches rated out in proper functioning condition followed by functional at risk. All lotic system reaches of the Verde River, Fossil Creek, Stehr Lake Wash and Sycamore Creek (near bridge on FR 708), are currently functioning properly except the middle reach of Fossil Creek and isolated access points on the Verde River and the Childs area. These reaches are subject to high levels of dispersed and day use recreation in and adjacent to the floodplain. Limited, seasonal cattle grazing occurs on Fossil Creek and isolated, unauthorized grazing along the Verde River. Proper functioning reaches have a high probability to withstand high flow events. Current management is adequate to protect riparian values.

All other riparian streams assessed are functioning at risk. There is a high probability of degradation with high flow event. Management actions should be designed, implemented and maintained to achieve PFC and protection of riparian values.

For lentic systems, Cottonwood/Mesquite springs are the only springs fenced for protection within the watershed and are in PFC. Mud Seep and Unnamed (Switchback) spring are in PFC and appear to not have been grazed for a long time. All other springs are either non-functional or functional-at risk. Management actions should be designed and implemented to improve, restore, maintain, and protect riparian values in these systems

Upland Vegetation, Soil, Hydrologic and Watershed Condition

Changes/Interpretations and Key Findings:

Vegetation:

Ponderosa Pine/Mixed Conifer: Current tree canopy cover is somewhat higher than under the pnc, or reference condition and understory species composition, diversity and productivity is less than under pnc or reference conditions. Areas of mixed conifer have current vegetative conditions near pnc or reference conditions.

Current vegetative ground cover is adequate to prevent accelerated sheet and rill erosion. On-site soil productivity is being maintained. High tree canopy cover and ladder fuels along with high litter buildup on the forest floor puts the Ponderosa Pine type at risk for catastrophic fires and adverse watershed effects from uncontrolled wildfire

Pinyon-Juniper: Vegetative ground cover and species composition vary according to slopes and ungulate access. Slopes greater than about 40 – 50 % have higher vegetative ground cover, and higher species composition, diversity and productivity than lesser slopes probably due to the inaccessibility to grazing ungulates. These slopes tend to have somewhat lower canopy covers of pinyon that what would be expected in the pnc. On slopes less than about 40 %, understory species composition, diversity and productivity is generally less than under pnc.

Consequently, slopes less than about 40 % are susceptible to accelerated erosion and loss of soil and vegetative productivity. Canopy cover varies but in general, approximates the pnc.

Juniper Shrubland and Chaparral: Current vegetative ground cover is about equal to what would be expected under reference condition. On slopes less than about 40%, vegetative ground cover is adequate to prevent accelerated on-site sheet and rill erosion. Herbaceous understory is generally less than what would be expected under reference conditions.

Juniper-Semidesert Grassland Transition, Semidesert Grassland/Grasslands and Semidesert and Desert Shrublands: Vegetative conditions vary but generally; vegetative ground cover, species composition, diversity and productivity are less to much less than what would be predicted in the pnc or reference condition. The majority of this type has been subject to high levels of historic grazing and is grazed today. Consequently, vegetative ground cover has been reduced resulting in current and potential accelerated erosion and loss of soil and vegetative productivity. Maintenance of ground cover is essential in protecting long-term soil productivity.

Streamside Riparian Area Vegetation: Fossil Creek has high vegetative species diversity but in accessible areas, is even-aged and lacks seedling, sapling and pole sized cottonwood, willow, and Arizona Sycamore that would be present in the pnc or reference conditions. The Verde River has recently been excluded from grazing for the most part and is beginning to recruit cottonwood and willow seedlings and other riparian species. It is expected that the vegetative community will improve to become more diverse and productive. Most other riparian areas have reduced vegetative species composition and productivity than what is predicted under a less disturbance regime as a result of grazing and recreational impacts.

Soil System and Condition

In analyzing summary data for the soil system, it is evident that soil condition varies considerably across the watershed and is more variable than the aquatic and riparian systems.

As was noted in Chapter 3, satisfactory and satisfactory –inherently unstable soils account for about 65% of the watershed. Impaired soils account for about 22% and unsatisfactory soils account for about 6% with the remaining 7% in various mixed classes. About ¼ of the watershed is functioning in a reduced condition.

Given this data, it appears as though select areas of the soil system are not functioning within their capability and productivity and resiliency is reduced. Portions of the drainage network are unstable. However, the majority of the watershed has favorable soil conditions and the soil system is functioning within its capability and productivity is maintained. About ¼ of the watershed is functioning in a reduced condition.

High levels of historic grazing coupled with current grazing strategies have contributed to soil degradation. In identified areas of impaired, unsatisfactory and satisfactory – inherently unstable soils, long-term soil productivity is reduced. The physical, and biological conditions of the soil system are at risk, or do not support additional disturbance including grazing activity beyond the current carrying capacity.

Following intense storms, areas of unsatisfactory and impaired soils adjacent to streams and drainageways leading into perennial streams likely contribute significantly to short-term increases in downstream turbidity. Where recreation access is favorable, soil condition is generally impaired or unsatisfactory but limited in overall extent. Impacts to Fossil Creek, the Verde River, and other perennials are localized and generally limited to $1/10^{th}$ of an acre/dispersed site. Although seemingly small, the incremental impact of continued use (especially along the middle reach of Fossil Creek) probably results in decreased streambank vegetation, and increased sedimentation and peakflows as compared to natural conditions with satisfactory soils and well-vegetated streambanks.

Much sediment delivered to streams probably comes from high connected disturbed areas (roads) located in or near stream channels and naturally erosive soils found on steep slopes throughout the watershed and planning area. These roads provide an avenue from which surface runoff may carry sediment laden water and deliver it into a stream that eventually drains into downstream perennial waters.

A major sediment contributor to Fossil Creek proper and the Verde River is sediment recruited directly from intermittent and ephemeral channel deposits connected and delivered to both streams (per. com. Zackary Mondry).

Additional sediment probably comes from inherently erosive soils on slopes greater than 40 percent (Satisfactory-Inherently Unstable) soils in areas largely inaccessible to grazing.

Environmental effects analysis will have to be conducted to determine if any adverse effects to fisheries or riparian habitat exists due to increased sediment delivery into riparian areas and perennial streams. Further analysis will have to be conducted to determine if a reduction of soil productivity results in adverse turbidity, or sediment delivery into riparian areas and perennial streams for warmwater fisheries use and habitat.

Unsatisfactory Soils:

Most of these soils are in accessible areas subject to high levels of historic and current grazing above the carrying capacity of the land. Past grazing practices have contributed to accelerated erosion with detachment and transport of sediment resulting in a reduction of long-term soil productivity. Most of these soils have current erosion exceeding tolerable limits and overall amount to 12,224 or 6.4 percent of the watershed. Most of these soils are located in juniper-grassland transition zones. Indicators signify that a loss of soil function has occurred.

A few soils are unsatisfactory as indicated by compacted soil surface horizons as a result of recreation and grazing impacts. The incremental effects of grazing and recreation use may be irreversibly impacted or require decades to improve enough to maintain inherent soil productivity.

The Tonto National Forest identified a few areas with unsatisfactory soils in areas of designated critical habitat for loachminnow and spikedace adjacent to the Verde River.

These soils can be improved through proper grazing strategy and may require 5 to 10 years of rest to build up effective vegetative ground cover and species composition to resist accelerated erosion or severe soil compaction. It may take decades to rebuild the organic surface A horizon and maintain inherent long-term soil productivity.

Satisfactory-Inherently Unstable Soils:
These soils are inherently unstable and have natural erosion exceeding tolerable erosion but are functioning within their capability. Due to the nature of the terrain, livestock are forced to graze on accessible areas with slopes ranging from 40 to 60 percent. Past and current grazing pressure in these areas may have caused accelerated soil erosion with a decrease in long-term soil productivity. It is not known how many acres are grazed or if grazing pressure has further impaired these soils.

Impaired Soils: Most identified impaired soils result from high levels of historic grazing pressure and continued grazing probably beyond the carrying capacity of the land. Many of these soils have compacted surface soil horizons. Long-term soil productivity is reduced. The effects of grazing and recreation impact may take decades to improve the soil resource. Compacted areas may require one or more decades to improve enough to maintain inherent soil productivity.

Where impaired soils exist, they are found on plains and hillslopes slopes in pinyon-juniper woodlands, juniper-semi-desert grassland transition and semidesert grassland vegetation or creosote vegetation types. There are identified impaired soils adjacent to areas of perennial streams and critical habitat along Fossil Creek, and the Verde River. Since these soils are found on both flat slopes and moderately steep slopes, surface runoff varies from slow to fast and accelerated peak flows or reduced baseflows vary accordingly. It is unlikely that these soils significantly alter water quantity, and timing of flows sufficient to adversely affect riparian habitat vegetation, and fluvial geomorphology, as long as the streambanks are protected with adequate vegetation to withstand peak flows.

Impaired soils are candidates for improved grazing management strategies and can generally be improved faster than unsatisfactory soils

Satisfactory Soil Condition:
The majority of satisfactory soil conditions occurs in pinyon-juniper or ponderosa pine vegetative types and are commonly grazed on slopes less than about 40 percent. Indicators signify that soil function is being sustained and soil is functioning properly and normally. For satisfactory soils, the ability of the soil to maintain resource values and sustain outputs is high.

Other Soil Condition Classes: Other soil condition classes share similar characteristics to the above-mentioned classes. See Chapter 3, Existing Soil, Hydrologic and Watershed Condition, for further detail.

Hydrologic and Watershed Condition

Physical and biologic conditions of the soil and riparian systems are variable throughout the watershed. Given this variability, watershed conditions in any given area range from **Class I** (predominantly functional with favorable conditions of water flow in terms of water quality, quantity and timing) to **Class III** (predominantly dysfunctional).

The majority of the watershed exhibits high geomorphic, hydrologic, and biotic integrity **(Class I,)** relative to its natural potential condition followed by **Class II condition**. However, the upper middle reach of Fossil Creek, and the effects of the existing dam have caused a loss of the stepped travertine morphology and the resulted in a simplified channel profile directly below the dam. This is not indicative of the natural potential condition. This small portion of the watershed is probably Class II.

Other portions of the watershed do exhibit unstable drainage networks. The soil, aquatic and riparian systems range from dysfunctional (smallest aerial extent) to predominantly functional (largest acreage extent) with significant areas at risk of being able to support beneficial uses.

Some of the watershed exhibits low geomorphic, hydrologic, and biotic integrity relative to its natural potential condition (Class III Condition).

Favorable conditions of water flow exist in many portions of the watershed. Many areas probably have increased peak flows and reduced base flows (in comparison to natural levels) following high storm events and streams may have increased short-term sedimentation above state water quality standards. The physical, chemical and biological conditions of the soil, aquatic and riparian systems vary across the watershed and all three systems are integral to overall watershed condition.

Overall, the watershed probably best fits **Class II condition.** Enough of the watershed exhibits moderate geomorphic, hydrologic, and biotic integrity relative to its natural potential condition. Portions of the watershed exhibit an unstable drainage network. In these areas, physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems are at risk in being able to support beneficial uses.

Human Uses, Impacts and Grazing

Changes, Interpretations/Key Findings:

Recreational and OHV Uses and Impacts,

12.8 miles of user-created road are located in the Fossil Creek area alone resulting in numerous dispersed campsites. Dispersed camping has denuded and compacted soils adjacent to Fossil Creek and created avenues for increased and concentrated water flow and sedimentation into Fossil Creek. Accessible areas along the middle Fossil Creek reach between Irving and Stehr Lake tend to be the most highly impacted as a result of concentrated recreation use stemming from fuelwood gathering, soil rutting and scarification from off-road vehicles, human waste and litter. Recreation use in the Childs area has similarly negatively impacted floodplains and riparian area habitat on the Verde River compared to natural conditions.

Numerous dispersed campsites have been created and have negatively impacted riparian, wildlife and fisheries, aquatic habitat soil and water quality, and cultural resources. Trail access to Fossil Springs is provided and dispersed camping puts this unique area at risk of degradation also.

Where recreation access is favorable, soil condition is generally impaired or unsatisfactory but limited in overall extent. Impacts to Fossil Creek, the Verde River, and other perennials are localized and generally limited to $1/10^{th}$ of an acre/dispersed site.

Anticipated decommissioning of the Irving Power Plant and restoration of full flows to Fossil Creek will likely add increased recreation activity and impact to the Fossil Creek area.

FR 9206W, 502E and 9248C have high hydrologic connectivity and the potential to deliver high amounts of sediment and water during high storm events.

Much of the sediment delivered to streams probably comes from high connected disturbed areas (roads) located in or near stream channels and naturally erosive soils found on steep slopes throughout the watershed and planning area. These roads provide an avenue from which surface runoff may carry sediment laden water and deliver it into a stream that eventually drains into downstream perennial waters.

Grazing Strategy

Current grazing strategy and information is contained in the individual Allotment Management Plans and related Environmental Assessments to reauthorize grazing permits Verde River Access:

Verde River:

Livestock grazing has not been permitted on almost all of the Verde River for the past 6 years, and longer on some allotments. The result is riparian vegetation is rapidly recovering and improving towards greater species composition, diversity and productivity. There are small areas where grazing continues and efforts are underway to limit access to the river by the installation of additional fences and cattleguards. Several livestock exclosures or riparian pasture fences have been built on major tributaries to the Verde River.

Fossil Creek Area and Uplands:

Several allotments and numerous pastures exist in the planning area. Compared to reference conditions, on slopes less than 30 percent, vegetation species composition, diversity and productivity is reduces.

Cattle gather on flat terraces adjacent to Fossil Creek. These same terraces are used by dispersed campers and also contain the remains of prehistoric ruins.

Cattle gather at and drink from natural springs. This has denuded riparian vegetation and affected invertebrates, amphibians and mammals. Some cattle tanks contain populations of Chiricahua Leapard frogs, which will soon be listed as Threatened and are potentially impacted by grazing practices.

Management Recommendations:

Water Quality Related:

1. Identify Best Management Practices (BMP's) for any proposed site disturbing or construction activities to mitigate non-point source pollution. Assure monitoring of BMP occurs and that BMP is effective. Adjust BMP as necessary.
2. Annually review ADEQ 305 (b) Report and 303 (d) List for all affected reaches. Coordinate further sampling and monitoring and adjust management as necessary.
3. Manage the Verde River and in particular, the Beaver Creek to West Clear Creek Verde Reach following "impaired" status. Consider decommissioning roads and dispersed campsites with high hydrologic connectivity to the Verde River. Follow the Verde River TMDL – For Turbidity, ADEQ, January 2001 recommendations for water quality.
4. Schedule construction activities during periods where the probabilities of rain and runoff are low to prevent unacceptable soil compaction and displacement.
5. Develop sanitary facilities near clustered campsites and encourage positive use through signage, pamphlets, public contacts and education.
6. Control refuse disposal to protect water from unacceptable levels of nutrients, bacteria and chemicals associated with solid waste. Encourage positive use through signage, pamphlets, public contacts and education.
7. The handling, storage and application of hazardous or toxic materials that pollutes streams, lakes, and wetlands or springs that may cause damage or injury to humans, lands, animals, or plants is prohibited.
8. Acquire in-stream flow water rights for recreation, wildlife and fishery use in Fossil Creek. Continue to gage and monitor flow following decommissioning of the Irving Power Plant and dam and return of full flows.

Riparian, Aquatic Systems and Fisheries Related:

9. Manage the Verde River following recommendations in the Verde River TMDL – For Turbidity, ADEQ, January 2001.
10. Continue riparian restoration and maintenance in springs and headwater streams in the Clover Springs Project. Actively pursue similar projects.
11. Consider native tree and herbaceous revegetation in disturbed riparian areas.
12. Provide streamside zones with adequate vegetative filter strips to trap sediments and prevent its entry into streams.
13. Stabilize road fill slope along switch back on FR 502 in the NE ¼ section 36, T. 12 ½ N. R. 6E. to mitigate sediment delivery into Fossil Creek. Consider in-sloping, use of straw wattles, erosion nets, mulch, rip rapping and seeding of native herbaceous, weed-free seed to minimize erosion of fill material into Fossil Creek.
14. Install fish barriers in Fossil Creek upstream from the Verde River confluence to prevent non-native fish predation on native populations.
15. Installation of fish habitat improvement projects should occur during low flow periods, using staged construction and using temporary sandbags or rock coffer dams, or pipes to divert streamflow around site.
16. Minimize use of heavy machinery operating in the channel, and/or using rubber-tired equipment within the channel.

17. Site rehabilitation consists of several revegetation methods, such as: 1) Store sod removed from the initial ground disturbance and replace the sod from the top of the bank on the disturbed site; 2) Seed with a native certified weed-free seed mix. Where it is physically possible, hydromulch of seed is the preferred application method. Due to the remoteness of some of the proposed sites, this may not be possible; 3) Protect site with slash spread across the disturbed area to create microclimates and protect from grazing ungulates. Slash placement will be limited to the upper 2/3 of the bank to limit transport downstream of woody material; 4) Fence out ungulates for 1 to 2 years (or until the site has re-established); 5) use using mycorhizal inoculum on severely disturbed sites where no topsoil is left.
18. Use law enforcement patrols and public education to ensure compliance with camping regulations and non-native fishery stocking.
19. Continue coordinating research activities with Rocky Mountain Research Station, ADEQ and other interested parties in inventory and monitoring of aquatic habitat, fish populations and water quality on all rivers.

Grazing, Vegetation and Soil and Watershed Condition Related:

20. Grazing along perennial streams may only occur in areas not designated as critical and or occupied habitat for any wildlife or fish and only occurs on hardened streambanks whereas not to reduce the proper functioning riparian condition.
21. Consider winter, seasonal grazing along functional - at risk riparian areas.
22. Consider fencing springs and if water source is necessary, pipe water to stable soils outside the riparian zone.
23. Determine the grazing capability and capacity of each pasture using the TES as a tool to determine capability. Assure grazing occurs within the capability of the land.
24. For unsatisfactory and impaired soils, the timing and intensity of livestock grazing should be better controlled with objectives of achieving soil vegetative ground cover and reducing compaction to prevent accelerated erosion, maintain or improve soil productivity riparian condition and water quality.
25. Consider resting pastures or old alluvial stream terraces with large areas of unsatisfactory or impaired soils for a period of 5 to 10 years based on on-site inspections.
26. Utilize salt to improve livestock distribution especially in areas with unsatisfactory or impaired soils or away from degraded riparian areas.
27. Consider thinning dense pinyon-juniper stands with canopy covers greater than what is predicted under the pnc. If implemented, woodland or brush treatments should be done to improve soil quality and accomplished to retain at least 5 tons/acre of coarse woody material (3 inches and larger) lopped and scattered across the site.
28. Prescribed fire treatments should be considered in vegetation types with higher canopy covers than what is expected under reference conditions to help reduce adverse watershed effects from uncontrolled wildfire. If implemented, fire intensity should be low to moderate to prevent loss of soil nutrients, organic

matter and alteration of soil properties, such as structure and pores that would reduce soil infiltration.

29. Seeding uplands should be implemented in areas where native seed is scarce, or in areas where eroding uplands are contributing directly to sedimentation in stream channels or filter strips. Use certified weed-free seed and provide a period of protection from grazing to promote establishment of herbaceous plants.

Human Uses and Impacts:

30. Close, rehabilitate and relocate current dispersed campsites located within flood plains of riparian areas, or within the streamside zone vegetative filter strip.
31. Consider designating dispersed campsites to minimize current and future loss of heritage resources, loss of soil and vegetative productivity, and adverse impacts to water quality, riparian, fisheries, and aquatic habitat conditions.
32. Provide parking and access trails for activities, such as swimming, fishing, hiking, wildlife viewing, camping, or picnicking.
33. Prohibit camping and campfires in floodplains along riparian areas.
34. Consider developing a Fossil Creek landscape or 6th code watershed plan proposing standards and guidelines, and site-specific improvements to mitigate expected increased recreation impact to the area (currently being developed as the Fossil Creek Planning Project).
35. Consider nominating and protecting the Fossil Creek area with Wild and Scenic Status (currently being planned under the Fossil Creek Planning project).
36. Recreation maintenance (trails, developed and dispersed sites) should be planned and implemented.
37. Locate pack, cattle and riding facilities away from water sources and be sure an adequate vegetative filter strip is between the facility and the water.
38. Consider decommissioning user-created roads and dispersed campsites with high hydrologic connectivity to Fossil Creek, Verde River, and other riparian areas.
39. Return user-created roads, and poorly located disturbed dispersed campsites into resource production or concert to trails in areas within riparian buffer zones (mainly Fossil Creek and the Verde River). Use native, certified weed-free seed or native tree species.
40. Manage off-road vehicle use to prevent unacceptable soil erosion, channelization and adverse effects to water quality.
41. Decommission, restore to natural condition or convert to trails FR 9206W, 502E, and 9248C (currently proposed under the Fossil Creek Planning Area Project).
42. Use appropriate water control mitigation measures on roads and trails such as water bars, cross ditches during maintenance and construction activities. Lead-out ditches and water bars shall be reconstructed or constructed away from watercourses
43. Roads and roadside ditches shall be maintained to provide proper surface drainage off the road and into vegetative-buffered zones to control surface runoff.
44. Never allow a ditch or ditch culverts to drain into a streamcourse. Consider cleaning out dysfunctional culverts identified under the 2002 contract.
45. For suitable timber sales, follow BMP's in the FSH 2509.22.

Useful Weblinks to Maps and TES

(Copies of project maps are available at the Coconino National Forest Supervisors Office and in GIS at file:///J:/fsfiles/ref/library/gis/projects/forest_wide/fossilcr_wa

TES soils information published in the manuscript for Coconino National Forest can be found by following the following link, http://alic.arid.arizona.edu/tes/tes.html.

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Roads Analysis Report

Fossil Creek-Lower Verde 5th order Watershed

Introduction

Background

In August 1999, the Washington Office of the USDA Forest Service published Miscellaneous Report FS-643 titled "Roads Analysis: Informing Decisions about Managing the National Forest Transportation System". The objective of roads analysis is to provide decision makers with critical information to develop road systems that are safe and responsive to public needs and desires, are affordable and efficiently managed, have minimal negative ecological effects on the land, and are in balance with available funding for needed management actions.

In October 1999, the agency published Interim Directive 7710-99-1 authorizing units to use, as appropriate, the road analysis procedure embodied in FS-643 to assist land managers making major road management decisions. The Rocky Mountain Region of the Forest Service then published a roads analysis guidance document as a supplement to Appendix 1 of FS-643. This document provides guidance concerning the appropriate scale for addressing the roads analysis.

Process

Roads analysis is a six-step process. The steps are designed to be sequential with the understanding the process may require feedback and iteration among steps over time as an analysis matures. The amount of time and effort spent on each step differs by project based on specific situations and available information. The process provides a set of possible issues and analysis questions for which the answers can inform choices about road system management. Decision makers and analysts determine the relevance of each question, incorporating public participation as deemed necessary.

Products

The product of an analysis is a report for decision makers and the public that documents the information and analyses used to identify opportunities and set priorities for future national forest road systems. Included in a report is a map displaying the known road system for the analysis area, and the risks and opportunities for each road or segment of road. A report may also include other maps and tables necessary to display specific priorities and changes in a road system.

This Report

This report documents the roads analysis procedure used for the Fossil Creek-Lower Verde 5th order watershed.

Step 1 Setting up the analysis

Purpose and Products

The purpose of this step is to:

- establish the level and type of decision making that the analysis will inform,
- identify the geographic scale or scales for the analysis,
- develop a process plan for conducting the analysis, and
- clarify the roles of technical specialists and line officers in the team.

The products of this step are:

- a statement of the objectives of the analysis,
- a list of interdisciplinary team members and participants,
- a list of information needs, and
- a plan for the analysis.

Objectives of the Analysis

The analysis will inform the Watershed Planning effort for the Fossil Creek-Lower Verde 5th order watershed, and help with planning for the Verde Wild and Scenic River reach. An assessment of risks and benefits for all FS roads in the Fossil Creek-Lower Verde 5th order watershed is attempted. Private roads and State Highways or Interstates were not evaluated. Areas of special sensitivity, resource values or both are identified. Priority locations are suggested for site-scale evaluation and project-NEPA.

Interdisciplinary Team Members and Participants

Rory Steinke, Watershed Program Manager, Coconino NF

John O'Brien, Transportation Engineer, Coconino and Kaibab NF's

Jennifer Burns, Landscape Architect, Red Rock RD

Debbie Hom, GIS Analyst, Red Rock RD

Sharynn Valdez, Archeologist, Red Rock RD

Jack Norman, Hydrologist, Red Rock RD

Jerry Bradley, Range Staff, Red Rock RD

Bill Stafford, Recreation Specialist, Red Rock RD

Ken Anderson, District Ranger, Red Rock RD

Information Needs

Information needed for the analysis includes GIS coverages for the area, the road layer, site specific information about Cultural resources and Threatened, Endangered, and sensitive species.

Analysis Plan

The ID Team met to determine important risks and benefits of the road system in the Fossil Creek-Lower Verde 5th order watershed, using the questions provided in the FS RAP publication (FS-643). The RAP team will further refine risk and benefits of roads into high/low categories, then apply those to the roads in the watershed, using GIS software and maps prepared and produced by the ID team. A matrix of high/low value and high/low risk will be constructed. The ID team will then examine a map of the roads coded by risk/value rating as a final check.

Step 2 Describing the situation

Purpose and Products

The purpose of this step is to:

- describe the existing road system in relation to current forest plan direction.

The products of this step are:

- a map or other descriptions of the existing road and access system defined by the current forest plan or transportation plan, and
- basic data needed to address roads analysis issues and questions.

Existing Road and Access System Description

The Fossil Creek – Lower Verde River watershed is located in the central part of Arizona. It is a 5th code watershed, the hydrologic unit code (huc) is 1506020302. The watershed analysis area encompasses approximately 192,000 acres: 108,000 acres on the Coconino National Forest, 40,000 acres on the Tonto National Forest, and 44,000 acres on the Prescott National Forest. Approximately 2900 acres of private lands fall within the watershed boundary but private roads are not analyzed in this RAP. The majority of the watershed is located in Yavapai County and parts of Coconino County (generally above the Mogollon Rim) and Gila County adjoining the Tonto National Forest.

The entire watershed covers about 300 square miles and ranges in elevation from about 7350 feet above sea level along the southern boundary of the Colorado Plateau to about 2550 feet below the confluence of the Verde River and Fossil Creek in the Transition Zone Province. Major perennial streams are the Verde River and Fossil Creek. The extreme downstream reach of West Clear Creek joins the Verde River in the northern part of the watershed. There are many other intermittent streams and riparian areas in the watershed.

The Forest Service manages almost the entire watershed. The Verde River is the boundary between the Coconino and Prescott National Forest to the southwest. Fossil Creek is the boundary between the Coconino and Tonto National Forest to the southeast. The upper part of the watershed was designated The Fossil Springs Wilderness Area in 1994. Closer to the Verde River, The Mazatzal Wilderness extends south from Fossil Creek.

The roads in the Fossil Creek range from State Highway 260 (AZ-260, formerly FH-9) to user-created motorized trails. Major roads are AZ-260 from I-17 at Camp Verde to AZ-87 at Cinch Hook pit, which serves as primary access from the southern Verde Valley to the Mogollon Rim and Payson. FS-708 from AZ-260 to Strawberry is a scenic route, used for tourism, and access to hiking, hunting, the upper works (Irving) of the APS Hydroelectric plant and FS-502. FS-502 is the primary access to the Verde River at Childs, and to the lower works of the Hydroelectric plant at Childs. Other classified roads in the watershed have been constructed for timber harvest (upper watershed), range allotment access, and power-line construction. There are also approximately 16 miles (25,410 meters) of user created trail that have been GPS'ed in the watershed.

AZ-260 serves mainly to pass through the watershed, and is near the northern boundary. FS-708 is also used to pass through the watershed, but as a scenic trip or part of a scenic loop (returning on AZ-260). FS-708 is also the main access route to the interior of the watershed, and nearly bisects the portion of the watershed contained on the Coconino NF.

The Verde River passes through the western third of the watershed. Interstate 17 also passes through a small corner of the watershed. Part of the Town of Camp Verde is in the Northwest corner, and the town of Strawberry is in the eastern edge of the watershed.

Some parts of the watershed have road densities of greater than 5 miles per mile, including those in the Town of Camp Verde and the town of Strawberry and the timber-lands above the Mogollon Rim along AZ-260. Much of the watershed below the Mogollon Rim has less than 2 miles per square mile of roads.

Basic Data Needs

Basic data needed includes locations and maintenance levels of all the roads in the watershed, the transportation section of the forest plan, and information about the ecological, social, and cultural uses and impacts of the roads.

Step 3 — Identifying issues

Purpose and Products

The purpose of this step is to:

- identify the key questions and issues affecting road-related management, and
- describe the origin of the issues.

The products of this step are:

- a summary of key road-related issues, including their origin and basis, presented by general categories of environmental, sociocultural and economic, and
- a description of the status of current data, including sources, availability, and methods of obtaining information.

Issue Summary

Potential risks from roads in the watershed include risks to water quality, erosion, native fishes, Mexican Spotted Owls, Management indicator species, Easement/ROW issues, recreational opportunities, and cultural-heritage resources. Potential values derived from roads in the area include fire management, and access to developed recreation, dispersed recreation, cattle shipping and mineral pits.

Status of Current Data

GIS coverages exist to evaluate many of these risks and benefits. For the rest, maps were prepared of the road system and the topography, and specialists were asked to identify segments of roads that were

Step 4 — Assessing benefits, problems, and risks

Purpose and Products

The purpose of this step is to:

- assess the various benefits, problems, and risks of the current road system and whether the objectives of Forest Service policy reform and forest plans are being met.

The products of this step are:

- a synthesis of the benefits, problems, and risks of the current road system,
- an assessment of the risks and benefits of entering any unroaded areas, and

- an assessment of the ability of the road system to meet objectives.

Current Road System Benefits, Problems, and Risks

Ecosystem Functions and Processes (EF)

EF(1): What ecological attributes, particularly those unique to the region, would be affected by roading of current un-roaded areas?

There are no plans to build roads within the Hackberry or Boulder Canyon inventoried roadless areas. In addition, no other un-roaded areas are planned to have permanent roads built. The ecological attributes of these areas will continue to be protected by the Forest Plan and project-level design features.

EF(2): To what degree do the presence, type, and location of roads increase the introduction and spread of exotic plant and animal species, insects, diseases, and parasites? What are the potential effects of such introductions to plant and animal species and ecosystem function in the area?

The presence of roads increases the risk of spread of existing and new noxious weeds. Maintenance level 3 roads (improved), have road maintenance and increased traffic which increases the chances for spread of exotic (noxious) plants into new areas. Maintenance level 1 and 2 roads do not have high volumes of traffic and probably have lower risk of invasive weed spread. User-created roads adjacent to Fossil Creek have high levels of traffic and have increased risk of invasive weed spread. These noxious weeds may displace the habitat of existing native species. The end result is ecosystem function can be dramatically altered by the introduction and spread of noxious weeds and our road system can provide an opportunity for introduction of new species from other areas.

A 3-Forest Noxious Weed EIS is currently being prepared. Staff members stationed on the Coconino NF are coordinating noxious weed efforts for the Coconino, Prescott and Kaibab National Forests.

EF(3): To what degree do the presence, type, and location of roads contribute to the control of insects, diseases, and parasites?

The presence of roads allows access to the forest for many types of treatment, including, mechanical, chemical, burning and other treatments as prescribed by the 3-ForestNoxious Weed EIS.

EF(4): How does the road system affect ecological disturbance regimes in the area?

The disturbance these roads cause has already occurred in the construction of the road, and all are well-established roads. These existing roads have already created the disturbance and now we deal with the effects of the presence, use and maintenance of the roads.

The most common disturbance regimes are fire, drought, flood, insects and disease in the Ponderosa Pine types. More recently, pine bark beetle has infected pinyon-juniper and Ponderosa pine stands. These regimes are interrelated since drought often leads to increased incidences of fire and outbreaks of insects and disease. Fire is thought to be the most significant disturbance regime.

Road access provides risk for man-caused fires. Roads also allow rapid response opportunity for fire suppression activities. Even though it is acknowledged that road access increases risk for human caused fire, this risk can be minimized through administrative means such as smoking and campfire restrictions and complete closures during high and extreme fire danger periods.

EF(5): What are the adverse effects of noise caused by developing, using, and maintaining roads?

Noise from developing, using and maintaining roads may affect people and wildlife within hearing distance. There is no specific data on the effects of noise on people or recreational opportunity.

Aquatic, Riparian Zone, and Water Quality (AQ)
AQ(1): How and where does the road system modify the surface and subsurface hydrology of the area?

Roads have three main effects on water: 1) they intercept rainfall directly on the road surface and road cutbanks and subsurface water moving down the hillslope or springs; 2) they concentrate flow, either on the surface or in an adjacent ditch or channel; and 3) they divert or reroute water from normal flow paths had the roads not been built. With increasing road density increases the impact to a watershed and it's waterways. For example, by intercepting surface and subsurface flow, and concentrating and diverting it into culverts, ditches, gullies, and channels, road systems effectively increase the density of streams in the landscape, thereby changing the amount of time it takes for water to enter a stream channel, altering the timing of peak flows and hydrograph shape. Usually the change in the hydrograph's shape is a quicker runoff response time (i.e. "flashier" flow response), which produces a taller and sharper shape in the hydrograph's peak flow design.

AQ(2): How and where does the road system generate surface erosion?

Different parts of the road system and their adjoining cutbanks and fillslopes behave quite differently hydrologically. All roads do not perform equally during storms, and the same road segment may behave quite differently during storms of different magnitudes. As storms become larger or soil becomes wetter, more of the road system contributes water and sediment directly into streams. Road gradient has a profound effect on the magnitude of hydrologic change on roads and to surrounding areas. Discharge from hillslopes, cutbank height, density of stream crossings, soil properties, and response to storms all differ by slope position or watershed aspect. The most important consideration of how roads impact the watershed is the number of roads and miles built as well as the type of road whether it's paved, graveled, or dirt. The number of miles of roads per area in a watershed is known as road density. The greater the road density value, the greater the potential impact to a watershed and its hydrologic system caused by those roads. Proper design and maintenance of roads can reduce the amount of sedimentation. The amount of traffic on a road can affect the FS ability to properly maintain the road.

AQ(3): How and where does the road system affect mass wasting?

There is no known incidence of mass wasting due to roads on the Coconino National Forest. Concentration and diversion of flow into headwater areas can cause incision of previously unchanneled portions of the landscape and initiate slides in colluvial hollows. Diversion of stream flow at road-stream crossings, road proximity next to stream channels, and the culvert placements and frequencies are key factors contributing to road failure and other landscape erosional consequences during large flood events. Another potential factor would be the unusually high antecedent moisture content in the soils as a result of above normal wet years or heavy snow pack allowing increased risk for slumping or small landslides along, usually, cutbanks and less often on fillslopes.

AQ(4): How and where do road-stream crossings influence local stream channels and water quality?

Road stream crossings can be a major source of sediment to streams, resulting from channel fill around culverts, subsequent road-crossing failures, and subtle or major changes in stream morphology caused by aggradations such as the increase number of point bars in stream channels. Greater road density will have a greater number of road-stream crossings and thereby increasing the likelihood of impact on stream water quality as a result of increasing amount of fine sediment or sand entering streams at those juncture points. Stream crossings such as ford crossings allow greater sediment delivery to streams because of the direct connection from a road to a stream as compared to culvert crossings or bridges. The greater number of traffic or higher road density of non-paved roads will have a greater propensity for sedimentation to streams and potentially increasing the impact to water quality, fishes, and/or macro-invertebrates.

AQ(5): How and where does the road system create potential for pollutants, such as chemical spills, oils, de-icing salts, or herbicides, to enter surface waters?

Clear and open pathways for pollutants to enter surface waters are either at road crossings such as fords and roadside culverts that pipe near or directly into surface waters. The potential for pollutants to enter surface waters is also based upon the design of the road system such as out-sloped vs. in-sloped road designs, the incorporation of broad road dips, and the number of culvert installations along road-side ditches. Other factors are the roads' proximity to streams and the amount of vegetation such as grasses that can serve as "pollutant traps" between the road and stream water. If the road is designed poorly or there is a lack of vegetation materials to serve as a "buffer strip" between the road and stream water, movement of pollutants into surface waters is likely to occur. Proximity of the road to a stream is the strongest controlling variable in determining problems on water quality in streams. However, paved road systems are likely to be the pollution source areas due to the higher public vehicular use, greater attention on road maintenance requirements, and accidental spills, while unpaved road system are likely to be the source for sedimentation problems to nearby streams.

AQ(6): How and where is the road system "hydrologically connected" to the stream system? How do the connections affect water quality and quantity (such as, the delivery of sediments and chemicals, thermal increases, elevated peak flows)?

See AQ(1), (2), (3), and (4) for additional information. For thermal increases, roads that are closely parallel to stream systems have the potential to increase greater sunlight exposures to streams due to the lack of sheer number of trees between roads and stream channels that act as shade corridors and immediate source of litter fall into stream channels. These areas are essentially riparian zones where riparian plant communities thrive close to a water source. Trees on stream banks have the potential to lose its soil materials due to the undermining or undercutting action by floods where weakened stream banks or fillslope areas slump into streams thereby introducing woody materials. These actions can reduce shade coverage and expose surface waters to more sunlight and potentially increase water temperature.

AQ(7): What downstream beneficial uses of water exist in the area? What changes in uses and demand are expected over time? How are they affected or put at risk by road-derived pollutants?

Recreational uses such as fishing, water diversions for agriculture and range uses, drinking water, stock ponds, and impoundments are the beneficial uses. Perennial stream systems support aquatic and wildlife species, and riparian plant species. Intermittent streams may support these as well during wetter seasons.

The continued increase in population in the west in communities in and around the Coconino National Forest has been observed and will likely generate an increase in recreational and transportation needs as result. These increases will likely cause additional impact to both paved and non-paved road systems throughout the National Forest. Impact to roads from pollutants and the mobilization of sediments to streams will likely occur thereby increasing the potential for additional strain to aquatic systems and degradation of water quality. This may be due in part to erosion, changes in sediment loads to streams, changes in water chemistry, acidity or pH, temperature, turbidity, and conductance as a result of the higher road maintenance requirements and increased road uses by public and private sectors.

Lands administered by the CNF include watersheds that provide domestic and agricultural water for the Salt River Valley, through the Verde River. Road-derived pollutants might include hydrocarbons, salts, mineral sediments, or anything spilled from a hauling vehicle. These pollutants, if present in enough quantity, could affect the drinking water and the health of the people using that water, or could affect wildlife and plants, especially and most directly aquatic species.

AQ(8): How and where does the road system affect wetlands?

Wetland roads are quite different from upland sites with regard to erosion potential and processes. Low gradients, high water tables, ample soil developments, water-loving plants, and poorly defined natural drainage and sheet flow areas during heavy rainfall events often define wetland areas. Trafficking of wetland roads generally occurs in the driest time of year while upland roads are usually designed for year-round access. The mobilization of fine sediment produces little impact immediately in the wetland areas but may be potentially impacted from upland sources and where floodwater could impact wetlands. However, wetlands on the CNF are rare. Wetlands are likely to be found near spring areas, or along flat valleys where perennial streams can be found.

AQ(9): How does the road system alter physical channel dynamics, including isolation of floodplains: constraints on channel migration; and the movement of large wood, fine organic matter, and sediment?

Roads affect geomorphic and channel dynamics from four different mechanisms: 1) accelerating erosion from the road surface and prism itself by both mass and surface erosion processes that adds or changes the equilibrium dynamics in a channel through sediment loading and erosional processes; 2) directly affecting channel structure and geometry by constraints to the floodplain or stream that have a natural tendency for lateral (or vertical) migration; 3) altering of surface flow paths and increasing stream density, leading to increased landscape dissection or channelization onto previously unchannelized portions of the landscape; and 4) causing complex interactions among water, sediment, and woody materials (see question #5 also about woody materials and roads) where an increase in sediment movements, road side failures, slumpings, stream bank failures, landslides, and changes in streamflow dynamics will occur. These mechanisms involve different physical processes, have varying effects on erosion rates, and are not uniformly distributed either within or among landscapes or watersheds. As variable as climatic results will occur, so will the responses of a watershed or landscape containing a road system.

AQ(10): How and where does the road system restrict the migration and movement of aquatic organisms? What aquatic species are affected and to what extent?

Road systems affect the migration and movement of aquatic organisms by blocking access to spawning grounds or suitable habitats through inappropriately installed culverts, poorly designed low water crossings, or changes in water velocities in a stream. Movement of fish within a stream or river system may be as important to native warmwater fish species, such as those on the Coconino, as it is to anadromous salmonids in the Pacific Northwest. An inappropriately installed culvert is likely to pose a movement barrier to resident fish attempting to move to headwaters to spawn. This same culvert may also affect juvenile fish attempting to move to rearing habitat or cooler waters by increasing water velocities through the culvert and prohibiting movement within a stream. Culverts and low water crossings can also affect habitat links between different streams and stream systems within a watershed or multiple watersheds. If culverts or low water crossings close off habitat links, then genetic exchange between fish populations is reduced or eliminated, resulting in isolated populations and inbreeding. The probability of losing these isolated populations to disease and extirpation increases with time.

Ironically, culverts that prevent fish passage may also protect populations of native species by excluding introduced predator species.

On the Coconino National Forest, it is currently not known where restriction of migration and movement of aquatic organisms occurs. No surveys of culverts or low water crossings have been conducted to determine where conflicts with aquatic organisms exist. This information still needs to be obtained.

It is currently not known to what extent barriers to migration and movement affect aquatic organisms on the Coconino National Forest. The aquatic organisms on the Coconino National Forest that could potentially be affected by barriers include: Little Colorado spinedace, Chiricahua leopard frog, Razorback sucker, Spikedace, Loach minnow, Gila chub.

Channel crossings by roads and culverts designed to allow uninterrupted stream flow may also affect the morphology of small tributary streams, as well as limit or eliminate fish passage due to incorrect culvert placement and slope angle. Indirect effects of roads on channel morphology include the contributions of sediment and altered streamflow that can alter channel width, depth, local gradients, and habitat features (pools, riffles) for aquatic organisms.

AQ(11): How does the road system affect shading, litterfall, and riparian plant communities?

See AQ(5). The nature, frequency, and intensity of organic or non-organic materials inputs in different zones between road and riparian areas occur as a result in the introduction of a road system in a natural setting. A road ecosystem does exist and may provide ecological niche areas for plant communities in some locations as a result. A road system can exacerbate conditions by altering an already dynamic environment. For example, road systems can increase noxious weeds or non-native plants into riparian areas introduced via vehicles or people. Or cause a change in the nature of lateral migration in a channel affecting riparian plant communities.

AQ(12): How and where does the road system contribute to fishing, poaching, or direct habitat loss for at-risk aquatic species?

The existing road system on the Coconino National Forest is considered to be adequate for access to fishing waters by sportsmen. It is unknown how much poaching of fish occurs on the Coconino National Forest.

Habitat loss for at-risk aquatic species occurs where the road prism results in direct or indirect loss of habitat. Direct loss of habitat results from the placement of roads in or near streams and riparian areas. For example, loss of stream habitat can occur by the placement of culverts in a stream, where a culvert and associated fill replaces native streambed materials. Encroachment of the road prism along streams also indirectly affects habitat by reducing riparian habitat that provides food, and shade that helps cool stream waters. In addition, added silt from roads that run parallel to streams affects spawning habitat by covering gravel beds and suffocating eggs and larvae. Roads that rank as a high risk for watershed values will likely be a high risk for aquatic species as well.

AQ(13): How and where does the road facilitate the introduction of non-native aquatic species?

The introduction of non-native aquatic species will likely be greater where access to waters is made easier. The introduction of non-natives, such as bullfrogs, goldfish, sunfish, and bait bucket minnows often occurs where access is easier and faster. Waters located along passenger roads are more likely to receive non-native introduced species than waters located in back country areas or along more rugged high clearance roads. In addition, waters with high recreational fishing use will tend to receive more bait bucket introductions that waters located in back country areas where access is limited to foot travel.

The status of non-native aquatic species has not been fully assessed on the Coconino.

AQ(14): To what extent does the road system overlap with areas of exceptionally high aquatic diversity or productivity, or areas containing rare or unique aquatic species or species of interest?

Analyses as to the extent in which roads overlap with areas of exceptionally high aquatic diversity or productivity have not been conducted to date on the Coconino National Forest.

Water Production (WP)

WP(1): How does the road system affect access, constructing, maintaining, monitoring, and operating water diversions, impoundments, and distribution canals or pipes?

There are only a few of these situations on the forest but certainly the level 3, 4 and 5 roads on the forest provide the needed access to administer these facilities.
Poorly designed roads or roads having close proximity to streams can affect road access where problem roads can wash out. Poorly designed roads in geologically unstable areas,

areas prone to erosional problems, or inadequate number of culverts to help relieve pressure of water exiting roads, problem culverts areas can increase difficulty for access when roads are regularly affected during intense rainfall events.

WP(2): How does road development and use affect water quality in municipal watersheds?

Road development can impact nearby streams when newly constructed roads are required. Temporary impact to stream waters can be seen from ground disturbing activities during road development. Road development has the potential to impact water quality but not necessarily affect water supply quality in a municipal watershed. Its significance in impact to water quality is dependent on the amount of road use, seasonal weather events, and road density values.

Municipal watersheds that have high road density values whose roads are unpaved can increase the potential for sedimentation and turbidity to streams and impounded waters such as dams. This is due in part to the greater acreage of exposed roads that are subject to erosion and vehicle use releasing sediment or fines into stream waters during heavy precipitation events. During dry periods where roads are accessed often by the public where swirls of dust from passing vehicles settle out on nearby plants and are subsequently released into the streams during rainfall events.

Watersheds with high road density values can also increase the timing and flow of stream waters increasing the potential for sedimentation impact from the scouring effects of flowing stream waters against banks and greater carrying capacity of sedimentation by streams. This may increase the need for dredging of sediments from dams or increased filtration requirements for piped-in drinking water supply. Roads in close proximity to streams have an added but increased risk in the introduction of sedimentation and fines into stream channels. Paved roads may contribute water quality problems from oils from passing cars, salting of roads during winter to help keep roads free from snow and ice, and the increased risk of accidents due to higher speed limits where cars, trucks, or tractor trailers may contribute the release of harmful liquids into nearby streams.

WP(3) How does the road system affect access to hydroelectric power generation?

There is limited hydroelectric power production on the forest

Terrestrial Wildlife (TW)

TW (1): What are the direct effects of the road system on terrestrial species habitat?

Vehicle travel is presently occurring both on and off roads on public lands as permitted by forest and resource management plans. Some level of impact is occurring to wildlife wherever this travel is allowed. Factors such as habitats and species present, density of species, location of travel in relation to important habitats, time of year or even time of day, amount of vehicle travel, and a myriad of other factors could apply in determining what and to what extent impacts are occurring.

A number of literature reviews, including the Grand Canyon Trust's Ecological Impacts of Roads in the Greater Grand Canyon (Brown et al. 2001), contain an exhaustive listing of research, much of which relates to vehicular effects on wildlife. Effects to wildlife from roads include habitat fragmentation; isolation of rare and unique habitats, collisions with animals causing death and injury; physical destruction of habitats; disruption of corridors, abandonment of home ranges or habitat features such as nests; and physiological penalties resulting from vehicular harassment.

When located under an open canopy, a simple linear strip of dirt or gravel can function as a physical or psychological hindrance to the movements of animals (Stamps et al. 1987). Certain facets of the biology and life history of reptiles and amphibians, such as poor dispersal capability and small home ranges (Stebbins and Cohen 1995, deMaynadier and Hunter 2000) make them especially prone to fragmentation of their habitat (Gilpin 1987). Habitat dividers such as roads contribute to slowing or reduction of gene flow between populations. Thus vehicular activity associated with social and designated roads may have a negative impact on these species. Nash et al. (1970) reported that loud noises immobilized sensitive leopard frogs. Another study (Busack and Bury 1974) showed that OHV use adversely affected desert lizard populations through loss of cover and food sources, as well as disturbing social structure. Reptiles and amphibians also tend to be less mobile than other groups of animals, increasing their chances of being killed directly by motorized wheeled vehicles on or off roadways. Research shows a decreasing trend in the number of frogs and toads per kilometer as traffic intensity increases (Fahrig et al. 1995). Continual use of an area, whether high or low intensity, may reduce recruitment of species that are slow to sexual maturity or have naturally low recruitment rates (Bury et al. 1977).

Small mammals are also susceptible to death or injury from collisions with off road vehicles (Taylor 1971, Oxley et al. 1974, Lode 2000, Berry 1980, Bury 1980, Bury et al. 1977). Small lightly trafficked roads, such as those that may be created by OHVs, have also been shown to strongly inhibit the movements of species such as voles (Swihart and Slade 1984, deMaynadier and Hunter 2000). Other impacts of OHVs on small mammals include habitat destruction and disturbance (noise, presence of humans, etc.). In the desert, noise from a single OHV may be heard for a 2-4 km (1.2-2.4 mi) radius (Rennison and Wallace 1976), and may be considered a form of harassment (Bury 1980). Kangaroo rats are deafened by even intermittent OHV noise, making them vulnerable to predation (Berry 1980, Lovich and Bainbridge 1999). OHVs can also collapse burrows (Bury et al. 1977, Bury 1980). Destruction and/or damage of vegetation indirectly affects small mammals by removing vital sources of food and cover. According to Bury et al. (1977), density, diversity and biomass of small mammals is inversely related to the level of OHV use in an area. Impacts to these species may be felt high up the food chain, as they form a prey base for many larger predators.

It is likely that disturbance also has long term and cumulative effects on small mammals. These often include abandonment of disturbed areas for undisturbed ones (Knight and Cole 1991), altering the natural range of a species or pushing species away from higher quality habitat. Disturbance may also reduce vigor (Knight and Cole 1991). Elevated heart rates and energy expended fleeing disturbances will elevate total energy expenditures or decrease energy acquisition. This may result in increased frequency of sickness, disease and potential death for small mammals (Knight and Cole 1991). Although these responses have been suggested, evidence remains largely circumstantial (Hutchins and Geist 1987).

Studies show that many raptors demonstrate sensitivity to disturbance as well. The presence of people and motorized wheeled vehicles has especially damaging impacts during nesting and incubation. Even mild disturbances can cause golden eagles and ferruginous hawks to abandon nests, exposing eggs or young to the elements, starvation or predation (Richardson et al. 1999, Sachet 1988). Fewer young are fledged from disturbed nests, which oftentimes remain unoccupied in subsequent years (White and Thurow 1985). Kahl (1972) cites examples of young osprey frightened into premature flights. Other raptors exhibit similar responses (Sachet 1988, Berry 1980). Humans can also stimulate alterations in raptor behavior outside of the breeding season. Disturbing birds while foraging or flushing birds from day or night roosts can enhance physical strain in times of prey scarcity and/or severe weather (Holmes et al. 1993, Stalmaster 1987, Stalmaster and Newman 1978, Bueler et al. 1991, Grubb et al. 1992).

Habitat fragmentation has long been established as a primary factor in the decline of songbirds. While forest roads and trails are not always wide enough to be considered sources of fragmentation in themselves (Rich and Dobkin 1994, Theobald 1998, Paton 1994), cumulatively, the convoluted network of lesser roads created by motorized wheeled cross country travel can mimic effects typically associated with habitat fragmentation (Rich and Dobkin 1994). These effects include reduction in habitat quality (Ortega and Capen 1999) and conversion of forest interior habitat to edge habitat. The creation of edges may influence species diversity by reducing habitat for forest interior species like the brown creeper and generating habitat for generalist species (Jones et al. 2000, Boren et al. 1999). Increases in predation and decreases in nest success have also been linked to edges (Paton 1994, Reed et al. 1996). Since so many songbird species are riparian obligates, fragmentation effects in these areas may be especially severe on a landscape perspective (Hamann et al. 1999).

Motorized wheeled cross country travel impacts gamebirds and waterfowl such as turkeys, ducks and quail through vegetation destruction, resulting in a loss of food and cover, as well as damage to bedding and nesting areas. Direct crushing of eggs laid by ground nesting species may occur as well. The increased mobility allowed by OHVs can also intensify hunting pressures (Holbrook and Vaughan 1985), and accounts from Bury (1980) connect heavy OHV use to declines in quail populations. Ducks are also susceptible to disturbance, and may not nest if agitated during key periods of the breeding cycle (Hamann et al. 1999).

Ungulates such as deer, elk, and pronghorn antelope suffer physiological effects from motorized wheeled vehicle disturbance. During critical periods such as winter and breeding, these effects can be especially detrimental. Nelson and Leege (1982) report that nearly 40% more food is required for survival in the winter; few winter ranges can support such a large forage increase (Canfield et al. 1999). Even healthy animals are physically strained by lack of forage, snow and cold temperatures, and weight loss is common in normal winters on the most productive ranges (Canfield et al. 1999). Recreational disturbances force additional energy expenditure from ungulates by stimulating physiological responses such as increased metabolism and heart rate (Chabot 1991, Geist 1978). Studies have confirmed this occurrence for white-tailed deer (Moen et al. 1982, Moen 1978), elk (Chabot 1991, Lieb 1981) and mule deer (Freddy 1977, Weisenberger et al. 1996), as well as other species. Cumulatively, the effects of harassment along with other winter hardships may result in increased vulnerability to predation, disease or death (Geist 1971a,b, Berwick 1968, Legg 1999). Disturbance-induced energy expenditure is costly to ungulates in summer as well when males are developing antlers or horns, and females must provide milk for young. Summer also marks the time when animals must accumulate precious fat reserves to endure the winter.

Disturbance-induced displacement from important habitats serves as a long term influence on ungulates. Many studies have shown that vehicle traffic on forest roads makes habitats near the road less available for elk use (Rost 1975; Edge 1982; Lyon 1979a, 1983; Edge and Marcum 1985, 1991; Marcum and Edge 1991). Lyon (1983) states that for two miles of road per square mile open to vehicular traffic, the impacted area could easily exceed half of available elk habitat. Swan (unpubl. data) reports a three-fold reduction in ungulate use in an area with heavy OHV activity. Repeated displacement may also result in a decline in calf survival during elk calving season (Phillips 1998). Displacement from water sources can be detrimental to ungulates as well as other wildlife species, particularly in the desert southwest where water is limited. Canfield et al. (1999) suggest that recreational use may alter the migratory movements of ungulates such as deer and elk.

TW (2): How does the road system facilitate human activities that affect habitat?

The current road system, including social roads, facilitates access into remote and otherwise inaccessible areas of Fossil Creek. Once an area is accessible by vehicles, it becomes open to a variety of activities including recreation, range/livestock improvements, forest product gathering, hunting, off-road vehicle use, mining, ruin exploration, etc. The types of activities substantially increase when roads provide access to riparian areas. Riparian areas attract a wide variety of recreational activities including camping, picnicking, swimming, fishing, hunting, and rafting/canoeing, among others. Increased human presence in the Fossil Creek area increases the: loss of soil stabilizing ground cover and native plant species; amount of habitat modified and destroyed; and introduction and spread of invasive plants.

Off road vehicular use including parking along system roads results in the destruction and eventual loss of native plants. As off road use occurs over time in the same area, soils become compacted decreasing the potential for re-establishment of native plant species and increasing the potential for establishment of undesirable invasive plant species. This loss of habitat can cumulatively lead to fragmentation of habitat, isolation of rare and unique habitats, physical destruction of habitats; disruption of corridors, and abandonment of home ranges or habitat features such as nests.

Both vehicles and people are excellent vectors for seed spread, and the increased access allowed by roads provides opportunity for exotic plant invasion in weed free areas. Exotic plants out-compete native flora, creating monocultures and reducing plant biodiversity. In this way weeds reduce the quality and quantity of forage for ungulates and other species. Many weed species contain chemicals that are toxic to wildlife. Uncontrolled, these plants can easily infest and take over vast expanses of forest land, influencing biological processes and altering the appearance of the landscape. The remarkably invasive nature of exotic weeds generates a high potential for serious wildlife habitat impacts, and should be viewed as a threat to the entire ecosystem.

TW (3): How does the road system affect legal and illegal human activities (including trapping, hunting, poaching, harassment, road kill, or illegal kill levels)? What are the effects on wildlife species?

Legal human activities are addressed above.

Roads, both social and system, provide hunters entry to previously inaccessible areas, as well as increased mobility. These two factors have contributed to acts of poor sportsmanship. Land managers in Montana report that most illegal OHV operations occur during hunting seasons (B. Walker, MT Fish, Wildlife and Parks at OHV & Hunting Summit 2000). Using decoy elk and deer, northern Arizona law enforcement officials documented numerous examples of roadside hunting, including shooting from vehicles (Bancroft 1990). Researchers in Flagstaff and the White Mountains also observed hunters shooting from vehicles, and concluded that high road densities in turkey habitat is likely a factor in turkey mortality (Jones and Barsch). Pronghorn hunters have reported other hunters herding antelope from OHVs and shooting into the herd from long distances (Canfield et al. 1999). On top of being unethical, these actions can lead to artificially high levels of hunter success and the resulting over-harvesting of animals (Posewitz 1994). It may also result in fewer hunting opportunities for other sportsmen.

In addition, road access increases the potential for off-road vehicle travel, illegal gathering of forest products, dispersed shooting or target practice, and unintentional damage from exploration of Indian ruins, which also serve as wildlife habitat, particularly for roosting bats. The effects of these activities on wildlife species are addressed under TW1, above.

TW (4): How does the road system directly affect unique communities or special features in the area?

Roads provide access to bald eagle breeding areas within the 5th code watershed. Because of the road system and the access it provides to the Verde River, the Forest Service has had to create a closure area to prohibit vehicular access to the Verde during the bald eagle breeding season. The presence of humans can disturb nesting bald eagles.

Roads also provide access to several areas with sensitive plant populations. These species include Heathleaf wild buckwheat and Verde Valley sage. Heathleaf wild buckwheat is an inconspicuous plant and therefore is easily trampled, even by unintentional recreators. The Verde Valley sage is a very showy plant during its blooming period and many similar species have been domesticated and used as ornamentals. Verde Valley sage is subject to collection due to its aesthetic appearance. Roads providing access into areas with these two plants increases the chance for trampling and collection.

The Chiricahua leopard frog, a threatened species, occurs in livestock tanks in the Buckskin Hills area. The majority of the Coconino's occupied sites occur within this watershed. Since these tanks require maintenance, the roads leading to these tanks have been retained and incorporated into Forest roads system. Access to these tanks is greatly facilitated by these roads and visitors to these tanks can introduce and spread nonnative fish and crayfish from tank to tank. These non-natives are extremely detrimental to the Chiricahua leopard frog and most oftentimes result in the extirpation of the frog from the infested tank. In addition to facilitating access, the road system amongst these tanks can allow for the spread of Chytrid fungus vehicles spread mud from tank to tank. The Chytrid fungus is deadly to Chiricahua leopard frogs and this fungus has recently been discovered in at least one tank in the Buckskin Hills area.

Various roads occur within 200 meters of a peregrine falcon eyrie. Not only can vehicles disturb nesting peregrines, by road provides access closer to the actual eyrie where recreational activities could further impact nesting birds.

While no roads occur within Mexican spotted owl protected activity centers (PACs), it is only because the owls nest in steep, inaccessible canyons. However, many of these roads end at the canyon rim and may contribute to increased instances of people hiking into the canyons.

Fossil Springs is accessed by vehicle by the flume road. While vehicular access is limited to authorized personnel, the road is recognized by the public as a trail and therefore use it to access the Fossil Springs area. In addition, ongoing planning for the area may result in the retention of the road for use as a trail in the future. Many riparian species have only been detected at the Springs and not along the remainder of Fossil Creek. The sensitive lowland leopard frog has only been detected in all life stages above the dam. The Fossil Springs population of lowland leopard frogs represents about 90% of the Coconino's lowland leopard frogs. One of the few known black hawk nesting areas occurs at the spring. The common black hawk is a sensitive species and is highly susceptible to disturbance from recreational activities occurring near their nest locations.

Both the hairy woodpecker and warbling vireo, both MIS species, have only been documented at Fossil Springs. In addition, the sensitive Fossil spring snail occurs only in the springs associated with Fossil Springs.

Many species of rare reptiles, amphibians, invertebrates, and birds are riparian dependent and occur or have the potential to occur along Fossil Creek. Sensitive and MIS birds documented along Fossil Creek include common black hawk, yellow-billed cuckoo, Bell's vireo, yellow-breasted chat, Lucy's warbler, summer tanager, hooded oriole, and western wood pewee. These species, particularly during critical seasons, can be disturbed by recreational activities (see discussion under TW1). High levels of disturbance can not only cause site abandonment for that year but can also render an area unsuitable for subsequent years.

Based on a preliminary review of sensitive invertebrates, much of the watershed provides habitat for various invertebrates' host plants. Upland host plants such as agave, buckwheat, and cliffrose occur throughout the watershed and where the host plants occur, there is potential for two sensitive skippers, one agave borer, the Early elfin, and Comstock's hairstreak. Riparian host plants such as cottonwood, willow, and violets indicate the potential presence of three sensitive butterflies. Roads, road maintenance, and activities facilitated by road access can all result in the destruction of sensitive invertebrate host plants and any invertebrates found on those host plants.

Sandy terraces adjacent to perennial water provide suitable habitat for several tiger beetles. While none are known to occur in the area, no surveys have been conducted specifically for these beetles. Therefore, any sandy terraces have the potential to support sensitive tiger beetles. There are many non-system roads that access the riparian areas and occur along these sandy terraces. Vehicular use can result in the destruction of burrows and mortality to tiger beetles.

Elk, antelope, deer and javelina are abundant with elk and antelope occurring above the rim and deer and javelina throughout the watershed. There are many roads in the uplands, mainly those accessing livestock tanks, which are used extensively by hunters. These roads increase access into the area and increase the frequency of hunter/game interactions. Refer to TW3 for further discussion.

Minerals Management (MM)
MM(1): How does the road system affect access to locatable, leasable, and salable materials?

While most of the analysis area is open to mineral location under the mining laws, there is little activity in the area. The geology in this area does not appear to contain precious metals or unique minerals that would warrant exploration and development under the Mining Laws. The existing level 2 and 3 road system could provide access for exploration activities, if proposed. There are no known existing mineral operations authorized in the project area that require access.

Leasable minerals have not been identified or analyzed for potential lease in this area. Again, due to lack of interest by the Bureau of Land Management and energy related companies, the geology does not indicate presence of leasable minerals.
Saleable minerals (mineral materials) are subject to Forest Service rules and regulations. Therefore it is a discretionary action to sell minerals. This area may contain resources for mineral materials but there are no current operations or approved public use gathering sites in the area. The Fossil Creek mineral pit along FR 708 is used by the Forest Service for road base material to maintain the level 3 road. Access to this site is directly from the main level 3 road and needed for continued maintenance of FR708. No other sites have been identified in the area. If additional new material sites are needed by the Forest Service in this area, road access would be considered based on resource issues and road maintenance would occur as needed to provide access. We do not expect new operations except possible small administrative use areas.
The project area includes congressionally designated Fossil Creek and Mazatzal Wilderness areas and the Verde Wild and Scenic River. These areas are withdrawn from mineral entry under the mining laws and are not subject to occupancy under leasing regulations. Any mineral operations proposed in the future would consider use and need for roads in this area, as well as how the proponent would take responsibility for any roads needed for these mineral operations and likely be limited for that particular.

Range Management (RM)

(RM1): How does the road system affect access to the range allotments?

The main road system consisting of Forest Road 708 and 502 are vital for access to the area and are a must for efficient management and administration of the Hackberry/Pivot Rock and Fossil Creek permitted livestock grazing allotments. These two roads under the current road system allows for reasonable access with large vehicles to these range allotment's winter range pastures.

These roads provide access to the area for the grazing permittees and the Forest Service range personnel to provide livestock management and rangeland administration. The permittee must be able to meet standards and guidelines of rangeland management and resource protections measures as required by their Ten-Term Grazing Permit, Allotment Management Plan and Annual Operating Instructions. Forest range resource program administrators must determine compliance and adherence to livestock and rangeland resource management policies and standards. Forest Service personnel must be able to monitor, inspect and evaluate range conditions on a regular basis to effectively administer existing grazing permits, complying with Regional and Forest Land Management Plan Standards.

Range permittees frequently transport cattle and horses in large trucks and stock-trailers on these two main system roads.

Access to isolated range structural improvements in these two range allotments is limited by the steep terrain of the general area. Historically, as range improvements were implemented or constructed within the allotments and frequently two-track roads were pioneered into these remote areas for the creation stock tanks or other water sources. Often general publics created new roads or improved the crude routes of access into areas or water sources to access favorite hunting or recreation areas. These two-track roads were often poorly located and their use has caused soil/watershed resource concerns due to erosion.

The landscape planning analysis' Alternative A identifies three two-track roads to closed or obliterated due to resource concerns. These Forest Roads include: 9206W, 502E and 9248C. Two of these roads, (9206W and 502E) provide the permittee sole access to key livestock water sources. Forest Road 9206 W accesses two water sources Quail Springs and Quail Tank. Forest Road 502E provides access into Buzzard Tank and Chalk Spring and the Chalk Springs Pipeline (three miles of pipe with six trough/drinkers) complex.

Closure and obliteration of Forest Road 9248C poses no issues or concerns to the permittee. But this road does provide access to a permanent range trend plot (Parker Three-Step Cluster #14) which is re-read every decade for analysis of rangeland condition class and trend. But because the plot location is approximately ¼ mile from the maid system road FR708, the plot can be easily accessed by foot when monitoring and analysis is required.

Closure and obliteration of Forest Road 9206W would eliminate the grazing permittee's road accesses Quail Tank, which has been routinely cleaned and maintained by the ranch at a interval of 10-11 years. Access for maintenance of the tank is possible without the existing road but the access would have to be cross-country by a crawler-tractor and/or a front-end loader. This road presently provides District range personnel access to a permanent range trend plot (Parker Three-Step Cluster #17) which is re-read every decade for analysis of rangeland condition class and trend. The Fossil Creek and Hackberry/Pivot Rock Parker Three-Step Clusters were re-read in 2000-2001 and are not scheduled for analysis again until 2010 or so. During NEPA evaluation of the allotment's 10 year management plan, a full analysis of rangeland resources are typically completed, and if the cluster data is greater than 5-6 years old the clusters are generally reread so current data is assessed in the planning process.

Closure and obliteration of Forest Road 502 poses a great concern to the grazing permittee. Loosing this road access the grazing permittee would stop access to Buzzard Tank, Chalk Spring and the Chalk Springs Pipeline complex. Constructed in the early 1980's the Chalk Springs Pipeline is vital to the grazing of the Chalk Springs Pasture. In the fall of 2002 the permittee reconstructed the spring box; this major maintenance project has occurred on a 10-12 year interval and has been accomplished with a rubber-tired backhoe. This spring services three miles of pipeline with six livestock drinkers, which function to distribute the permitted livestock. Annual maintenance of the spring box is common as woody plant's roots clog the pipe restricting the water flow of the pipeline. The Chalk Springs Pasture typically has been grazed annually for a 30 day time period usually in January or February. The ranch monitors the springs and troughs every 2-3 days during the 30 day period, and twice a year or less the permittee uses a pickup vehicle to access the area to carry in supplies and tools that can not be carried on a horse.

Following the construction of the Chalk Springs Pipeline project a gate was constructed on the road below Buzzard Tank. The purpose of the gate was to restrict vehicle traffic on the second half of the road past Buzzard Tank; giving the permittee the sole use of the road. This minimized the recreational traffic and reduced resource damage. However, within 10 months of the gate construction it was pulled out of the ground with a vehicle winch, and it was never replaced. The permittee believes that a second gate could be installed and if properly anchored it could stop unwanted vehicle traffic. To date the permittee is evaluating the maintenance cost of the last one and half miles of this road following a gate closure. They certainly would not agree to maintain the road if it was still left open for the general public to use.

If this road is totally closed, access to Buzzard Tank will be eliminated. This closure will make tank maintenance more difficult and may pose problems if equipment is walked cross-country for routine maintenance. Buzzard Tank serves as a livestock water source for four pastures, and it is very important for distribution to a big percentage of the allotment's winter range use. So the ability of provide stock tank maintenance, insuring the integrity of the tank, is very critical to the Fossil Creek Allotment

The Forest Road 502E provides District range personnel access to a permanent range trend plot (Parker Three-Step Cluster #16). If this road was closed in full or in part it would restrict the access to the long-term-trend cluster plot location. This would make access for monitoring and analysis to the cluster difficult and time consuming.

Rangeland management and livestock grazing activities are certainly one of the many uses of the Coconino National Forest that have grown dependent on the current road system to manage livestock operations to the intensity that is required today. Without these roads there is no doubt the cost and complexity of proper managing the Hackberry/Pivot Rock and Fossil Creek range allotments would increase.

Special-Use Permits (SU)
SU (1): How does the road system affect managing special-use permit sites (concessionaires, communications sites, utility corridors and so on?)

The project area includes several permitted activities, including utility corridors, small communication sites and a hydropower project. Road access has developed in this area as a result of construction access routes to utility lines and the hydropower facilities. Although access to each power pole is not required by the permit holder, access along the corridors is needed at various times to conduct maintenance or repair activities. In some cases, vehicle access may not be allowed if conditions on the road require substantial reconstruction of a non-system track. Alternative access methods could be required in these locations.
A communication site on Ike's Backbone continues to require low level access on a level 2 roadway. The need for access to that location is limited, however the permit holder does prefer vehicle access to this site. In addition, the Forest Service has an air quality monitoring station associated with this facility that requires access.

The hydropower project is spread throughout the Fossil Creek immediate area. There are various access routes to project facilities. These routes are used for maintenance and operation of the hydropower plants. Many of these routes are maintained by Arizona Public Service. Future decommissioning of the plants could allow for access roads to be closed to some locations.
There are smaller special use permits in the area that include stream gages or flood control monitoring stations that are accessed from existing roadways. These facilities are primarily remotely operated once the initial construction is complete. Occasionally maintenance access is needed.
Other shorter term special use permits for recreation events or guiding activities (river running guide) occur in the area. Their access is limited to existing roads subject to the terms of their permits. Permit operation plans could include maintenance requirements for roads if the operations warrant.
While there is no special use permit or easement granted for the main road (FR708) in this area, there is a piece of private property near the bridge crossing of Fossil Creek in Yavapai County. The county has included FR708 in its maintenance agreement with the Coconino National Forest because of this private property. The Forest Service must allow reasonable access to private property inholdings under current laws. However, responsibilities for road maintenance, the road standard needed, resource protection requirements and location of road can be determined by the Forest Service and part of any future needed authorization for a road access.

Unroaded Recreation (UR)

UR (1): Is there now or will there be in the future excess supply or excess demand for unroaded recreation opportunities?

There will be an excess demand for unroaded recreation opportunities in the future. The proof of this is the increase in "social trails" along Fossil Creek, Fossil Springs, major canyon bottoms, the Verde River, archaeological sites, stock tanks and dispersed campsites. Water and "icon" types of destinations, i.e. Fossil Springs, Childs, archaeological sites attract visitors for unroaded recreation opportunities. There is and increasing demand for Forest Service System Trails in the area. For example, the increased historic and recreational interest in a soon to be opened section of the Mail Trail, the Towel Creek Trail, the Falls Trail on the Verde, the General Crook Trail, the Hackberry Trail and others. Demand for un-roaded ATV trails has always been high in the area with hunting seasons spanning the entire year.

There are no plans to construct roads in the inventoried roadless areas (areas larger than 5000 acres). Closure of the Chalk Springs, Quail Springs and Sally May roads and maintaining existing road closures throughout the area will increase the supply of unroaded opportunity. The supply of unroaded recreation opportunities in inventoried roadless and designated wilderness areas will be unchanged. As population increases all types of recreation, including un-roaded is expected to increase. Last year in the Phoenix area over 90,000 ATV's were sold. This is one of the areas they use.

UR (2): Is developing new roads into unroaded areas, decommissioning of existing roads, or changing the maintenance of existing roads causing substantial changes in the quantity, quality, or type of unroaded recreation opportunities?

Decommissioning of existing roads is increasing the quantity, quality and type of unroaded recreation opportunities in the Fossil Creek-Lower Verde 5th order watershed. These decommissioned roads turn into multiple purpose trails. Numerous roads have been closed in the Fossil Creek-Lower Verde 5th order watershed. These closed roads often get re-opened illegally and revert back into open roads. It often takes years before they are closed again. Decommissioned roads continue to look like roads except they are closed. Decommissioned roads that are re-habilitated and returned to a natural state to match the pre-existing topography can often do more to improve un-roaded recreation opportunities than closed roads that still look like roads.

Road maintenance has slowly decreased for many years in the Fossil Creek Watershed. With the reduction in fuel wood and timber cutting, harvest road construction and maintenance has decreased. This has increased unroaded recreation opportunities. With the decommissioning of the Childs-Irving Hydroelectric Facility road maintenance by APS will decrease and unroaded recreation opportunities will increase.

UR (3): What are the adverse effects of noise and other disturbances caused by developing, using, and maintaining roads, on the quantity, quality, and type of un-roaded recreation opportunities?

There will be very few effects of noise because there will be road development. There may be some short term effects during decommissioning of the power plant and road closure work.

UR (4): Who participates in unroaded recreation in the areas affected by constructing, maintaining, and decommissioning roads?
Hunters, fishermen, campers, swimmers, hikers, ATV riders and backpackers participate in unroaded recreation in the Fossil Creek-Lower Verde 5th order watershed. Fuel wood gatherers (although mostly non-recreation users) also are affected by road construction, maintenance and decommissioning.

UR (5): What are these participants' attachments to the area, how strong are their feelings, and are alternative opportunities and locations available?

Participant attachment is strong in the Fossil Creek-Lower Verde 5th order watershed. "Special Places" such as Fossil Springs, Verde Hot Springs, the Verde Wild and Scenic River, the Irving-Childs Hydroelectric Facility, Fossil Springs Wilderness, the Mail Trail, Baker Butte and Yavapai-Apache Traditional Cultural Properties all have strong attachments to groups and individuals. There is no place in the world like this location. Alternative locations are either not available or so far away that they are not feasible.

RR (1): Is there now or will there be in the future excess supply or excess demand for roaded recreation opportunities?

There will be an excess demand for roaded recreation opportunities in the future. Arizona is one of the fasted growing states in the nation and Yavapai, Coconino and Gila Counties are growing rapidly also. Visiting outstanding scenic areas has always ranked near the top in the "Arizona Outdoor Recreation Needs Survey". This activity requires good roads as do most recreation activities. The population increase will continue to drive up demand for roaded opportunities particularly in the Fossil Creek-Lower Verde 5th order watershed which is within one and one half hours of the Phoenix Metropolitan Area.

RR (2): Is developing new roads into unroaded areas, decommissioning of existing roads, or changing maintenance of existing roads causing substantial changes in the quantity, quality, or type of roaded recreation opportunities?

Most of the development of new roads into the area is from dispersed campers, hunters and four wheel drivers who are pioneering roads into previously unroaded areas. Although this increases the quantity of roaded recreation opportunities it reduces the quality by directing drivers into "dead end" roads with no maintenance, trash and damage to soil and vegetation resources.

There is almost no development of new roads in the area. Maintenance has very little effect on quantity of roaded recreation opportunity in the area. Visitors continue to arrive regardless of maintenance level. Quality and type of roaded recreation opportunity varies substantially with maintenance. Maintenance interval regularly reduces quality or roaded experience because roads can go from "passenger car friendly" to pick-up truck only between maintenance intervals. Many level 2 roads in the area are now "four wheel drive and/or high clearance only" due to poor maintenance.

RR (3): What are the adverse effects of noise and other disturbances caused by constructing, using, and maintaining roads on the quantity, quality, or type of roaded recreation opportunities?

There is little effect. Construction, use and maintenance levels are relatively low in the Fossil Creek-Lower Verde 5th order watershed. Use levels during peak use weekends can be high along FR 708 and 502. Peak use weekends such as Easter, Memorial Day, Fourth of July and Labor Day can adversely effect roaded recreation opportunities.

RR (4): Who participates in roaded recreation in the areas affected by road constructing, changes in road maintenance, or road decommissioning?

Swimmers, hot spring bathers, ATVers, campers, fishermen, sightseers and hunters comprise the majority of the recreationists.

RR (5): What are these participants' attachments to the area, how strong are their feelings, and are alternative opportunities and locations available?

Attachments are strong. Water based recreation opportunities particularly perennial flowing streams, rivers and hot springs are very rare in Arizona. Alternative locations are not available. People are very attached to "special places" located in the area such as Fossil Springs, Childs, the Verde Hot Springs, the Mogollon Rim, Traditional Cultural Properties and other sites within the area.

PV (1): Do areas planned for road constructing, closure, or decommissioning have unique physical or biological characteristics, such as unique natural features and threatened or endangered species?

The areas being considered in the roads analysis may contain historic roads or roads that have yet to be evaluated for historic properties. Some of the roads would fit the criteria of physical characteristics or setting that are of unique values. Each road will need to be individually assessed for risk levels to each cultural property.

PV (2): Do areas planned for road construction, closure, or decommissioning have unique cultural, traditional, symbolic, sacred, spiritual, or religious significance?

Several groups, including the Yavapai Apache, and people who have lived on, hunted, gathered, ranched, logged or farmed in the area, claim affinity for the land that is now the Fossil Creek Planning Area. The Yavapai-Apache tribe has identified various parts of the planning area as having cultural, spiritual and religious significance. Local ranchers have expressed a value for their traditional land-based lifestyle. And the people involved with the construction and maintenance of the Childs-Irving Hydroelectric facilities also have expressed a value for the hydroelectric facilities. Some "traditional cultural properties" (TCPs) have been identified.

The "Flume Road" above Irving is of special concern in this planning area – the road is historic in age and intrinsically tied to the construction, maintenance, and production of the hydroelectric system. FR 708 is also historic in age and has functioned as a transportation artery in the past – between the residents of Camp Verde and Strawberry/Payson. An archaeological survey has been conducted of the Flume Road and the cultural properties identified along its route. No archaeological survey of FR 708 has been conducted, however there are many cultural properties identified adjacent to the portion of the road that is adjacent to the creek and in several other areas along its route. There are also several jeep and social roads in the section of the road along the creek that access campsites that bisect archaeological sites. A few other jeep/access roads and social roads also exist within the wider planning area that will have to be evaluated because they are in high site density areas or high site probability areas.

PV (3): What, if any, groups of people (ethnic groups, subcultures, and so on) hold cultural, symbolic, spiritual, sacred, traditional, or religious values for areas planned for road entry or road closure?

Same as PV (2).

PV (4): Will constructing, closing, or decommissioning roads substantially affect passive-use value?

Yes, since there are so few roads in the planning area any closures or decommissioning will have an effect on the use. For example, the Flume Road is a possibility for closure during this planning process – this will effect how the Fossil Springs area is accessed. It will affect how the range allotment is managed and how ranch access to the area is accomplished. Spur and access roads that are closed due to resource needs or as part of the planning process will also effect how the area is used – for example, hunting and ranching access will be limited.

Social Issues (SI)

SI (1): What are people's perceived needs and values for roads? How does road management affect people's dependence on, need for, and desire for roads?

Since the roads in the planning area have been in place for so long, there is a perception of the planning area that is intrinsically tied to road placement. Any change in the number of roads or the alignment of those roads is sure to cause concern among the historic users of the area.

SI (2): What are people's perceived needs and values for access? How does road management affect people's dependence on, need for, and desire for access?

Road management is critical for access to this remote area. Road maintenance levels have been improved by the presence of APS and their need for a certain level of access for their fleet of vehicles. Maintenance of FR 708 will be/has been perceived by many users as of primary importance.

SI (3): How does the road system affect access to paleontological, archaeological, and historical sites?

The road system allows access to paleontological and archaeological sites. By providing access prehistoric and historic sites can become targets of overuse, vandalism, illegal collecting, and illegal excavation. Conversely, access provides interpretive opportunities that may counteract the attitudes and behaviors that are detrimental to all kinds of paleontological and cultural properties.

SI (4): How does the road system affect cultural and traditional uses (such as plant gathering, and access to traditional and cultural sites) and American Indian treaty rights?

The road system allows access to cultural properties and areas of traditional use. Often traditional plant gathering is conducted by older Native peoples and would be difficult for them to accomplish without road access. Other kinds of traditional gathering also occur in remote locations that would be difficult to access without system roads.

SI (5): How are roads that constitute historic sites affected by road management?

Road management, within existing alignments, helps to preserve the location and use of historic roads.

SI (9): What are traditional uses of animal and plant species in the area of analysis?

Use of animal and plant species in the Fossil Creek Planning Area dates back to Archaic times. Plants and animals have been and continue to be harvested for food, for medicine, for traditional crafts, and for religious purposes.

Civil rights and Environmental Justice (CR)

CR(1): How does the road system, or its management, affect certain groups of people (minority, ethnic, cultural, racial, disabled, and low-income groups)?

While the road system is used by many different groups of people, there is a lack of known data to document current effects on different groups of people. The current road system does not appear to discriminate against any group or persons based on color, creed, abilities, nationality, or background. All persons are treated equally in policy and management of the National Forest. Travel management is no exception. The rules, standards, and laws that govern how the travel system is developed and used apply equally to all that use it.

The policy holds true for persons with a disability. According to direction set forth in 'Section 504 of the Rehabilitation Act of 1973

"No otherwise qualified person with a disability* in the United States shall, solely by reason of his disability, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance or under any program or activity conducted by any Federal Executive agency or by the United States Postal Service".

7CFR 15e.103(iii)(2)

"Further the person with the disability must be able "to achieve the purpose of the program or activity without modifications to the program or activity that fundamentally alters the nature of that program or activity".

It should be noted that the term "reasonable accommodation" is only used in reference to employment; there is no such requirement for program access.

OHV access by persons with disabilities:

There is no legal requirement to permit a person with a disability to utilize an OHV in any area that restricts or prohibits OHV use under the Forest Plan or the Forest Travel Plan/Transportation Plan.'

' ' Source: Document produced by Janet Zeller, Interim National Accessibility Program Manager on Issue: Legal requirements re accessibility and UDSA Forest Service Programs.

There is an expressed interest by elders of the Yavapai Apache Nation for access to specific locations within the Fossil Creek area for cultural activities. Current access is to the dam area using the Flume Road/Trail. No other specific information is known about other groups expressing interest in this area.

Risks and Benefits of Entering Unroaded Areas

No new road construction is contemplated in currently unroaded areas.

Ability of the Road System to meet Objectives

The road system currently provides adequate access for industrial use and allotment access. It currently provides adequate access to motorized recreation in the area.

Step 5 Describing opportunities and setting priorities

Purpose and Products

The purpose of this step is to:

- compare the current road system with what is desirable or acceptable, and
- describe options for modifying the road system that would achieve desirable or acceptable conditions.

The products of this step are:

- a map and descriptive ranking of the problems and risks posed by the current road system,
- an assessment of the potential problems and opportunities of building roads in a currently unroaded area,
- a map and list of opportunities, by priority, for addressing important problems and risks, and

- a prioritized list of specific actions, projects, or forest plan adjustments requiring NEPA analysis.

Problems and Risks Posed by the Current Road System

Roads were classified as low or high value and low or high risk, according to evaluation criteria developed by specialists on the ID Team. All analyzed roads (or road segments) can then be classified into four categories: 1) High Value, High Risk; 2) High Value, Low Risk; 3) Low Value, High Risk; and 4) Low Value, Low Risk.

Some roads and user-created roads are in sensitive riparian areas, or erosive soils. Additionally, the condition of some roads, especially user-created roads may lead to creation of "detours" that would further impact the area. Some roads in erosive soils increase the hydrologic connectivity ot the watershed, and may be responsible for increased sediment loading to sensitive riparian areas. Roads also may provide motorized access to areas of sensitive or endangered plants, or facilitate disturbance or harassment or harassment of wildlife. The upper part of the watershed, above the Mogollon Rim has areas with road densities in excess of 5 miles per square mile of road. This is clearly above the Forest Plan's started goal of 2 miles per square mile in the Ponderosa Pine type.

Assessment of Building Roads in a Currently Unroaded Area

No new road construction is contemplated in currently unroaded areas.

Opportunities for Addressing Important Problems and Risks

A detailed look at roads in the ponderosa pine type, with special attention to sediment production, road density, wildlife impact, and the seasonal need for dispersed camping and recreation opportunities along AZ-87.

Closure of non-maintained roads that cross erosive soils. Retention of roads that are on stable soils to allow for dispersed camping and recreation. Decommissioning or closure (seasonal?) of non- maintained roads in Riparian or sensitive areas.

NEPA analysis needs

Type away following FS-643 pages 31 through 33

Step 6 Reporting

Purpose and Products

The purpose of this step is to:

- report the key findings of the analysis.

The products of this step are:

- a report including maps, analyses, and test documentation of the roads analysis, and
- maps that show the data and information used in the analysis, and the opportunities identified during the analysis.

Report

Summarize the analysis following FS-643 pages 33 through 35 and complete Table 1.

Maps

Maps are located in the Coconino National Forest Red Rock Ranger District Office, Sedona, Arizona.

Documentation Table for Roads Analysis Process Step 4

Question Number	Addressed in Analysis (Yes/No)	If addressed directly, page number in environmental document; or Forest Plan location or standard and guideline	If addressed indirectly, location in administrative record	If not addressed, rationale or location in administrative record
EF1				
EF2				
EF3				
EF4				
EF5				
AQ1				
AQ2				
AQ3				
AQ4				
AQ5				
AQ6				
AQ7				
AQ8				
AQ9				
AQ10				
AQ11				
AQ12				
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Fossil Creek EcoNotes: A Summary of Current Research Results

Fossil Creek Ecosystem Studies Group, Northern Arizona University, June 2007

Edited by Michele James and Elizabeth Reese

Fossil Creek, located in north-central Arizona, is fed by over 60 springs and is one of a handful of travertine waterways in Arizona. The decommissioning of the Childs and Irving power plants by Arizona Public Service (APS), and the subsequent return of full flows to Fossil Creek on June 18, 2005, after nearly 100 years of water diversion, has created one of the most exciting stream restoration opportunities in the west. It has also provided an unprecedented opportunity for Northern Arizona University (NAU) researchers to study the before and after effects on the aquatic ecosystem, travertine, and human use.

The Native Fish Restoration Project, which took place in the fall of 2004, was also an integral part of the restoration of Fossil Creek. This project, undertaken by multiple state and federal agencies and individuals, removed non-native fish from the upper 9 kilometers of Fossil Creek, using a piscicide called Antimycin A. The native fish were manually removed from the creek prior to the project implementation and were subsequently returned. The construction of a fish barrier upstream of the confluence with the Verde River will ensure that non-native species from that river are not able to travel upstream into Fossil Creek.

By every measure, the restoration of Fossil Creek has been a resounding success; however, significant concerns remain, and stewardship of this unique area is vital and an on-going need.

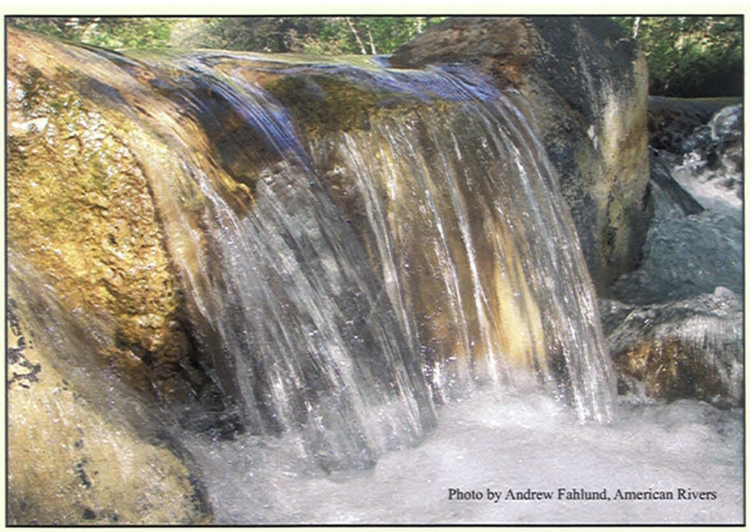


Photo by Andrew Fahlund, American Rivers

These pages contain EcoNotes covering the research subjects of the lead investigators in the Fossil Creek Ecosystem Studies-Group at NAU.

The Department of Biological Sciences, under the direction of Jane Marks, reports on multiple aspects of the biotic community at Fossil Creek, including the native fish community, the effects of the piscicide Antimycin A, retention rates of leaf litter as related to travertine, and the concern with the presence of non-native crayfish.

Rod Parnell and others from the Center for Environmental Sciences and Education and Department of Geology report on increased travertine deposition rates since the return of full flows to Fossil Creek.

From Marty Lee and her graduate student Paul Hancock in the School of Forestry, we learn that stewardship of Fossil Creek is a necessary component in the future management of the area. The results of two surveys of Arizona residents indicate that the respondents have very strong feelings about Fossil Creek and that they have a high sense of stewardship.

The NAU researchers believe that future stewardship of Fossil Creek, in the form of a stakeholders group to advise the Forest Service and a "Friends of Fossil Creek" group, is a critical need for this area. Without public stewardship of Fossil Creek, much of the natural resources of this restoration success story may be degraded or lost in the future.

Michele James
Fossil Creek Coordinator

The Hydrogeology of Fossil Springs

Megan Green and Abe Springer, Department of Geology

NORTHERN ARIZONA UNIVERSITY

Fossil Creek, an oasis in the central Arizona desert, gushes from a series of springs and is thought to have a relatively constant year-round flow. A major tributary to the Verde River, Fossil Creek's stream flow of approximately 45 cubic feet per second nearly doubles the Verde base flow at the confluence with the creek. The stream's natural travertine barriers form waterfalls and lush blue-green pools due to the unusual chemistry of the springs, which are saturated with calcium carbonate. A haven for native fish, frogs, birds and plants, the creek is home to a combination of species rare among Arizona's declining riparian areas.

A continuous source of water flowing from the springs is essential for the long-term sustainability of the ecosystem.

All of the restoration and decommissioning work in Fossil Creek is dependent on the discharge from Fossil Springs being relatively constant and unchanging. Water discharging from the springs has traveled through the limestone and sandstone rocks in the area in the regionally continuous C and RMX aquifers (Figure 1). As the climate and other factors change, it is important to understand how the geology is connected to the sustainability of Fossil Springs, and other springs in the region.

The subsurface geology of the West Mogollon Mesa area and the sources of the water for the springs are only beginning to be understood. A combination of volcanism in young rocks and faulting of the older Paleozoic carbonate rocks, make the geology very complex. Understanding and quantifying groundwater flow in these aquifers first requires a complete understanding of the geology of this region.

A preliminary Digital Hydrogeologic Framework Model (DHFM) has been constructed using EarthVision, a 3-dimensional geographic information system software, from a collection of geologic data. The DHFM will serve as a tool for understanding and conveying the complex subsurface geology of the region.

What are the source areas for Fossil Springs? How does water flow to Fossil Springs?

We have found that the springs discharge from the RMX aquifer in the Naco Formation at the intersection of two major faults, the Diamond Rim Fault and the Fossil Springs Fault. The next step is to use this model to construct a Groundwater Flow Model to understand the hydrology of the area. Water managers in this region need to understand the geology and hydrogeology of the area to develop their resources effectively, without causing unnecessary or unintentional environmental impacts to Fossil Creek.

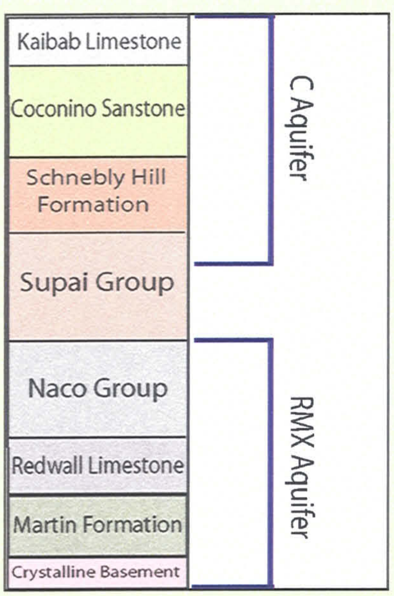


Figure 1. Stratigraphic column of geologic formations and aquifers present in the Fossil Creek area, Arizona, which are modeled in the digital DHFM.

Supported by: Town of Payson, National Science Foundation and Nina Mason Pullium Trust

Native Fish Quickly Rebound Following Restoration

Matt O'Neill, Cinnamon Pace, Allen Haden and Jane Marks
Department of Biological Sciences
NORTHERN ARIZONA UNIVERSITY

Native fishes are among the most endangered desert animals in Arizona, partly due to water diversions and exotic species introductions. Since all desert fishes suffer from severely reduced ranges, and several hover on the brink of extinction, a driving force behind restoration is to increase native fish habitats. The restoration of Fossil Creek has focused on increasing the amount and quality of stream habitat by both removing exotic fishes and restoring natural water flow to the river. Will the return of flow bring back native fish? Will the removal of exotics help native fish? Which is more important? Our research team monitored native fish populations before and after restoration to answer these questions.

The unique layout of Fossil Creek allowed us to compare the independent and interactive potential of these two restoration actions. We used a section of the river above the dam as a control site because this area has always had full flows and was never invaded by exotic fish. Just below the now defunct dam, we were able to measure the effect of restored flows alone in a reach where stream flow had been diminished, but no exotics had invaded. In a long section where flow was diminished and exotics dominated, we studied the combined effects of flow restoration and exotic fish removal. Finally, we could measure the effect of flow restoration without exotic fish removal in a reach below a newly constructed fish barrier, where exotics continued to dominate even after flow restoration.

Native fish increased where exotic fish were removed.
Increased flow benefited natives only in the absence of exotics.

Native fish species, such as these Speckled Dace, are re-populating Fossil Creek.

We observed dramatic shifts in the fish community (Figure 1). Increases in native fish were seen in all areas of Fossil Creek where flow was restored and exotic fish were removed. Both restoring flow and removing exotics are important for native fish rehabilitation, however, exotic fish may be of primary concern. This is supported by two lines of evidence: (1) sites where exotics were removed and flow was restored showed a higher increase in fish than sites where only flow was restored (7800% versus 170%); and (2) native fish have not rebounded in areas where exotic fish remain, even though flow has been restored.

Although native fish populations have rebounded following the stream restoration, there are still many unanswered questions about how community structure is changing. Crayfish, an exotic species that competes with fish for resources, are moving up Fossil Creek, and could compromise the fish recovery. The restored water flow is allowing the deposit of travertine, altering portions of the stream, and possibly affecting habitat availability for fish. NAU researchers are continuing to study fish at Fossil Creek.

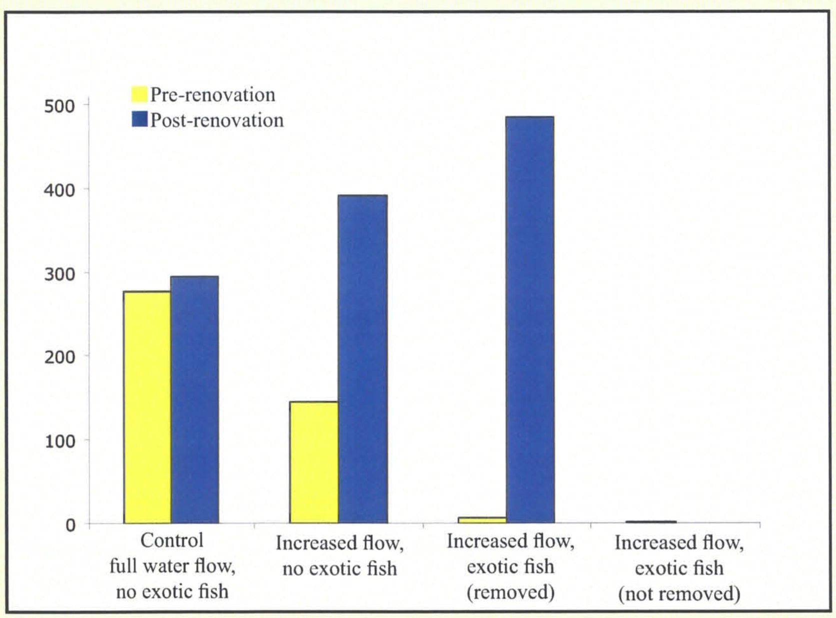
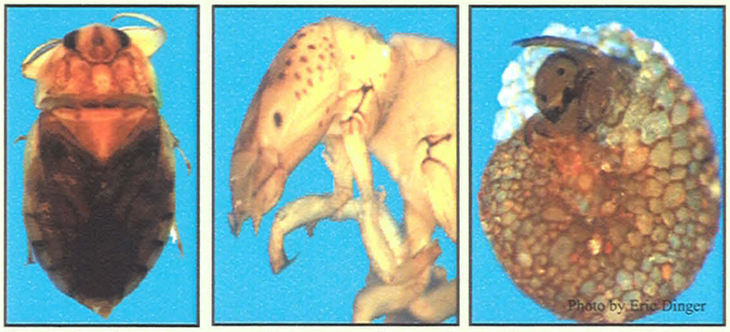


Figure 1. Native fish populations before and after restoration. Sites where exotics were removed and flow was restored had higher increases in fish than sites where exotics were not removed.

Does Antimycin A, the Chemical Used to Kill Exotic Fish, Have Unwanted Side Effects?

Eric Dinger and Jane Marks, Department of Biological Sciences
NORTHERN ARIZONA UNIVERSITY

One of the most controversial aspects of exotic fish removal projects that use poison to kill fish is the potential side effects on other animals living in the stream. The group of organisms most at risk is macroinvertebrates because they use gills to breathe and can't escape into the terrestrial environment. There have been very few field studies on how relatively high concentrations of Antimycin A, such as were used in Fossil Creek, affect macroinvertebrates.



Fossil Creek supports one of the most diverse invertebrate communities in the Southwest.

Why should we care about macroinvertebrates? Macroinvertebrates, comprised mostly of snails, worms and aquatic insects like mayflies, caddisflies, and dragonflies, are essential for the healthy functioning of streams. They are the main source of food for native fish and are important to the diets of birds and lizards. Macroinvertebrates are also essential for the breakdown of leaf litter that enters the stream, and are an important conduit of energy between the food base (algae and leaf litter) and higher trophic levels. Macroinvertebrates are interesting in their own right. Fossil Creek supports over 130 different species of macroinvertebrates, each with their own morphology, life history, and unique adaptations to stream life.

Antimycin A kills stream invertebrates.
The effects are short-lived and recovery is rapid.

We measured macroinvertebrate mortality during the chemical treatment and found that large numbers of insects were innocent victims of the fish poison. Insect mortality was roughly 5-10 times higher where the chemical was used than in an upstream control site. We also monitored the densities of macroinvertebrates 6 months and 1 year after the treatment and found that, at most sites, the abundance of macroinvertebrates rebounded within this short time period. At other sites they remained slightly depressed but appear to be recovering (Figure 1). There were a few species that disappeared from sites and have yet to return, but there were no species that disappeared entirely from the river. This tells us that the chemical kills macroinvertebrates, but that the effects are relatively short-lived. Certain approaches of the Fossil Creek restoration likely contributed to the quick recovery. For example, there were reaches above and below the treated area that were left untreated, providing a source of macroinvertebrates to re-colonize the disturbed sites.

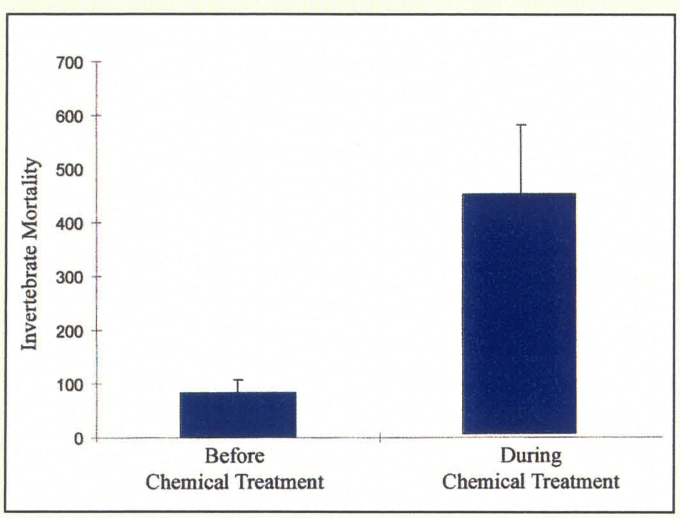


Figure 1. Invertebrate mortality, measured as the number of insects found drifting downstream, increased between five and ten fold when Antimycin A was in the water. This shows that one of the unfortunate side effects of chemical treatment is killing invertebrates.

These findings can be used by managers working in other rivers. Antimycin A should be used with caution in rivers where there are endangered or listed macroinvertebrates. In Fossil Creek, there are two endemic macroinvertebrates, the Fossil Springs snail and the Page Springs caddisfly. Luckily, their populations are concentrated above the dam, near the springs, well upstream of the treated area.

Stream Flow Restoration is Good News for Travertine Dam and Pool Habitats

Rod Parnell, Adam Schwarz, and Matt Germansen
Center for Environmental Sciences and Education, Department of Geology
NORTHERN ARIZONA UNIVERSITY

Fossil Creek is a travertine-dominated system with a series of perennial spring vents providing a consistent base flow. Water emitted from Fossil Springs is supersaturated with the mineral Calcite ($CaCO_3$) and outgassing of Carbon Dioxide (CO_2) allows precipitation of calcium carbonate. Travertine is limestone that is formed by rapid chemical precipitation of calcium carbonate from solution, as by agitation of stream water. Historic accounts of Fossil Creek prior to the construction of the hydropower plants describe a river with large travertine dams. The hydropower plants and associated diversion flumes starved the river of calcite, greatly reducing the number and size of dams.

The accrual of travertine dominates stream morphology by forming a series of pools throughout the actively precipitating reach. The upper reach near the springs does not deposit travertine because there has not been sufficient outgassing to induce precipitation; travertine formation decreases in the lower reach eventually stopping entirely as the system approaches equilibrium. This study quantifies travertine accrual rates and stream geochemistry to assess how flow restoration will affect the size, distribution, and restoration of travertine dams and pools.

Figure 1. Artificial substrates, before and after placement in Fossil Creek.

Travertine deposits form in the streambed as CO_2 bubbles out of the water, causing calcium carbonate to precipitate.

Travertine deposition rates have increased 2 - 8 times since flow was restored.

Artificial substrates, including travertine tiles and stainless steel and copper mesh were placed in the streambed at seven sites. Substrates were collected after 4-6 weeks of submersion in the creek. Prior to flow restoration, active precipitation occurred in the seepage reach immediately below the dam, decreased with distance downstream, but increased again below the Irving Power Plant where "fresh" spring water from the flume passed through the power plant and returned to the creek bed.

Following restoration of flow, substrates were again placed at the same sites to compare travertine accumulation before and after restoration. As seen in Figure 2 , rates are two to eight times higher in the reach and there is now a gradual, continuous decline throughout the study area. Although the higher precipitation rates immediately below the dam had been predicted based on the higher volume of water in the streambed after restoration, the higher precipitation rates below Irving came as a surprise. With restoration of full flows, much higher flow rates now occur in the streambed below Irving. These flows are responsible for higher calcium and bicarbonate fluxes now. Precipitation rates remain higher throughout the study reach, even as far as Irving.

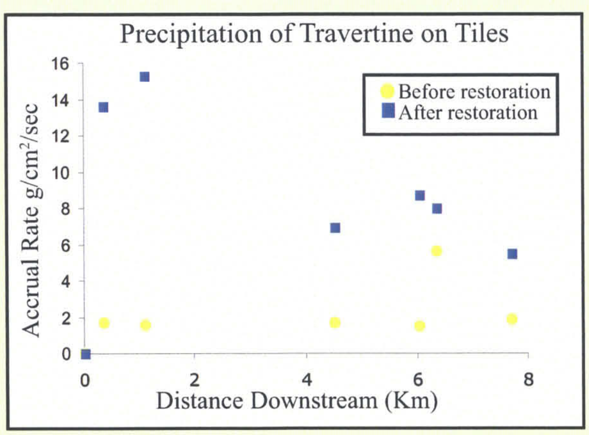


Figure 2. Comparison of travertine precipitation rates before (yellow) and after (blue) restoration of flow with distance from springs. Data show post restoration increase in accrual of calcium carbonate on travertine tiles along the stream gradient.

The major complication in predicting the long-term growth of travertine dam habitat is in predicting the occasional erosional events which degrade the dams. We are confident in our prediction of dam aggradation rates, but have not yet been able to observe the effects of runoff from a large thunderstorm on dam erosion. Finally, the increased use of the reach above Irving by kayakers holds a potential threat for dam stability, as kayakers wade on or scrape their kayaks along the tops of the fragile dam structures.

Changes in Leaf Litter Retention: The Effects of Travertine and Increased Flow

Zacchaeus Compson and Jane Marks
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Leaf litter falling from surrounding trees into streams is an important source of food in stream ecosystems. In highly shaded streams, like Fossil Creek, animals including insects and fish depend on leaf litter for food. Birds, lizards, frogs and spiders living along the banks derive some of their food energy from leaf litter, by eating the leaf-consuming insects from the stream. To contribute to the food base, leaves that fall in the stream must stay there. "Leaf Litter Retention" is a measure of how long a leaf stays in a section of stream. Factors affecting retention include flow, gradient, and structures that trap leaves, such as woody debris dams, beaver dams and travertine dams. Restoring water flow to Fossil Creek should increase the number and size of travertine dams. Increasing the structural complexity of streams generally increases leaf litter retention, while increased flow tends to decrease leaf retention. Our study is the first to look at the effect of travertine dam formation on leaf litter retention.

Litter retention being measured by students and researchers at NAU

To measure leaf litter retention, we dropped 2000 leaves into the water 100 meters upstream of a large net that was stretched across the river. After one hour, we counted the number of leaves that had been caught. Leaves that didn't make it to the net were considered to have been retained in the 100-meter section, and thus were available as a food source for animals living in that reach.

We conducted this experiment before and after flow restoration and found that before flow was restored, areas with travertine dams retained significantly more leaves than areas without dams (Figure 1). Most leaves were not trapped by the dams, but simply floated to the bottom of the slow-velocity pools formed behind the travertine dams. This suggests that there is more food available in areas with travertine dams. After restoration of flow, retention rates decreased at most sites, which was no surprise: fast moving streams generally retain less leaf litter. In addition, the travertine dams were not as effective at retaining leaf litter after flow was restored. We suspect this will change in the next few years as travertine dams continue to grow.

In this study, gradient and discharge did not play a factor in leaf retention, though coarse woody debris was higher in travertine reaches before and after restoration. A higher volume of coarse woody debris further supports the idea that travertine is associated with a more complex stream morphology.

In summary, we expect to see a short-term decrease in leaf litter retention, but expect retention to increase in the long-run as travertine dams grow.

Leaf litter is an important food source in streams.

Travertine dams increase the amount of time leaves stay in the river and are available as food for insects and fish.

Increased flow has reduced leaf retention in Fossil Creek.

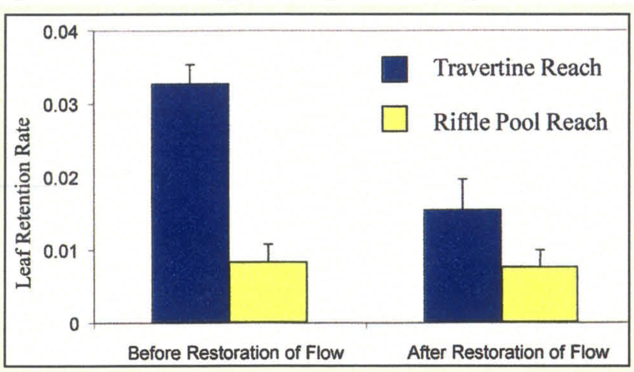


Figure 1. More leaves were retained at sites wth travertine dams than sites with a more typical riffle pool morphology. Increased flows decreased reention rates, particularly at sites with travertine dams. We believe that as travertine rebuilds, retention will increase in large stretches of the river.

Will Exotic Crayfish Undermine Restoration in Fossil Creek?

Ken Adams and Jane Marks
Department of Biological Sciences
NORTHERN ARIZONA UNIVERSITY

Exotic crayfish are increasing in Fossil Creek.

Increased travertine may reduce crayfish numbers.

A trapping program should help reduce crayfish while native fish recover.

Crayfish are notorious for wreaking havoc on stream ecosystems. They are voracious feeders, eating everything from leaf litter to insects and small fish. In some places they shred so much leaf litter that the debris they create actually lowers light levels enough to keep algae and plants from photosynthesizing. As Arizona has no native crayfish, each crayfish you see in Fossil Creek is an invader.

Exotic crayfish from Fossil Creek

Crayfish were introduced into Arizona streams as bait for sports fisheries. Once they became established in a few ponds and streams, they quickly expanded their range. Crayfish disperse quickly and can crawl across land to colonize new habitats. Because crayfish are abundant in the Verde River and in other tributaries, (particularly East Clear Creek), they have easy access to Fossil Creek. Exotic crayfish were not killed when the river was chemically treated to eradicate the exotic fish, probably because they could crawl out of the water or burrow into the river bed when the chemical levels were high. We are monitoring the crayfish in Fossil Creek because of concern that the removal of exotic bass, which are known to eat crayfish, could release them from predation pressure and cause their populations to explode (Figure 1).

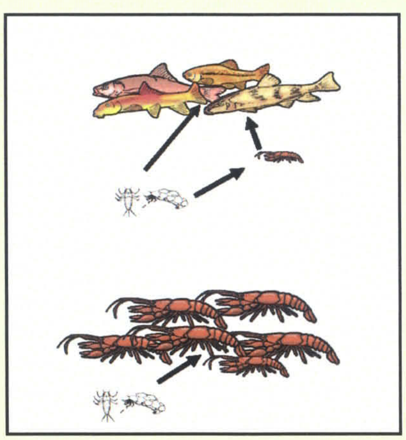


Figure 1. Native fish may do well enough to control crayfish, but the release of predation pressure may cause their populations to explode.

Have crayfish populations changed since water was restored and exotic fish were removed? Crayfish populations are increasing in Fossil Creek. Figure 2 shows that after restoration, crayfish increased at most sites in Fossil Creek, but that the largest increase was in the section where exotic fish were removed. We suspect that exotic bass helped keep crayfish densities down. Now that exotic bass have been removed, it is possible that more young crayfish are being recruited into the population. Our most recent surveys suggest that the newly forming travertine may keep crayfish populations at bay. The calcium carbonate deposits that form the picturesque travertine dams also form on crayfish shells, much like calcium carbonate clogging pipes. In addition, travertine can armor the river bed, making it difficult for crayfish to burrow into the sediments where they go to avoid predators. Although no one has studied how travertine affects crayfish, our initial observations suggest that the deposits interfere with molting and growth. We will continue to study how travertine affects crayfish and hope that it may provide a "geological" control on crayfish growth rates. In addition, as native fish rebound, they may replace exotic bass as crayfish predators.

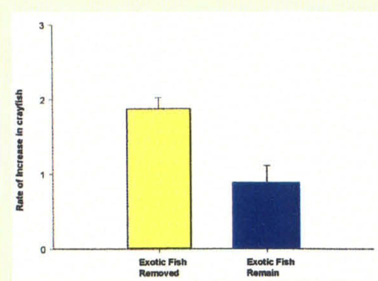


Figure 2. Estimated per-capita population growth rates (r) from years 2004-2005 were significantly higher at sites where fish were removed relative to where fish were not removed.

What can be done to control crayfish? It is probably impossible to eradicate crayfish, but it may be possible to keep their densities low enough that they won't interfere with the re-establishment of fish and invertebrates. This will require trapping crayfish using a range of trap types that target different size classes. We are working with local groups to establish a crayfish removal program.

Stewardship and Fossil Creek

Paul H. Hancock and Marty E. Lee, School of Forestry

NORTHERN ARIZONA UNIVERSITY

"Action speaks louder than words."

Mark Twain

Stewardship is defined as the careful and responsible management of our natural resources. It shares several qualities with conservation and is often associated with a land ethic. Aldo Leopold once wrote, "A land ethic changes the role of *Homo sapiens* from conqueror of the land-community to plain member and citizen of it." In his book, *A Sand County Almanac*, he also explained that conservation and a land ethic may require actions in spite of an economic return. Stewardship is, then, more than the careful and responsible management of our natural resources, it involves respect, preservation, and actions toward the betterment of our natural resources, regardless of economic gain.

Individuals with a high sense of stewardship are important proponents of healthy ecosystems and contribute to ecosystem and community viability. The Fossil Creek dam decommissioning project offers many unique opportunities to document changes in biological, physical, and social conditions which will occur as the riparian ecosystem is restored.

53% of visitors supported removal of the Fossil Springs Diversion Dam.

46% of visitors supported removal of non-native fish from Fossil Creek.

Support and involvement of local communities is key to the long-term success of the Fossil Creek restoration project.

A section of the flume illustrating the passion visitors have for Fossil Creek and its unique characteristics.

Efforts have been made to document local residents' sense of stewardship, including their knowledge, attitudes, and perceptions of the Fossil Creek restoration project. These efforts involved a mail-back survey sent to a sample of Arizona residents from Camp Verde, Pine, Payson, and Strawberry. A similar survey and an education outreach effort have involved local high school students. The opinions and perspectives of both the local residents and high school students have been gathered and are currently being analyzed.

Involving local residents and communities in restoration projects can create personal interest in the successful outcome of a restoration project. Initial results from the resident and high school surveys suggest the local communities were not aware of or involved in the restoration activities.

The lack of social support and involvement from the four communities is a worrisome aspect for the long-term health and success of the restoration project. Preliminary analysis of the two surveys suggests the respondents have strong feelings for Fossil Creek and have a relatively high sense of stewardship.

Litter has been documented as a major issue regarding the condition of recreation sites along Fossil Creek. Researchers feel recreators are a point of concern and many questions arise about how to mitigate impacts.

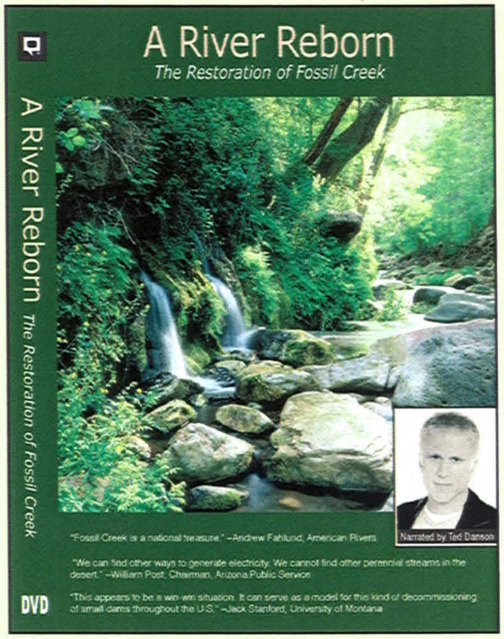
Actions have already been set in motion to begin the restoration of Fossil Creek. Stewardship is vital to the future of Fossil Creek; it is the link that unites researchers, managers, local residents, and recreators. In order to guarantee success in the long run, steps need to be taken to involve the local residents and communities. Stewardship is one thing we all have in common. What happens next will depend on all of us.

This research was funded by the Nina Mason Pulliam Charitable Trust and the NAU School of Forestry.

Announcing the release of the documentary, A River Reborn: the Restoration of Fossil Creek

NORTHERN ARIZONA UNIVERSITY

The Merriam-Powell Center at Northern Arizona University is proud to announce the release of a documentary about the ground-breaking developments at Fossil Creek. Two years in the making, the public television production, *A River Reborn: The Restoration of Fossil Creek*, presents a critical examination of dam decommissioning and watershed restorations.



Produced by Emmy Award-winning producer, Paul Bockhorst, and narrated by Ted Danson, *A River Reborn* chronicles both the natural and human history of the scenic waterway. It introduces the scientists who have investigated Fossil Creek's outstanding biological and geological features, environmental advocates who have fought for its restoration, federal and state resource mangers who are working to establish it as a refuge for threatened native fish, and officials at APS, the utility that ran the hydroelectric facilities for a century.

A River Reborn is a powerful case study in environmental restoration. It highlights a broad reassessment of rivers and dams globally, as well as the growing effort to balance fulfillment of human needs with protection of the natural systems that support human life. This includes the safeguarding of precious water resources and the protection of threatened and endangered species. As a focal point for this reassessment, Fossil Creek reveals both challenges and opportunities associated with riparian restoration.

Award winning producer, Paul Bockhorst, during the filming of *A River Reborn: the Restoration of Fossil Creek.*

In addition to broadcast on public television stations in Arizona and across the U.S., *A River Reborn* is designed for multiple educational applications. They include 1) use in environmental science and ecology classes in high schools, colleges, and universities; 2) use by environmental advocacy organizations as a case study in riparian restoration; and 3) use in interdisciplinary discussions of environmental issues (e.g., dialogues between scientists, economists, resource managers, and environmental advocates).

The documentary is a joint project of the Museum of Northern Arizona, Northern Arizona University, and Paul Bockhorst Productions. Principal funding comes from the National Science Foundation, the Bureau of Reclamation of the USDI, and the Heritage Program of the Arizona Game and Fish Department, with additional funding from the Nina Mason Pulliam Charitable Trust, the Merriam-Powell Center, and the Ecological Restoration Institute at NAU.

For more information, including national and local air times, visit the web site for *A River Reborn* at :

http://www.mpcer.nau.edu/riverreborn.org

Or contact:

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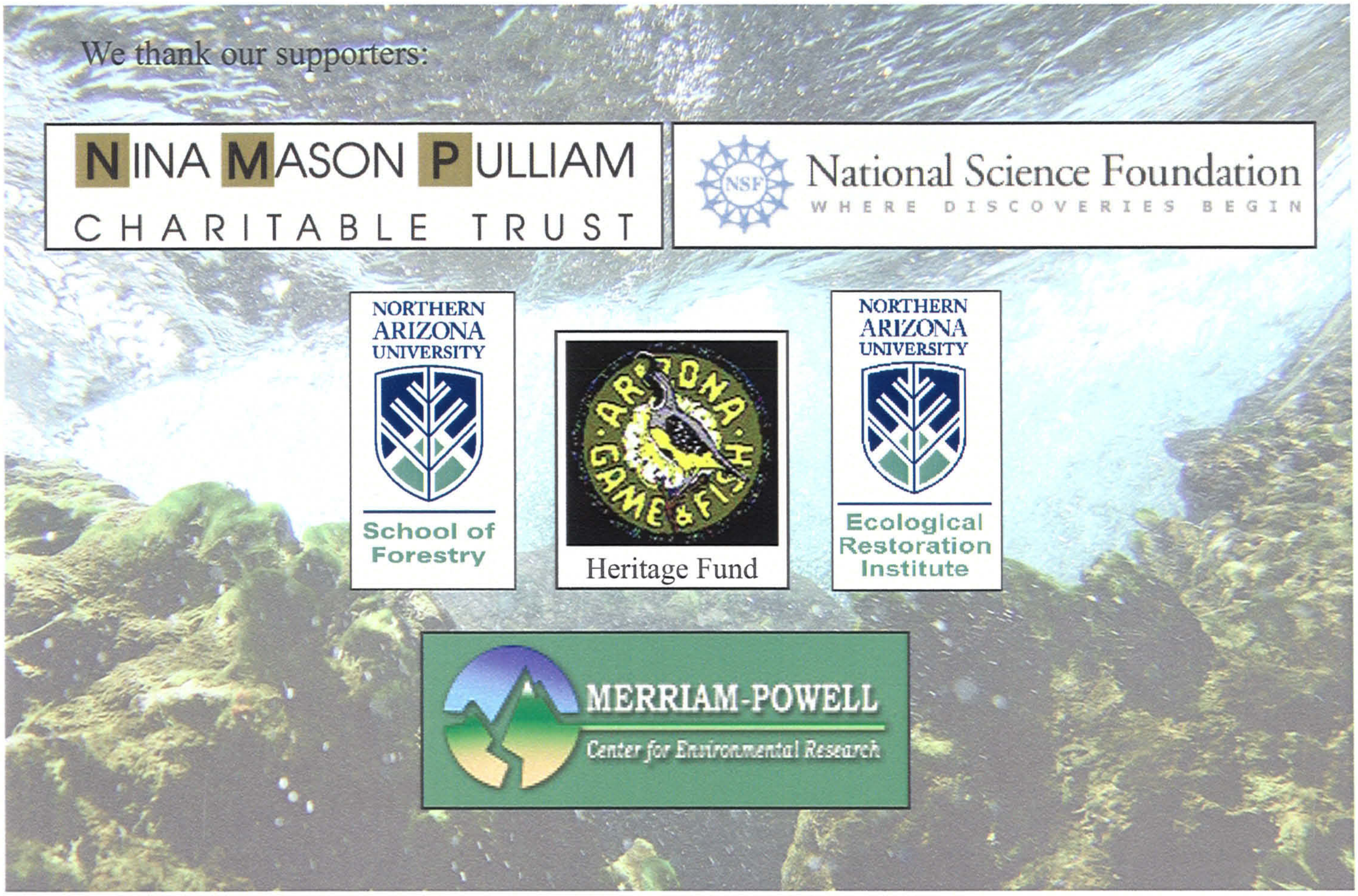

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Let's not allow Fossil Creek to be loved to death

Our view: The newly free-flowing stream deserves more protection from thoughtless campers.

Tuesday, April 22, 2008

Today's Daily Sun editorial

Maybe it's time for a "broken windows" approach to the wilderness.

That's one suggestion in response to news that the newly free-flowing Fossil Creek is in danger of being trashed by a small but virulent strain of camper whose ethic is just the opposite of "Leave no trace."

As Ben Norris reported last week, some urban thrill-seekers are treating the creek more as a theme park than a wilderness, cutting trees, stoking bonfires and leaving a trail of trash along its 4-mile length.

As police have learned, even though the majority of citizens are law-abiding, it only takes a few broken windows and graffiti-stained walls, if left unattended, to weaken pride of place and the community bonds that form around that pride. A place of natural beauty needs even more care -- it takes months to restabilize an eroded streambank and decades for a hacked-over grove of trees to provide new shade.

In the case of Fossil Creek, however, promotion of its newfound beauty got out ahead of plans to manage the inevitable increase in visitation. For years, the creek was channeled through a pipe four miles to a hydropower plant, leaving only the headwater springs as an attractive day-hike destination. But with the decommissioning of the plant, the creek was returned to its natural channel, reviving in just two years a lush, riparian habitat unlike any above the Mogollon Rim.

Land managers and power company officials responsible for the transformation were justly proud, trumpeting it in press releases and inviting scores of journalists to witness the makeover. Researchers from Northern Arizona University created an hour-long video documentary that has been widely screened throughout the state.

Although the creek is part of the Fossil Springs Wilderness, and thus off-limits to ATVs and mountain bikes, it can be reached by motor vehicle by driving to the old power plant and hiking upstream. Hikers who previously had only the springs as their destination now have a 4-mile-long waterway along which they can camp and swim.

The Forest Service has formed a stakeholders group to address access, but it appears not to have anticipated the sharp surge in visitors to what is now a drive-up wilderness attraction. During his weekend camping trip, Norris reported seeing no rangers nor any signs directing campers to designated areas. Without supervision or regulation, it's no wonder the creek's natural beauty is fast deteriorating.

One solution would be to temporarily ban overnight camping, as the Forest Service does in many sensitive wilderness areas. Granted, that would mean enforcing the ban, but how difficult would that be?

Another approach is to set up primitive but designated camping areas well back from the stream, then manage them, perhaps with a private concessionaire, as is done on other parts of the national forest. Charging a parking fee along the access road and in parking lots would also seem justified, especially if it meant the Forest Service could then supply more portable toilets and trash receptacles.

One way to get involved is through the Sedona-based Friends of the Forest, which has organized trash pickups at the creek. You can also lobby Congress to designate Fossil Creek as a wild and scenic river, which would make it eligible for more protection.

It's one thing to designate a special place on a national forest as wilderness. But the easier the motorized access and the more widely publicized it is, the more preparation has to go into dealing with the inevitable impacts that more visitors can inflict. Fossil Creek is too special to be left to fend for itself, even for one more summer. It needs immediate and heightened protection if continued public access is to be not only allowed but promoted.

CLARIFICATION

An editorial Friday that urged local candidates to support "aggressive" business recruitment should have noted that Coral Evans is on record as supporting just that.

Fossil Creek Stakeholders Meeting, May 22, 2008, duBois Center, NAU campus
Draft meeting notes compiled by Michele James, NAU Fossil Creek Project Coordinator

Attendees: 40 attendees representing 14 organizations/governmental entities.

Jane Marks (NAU) and Heather Provencio (FS) thanked everyone for attending. Heather thanked everyone for their enthusiasm and commitment and said that the purpose of the group is to get things done at Fossil Creek; she would like the group to determine appropriate short and long-term actions. All attendees introduced themselves.

Overview and Discussion of Possible Fossil Creek Vehicle Closure/ Q & A: Heather Provencio gave a brief overview of the recent discussions within the Forest Service to consider the possibility of a vehicle closure at Fossil Creek. Such a closure would be a temporary and emergency closure for reasons of public health and safety as well as for cultural and ecological concerns. The Forest Service has the ability to enact such an emergency closure for up to one year.

Heather indicated that she had a conference call with law enforcement last week: public safety concerns at Fossil Creek were raised. Heather said that these concerns were present at Fossil Creek due to population increases in Arizona and curiosity about Fossil Creek. Heather's concerns relate to the safety of visitors to Fossil Creek, primarily due to the actions of visitors (not trash or human waste). There have been destruction actions on the private property at Fossil Creek. The law enforcement folks on the conference call said that they were afraid for their safety at night in Fossil Creek. To open Fossil Creek to day use only, the FS would need a full-time presence; they can't commit to this right now as they don't have enough staff.

At this point, Heather is thinking that swinging gates are a possibility for implementing a vehicle closure. With such a closure, the springs trailhead would remain open on the Tonto side. Heather indicated that on the Coconino side, the closure needs to consider access to Childs. She and other FS staff will be visiting Fossil Creek this weekend (Memorial Day) to look at logistics of the closure and determine feasibility, issues and options.

If the FS decides to implement an emergency vehicle closure, it would physically occur on the Tonto side along the road where a gate currently exists. On the Coconino side, the FS is looking at the feasibility of swinging a gate on the road just north of the turn down to Childs. One of the concerns the FS has is that such a closure would concentrate people on a small stretch of Fossil Creek that would still be accessible by vehicle. In addition, it may concentrate use at the springs as well.

Discussion: Vincent Randall (Yavapai-Apache) said that he is not against such a closure, however their elders will need access to Fossil Creek to collect herbal medicines. Heather responded that the tribe can get a permit and/or escort from the FS to allow access. The

FS understands the needs for access by the tribe as well as researchers. Such a closure would be dealt with in the same way that fire closures of Fossil Creek have been dealt with in the past.

Heather indicated that they are not considering day-use only restrictions at this time because they have concerns about how they would get the visitors out at night-time. The FS believes that a vehicle closure may address many of the issues.

APS indicated that they support a one-year emergency closure and even a full closure of Fossil Creek. Phil Smithers pointed out that some cars will just drive around the APS gate on the Tonto side.

Heather said that the FS may try a closure for awhile and find that they need to come up with another plan. A mobile repeater is being discussed for the Fossil Creek area in order to improve communication. The FS could use monies for a full-time law enforcement presence at Fossil Creek.

The subject of funding for Fossil Creek brought up discussion of the pending Wild and Scenic River designation. Heather indicated that the FS is not sure such a designation will happen or when. Appropriations related to designation are not a given. Delvin Lopez (FS) indicated that, while awaiting possible designation, the FS can't do anything considered "irreversible" in terms of Wild and Scenic River designation.

There was general agreement and support by the stakeholders for an emergency closure of Fossil Creek.

Short Review of Working Group Priorities/Action Plans: **Recreation:** Ed Armenta (FS) provided a review of the recreation group's priorities. These are: 1) law enforcement, and; 2) addressing trash and sanitation.

Ed indicated that the Tonto NF has funded the placement of a trash dumpster at the springs trailhead. It was recently placed there on a trial basis to see if it is used. Ed wrote a memo to Heather Provencio relating the results a meeting he had with FS law enforcement (LE) in December 2007 (this memo is included in the agenda material prepared for this meeting). At this meeting, agreement was reached on several issues including the need for signage, trash pick-up and education. The use of volunteers was not recommended. The FS followed up with a conference call with LE after the saturation patrol that took place on April 19 and 20. This is where the discussion of a possible emergency closure was raised. Ed said that on the weekends, Fossil Creek is exceeding its carrying capacity. The FS discussed placing a repeater somewhere "on top" at Fossil Creek to address the need for radio communication. In the long-term, Ed said that the FS may need to go to a fee/permit program.

Heather responded to a question related to the time-frame for a closure at Fossil Creek: The FS can institute a closure almost immediately as no public input is required for an emergency closure for public safety concerns. It would take a week or two to produce an order. They have to get the gates and install them (with the help of volunteers, this shouldn't take long). The FS will also have to address parking areas. At this point, the FS is discussion the possibility of a vehicle closure and is willing to try it. She is open to other ideas; a total or partial closure, a closure to hiking too, etc.

Phil Smithers (APS) indicated that in 1 ½ years, the bridges at Fossil Creek and the Flume Road will be gone.

Heather indicated that in the long-term, the FS will likely need to implement a Red Rock Pass-type of system; this would provide funding for one LE person to patrol the area.

Ed Armenta indicated that he got an estimate from a firm out of Pine to install 8 toilets for $1800/month. He thinks this means they would be checked one/week, but he's not sure about this detail.

Heather indicated that Coconino LE folks are trying to go down to Fossil Creek 1-2/week, but it's hard for them to commit to this in the summer due to fire assignments. Coconino recreation folks are visiting the area once/week and Friends of the Forest (volunteers) are visiting every 2 weeks. Wilderness staff is getting in about 1-2/week. Ed indicated that the Tonto is patrolling the area 2 days/month (LE); they have no recreation staff to patrol.

The issue of kayak damage to travertine was raised. Delvin Lopez (FS) said that he needs photos to document such damage. If you have such photos, please provide it to him. This will help with an emergency closure.

Education: Connie Birkland (FS) and Mark Sensibaugh (FS) gave a brief summary of priorities discussed in this working group. Please see the meeting notes attached to the agenda materials for a more detailed summary.

There is overlap with many of the issues discussed by LE folks. Providing information is the priority. The group believes information needs to be provided to visitors about: Leave No Trace/stewardship, historical/cultural issues, water issues, ecological benefits, changes due to the restoration, and research. They discussed producing a traveling display, addressing school groups, e-mails, websites, and an AZ curriculum that would address broad-based conservation and ethics. Providing information at the trailheads (particularly at the springs trailhead) is key.

Stefan Sommer (NAU) indicated that NAU is putting together "resource guides" (three types) related to the River Reborn documentary. He is willing to put information on his website.

Shaula Hedwall (FWS) reminded the group that Carrie LeRoy (former NAU graduate student) completed a master's degree related to education at Fossil Creek. This information could be used in developing curriculum.

Connie Birkland proposed that perhaps an educational video could be developed about resources at Fossil Creek Or we can look into Facebook and Myspace. Connie emphasized that requiring a permit to access a place is a good way to get educational material to visitors. The permits can be placed at the trailhead with Leave No Trace language on the back. Connie indicated that this makes visitors feel accountable.

Priorities for the Education Committee: 1) Education related to the possible emergency closure (getting information out in the newspapers, etc.); 2) Leave No Trace messages at kiosks; 3) Funding for education.

Phil Smithers (APS) indicated that he has heard that Phoenix Magazine is planning to do a story about Fossil Creek soon. Someone should contact them about the issues we're discussing here.

Natural Resources: Shaula Hedwall gave an overview of this working group's discussions. A lot of this group's priorities are long-term and related to all the issues. Shaula is putting together a summary of everything that is going on at the creek (research, etc.) and will get it out to everyone soon. The group has discussed longfin dace and threatened and endangered fish reintroductions, as well as installation of a stream gage which is important for many reasons including the designation of water rights. They have submitted a proposal for desert fish habitat restoration funding. The group has developed a vision statement (see agenda attachments). One of their primary concerns is groundwater pumping on the rim and potential affects to the springs at Fossil Creek. The long-term goal is the installation of a gage to determine potential effects. The new ADWR Regional Groundwater model may help determine landscape impacts.

In the short-term, the group's concerns relate to the introduction of non-native fish. They would like to have the ability to enforce a closure and any restrictions and provide education to help prevent the reintroduction of non-native fish. Shaula indicated that she has some concerns related to the razorback sucker introduction site and the effects of this area staying open during an emergency closure.

Shaula summarized upcoming changes in regulations related to a short season Catch-and-Release Chub Fishery in a small part of Fossil Creek. At this point it is likely that the fishery will be located from the waterfall to downstream of Sally Mae and be in place from the first Saturday in October through the end of March, starting in October 2009. The regulation will have an enforcement component so that if fishing materials or equipment are found outside the open area, the owner will be ticketed.

Cultural/Historical Resources: Phil Smithers (APS) and Chris Coder (Yavapai-Apache) provided a summary. In the short-term, the group would like to see signage related to the Yavapai-Apache presence at Fossil Creek. In the long-term, they would like to see signage interpreting the area before APS moves out of Fossil Creek. Chris Coder indicated that the tribe has nearly completed an ethnohistory of the Payson Ranger District (FS) and that it will be available as a reference for education. All Yavapai-Apache pre-historic sites are protected at this time because no one knows where they are.

Vincent Randall (Yavapai-Apache) said that Fossil Creek is considered the "naval of mother earth" to the Yavapai-Apache. The closure idea sounds good to them and will help protect their cultural resources. Public access immediately adjacent to Fossil Creek is not a concern to the tribe. It's the area outside the creek bed that is important to them. Signage on the kiosks is fine, but not at the actual sites.

Phil Smithers (APS) gave a brief update of the Decommissioning: Pipe ridges have been removed. All of the flume from the diversion dam to Irving is down and 95% of it is out. APS is working at the Purple Mountain flume this week. They are almost done with flume removal between Irving and the Verde. Stehr Lake regarding will take place next year. The dam removal will start at the end of August. The first transfer of land to the FS will take place any day now (in the Childs area first).

APS supports the closure, including closing the upper trail. They are working with the Tonto regarding a trail closure in relation to the removal of the diversion dam this fall. APS can help provide security for the LE effort during any closure the FS chooses to conduct. APS indicated that maintenance of the road from Strawberry (trailhead to Irving) costs $110,000/year.

Funding: Michele James (NAU) gave a brief summary of what the funding group has done. The funding group has completed two draft databases that summarize over 50 potential foundations and state/governmental funding sources. These were completed based on the broad issues discussed at the first stakeholder's meeting and can and will be refined based upon specific proposed actions. Michele is working with the FS now to complete a grant proposal to the AZ Water Protection Fund for the Middle Fossil Creek Riparian Restoration Project (moving and rehabilitating dispersed campsites out of the riparian area and designation of campsites). She is working to gain funding for this project in combination with a potential ADEQ grant.

Delvin Lopez (FS) with the funding group gave a brief overview of the FS funding process and provided a handout. Money comes to the FS from three different sources: appropriation dollars; volunteers and partnerships; grants.

If a fee system is proposed at some point for Fossil Creek, a proposal would have to be written. This proposal has to be improved by the AZ RAC Committee and requires public outreach and input. The FS has to provide some amenities in order to implement a fee system. The FS needs to develop a strategy for the area.

The FS clarified that they have to know the Wild and Scenic River legislation before they can do anything that may impact it, thus, there will be no permits until this legislation is in place.

Discussion: How can we facilitate a successful closure for this year? How can we lay the groundwork for long-term protection of Fossil Creek?

With a closure, we need to focus on the upstream area and provide specific information at the trailhead (signs). This information should include the fact that this is not a loop trail, to carry water, that it's a steep trail, don't bring rafts, and pack your garbage in and out.

With a closure, we need to provide information about the multi-faceted reasons for a closure. The message should include information about the decommissioning, safety, resource damage, etc. It must be a major communication campaign and communicate that this is a "time out" for Fossil Creek to provide time for planning. Involve the stakeholders and get Strawberry involved. This is a time to "stand down" until we can get control of the situation. It is the hope that this will lead to visitors behaving differently.

A PR package should include: press releases, facts, etc. We should include information about the "closure" which is really "modified access" and should be called this. We need to provide information about safety, resources and damage that is taking place, sanitation, and the fact that we don't have funding at this point.

Heather stated that we still need to go after the "low hanging fruit": determine if the trash container at the springs trailhead is working; investigate toilets; provide education; secure grants.

Larry Phoenix (AGFD) and Phil Smithers (APS) said that they would rather have a full "closure" at Fossil Creek and then phase in opening of the trail again after dam removal. This would allow time for monitoring.

Specifically, it was decided that the FS should do the following: provide information to reporters about the impacts that are occurring at Fossil Creek; provide education materials at kiosks; and get the media involved in focused patrols at Fossil Creek. Use data from law enforcement at Fossil Creek to educate the public about what is going on down there.

A PR Committee was formed and is composed of the following individuals:
Connie Birkland (FS), Michele James (NAU), Karen Malais-Clark (FS), Cecilia Overby (FS), Chip Norton, Stefan Sommer, Delvin Lopez, Heather Provencio, Jenna Henry (APS).

A Law Enforcement Committee was formed and is composed of the following individuals: Delvin Lopez, Kimberly Ashcroft (APS).

Heather and Ed Armenta will work with their FS staff (Coconino and Tonto) and APS and let us know their decision regarding a closure. Heather would like the stakeholders group to continue to assist them in efforts at Fossil Creek. Fossil Creek is on the Regional Forester's and Deputy's watch list. It is currently an unfunded priority and the FS does not expect funding to increase. The FS wants us (the stakeholders) to help them.

The full Stakeholders Group will meet again when a decision is made regarding a closure at Fossil Creek or in early August at the latest.

In conclusion, the stakeholders group and FS agreed to complete the following specific tasks:

1) Continue to pursue funding for the Middle Reach campsite work and implement this project once funding is obtained (FS and Michele James);

2) The Coconino and Tonto NFs will explore the need for, and determine the logistics of, a vehicle or full "closure" at Fossil Creek based on public safety;

3) The PR Committee will develop a media/public relations strategy and campaign designed to reach the target audiences Compile materials and information for a public relations campaign (Connie Birkland and others);

4) Design and install educational signs at the trailhead that include preparedness, warnings and Leave No Trace messages (FS and Michele James, NAU) ;

5) Design and install site-specific Leave No Trace signs for all kiosks at Fossil Creek;

6) Monitor use of the trash bin placed at the trailhead;

7) Find money to install porta-potties (Janie Agaygos, FS);

8) Complete regular, focused LE events and invite the media;

9) Look into hiring a law enforcement person to regularly patrol Fossil Creek (a FS LEO costs $110,000/year; training not included; a FS FPO costs about $60,000/year (includes vehicle). Or the FS can contract with the County Sheriff's office for specific time slots). APS has agreed to contribute money toward such an effort.) (Law Enforcement Committee);

10) Investigate the cost and location of installing a radio repeater to allow radio communication for LE while at Fossil Creek(FS);

11) Some stakeholder members will attend the River Action Day in DC and advocate for Fossil Creek (Yavapai-Apache, AZ Wilderness Coalition);

12) The FS will continue baseline enforcement;

13) A fundraiser will be organized, potentially to allow the placement of toilets for the peak three months (at least $6,000 for June-August) and may include a T-shirt (Shaula Hedwall volunteered to design a T-shirt);

14) Stakeholders will support the FS with implementation of action items, potential closures and share key information within their organizations;

15) APS is working with the Tonto regarding a proposed 6 month trail closure during deconstruction of the dam which is scheduled to start in August/September 2008. APS will also assist the FS with potential closure needs;

16) FS engineering will replace road signs as needed.

NORTHERN ARIZONA UNIVERSITY

Fossil Creek Ecosystem Studies Group

Newsletter, Spring 2006

Research supporting the restoration of Fossil Creek, Arizona

Unusually High Discharge Recorded for Fossil Springs

In response to the unseasonably high amount of precipitation during the winter of 2004-2005, the NAU Department of Geology has recorded unusually high discharge measurements for Fossil Springs during the winter of 2005-2006. A discharge of 66 cubic feet per second (cfs) was recorded on December 17, 2005 and a discharge of 63 cfs was recorded on February 11, 2006. These measurements were made about 400 meters upstream from the diversion dam, just below the fig tree spring, using a Swoffer 3000 flow meter. Monthly discharge measurements by the USFS from 1999-2004 recorded an average spring discharge of 45 cfs with the highest recorded flow at 52 cfs.

One theory regarding the recent high flows is that the extremely wet winter of 2004-2005 has increased recharge in the C aquifer and thus supplied more water to Fossil Springs. NAU will continue to monitor discharge from Fossil Springs over the next year to see how it is responding to these recent climate phenomena.

Photo by Ian Reed, USFS

Fossil Creek Stewardship Meeting Highlights the Importance of Collaboration

The Fossil Creek Stewardship meeting held on October 26, 2005 was designed to bring together managers, researchers, environmentalists, tribal leaders, and interested citizens to talk about the future management of Fossil Creek, specifically the short- and long-term management, stewardship, and education/outreach needs for Fossil Creek. Written comments were provided by one invitee who could not attend, while twenty four people attended the meeting at the Southwestern Academy's Beaver Creek campus. A brief summary of the needs identified at the meeting are:

For more information and research about Fossil Creek, see: www.watershed.nau.edu/FossilCreekProject

Fossil Creek Restoration a Hot Topic at 8th Biennial Conference of Research on the Colorado Plateau

The 8th Biennial Conference of Research on the Colorado Plateau, held at NAU in November 2005, provided a showcase for many aspects of research and policy making at Fossil Creek. Fourteen presentations at the conference provided updates on a wide variety of research and restoration topics at Fossil Creek. The special session entitled *Fossil Creek: An Opportunity to Restore a Diverse Native Fishery and Study the Effects of Return of Full Flows* was organized by Michele James and chaired by Allen Haden. This session was well attended and consisted of eight presentations highlighting research and the technical aspects of the native fish restoration program.

Continued on page 3

Stewardship meeting
Continued from front page

Short-Term Management Needs

- recreation management to enhance experiences and reduce impacts;
- collaborative, interagency management and monitoring;
- protection of native fish (e.g., crayfish control, enforcing regulations, developing a monitoring plan).

Long-Term Management Needs

- maintain native fisheries (control of crayfish, non-natives);
- management of recreation infrastructure, including roads, trails, motorized access;
- acquiring funding and additional human resources;
- management presence/law enforcement.

Short-Term Stewardship Needs

- formation of a stewardship group – Friends of Fossil Creek;
- form relationships with other existing stewardship groups;
- collaborative planning;
- keep the area clean;
- provide stewardship information to users.

Long-Term Stewardship Needs

- Friends of Fossil Creek and agency interaction;
- keep the area clean;
- consider user fees;
- law enforcement;
- increase volunteerism (e.g., in local communities, school groups).

Short-Term Education/Outreach Needs

- On-site information sharing targeting users;
- Off-site information sharing – schools, communities, seek volunteers;
- Share information within and among agencies.

Long-Term Education/Outreach Needs

- education of visitors and locals about stewardship, ethics, Leave No Trace;
- education on native fish to prevent reintroduction of non-natives;
- gathering and sharing information on Fossil Creek research and management with the public via symposia, liaison, surveys.

While the results of this meeting are largely intended to serve as recommendations—a proposal—to land managers responsible for the short– and long-term management of Fossil Creek, it was evident from the meeting that there are many other individuals and groups who would like to be part of the future of Fossil Creek. Collaboration and partnerships are strong elements of the Fossil Creek restoration effort and will undoubtedly continue. A core working group and a "Friends of Fossil Creek" group are only two formal collaborations suggested at the meeting. Communication, knowledge sharing, and partnering on projects were suggestions for less formalized collaboration. The message was clear—working together is critical to the success of a restored Fossil Creek ecosystem.

Engineering Graduate Students Study Sediment and Feasibility of a Gaging Station

Work by students in Civil & Environmental Engineering at NAU addresses the release of sediment accompanying the planned lowering of the Fossil Springs Diversion Dam, slated to occur in late 2007, and hydrologic gaging on Fossil Creek.

Lorrie Yazzie is wrapping up her Masters of Science project to establish baseline conditions in that portion of Fossil Creek between the Fossil Springs and Irving. She has completed stream classification, pebble counting and surveying work, has placed all the data into a Geographic Information System (GIS) and is writing up her results. Lorrie has documented the fining of sediments between the Springs and the Diversion Dam, and has established a series of nearly a dozen baseline cross-sections for repeat surveys and pebble counts. These will be used to study the movement of sediment, presently stored behind the Diversion Dam, mobilized, transported, and re-deposited by large storms. Lorrie was assisted in her research by Kevin Gore and Randy Perham of NAU.

Ed Monin is finishing his Masters of Science project to identify locations, approaches and technology suitable for low-flow gaging on Fossil Creek. As part of this work, Ed has completed a stream classification, using a modification of Montgomery & Buffington's scheme, of the entire Fossil Creek stream reach, from the confluence of Calf Pen and Sand Rock Canyons, to the confluence of Fossil Creek with the Verde River.

Ed has identified and evaluated 5 potential locations for low flow-gaging system installation, which will possibly be done by SRP. A low-flow rating curve has been prepared for each location using HEC-RAS software. In addition, he has considered standard and state-of-the-art technologies. His recommendations will be forthcoming in the 2nd quarter of 2006.

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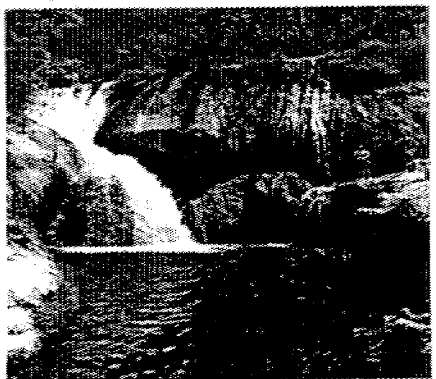
Gaging Station, *continued*



June 18, 2005 at 10:47 a.m., immediately prior to return of full flows (Ed Monin)

June 18, 2005 at 11:13 a.m., immediately after return of full flows (Ed Monin)

Ed has identified and evaluated 5 potential locations for low-flow gaging system installation, which will possibly be done by SRP. A low-flow rating curve has been prepared for each location using HEC-RAS software. In addition, he has considered standard and state-of-the-art technologies. His recommendations will he forthcoming in the 2nd quarter of 2006.

Biennial Conference

Continued from front page

Shaula Hedwall of the U.S. Fish and Wildlife Service provided an overview of the cooperative multi-agency effort to restore the native fish community in conjunction with restoration of flows and decommissioning. While nonnative fish removal was independent of restoration of flows, removal had to be completed before increased volume in the stream precluded the use of chemical treatment. Two national forests were involved and an environmental assessment had to be approved before a fish barrier could be built within the boundaries of a wilderness area. Bureau of Reclamation was responsible for design and construction of the barrier as well as overall project funding. Arizona Game and Fish Department was given the task of chemical treatment of the stream to remove nonnatives and the U.S. Fish and Wildlife Service was responsible for temporary removal and repatriation of native taxa. All scheduling for the various tasks had to include the cooperation of Arizona Public Service Company in order to meet their decommissioning schedule as well as take into account uncooperative weather. Cooperation among so many Federal and State agencies as well as the many non-governmental organizations and private entities was the key to successfully completing the fish restoration. David Weedman of Arizona Game and Fish Department (AGFD) described the coordinated efforts of his department and other agencies charged with removing nonnative fish from the stream. Extensive preplanning and application development were carried out during the summer of 2004 in order overcome the rapid breakdown of antimycin-a within the stream. A temporary, small-scale hatchery with 24-hour staff was built on the site of the Irving Power Plant to house all the salvaged native fish during chemical treatments. The extensive upfront work by AGFD paid off when the chemical renovation proved 100 percent effective.

From a research perspective Allen Haden and Jane Marks provided evidence that nonnative smallmouth bass and green sunfish were having a greater impact upon the abundance and feeding ecology of native fishes than discharge. Total abundance of all native fishes and especially small-bodied natives was severely depleted in the presence of nonnatives compared to dewatered portions of the stream. Likewise, stable isotope data indicated that feeding ecology of native chub and dace was disrupted in the presence of nonnatives compared to loss of water in the stream. Haden's study helps to justify the removal of nonnative fishes from the stream. Removal of nonnative fish may not have entirely beneficial effects. Ken Adams and Jane Marks presented data that showed nonnative crayfish densities increased two-fold in areas where nonnatives were removed compared to portions of the stream where nonnative fish remained. Additionally, Adams presented data on algal accrual and litter decomposition in enclosures with various crayfish densities. His results suggest that densities of crayfish in the stream previous to fish removal may have been below the threshold that can induce measurable ecosystem effects. Further research and monitoring will show if crayfish will continue to increase in abundance or if their densities remain under control after native fish populations recover.

Return of full flows to the stream will increase the number and size of travertine terraces in the stream. This important change in morphology is

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Biennial Conference
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likely to have profound effects on ecosystem processes. Cody Carter and Jane Marks found that both algal accrual on clay pots and decomposition of leaf litter was significantly faster in travertine dam forming reaches of Fossil Creek compared to areas without dams. Additionally, invertebrate communities on the algal and leaf substrates were more diverse in the travertine forming reach. Zachaeus Compson and coauthors showed that travertine dams profoundly affect the retention of leaf litter material in the stream. Travertine dams created large, wide pools and braided channels which decreased velocities and retained significantly more litter than free flowing sites over a range of discharges.

Brenda Harrop and coauthors are using cutting edge molecular techniques to describe the composition of fungal and bacterial communities colonizing leaf litter in travertine and non-travertine forming reaches of Fossil Creek. Initial data indicate that fungal communities vary by site while bacterial communities vary by both site and leaf species, yet further work is need to fully describe these communities.

Finally, from the human perspective, Paul Hancock and coauthors are exploring the impacts to recreation caused by the restoration project. Their results showed that the majority of users were from Arizona and generally were supportive of the hydropower decommissioning and nonnative fish removal. Interviewees were generally wary of regulations that might limit camping in the upper portion of Fossil Creek but were supportive of designated camping areas away from the spring area. This information combined with continued monitoring of recreational users activities and attitudes will be used by the Forest Service to build a management plan for recreation in Fossil Creek.

Fossil Creek was also the subject of presentations in other sessions of the Biennial Conference. Most provided the unique perspective of agencies, utilities, NGO's and individuals on the process that led to the decommissioning decision. All of the agency and NGO presentations stressed the high level of interagency cooperation and openness required to plan and implement large-scale restoration projects such as Fossil Creek. Jerry Stefferud provided a first person historical account of the decision process. Stefferud has been involved in the Fossil Creek process since 1989 as both fisheries biologist for the U.S. Forest Service and as private citizen. Rob Clarkson presented the role of the Bureau of Reclamation in the fisheries restoration program. The Bureau funded the fish restoration and fish barrier construction to improve native fish habitat for the existing native taxa and help with introduction of other imperiled Gila River basin native fish. Phil Smithers of Arizona Public Service Company provided the perspective of the utility, which surrendered its hydropower license and made the whole restoration project possible. Mindy Schlimgen-Wilson (formerly of American Rivers) spoke about the important lessons learned during the process of building the partnerships between agencies, APS, environmentalists and citizens which where necessary to produce the agreement to restore flows to the stream. Finally, Cecelia Overby and Janie Agyagos of the U. S. Forest Service provided a perspective from the land management agencies tasked with managing the Fossil Creek area and the restoration program.

The biennial conference provided an excellent venue for Fossil Creek research and management issues and we look forward to organizing a second session to follow up on research results in two years.

Central Repository for Fossil Creek Materials

NAU's Cline Library has agreed to provide a central repository for archiving materials related to Fossil Creek. Michele James, Fossil Creek Coordinator, is overseeing this effort for the Ecosystem Studies Group. Please contact her if you have materials associated with Fossil Creek that provide valuable information on past or existing conditions or in telling the story of Fossil Creek.

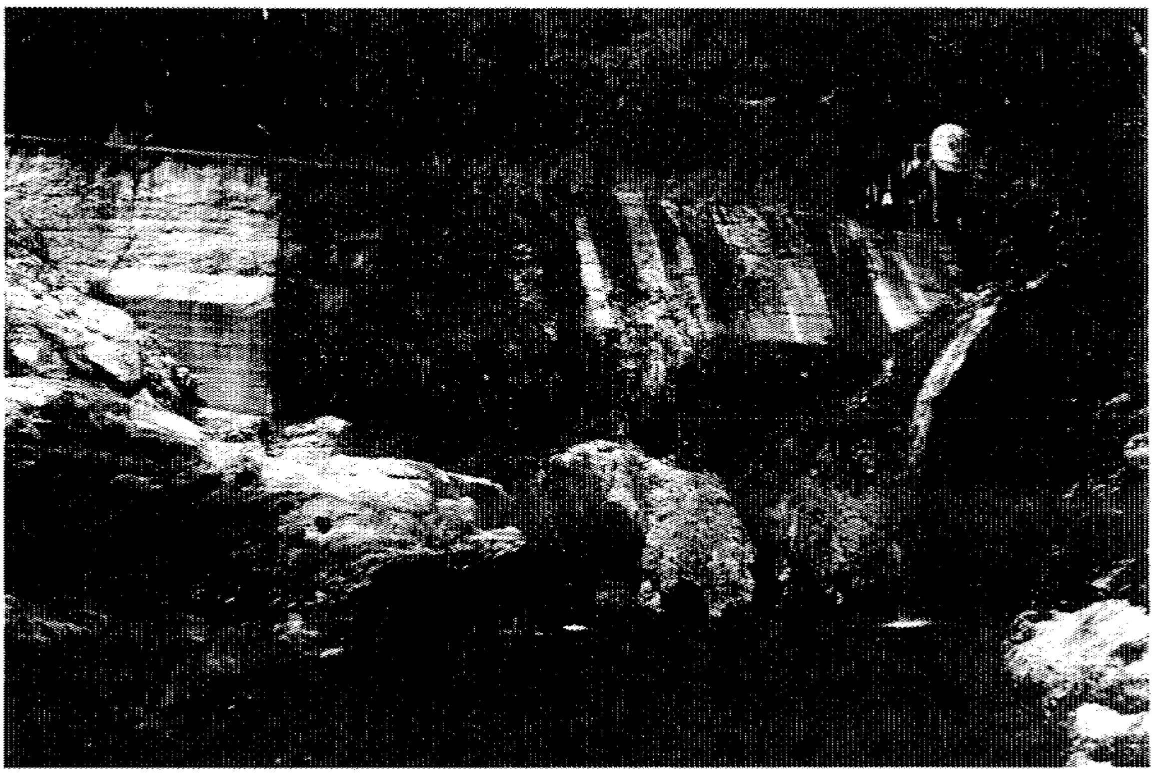
Acknowledging those who make our work possible

The work conducted on Fossil Creek by the students and faculty of NAU has been supported by the Nina Mason Pulliam Charitable Trust, Arizona Public Service, Salt River Project, National Science Foundation, Arizona Game and Fish Department Heritage Fund, and Watershed Research & Education Program and School of Forestry at Northern Arizona University.

NINA MASON PULLIAM
CHARITABLE TRUST

Questions or comments about something in this newsletter? Contact Michele James at: Michele.James@nau.edu.

Econotes from Fossil Creek
Volume I: Before Decommissioning



Jane C Marks, Ph.D., G Allen Haden, Eric C Dinger, Cody Carter, Kenneth Adams and Carri LeRoy; Photos by Sylvester Allred and Eric Dinger

For further information, please contact Jane Marks (Jane.Marks@nau.edu, 928 523 0918)
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Merriam-Powell Center for Environmental Research

Fossil Creek Restoration: an Ecological Experiment

A publication of the Stream Ecology and Restoration Group at Northern Arizona University

Exotic species, pollution, and human appropriation of fresh water have degraded streams and lakes around the world and contribute to the widespread losses of native species. Can ecosystem restoration projects help reverse these alarming trends? In Fossil Creek, Arizona, scientists and natural resource managers are working together to find out.

Nearly a century ago, Arizona Public Service (APS) built a hydropower dam on Fossil Creek. Reduced flow caused by the dam and invasion by exotic fish have caused native fish populations to decline. APS, natural resource managers, and scientists hope their ambitious restoration plan can fix this damaged ecosystem.

The Restoration Plan has two parts. First, the reach of the creek immediately below the dam will be purged of exotic fish. Second, water will no longer be diverted for hydropower production, but instead will be allowed to flow in the natural stream channel. Return of full flows by decommissioning the dam is scheduled for December 31, 2004, though it's not yet decided whether the dam will be removed completely or only partially. Safety, liability, and aesthetic concerns argue for completely removing the dam, but there are ecological reasons to leave a portion of it in place. First, the dam is an effective barrier to exotic species migrating further up stream. Second, the dam prevents sediments from being unleashed into the stream. Third, the pool created by the dam has an extensive riparian zone that supports the largest known breeding population of lowland leopard frogs in the Cocconino National Forest.

To eradicate exotic fish, managers will treat the river with a chemical that kills fish called Antimycin A. Prior to chemical treatment, native fish will be removed and kept in holding tanks, to be released back into the stream once the exotics have been eradicated. The plan also includes constructing a barrier at the downstream end of the chemical treatment to prevent reinvasion of exotic fish from the Verde River.

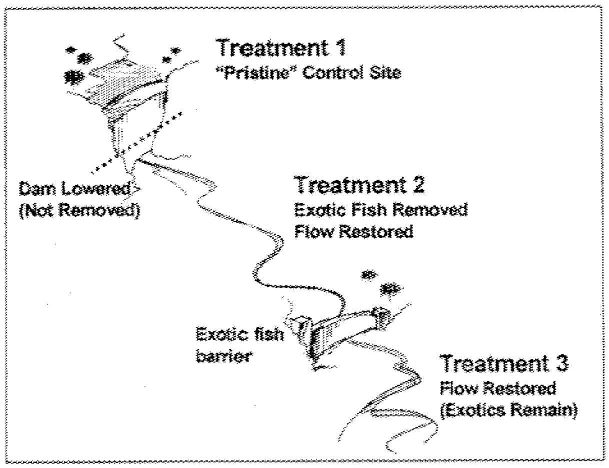


Figure 1. The Fossil Creek Restoration Project viewed as an ecological experiment with three treatments: 1) 'Control', above the dam in pristine state, with no exotic species and with a natural flow regime, 2) 'Complete Restoration', where exotics are removed and flow is restored; and 3) 'Partial restoration', below the barrier, where flow will be restored but exotic species will still be present.

Working Together for Restoration

Restoring the Fossil Creek ecosystem will benefit freshwater resources in Arizona, enhancing visitors' aesthetic and recreational experiences and providing a native fishery in a region where native fish are increasingly rare. Equally important, the collaboration between managers and scientists in the design, execution, and monitoring of this ambitious restoration project can serve as a model for stream restoration.

Of the hundreds of dam removal projects that have already occurred around the country, very few monitored the recovery of the ecosystem. Fewer still had enough baseline information to be able to articulate clear goals for ecosystem recovery. Did restoration really restore the ecosystem? Why, or why not? Unlike most dam removal projects around the country, it **will** be possible to answer these questions in Fossil Creek.

As an experiment, Fossil Creek has three treatments (Figure 1). The reach above the reservoir is mostly pristine, having experienced neither flow reduction nor invasion by exotics. This reach (Treatment 1) provides baseline conditions and a target for restoration. The reaches below the dam have been altered by a century of flow reduction and invasion by exotic species. Will restoring flow promote the unique chemistry and morphology of these reaches, increasing habitat availability for aquatic and riparian species? Will the chemical treatment release natives from exotic competitors and predators? The synergy between scientists and natural resource managers in Fossil Creek provides a unique opportunity to address these key questions.

Fossil Creek, a model system. Fossil Creek offers a unique opportunity to document ecosystem responses to restoration because researchers and managers are working together to collect sufficient baseline data prior to restoration and to develop a plan to evaluate ecosystem recovery. Treating the restoration project as an ecological experiment makes Fossil Creek a model system for restoration programs around the world.

For further details, please consult the Draft Environmental Assessment:
www.fs.fed.us/r3/coconino/nepa.index.shtml

Supported by the National Science Foundation, the US Forest Service, the Arizona Heritage Fund, the Ecological Restoration Institute and the Merriam-Powell Center for Environmental Research

Travertine: a source of diversity and productivity in Fossil Creek

A publication of the Stream Ecology and Restoration Group at Northern Arizona University

Before flow was diverted for hydropower on Fossil Creek, large travertine dams and pools extended over a 10 kilometer reach. Now, this unique travertine habitat is confined to less than one kilometer. Returning spring-water flow to Fossil Creek will supply more carbonate, more turbulence, and more CO_2 outgassing, the essential drivers of travertine formation. Increased flow is expected to increase travertine deposition to 12,000 kg d^{-1}, enough to restore travertine dams and pools to their original state (Malusa et al. 2003).

How will this affect the ecology of the creek? Will travertine buildup threaten recovery of the native fishery? Is the cement-like substrate formed by travertine poor habitat for fish and stream insects, discouraging algal growth and energy flow up the food chain? Probably not.

Travertine promotes algae and decomposer organisms (Figure 1), making more energy available to higher trophic levels. The food web in Fossil Creek relies on energy from algal growth and from leaf litter produced by riparian trees. We measured algal growth in travertine and non-travertine reaches using clay substrates, and rates of leaf litter decomposition using litter bags. We found that algal growth was higher in the travertine and that leaf litter decomposed more quickly (Figure 1). So, in the travertine reach, there is more energy available to higher trophic levels.

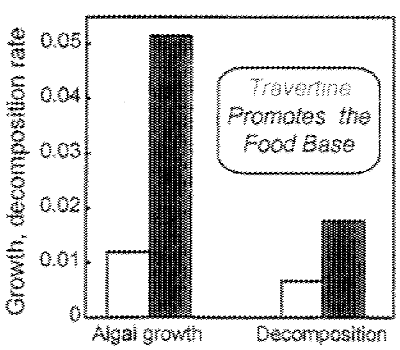


Figure 1 Rates of algal growth and decomposition of leaf litter are higher in travertine (■) compared to non-travertine (□) reaches (data from C Carter and J Marks).

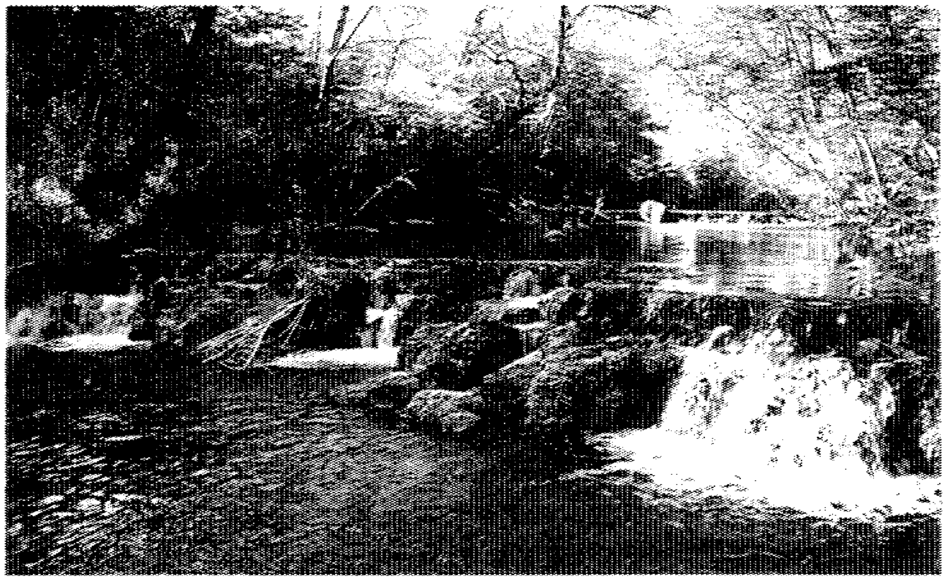


Figure 2. Travertine dam below Irving

Travertine enhances fish and insect diversity. Insect densities are similar in travertine and non-travertine reaches, but travertine sites promote a unique insect fauna with specialized adaptations to travertine deposition. In contrast to other southwestern streams, travertine deposition in Fossil Creek enhanced insect species richness - the total number of insect species present in an area (E. Dinger). This indicates that the pre-dam conditions possibly supported diverse communities and that richness has been reduced in areas by flow regulation. Flow restoration may thus increase insect diversity.

Native fish species are also more abundant in the travertine compared to non-travertine areas with similar flow, likely because of the habitat complexity associated with this geomorphological feature of Fossil Creek.

Travertine favors algal growth, decomposition, and native biodiversity. Travertine is also a widely appreciated aesthetic feature of the Fossil Creek ecosystem (Figure 2). In the coming years, scientists and managers working in Fossil Creek will be watching to determine whether the Fossil Creek restoration program will promote travertine and its unique ecology.

Supported by the National Science Foundation, the US Forest Service, the Arizona Heritage Fund, the Ecological Restoration Institute and the Merriam Powell Center for Environmental Research

Where exotics flourish, natives decline – fish distributions in Fossil Creek, Arizona

A publication of the Stream Ecology and Restoration Group at Northern Arizona University

Native fish are among the most threatened groups of organisms in the southwest, primarily because of water diversions and the introduction of exotic fish. Over half of Arizona's fish are listed as endangered or threatened. Fossil Creek provides an opportunity for preserving native fish because it is one of a few streams in Arizona that supports viable populations of five native fish species. These species include Headwater chub (*Gila nigra*), Roundtail chub (*Gila robusta*), Sonoran sucker (*Catostomus insignis*), Desert sucker (*Catostomus clarki*), speckled dace (*Rhinichthys osculus*), and possibly longfin dace (*Agosia chrysogaster*).

Exotic fish have been introduced into many southwestern streams for sport fishing and as bait fish and have spread throughout Arizona streams. In Fossil Creek, these exotics have invaded and are quickly displacing native fish in the downstream reaches. The fish community above the dam comprises only native fish, because the dam also functions as a fish barrier, preventing upstream migration of exotics. The relative abundance and diversity of exotic fish increase downstream towards the Verde River, the source of introductions into Fossil Creek (Figure 1). One argument in favor of lowering rather than removing the dam is to prevent exotic fish from invading the small reach above the dam. The dominant invaders are green sunfish (*Lepomis cyanellus*) and smallmouth bass (*Micropterus dolomieui*); but there are also yellow bullhead (*Ameiurus natalis*), and flathead catfish (*Pylodictiss olivaris*).

Exotic species threaten natives worldwide but are particularly detrimental in freshwater ecosystems where their effects ripple through food webs, affecting insects, native fish, and even birds, such as bald eagles that feed on fish. Exotic fish compete with natives for food and habitat, prey on smaller native fish, and interfere with spawning. In Fossil Creek, the effects of exotics are most pronounced on juvenile and small bodied natives. Speckled Dace, a small bodied native, are abundant directly below the hydropower dam but are absent just one kilometer downstream where exotic green sunfish are abundant (Figure 1). Similarly, juvenile suckers and chubs are rare in the downstream sites, suggesting that reproduction and recruitment are compromised by exotics. When exotics reduce the growth and survival of juveniles, native fish populations continue to decline because adult fish die but are not replaced.

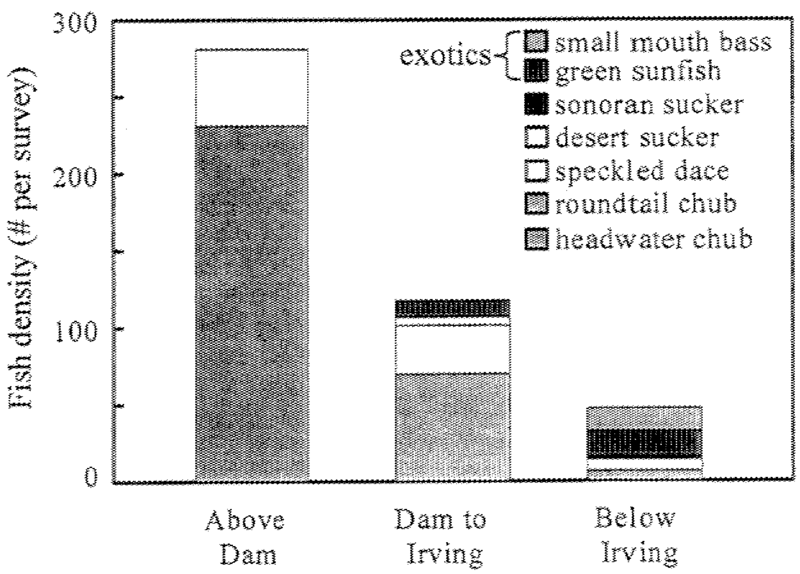


Figure 1. Native fish densities in Fossil Creek decline downstream as densities of exotics increase. (Data from fish surveys of A Haden et al.).

Managers and scientists are capitalizing on the dam decommissioning project to improve conditions for native fish by removing exotics prior to return of full flows. Managers from the Arizona Game and Fish Department, Bureau of Reclamation, U.S. Forest Service and the U.S. Fish and Wildlife Service are working together to chemically treat a section of the river with antimycin A, an antibiotic that kills fish at relatively low concentrations. Prior to chemical treatment they will remove as many native fish as possible and keep them in holding tanks, releasing them into the stream when the treatment is completed. A five foot barrier will be constructed at the downstream end of the chemical treatment to prevent reinvasion of exotic fish from the Verde River.

Will the removal of exotic species increase native fish populations? Will recruitment and reproduction increase? How will restoration of full flows affect native fish? Will exotic fish reinvade? The NAU Stream Ecology & Restoration Group is working with managers to design a monitoring program to answer these questions.

Supported by the Arizona Heritage Fund and the Merriam-Powell Center for Environmental Research

Could Crayfish Undermine Restoration in Fossil Creek?

A publication of the Stream Ecology and Restoration Group at Northern Arizona University

Crayfish are notorious for invading freshwater ecosystems and initiating aggressive and complex interactions with native species. Arizona has no native crayfish, but two exotic species were introduced by the Arizona Game & Fish Department and the U.S. Fish & Wildlife Service in the 1970's to control aquatic weeds, for sports fish forage and as bait. Crayfish were first observed in Fossil Creek during the1990s.

Crayfish are migrating upstream from the Verde River but have not yet established stable populations near the dam. In 2003, we systematically trapped crayfish at different sites along Fossil Creek. Crayfish densities are highest near the confluence of Fossil Creek and the Verde River. Densities decrease upstream, with no crayfish captured above the dam or directly below it (Figure 1). Although we did not trap crayfish directly below the dam, we have seen a few crayfish or their carapaces (outer shells) there, indicating that they are penetrating the upper watershed.

Will chemical treatment also remove crayfish? No. Anitmycin will not affect crayfish. In fact, crayfish farmers in the southeast use it to remove bass from ponds without harming crayfish. There are no approved chemical methods for eradicating crayfish. The only way is to remove them manually with traps and nets. Trapping is labor intensive and will reduce but not eliminate crayfish.

Predicting how crayfish will respond to restoration requires understanding how crayfish interact with other species. Crayfish affect native species by competing for food, preying on small fish and eggs, and reducing habitat quality by shredding copious amounts of leaf litter and making the water turbid. Crayfish in Fossil Creek eat a range of foods including algae, leaf litter, and macroinvertebrates, but they prefer macroinvertebrates, a primary food source for both native and exotic fish. **Exotic bass eat crayfish** and could be controlling crayfish populations. Removal of bass will reduce this pressure, potentially causing crayfish populations to explode after restoration. If this occurs, crayfish could undermine efforts to restore native fish, because crayfish eat their eggs and also compete with them for macroinvertebrates.

In contrast, if native fish respond positively and quickly to restoration, they may control crayfish densities. We plan to monitor crayfish densities after restoration. If their populations begin to increase, it may make sense to reduce their densities through trapping to allow recovery of the native food web and its endangered fish, the targets of restoration of this stream ecosystem.

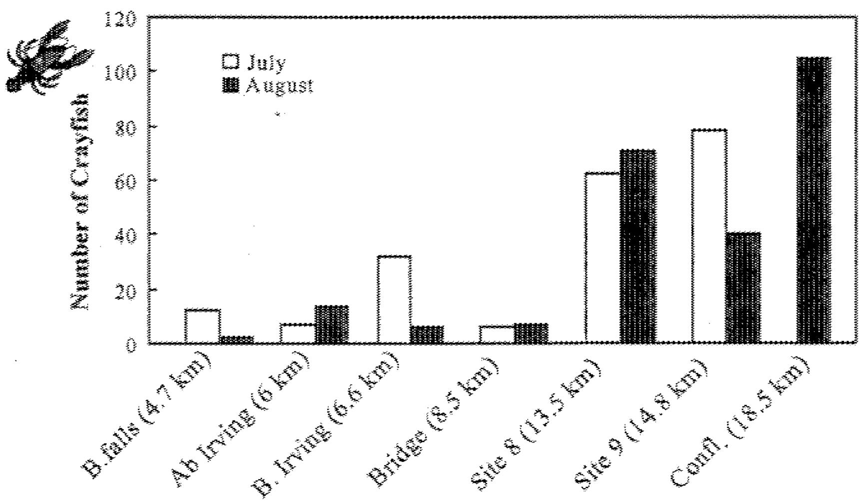


Figure 1. Crayfish densities increase downstream in Fossil Creek, Arizona. Data are means from two trapping efforts in 2003. For each site, the value in parentheses shows the distance downstream from the springhead. Three upstream sites were monitored (0.25, 0.4, and 2.4 km from the springhead) in which no crayfish were trapped during either period. Data from K. Adams and G. Merez.

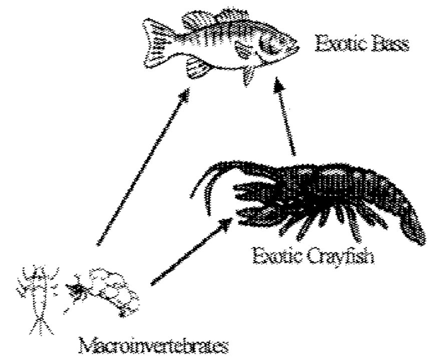


Figure 2. Exotic bass compete with and prey upon crayfish. Removing bass could increase crayfish populations.

Supported by the Arizona Heritage Fund and the Merriam-Powell Center for Environmental Research

Can we restore river food webs after a century of disturbance?

A publication of the Stream Ecology and Restoration Group at Northern Arizona University

Species interact with each other, creating complex food webs. Food web structure reveals what species are eating, which species are competing, and who is preying upon whom. A century of disturbance has altered food web structure in Fossil Creek. Will restoration help the food web recover? Stable isotope analysis can answer this question.

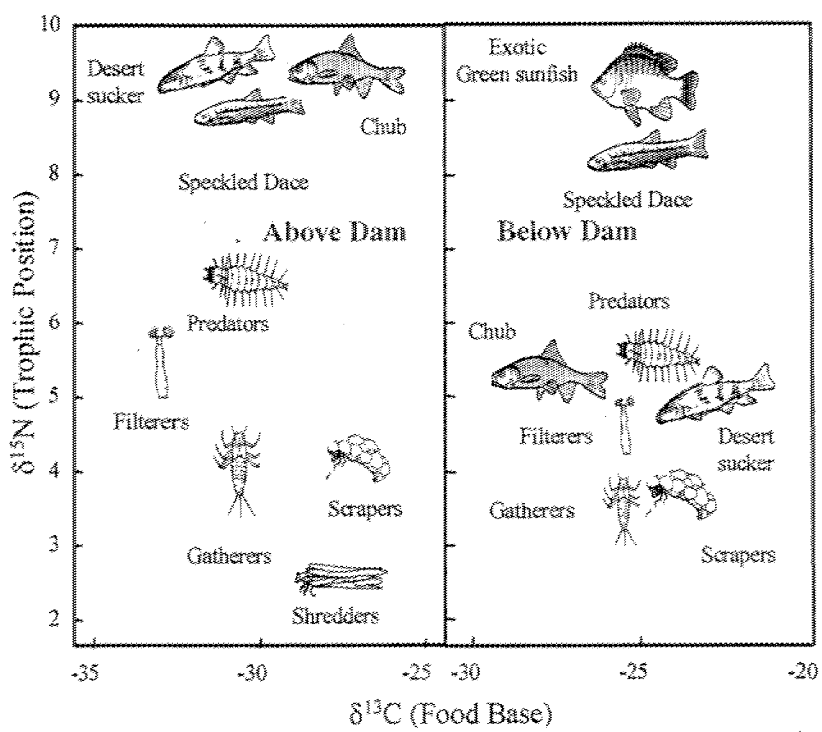
Stable isotopes are atoms of the same element that differ in atomic mass, due to differences in the number of neutrons contained in the atoms' nuclei. Many elements have multiple stable isotopes found in nature. Most carbon atoms are carbon 12 with 6 protons and 6 neutrons, but carbon 13 atoms have 6 electrons and 7 neutrons. Similarly, nitrogen atoms can have 7 or 8 neutrons. Ecologists use stable isotopes to trace energy through food webs.

Stable carbon isotopes are conservative tracers: predators have the same isotope values of their prey. In other words, you are what you eat. Stable nitrogen isotopes indicate trophic position, because ^{15}N values increase up the trophic chain. This is because organisms excrete lighter isotopes more quickly than heavier ones, so the heavier nitrogen atoms, with more neutrons, become incorporated into their tissues.

Together, carbon and nitrogen isotopes give a schematic diagram of the food web (Figure 1). Two rules of thumb are useful for interpreting these graphs. 1) Species with similar carbon and nitrogen isotope values are likely competing for the same resources. 2) Species with high nitrogen isotope values are top predators.

We compared the food web structure above and below the dam. Two major differences are likely due to habitat degradation and exotic species. First, below the dam native fish feed lower on the food chain. Native fish living above the dam eat mostly large macroinvertebrates. Below the dam exotic fish compete with natives for large macroinvertebrates, forcing natives to eat more algae and smaller macroinvertebrates. Second, reduced flow below the dam causes macroinvertebrates to compete more for food. Macroinvertebrates are divided into functional feeding groups based on what they eat. Grazers eat algae, shredders eat leaf litter, collectors eat detritus and bacteria, and predators eat other invertebrates. The multiple food types in healthy streams reduce competition and support a diverse invertebrate assemblage. With greater resource overlap below the dam, macroinvertebrates compete more for scarce resources. Dam decommissioning should increase habitat, helping restore the diverse community. Removal of exotics should increase the trophic position of native fish.

We are monitoring food web structure of eight sites in Fossil Creek, from above the dam to the confluence. Through repeat sampling, we will document how food web structure responds to restoration. Traditionally, such efforts have monitored responses of only a few target species. If successful, our approach will set a precedent for using stable isotopes to characterize changes in disturbed ecosystems and to set restoration targets based on food web interactions.



Food web diagrams, based on stable isotopes, show that native chubs and suckers are top predators above the dam but are displaced by exotic sunfish below the dam. Macroinvertebrates occupy distinct niches above the dam but overlap in resource use below the dam. Data collected by

Supported by the Arizona Heritage Fund, the Ecological Restoration Institute and the National Science Foundation

Aquatic Macroinvertebrates – sources of energy and diversity

A publication of the Stream Ecology and Restoration Group at Northern Arizona University

Aquatic macroinvertebrates, or stream bugs, are a diverse group made up of various animals – mainly insects (Figure 1-3), snails (Figure 4), and worms. In aquatic ecosystems, these organisms are important in transferring energy and nutrients contained in algae and leaf litter to higher food levels, both aquatic (e.g. fish) and terrestrial (e.g. spiders, birds, and bats). The aquatic

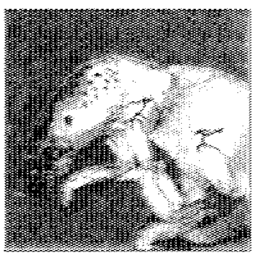


Figure 1 *Polyplectropus* sp., a caddisfly, initially thought to only live in Texas, is found in Fossil Creek.

macroinvertebrates of Fossil Creek are no exception – they are a vital link in sustaining the native ecosystem.

Our studies of the aquatic macroinvertebrates reveal an abundant and diverse collection of aquatic insects. Diversity enhances the flow of energy and nutrients, because different types of insects eat different foods.

Groups of invertebrates that consume specific types of food resources are categorized into "functional feeding groups". ***Grazers*** consume algae growing on rocks and travertine, ***shredders*** eat leaf litter, ***collectors*** feed on bacteria growing on leaves or bark, whereas ***predators*** feed on other insects like the bug shown in

Figure 2 *Ambrysus* sp., "Toe-biter", uses its piercing beak to capture small insects. Occasionally it will bite people's toes. Although the bite feels like a bee sting, it is

Figure 2, which uses a piercing beak to kill its prey. Healthy streams need representatives from different functional feeding groups to ensure proper cycling of energy and nutrients.

Macroinvertebrate diversity in Fossil Creek is amazing relative to other southwestern streams! To date, we have collected 124 different species of aquatic macroinvertebrates including the endemic Fossil Springsnail (Figure 4). Other surveys of southwestern streams, show limited diversity – often well below 100 species.

Why does Fossil Creek have such high diversity of aquatic insects? This probably results from several factors. 1) The springs at Fossil Creek have remained relatively pristine, with no exotic fish or crayfish. This area above the dam with full flow and no exotics serves as a refuge, ensuring that there is always a colonizing source for the rest of the stream. 2) The watershed is small for a southwest stream. This limits extreme floods reducing

Figure 3 *Lepidostoma* sp., or the "Turret-case caddisfly". This insect, shown on the left, builds a case out of sticks and stones in which it lives. Caddisflies are one of the only insect groups that make silk. Silk holds their cases together.

disturbance. Although spates will still be frequent, their magnitude is much smaller than many southwest streams. 3) Travertine deposition in Fossil Creek promotes diversity where travertine areas are characterized by unique insects.

How will the exotic fish removal affect macroinvertebrates? There are few studies on how macroinvertebrates are affected by antimycin A, the chemical that will be used to kill exotic fish. The data collected by the Stream Ecology and Restoration Group at NAU will be instrumental in determining whether invertebrates are harmed by the chemical treatment.

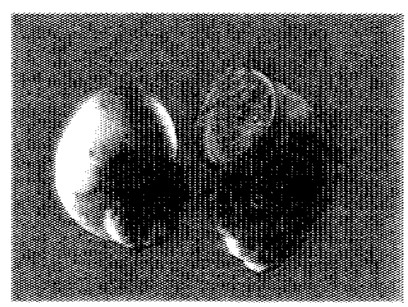


Figure 4 *Pyrgulopsis simplex*, the Fossil Springsnail, is endemic to Fossil Creek. It is not found any where else in the world.

Supported by the US Forest Service, Coconino District, the Arizona Heritage Fund, and the Merriam-Powell Center for Environmental Research. Special thanks to M Whitney who initiated this project. Photos by E Dinger.

Stream Ecology & Restoration Group

The Stream Ecology and Restoration Group at Northern Arizona University studies freshwater food webs and ecosystem processes in the southwestern United States and Mexico

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Logan Simpson Design Inc.
Project Name: Middle Fossil Creek EA
LSD # 083229
Date: May 23, 2008
PM: Beth Defend
Math check done by: Marta B.

Tasks	Project Principal	Landscape Arch IV	Archaeologist III	Archaeologist I	Tech Editor II	Biologist IV	Biologist III	Biologist II	Permitting Specialist III	Permitting Specialist II	Environ. Planner III	Environ. Planner II	Environ. Coord. I	Graphic Designer III	GIS Tech. II	Subtotal Hours	Subtotal Costs
Task 1. Initial Site Visit, Project Meetings, and Scoping																	
Site Visit Summary	1	10	10		1	10					12					44	$ 5,030
Project Meetings (4) and Meeting Summaries		7	7			7					36	7				64	$ 6,837
Draft and Final Purpose & Need/Proposed Action for Scoping	2										20	8				30	$ 3,104
Draft and Final Scoping Letter	1				1	2					8			4	4	20	$ 1,971
Mailing List Maintenance												12	24			36	$ 1,706
Subtotal Task 1 Labor	4	17	17	0	2	19	0	0	0	0	76	27	24	4	4	194	$ 18,648
Task 2. Public Meeting																	
Meeting Preparations, Facility Arrangements, Meeting Materials	3				6	4					12	32		18	16	89	$ 7,780
Meeting Participation						6					6					12	$ 1,422
Scoping Meeting Summary	1				2	2					12	48				65	$ 5,714
Subtotal Task 2 Labor	4	0	0	0	8	12	0	0	0	0	30	80	0	18	16	166	$ 14,916
Task 3. Issues and Alternative Development																	
Draft and Final Significant Issues and Alternatives Report	2										22	16				40	$ 3,963
Alternative Development Meeting and Meeting Summary	1				2	6					9					18	$ 2,034
Draft of EA Chapters 1 and 2 and revisions based on FS Comments	6				10						40	16		6	12	90	$ 8,504
Subtotal Task 3 Labor	9	0	0	0	12	6	0	0	0	0	71	32	0	6	12	148	$ 14,501
Task 4.1 Predecisional EA																	
Project Management, Quality Control, Front/Back Matter, GIS	10				24						60	30	4	20	20	168	$ 15,229
Biological Resources (Vegetation, wildlife, acquatics, T&E)						16	20									36	$ 3,939
Soil Resources									8	18						26	$ 2,345
Water Resources									8	18						26	$ 2,345
Air Quality												18				18	$ 1,458
Cultural Resources	2		16													18	$ 1,728
Recreation											16	30				46	$ 4,119
Visual Resources	4	40														44	$ 6,098
Environmental Justice											4	16				20	$ 1,719
Draft EA Legal Notice and Cover Letter	1										8			5		14	$ 1,475
Subtotal Task 4.1 Labor	17	40	16	0	24	16	20	0	16	36	88	94	4	25	20	416	$ 40,456
Task 4.2 Biological Assessment and Evaluation																	
Field Surveys						8	8	16								32	$ 2,980
Draft and Final BAE	2				12	24	60	60			8			2	8	174	$ 15,486
Subtotal Task 4.2 Labor	2	0	0	0	12	32	68	76	0	0	8	0	0	2	8	206	$ 18,446
Task 4.3 SHPO Consultation Documentation																	
Consultation and TCP Support	24		24													48	$ 6,220
Draft and Final Cultural Documentation	4		32	40										2	12	90	$ 6,410
Subtotal Task 4.3 Labor	28	0	56	40	0	0	0	0	0	0	0	0	0	2	12	138	$ 12,630
Task 5. Comments on Predecisional EA and Final EA																	
Draft and Summary of Comments and Responses	8	6	8		12	8	8		8		64	56	6	2	2	188	$ 18,024
Final EA	8	8	4		12	8	6		6		32	32	4	12	8	140	$ 13,488
Subtotal Task 5 Labor	16	14	12	0	24	16	14	0	14	0	96	88	10	14	10	328	$ 31,512
Task 6. Decision Notice and Project Record																	
Draft and Final Decision Notice (FONSI)	1										38					39	$ 4,182
Project Record and Index		2	2			2	2	2		2	12	12	60	2	2	100	$ 5,593
Subtotal Task 6 Labor	1	2	2	0	0	2	2	2	0	2	50	12	60	2	2	139	$ 9,775
Subtotal Labor Hours	81	73	103	40	82	103	104	78	30	38	417	333	98	71	84	1,735	$160,893
Subtotal Labor Costs	$13,995	$8,867	$8,898	$1,682	$5,015	$13,544	$8,541	$5,725	$3,119	$3,196	$43,934	$26,985	$2,997	$6,514	$5,523	1,735	$160,893

Total Labor	$160,893
Direct Expenses -Field Work	$2,171
Total Fee	$ 163,064

Logan Simpson Design Inc.
Project Name: Middle Fossil Creek EA
LSD # 083229
Date: May 23, 2008
PM: Beth Defend
Math check done by: Maria B.

Tasks	Per Diem 34.000	Vehicle/Gas 80.000	B/W Repro 0.100	CDs & Color Rpro 1.000	Pub. Mtg Displays 50.000	Total
	Direct Expenses-enter quantity not $ value					
Task 1. Initial Site Visit, Project Meetings, and Scoping						
Site Visit Summary	2	1				$148
Project Meetings (4) and Meeting Summaries	3	4				$422
Draft and Final Purpse & Need/Proposed Action for Scoping						$0
Draft and Final Scoping Letter						$0
Mailing List Maintenance						$0
Subtotal Task 1 Labor	5	5	0	0	0	$570
Task 2. Public Meeting						
Meeting Preparations, Facility Arrangements, Meeting Materials					3	$150
Meeting Participation	1	1	450			$159
Scoping Meeting Summary			500			$50
Subtotal Task 2 Labor	1	1	950	0	3	$359
						$0
Task 3. Issues and Alternative Development						$0
Draft and Final Significant Issues and Alternatives Report		1	100			$90
Alternative Development Meeting and Meeting Summary						$0
Draft of EA Chapters 1 and 2 and revisions based on FS Comments			100	10		$20
Subtotal Task 3 Labor	0	1	200	10	0	$110
Task 4.1 Predecisional EA						
Project Management, Quality Control, Front/Back Matter, GIS			1000	100		$200
Biological Resources (Vegetation, wildlife, acquatics, T&E)						$0
Soil Resources						$0
Water Resources						$0
Air Quality						$0
Cultural Resources						$0
Recreation						$0
Visual Resources						$0
Environmental Justice						$0
Draft EA Legal Notice and Cover Letter						$0
Subtotal Task 4.1 Labor	0	0	1000	100	0	$200
Task 4.2 Biological Assessment and Evaluation						
Field Surveys	3	1				$182
Draft and Final BAE			200	8		$28
Subtotal Task 4.2 Labor	3	1	200	8	0	$210
Task 4.3 SHPO Consultation Documentation						
Consultation and TCP Support	2	2				$228
Draft and Final Cultural Documentation			400	10		$50
Subtotal Task 4.3 Labor	2	2	400	10	0	$278
Task 5. Comments on Predecisional EA and Final EA						
Draft and Summary of Comments and Responses			1000	2		$102
Final EA			2000	100		$300
Subtotal Task 5 Labor	0	0	3000	102	0	$402
Task 6. Decision Notice and Project Record						
Draft and Final Decision Notice (FONSI)			100	2		$12
Project Record and Index			300			$30
Subtotal Task 6 Labor	0	0	400	2	0	$42
Subtotal Labor Hours	11	10	6,150	232	3	$2,171
Subtotal Labor Costs	374	800	615	232	150	$2,171

Fossil Creek
State of the Watershed Report

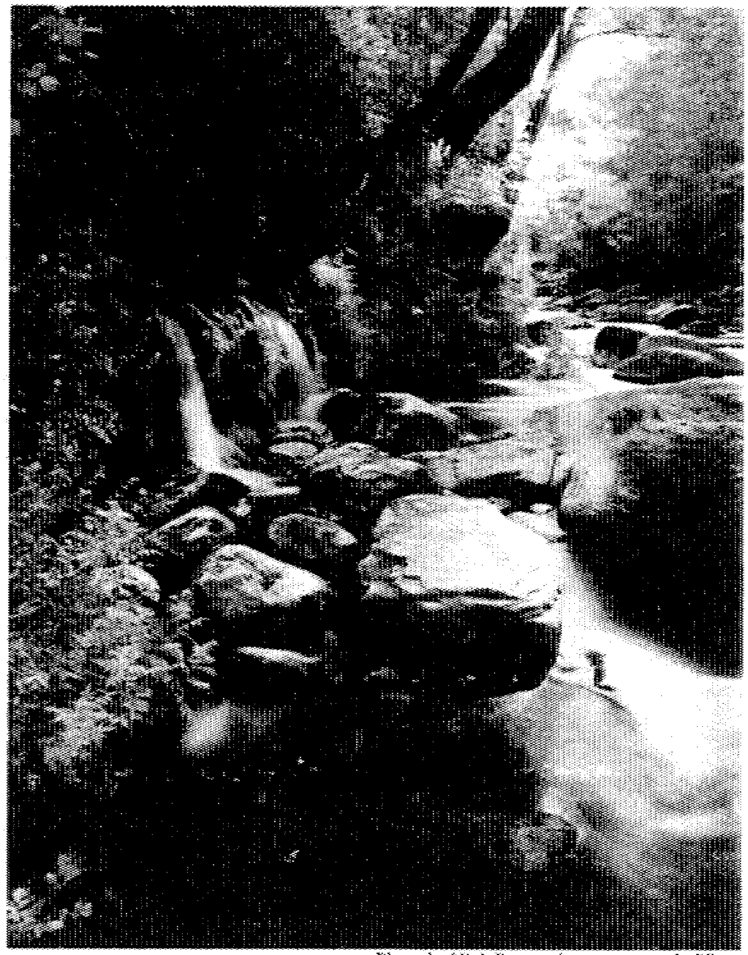

Photo by Nick Berezenko, courtesy of APS

Current Condition of the Fossil Creek Watershed Prior to Return of Full Flows and other Decommissioning Activities

Northern Arizona University
July 2005

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Acknowledgments

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U.S. Forest Service, Coconino National Forest
U.S. Forest Service, Tonto National Forest
U.S. Fish and Wildlife Service, Flagstaff Suboffice

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The *Fossil Creek State of the Watershed Report* is dedicated to the memory of Mark Whitney, Coconino National Forest Fishery Biologist, and Elizabeth Matthews, Forest Service Geologist, Northern Arizona Zone.

Comments and feedback to this report are welcome.
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Executive Summary

The Fossil Creek State of the Watershed Report summarizes available information on the current conditions of the physical, biological, and social environment of the Fossil Creek Watershed (see Figure 5) prior to the start of the Arizona Public Service Company (APS) Childs-Irving decommissioning activities which began in spring 2005. While this report is a summary of the current watershed conditions, some of the information provided by individual authors is specific to and focused primarily on Fossil Creek or the riparian corridor.

This report addressesses the physical and biological features of the Fossil Creek Watershed as the human and social environment. Below is a summary of the main points of each topic discussed in detail within this report.

Fossil Creek and its History

Background

- Fossil Creek is a major tributary of the Verde River and is located within the incised canyons of the Mogollon Rim country of central Arizona.
- Fossil Creek is located nearly entirely (with the exception of approximately 20-acres of private parcels) on lands under the jurisdiction of the USDA Forest Service and forms the boundary between the Coconino and Tonto National Forests and between Gila and Yavapai Counties. Fossil Creek flows through the Fossil Springs and Mazatzal Wilderness areas.
- Fossil Springs represents the largest concentration of spring-water discharge in the Mogollon Rim region. Spring flows emerge over approximately a 1,000-foot reach of Fossil Creek and flow is relatively constant at nearly 46 cubic feet per second (cfs).
- The major human land uses within the Fossil Creek Watershed are recreation, livestock grazing, and until June 18, 2005, hydroelectric power production.
- Fossil Creek supports an abundant and diverse native fish community. A native fish restoration project completed in the fall of 2004 removed non-native fish in an attempt to restore a native fishery to all but the lower five miles of Fossil Creek.

Travertine

- The base flow of Fossil Creek is supplied by water discharged from Fossil Springs which contains high concentrations of calcium carbonate and dissolved carbon dioxide, leading to the formation of travertine. Rich in calcium carbonate, travertine precipitates and deposits on the bed and bank of the channel and on rocks, leaves, and other objects in the channel.
- Encrustation of these features by travertine, forming "fossils", is the basis for the origin of the creek's name.
- The travertine deposition forms dams and deep pools behind these dams, creating a series of steps and pools. Deposition rates of almost one foot per month were

recorded on Fossil Creek in March 1996 when the Irving Power Plant was shut down for maintenance.

- Since the beginning of the diversion of most of the Fossil Creek baseflow to the Irving and Childs power plants which began nearly 100 years ago, much of the pre-existing travertine has deteriorated.

Hydroelectric Generation: Childs-Irving Power Plants

- The Childs Power Plant was constructed in 1909 and most of the flow of Fossil Creek was diverted at the current Irving Power Plant site into a series of flumes, siphons, penstocks, turbines, and a reservoir (Stehr Lake).
- The Irving Power Plant was constructed and came on line in 1916 to meet the increasing demands for power in Yavapai County.
- Childs-Irving project facilities begin at the Fossil Springs Diversion Dam, a 25-foot high concrete structure located approximately 0.2 miles below the lowermost spring of the Fossil Springs complex. The dam diverts almost the entire discharge of Fossil Springs.
- To ensure an adequate, continuous supply of water to the Childs plant, Stehr Lake was built in an old dry lakebed located on a natural bench above Fossil Creek. Originally, Stehr Lake had a surface area of nearly 23 acres, although in recent years open water has covered only 3-4 acres due to sedimentation and vegetative infilling.

Decommissioning of Childs-Irving

- The Federal Power Commission issued a license for a period of 50 years on January 1, 1945 for the Childs-Irving power plants. In 1992, APS filed an application for a new license for the power plants.
- APS then entered into discussions with the Forest Service, US Fish and Wildlife Service, and environmental interveners and in 2000, APS and the other parties filed an Offer of Settlement (Settlement Agreement) requesting that the Federal Energy Regulatory Commission (FERC) approve the surrender of the license to operate the hydroelectric facility and proposed to remove facilities and restore the area.
- The Settlement Agreement stated that APS would cease power generation and restore full flows to Fossil Creek no later than December 31, 2004 and complete site restoration by December 31, 2009.
- Full flows were returned to Fossil Creek on June 18, 2005.

Physical and Biological Environment

Climate

- The Fossil Creek watershed is located in a semi-arid climatic region, although temperature, vegetation, and precipitation very greatly depending on elevation. Average daily temperatures range from 8.3 to 27.2 degrees C at Childs.
- This watershed is located on the edge of the Mogollon Rim; this escarpment can give rise to large storms due to the orographic effect. Average annual

precipitation on the Fossil Creek watershed ranges from 25 inches on the Mogollon Rim to 18 inches at Childs on the Verde River.

Soils

- Available soils information is developed from a summary of soil condition using Terrestrial Ecosystem Survey (TES) data for a 36,225-acre Forest Service-defined area called the Fossil Creek Planning area (see Figure 5).
- 8 percent of the planning area contains soils rated as unsatisfactory. Most identified unsatisfactory soils result from high levels of historic grazing and continued grazing probably beyond the carrying capacity of the land.
- 49 percent of the planning area has soils that are rated satisfactory-inherently unstable where, although functioning properly and normally, the soil is eroding faster than it is renewing itself. Almost all acreage in this class occurs on slopes greater than 40 percent within the central and western portions of the planning area.
- Areas where grazing has historically occurred and has continued, and areas where access is favorable to dispersed camping and recreation tend to exhibit reduced vegetation ground cover and soil degradation.
- The physical and biological conditions of the soil system are at risk, or will not support additional disturbance.

Water

Watershed Hydrology, Watershed and Channel Conditions, & Water Rights

- Continuous stream flow guage data are unavailable for Fossil Creek.
- The Fossil Springs provide approximately 74 percent of the average annual basin yield above the Fossil Springs Diversion Dam.
- The contribution of watershed runoff, generally snowmelt or precipitation from frontal storms, to stream flow varies considerably from winter/early spring to summer.
- Reduced runoff in the summer can be attributed to the high air temperatures and associated high rates of evapotranspiration that are common to this area in Central Arizona.
- The Fossil Creek watershed condition suffered greatly from overgrazing into the early 20th century due to excessive runoff, erosion, and loss of riparian habitat.
- Sedimentation behind the dam, with an estimated volume of 25,000 cubic yards, has created a large flood plain.
- APS has held since 1900, a statement of claim of rights to use public waters of the state of Arizona on Fossil Creek. In addition, there are several other water rights and claims involving Fossil Creek due to it being a tributary to the Verde River. As described in the decommissioning settlement agreement, APS will transfer their water rights to the USDA Forest Service.
- As part of the license surrender, the Fossil Creek Diversion Dam crest will be lowered by at least 14 feet, with anticipated action in 2007. Once the crest is lowered, a significant portion, probably in excess of 50 percent, of the nearly 25,000 cubic yards of sediment presently stored behind the dam will be able to move downstream in response to storm flows.

Spring Characterization and Groundwater

- Fossil Springs is one of the few remaining unmanipulated major springs left in the West, and provides insight into the natural function of a critical keystone ecosystem.
- Fossil Springs has a discharge which is greater than any spring complex outside the tributaries to the Colorado River in Grand Canyon.
- There is estimated to be over 60 individual spring orifices of Fossil Springs.
- Critical to monitoring the baseflow of the springs in Fossil Creek is the establishment of a gauging station on Fossil Creek downstream of the springs.

Water Quality

- Water discharging from Fossil Springs is a Calcium-Bicarbonate type water.
- Preliminary examination indicates CO2 is being released as the springs mix with atmospheric gases.
- Baseline monitoring is recommended to detect any changes in water chemistry. Long-term monitoring of spring discharge and water quality will assist in determining if there are any important changes in the rates of travertine formation.

Vegetation

- There are eight biotic communities documented in the Fossil Creek-Lower Verde River 5^{th} Code Watershed.
- Within the smaller Fossil Creek Planning Area boundary, 314 species of flowering plants and ferns from 77 families have been documented.
- The 50-acre Fossil Springs Botanical Area is located above the Fossil Springs Diversion Dam. A total of 166 plant species have been recorded.
- The riparian zone along Fossil Creek is dominated by deciduous trees.
- Potential habitat is present within the Fossil Creek Planning Area for six sensitive or listed plants.
- Forty-two exotic/noxious weeds have been identified in the Fossil Creek Planning Area although no formal inventories have been conducted in the larger watershed area.

Aquatic Habitat and Fish

Aquatic Habitat and the Fisheries Resource

- The variation in fish species composition in Fossil Creek is a function of the change in habitat conditions, the influence of the Verde River fishery, both natural and man-made barriers, and introductions of non-native fish above these barriers.
- Above the diversion dam, the aquatic conditions are a combination of cobble/small boulder riffles, shallow runs, and moderately deep pools.
- Natural barriers near the Irving Power Plant have kept non-native fish species from traveling further upstream.
- The aquatic habitat in the stretch between the diversion dam and a little past the Irving Power Plant are characterized with runs, riffles, and moderately deep pools.

- Remnants of large travertine pools can be observed along the banks of this stretch while small travertine formations can be observed.
- A little below the Forest Road 708 bridge, travertine formations are no longer as evident. The aquatic habitat is mainly runs, riffles, and moderately deep pools.

Fish

- Fossil Creek provides an opportunity to preserve native fish because it is one of the few streams in Arizona retaining viable populations of six native fish species including headwater chub, roundtail chub, speckled dace, longfin dace, desert sucker, and Sonora sucker.
- Non-native fish have been one of the greatest threats to native fish in Fossil Creek. In the fall of 2004, an intensive multi-agency native fish restoration effort removed non-native fish from the upper 9 km of Fossil Creek and constructed a fish barrier on the lower end of Fossil Creek, upstream of the confluence with the Verde River.
- Two potential threats remain to native fish following the restoration: 1) exotic crayfish; and, 2) the release of sediments trapped behind the diversion dam.
- There is a critical need for monitoring of non-native fish following the native fish restoration project to determine if the constructed fish barrier effectively prevents upstream migration of non-native fish and to assess whether non-native fish are being transplanted by humans back into Fossil Creek above the barrier.

Special Status Fish Species' Natural History and Occurrence

- This section gives life history and distribution information on the following threatened, endangered, and sensitive species existing and potentially existing in the Fossil Creek Watershed: roundtail chub, headwater chub, longfin dace, desert sucker, Sonora sucker, speckled dace, Colorado pikeminnow, razorback sucker, Gila topminnow, loach minnow, and spikedace.

Macroinvertebrates

- Aquatic macroinvertebrates, a diverse group of organisms comprising primarily insects, snails and worms, are important for transferring energy and nutrients contained in algae and leaf litter to higher trophic levels.
- The diversity of macroinvertebrates in Fossil Creek is high compared to other southwestern streams; to date, 147 macroinvertebrate species have been collected, including the endemic Fossil springsnail.
- Fossil Creek is thought to contain a high diversity of macroinvertabrates because 1) the springs at Fossil Creek have remained relatively pristine, with full flows and no exotic species, presumably due to the barrier created by the diversion dam and, 2) travertine deposition in Fossil Creek promotes diversity because travertine areas are characterized by unique insects.
- During the fish restoration project, the piscicide used was harmful to macroinvertebrates, causing increased numbers in the drift samples, an indication of mortality and stress. The Fossil springsnail and the Page caddisfly are concentrated above the diversion dam and were not affected by the piscicide treatment.

- Aquatic macroinvertebrates are necessary for the recovery of native fish because ongoing stable isotope studies indicate that macroinvertebrates are a key food resource for native fish.

Leaf Litter Decomposition

- Leaf litter provides large quantities of energy to aquatic ecosystems.
- The energy provided by leaf litter inputs is important for the production of stream invertebrates and is transferred up the trophic chain to fish and riparian predators whith often depend on aquatic insects during some part of their life cycle.
- Studies undertaken to date at Fossil Creek indicate that leaf litter decomposition rates for both Arizona alder and Freemont cottonwood are faster above the diversion dam than directly below the dam. It has also been found that leaf litter decomposes more quickly in an active travertine deposition reach than in a non-travertine reach.
- Restoration of full flows to Fossil Creek is expected to result in overall higher decomposition, and the associated increase in available habitat will also likely increase macroinvertebrate production, providing more prey items for predatory fishes and birds along Fossil Creek.

Crayfish

- Arizona has no native crayfish, but two exotic crayfish species were introduced in Arizona in the 1970s. Crayfish have been observed in Fossil Creek since the 1990s.
- Crayfish in Fossil Creek eat a wide range of food including leaf litter, algae, and macroinvertebrates, with a preference toward macroinvertebrates, a primary food source of fish. This indicates that the crayfish have the potential to compete with native fish populations for food.
- Crayfish were not harmed by the piscicide used during the native fish restoration project. The only currently available way of removing crayfish is through manual trapping and netting.

Terrestrial Species

- The Fossil Creek Watershed supports over 175 known species of mammals, birds, reptiles, amphibians, and terrestrial invertebrates. There are many more species that potentially, and likely, occur in the watershed but have not yet been documented.
- The Fossil Creek watershed contains habitat for five federally listed species (bald eagle, Mexican spotted owl, southwestern willow flycatcher, Yuma clapper rail, and western yellow-billed cuckoo). In addition, the area provides habitat for state and federal sensitive species: 6 mammals; 4 birds; 2 amphibians; 3 reptiles; 1 snail; 14 invertebrates; and 10 Management Indicator Species (MIS).
- This section provides life history and distribution information on the federally listed and sensitive terrestrial species known to be present, or with habitat, in the Fossil Creek watershed. It also provides specific restoration goals and inventory and monitoring recommendations for these terrestrial species.

- Recreation impacts are a concern in relation to several listed and sensitive species because of the disturbance to breeding/nesting areas, especially along the Fossil Creek riparian area.

Humans and the Social Environment

Cultural and Archeological Resources

- The Fossil Creek watershed contains prehistoric and historic archaeological sites and historic structures.
- Archaeological surveys have been conducted in the Fossil Creek drainage and adjacent areas since 1890 and have continued periodically since then.
- The Child's-Irving hydroelectric power project is listed on the National Register of Historic Places and is recognized as the 11th National Historical Mechanical Engineering Landmark.
- The Fossil Creek watershed may contain sites of human use and occupation from as long ago as 8,000 to 10,000 years.
- It contains a number of historic sites reflecting use by Yavapai and Apache hunters, gatherers, and farmers and by stockmen who raised or drove cattle and sheep throughout the area.
- A majority of the features are prehistoric in date and consist most frequently of collapsed stone masonry structures, stone-built water control devices, pit ovens, and petroglyphs.
- Less than 3% of the cultural resources within the Fossil Creek watershed have been inventoried to current standards.
- All of the inventoried sites are currently considered eligible for the National Register of Historic Places, pending further evaluation.
- Vandalism and looting are primary causes of impacts to the historic and cultural resources in the Fossil Creek watershed.

The Yavapai-Apache Nation's Ancestral Ties to Fossil Creek

- This section provides an overview of the cultural ties of the Yavapai-Apache Nation to Fossil Creek.
- The Tonto Apache or Dilzhe'e People lived throughout the length of the Fossil Creek Canyon for centuries and called it Tu Do Tliz, the Blue Water Place.
- Today, based on trips into Fossil Creek with tribal elders, the Yavapai-Apache know of dozens of Apache places. However, there is little evidence remaining on the surface in these places because much of it was perishable being made from bone, wood, sinew, buckskin, rawhide, hair or plant fibers.

Recreation

- Recreation opportunities in Fossil Creek consist primarily of camping, swimming, and hiking.
- There are two established trail systems to Fossil Springs that are each approximately four miles in length and receive the most use in the late spring and summer months.

- Visitor surveys indicate that weekday use is predominately by visitors from the surrounding communities of Strawberry, Pine, and Camp Verde while weekend use attracted many visitors from Phoenix, Flagstaff, and other communities.
- A 2004 visitor survey found that 71 percent of visitors access Fossil Creek from the town of Strawberry via Forest Road 708.
- This survey found that 52% of Fossil Creek use occurs between Irving Power Plant and the Fossil Springs Diversion Dam.
- An inventory of 211 dispersed campsites in the Fossil Creek was conducted to evaluate the amount of impact such sites are having on the surrounding environment. Results indicated that of the 211 campsites, 85 were rated as low impact, 120 were rated as moderately impacted, and 6 were highly impacted. Indicators of impact included size and number of fire rings, vegetation loss, and the amount of toilet paper at each site.

Grazing in the Fossil Creek Watershed

- There are currently seven allotments that fall partially within the Fossil Creek watershed; these allotments are located on both the Coconino and Tonto National Forests.
- The four allotments on the Coconino National Forest are year-round allotments with three zones (winter, transition, summer). All are currently being grazed.
- Two of the three allotments on the Tonto National Forest are in a non-use status while the other is actively being used.
- A table in this section summarizes available information for these allotments including the number of livestock permitted, the grazing system, the vegetation type, range condition and trend, and soil condition.

What's Next: Research and Monitoring at Fossil Creek

- This section summarizes planned and desired research and monitoring as discussed in each section of the State of the Watershed Report.

Introduction

This report summarizes the current information available regarding the Fossil Creek Watershed located in central Arizona (Figure 1). It has been compiled in advance of the Arizona Public Service Company (hereafter referred to as APS) Childs-Irving decommissioning activities scheduled for 2005 – 2009. The decommissioning activities include the return of full flows to Fossil Creek, removal of most of the infrastructure associated with the Childs and Irving power plants including the flume, and the lowering of the Fossil Springs Diversion Dam.

This report summarizes the information available at the time of writing about the physical and biological environment as well as the social and human environment within the Fossil Creek Watershed (Figure 3). Within this watershed, the Report focuses primarily on Fossil Creek; the uplands are addressed only to a limited extent. This report is primarily intended to serve as an information source for those involved and interested in the current and future management of the Fossil Creek Watershed, including governmental agencies, conservation organizations, and citizens. Our goal in compiling this report has been to create a baseline condition report that can be used as a basis for tracking changes to the environment that may occur within the watershed in the future. This information could be used to develop a comprehensive watershed management plan in the future and/or to assist the Forest Service in determining appropriate management of the watershed. As new information becomes available as a result of on-going research and monitoring within the watershed, this report will become outdated and will no longer function as a current state of the watershed report. However, the digital and public nature of this report allows it to be updated by NAU or others in the future.

The various sections in this report utilize either English or metric figures. Please refer to Appendix D for a metric to English conversion table.

Fossil Creek and its History

Michele A. James, Grant Loomis, and Charles Schlinger

Background

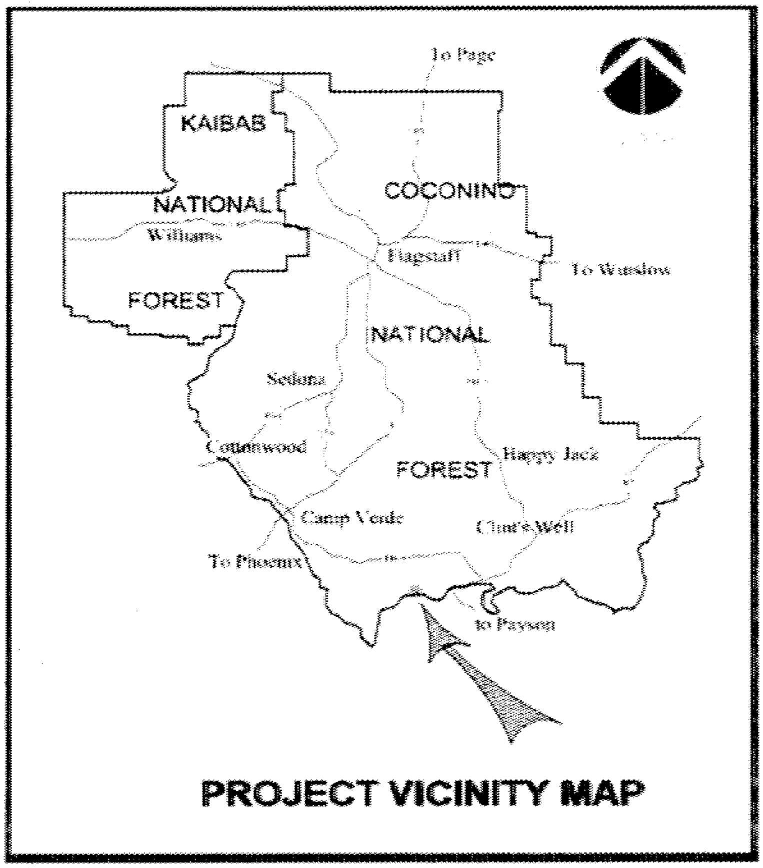
Fossil Creek is a major perennial tributary of the Verde River. It is located within the incised canyons of the Mogollon Rim[1] country in central Arizona (Figure 1) at elevations of 7260 feet along the Mogollon Rim to 2550 feet at the Verde River confluence. Fossil Creek begins about four miles northwest of the village of Strawberry at the convergence of Sandrock Canyon and Calf Pen Canyon just below the edge of the Mogollon Rim. The creek flows in a southwesterly direction for approximately 17 miles before entering the Verde River.

Fossil Creek is located nearly entirely on lands under the jurisdiction of the USDA Forest Service and forms the boundary between the Coconino and Tonto National Forests and between Gila and Yavapai Counties; Coconino National Forest and Yavapai County are located to the north of Fossil Creek, and the Tonto National Forest and Gila County are located to the south.

Fossil Creek flows partly through two wilderness areas. The creek lies within the Fossil Springs Wilderness Area from the confluence of Sand Tank and Calf Pen Canyons until Fossil Springs, and within the Mazatzal Wilderness from a short distance below the confluence with Sally May Wash, 3.5 miles downstream of the Irving hydroelectrical facility, until its confluence with the Verde River. The boundary of the Mazatzal Wilderness follows the "thread of Fossil Creek" from near Irving to Sally May Wash. Fossil Creek has been found to be potentially eligible for designation as a Wild and Scenic River because of its outstanding remarkable values[2]. Fossil Creek enters the boundary of the Verde Wild and Scenic River one-quarter mile east of the Verde River (Nelson 2003).

Fossil Creek is an intermittent stream from its headwaters until it reaches Fossil Springs, which are located approximately one third of the way down from the origin of the creek (Mathews et al. 1995). The numerous springs are collectively called Fossil Springs. Fossil Springs emanate from Mississippian Naco Limestone in an area spread out over approximately 900 feet in length along the creek (Monroe 2000). Spring flows emerge over about a 1,000-foot reach of Fossil Creek and flow is relatively constant at nearly 46 cubic feet per second (cfs), based on Coconino and Tonto National Forest stream flow measurements that have been ongoing since 2000. The springs discharge at a near constant temperature of 72°F making Fossil Creek one of Arizona's rare warm water streams. Fossil Springs represents the largest concentration of spring-water discharge in the Mogollon Rim region (Malusa 1997), and generates about 74 percent of the average annual total volume of water yielded by the Fossil Creek watershed at the Fossil Springs Diversion Dam location (Loomis 1994).

Figure 1. Location of Fossil Creek in north-central Arizona on the Mogollon Rim.



There are several special areas within the Fossil Creek watershed. These include the Fossil Springs Botanical Area (20-acre site containing Fossil Springs and an associated riparian deciduous forest) and the Fossil Springs Wilderness Area (11,550 acres in size). The Fossil Springs Wilderness Area and the Fossil Springs Botanical Area are on the Coconino National Forest. Another special area, the Fossil Springs Natural Area is on the Tonto National Forest. Both the Botanical and Natural Areas are above the Fossil Springs Diversion Dam, ending at, or a short distance above, the Diversion Dam.

Fossil Creek flows through one parcel (70 acres) of private property approximately one mile below Irving. Recreation areas, hiking trails and dispersed campsites along the creek are used by an ever-increasing number of people. The major land uses along Fossil Creek are recreation, livestock grazing, and until mid-2005, hydroelectric power production.

Fossil Creek supports an abundant and diverse native fish community. Native fish are found throughout the creek although, prior to the native fish restoration project (fall 2004) native fish were found in lower numbers in the reaches furthest downstream due to diversion of stream flows and competition with nonnative species. Native fish species present above the Fossil Springs Diversion Dam included headwater chub, desert sucker, and speckled dace. Below the dam these species as well as roundtail chub, longfin dace, and Sonora sucker were also present. During the late fall, 2004 a fish renovation project commenced. The Bureau of Reclamation in cooperation with the US Fish and Wildlife Service, the Arizona Game and Fish Department, and the Forest Service constructed a fish barrier approximately 5 miles upstream from the confluence with the Verde River. The stream between the fish barrier and the Fossil Springs Diversion Dam was treated with a piscicide to eradicate populations of nonnative fish. Native fish salvaged prior to the application of the piscicide were then repatriated to the stream in an attempt to restore a natives-only fishery to Fossil Creek.

Travertine

The large and sustained baseflow of Fossil Creek (recently returned fully to the Fossil Creek channel), the native fish community, and a diverse riparian community all contribute to the remarkable resource values of Fossil Creek. The factor which makes Fossil Creek truly unique is that the water discharged from Fossil Springs leads to the formation of travertine, which is calcium carbonate. The spring water that is discharged from the limestone formations at Fossil Springs contains high concentrations of calcium carbonate and dissolved carbon dioxide. As this water travels downstream and is exposed to atmospheric conditions and turbulence, carbon dioxide gas is released. This release causes the water to become supersaturated with calcium carbonate; when a critical level of supersaturation is reached, travertine precipitates from solution and deposits on the bed and banks of the channel. Most travertine deposition occurs at and below areas of turbulence, although algae also play a role in travertine deposition through the photosynthesis process, which consumes carbon dioxide (Mathews et al. 1995).

In free-flowing streams, travertine precipitates on rocks, leaves, and other objects in the channel. Encrustation of these features by travertine, forming "fossils", accounts for the origin of the creek's name. Typically, travertine deposition forms dams that can build up to many feet in height. Deep pools form behind these dams and a series of steps and pools are created. It is not uncommon for travertine formations to accrete several inches per year in areas of stream turbulence (Mathews et al. 1995). Deposition rates of almost one foot per month were recorded on Fossil Creek during March 1996 when the Irving Power plant was shut down for maintenance (Overby and Neary 1996).

Historic accounts predating the construction of the Childs/Irving project report large travertine structures in Fossil Creek. Early visitors to the area, Charles F. Lummis (1891) and F.W. Chamberlain (1904) describe Fossil Creek as so impregnated with minerals that it is "constantly building great round basins" that "flow down bowl after bowl". They described dams "from several inches to few feet in height, the highest is said to be 10 feet". According to Chamberlain's account (he did not see this reach of Fossil Creek and his account is based up local sources), travertine formations were present along "a couple of miles" of Fossil Creek beginning about a half mile below Fossil Springs (Mathews et al. 1995; pers. comm. Jerry Stefferud). Travertine formations extend along Fossil Creek nearly to Sally May Wash (pers. comm. Jerry Stefferud).

Beginning in 1916, the diversion of most of the baseflow of Fossil Creek to the Irving and Childs power plants halted travertine deposition in areas where it had occurred historically. Without the input of calcium carbonate-rich baseflows, the travertine features built up in the channel began to deteriorate (Overby and Neary 1996). The erosive power of storm water flows contributed to the degradation. With the absence of new travertine deposition, all that remains in the reach above Irving are low travertine features maintained by the 0.2 cfs flow that seeps through the diversion dam. Remnants of the travertine structures that predated the Childs-Irving project persist. Reconnaissance of the 3.4 mile reach of Fossil Creek between the diversion dam and Irving by Overby and Neary (1996) found 81 distinct sets of remnant travertine structures, located mainly at or near channel nick points where turbulence increases. Prior to the construction of the Childs-Irving facilities, it is likely that storm flows would degrade travertine structures but that they would rebuild during periods when travertine-laden baseflow comprised most of the flow in the creek.

The travertine formations at Fossil Creek result in a unique geomorphology and riparian system. Deposits of travertine are rare in Arizona. Areas with travertine such as Tonto Natural Bridge and Montezuma's Well are valued natural wonders in the southwest and are recognized as a National Monument and a State Park. Other travertine systems such as Havasu Creek and Blue Spring on the Little Colorado River, both tributaries to the Colorado River, are held sacred by Native American tribes.

Hydroelectric Generation: Childs-Irving Power Plants

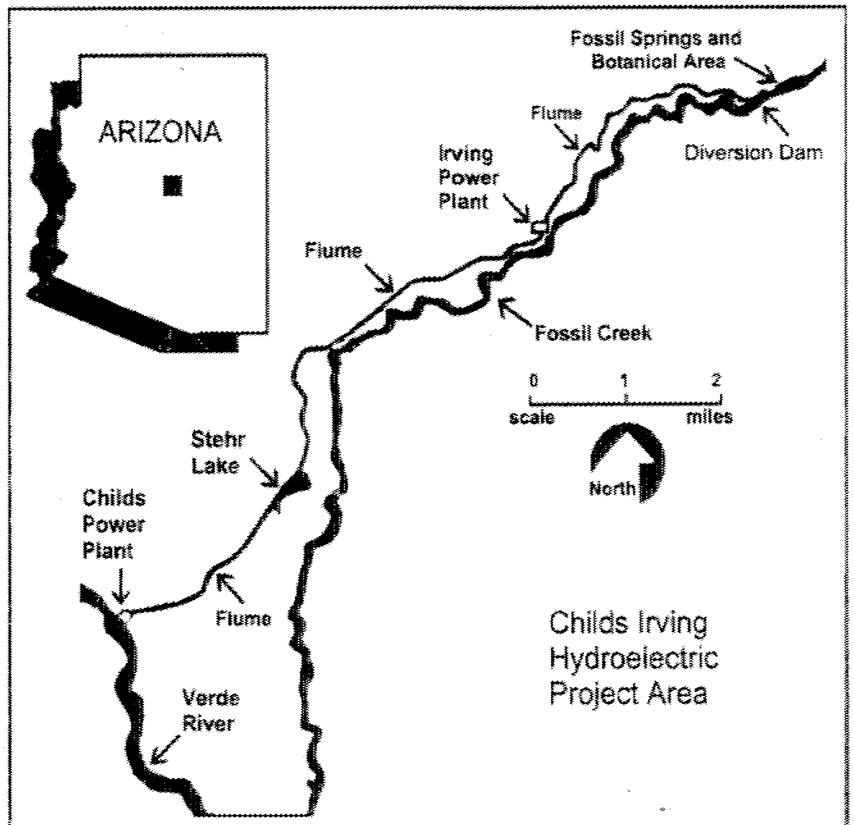
As discussed above, the Childs-Irving power plant facilities (Figure 2) have been in operation since the early 1900's and have since diverted, on a near-continuous basis, almost the entire spring-supplied baseflow of Fossil Creek for power generation.

In 1900, rancher Lew Turner filed the first claim to the water rights of Fossil Creek and planned to divert the water to generate electricity to sell to the numerous mines in the Bradshaw Mountains and the Black Hills (APS undated). Construction started in March of 1908. In 1909, most of the flow of Fossil Creek was diverted at the current Irving power plant site from the creek into a system of flumes, siphons, penstocks, a reservoir (Stehr Lake), and turbines associated with the newly-built Childs hydroelectric power plant. Childs was one of the first hydroelectric power plants built in the West. The plant sits on the banks of the Verde River. Electricity generated from the Childs plant was used by the mining industry in the Jerome area as well as by large irrigation companies and individual farmers in the Verde Valley to run pumps to water thousands of acres of land.

Because of increasing demands for power by the end of 1914 due to the revival of the mining industry and the high price of copper, the Irving Power plant was built in 1916.

In their heyday these stations supplied all the electrical needs of Yavapai County and combined they generated nearly 7 megawatts of electric power. At the present time, the combined power output of the two plants is nearly 4 megawatts.

Figure 2: Childs-Irving facilities.



Childs-Irving project facilities begin at the Fossil Springs Diversion Dam, a 25-ft high concrete structure, located approximately 0.2 mile below the lowermost spring of the Fossil Springs vent complex. This dam diverts almost the entire discharge of the springs (nearly 46 cfs) into a system consisting of a flume, a siphon and a penstock (static water pressure head of nearly 480 ft) that deliver water to the Irving Powerhouse. Approximately 0.2 cfs leak through and around the Fossil Springs Diversion Dam and maintain perennial flow in a 3.4-mile reach of Fossil Creek from the Fossil Springs Diversion Dam to the Irving Powerhouse (the Irving Reach).

To ensure an adequate, continuous supply of water to the Childs plant, Stehr Lake was built by constructing two earth-filled dams at either end of an old dry lakebed located on a natural bench above Fossil Creek; covering 27.5 acres, the reservoir allowed the Childs plant to be run when repairs and maintenance activities shut off the flume's water flow (APS undated). Originally, Stehr Lake had a water surface area of nearly 23 acres, though at the present time, open water covers only 3-4 acres, due to sedimentation and vegetative infilling along the perimeter. As part of the decommissioning activities, Stehr Lake is slated for removal and the site will be restored in 2005/2006.

An additional 2.1 miles of pressure tunnels and penstock convey Fossil Creek water from Stehr Lake to the Childs Power Plant, which is located on the banks of the Verde River, 3.5 miles upstream of the confluence with Fossil Creek.

A small cluster of employee housing and support buildings is currently permitted on National Forest System lands next to Fossil Creek to support operation of the Irving power plant, operated by APS. These structures will be dismantled and the site restored to natural conditions after the power plant ceases operation. At Childs, the powerhouse and ice house will be the only buildings that will remain on site after decommissioning activities cease. Housing is also present on Forest Service land at Childs (pers. comm. Cecilia Overby).

Presently, the power plants at Childs and Irving have a combined output of nearly 4.0 megawatts and produce 37,000 megawatt hours per year, or enough power to sustain 4,000 homes (Mathews et al. 1995). Total generating capacity of these plants is less than 0.1 percent of the total power production capacity of APS (Mathews et al. 1995).

The electricity from Childs-Irving was eventually sent to Prescott, Wickenburg, Ash Fork and Seligman. While originally used for mining purposes and agriculture, the electricity generated at Childs-Irving was eventually redirected to the growing population of Phoenix. The Childs-Irving project was designated as a National Historic Mechanical Engineering Landmark in 1976 and was entered into the National Register of Historic Places in 1991.

Travertine deposition in the concrete flume that conveys water from the Irving Powerhouse to Stehr Lake has reduced the conveyance capacity of the flume and results in discharge of an additional 2-5 cfs into Fossil Creek below the Irving Powerhouse (FERC 1997, referenced in Monroe 2002). This discharge remains in the creek in the 10 mile reach from Irving to the Verde River (the Childs Reach).

Decommissioning of Childs-Irving

Childs-Irving was issued a license for a period of 50 years on January 1, 1945 by the Federal Power Commission. In 1992, APS filed an application for a new license for the existing Childs-Irving Project. The entire relicensing process takes about 5 years and is triggered by the Federal Power Act that requires water power operators to be periodically reevaluated so that, if warranted, the operation may be either discontinued or modified, to reflect changing societal values, operational advances, or other factors (Mathews et al. 1995). In 1997, the Federal Energy Regulatory Commission (FERC) issued a Draft Environmental Assessment (DEA) on the proposal to relicense the project. The relicensing DEA considered the alternative of retiring the project, but recommended that a new license be issued but with increased flows into Fossil Creek.

After issuance of the relicensing DEA, APS entered into discussions with the intervenors in the relicensing proceeding (which included American Rivers, the Center for Biological Diversity, the Yavapai-Apache Nation, the Arizona Chapter of The Nature Conservancy, and Northern Arizona Audubon Society), and other interested entities including the U.S. Forest Service and the U.S. Fish and Wildlife Service. On September 15, 2000, APS and the other parties filed an Offer of Settlement (Settlement of Agreement) that was signed by the intervenors. The filing requested that FERC approve the surrender of the license to operate the hydroelectric project and included a proposed plan to remove facilities and restore the area. The Settlement Agreement stated that APS will cease power generation and restore full flows to Fossil Creek no later than December 31, 2004[3] and complete site restoration to the satisfaction of FERC and the Forest Service by December 31, 2009. The decommissioning of the Childs-Irving Project had to be approved by FERC and a surrender of license had to be provided to APS.

APS filed an application to surrender the license and a Removal and Restoration Plan with FERC on April 30, 2002. This plan outlined the following actions (summary from USDI 2004):

> Removal of existing above-ground structures and equipment at the Fossil Springs diversion area; (2) removal of the Irving Development's steel flume and supporting wooden trestle, and elimination and restoration of the flume road between the Fossil Springs Diversion Dam and the Irving powerhouse; (3) sealing of the Irving flume tunnel No. 1; (4) removal of the above-grade Hot Water Canyon siphon pipe, including the concrete inlet structure; (6) removal of the Irving powerhouse and related equipment, fencing, power poles, wires, and transformers; (7) removal of all buildings at the Irving powerhouse site, including seven houses, a commissary building, maintenance shop, and sheds; (8) disconnection and burial of the Irving plant potable water system (per the direction of the Forest Service); (9) removal of the concrete forebay wing walls and 5-foot-high Fossil Creek diversion dam at the Irving power plant; and (10) removal of the above-grade portions of the gravity conveyance system (consisting of concrete box flume sections, steel pipe sections, tunnel sections and steel flume sections supported on wooded trestles) between the Irving plant site and Stehr Lake.
>
> Stehr Lake, a 23-acre off-stream impoundment that serves as a forebay for the pressure tunnel and steel pipe delivery system to the Childs plant, would be dewatered, the earthen embankments breached, and the lake area returned to natural vegetation. The Stehr Lake works would be removed and the pressure tunnel sealed off at both ends. A 1,394-foot-long reinforced concrete pressure pipe from the tunnel to the concrete surge tank would be sealed at both ends and left in place; the surge tank would be removed; and the 4,635-foot-long steel penstock with diameters ranging from 48 inches to 32 inches would be sealed at

both ends and left in place. The Childs powerhouse would be left in place as an historic feature, and removal of all electrical, mechanical, and maintenance equipment. The Childs substation, located next to the powerhouse, would remain in service, with all poles, equipment, and wires not required for customer service removed.

APS will remove at a minimum the top 14 feet of the Fossil Springs Diversion Dam and may remove the entire dam depending upon the results of habitat development and sensitive species monitoring[4]. The dam will be removed in 3-foot stages, beginning in September 2007, with work expected to last 12 to 16 weeks. The final decision on how much of the dam will be removed will be made by APS and the Forest Service based upon the results of monitoring, which will occur from 2005 through 2007 (see footnote below for further details). To remove the dam, APS plans to construct a diversion channel to convey the 43 cfs base flow around the work area during dam deconstruction and until natural high-flow events transport the reservoir sediments downstream. The sediment immediately behind the dam will be excavated to a stable working slope to allow for the removal of the concrete dam. Sediment mechanically removed from the stream bed will be dewatered and used as fill in the restoration of the Irving site. Concrete removed from the dam will be disposed of in the Irving flume tunnel before sealing the tunnel entrance with concrete or placed in designated staging areas for later disposal.

At about the same time that APS was in the midst of its relicensing application preparation, the Bureau of Reclamation (Reclamation) in 1991 recognized that the Central Arizona Project (CAP) which delivers Colorado River water for agricultural, industrial, and municipal used in central and southern Arizona, could potentially affect protected native fishes. Thus, Reclamation requested formal consultation with the U.S. Fish and Wildlife Service (FWS) pursuant to Section 7(a)(1) of the Endangered Species Act. On April 15, 1994, the FWS issued a final biological opinion on the delivery of CAP water to the Gila River basin. In 1997, the Southwest Center for Biological Diversity filed suit alleging that the biological opinion's reasonable and prudent alternative did not sufficiently remove jeopardy to threatened and endangered fishes or adverse modification to their critical habitats. In September 2000, the U.S. District Court upheld the FWS' jeopardy conclusion but also held that subsequent amendments to the reasonable and prudent alternative were arbitrary and capricious. As a result, Reclamation and the FWS reentered formal consultation and the FWS issued a revised biological opinion on CAP water delivery in 2001.

The 2001 CAP biological opinion incorporated the 1994 reasonable and prudent alternatives and mitigative commitments proposed by Reclamation during reconsultation. These conservation measures required construction and operation of a single drop-type fish barrier in Fossil Creek and other specific drainage systems of the Gila River basin in Arizona and New Mexico. The Fossil Creek fish barrier would prevent non-native fish from migrating up from the Verde River.

Given the biological opinion's requirement, the Bureau of Reclamation and the Forest Service completed an environmental assessment on the restoration of Fossil Creek. This action included the construction of the fish barrier in Fossil Creek, as required under the FWS biological opinion, as well as fish salvage, stream renovation, and repatriation of native fishes. The original timeline for completion of the native fish restoration project was delayed because environmental compliance took much longer than originally anticipated. In addition, a failure of the diversion flume at the Childs-Irving Project in the fall of 2004, caused by intense rainfall from the remnants of Hurricane Javier, caused further delay in initiation of the project (letter from Reclamation to FERC, October 27, 2004). The result of these delays compressed into two months what was originally envisioned as a one-year project. It was determined that this constricted schedule which resulted from these delays would not adequately accommodate additional delays or provide a sufficient post-project monitoring period to assess the project's success. Reclamation requested all deconstruction/return of flow activities be postponed from the date determined in the Settlement Agreement (December 31, 2004) until March 15, 2005 unless otherwise notified (letter from Reclamation to FERC, October 27, 2004).

On October 8, 2004, the FERC Commission issued an order approving the surrender by APS of its license for the Childs-Irving Hydroelectric Project. The order also approved removal of project works but required APS to take certain steps prior to commencing any removal operations. Specifically, the order required APS to submit certain information to various agencies. APS provided the required documents and agency review comments to FERC on January 13, 2005. In addition, APS provided a more detailed estimate of when full flows could be expected to be allowed to return to Fossil Creek stating:

> "Based upon the schedule submitted to FERC by APS on November 8, 2004, the Commission's 60-day review would result in a response from the Commission on or near March 18, 2005. Based upon this approval date, APS could then commence ground disturbing activities, which would include the construction of the temporary bridge across Fossil Creek at Irving, on March 21, 2005. APS requires this bridge to be in place prior to return of full flows and the start of deconstruction to avoid construction traffic through the creek itself. The construction of the bridge requires eight weeks of work, which would result in a date for return of flows no later than May 13, 2005. APS will start work shortly after we receive FERC's approval and will work to return flows earlier than May 13 if possible" (letter from APS to FERC, January 13, 2005).

APS returned full flows to Fossil Creek on June 18, 2005.

Watershed Description

Charlie Schlinger and Lori Yazzie

The Fossil Creek watershed boundary (Figure 3) referred to in this report represents, in essence, a sixth order watershed (e.g. see federal standards for delineation of hydrologic unit boundaries; Version 2.0, October 1, 2004, available at: www.ncgc.nrcs.usda.gov/products/watershed/). This watershed boundary represents the contributing area for all the tributary flows into Fossil Creek. The watershed at the confluence with Verde River covers 135 square miles (86,400 acres). The watershed ranges in elevation from over 7,200 feet on the Mogollon Rim to 2,543 feet at its confluence with Verde River.

Physical and Biological Environment

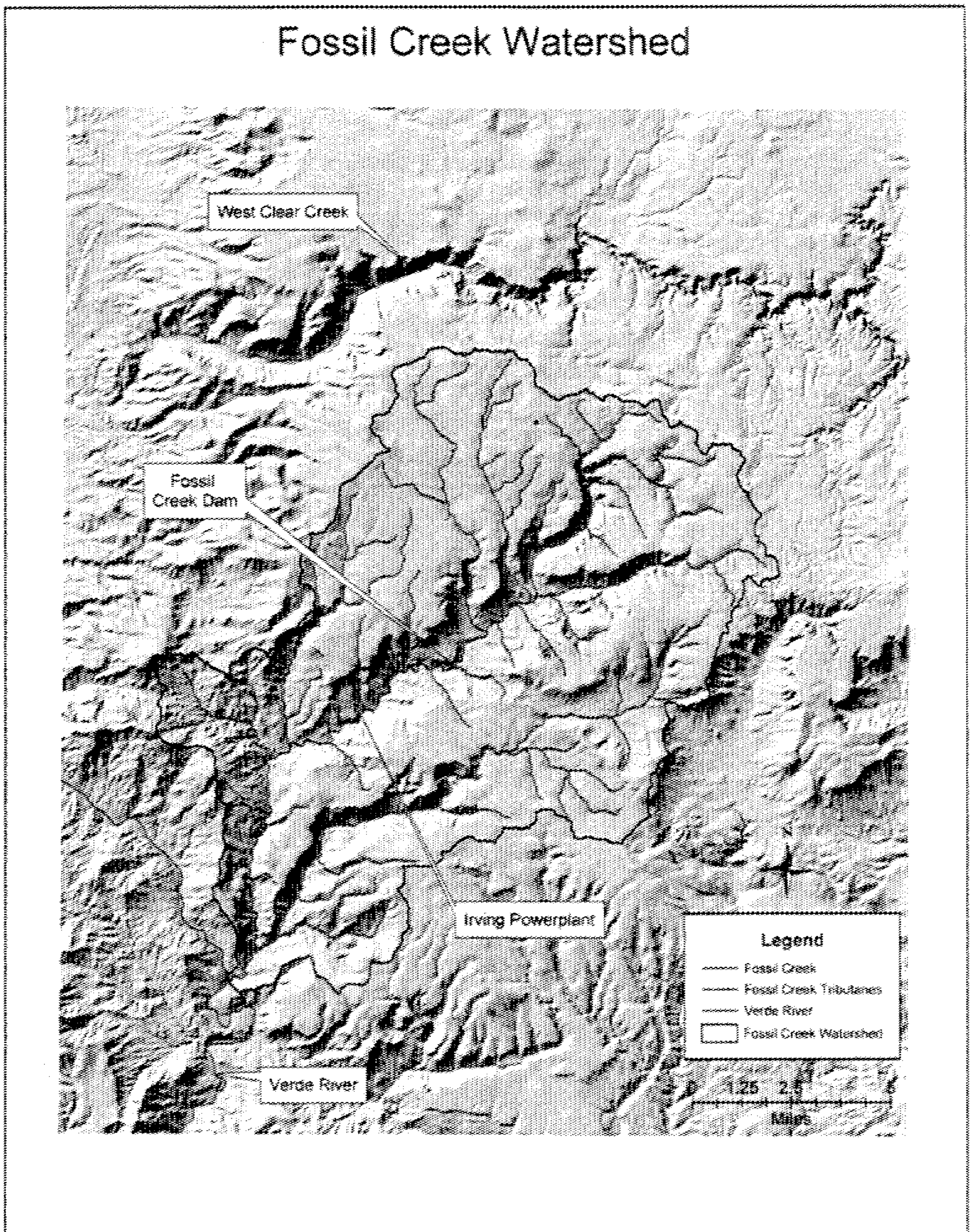
Climate

Abe Springer

Climate along Arizona's Mogollon Rim is highly variable. Precipitation is bimodal, with one distinct peak occurring in the winter/early spring and a second in late summer. Winter/early spring storms occur between December and March and are the result of cyclonic events. These cyclonic events often originate offshore in the Pacific Ocean and are typically large in aerial extent, relatively long in duration and of mild intensity. Large amounts of snowfall may occur within Fossil Creek's watershed during this time.

Summer monsoons are the result of local convective events usually originating from moisture advancing from the Gulf of Mexico. Precipitation usually occurs as thunderstorms which are often small in aerial extent and can be quite intense. Another factor is the physical geography of the Mogollon Rim. This escarpment can give rise to large storms due to the orographic effect. Warm, humid air moving northward and up gradient reaches the rim and rises rapidly. As the air mass moves upward, water condenses. The resulting clouds, segregated from the plateau by cooler air atop it, yield heavy precipitation near the edge of the rim (Sellers and Hill 1974).

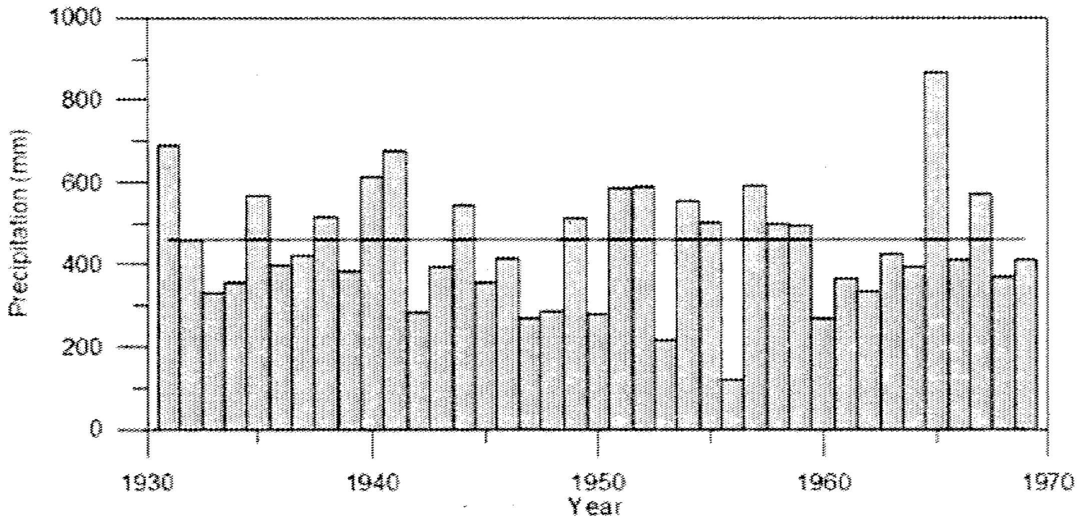
Figure 3. Fossil Creek watershed (figure created by Lorrie Yazzie).



The Fossil Creek watershed (Figure 3) is located in a semi-arid climatic region, although temperature, vegetation, and precipitation vary greatly depending on elevation (Flora 2004). Average daily temperatures range from a high of 27.2° C to a low of 8.3° F at Childs. At Irving, the temperature can be as low as 0° F and at Childs the temperature can exceed 43.3° F in summer. Above the rim, in the higher elevations of the watershed average temperatures tend to be about 15° cooler (Sellers and Hill 1974). Average January temperatures range from -9.1°C to 4.9°C at Happy Jack (elevation = 2,279 meters) and -0.2°C to 15.7°C at Childs (elevation = 807 meters). Average July temperatures range from 9.1°C to 26.2°C at Happy Jack and 19.8°C to 38.8°C at Childs (Table 1, Western Regional Climate Center 2004).

Average annual precipitation on the Fossil Creek watershed ranges from 25 inches on the Mogollon Rim to 18 inches at Childs on the Verde River. At Childs, the annual precipitation for 2002 was the second lowest amount of annual precipitation from 1930 to 2002 (Figure 4). In 2002, lower amounts of precipitation occurred throughout the watershed resulting in lower than normal amounts of recharge. Although it was not measured, is it possible that the lower amounts of recharge could eventually impact the flow of Fossil Springs.

Figure 4. Annual precipitation totals measured at Childs from 1931 to 2002, Elevation = 807 meters (Flora 2004; U.S. Department of Commerce NOAA 2004).



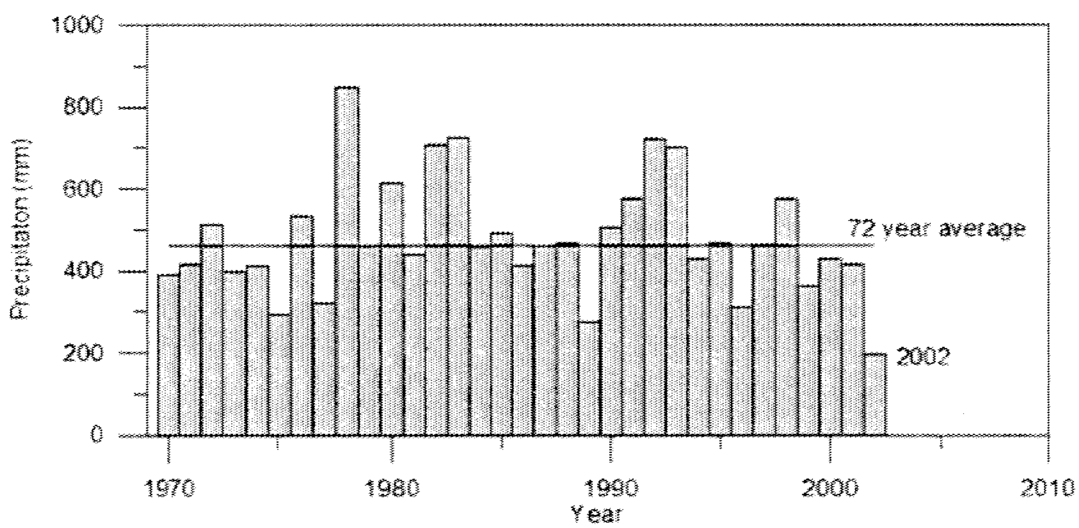


Table 1. Climate data for (A) Happy Jack, AZ and (B) Childs, AZ weather stations (Flora 2004).

A - HAPPY JACK RANGER STN, ARIZONA (023828)
Period of Record : 5/ 1/1969 to 7/31/2003

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max Temp (C)	4.9	7.4	8.8	12.6	17.8	24.2	26.2	24.7	21.7	15.5	9.3	4.5	14.8
Average Min Temp (C)	-9.1	-7.1	-6.0	-3.1	0.6	4.8	9.1	8.8	5.2	-0.7	-5.4	-9.3	-1.0
Average Mean Temp (C)	-1.8	0.3	1.4	5.0	9.1	14.4	17.7	16.8	13.4	7.4	1.9	-9.3	6.9
Average Total Precipitation (mm)	79.0	73.2	88.6	38.4	21.8	10.2	64.0	75.7	61.0	50.0	51.3	63.5	676.9
Average Total Snowfall (mm)	599.4	502.9	475.0	251.5	15.2	0.0	0.0	0.0	0.0	22.9	215.9	332.7	2413.0
Average Snow Depth (mm)	152.4	152.4	101.6	25.4	0.0	0.0	0.0	0.0	0.0	0.0	25.4	76.2	50.8

B - CHILDS, ARIZONA (021614)
Period of Record : 9/ 1/1915 to 7/31/2003

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max Temp (C)	15.7	18.4	21.3	26.1	31.4	36.9	38.8	37.2	34.7	29.0	21.5	16.1	27.3
Average Min Temp (C)	-0.2	1.5	3.4	6.7	10.6	15.1	19.8	18.9	15.3	9.1	3.2	0.3	8.7
Average Mean Temp (C)	7.7	10.0	12.4	16.4	21.0	26.0	29.3	28.1	25.0	19.1	12.4	8.2	17.9
Average Total Precipitation (mm)	49.0	46.5	45.0	23.9	10.2	8.9	49.8	67.3	43.2	30.5	31.8	51.1	457.2
Average Total Snowfall (mm)	7.6	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5	22.9
Average Snow Depth (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Soils[5]

Rory Steinke

Introduction

This existing condition report assesses soil condition in the Fossil Creek Planning Area located entirely within the Fossil Creek – Lower Verde River Hydrologic Unit 5th code watershed, Coconino National Forest (see Figure 5). The Fossil Creek – Lower Verde River Hydrologic Unit 5th Code watershed condition assessment is a separate watershed condition assessment and describes watershed condition of areas draining into Fossil Creek and the lower Verde River.

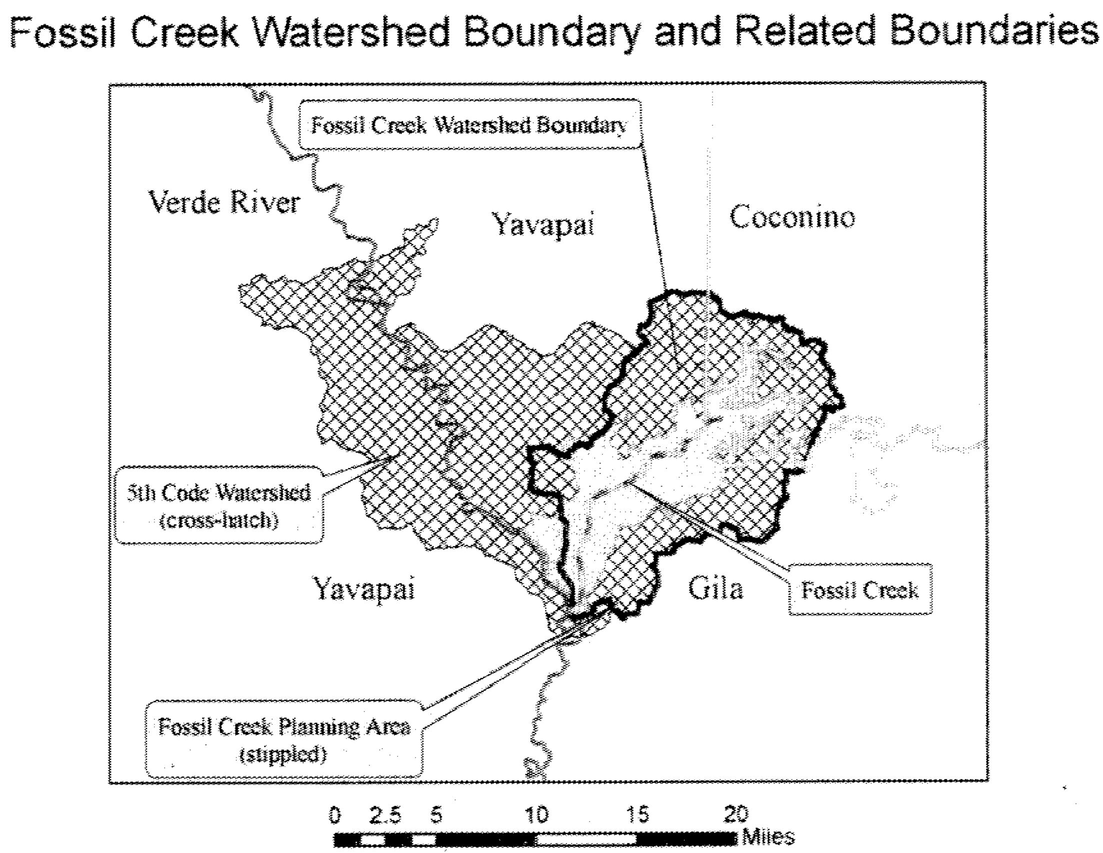
The Fossil Creek Planning Area boundary encompasses parts of the Coconino and Tonto National Forests. This planning area includes all of Fossil Creek itself and a large portion of the watershed draining into Fossil Creek. The Terrestrial Ecosystem Survey was clipped to the planning area boundary. Based on this GIS operation, there are 36,225 acres in the planning area.

Overall watershed condition is based on evaluation of the soil, aquatic and riparian (including vegetation) systems as prescribed by the watershed classes defined in Forest Service Manual 2520. A description of how watershed condition and classes are derived is found in Forest Service Manual 2520.

Soil Condition

An important component of watershed condition is soil condition. The Terrestrial Ecosystem Survey (TES) for the Coconino National Forest (USDA 1995) and the Tonto National Forest were the basis for our soil condition assessment (USDA 1985). The soil condition ratings are based on interpretations of the three primary soil functions: soil hydrologic function, soil stability and nutrient cycling. The Coconino and Tonto National Forests TES based soil condition primarily on quantitative on-site erosion rates (stability) measured and predicted by the Universal Soil Loss Equation (USLE). Since its publication in 1995, a new approved soil condition protocol was developed in R3 (FSH 2509.18-99-1) assessing three soil functions including the ability of the soil to resist erosion, infiltrate water and recycle nutrients. Due to a lack of newer data, the assessment used in this analysis is based primarily on the ability of the soil to resist erosion however, numerous refined on-site soil condition assessments were made primarily on slopes of less than 40 percent on the Coconino National Forest. On the Tonto National Forest, no on-site soil condition assessments were made and soil condition classes are based primarily on soil stability as predicted by the USLE, and professional judgment of the Forest Soil Scientist Norm Ambos.

Figure 5. Fossil Creek Watershed boundary and related boundaries (figure created by Charlie Schlinger).



Erosion and its consequence, sedimentation, are generally considered to be the number one problem associated with watershed management (Dissmeyer 2000).

The Fossil Creek planning area encompasses acreage from both the Coconino and Tonto National Forests. Therefore, this report combines TES mapping from both forests. On the Coconino National Forest, we make one soil condition call per TES map unit except on map units 33 and 46 located in riparian areas where a dual class is used. In multi-component TES units (complexes) we used the more limiting component (in a reduced soil condition class) if the aerial percentage was 30 percent or more. The Tonto National Forest used dual classes where soil map unit design indicated more than one soil condition class exists.

A map unit is a collection of areas defined and named in terms of their soil/vegetation/climate components. Each map unit differs in some respects from all others in a survey but is comprised of each major component identified in the map unit legend. Soil condition may vary within the same map unit across the landscape due to differences in disturbance. On-site investigation is recommended to validate soil condition or rate soil condition including all three-soil functions on a large-scale (small acreage basis).

Definitions:

Unsatisfactory: Soil indicators signify that a loss of soil function has occurred. Degradation of vital soil functions result in the inability of the soil to maintain resource values, sustain outputs or recover from impacts. Unsatisfactory soils are candidates for improved management practices or restoration designed to recover soil functions.

Impaired: Soil indicators signify a reduction in soil function. The ability of the soil to function properly and normally has been reduced and/or there exists an increased vulnerability to degradation. An impaired category indicates there is a need to investigate the ecosystem to determine the cause and degree of decline in soil functions. Changes in land management practices or other preventative measures may be appropriate.

Satisfactory: Soil indicators signify that soil function is being sustained and soil is functioning properly and normally. The ability of the soil to maintain resource values and sustain outputs is high

Table 2. Soil condition in the Fossil Creek Planning Area.		
Soil Condition Class	**Acres**	**Relative Percent**
Satisfactory	5772	16
Satisfactory – Inherently Unstable	17,939	49
Satisfactory and Impaired	196	1
Satisfactory and Unsatisfactory	766	2
Impaired	5054	14
Impaired and Unsatisfactory	3799	10
Unsatisfactory	2699	8
TOTAL % (Acres):		
	36,225	100

Unsatisfactory Soil Condition

Most of these soils are in accessible areas subject to grazing. These soils have current erosion exceeding tolerable limits and overall amount to 8 percent of the planning area (Table 2). Most of these soils are located in juniper-grassland transition zones. Soil indicators signify that a loss of soil function has occurred. Most identified unsatisfactory soils result from high levels of historic grazing pressure and continued grazing probably beyond the carrying capacity of the land. Past grazing practices have contributed to accelerated erosion with detachment and transport of sediment resulting in a reduction of long-term soil productivity. A decrease in long-term soil productivity does not necessarily equate to sediment delivery into nearby drainage systems or downstream into areas of loach minnow and spinedace designated critical habitat. However, some sediment may be transported into ephemeral and intermittent streams, eventually connecting to perennial streams. Much of the sediment is redeposited on the uplands before reaching any drainage system and cannot be equated to sedimentation. The USLE is not intended to be a tool to determine sediment yield and delivery into streams. Sedimentation is a natural product of forestland, where in proper amounts, is essential to the well being of stream ecosystems. It provides a rooting medium for aquatic plants, spawning gravel for fish, shelter for small aquatic plants, and conveys nutrients into streams necessary by all biota (Patric 1982).

The Tonto National Forest, most riparian areas have unsatisfactory soils in areas of designated critical habitat for loach minnow and spikedace adjacent to the Verde River. Although no on-site data has been collected, the Forest Service believes it is likely that there are no unsatisfactory soils adjacent to Fossil Creek below Stehr Lake due to the inaccessible nature of this reach.

There are small areas of unsatisfactory soils (TES units 33 and 46) adjacent to Fossil Creek, the Verde River and other perennial streams in the planning area. Where access is favorable to dispersed camping, recreation and grazing, these riparian areas tend to exhibit reduced vegetative ground cover (litter and basal vegetation) and increased soil compaction resulting in accelerated soil erosion and decreased soil productivity.

The northwest portion of the watershed contains sizeable acreage of unsatisfactory soils. During high intensity storm events, it is possible that these upland areas may deposit sediment into both Sycamore Canyon and Cottonwood Creek neither of which are perennial streams. Another sizeable area with unsatisfactory soils occurs adjacent to Boulder Creek and middle reaches of Fossil Creek. Additional areas occur scattered throughout the watershed and planning area and may contribute a little more sediment downstream than would occur under areas with satisfactory soil condition. Following intense storms, peak flows probably are amplified and *short*-term increases in turbidity probably occurs downstream into areas of perennial streams and loach minnow and spikedace designated critical habitat.

Most sediment probably comes from connected disturbed areas (roads) located in or near stream channels and naturally erosive soils found on steep slopes throughout the watershed and planning area. These roads provide an avenue from which surface runoff may carry sediment laden water and deliver it into a stream that eventually drains into downstream perennial waters. Additional sediment probably comes from inherently erosive soils on slopes greater than 40 percent (Satisfactory-Inherently Unstable) soils in areas largely inaccessible to grazing.

Satisfactory-Inherently Unstable

TES map units 350, 430, 3339, 3712, 4176, 9239, and 9349 (located throughout the planning area and on steep slopes) are rated as satisfactory-inherently unstable. These soils are located primarily in pinyon-juniper – chaparral vegetation types. These soils have natural erosion exceeding tolerable limits and overall amount to 17, 939 acres or 49 percent in the planning area. Based on the Universal Soil Loss Equation (USLE) these soils are eroding faster than they are renewing themselves and are functioning properly and normally. Almost all acreage in this class occurs on slopes greater than 40 percent and is located in the central and western portions or the planning area. Due to the predominantly steep nature of the terrain, livestock are forced to graze on accessible areas with slopes ranging from 40 to 60 percent. Past and current grazing pressure in these areas may have caused accelerated soil erosion with a decrease in long-term soil productivity. It is not known how many acres are grazed or if grazing pressure has further impaired these soils.

Limited on-site soil condition refinement on TES map unit 430 indicates steep slopes where livestock access is prohibited generally have vegetative ground cover, and species composition similar to the potential plant community. However, based on estimates as predicted by the USLE, natural erosion rates are higher than tolerable indicating inherently unstable soil condition.

TES mapping includes up to 15 percent of other soils or lesser slopes in to the map unit design. Visual on-site investigations show slopes of less than 40 percent are common and in select areas, may include up to 25 percent of any one TES polygon. These areas typically have slopes ranging from 25 – 40 percent and are located on the footslopes of hills and mountains. These areas probably are not inherently unstable based on erosion as predicted by the USLE. Soil condition may be either unsatisfactory or impaired.

The processes of sediment delivery and effects to perennial streams and areas of designated critical habitat are similar to areas with unsatisfactory soil condition areas.

Impaired

Excessive livestock grazing may compact soil and reduce the soils ability to accept, hold, and infiltrate water. 5054 acres are rated as impaired soil condition and amount to 14% of the planning area. These soils have reduced ability to accept, hold, and release water and are generally caused by ungulate grazing and recreation use. On-site soil condition assessments were made and identified several TES units as impaired. It is not precisely known how many additional acres are impaired or unsatisfactory due to physical compaction or trampling by livestock in the planning area. It is likely that more impaired areas exist but would require additional on-site assessment to accurately display these numbers. Most identified impaired soils result from high levels of historic grazing pressure and continued grazing probably beyond the carrying capacity of the land. There are identified impaired soils adjacent to areas of perennial streams and critical habitat along Fossil Creek, and the Verde River.

Where impaired soils exist, they are found on plains and hill slopes in pinyon-juniper and juniper-semi-desert grassland transitional vegetation types or adjacent to Fossil Creek on the Coconino National Forest. Since these soils are found on both flat slopes and moderately steep slopes, surface runoff varies from slow to fast and accelerated peak flows or reduced baseflows vary accordingly. It is unlikely that these soils significantly alter water quantity, and timing of flows sufficient to adversely affect riparian habitat vegetation, and fluvial geomorphology, as long as the streambanks are protected with adequate vegetation to withstand peak flows. Beyer (1997) has concluded that the Verde River is capable of handling sediment (indicating a certain level of stream stability) during large storm events.

Satisfactory Soil Condition

The majority of satisfactory soil conditions occur in pinyon-juniper or ponderosa pine vegetative types and are commonly grazed on slopes less than about 40 percent. Approximately 17 percent of the planning area has satisfactory soil condition (Tables 3 and 4). Indicators signify that soil function is being sustained and soil is functioning properly and normally. For satisfactory soils, the ability of the soil to maintain resource values and sustain outputs is high.

Satisfactory and Unsatisfactory

TES units 33 and 46 are identified in this class and are located in riparian areas. There are small areas of unsatisfactory soils mixed with satisfactory soils (TES units 33 and 46) adjacent to Fossil Creek, the Verde River and other perennial streams in the planning area. Where access is favorable to dispersed camping, recreation and grazing, these riparian areas tend to exhibit reduced vegetative ground cover (litter and basal vegetation) and increased soil compaction resulting in accelerated soil erosion and decreased soil productivity.

Satisfactory and Impaired

TES map unit 3231 on the Tonto National Forest fits this class and is very limited in extent (196 acres). This map unit has 2 major soil components and may have both soil condition classes present. On-site investigation should be conducted to validate the soil condition.

Impaired and Unsatisfactory

TES map units 3710 and 4140 are located on the Tonto National Forest in pinyon-juniper woodlands. These map units have either two major soil components with distinct soil loss tolerances and erosions rates resulting in impaired and unsatisfactory soil conditions or vary in soil condition throughout their range.

Table 3. Soil condition class by TES map unit – Coconino National Forest.

TES Map Unit Symbol	Acreage	Vegetation Type	Soil Condition Class
33	371	Riparian	Satisfactory & Unsatisfactory
45	112	Pinyon-juniper-evergreen oak in drainageways	Satisfactory
46	370	Riparian	Satisfactory & Unsatisfactory
350	79	Semi-desert grassland	Sat. - Inherently Unstable
382	195	Semi-desert grassland	Impaired
402	527	Juniper-semidesert grassland	Unsatisfactory
403	14	Juniper-semidesert grassland	Impaired
404	440	Juniper-semidesert grassland	Unsatisfactory
420	1468	Juniper-semidesert grassland	Unsatisfactory
430	12,113	Pinyon-juniper-evergreen oak	Sat. - Inherently Unstable
457	257	Pinyon-juniper woodland	Impaired
458	343	Pinyon-juniper woodland	Impaired
462	69	Pinyon-juniper woodland	Impaired
463	1231	Pinyon-juniper woodland	Impaired
492	63	Pinyon-juniper woodland	Satisfactory

493	9	Pinyon-juniper woodland	Satisfactory
495	5	Pinyon-juniper woodland	Satisfactory
520	0	Ponderosa pine-pinyon-juniper	Satisfactory
530	87	Ponderosa pine-juniper-evergreen oak	Unsatisfactory
550	118	Ponderosa pine-Gambel oak	Satisfactory
555	4261	Mixed conifer	Satisfactory
567	11	Ponderosa pine-juniper-Gambel oak	Satisfactory
572	422	Ponderosa pine-juniper-evergreen oak	Satisfactory
578	5	Ponderosa pine-juniper-Gambel oak	Satisfactory
584	19	Ponderosa pine-Gambel oak	Satisfactory
Lake	28		Satisfactory

Table 4. Soil condition class by TES map unit – Tonto National Forest.

TES Map Unit Symbol	Acreage	Vegetation Type	Soil Condition Class
9	232	Mesquite-dry riparian	Unsatisfactory
3050	85	Juniper-semidesert grassland	Satisfactory
3187	32	Juniper-semidesert grassland	Unsatisfactory
3231	196	Juniper-semidesert shrubland	Satisfactory and Impaired
3339	293	Juniper-semidesert shrubland	Sat. - Inherently Unstable
3521	1698	Juniper-semidesert shrubland	Impaired
3710	3123	Pinyon-juniper woodland	Impaired and Unsatisfactory
3711	1188	Pinyon-juniper	Impaired

		woodland	
3712	369	Pinyon-juniper – evergreen oak woodland	Sat. - Inherently Unstable
3770	126	Pinyon-juniper – evergreen oak woodland	Impaired
4140	676	Grassland	Impaired and Unsatisfactory
4176	16	Pinyon-juniper – evergreen oak woodland	Sat. - Inherently Unstable
5550	264	Ponderosa pine-juniper-evergreen oak	Satisfactory
5551	325	Ponderosa pine-juniper-evergreen oak	Satisfactory
6405	45	Mixed conifer	Satisfactory
9239	684	Desert and semidesert shrubland	Sat. - Inherently Unstable
9349	4395	Juniper woodland	Sat. - Inherently Unstable

Summary

Upland soil conditions are variable, with the majority of the areas rating satisfactory – inherently unstable on slopes greater than about 40 percent. Following intense storms, areas adjacent to streams and drainageways leading into perennial streams likely contribute significantly to short-term increases in downstream turbidity. Where recreation access is favorable, soil condition is generally impaired or unsatisfactory but limited in overall extent. Impacts to Fossil Creek, the Verde River, and other perennials are localized and generally limited to 1/10th of an acre/dispersed site. Although seemingly small, the incremental impact of continued use (especially along the middle reach of Fossil Creek) probably results in decreased streambank vegetation, increased sedimentation and peakflows as compared to natural conditions with satisfactory soils and well-vegetated streambanks. High levels of historic grazing coupled with current grazing strategies have contributed to soil degradation. In identified areas of impaired, unsatisfactory and satisfactory – inherently unstable soils, long-term soil productivity is reduced. The physical and biological conditions of the soil system are at risk, or do not support additional disturbance including grazing activity beyond the current carrying capacity.

Water

Watershed Hydrology, Watershed and Channel Conditions, and Water Rights

Charlie Schlinger and Grant Loomis

Introduction and Overview

This section addresses watershed hydrology and channel condition with supplemental material on water rights. These elements are priorities for land and resource managers and decision makers, and may be of interest to recreational and other visitors to the watershed in general and to the riparian/channel environment in particular.

In preparing this section, we have drawn heavily, paraphrasing in places, on a report by Nelson (2003), as well as volumes II and III of the 1992 license application prepared for the Child Irving hydroelectric project (APS 1992).

Fossil Creek is a tributary to the Verde River and falls within the Verde River watershed. Regional overviews that consider the upper and middle Verde River watershed are available from ADWR (2000) and Barnett & Hawkins (2002). Though these overviews provide minimal information on Fossil Creek itself, they provide a regional perspective in which one can more clearly understand Fossil Creek hydrology and watershed condition.

Hydrology

Fossil Creek is an intermittent stream from its headwaters at the confluence of Sand Rock and Calf Pen Canyons to Fossil Springs, flowing in response to summer thunderstorms, widespread frontal storms and snowmelt runoff. Perennial flow in Fossil Creek begins where a complex of springs emerge over a 1,000 foot reach of the creek that ends approximately 1000 feet upstream of the Fossil Springs Diversion Dam. Fossil Springs reportedly discharge at a constant temperature of 72°F (Overby and Neary 1996). Nineteen concurrent flow measurements by Tonto National Forest hydrologists above and below the springs from 2000 to 2004 result in a median flow of 46.1 cfs, and an average flow of 46.3 cfs, from the springs.

Continuous site-specific stream gage data are not available for Fossil Creek. The US Geological Survey has operated a gage on the flume from Irving to Stehr Lake since 1952. This gage is known as *Fossil Creek Diversions to Childs Power Plant, Near Camp Verde. AZ, gage No. 09507500.* It measures the flow diverted at Irving and is located just upstream of Stehr Lake. It does not record flows discharged from Irving to the Fossil Creek channel (estimated at 2-5 cfs) or flood flows down the mainstem of Fossil Creek. The gage does indicate the long term and constant nature of the baseflows discharged from the springs that is available for power generation at both Irving and Childs, and to the channel, once decommissioning of these plants commences. Average monthly flow at this gage ranges from 39.5 cfs in April to 43 cfs in July through

September. Months of no flow are included in this average during periods when the power plants or flumes were shut down for maintenance. Median monthly flows range from 43 to 44 cfs.

The watershed area that is tributary to stream flow at the Fossil Springs Diversion Dam location is 55 sq mi (APS 1992; Loomis 1994). Average annual water yield of the Fossil Creek watershed above the Fossil Springs, (with a tributary area of nearly 55 sq mi) is estimated at about 11,900 ac-ft per year based on comparisons with similar nearby gaged watersheds (West Clear Creek, Wet Bottom Creek, Red Tank Draw & Dry Beaver Creek) and from published runoff values for the vegetation communities occupying the watershed. Thus, the average annual basin water yield jumps at the springs, where the average spring discharge of 46 cfs adds 33,300 acre feet annually for a total yield of 45,200 acre feet per year. Thus, the Fossil Springs provide approximately 74 percent of the average annual basin yield above the diversion dam.

The estimated monthly distribution of the average annual water at the location of Fossil Springs is provided below. The distribution is developed using monthly runoff distributions from nearby gages on West Clear Creek, Red Tank Draw, Dry Beaver Creek, and Wet Bottom Creek. The percent contribution of discharge from Fossil Springs during each month is also tabulated (based on an average discharge of 46 cfs) in Table 5.

Table 5. Estimates of monthly precipitation at Irving, runoff (based on data for nearby gaged watersheds), contribution from springs (46 cfs or 33,000 ac-ft/yr), and total streamflow at location of Fossil Springs

Month	Average Monthly Rainfall (inches)	Average Monthly Runoff (ac-ft)	Average Monthly Runoff (cfs)	Percent of Annual Runoff	Average Monthly Total Streamflow (cfs)	Percent of Streamflow From Springs (%)
Jan	2.29	1,180	19.5	9.9	65.5	70
Feb	1.86	2,420	39.9	20.3	85.9	54
March	2.14	3,240	53.5	27.2	99.5	46
April	1.16	1,680	27.7	14.1	73.7	62
May	0.54	180	2.9	1.5	48.9	94
June	0.50	60	1.0	0.5	47	98
July	2.20	80	1.4	0.7	47.4	97
August	2.71	150	2.5	1.3	48.5	95
September	1.55	330	5.5	2.8	51.5	89
October	1.48	460	7.7	3.9	53.7	86
November	1.49	550	9.0	4.6	55	84
December	2.02	1,570	26.2	13.2	72.2	64
Total	19.94	11,900	16.4	100	62.4	74

From this table it is evident that snowmelt runoff and widespread frontal storms from December through April generate the majority (85%) of the watershed runoff at the location of Fossil Springs. Even though about one third of the precipitation occurs during the summer, the percentage of annual runoff during that period is negligible (5.3%). August is the wettest month of the year, yet less than 2 percent of the total annual runoff occurs during this month. The reduced runoff can be attributed to the high air temperatures and associated high rates of evapotranspiration that are common to this area of Central Arizona. Although contribution to stream flow from Fossil Springs averages approximately 74 percent on an annual basis, contribution to stream flow ranges from a low of 44 percent in March when watershed runoff is greatest to a high of 98 percent in June when watershed runoff is negligible. Discharge from Fossil Springs provides greater than 90 percent of the total stream flow through the summer months.

Evaluation of annual flow duration curves for neighboring watersheds suggests that stream flow in Fossil Creek consists almost entirely of baseflow (discharge from the springs) about 77 percent of the time. Watershed runoff contributes substantially to stream flow the remaining 23 percent of the time.

Peak flows at the location of the Fossil Springs Diversion Dam, and at several other downstream locations, were estimated as part of the 1992 APS re-licensing application process (APS 1992; Loomis 1994), and as part of pre-decommissioning evaluations of diversion dam removal scenarios (Schlinger et al. 2002; 2003). A compilation of peak flows estimated for the diversion dam site appears in Table 6 below.

Table 6. Estimated peak storm flows at the Fossil Springs Diversion Dam site

Recurrence Interval (yr)	USGS Regression Equations[1] Arizona Public Service Company 1992)	USGS Flood Regression Equations[2] (Monroe 2002; Loomis, 1994)	USFS HEC-1 Current Condition (Loomis 1994)	HEC-HMS Spring Cyclonic Storm – Current Condition (Schlinger et al. 2002, 2003)
2	600	508	1,026	1,077
5	1,700	1,979	2,257	2,317
10	2,900	3,348	3,737	3,235
25	4,900	5,971	6,034	4,539
50	7,000	9702	8,998	5,609
100	9,400	14200	13,531	6,743
500	16,800	–	–	–

[1] regression equations, now obsolete, of Roeske (1978)
[2] regression equations of Thomas et al. (1994)

These projections verify that estimated peak flow magnitudes are dependent on the rainfall distribution assumed for the simulation. In particular, the spring cyclonic storm considered by Schlinger et al. (2002; 2003) is less 'flashy', with peak precipitation occurring later in the storm and being longer in duration and lower in intensity. However, in the case of each estimate, the hydrologic model used was uncalibrated – due to the absence of streamflow gage data for Fossil Creek. The data in the table thus provide only 'ballpark' estimates.

Flood flow estimates for other locations in the watershed appear in Table 7 below. Boulder Creek is a tributary of Fossil Creek that enters Fossil Creek, from the north, nearly 3 miles below Irving.

Table 7. Peak flows at other locations – from USGS Regression Equations[1] (APS 1992; after Roeske 1978)

Recurrence Interval (yr)	Fossil Creek at Irving	Fossil Creek 4 miles below Irving	Boulder Creek
2	700	1,000	200
5	2,100	2,800	700
10	3,500	4,700	1,200
25	6,100	8,200	2,100
50	8,700	11,900	3,100
100	11,800	16,000	4,200
500	21,300	29,300	7,800

[1] regression equations, now obsolete, of Roeske (1978)

The watershed area tributary to flow: at Irving is 64 sq mi; at a location 4 miles below Irving is 90 sq mi; in Boulder Creek is 12 sq mi.

Watershed and Channel Conditions

Beginning around 1880 and continuing into the early 20th century (c. 1920), overgrazing was rampant in many Arizona watersheds; see Barnett and Hawkins (2002) for an excellent discussion. Fossil Creek was no exception (Chamberlain 1904) in this regard. As a consequence, excessive runoff, erosion in the channel and in the uplands, headcutting and loss of riparian habitat occurred. The evidence for channel erosion and downcutting is evident at many locations along Fossil Creek. The diversion of the travertine-forming Fossil Creek baseflow for Childs-Irving facility operations (Overby & Neary 1996) by the Fossil Springs Diversion Dam, and, to a lesser extent, the influences of this heavily degraded watershed condition, coupled with floods (APS 1992) led to the destruction of travertine dams since 1916.

Loomis (1994) completed a hydrological evaluation of that portion of the Fossil Creek watershed that is tributary to flow at the Fossil Springs Diversion Dam, with an eye toward assessing the effects of watershed condition on flood peaks in Fossil Creek. Loomis evaluated the then-existing watershed condition using the draft edition Coconino National Forest Terrestrial Ecosystem Survey, or TES (USDA Forest Service 1995), which covers the watershed above the diversion dam. He determined that the then-current condition of the watershed would not significantly impact flood flows, relative to the ungrazed condition, though small impacts were estimated.

It is important to note that effects of watershed condition on the forecasted flood flow magnitudes were greater for more frequent than for less frequent floods. Watershed condition is known to have a greater impact on runoff generation at lower rainfall amounts than at higher rainfall volumes associated with the more rare floods, where the sheer volume of precipitation dominates (e.g., Schlinger et al. 2004). For example, after watersheds burn, dramatic increases in runoff occur for low-recurrence-interval frequency storms, with less dramatic increases for high-magnitude low-frequency storms (e.g., Nasseri 1989; Schlinger et al. 2004). In the Fossil Creek watershed, relative to the current condition, the flows for the degraded condition were 10% larger for the 2-yr flood and 4% larger for the 100-yr flood.

Watershed sediment yield was estimated by Monroe (2002), using a variety of methods, but the results spanned 4 orders of magnitude. Given that there are no data on sediment yield due to natural erosion in the watershed, and given the wide range of these forecasts, it is impossible to interpret stream channel sediment transport simulation results (presented below) in the light of erosion and sediment transport that occur in the upland areas of the watershed.

Stream Channel and Floodplain Morphology and Sediment

An overview of Fossil Creek stream channel morphology has been provided by Nelson (2003), and we quote:

> *The stream channel morphology from the springs to the Fossil Springs Diversion Dam impoundment consists of runs, steps, riffles and deep pools. The substrate is primarily cobble and boulders. The dam has trapped an estimated 25,000 cu yd, deposited in the impoundment area upstream of the dam and resulted in an area of finer grained sediments that has developed into a wider floodplain than exists along unimpacted reaches of the channel. Mature riparian vegetation has developed on this floodplain.*
>
> *Below the dam the gradient is steep (almost 3%) and the stream flows through a narrow canyon before reaching the Irving power plant. Substrate is mostly cobble and boulder with significant exposures of bedrock. Overby and Neary (1996) mapped the remnants of 81 travertine dams in the 4 mile reach from the diversion dam to Irving.*

Below Irving, a discharge of 2-5 cfs from the power plant into the natural channel has resulted in deposition of a series of travertine dams ranging up to about 6 feet in height that extend downstream for approximately 2.5 miles to below the confluence with Boulder Creek. Travertine deposits in this reach have widened the wetted perimeter of the channel and resulted in areas of lush emergent and riparian vegetation. This reach may be representative (although at a smaller scale) of conditions that can be expected in the reach above Irving when full flows return to the channel.

Shortly below the confluence with Boulder Creek the channel becomes more confined and riparian vegetation is limited to narrow discontinuous stringers. Substrate again is dominated by cobbles boulders and bedrock. Approximately 1.5 miles below the confluence with Boulder Creek the channel enters a narrow confined canyon that is characterized by a step pool system dominated by cobbles, boulders and bedrock. Gradient increases from about 1.5% in the upstream reach to about 2.5% through the canyon. Riparian vegetation is again limited to narrow stringers due to the confining canyon walls. The canyon reach extends downstream for approximately 2.5 miles.

Below the canyon to the confluence with Hardscrabble Creek the valley bottom widens, gradient flattens to about 2%, and some discontinuous floodplain and terrace surfaces are present. Riparian vegetation is more continuous in this reach.

Below the confluence with Hardscrabble Creek to the confluence with the Verde River, a distance of approximately 1.3 miles, the gradient flattens to about 1.5%, the valley bottom remains comparatively wide and aerial photos indicate active unvegetated point or alternating bars are present. Some patchy vegetation exists on floodplain surfaces.

As stated above, the sediment that is presently stored behind the Fossil Springs Diversion Dam is relatively fine-grained. This 'sediment wedge' received considerable attention in the past few years (Monroe 2002; Schlinger et al. 2002; 2003), mainly with an eye toward how rapidly and how much of this sediment would be transported downstream following partial or complete removal of the dam.

High-resolution topographic survey data (with tree locations) for the diversion dam and extending 1200 ft upstream, just beyond the limits of the sediment wedge were obtained by APS in 2000. Schlinger et al. (2002; 2003) supplemented these data with high-resolution topographic survey data for the reach that extends downstream of the dam for a distance of nearly 350 ft. Monroe (2002) provided a survey of the sediment wedge that included the distribution of surficial sediment, the water surface and trees.

Channel and floodplain sediment grain-size distributions based on pebble-counts have been obtained both upstream and downstream of the dam by Monroe (2002) and Schlinger et al. (2002; 2003). Flood reconstruction based on geomorphic evidence and HEC-2 simulations of channel hydraulics were prepared for 4 sites in Fossil Creek (work by CH2MHill, documented by APS 1992). Floods with recurrence intervals between 30 and 300 years appear to have occurred in the past 100 years, with peak flow velocities approaching 8 to 19 ft/second – capable of transporting cobbles and small boulders. It is not possible to say whether the water surface elevations recorded by CH2MHill for the largest flood reflect current channel conditions or channel conditions early in the 20th century, when large travertine dams were extensively present in portions of the channel.

Loomis (1994) estimated the average tractive force and the average maximum diameter of sediment that will be set in motion during floods with recurrence intervals of 10-, 50- and 100- years. A summary table follows.

Table 8. Flood intervals, flood flow, average tractive force and average diameter of sediment set in motion.

recurrence interval (yr)	flood flow (cfs)	average tractive force (lb/ft^2)	average maximum diameter of sediment set in motion (inches)
10	3,737	5.6	10.8
50	8,998	7.6	14.6
100	13,531	8.4	15.8

Hydraulic evaluations of stage versus discharge for storms with recurrence intervals of 2, 5, 10 & 25 years, at five discrete locations with surveyed cross-sections were prepared by Monroe (2002). Storm flows were based on regression equations of Thomas et al. (1994), which yield estimates similar to those of Loomis (1994). Based on data from nearby gaged watersheds, 1-yr-duration proxy hydrographs that included these storms were prepared and Monroe estimated sediment transport capacity at the 5 locations. As can be anticipated, floods have the potential to move large quantities of sediment at those cross-section locations with a large percentage of relatively fine-grained bed material.

A water surface and moveable-bed sediment transport model (HEC-6, provided by the U.S. Army Corps of Engineers) was prepared by Schlinger et al. (2002; 2003) to assess probable sediment transport for the following Fossil Springs Diversion Dam decommissioning scenarios:

- ❑ Full removal of the diversion dam;
- ❑ Removal of 6 feet off the top of the diversion dam;
- ❑ No removal of the diversion dam.

The simulation considered a reach that extended from nearly 1200 feet upstream of the dam to 350 ft downstream. The results of that study must be set in the context of FERC's subsequent October 8, 2004, license surrender order (FERC 2004b) that the Fossil Springs Diversion Dam be lowered by 14 feet, which is a scenario intermediate between that of full removal and that involving the removal of the upper 6 feet. Under the 14-foot removal scenario:

- ❑ A drop in the water table of nearly 14 feet at the dam and in much of the sediment wedge area upstream of the dam can be anticipated.
- ❑ Over the course of a nine-month period, selected as the likely maximum duration of time that might pass without storm flows, the 46 cfs Fossil Springs base flow has minimal impact on the sediment wedge presently behind the dam.
- ❑ Seasonal flows corresponding to the 2-year summer or winter/spring storms have the potential to move significant quantities of sediment for the total removal option. Sediment volume eroded from the wedge area during the 2-yr summer event is estimated to be in the ballpark of 500-1,000 cu yd. We project sediment erosion during the 2-yr winter/spring event, of perhaps 800-1,200 cu yd.
- ❑ The 100-yr storm has the potential to remove upwards of 1/6th to 1/4, or 4,000 to 6,000 cu yd, of the total sediment wedge volume of approximately 25,000 cu yd.

Considering the 100-yr storm as a baseline event, based on the results of the HEC-6 simulations, which provide an estimate of the change in the bed profile following a storm flow, it is anticipated that erosion of the sediment wedge behind the dam will not be significant beyond a distance of approximately 600 ft upstream of the dam. Larger storms (500-year, probable maximum flood, etc.) will have impacts not yet considered with sediment transport modeling. However, bedrock control that exists at and below the dam, and in the Fossil Springs area will limit long-term downcutting.

Downstream of the dam, significant impacts are expected as the sediment wedge is eroded and transported downstream, as a 'sediment wave' by flood events. Over time, the peak of this sediment wave will be attenuated, and the profile of the sediment wave in the downstream channel will be stretched out over greater distance.

Water Rights

APS or its predecessor(s) has, since 1900, held a "36" water right, which is a *statement of claim of rights to use public waters of the state of Arizona* on Fossil Creek, for 31,123 ac-feet per year. The number 36 refers to the prefix assigned by the Arizona Department of Water Resources to these claims of rights. The point of diversion is the Fossil Springs Diversion Dam, and the diverted water is eventually discharged to the Verde River at Childs, 3.5 miles above its confluence with Fossil Creek. As part of the above-described decommissioning settlement agreement, APS will transfer their water rights to the Forest Service. Specifics of Arizona water law may make this transfer difficult.

In addition to the APS water right for power generation, there are several other water rights and claims within the Fossil Creek watershed. These include water right claims ("38's") for stock ponds, water rights (certificates) for domestic use from springs in the watershed for use at APS's employee housing, and water rights claims ("36's") for instream livestock use by grazing permittees.

There are also downstream water rights that rely on water discharged from Fossil Creek. Fossil Creek is a tributary to the Verde River, which is impounded by Horseshoe Reservoir and Bartlett Lake below the confluence with Fossil Creek for use by downstream water right holders. Downstream appropriators include the Salt River Valley Water Users Association (SRP), Fort McDowell Indian Tribe and cities within the Phoenix metropolitan area. The Tonto, Coconino and Prescott National Forests also have an instream flow water right certificate for a reach of the Verde River that extends above and below the confluence with Fossil Creek.

Additionally, the US Forest Service applied for an instream flow water right on December 1, 1999 (Application #33-96622) and seeks to permit a total volume of 33,305 acre-feet per year (Nelson 2003). The reach included within the instream flow application begins above Fossil Springs, approximately one half mile above the Fossil Springs Diversion Dam, and extends to the confluence of Fossil Creek with the Verde River. The short reach of Fossil Creek that flows through private property is excluded from the claimed reach.

The Fossil Creek instream flow appropriation sought by the Forest Service would not have a detrimental affect upon valid, existing, senior surface water rights because the appropriation is for an in-situ, non-consumptive use that would not reduce water available to these water right holders (Nelson 2003).

Restoration Actions and Goals

The key water- channel- and watershed-related restoration actions for Fossil Creek as a result of Childs-Irving decommissioning are:

- ❑ Restoration of the 46-cfs baseflow;
- ❑ Lowering the crest of the Fossil Springs Diversion Dam by 14 feet;

As a direct result of these actions the following restoration objective will be met:

- ❑ Riparian corridor restoration, including restoration of the travertine pool and dam complexes.

These restoration goals will require no specific actions but will follow directly from baseflow restoration. The dam crest lowering addresses Forest Service safety and maintenance concerns, and results in nearly complete removal of an artificial water control structure. Removal of 14 feet of the dam and lowering of the water table upstream of the dam will likely result in mortality of some of the riparian vegetation currently occupying the sediment wedge upstream of the dam. The above two restoration actions have implications, presumed positive, for the native fish restoration project that took place in the fall of 2004.

In addition there are several other restoration actions planned as part of the decommissioning:

- ❑ Removal of the Irving facilities;
- ❑ Removal of flumes and siphons;
- ❑ Stehr Lake regrading and revegation;
- ❑ Other lesser actions.

With the exception of the Stehr Lake actions, these other restoration actions are of minor consequence with regard to water- channel- and watershed-related restoration objectives. The Stehr Lake regrading and revegetation will remove an artificial water feature that would not otherwise exist in the Fossil Creek watershed.

Research, Monitoring and Evaluation

Restoration of the 46-cfs Fossil Springs baseflow to Fossil Creek requires no monitoring or evaluation, per se. However, the spring-supplied baseflow may, in the long term, be affected by groundwater development in the surrounding area, or by climatic or other factors. Long-term monitoring of the Fossil Springs baseflow is desirable, but it is not presently the responsibility of any party or parties. Beginning in summer, 2005, a civil and environmental engineering Master's student at Northern Arizona University will be looking at identifying and evaluating suitable locations for flow gaging in Fossil Creek. See further discussion of gaging in the following section, Spring Characterization and Groundwater.

FERC (2004b) has stipulated that, as part of license surrender and removal of project works, the Fossil Springs Diversion Dam crest will be lowered by at least 14 feet, with anticipated action in 2007. Once the crest is lowered, a significant portion, probably in excess of 50 percent, of the nearly 25,000 cu yd of sediment presently stored behind the dam will be able to move downstream in response to storm flows (Monroe 2002; Schlinger et al. 2002; 2003). This sediment movement will be accompanied by environmental and ecological impacts, both upstream and downstream of the dam, and these impacts will be monitored and evaluated. This is important because in many, if not most, dam removal actions, hypotheses and assumptions concerning sediment movement, made during planning the actions, are rarely tested and impacts are rarely evaluated.

Researchers in civil and environmental engineering at Northern Arizona University are engaged in a long-term study of sediment transport related to the above decommissioning action at the Fossil Springs Diversion Dam. It has been assumed that other decommissioning actions (Stehr Lake restoration; flume, pipeline, building removal) will have minimal affects on sediment in the channel, as these other actions will utilize best management practices (BMPs) for erosion control. However, in the case of the Fossil Springs Diversion Dam removal, sediment behind the dam will be managed by allowing intermittent storm flows to transport the sediment downstream.

Changes in sediment thickness will be monitored with a series of cross-sections and topographic surveys, both upstream (approximately 600 feet) and downstream (approx. 1600-2400 feet) of the Fossil Springs Diversion Dam. Pebble counts will also be completed to document sediment grain-size distributions. Initial monitoring to document existing, or *baseline*, conditions with respect to channel cross-section and sediment sizes began during fall 2004 and will be completed by spring of 2005. This work consists of:

- ❑ Research in stream channel morphology along the entire channel length;
- ❑ Developing channel cross sections and topographic survey data at selected locations for repeat observations;
- ❑ Pebble counts.

The results will be of value to assess sediment transport due to lowering of the diversion dam – which must, in the long term, be set in relationship to sediment transport in the watershed.

Conclusions

The hydrology and channel conditions in the Fossil Creek watershed dramatically changed in response to the Childs-Irving hydroelectric power plants coming on line in 1909, nearly a century past. The year 2005, with the restoration of the 46-cfs travertine-forming baseflow, is truly a 'watershed' year in this remarkable corner of Arizona.

With the flow restoration, the stream hydrology will change dramatically, as far as the dramatic increase in baseflow that will result. The flood hydrology will change little, as flood peaks are large compared to baseflow. We fully anticipate that travertine formation will resume – at rates and with dam and pool distribution similar to what existed before 1909. Channel modifications will result from increased travertine formation and from changes in the riparian plant community in response to the change in wetted perimeter from the persistent 46 cfs baseflow.

In the latter years of the decommissioning process, c. 2007 or 2008, the planned 14-ft lowering of the Fossil Springs Diversion Dam will produce dramatic changes in the vicinity of the dam. Upstream of the dam, the sediment wedge will begin to erode in response to sediment transport by infrequent high-magnitude storm events. Downstream of the dam, this sediment will be deposited, in existing pools, in bank areas, and behind newly formed/forming travertine dams. Within a period of several tens to several hundred years, a new dynamic equilibrium will take hold – one that we expect to be similar to that which existed prior to 1908.

Spring Characterization and Groundwater

Abe Springer

Introduction

Springs form the headwaters or sources of water for many watersheds in the Western United States. Even though Arizona has the second highest density of springs of any state west of the Mississippi River, it is estimated that more than half of them are not located or characterized (Springer et al. 2004). The discharge from springs in the Verde River watershed such as Fossil Springs is an essential contribution to the surface-water of the watershed. Groundwater conditions in the region effects the resulting discharge from these springs.

Fossil Springs is one of the few remaining unmanipulated major springs left in the West, and provides insight into the natural function of a critical keystone ecosystem. Springs are important because: 1) they provide critical water and food resources for wildlife and recreation; 2) they are important point sources of biodiversity and productivity in otherwise low productivity desert landscapes; and 3) they are the focus of human activities, regional history, and land and wildlife management (Springer et al. 2004). Unfortunately, springs ecosystems such as Fossil Springs are highly threatened by human activities.

Fossil Springs has a discharge which is greater than any spring complex outside of the tributaries of the Colorado River in Grand Canyon. Compared to the major springs of the Grand Canyon (Blue Springs, Havasu Springs, and Tapeats Springs), Fossil Springs is of nearly the same order of magnitude of discharge. Without this perennial discharge from the spring complex, there would not be the unique and important aquatic ecosystem in Fossil Creek or the spectacular travertine complexes.

Fossil Creek is an intermittent stream from its headwaters at the confluence of Sand Rock and Calf Pen Canyons to Fossil Springs, flowing in response to summer thunderstorms, widespread frontal storms and snowmelt runoff (Nelson 2003). Perennial flow in Fossil Creek begins where a complex of springs emerge over a 1,000 foot reach of the creek that ends approximately 1,000 feet upstream of the Fossil Springs Diversion Dam.

Fossil Springs discharge from the bottom of the Naco Formation (Upper Middle Pennsylvanian age) at the contact of the Redwall Limestone in Fossil Creek (Figure 6). The Naco Formation is present along the Mogollon Rim east of Fossil Creek and consists mainly of limestone and mudstone. The springs discharge in a canyon which has incised through a thickness of about 3,000 feet of sedimentary and volcanic rocks (Figure 6). Rainfall and snowmelt infiltrate through these rocks on higher elevations of the Mogollon

Rim and flow through faults and fractures to eventually discharge through the multiple spring orifices in the Fossil Springs complex.

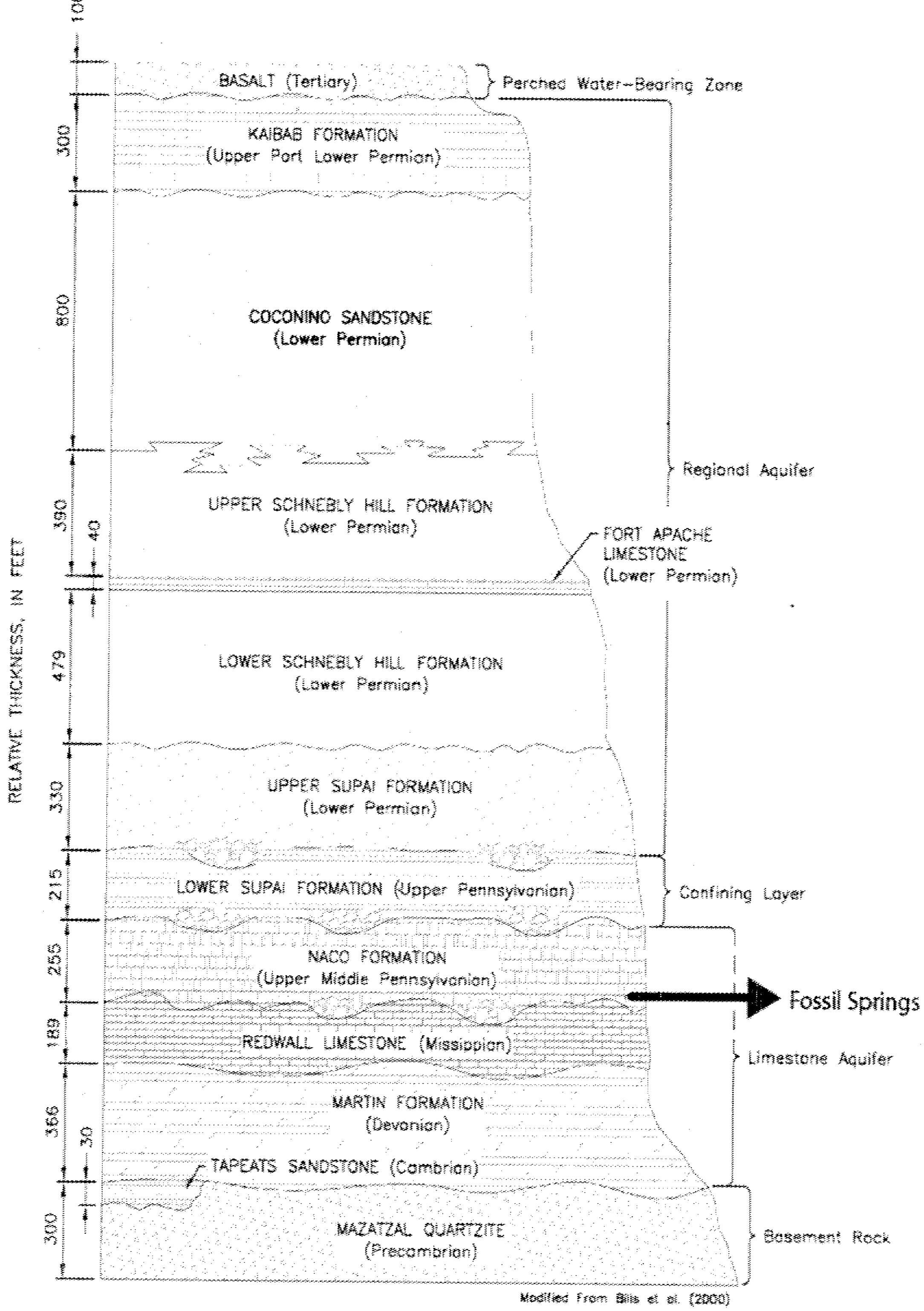
General Trends

Continuous gauged spring discharge data for Fossil Springs are not available and have never been collected. The USGS gage on Fossil Creek (Fossil Creek Diversions to Childs Power Plant, Near Camp Verde, AZ, gage No. 09507500) was for the diversion on the flume from Irving to Stehr Lake, not for the flow within the channel. It did not record flows discharged from Irving to the Fossil Creek channel (estimated at 2-5 cfs) or flood flows down the mainstem of Fossil Creek (Nelson 2003). Discharge from the springs in the Fossil Springs complex was measured sporadically till 1999 when the USFS began measuring discharge monthly for an instream flow right (Nelson 2003) (Figure 7).

Discharge of the springs is not constant and varies seasonally and potentially annually (Nelson 2003) (Figure 7). Spring discharge has been measured to vary between about 40 and 54 cfs. There is a slight, but not statistically significant ($r^2 = 0.16$), decline of discharge over the period of record. Discharge may be responding to reduced recharge from current drought conditions with a diminished winter low flow trend over the past 5 years. Because there are little to no groundwater withdrawals from wells tapping the aquifer which supplies Fossil Springs, it is unlikely that recent groundwater pumping is influencing spring discharge. A survey of 160 springs in the Middle Verde River Watershed in 2002 found that nearly 50 % of the springs were dry in response to the dry climate conditions from 1995 to 2002 (Flora 2004).

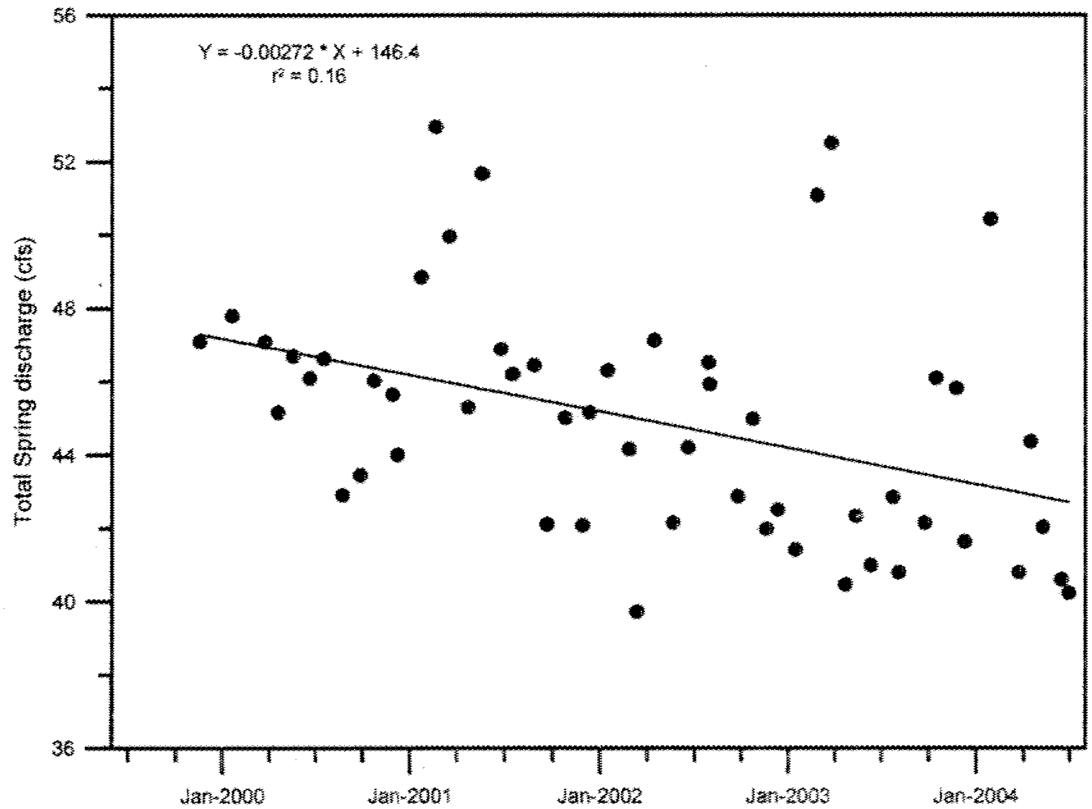
All previous discharge measurements for Fossil Springs have been for total, aggregate discharge from each individual spring orifice in the spring complex. Reconnaissance surveying in 2004 as part of this study indicated that there are over 60 individual spring orifices at Fossil Springs, discharging between a few gallons per minute and 10 cfs. The individual spring orifices of Fossil Springs have never been located or characterized, but are being located as part of ongoing studies.

Figure 6 (next page). Generalized stratigraphic section for the Pine/Strawberry/Fossil Springs area (Kaczmarek 2003).



RELATIVE THICKNESS, IN FEET
100
300
800
390
40
479
330
215
255
189
366
30
300
BASALT (Tertiary)
Perched Water-Bearing Zone
KAIBAB FORMATION
(Upper Part Lower Permian)
COCONINO SANDSTONE
(Lower Permian)
Regional Aquifer
UPPER SCHNEBLY HILL FORMATION
(Lower Permian)
FORT APACHE
LIMESTONE
(Lower Permian)
LOWER SCHNEBLY HILL FORMATION
(Lower Permian)
UPPER SUPAI FORMATION
(Lower Permian)
LOWER SUPAI FORMATION (Upper Pennsylvanian)
Confining Layer
NACO FORMATION
(Upper Middle Pennsylvanian)
Fossil Springs
REDWALL LIMESTONE (Missippian)
Limestone Aquifer
MARTIN FORMATION
(Devonian)
TAPEATS SANDSTONE (Cambrian)
MAZATZAL QUARTZITE
(Precambrian)
Basement Rock
Modified From Bills et al. (2000)

Figure 7. Point measurements of cumulative discharge of all springs discharging from Fossil Springs complex from 1999 to 2004 (Nelson 2003; unpublished USFS and NAU data).



Restoration Goals

Unlike the aquatic ecosystems of Fossil Creek which will be restored when diversion ceases, the springs of Fossil Creek will not be influenced by restoration activities below the diversion dam. The impacts to the sources of water for the springs are from changes to recharge and groundwater withdrawals from the large regional aquifer which supplies the springs. The goal of management for the springs of Fossil Creek is to sustain a baseflow of spring discharge necessary and sufficient to maintain the associated aquatic and riparian ecosystems, and the travertine processes. A request to maintain baseflow in Fossil Creek is part of the U.S. Forest Service instream flow assessment (Nelson 2003).

Monitoring

All of the planning for future management of Fossil Creek assumes the quality and quantity of water discharging from Fossil Springs are unchanging. Climate change, land management changes that affect recharge, or pumping of water from the aquifer all have the potential to affect this assumption of unchanging quality and quantity of the water discharging from Fossil Springs. There is a critical need to establish a gauging station on Fossil Creek immediately downstream of the last spring orifice to monitor trends in the baseflow of Fossil Springs.

Once the individual spring orifices have been located and characterized as part of ongoing studies, it will be possible to identify and track changes to their location or discharge through time. Although comprehensive biological surveys have not been completed, it is likely that specific microhabitats and specific species are dependent on each of the over 60 individual spring orifices in the spring complex.

After finishing baseline characterization of the individual spring orifices which contribute to the total discharge of the Fossil Springs complex, NAU will build a three-dimensional hydrogeologic framework model for the aquifer which contributes flow to Fossil Springs. The framework model will serve as the base for future numerical groundwater flow models for Fossil Springs which can help understand how changes in management to the aquifer or the watershed may influence the quantity and quality of water discharging from the springs.

Indicators

Critical to indicating the baseflow of the springs of Fossil Creek is the establishment of a gauging station on Fossil Creek downstream of the springs. Once the gage is established, it would be possible to start developing correlations between quantities of discharge from the springs and the rates and amounts of travertine formation, and the health of the associated riparian and aquatic ecosystems. As has been done for other riparian and aquatic ecosystems, it may be possible to establish the necessary and sufficient discharge conditions to sustain the unique aquatic and riparian systems in Fossil Creek. Once these conditions are established, it would be possible to inform groundwater management decisions for the aquifer associated with Fossil Springs. This gauging data will be invaluable to the construction and calibration of numerical groundwater flow models for the aquifer. Also, once the individual spring orifices are located and characterized, it will be possible to monitor their response to climatic and other changes through time. If the number of orifices or the rate of discharge of individual orifices changes through time, it will be possible to gain insight into the changes to baseflow of the stream and condition of the aquifer.

Water Quality

Abe Springer

Introduction

Fossil Springs emit water supersaturated with respect to $CaCO_3$ which create travertine features that dramatically influence the stream morphology. These travertine features are formed by an unusal combination of natural processes (Malusa et al. 2003). Elevated levels of CO_2 in the aquifer from various processes lead to supersaturation with respect to $CaCO_3$. Because one of the sources of CO_2 may not be meteoric, but from deep earth crustal processes, this may lead to some of the unique water quality characteristics of Fossil Springs.

General Trends

In June 2004, water samples were collected from three separate spring orifices in the Fossil Springs complex to determine if there were any differences in water chemistry between individual orifices. Water discharging from Fossil Springs is a Calcium-Bicarbonate type water (Table 9). The total dissolved solids concentrations are between 650 and 700 mg/L. Arsenic concentrations are between 5 and 7 µg/L. There appear to be no significant chemical differences between the water discharging from individual spring orifices, but this will continue to be investigated.

For comparison, samples collected at the springs (unknown which spring orifice) by Malusa et al. (2003) in March 1996 and Feth and Hem (1962) are listed in Table 9. APS (1992) collected water quality data from November 1989 and 1990 as part of the application for new license for major project, existing dam. A sample collected at the springs (unknown orifice) indicated a dissolved oxygen content of 7.9 ppm, a pH of 7.53, an electrical conductance of 810 umhos/cm and a temperature of 69° F.

Table 9. Summary of chemical analyses from water collected from various spring orifices in Fossil Springs in June 2004, Malusa et al. (2003) and Feth and Hem (1962) (all units mg/L unless noted otherwise).

Orifice	**K**	**Na**	**Ca**	**Mg**	**Cl**	**SO_4**	**H_2CO_3**	**HCO_3**	**As (ug/L)**
Upper Left	2.00	10.70	92.0	36.5	8.03	23.57	185.8	340.6	6.98
Upper Right	1.70	10.05	86.0	34.0	8.80	25.42	161.8	332.7	5.18
Fig Tree	1.95	10.80	87.5	34.5	7.99	23.60	163.7	328.8	5.43
Malusa et al. 2003	1.5	11.9	102.6	38.5	8.9	29.4	99.0	466.1	---
Feth & Hem 1962	34 (K+Na)		56	34	8	2.9	----	370	----

K = Potassium, Na = Sodium, Ca = Calcium, Mg = Magnesium, Cl = Chloride, SO_4 = Sulfate, H_2CO_3 = Carbonic acid, HCO_3 = Bicarbonate, As = Arsenic

In conjunction with Laura J. Crossey, Karl Karlstrom, and Dennis Newell of the Department of Geology, University New Mexico, NAU has been examining the geochemistry of travertine-depositing springs of the Arizona Transition Zone (which includes Fossil Springs). Travertine-depositing springs located in the Colorado Plateau region of the southwestern U.S. are hypothesized to be genetically linked to mafic magmatism and extensional tectonics, providing a window into a previously unrecognized component of deeply circulated hydrothermal fluids influencing groundwater. Active springs are commonly located along deep, basement rock-penetrating faults and associated with large accumulations of Quaternary travertine deposits, implying that these hydrologic systems have persisted through long-periods of geologic time. Preliminary sampling for aqueous and gas geochemical tracers was undertaken with Abe Springer and NAU students in summer 2004 to see whether springs of the Arizona Transition Zone exhibit the same features as those found for travertine systems of the Grand Canyon region. Preliminary major ion and trace element analyses along with SO_4, Cl, Br (bromine), HCO_3, $\delta^{18}O$, Sr (strontium), and $^{87}Sr/^{86}Sr$ analyses will be used to trace the origins of travertine-depositing spring waters. Springs in the Colorado Plateau region fall on a trend between dilute and very saline end-members.

Analysis of dissolved gases within the spring waters is underway. Preliminary examination suggests a mixing trend between atmosphere/soil gas with an end-member dominated by CO_2 (carbon dioxide) (high CO_2/N_2) (N_2 = nitrogen) gas compositions range to over 99 volume % CO_2 in some springs. Trace gas analyses shows elevated He concentrations (low N_2/He) in some springs suggestive of a deep origin for the gases. $^3He/^4He$ analysis demonstrates the presence of mantle-derived He component in travertine-depositing springs (Fossil Creek and Montezuma Well), likely associated with magmatic CO_2.

Restoration Goals

Although the chemistry of the water from Fossil Springs will not be influenced by the dam decommissioning and the return of flows to the channel, changes in geochemical processes in the aquifer which supplies the springs may influence the water chemistry. Increases or decreases of recharge to the aquifer, which might lead to changes in the volume of water stored in the aquifer, may lead to changes in residence time, and subsequent changes in chemistry.

Monitoring

Because changes in the chemistry of water from Fossil Springs is influenced by factors external to the actions below the springs, it will be essential to establish a baseline monitoring program to detect any changes in water chemistry. This baseline monitoring should include major cations and anions to examine the change in carbonate chemistry and the potential for changes in travertine formation. The monitoring should also include other dissolved constituents important for determining any impacts to the associated aquatic ecosystem. Samples for chemical analysis should be collected at the location of the spring discharge gauging station.

Indicators

When relationships between the discharge of Fossil Springs and the rates of travertine formation are determined, it will be possible to use the long-term monitoring of spring discharge and water quality to determine if there are any important changes in the rates of travertine formation. Rates of change of travertine formation caused by changes in spring discharge could alter the number and height of dam/pool travertine complexes, altering the aquatic habitat.

Vegetation[6]

Daniela Roth

Eight biotic communities have been documented from the Fossil Creek – Lower Verde River 5th code watershed: chaparral, desert scrub, grassland, mixed conifer, pinyon/juniper, ponderosa pine, ponderosa pine/Gambel oak and riparian, totaling 203,715 acres (USDA Forest Service 2003a; Table 10). The Fossil Creek area is distinguished by its extensive riparian areas, numerous springs, Stehr Lake and the Fossil Springs Botanical Area.

Table 10. Acres of eight biotic communities within the Fossil Creek – Verde River 5th Code Watershed and the Fossil Creek Planning Area (USDA Forest Service 2003a). The Fossil Creek Planning Area roughly corresponds to the Fossil Creek Watershed boundary used in this report (see Figure 5).

Biotic Community	Acres Within 5th Code Watershed	Acres Within Planning Area
Chaparral	4,686	0
Desert Scrub	15,811	508
Grassland	4,432	685
Mixed Conifer	6,702	4,288
Pinyon Juniper	128,483	28,031
Ponderosa Pine	17,429	1,121
Ponderosa Pine/Gambel Oak	5,138	139
Riparian	18,108	1,460
Total Acres	203,715	36,260

The dominant community in the Fossil Creek – Verde River 5th code watershed is pinyon/juniper (128,483 acres), followed by riparian, ponderosa pine and desert scrub. Due to the elevational changes between Fossil Springs (4100 ft) and the confluence at the Verde River (2600ft), the vegetation of the upland canyon slopes changes from pinyon/juniper at Fossil Springs to desert scrub below Irving (Goodwin 1980).

The dominant upland vegetation near the Childs Power Plant consists of prickly pear (*Opuntia engelmannii*), velvet mesquite (*Prosopis glandulosa*), catclaw acacia (*Acacia greggii*), buckhorn cholla (*Opuntia acanthocarpa*), and paloverde (*Cercidium microphyllum*). As elevation increases within the Fossil Creek Planning Area, the dominant vegetation includes velvet mesquite, catclaw acacia, prickly pear, shrub live-oak (*Quercus turbinella*), desert ceanothus (*Ceanothus greggii*), pinyon pine (*Pinus edulis*), one-seed juniper (*Juniperus monosperma*), Utah juniper (*Juniperus osteosperma*), banana yucca (*Yucca baccata*), and golden-flowered agave (*Agave chrysantha*). At the highest elevations, pinyon pines increase in dominance within the Fossil Creek Planning Area, and mormon tea (*Ephedra viridis*), birch-leaf mountain mahagony (*Cercocarpus montanus*) and pointleaf manzanita (*Arctostaphylos pungens*) are common (Baker Engineering 2002a).

Fossil Springs Botanical Area is located above Fossil Springs Diversion Dam and is adjacent to the Fossil Springs Wilderness. The area encompasses about 50 acres and consists of both riparian and upland vegetation (pers. comm., B. Phillips, Forest Service Zone Botanist, 2005). Fossil Springs Botanical Area was given Special Management Area status by the U.S. Forest Service due to its unique natural value including many springs and intact riparian forest. A total of 166 species of plants has been recorded from the Botanical Area (USDA Forest Service 2003a; see Appendix A of this report for a full listing).

Three hundred fourteen species of flowering plants and ferns from 77 families have been documented from the Fossil Creek Planning Area (USDA Forest Service 2004). However, a full inventory of the Fossil Creek – Verde River 5th code watershed has not been completed.

Riparian Areas

The riparian zone along Fossil Creek is dominated by deciduous trees. Tree diversity is good throughout but there are differences in overstory dominance between the reach above the Fossil Springs Diversion Dam to the reach below the dam (Sayers 1998). Seedlings are the most common age class among riparian trees at Fossil Creek, generally found in a narrow band along the creek. The number of riparian species decreases with horizontal distance away from the stream bank in direct proportion to decreasing soil moisture availability (APS 1992).

The Fossil Creek riparian area has been divided into 5 different sections for management purposes (USDA Forest Service 2003a). Zone 1 is located above Fossil Springs where stream flow is intermittent. In this area riparian vegetation is sparse and low in diversity with scattered Arizona sycamores (*Platanus wrightii*) dominating the riparian trees. Riparian trees generally show a good age class distribution. The understory is comprised mostly of upland species and is very sparse. Zone 2 consists of the intact riparian corridor from Fossil Springs to the Diversion Dam. Species diversity of riparian tree species is high and with a good age class representation. Fossil Springs Botanical Area is located within this zone. Ash (*Fraxinus velutina*), alder (*Alnus oblongifolia*) and Arizona walnut (*Juglans major*) dominate the riparian areas above the dam (Sayers 1998). Other tree species occurring throughout the riparian area are boxelder (*Acer negundo*), Arizona sycamore, willow (*Salix* sp.) and netleaf hackberry (*Celtis reticulata*). Grasses and ferns are the second most prominent group of plants in this zone, followed by shrubs and other herbaceous vegetation. The understory above the Fossil Springs Diversion Dam also contains a variety of shrubs, including chokecherry (*Prunus virginiana*), New Mexico locust (*Robinia neomexicana*) and smooth sumac (*Rhus glabra*). Introduced and invasive blackberry is increasing and becoming more dominant, especially at several of the spring sources (pers. comm. Cecilia Overby to Michele James).

Below the Fossil Springs Diversion Dam begins the compromised riparian zone, impacted by water diversion from the streambed since the construction of the dam in 1916. Zone 3 begins below the Fossil Springs Diversion Dam, where the substrate type shifts to a higher percentage of bedrock and although there is some deposition of alluvium, there is little soil to support understory vegetation (Sayers 1998). In this zone overstory dominance shifts to Arizona sycamore (Goodwin 1980). Other dominant tree species below the dam are velvet ash, Arizona alder and cottonwood (*Populus fremontii*) (Sayers 1998). Of lesser dominance are boxelder (*Acer negundo*), willow (*Salix* sp.) and netleaf hackberry (*Celtis reticulata*). Tree cover is higher than above the dam and mature trees represent the majority in the age class distribution (Goodwin 1980; Sayers 1998). The reach contains no shrubs. Grasses and ferns comprise the majority of the understory while herbaceous vegetation is the least dominant life form (Sayers 1998). Zone 4 begins below the Irving Power Station and ends downstream at the beginning of the "narrows". In this zone, well developed riparian vegetation occurs only in association with springs (Goodwin 1980). The substrate in this zone consists mostly of bedrock but localized sand bars support extensive cottonwood reproduction (Goodwin 1980). Zone 5 includes the narrows and the riparian area downstream to the confluence with the Verde River. The narrows consist of a narrow canyon with sheer walls and little stream banks. Therefore, this section of the creek supports little or no riparian vegetation (Goodwin 1980). Past the narrows, the floodplain broadens and becomes less steep. Within one-half mile of the Fossil Creek confluence with the Verde River, riparian vegetation becomes sparse and poorly developed, likely due to a large cobble/small boulder component in the substrate adjacent to the channel and the increased potential of flooding (Sullivan and Richardson 1993). At the confluence with the Verde River, widely scattered ash, hackberry and sycamore characterize the riparian area. These trees are widely scattered and only near the Childs Power Plant a good stand of deciduous trees is present (Sullivan and Richardson 1993). Downstream from the Fossil Creek confluence the floodplain is broad and dominated by seep willow (*Baccharis salicifolia*). Emergent vegetation is lacking and the overall vegetation density is low (Sullivan and Richardson 1993).

Stehr Lake was once a 23-acre regulating reservoir which has now been reduced to 3 acres of surface water due to sediment accumulation and dense growth of emergent vegetation such as cattails (*Typha* sp.) and Torrey's rush (*Juncus torreyi*). Currently, cattails occupy 13 acres of the former reservoir bordered by Torrey's rush. The northeast part of the lake is beginning to dry up and the cattails and rushes are replaced by drier site riparian vegetation. Deciduous hardwoods are scattered throughout and the lake is surrounded by willows, ash, mesquite, cottonwoods, walnuts, shrubs and grasses (USDA Forest Service 2000).

In addition to Fossil Creek, Stehr Lake, and the Verde River, there are several other riparian areas within the Fossil Creek fifth code watershed. Deciduous riparian vegetation has been documented from Calf Pen Canyon, Sandrock Canyon, Tin Can Draw, Mud Tanks Draw, Boulder Canyon, Sally May Wash, Stehr Lake Wash, and Hardscrabble Creek. Only Stehr Lake Wash has perennial flows, all others are intermittent streams (USDA Forest Service 2003a). Outside of the many springs associated with Fossil Springs and the stream corridor, there are 13 other springs located within the uplands of the Fossil Creek Planning Area. Ten of these springs have been assessed for riparian condition. Of these, six support riparian vegetation, and six have perennial flow.

Rare Plants

Numerous plant surveys at Fossil Springs and along Fossil Creek have not yet documented the presence of threatened, endangered or sensitive plants (Baker

Engineering 2002b). Table 11 summarizes the rare plant species have been determined to have potentially suitable habitat within the Fossil Creek Plannning Area:

Table 11. Forest Service sensitive or listed plant species with potential suitable habitat within the Fossil Creek Planning Area (USDA Forest Service 2003a).

Species	**Status**
Aravaipa Sage (*Salvia amissa*)	Sen
Arizona Agave (*Agave arizonensis*)	ESA – E
Arizona Giant Sedge (*Carex ultra*)	Sen
Gila Rock Daisy (*Perityle gilensis var. salensis*)	Sen
Hualapai Milkwort (*Polygala rusbyi*)	Sen
Tonto Basin Agave (*Agave delmateri*)	Sen

ESA = Endangered Species Act, E = endangered; Sen = Forest Service Sensitive

Several other Forest Service sensitive species previously considered as having potential to occur in the Fossil Creek watershed have been removed from the list because no suitable habitat is found in the area or the Fossil Creek Planning Area is outside of their known distribution range; these are Chihuahua sedge, *Carex chihuahuensis,* Eastwood alumroot, *Heuchera eastwoodiae,* Flagstaff penstemon, *Penstemon nudiflorus,* and mapleleaf false snapdragon, *Mabrya acerifolia* (Baker Engineering 2002b).

Exotic Species/Noxious Weeds

Formal inventories for noxious weeds have been conducted only for the Fossil Creek Planning Area. The Fossil Creek Database has documented 42 plant species considered invasive for the Coconino and Tonto National Forests (USDA Forest Service 2003a, Table 12). No formal inventories have been conducted for the Fossil Creek firth code watershed. Since the watershed is managed by the Forest Service, noxious weed control will follow the U.S. Department of Agriculture Forest Service Guide to Noxious Weed Prevention Practices, which provides a comprehensive directory of weed prevention practices for the Forest Service to use in planning and wildland resource management activities (Baker Engineering 2002c).

Several cultivated plants are documented from the Fossil Creek Planning Area including figs (*Ficus carica*), sycamore maple (*Acer pseudoplatanus*), tree-of-heaven (*Ailanthus altissima*), bird-of-paradise (*Caesalpinia gilliesii*), Siberian elm (*Ulmus pumila*) and periwinkle (*Vinca major*) (USDA Forest Service 2004). These have likely been introduced by early homesteaders, still surviving in the area following abandonment (pers. comm., B. Phillips, Forest Service Zone Botanist, 2005)

Table 12. Invasive plant species documented from the Fossil Creek Planning Area (USDA Forest Service 2003a).

Scientific Name	Common Name
Aegilops cylindrica	Jointed goatgrass
Ailanthes altissima	Tree-of-heaven
Arundo donax	Giant reed
Avena fatua	Wild Oats
Bromus japonicus	Japanese brome
Bromus madritensis	Foxtail chess
Bromus diandrus	Ripgut brome
Bromus tectorum	Cheatgrass
Capsella bursa-pastoris	Shepherd's purse
Centaurea solstitialis	Yellow starthistle
Chorispora tenella	Blue mustard
Cirsium vulgare	Bull thistle
Cortaderia selloana	Pampas grass
Cynodon dactylon	Bermuda grass
Eragrostis lehmanniana	Lehmann's lovegrass
Erodium cicutarium	Redstem filaree
Festuca arundinacea	Tall fescue
Gleditsia triacanthos	Honeylocust
Hordeum murinum ssp. leporinum	Mediterranean barley (Hare barley)
Iris sp.	Iris
Lactuca serriola	Prickly lettuce
Lamium amplexicaule	Dead nettle, henbit
Lathyrus latifolius	Perennial sweetpea
Malva parviflora	Cheeseweed, little mallow
Marrubium vulgare	Horehound
Medicago polymorpha	Burclover
Melilotus officinalis	Sweetclover
Phalaris minor	Littleseed canarygrass
Plantago major	Broadleaf plantain
Prunella vulgaris	Selfheal
Rubus procerus	Himalayan blackberry
Salsola kali	Russian thistle

Scientific Name	Common Name
Solanum elaeagnifolium	Silverleaf nightshade
Sisymbrium altissimum	Tumble mustard
Sisymbrium irio	London rocket
Sonchus asper	Spiny sowthistle
Sonchus oleraceus	Sowthistle
Sorghum halepense	Johnson grass
Tamarix ramosissima	Tamarisk, Salt cedar
Tragopogon dubius	Western salsify
Ulmus pumila	Siberian elm
Vinca major	Greater periwinkle

Aquatic Habitat and Fish

Aquatic Habitat and the Fisheries Resource[7]

Mark Whitney

Aquatic habitat conditions and the associated fish communities vary along the length of Fossil Creek. Variations in habitat conditions are the result of changes in gradient, stream discharge, and stream channel substrates. The differences in fish species composition is a function of the change in habitat conditions, the influence of the Verde River fishery, both natural and man-made barriers, and introductions of non-native fish above these barriers. Personal observations and information obtained through a 2002 Forest Service stream habitat inventory provide the basis for the descriptions on fish habitat and associated species.

Aquatic habitat conditions from the springs downstream to the Fossil Springs Diversion Dam are fully influenced by and a function of, the accumulated discharge of the numerous springs. Between the springs and the Fossil Springs Diversion Dam lies a combination of cobble / small boulder riffles, shallow runs, and moderately deep pools. The fishery consists of three, and only three, native cypriniforms[8]: desert suckers (*Pantosteous clarki*), speckled dace (*Rhinichthys osculus*), and headwater chub (*Gila nigra*). All three species have been observed using the three prominent habitat types (run, riffle, pool), where the larger sized chubs are generally found in the pools. Table 13 lists all the native fish known to have occurred, or which currently occupy habitat within Fossil Creek and the associated portion of the Verde River. This table also displays species special status, occurrence within the watershed, and designated critical habitat.

Table 13. Threatened, endangered, or sensitive fishes and / or their habitat expected to occur in the Fossil Creek 5th Order Watershed.

Species	Status[1]	Occurrence[2]
Colorado pikeminnow	Endangered, WC, FS-S, T-S	O Experimental, nonessential
razorback sucker	Endangered, WC, FS-S, T-S	O Critical habitat (Verde River)
Gila topminnow	Endangered, WC, FS-S, T-S	H*
loach minnow	Threatened, WC, FS-S, T-S	H* critical habitat
spikedace	Threatened, WC, FS-S, T-S	H* critical habitat
roundtail chub	WC, FS-S, T-S	O
headwater chub	WC, FS-S, T-S	O
longfin dace	T-S, T+	O
desert sucker	T-S, T+	O
Sonora sucker	T-S	O
speckled dace	T-S	O

[1]**Status:**
T-S=Tonto NF Sensitive Species (USFS 2000)
T+=Tonto NF S&G emphasis species (USFS 1985, as amended)
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 July 1999)
[2]**Occurrence:**
O=Species known to occur in the project area, or in the general vicinity of the area.
H=Species not known to occur in the project area, but whose suitable or potential habitat does.
*=Species have historically been known to occur in project area, no recent confirmation of presence.

From the Fossil Springs Diversion Dam downstream to the Irving Power Plant habitat conditions change rather dramatically. Diversion of virtually the entire ~43 cfs spring discharge leaves this stretch of Fossil Creek with only seepage flows. Seepage flow has been estimated at between approximately 0.2 and 1.5 cfs. A 22-foot high bedrock shelf in the stream channel creates a natural barrier (to upstream fish movement) approximately 1.4 miles upstream from the Irving Power Plant. This feature is approximately 2.4 miles downstream from the Fossil Spring diversion dam. A 10-foot waterfall approximately ½-mile downstream of the diversion dam apparently prevented upstream movement of green sunfish (pers. comm. Jerry Stefferud, to Michele James, June 1, 2005). Runs and pool / riffle complexes dominate the habitat types between the diversion dam and Irving. Cobble and boulder substrates are the dominant substrates found along the reach between the dam and the natural barrier. Bedrock lines the majority of the stream channel between the barrier and Irving. Historically, prior to the diversion of the spring flow, this length of the creek contained numerous travertine dams that formed very large and deep pool habitats. Today, only remnants of these travertine dams can be seen. Small travertine dams are present just downstream of the diversion dam. A calcite (travertine) layering covers and binds much of the gravel / cobble substrates along this length of creek, but travertine dams are virtually nonexistent. Prior to the native fish restoration project (fall 2004), the fish community along this length of the creek was comprised of desert sucker, Sonora sucker (*Catostomus insignis*), headwater chub, speckled dace, and non-native green sunfish (*Lepomis cyanellus*). The native fishes (suckers, chub, and dace) comprised the greater majority of the fish numbers nearer the diversion dam; whereas, the sunfish were more dominant nearer to Irving.

An estimated 5.5 cfs is returned to the stream channel downstream of the Irving Power Plant. Combined with the ~1.5 cfs seepage flow in the stream channel upstream of the Irving Power Plant, the ~5.5 cfs flow returned from Irving brings the total flow downstream of Irving to ~7 cfs. This increased flow has resulted in the formation of travertine dams from Irving to about three-quarters of a mile downstream of the 708 Road crossing. Some of these travertine dams are three to four feet in height, and all of them form long runs / shallow pools that intermix with low gradient riffles and deep bedrock pools. The stream channel adjacent to the Irving Power Plant contains another bedrock shelf that drops an estimated 14 feet into a large pool below. This bedrock shelf (natural barrier) marks the upstream extension of the non-native smallmouth bass (*Micropterus dolomieui*), and is possibly the transition point between the occurrence upstream of the headwater chub and the occurrence downstream of the roundtail chub (*Gila robusta*) (note: this was the condition prior to the native fish restoration project, fall 2004). In addition to the bass and chub, the fish community includes the desert and Sonora suckers, and green sunfish. The larger bass, chub, suckers, and sunfish tend to inhabit the calmer waters found in the runs and deeper pools; whereas, the smaller sized bass and the mid to large size classes of the two suckers can typically be found using the riffles. The two suckers also make use of the plunge areas on the downstream side of the travertine dams. Smaller size classes of the native species are not usually found within this length of Fossil Creek.

From that point downstream of 708 Road crossing (mentioned above) to the Verde River confluence, stream habitat types are a mix of runs, riffles, and pools. The riffles tend to be medium to high gradient, and appear to comprise the greater majority of the length of this stretch of the creek. Several sizable pools are found, but only a few exceed depths of greater than six feet. It is suspected that the upstream end of this reach contains a greater abundance of the native fish species than the downstream end nearer the Verde River. The native longfin dace (*Agosia chrysogaster*), and the non-native piscivorous[9] flathead catfish (*Pylodictis olivaris*) and yellow bullhead (*Ameiurus natalis*) were collected during a 1994 through 1996 Arizona Game and Fish Department fish survey near the Verde River confluence (Roberson et al. 1996). Continued existence of the longfin dace is questionable given occupancy by the catfish and bass species.

Fish

Allen Haden and Jane Marks

Introduction

Native fish are among the most threatened groups of organisms in the southwest, primarily because of water diversions and the introduction of nonnative fish. Over half of Arizona's fish are listed as endangered or threatened. Fossil Creek provides an opportunity for preserving native fish because it is one of a few streams in Arizona retaining viable populations of six native fish species, including headwater chub, roundtail chub, speckled dace, longfin dace, desert sucker, and Sonora sucker.

The federally endangered razorback sucker (*Xyrauchen texanus*) was stocked into the up-stream springs of Fossil Creek (Barrett and Maughn 1995; EnviroNet 1998). Razorback suckers have not recently been collected from Fossil Creek but have been collected from Stehr Lake (Sponholtz unpublished data; Haden unpublished data) and likely no longer occur in the springs area. Fossil Creek's four non-native fish – green sunfish, smallmouth bass, flathead catfish, and yellow bullhead – are most abundant in the lower portions of the stream where they likely entered from the Verde River. Nonnative fish were one of the greatest threats to native fish in Fossil Creek (Marks et al. 2003). However, in the fall of 2004, an intensive multi-agency native fish restoration effort removed nonnative fish from the upper 9 km of Fossil Creek (using a piscicide) and constructed a fish barrier on the lower end of Fossil Creek, upstream of the confluence with the Verde River.

Two potential threats to native fish following restoration of full flows to Fossil Creek are: 1) nonnative crayfish which were not negatively affected by the piscicide treatment (See Crayfish section of this report); and, 2) the release of sediments trapped behind the diversion dam which could detrimentaly affect native fish and macroinvertebrates downstream. Studies on the effects of sediments following dam removals show mixed results. In Wisconsin streams, macroinvertebrates rebounded quickly following short-term reductions following sediment release (Stanley et al. 2002). In contrast, in western streams sediments had longer lasting effects (Wohl and Cenderelli 2000; Rathburn and Wohl 2003). In Fossil Creek, the effects of sediments will depend on the capacity of the river to transport sediments and on the hydrologic regime in the first few years following sediment release (Marks et al. 2003).

Current Trends

Fish community and distributions: We have synthesized data on the distribution of fish in Fossil Creek from several sources which collected data from a common site below the Irving Power Plant. Arizona Game and Fish Department has collected data at five different sites from1994 through 1996 (Roberson et al. 1996). Tom Jones of Grand Canyon University has also collected data on Fossil Creek fish distribution from1997 through 1998. Pam Sponholtz of the U. S. Fish and Wildlife Service provided data collected from 1999 through 2001. Cody Carter of Northern Arizona University provided snorkeling observational data from below the Irving Power Plant during 2001, and the NAU Stream Ecology and Restoration Group began conducting seasonal samples in August, 2002. Fish sampling methods included backpack electrofishing, netting in deeper pools, seine netting, and snorkeling observations. Results from the NAU surveys are reported in Marks et al. (2005a) and summarized below.

Fossil Creek retains populations of fish native to the southwestern United States. Native fishes include: large minnows - headwater chub (*Gila nigra*), roundtail chub (*G. robusta*), small minnows - speckled dace (*Rhinichthys osculus*), longfin dace (*Agosia chrysogaster*), and suckers - desert sucker (*Pantosteous clarki*), and the Sonora sucker (*Catostomus insignis*) (see the following section for an overview of these species. Non-native species have also made their way into the stream, probably moving upstream from the Verde River. Green sunfish (*Lepomis cyanellus*), smallmouth bass (*Micropterus dolemieu*), flathead catfish (*Pylodictis olivaris*), channel catfish (*Ictalurus punctatus*) and yellow bullhead (*Ameiuris natalis*) have all been found in the stream. Nonnative fish increase towards the confluence of the Verde River supporting the hypothesis that they migrated upstream from the Verde River (Table 14). The section of Fossil Creek above the diversion dam contains only native fish (Figure 8). In addition, a short (<1 km) reach immediately below the diversion dam contains only native fish. The upper limit of nonnative green sunfish is a small barrier falls (~3 meters high) roughly 1 km from the diversion dam (Figure 8). Flathead catfish, channel catfish and yellow bullhead were only found at the site closest to the Verde River in our study. Green sunfish and smallmouth bass are the most predominant nonnative fish. Green sunfish were abundant in the reach from the small barrier fall to the Irving power plant before piscicide treatment in 2004. Smallmouth bass have not been found above a barrier falls at the Irving power plant (Figure 8). The invasion of smallmouth bass has been relatively recent and rapid. Grand Canyon University began finding smallmouth bass near the bridge below the Irving Power plant in 1996. Continued monitoring by Northern Arizona University at the same sites has shown that smallmouth have since become the dominant species in this area (Figure 9). Nonnatives have the greatest impact on the smaller-sized native fish. Adult dace and juvenile chubs and suckers are less common in the presence of non-native fishes (Figure 10). In contrast to bass and sunfish the three nonnative catfish have only been observed in the lower reaches of the river.

*Table 14. Distribution (presence/absence) of native and non-native fish species in Fossil Creek Data are from NAU sampling prior to piscicide treatment (2002-2004). Distribution of headwater chub (*G. nigra*) below the diversion dam is unknown since distinguishing this species from roundtail chub (*G. robusta*) in the field is very difficult. For the purposes of this table, we follow the accepted policy that all chubs Irving Power Plant are considered roundtail chubs and those above are headwater chubs.*

Taxa	Above Diversion Dam	Dam to Irving Power Plant	Irving to confluence with Verde River
headwater chub	X	X	
roundtail chub			X
speckled dace	X	X	X
longfin dace	X	X	
desert sucker	X	X	X
Sonora sucker		X	X
green sunfish		X	X
smallmouth bass			X
yellow bullhead			X
flathead catfish			X
channel catfish			X

Figure 8. Increasing dominance of non-natives in fish community composition of Fossil Creek below Irving power plant from 1996 to 2004. Data are combined from two sites which have both been monitored by Grand Canyon University and Northern Arizona University: 1996 through 1999 are electrofishing surveys conducted by Tom Jones (Grand Canyon University); 2002 is electrofishing surveys conducted by Northern Arizona University; and, 2003 through 2004 are snorkel surveys conducted by Northern Arizona University.

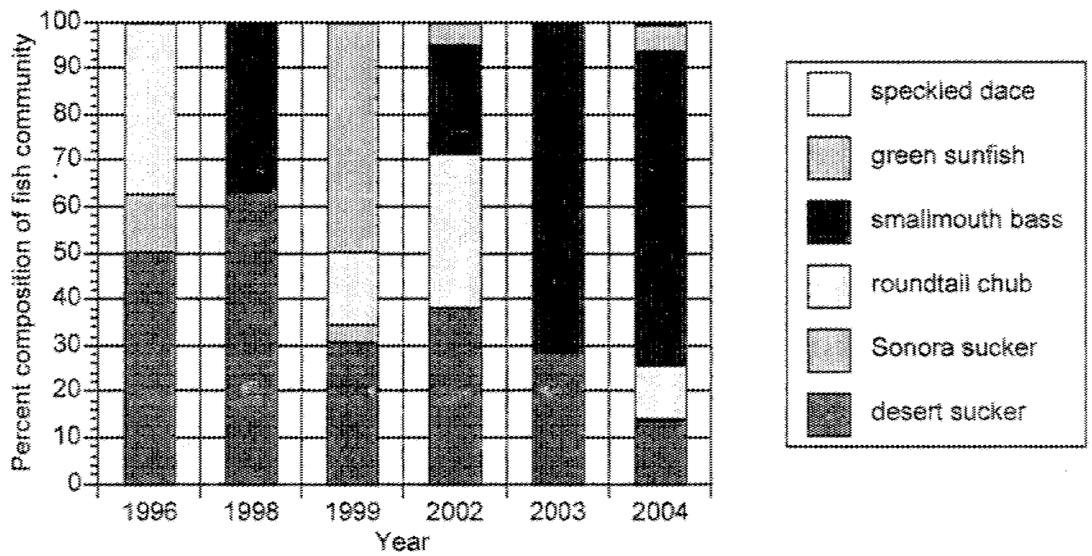


Figure 9. Fish community composition of Fossil Creek showing the increasing influence of non-native fishes downstream of the diversion dam to the Verde River. Data were collected in 2003-2004 by snorkel survey. By convention, all chubs above Irving are designated as headwater chub while all chub below Irving are roundtail chub. Figure taken from Marks et al. (2005a).

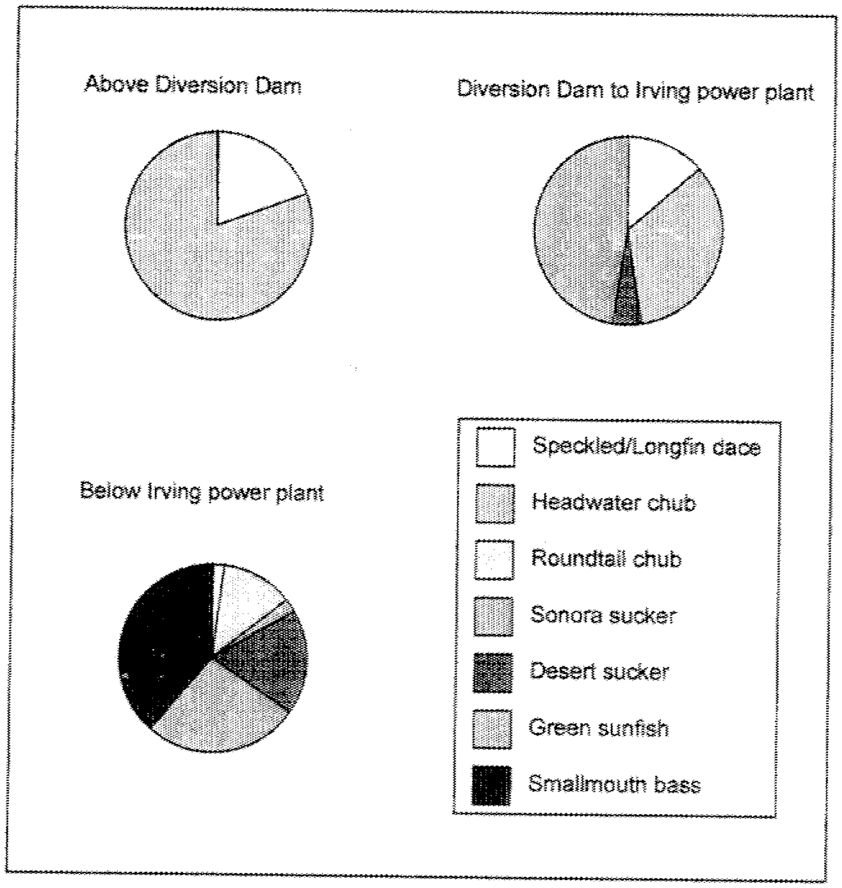
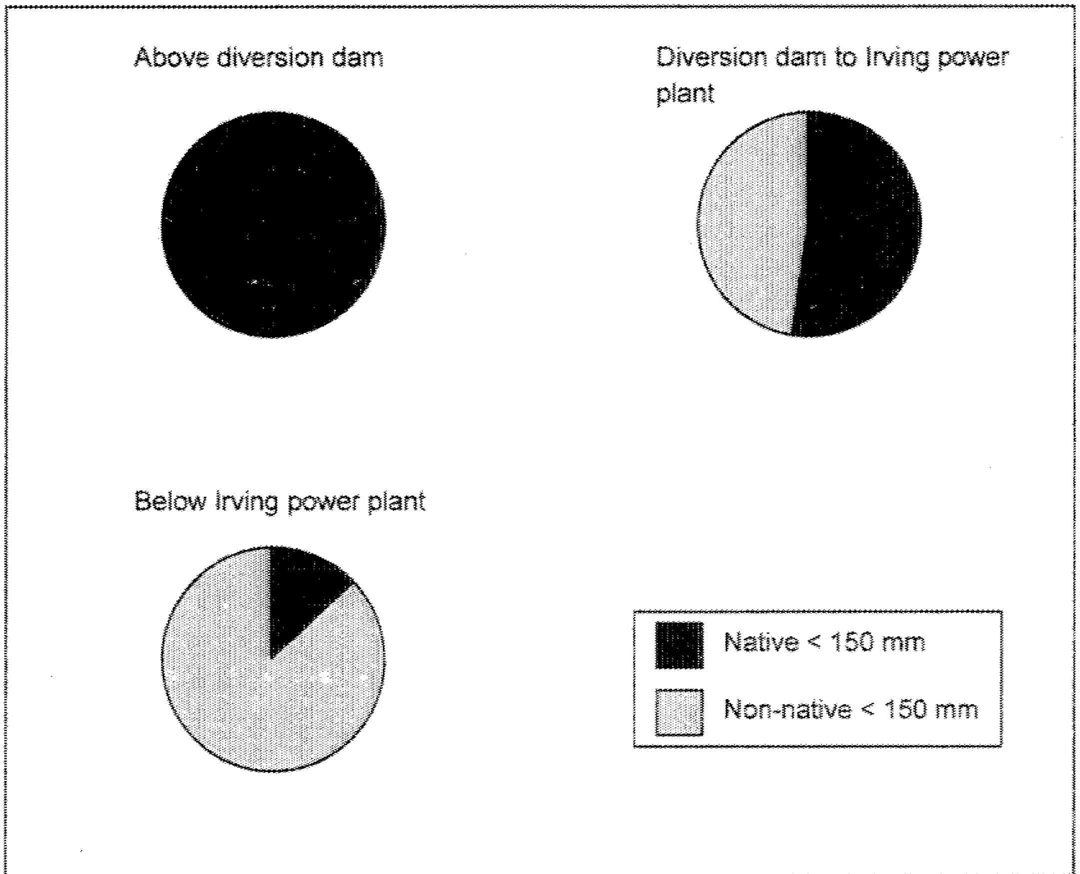


Figure 10. Fish community composition for fish <150 mm total length in Fossil Creek. Increasing relative abundance of non-native fishes is associated with a decline in small size classes of native fishes indicating poor recruitment of native fishes. Data were collected 2002-2004 by electrofishing and snorkel survey. Figure taken from Marks et al. (2005a).



Restoration Goals

1) Eradicate all nonnative fish from a 9 km reach from the diversion dam to the newly constructed fish barrier;

2) Restore and enhance the native fish population;

3) Increase recruitment of native fish; and,

4) Restore native fishes that likely ocurred pre-impoundment but have since been extirpated.

Monitoring

There is a critical need for monitoring for nonnative fish following the treatment to make sure that the constructed barrier effectively prevents upstream migration of nonnatives and to assess whether nonnatives are being transplanted back into Fossil Creek. In addition we recommend monitoring the population recovery for native fishes. Monitoring should include densities of both native and nonnative fish using the same standardized methods used in the pre-removal surveys. We expect to see an increase in native fish densities after extirpation of non-natives and with return of full flows. Research avenues that will help interpret native fish responses include quantification of invertebrate assemblages (including crayfish) and food-base standing mass, experiments studying whether native chub are able to control nonnative crayfish and stable isotope studies to test if the trophic position of native fish increases once nonnatives are removed.

Indicators

1) Presence of nonnative fish (presence shows that management objectives are not met);

2) Changes in population densities of native fish (increases show that management objectives are met, decreases show that they are not).

Special Status Fish Species' Natural History and Occurrence[10]

Mark Whitney

Information on the following threatened, endangered, and sensitive fish species is taken in part or whole from species abstracts prepared by Jerry Stefferud (Tonto National Forest Fisheries Biologist – retired) dated June 2000. This is particularly the case for those six species (roundtail chub, headwater chub, longfin dace, Sonora sucker, desert sucker, and speckled dace) identified as Tonto National Forest sensitive and management emphasis species.

Roundtail & Headwater Chubs

As moderately streamlined members of the minnow family (Cyprinidae), the roundtail and headwater chubs have a slender caudal peduncle and a deeply forked, relatively large caudal fin. Coloration of adults is silvery shading dorsally to dusky yellow or light green. Both sexes have orange-red coloration of the ventrolateral surface and on all fins except the dorsal. Both males and females possess breeding tubercles to a highly variable degree. Adult roundtails can attain 20 inches in length and two pounds in weight; whereas, adult headwater chub would be something less. Differences in fin ray counts, lateral line scale counts, and ratio of head length to caudal peduncle depth separate these two chub species.

The roundtail chub (*Gila robusta*) was included on the Regional Foresters' (USDA Forest Service – Southwestern Region) 21 July 1999 sensitive species list. Taxonomic classification for the headwater chub (*Gila nigra*) was made in 2000 (Minckley and DeMarais 2000). This classification established the distinction between the roundtail and headwater chub species. Although not officially listed as a Forest Service Sensitive Species, the status of the headwater chub, being no different from that of the roundtail, warrants the special consideration. These chub species presently occur in the Verde River Basin, which includes Fossil Creek and that portion of the Verde River associated with the analysis area. The roundtail occupies the Verde River and the lower elevation reaches of the major tributaries (Fossil Creek) to the Verde River, where the headwater chub occupies the higher elevation reaches of the tributaries.

Roundtail chub is widespread in moderate to large rivers of the Colorado River Basin. In Arizona, it still occurs in the mainstem and tributaries (Fossil Creek) to the Verde and Salt Rivers. Populations have declined considerably during the past few decades. Headwater chub are restricted in overall range to the headwater reaches of major tributaries to the Verde River.

Roundtail chub occupy cool to warmwater, mid-elevation streams and rivers where typical adult microhabitat consists of pools to eight feet deep adjacent to swifter riffles and runs. Cover is usually present and consists of large boulders, tree rootwads, submerged large trees and branches, undercut cliff walls, or deep water. Smaller chubs generally occupy shallower, low velocity water adjacent to overhead bank cover. Roundtail chub appear to be very selective in their choice of pools, as they are commonly found to congregate in certain pools, and are not found in similar, nearby pools. Spawning takes place over gravel substrate. Tolerated water temperatures range up to 80°F. Headwater chub typically use similar habitats, but existing in the headwater reaches means using smaller habitats (pools with less depth) with cooler water temperatures.

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

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

Longfin Dace

The longfin dace (*Agosia chrysogaster*) is a small, silvery minnow (Family: Cyprinidae) that seldom exceeds 4 inches in length. Its mouth is slightly subterminal, and there is a minute barbel present on each side of the upper lip. Coloration is usually dark gray above and white below. Sides are sometimes silvery or with a dark, lateral band terminating in a black spot at the base of the caudal fin. Breeding males develop nuptial tubercles on head and fins, and may have some yellowing of lower parts and bases of paired fins.

The longfin dace occurs naturally in the Yaqui, Magdalena, Sonoyta, Gila, and Bill Williams drainages, and has been introduced into the Virgin and Mimbres rivers. It ranges from low, hot, sandy-bottomed desert streams to clear, cooler brooks in the lower reaches of the conifer zones. It is rarely abundant in larger streams, or at elevations above 5,000 feet.

It is usually found in waters less than 0.6 feet deep, with moderate velocities (1.1 feet/second) over pebble/gravel/sand substrate. Water flow is typically smooth and laminar. It has a tendency to remain in open, shallow areas throughout much of the day. The fish is highly opportunistic, moving rapidly into flowing water during periods of high precipitation and runoff to travel amazing distances in relatively short periods of time. During desiccating conditions, longfin dace persist beneath moist debris and algal mats throughout the day, then become active at night when meager flow returns. Adults tend to congregate in shaded, deep areas when water temperatures exceed 75° F. Thermal mortalities of longfin dace have rarely been observed.

Longfin dace is an opportunistic omnivore, consuming primarily insects when the preferred taxon[11] (baetid mayflies) is abundant, but consuming primarily algae when mayfly abundance is low. Other foods include detritus and zooplankton.

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

Desert Sucker

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

Desert suckers occur in the Bill Williams, Salt, Gila, San Francisco, and Verde River drainages in Arizona and New Mexico. They are characteristic of small to moderately large streams, at elevations of about 1,000 to 6,000 feet. They do not occur in reservoirs, and dams and diversions of free-flowing streams have diminished its range somewhat. The species is generally common throughout its range, however continuing threats of water development make its future uncertain.

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

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

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

Sonora Sucker

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

Sonora suckers are widely distributed and common between 1,000 and 6,500 feet elevation in the Gila, Verde, Bill Williams, and San Francisco River Basins of Arizona and New Mexico. It is uncommon in the upper Santa Cruz River in Arizona. Except in Aravaipa Creek, it has been extirpated from the San Pedro River in southern Arizona and northern Sonora, Mexico. The species is intolerant of reservoir conditions. Dams and diversions of free-flowing streams, water pollution, and sedimentation of streams have diminished its range, and the status of the species is uncertain.

Sonora suckers are characteristic of gravelly or rocky pools of creeks and rivers. It can be found in a variety of habitats from warm water rivers to trout streams. Adults tend to remain near cover in daylight, but move to runs and deeper riffles at night. Young Sonora suckers typically live in runs and quiet eddies. Individuals are sedentary, exhibiting little seasonal movement and resisting downstream displacement during floods.

In Aravaipa Creek, it commonly inhabits pools greater than 1 foot deep with slow current (1.0 feet/second), and with sand/gravel substrate. Information on temperature tolerances, or other habitat preferences has not been obtained.

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

Spawning begins in February and extends till July. Eggs are deposited in riffles, and fall into the interstices between gravel particles where they incubate. Larval fish appear within a few days. Areas where suckers have been spawning may often be identified as elongated patches of "cleaned" gravel on riffles, marking the places where algae-covered bottom materials have been shifted about. Spawning does not appear correlated with any specific pattern of stream flow or temperature. Information on age and growth has not been developed.

Speckled Dace

A small minnow (Cyprinidae), the speckled dace (*Rhinichthys osculus*) seldom achieves 3 inches in length. Its body is chunky and somewhat flattened ventrally. Its mouth is slightly subterminal, with barbels present at the sides of the upper lips. Coloration is highly variable, drab olivaceous with patterns ranging from large black blotches on the body, through a single or double lateral band, to almost unicolored (darker above, lighter below). Breeding males with brilliant red on bases of paired fins and on body near those fins, on and near anal fin base, the lower caudal lobe, the mouth, and near the upper part of gill cleft.

The species is the most ubiquitous freshwater fish in the western United States, naturally occurring in all seven major drainages. In Arizona, it exists in at least two major body forms, a small, highly-speckled or blotched, chubby-bodied kind in the southern part of the Gila River system, and a larger, banded or unicolored, more streamlined kind in larger rivers and creeks to the north of the Mogollon Rim. It has been extirpated from the San Pedro River in southern Arizona and northern Sonora, Mexico, but still exists in Aravaipa Creek. It has a proclivity for small, headwater streams, often occurring in spring streams and other waters isolated by many miles of dry streambed from larger streams. This species is presently rare below about 5,000 feet elevation, but once occurred in the larger streams below that level.

The speckled dace is a bottom dwelling species that inhabits shallow, rocky, headwater streams with relatively swift flow, sometimes in areas with considerable aquatic vegetation. It is found in riffles that are about 0.5 feet deep, with water velocities of about 1.3 feet/second over pebble/cobble substrate. Adult speckled dace appear quite capable of maintaining position in streams during flash flooding, but young are carried downstream, often to their deaths in pools that later desiccate. Individuals can persist, however, for amazing periods of time in intermittent pools, although greatly crowded, diseased, and starving. Rapid, overall responses to high runoff have been recorded, in which the fish was essentially extinct during years of low discharge, but when conditions improved enjoyed high reproductive success and became abundant. Although it can acclimate to temperatures as high as 98° F, the species has a relatively low tolerance for elevated temperatures and reduced oxygen, which accounts for its peak abundance in relatively swift, moderately sized, pool-and-riffle creeks between 5,000 and 10,000 feet elevation. Preferred water temperature appears to be around 60° F.

Breeding adults seem to prefer swifter water, particularly the males, and in the late winter and early spring both sexes sometimes are numerous in swirling waters behind stones or other obstructions in the swiftest riffles. Spawning occurs in spring and again in late summer. Reproductive period is regulated by photoperiod. A single late summer flood will induce spawning whereas the same event in early summer does not. Breeding fish seek swift water where the males build the nests by cleaning the gravel clear of bottom debris and algae. Numerous males attend one female. Territoriality is exhibited with the male defending the nest. The eggs are demersal and adhesive, hatching time is six days at 65° F, and the larvae remain in the gravel interstices for about seven to eight days.

Speckled dace feed principally on benthic insects, but also takes algae, other aquatic invertebrates, and detritus.

Colorado Pikeminnow

The Colorado pikeminnow (*Ptychocheilus lucius*) was Federally listed as an endangered species, on the Endangered Species List, on March 11, 1967 in Federal Register Vol. 32 (p.4001) (USDI 1967). On July 24, 1985, the Salt River from Roosevelt Dam upstream to U.S. Highway 60 bridge and the Verde River from Horseshoe Dam upstream to Perkinsville were designated as locations for experimental, non-essential populations of Colorado pikeminnow (Federal Register 50(142):30188), meaning that their loss would not appreciable reduce the survival of the species in the wild. Those areas were subsequently stocked with the species.

The pikeminnow was once common throughout the Colorado River system, including the Gila River Basin, but natural populations are now found only in scattered areas of the upper Colorado River system in Utah, Colorado, and New Mexico (USDI 1991d). Colorado pikeminnow are believed to have ranged in the Verde River[12] up to Perkinsville, Arizona. This belief is based on bone samples taken from an archaeological site near Perkinsville (Minckley and Alger 1968). No other historic information is available to indicate Colorado pikeminnow inhabitance of the Verde River, or its tributaries within or adjacent to the Coconino National Forest (Minckley 1993).

The Colorado pikeminnow is characterized as a "big river" generalist species, occurring in turbid, deep, and strongly flowing water. However, small individuals occupy shallow backwater areas with little or no current and silt/sand substrates. Spawning occurs from early July through about mid-August, and coincides with rising water temperature and decreasing flow. Eggs are broadcast over gravel and cobble substrates in riffles or rapids. Juveniles feed primarily on insects and crustaceans, while individuals over 8 inches feed principally on fish (Minckley 1973).

Historically, the Colorado pikeminnow was the top fish predator in the Colorado River Basin, relying almost exclusively on other fishes for food once they grew past a few inches in length. The species can make migrations of several hundred kilometers to spawn in very specific canyon-like habitats. Following hatching, larvae drift downstream with the currents for up to hundreds of kilometers before settling in backwaters and initiating feeding (Tyus 1990).

The near extinction of this species is due to a combination of factors, the largest being those associated with the construction of dams for flood control, irrigation, and power development. Dams throughout the historic range of Colorado pikeminnow have altered stream morphology, flow patterns, temperatures, water chemistry, and silt loads. The dams also present migration barriers that prevent access to spawning areas.

The free flowing nature of the Verde River may provide a good opportunity for the reintroduction and/or recovery of pikeminnow in the lower Colorado River Basin. Baseline conditions of the Verde River are considered relatively good in the upper reaches above Sycamore Creek and the lower reaches below Beasley Flats (Sullivan and Richardson 1993). Habitat modifications such as stream diversions, urban development, impacts to riparian vegetation, and the predominance of nonnative fish species limit the recovery potential for the pikeminnow along the middle portion of the Verde River.

Since 1985, extensive reintroductions of hatchery-raised Colorado pikeminnow have been made into the Salt and Verde River systems. Colorado pikeminnow, although stocked annually in the Verde River near Childs, have never been captured in Fossil Creek, although in theory the species could enter lower reaches if a suitable native fish prey base reestablishes. Returns from these stocking efforts have been poor (Hendrickson 1993).

Razorback Sucker

The razorback sucker (*Xyrauchen texanus*) was Federally listed as endangered, under the Endangered Species Act, on October 23, 1991 (Federal Register 56(205):54957). Critical habitat was designated on March 21, 1994 (Federal Register 59(54):13374) and includes portions of the Verde, Gila and Salt Rivers. Designated critical habitat in the Verde River extends from Horseshoe Reservoir upstream to Sullivan Lake (USDI 1994c). This species was once common throughout the Colorado River Basin, but now exists sporadically in only about 750 miles of river in the upper basin. In the lower basin, a substantial population exists only in Lake Mohave with occasional individuals occurring both upstream in Lake Mead and the Grand Canyon and downstream in the mainstem and associated impoundments (USDI 1991c).

Razorback suckers are believed to have ranged in the Verde River mainstem up to Perkinsville, based on bone samples taken from the same archaeological site as that mentioned for Colorado pikeminnow. Razorback suckers persisted in the Verde River near Peck's Lake until 1954 (Minckley 1973). There is no evidence of razorback suckers inhabiting any tributaries on the Forest, but it is speculated they may have occasionally used the lower reaches of the larger tributaries.

Razorback suckers have been stocked in numerous locations in the Gila, Salt and Verde River Basins in an attempt to recover the species. Early stocking sites on the Forest included the Verde River below Camp Verde, Fossil Creek, Oak Creek, and West Clear Creek. Reintroduction of razorback suckers into the Verde River was initiated in 1981. Returns from these early reintroduction efforts were poor. Razorback suckers were stocked above the Fossil Springs Diversion Dam in 1989 and survived for several years, but may no longer occur in Fossil Creek (Barrett 1992, Hendrickson 1992, 1993).

Information on habitat of razorback sucker is limited. Except for spawning migrations, razorback suckers are fairly sedentary, moving relatively few miles over several months. They tend to occupy strong, uniform currents over sandy bottoms, eddies and backwaters lateral to the river channels, and sometimes concentrating in deep places near cut banks or fallen trees. During spawning season, razorback suckers are found in runs with coarse sand, gravel, and cobble substrate, flooded bottom lands, gravel pits, and large eddies formed by flooded mouths of tributary streams and drainage ditches. Habitat needs of young and juvenile razorback suckers in the wild are largely unknown because researchers rarely encounter them. The diet of razorback suckers consists of midge larvae, planktonic crustaceans, diatoms, filamentous algae, and detritus.

Declines in razorback sucker populations are largely attributed to habitat modification due to water development projects similar to those described for the pikeminnow. Thus, the few remaining unaltered rivers (e.g. the Verde River) and their tributaries are vital to the continued existence of razorback sucker. Razorback suckers are also threatened by the presence of non-native species.

Gila Topminnow

The Gila topminnow (*Poeciliopsis occidentalis occidentalis*) was federally listed as a endangered species, on the Endangered Species List, on March 11, 1967 (32 FR 4001). The Gila topminnow is a small member of the livebearer family, Poeciliidae. Males seldom exceed one inch in length and females two inches. Coloration is tan to olive on the body and usually white on the belly. Scales on the dorsum are darkly outlined, and the fin rays are outlined with melanophores[13], although lacking in dark spots. Breeding males are impressively blackened. Gonopodium[14] of male reaches past snout when in copulatory position. Gila topminnow is similar in appearance to western mosquitofish (*Gambusia affinis*).

Historically, Gila topminnow occurred throughout the Gila River system in southern Arizona and at the Frisco Hot Springs on the San Francisco River in New Mexico. It also occurred in most river systems through the State of Sonora, Mexico as far south as the Rio Mayo. Natural populations continue to persist in 12 sites in Arizona, and persist in several Sonoran watersheds. Recovery of the species has included introductions into approximately 175 historic and non-historic habitats across the State. These introduced populations exist in small streams and ponds in Santa Cruz, Graham, Gila, Pinal, Pima, Maricopa, Yavapai, and La Paz Counties, Arizona. Only 18 of the 175 introduced populations persist today. Fossil Creek was one of the non-historic introduction sites stocked with Gila topminnows in 1967 and 1969. This stocking of Gila topminnows into Fossil Creek has been deemed unsuccessful (Bagley et al. 1991 *in* undated paper by T. Cain, former Coconino National Forest Fishery Biologist).

Habitat requirements of Gila topminnow are fairly broad; it prefers shallow, warm and fairly quiet waters, but can adjust to a rather wide range, living in quiet to moderate currents, depths to three feet, and water temperatures from constant 80°F springs to streams fluctuating from 43-99°F. The species lives in a wide variety of water types; springs, cienegas, marshes, permanent or interrupted streams, and formerly along the edges of large rivers below 4,500 feet in elevation. Preferred habitat contains dense mats of algae and debris, usually along stream margins or below riffles, with sandy substrates sometimes covered with organic mud and debris. Gila topminnow also live in a fairly wide range of water chemistries, with recorded pH levels from 6.6 to 8.9, dissolved oxygen readings from 2.2 to 11 parts per million, and salinities from tap water to sea water.

Gila topminnow food habits are generalized and include bottom debris, vegetative materials, amphipod crustaceans and insect larvae, including mosquitoes.

The mode of reproduction in Gila topminnow is internal fertilization of the eggs with internal development of the young. The young are born alive. Onset of breeding and brood size is affected by water temperature, photoperiod, food availability, and predation. In constant warm temperature springs, breeding takes place year-round, whereas in fluctuating habitats, breeding occurs from April to August. Brood size varies from 1 to 20 young, and two broods are carried simultaneously by the female, one much further developed than the other. Gestation period is 24 to 28 days. Topminnow life span is approximately one year.

The species is declining due to the introduction and spread of exotic predatory and competitive fishes, water impoundment and diversion, water pollution, groundwater pumping, stream channelization, and habitat modification. The topminnow has been declining since the late 1800s. The loss of aquatic habitats in the southwest, due to man's activities, has been well documented. The Gila River system contains only a small fraction of its pre-1860 aquatic habitat. Major rivers were essentially perennial streams with stable channels and expensive lagoons, marshes, and backwaters. The many springs, marshes, cienegas, and backwaters formed the primary habitat for the topminnow. Channel downcutting, damming, and other manmade changes have lowered water tables changing the habitat structure of rivers and streams (U.S. Fish & Wildlife Service website – species abstract).

Loach Minnow

The loach minnow (*Rhinichthys {=Tiaroga} cobitis*) was Federally listed as a threatened species, under the Endangered Species Act, on October 28, 1986 (USDI 1986b). U.S. Fish and Wildlife Service approval of the species' recovery plan came in September 1991 (USDI 1991b). Loach minnow critical habitat was designated in 1994 (USDI 1994a), and subsequently rescinded (USDI 1998) in response to a District Court ruling on the need for analysis under the National Environmental Policy Act (NEPA). Completion of the necessary NEPA analysis resulted in the most recent designation of critical habitat (USDI 2000). In contrast to the 1994 designated critical habitat, the 2000 designation now includes segments of the Verde River, Oak Creek, Beaver/Wet Beaver Creek, West Clear Creek, and Fossil Creek. These stream courses drain National Forest lands administered by the Coconino National Forest. Critical habitat designated along Fossil Creek extends from the creek's confluence with the Verde River upstream for approximately four and seven-tenths (4.7) miles. Designated critical habitat along the Verde River extends from its confluence with Fossil Creek upstream to the Verde River / Granite Creek confluence on the Prescott National Forest (USDI 2000).

Loach minnow inhabit turbulent, rocky riffles on mainstem rivers and tributaries up to 7,200 feet in elevation. Most habitat occupied by loach minnow is relatively shallow, has moderate to swift current velocity over gravel/cobble substrates. It has been observed that the depth, velocity, and substrate of occupied habitats vary by fish age/size, seasonally, and geographically. Co-occurring native fish that inhabit riffle habitats occupied by the loach minnow are the speckled dace and the desert sucker (USDI 1991b).

Historically, loach minnow were locally common throughout much of the Gila River Basin of Arizona and New Mexico. Loach minnow distribution in Arizona included the Gila, Salt, and Verde Rivers and their major tributaries. Loach minnow populations are considered to be extirpated from the Verde River Basin (Minckley 1993, USDI 2000). The last recorded collections of loach minnow, from within the Verde River Basin, were by C.L. Hubbs in 1938. These 1938 collections came from the Verde River above Camp Verde, and from Beaver Creek near its confluence with the Verde River (Minckley 1993, Girmendonk and Young 1997). Currently, the only known loach minnow populations are in the Salt, San Pedro, Gila, and San Francisco River Basins.

Since 1987, the Arizona Game and Fish Department has conducted extensive surveys of the Verde River mainstem. Since 1994, research fisheries biologists from the Rocky Mountain Research Station have monitored seven sites on the upper Verde River. Neither of these efforts has resulted in finding loach minnow. A comprehensive listing of fish collections and museum specimens from within the Verde River Basin is given in Girmendonk and Young (1997). C.L. Hubbs' 1938 collections are the only listings that include loach minnow.

Spikedace

The spikedace (*Meda fulgida*) was Federally listed as a threatened species, under the Endangered Species Act, on July 1, 1986 (USDI 1986a). U.S. Fish and Wildlife Service approval of the species' recovery plan came in September 1991 (USDI 1991a). Spikedace critical habitat was designated in 1994 (USDI 1994b), and subsequently rescinded (USDI 1998) in response to a District Court ruling on the need for analysis under the National Environmental Policy Act (NEPA). Completion of the necessary NEPA analysis resulted in the most recent designation of critical habitat (USDI 2000). In contrast to the 1994 designated critical habitat, the 2000 designation included a much longer length of the Verde River; and newly designated reaches of Oak Creek, Beaver/Wet Beaver Creek, West Clear Creek, and Fossil Creek. These stream courses drain National Forest lands administered by the Coconino National Forest. Critical habitat designated along Fossil Creek extends from the creek's confluence with the Verde River upstream for approximately four and seven-tenths (4.7) miles. Designated critical habitat along the Verde River extends from its confluence with Fossil Creek upstream to the Verde River / Granite Creek confluence on the Prescott National Forest (USDI 2000).

Spikedace inhabits riffles and runs in shallow flowing waters over gravel, cobble, and sand bottoms. The primary habitat for adults consists of shear zones along gravel/sand bars, quiet eddies on the downstream edge of riffles, and broad, shallow areas above gravel/sand bars. Larval spikedace most commonly occupy slow-velocity waters near stream margins over sand dominated substrates. Spawning habitat for spikedace occurs in shallow riffles. It has been observed that the depth, velocity, and substrate of occupied habitats vary by fish age/size, seasonally, and geographically. Co-occurring native fish that inhabit habitats occupied by the spikedace are the loach minnow, speckled dace, desert sucker, and Sonora sucker (USDI 1991a).

Neary et al. (1996) described the physical habitat parameters used by spikedace in the upper Verde River, within vicinity of the Burnt Ranch area. Spikedace were found in greatest abundance in gradients between 0.4 and 0.6 percent, velocities ranging from 55 to 85 cm/sec (1.8-2.8 ft/sec), and in substrates of less than 10 percent sand. Depth of water appeared to have little influence on the presence or absence of spikedace. The greatest determining factor in spikedace occurrence was velocity. The species was found in only medium velocity flows, which corresponded to run and low-gradient riffle microhabitat classifications. Spikedace were absent where stream velocities averaged <50 cm/sec (1.6 ft/sec) or >90 cm/sec (3 ft/sec).

Historically, the spikedace was common and locally abundant throughout the upper Gila River Basin of Arizona and New Mexico. Its distribution was widespread in large and moderate-sized rivers and streams in Arizona, including the Gila, Salt, and Verde Rivers and their major tributaries. In the Verde River Basin, spikedace have been recorded in the lower end of WCC, in Wet Beaver Creek at the confluence with the Verde River, and also within the Montezuma Castle National Monument. The most recent occurrences of spikedace have been recorded in the upper Verde River from the headwaters downstream to the confluence with Sycamore Creek (Minckley 1993; Rinne and Stefferud – unpubl. long-term dataset – 1994 to present).

Girmendonk and Young's 1997 status review of the roundtail chub includes survey and museum collection records containing lists of fish collected from various stream reaches within the Verde River Basin. Their earliest record for West Clear Creek (WCC) is dated 1937, and notes the collection of five native fish species from a location one mile above the Verde River confluence. Spikedace were one of the five species. This reach of WCC typically dries up during the summer months, due to private land irrigation withdrawals from the creek.

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

As with loach minnow, spikedace may also be extirpated from the Verde River Basin. Until recently, spikedace were thought to persist in the upper reaches of the Verde River; however, formal monitoring surveys over the past four years have failed to collect spikedace (pers. comm. J. Stefferud, B. Deason, J. Rinne; Rinne and Stefferud – unpubl long-term dataset – 1994 to present; and pers. obs.). During a 1999 survey (other than the formal monitoring mentioned above), a single spikedace was collected from a location along the upper Verde River (pers. comm. Mark Brouder, U.S. Fish & Wildlife Service).

Macroinvertebrates

Eric Dinger and Jane Marks

Introduction

Aquatic macroinvertebrates are a diverse group of organisms comprising primarily insects, snails and worms. In aquatic ecosystems, macroinvertebrates are important in transferring energy and nutrients contained in algae and leaf litter to higher trophic levels, both aquatic (e.g. fish) and terrestrial (e.g. arthropods, lizards, bats, and avian species). The aquatic macroinvertebrates of Fossil Creek are a vital link in sustaining the native ecosystem. Fossil Creek contains a particularly abundant and diverse collection of aquatic macroinvertebrates, and this diversity enhances the flow of energy and nutrients, because different macroinvetebrates eat different foods. Groups of invertebrates that consume specific types of food resources are categorized into "functional feeding groups". *Grazers* consume algae growing on rocks and travertine, *shredders* eat leaf litter, *collectors* feed on bacteria growing on leaves or bark, whereas *predators* feed on other insects. Healthy streams need representatives from different functional feeding groups to ensure proper cycling of energy and nutrients.

Current Trends:

Collections of aquatic macroinvertebrates in Fossil Creek have been ongoing since 2001. Beginning in 2002, we focused on quantitative surveys of pools and riffles in a select group of eight sites, including: the ephemeral pools, the springhead, and a riffle-pool area above the dam; sites immediately below the dam, above the power plant, and below the power plant; and downstream sites approaching the confluence of with the Verde River. Detailed descriptions of the sample sites and macroinvertebrate distributions across sites and seasons are presented in Marks et al. (2005a) and summarized below.

The diversity of macroinvertebrates in Fossil Creek is high compared to other southwestern streams (Table 15). To date, 147 macroinvertebrate species have been collected, including the endemic Fossil Springsnail (*Pyrgulopsis simplex*) and the Page Springs caddisfly (*Metrichia nigritta*) which has only been documented from Page Springs and Fossil Creek. Other surveys of southwestern streams show limited diversity, often well below 100 species (Dinger 2001, Dinger et al. 2005). Two aspects of Fossil Creek likely contribute to this relatively high diversity: 1) the springs at Fossil Creek have remained relatively pristine, with full-flows and no exotic species, presumably due to the barrier created by the diversion dam; and 2) travertine deposition in Fossil Creek promotes diversity, because travertine areas are characterized by unique insects (for more details, see Marks et al. 2005a). However, Shannon's Diversity, an index that incorporates both diversity and eveness, indicate more "balanced" assemblages in sites above the dam (excluding the ephemeral pools). Furthermore, they indicate that travertine depositing areas, along with the Above Power Plant site are not as balanced, with certain species (especially Simuliidae black flies and Hydropsychidae caddis flies) dominating the assemblage.

Table 15. Aquatic macroinvertebrate diversity measurements for Fossil Creek.

	Species Richness	Evenness	Shannon's Diversity
Ephemeral Pools	49	0.500	0.624
Springs	51	0.617	1.243
Above Dam	55	0.662	1.399
Below Dam	77	0.432	0.905
Above Power Plant	63	0.397	0.865
Below Power Plant	69	0.597	0.935
Below Bridge	46	0.628	1.027
Near Verde	50	0.439	1.081

Macroinvertebrate diversity is slightly higher above the dam than below (Marks et al. 2005a), and species richness is highest in sites with travertine deposition (Marks et al. 2005b, [Table 2]). Macroinvertebrate species distributions, biodiversity, and community structure are reported in Dinger and Marks (2002) and Marks et al. (2005a). These baseline data will be critical for evaluating how macroinvertebrates respond to restoration.

Antimycin A[15], the piscicide used during the native fish restoration project, has minimal long-term effects on macroinvertebrates if used at low enough concentrations, around 10 ppm (e.g. Minckley and Mihalick 1981). Trial studies in Fossil Creek however, indicated that relatively high doses (50 ppm) would be needed to remove exotic fish. The, amount of antimycin A applied in the Fossil Creek restoration was harmful to macroinvertebrates, causing increased numbers in the drift samples, an indication of mortality and stress. We are in the process of estimating the short term effects of this disturbance and the long term recovery rates (Dinger and Marks, unpublished data.). Both the Fossil Springsnail and the Page Springs caddisfly are concentrated above the diversion dam and were probably not affected by the antimycin treatment which was applied downstream of the Fossil Springs Diversion Dam.

Restoration Goals

Macroinvertebrates are vital to the successful restoration of Fossil Creek for two reasons. First, the native macroinvertebrate assemblage in Fossil Creek has intrinsic value due to

its high biodiversity, including its two endemic species, distinct travertine community, and overall higher diversity compared to other southwestern streams (Marks et al. 2005b; Dinger and Marks 2002; Marks et al. 2003). Second, the reestablishment of a healthy aquatic macroinvertebrate assemblage is necessary for recovery of the native fish, because our ongoing stable isotope studies indicate that macroinvertebrates are a key food resource for native fish.

Monitoring

Monitoring invertebrates following flow restoration is an essential component of documenting food web and ecosystem recovery (Stanley et al. 2002). The pre-treatment data we have already gathered sets the stage for assessing the impacts of restoration activities on macroinvertebrate densities, assemblages, and distributions. We advocate repeating the sampling we have already conducted, using the same methods, and focusing on the same sites, using pre-restoration data and above diversion dam sites as controls. Future monitoring should focus on documenting changes in composition and distribution, particularly monitoring the characteristic assemblages we have already described and the species of concern we have identified (see Indicators, below).

We expect that flow restoration will promote macroinvertebrates by creating habitat directly, increasing the area of pools and riffles, and also indirectly, by promoting travertine deposition (Marks et al. 2005b). Increased flow should also enhance dispersal of invertebrates currently restricted to areas above the dam. Removal of exotic fish should also promote macroinvertebrates, by releasing them from predation pressure. On the other hand, the chemical treatment was detrimental to macroinvertebrates (Dinger and Marks, unpublished data), so monitoring their recovery will be important.

Indicators

Macroinvertebrate assemblages in Fossil Creek differ between areas above and below the dam, and between zones with and without travertine deposition. These distinct assemblages likely result from the refuge from exotic fish found above the dam, and from the unique chemical and physical characteristics of travertine, which provides important habitat for some species of macroinvertebrates. By removing exotic fish and enhancing travertine deposition, restoration should promote these characteristic macroinvertebrate assemblages. Thus, persistence and expansion of these characteristic assemblages of macroinvertebrate species will likely be the best indicators of recovery of aquatic macroinvertebrates in Fossil Creek. For example, comparing assemblages in newly-formed travertine zones to the current, remnant travertine will indicate whether returning flow helped promote native macroinvertebrate assemblages.

There are, however, certain species that should be specifically monitored and used as indicators of success or failure based on issues of concern. These include the endemic Fossil Springsnail and the Page Springs caddisfly which occur in few places and at low densities in Fossil Creek (Marks et al. 2005a). Flow restoration could increase dispersal of the Fossil Springsnail, enabling it to colonize new spring habitats along the length of Fossil Creek. In springs that currently harbor springsnails, the increased flows may increase gene flow among populations. This should be monitored. Also of concern is an exotic freshwater clam from Asia, *Corbicula fluminea*, which was initially found in lower reaches of Fossil Creek, but may be actively moving upstream. Increased flow due to restoration can be expected to mitigate their migration due to potentially higher velocities washing more of them downstream, but this also should be monitored.

Leaf Litter Decomposition

Carri LeRoy, Cody Carter and Jane Marks

Introduction

Leaf litter subsidies to aquatic ecosystems provide large quantities of energy in headwaters streams with low levels of primary productivity (Peterson and Cummins 1974; Vannote et al. 1980; Wallace et al. 1999). Leaf processing capacities in streams are controlled by two main factors: 1) litter inputs (litter quality, quantity and timing); and, 2) physical differences among streams (Webster and Benfield 1986). The energy provided by leaf litter inputs is important for the production of stream invertebrates and is transferred up the trophic chain to fish and riparian predators (e.g. spiders, birds, lizards) which often depend on aquatic insects during some of their life cycle. Estimates of the importance of detritus to Fossil Creek food webs show strong dependence on terrestrial leaf litter.

Physical factors within a stream can also alter the capacity of streams to process leaf litter. Natural stream systems have been shown to repeatedly conform to the River Continuum Concept with high reliance on terrestrial inputs at high elevations and relatively more reliance on algal productivity at lower elevations (Vannote et al. 1980). Regulated rivers, on the other hand, are thought to have this continuum reset below dams (Ward and Stanford 1983) because dams disturb natural flow patterns, and the transport of organic material downstream.

Current Trends

We measured litter processing rates for two leaf litter species (*Populus fremontii* and *Alnus oblongifolia*) above and below the diversion dam to test if reduced flow impedes decomposition (LeRoy et al. 2005). Reaches within Fossil Creek also differ in the amount of travertine deposition. Travertine deposition is expected to increase following return of full flows (Malusa et al. 2003). We compared litter processing rates for two species (*Populus fremontii* and *Platanus wrightii*) directly below the Irving Power Plant, a reach characterized with travertine dams, and further downstream where travertine deposition is not sufficient to form dams (Marks et al. 2005b). Flow is similar at the two sites. Understanding how ecosystem processes differ between high and low flow areas and between sites with and without travertine dams is useful for predicting how the ecosystem will respond to increased flow.

Leaf litter decomposition rates for both Arizona alder and Fremont cottonwood are faster above the dam than directly below the dam (Figure 11). Surprisingly, leaf litter also decomposes more quickly in an active travertine deposition reach than in a non-travertine reach (Figure 12).

Figure 11. Leaf litter decomposes faster above the dam than below it. The two species did not differ in decomposition rate at either site. Letters above treatments denote signficant differences based on pairwise comparisons. Figure taken from LeRoy et al. (2005).

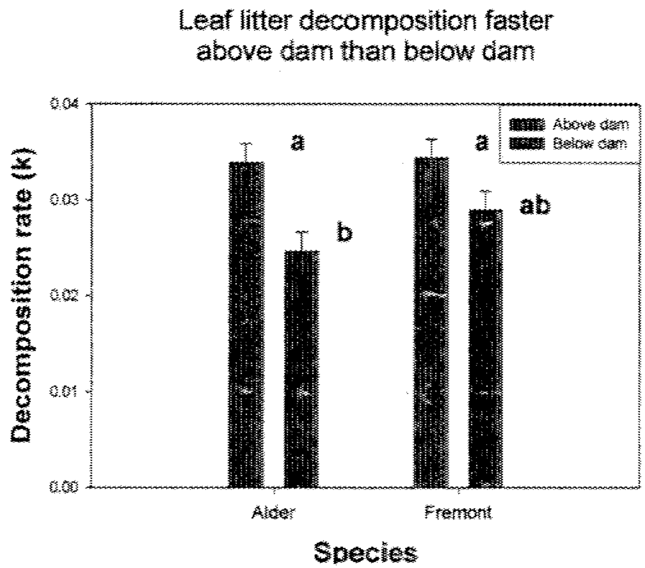
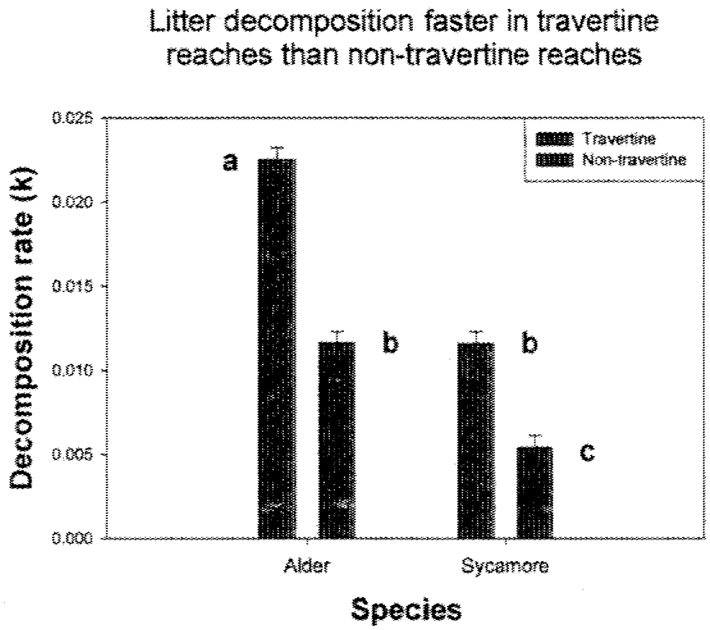


Figure 12. Leaf litter decomposes faster in travertine site relative to site further down stream. Alder decomposed more quickly than sycamore at both sites. Letters above treatments denote signficant differences based on pairwise comparisons. Figure modifed from Marks et al. (2005b) and Carter (2005).



Restoration Goals

Because fish and other aquatic species of interest rely on functioning communities and ecosystems, quantifying how dams affect ecosystem processes and determining whether restoration of flow reverses these effects is essential for determining the full potential of restoration (Poff and Hart 2002; Hart et al. 2002; Doyle et al. 2003).

Restoration of flows to Fossil Creek should result in overall higher decomposition along the currently dewatered reach because of increased area, and will return these sections of stream to a healthier amount of detrital processing. Restoration of flows, and the associated increase in available habitat will also likely increase macroinvertebrate production, providing more prey items for predatory fishes and birds along Fossil Creek. With increased discharge along its length, Fossil Creek should support a more diverse and productive riparian forest which will increase shade cover, increase habitat for terrestrial organisms and increase terrestrial inputs into the stream. Our research provides some evidence for the importance of maintaining terrestrial tree species diversity in the riparian zone of Fossil Creek.

Indicators

1) After restoration of full flows we expect to see leaf litter decomposition rates below the dam site become more similar to rates recorded above the dam site.

2) We expect the travertine deposition zone to expand and, within this zone, we expect to see higher rates of decomposition.

We are concerned that sedimentation rates will temporarily increase when the dam is lowered and these sediment loads may cause a temporary reduction in macroinvertebrate production as well as leaf litter decomposition. We are also concerned that if macroinvertebrate populations do not recover from the antimycin treatment, leaf litter processing rates may not be as high as expected.

Crayfish

Ken Adams and Jane Marks

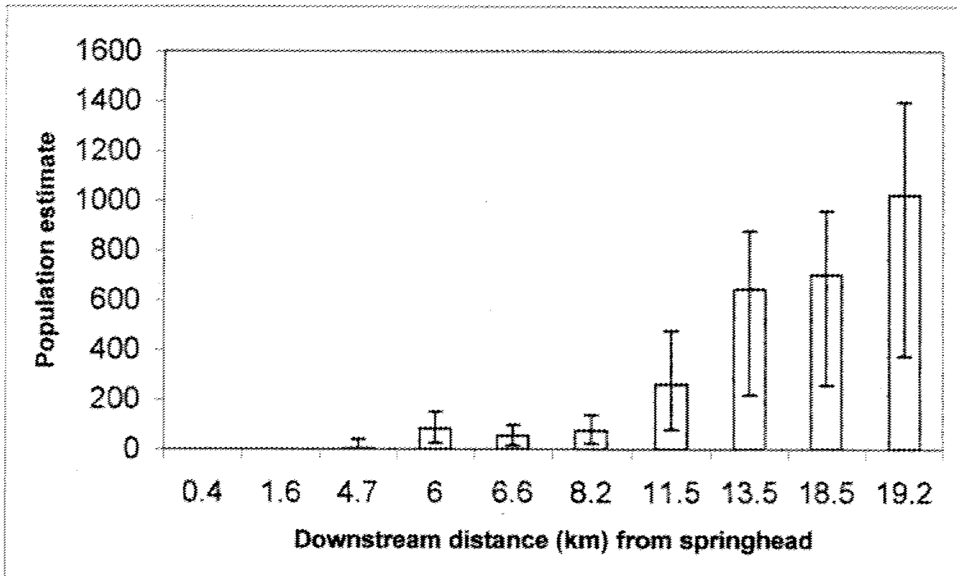
Introduction

Crayfish are notorious for invading freshwater ecosystems and initiating aggressive and complex interactions with native species (Charlebois and Lamberti 1996; Rosen and Fernandez 1996; Gamradt et al. 1997). Arizona has no native crayfish, but two exotic species were introduced by the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service in the 1970s to control aquatic weeds, for sports fish forage and as bait, *Orconectes virilis* and *Procambarus clarkia*.

Current Trends

Observations of exotic crayfish in Fossil Creek date back to the 1990s. Preliminary evidence in 2003, from trapping, indicated that the crayfish *Orconectes virilis* was migrating up-stream from the Verde River, although the population has not yet established itself close to the Fossil Springs Diversion Dam. Further evidence from a series of mark-recapture studies in 2004 substantiates these findings. The density of adult crayfish in Fossil Creek ranged from 0.05 crayfish/m^2 at a distance 4.7 km downstream of the dam to 1.17 crayfish/m^2 at a distance of 18.5 km downstream (Figure 13). The biomass of crayfish at the furthest downstream site was 4.4 grams/m^2.

Figure 13. Population numbers of crayfish from ten sites down the length of Fossil Creek using adjusted Petersen estimates of mark-recapture data. Trapping data from 2003-2004 indicate a 50% reduction in catch per unit of effort at km 6.6 in 2004, possibly due to trapping from the removal efforts of Jim Walters in 2003, although there were no significant decreases at kms 6 and 8.2.



The crayfish in Fossil Creek eat a wide range of food including leaf litter, algae, and macroinvertebrates, with a preference towards macroinvertebrates, a primary food source of fish. This indicates that the crayfish have the potential to compete with native fish populations for food. Exotic smallmouth bass eat crayfish and are likely competing with them for macroinvertebrates. Thus removal of bass could inadvertently cause crayfish densities to increase. Alternatively, restoration treatments could make conditions less favorable for crayfish if increased chub populations will prey on young-of-year crayfish.

Antimycin A, the chemical used to eradicate exotic fish does not harm crayfish. There are no approved chemical methods for eradicating crayfish. The only currently available way of removing them is through manual trapping and netting, which is labor-intensive and will reduce, but not eliminate, crayfish. The NAU Stream Ecology and Restoration Group have initiated a study to test the effectiveness of different trap types on crayfish of different size classes. In addition, we will be testing for the direct effects of crayfish on macroinvertebrates and the food base under both low and restored flow.

Restoration Goals

Although it would be ideal to eradicate crayfish, more realistic goals include:

1) Preventing crayfish from establishing populations in the upper reaches of Fossil Creek where native fish are now concentrated; and,

2) Reducing population densities in the lower reaches to maintain pre-restoration levels.

Preliminary evidence from enclosure experiments suggest that crayfish will start to have significant impacts on the biological community once they reach a density of 3 adults per square meter. A current estimate of the density of adult crayfish at the furthest downstream sites is 2 per square meter.

Both of these goals could be accomplished by vigilantly trapping as long as a trapping design targets multiple size classes. Crayfish population structure is density dependent (Momot and Gowing 1977), and many crayfish removal techniques, such as trapping, are only successful at targeting larger, older adults (Bills and Marking 1988). Crayfish removal programs are further complicated by the observation that female crayfish quickly compensate for density decreases with increased reproduction via increased egg production and vitality (Momot and Gowing 1977). In order to accomplish suppression of future population density increases, a trapping program would need to target younger size classes to prevent compensatory recruitment.

Monitoring

We recommend continued monitoring of crayfish at the sites that NAU has already established. We recommend a mark and recapture protocol over standard trapping because it gives a more accurate estimate of population size.

Indicators

1) Crayfish densities – if densities are reduced or maintained then goals will be met, if densities increase goals will not be met.

2) Crayfish range – if range does not expand then goals will be met, if range extends further up stream then goals will not be met.

3) Crayfish effects on native fish recruitment – if juvenile native fish are abundant this will indicate that crayfish are not undermining their recovery in contrast if recruitment is compromised by exotic crayfish then goals will not be met.

Terrestrial Species

Janie Agyagos and Michele James

Introduction

The Fossil Creek watershed supports over 175 known species of mammals, birds, reptiles, amphibians, and terrestrial invertebrates. Terrestrial species discussed in this section include those not discussed previously under aquatic species (birds, mammals, reptiles and amphibians, and invertebrates). The number of known species in the watershed is based on actual sightings of species. There are many more species that potentially, and likely, occur in the area but have not yet been documented. The Forest Service has compiled a database of actual species documented in the area as well as species that various sources have listed as hypothetically occurring there. A query of this database shows that 298 species of mammals, birds, reptiles and frogs may occur but have not yet been documented in the Fossil Creek area.

Current Trends

Much of what is known about the terrestrial species that occur in the Fossil Creek watershed comes from the U.S. Forest Service. Information in the "current trends" sections that follow, unless otherwise noted, is from the Internal Draft Specialist Report for the Fossil Creek Watershed Planning Analysis of Affected Environment, Environmental Consequences, and Cumulative Effects for: Listed, Proposed, Sensitive, and Management Indicator Species; Neotropical Migratory Birds; and General Wildlife (USDA Forest Service 2003a).

This section is organized by species group, with a discussion of the current special status species in a given group occurring first. However, a summary of all terrestrial special status species is previewed first.

<u>Special Status Species</u>

Special status species include those listed as federal endangered, threatened, or candidate, as well as Wildlife of Special Concern [(Arizona Game and Fish Department 1996), Forest Service Sensitive Species (1999), High Priority Species "at risk of imperilment (Western Bat Species Regional Priority Matrix, 1998), Forest Service Management Indicator Species (MIS)[16] (from Coconino and Tonto Forest Management Plans), and Federal Species of Concern (former USFWS Category 2 species)]. Table 16 below summarizes these species; further discussion of each of these species follows under the appropriate species group.

Table 16. Threatened, endangered, sensitive, and management indicator species (MIS) for the Fossil Creek area (terrestrial species).

Common Name	Scientific Name	Status
Federally Listed (End, Thr, Proposed) (5)		
Bald Eagle	*Haliaetus leucocephalus*	T,WC,Sen,MIS
Mexican Spotted Owl	*Strix occidentalis lucida*	T,WC,Sen,MIS
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	E, WC,Sen
Yuma Clapper Rail	*Rallus longirostris yumanensis*	E, WC,Sen
Chiricahua Leopard Frog	*Rana chiricahuensis*	T, WC,Sen
Sensitive Mammals (6)		
Southwestern River Otter	*Lutra canadensis sonora*	SC, WC,Sen
Western Red Bat	*Lasiurus blossevillii*	WC, HP
California Leaf-nosed Bat	*Macrotus californicus*	WC, HP
Spotted Bat	*Euderma maculatum*	WC, HP
Allen's Big-eared Bat	*Idionycteris phyllotis*	HP
Townsend's Big-eared Bat	*Corynorhinus townsendii* (formerly *Plecotus*)	HP
Sensitive Birds (4)		
American Peregrine Falcon	*Falco peregrinus anatum*	WC, Sen
Common Black Hawk	*Buteogallus anthracinus*	WC, Sen, MIS
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	C, WC, Sen
Bell's Vireo	*Vireo bellii*	Sen, MIS
Sensitive Amphibians (2)		
Lowland Leopard Frog	*Rana yavapaiensis*	SC, WC, Sen
Arizona Toad	*Bufo microscaphus microscaphus*	SC, Sen
Sensitive Reptiles (3)		
Narrow-headed Garter Snake	*Thamnophis rufipunctatus*	SC, WC, Sen
Mexican Garter Snake	*Thamnophis eques megalops*	SC, WC, Sen
Arizona Night Lizard	*Xantusia vigilis arizonae*	Sen
Sensitive Snails (1)		
Fossil Springsnail	*Pyrgulopsis simplex*	SC, Sen
Sensitive Invertebrates (14)		
Maricopa Tiger Beetle	*Cicindela oregona maricopa*	SC, Sen
Tiger Beetle	*Cicindela hirticollis corpuscular*	Sen
Freeman's Agave Borer	*Agathymus baueri freemani*	Sen
Neumogen's Giant Skipper	*Agathymus neumoegeni*	Sen
Aryxna Giant Skipper	*Agathymus aryxna*	Sen
Blue-black Silverspot Butterfly	*Speyeria nokomis nokomis*	SC, Sen
Mountain Silverspot Butterfly	*Speyeria nokomis nitocris*	Sen

Common Name	Scientific Name	Status
Obsolete Viceroy Butterfly	*Limenitis archippus obsolete*	Sen
Early Elfin	*Incisalia fotis*	Sen
Comstock's Hairstreak	*Callophrys comstocki*	Sen
Spotted Skipperling	*Piruna polingii*	Sen
Netwing Midge	*Agathon arizonicus*	Sen
Hoary Skimmer	*Libelula nodisticta*	Sen
Arizona Snaketail	*Ophiogomphus arizonicus*	Sen
Other Management Indicator Species (10)		
Yellow-breasted Chat	*Icteria virens*	MIS
Cinnamon Teal	*Anas cyanoptera*	MIS
Lucy's Warbler	*Vermivora luciae*	MIS
Lincoln's Sparrow	*Melospiza lincolnii*	MIS
Summer Tanager	*Piranga rubra*	MIS
Hooded Oriole	*Icterus cucullatus*	MIS
Hairy Woodpecker	*Picoides pubescens*	MIS
Warbling Vireo	*Vireo gilvus*	MIS
Western Wood Pewee	*Contopus sordidulus*	MIS
Arizona Gray Squirrel	*Sciurus arizonensis*	MIS

Table Legend

E = Federally listed as Endangered under Endangered Species Act (ESA)
EXNE = Federally Endangered, Experimental, Non-essential
T = Federally listed as Threatened under ESA
P = Federally Proposed for listing under the ESA
C = Federally designated as Candidate for listing
WC = Wildlife of Special Concern in Arizona (AGFD in prep. 1996)
Sen = On Regional Forester's Sensitive Species List (7/21/99)
HP = High Priority Species; "at high risk of imperilment" (Western Bat Species Regional Priority Matrix (1998)
MIS = Tonto and Coconino Management Indicator Species from the Respective Forest Plans

SC = Federal Species of Concern (former C2 species)

Birds

Janie Agyagos and Michele James

Federally Threatened, Endangered, and Candidate Species

Four federally listed as threatened or endangered birds are known to occur, or have existing or potential habitat within the Fossil Creek watershed. These are the threatened bald eagle (*Haliaeetus leucocephalus*) and Mexican spotted owl (*Strix occidentalis lucida*), and the endangered southwestern willow flycatcher (*Empidonax traillii*) and

Yuma clapper rail (*Rallus longirostris yumanensis*). Habitat (as well as one documented observation) for the yellow-billed cuckoo (*Coccyzus americanus occidentalis*), a federal candidate for listing, occurs in the watershed as well.

Bald Eagle (Haliaeetus leucocephalus)

Bald eagles are known to nest along the Verde River on the Coconino, Prescott, and Tonto National Forests. Two bald eagle breeding areas occur on the Verde River within proximity of the Fossil Creek watershed. The East Verde breeding area is located just over 1 mile downstream of the confluence of Fossil Creek on the Verde River. This pair of bald eagles has been known to nest in this location in 1984, 1985, 1987, and 1998 and are among the most successful reproducing eagles in Arizona. The Coldwater North and Coldwater South breeding areas have been used by the same pair of eagles but in different years. The Coldwater South breeding area was occupied for the first time in 1998. This breeding area, located on the Verde River between the Childs Power Plant and the confluence with Fossil Creek, has not been used since 1998 when this first attempt to nest in a new location failed and no young were produced. The Coldwater North breeding area is located one and one-half miles upstream of the Childs Power Plant and was used in 1998 and 1999. The nests failed in both these years. Other nest locations associated with the Coldwater North breeding area are located approximately six miles upstream of the Child's Power Plant. The pair attempted to nest in this area in 2000, but the nest failed.

According to the Arizona Game and Fish Department, the Coldwater eagles, even when nesting six miles upstream of Childs frequently use the reach of the Verde between Childs and the Fossil Creek confluence for foraging. Telemetry during the 1987 breeding season indicated that the male bald eagle visited Fossil Creek a number of times in April, foraging on spawning suckers and using hunting perches 2.5 miles up Fossil Creek (Hunt et al. 1992).

Wintering bald eagles are known to use the Verde River and are consistently detected during midwinter surveys from the East Verde up to the West Clear Creek confluence. Fossil Creek above its confluence with the Verde River is not included in any bald eagle midwinter survey routes, and the fishery supported by minimal flows currently at Fossil Creek provides limited foraging and roosting habitat for bald eagles. Stehr Lake provides potential foraging and roosting habitat for bald eagles although eagles are not known to use the lake and habitat may be marginal.

Wintering bald eagle use night communal roosts that are often located on slopes (Platt 1976; Hansen et al. 1980; Dargan 1991) or are protected from prevailing winds by surrounding vegetation (Sabine 1981; Steenhof 1976). Within the Fossil Creek watershed, communal bald eagle roosts may potentially occur in the over 5,500 acres of mixed conifer, ponderosa pine, and pine/oak vegetation present in the Sand Rock and Calf Pen Canyons, where suitable conditions occur (steep slopes, wind protection, open canopy, and larger trees). Grubb and Kennedy (1982) document Fossil Springs as an area where there was either historic or reported use. Due to the presence of large trees protected from wind by adjacent slopes along portions of the creek, potential roosting habitat occurs along Fossil Creek. No known bald eagle winter roost sites are known to occur in the watershed however.

Mexican Spotted Owl (Strix occidentalis lucida)

Spotted owl habitat in the watershed consists of mixed conifer and ponderosa pine-Gambel oak vegetation types. This habitat is usually characterized by high canopy closure, high stem density, multi-layered canopies within the stand, numerous snags, and downed woody material. Often, nesting and roosting habitat for the spotted owl is located on steep slopes or in canyons with rocky cliffs, where dense vegetation or crevices or caves provide cool moist microsites.

There are three known spotted owl protected activity centers (PACs) within the watershed. These PACs are at least 600 acres in size and are designated around known nest and/or roost sites of a pair or single spotted owl. The PACs in the watershed include Sandrock (No. 040103), Calf Pen (No. 040421), and Horse (No. 040444). These PACs are located primarily in mixed conifer and ponderosa pine-Gambel oak vegetation in the northeastern portion of the watershed.

Spotted owls nest in riparian gallery forests, however, no breeding spotted owls have been documented in riparian forests in recent times (USDI 1995). Surveys for the spotted owl have not been conducted in the riparian portions of the watershed. According to definitions of habitat as described in the Mexican Spotted Owl Recovery Plan (USDI 1995), the riparian area along Fossil Creek and the Verde River qualify as restricted habitat, and the lands within the Wilderness boundaries and the Botanical Area qualify as protected habitat. Currently, there is little or no suitable nesting habitat in the riparian areas within the watershed. The Fossil Springs area provides suitable habitat structure, but its extremely small size probably precludes its use by nesting owls. Riparian habitat along the rest of the 14 miles of Fossil Creek does not currently provide the density and structure needed for good nesting habitat.

Some spotted owls are known to migrate in the winter, usually to lower elevations consisting of more open woodland or scrub habitats (USDI 1995). The watershed contains over 140,000 acres of pinyon-juniper woodlands and desert scrub vegetation that may provide habitat for wintering and possibly dispersing, spotted owls.

Southwestern Willow Flycatcher (Empidonax traillii extimus)

In the Verde Valley, nesting habitat for the willow flycatcher occurs in tamarisk and mixed riparian habitats. Patch width of breeding sites in both tamarisk mixed riparian habitat types tend to be more linear, varying from 460 feet to 1,640 feet in maximum width (Sferra et al. 1995). Overstory canopies average between 50 and 55 feet tall, and patch size varies from 5 to 121 acres in mixed riparian and tamarisk (Spencer et al. 1996).

Surveys for the southwestern willow flycatcher have been conducted at several locations along Fossil Creek. In 1994, U.S. Forest Service personnel conducted surveys at Fossil Springs and along the six miles of Fossil Creek below the dam. Later, the Forest Service determined that these areas were unsuitable for nesting flycatchers. Environet consultants surveyed three additional sites in 1998; these were located 800 feet, 1.2 miles, and 2 miles downstream of Irving. The three sites were selected for surveys based on aerial inventory of habitat which indicated that these where the widest and thickest areas of riparian habitat. Surveys conducted in 1998 at these sites did not located flycatchers. Comparison of the three sites along Fossil Creek with occupied sites in the Verde Valley indicate that these sites have little to no potential for supporting nesting willow flycatchers. Riparian habitat along Fossil Creek differs from habitats typically occupied by southwestern willow flycatchers in the Verde Valley and in Arizona. The riparian vegetation is too narrow and the mid and understory vegetation layers are relatively open.

Yuma Clapper Rail (Rallus longirostris yumanensis)

The Yuma clapper rail nests and lives in freshwater marshes where moist to wet soil and dense vegetation at least 40 cm (15.7 inches) in height occurs (Todd 1986; Eddleman and Conway 1998). Flooded areas are important, but generally the rail uses areas of shallow water (<12 in) near shore.

Currently there is no nesting habitat for Yuma Clapper rails along Fossil Creek. Increased flows into Fossil Creek may provide adequate size patches of emergent vegetation suitable for nesting, however, spring flows from snow melt and spring precipitation would likely result in fluctuating water levels that could inundate Yuma clapper rail nests. While suitable habitat occurs in Stehr Lake, surveys conducted by Environet in 1998 failed to detect nesting rails.

The Verde River above and below Fossil Creek's confluence may support suitable Yuma clapper rail habitat. Recent changes in livestock management along the Verde River are allowing for riparian vegetative species to become established. This includes deciduous tree, herbaceous, emergent and aquatic species.

Western Yellow-billed Cuckoo (Coccyzus americanus occidentalis)

The future of the yellow-billed cuckoo (*Coccyzus americanus*), a neotropical migrant that breeds throughout northern Mexico, the United States, and southern Canada, is uncertain (Hughes 1999). Yellow-billed cuckoo populations have declined throughout the species' range (Hughes 1999); western populations, in particular, have decreased and suffered catastrophic range reductions in the twentieth century (Laymon and Halterman 1987; Hughes 1999; Corman and Magill 2000). Consequently, on July 25, 2001, the yellow-billed cuckoo became a Candidate Species under the Endangered Species Act (ESA). Yet, despite concern over the fate of this species, few aspects of yellow-billed cuckoo life history have been adequately studied (Hughes 1999). Probable factors believed to be contributing to population declines are the loss, fragmentation, and alteration of native riparian breeding habitat, the possible loss of wintering habitat, and pesticide use on breeding and wintering grounds (Corman and Magill 2000).

The facts that yellow-billed cuckoos were once common and now are extremely rare and that riparian habitats have been severely impacted demonstrate that there is a clear need to elucidate the interrelationships of yellow-billed cuckoo ecology and riparian habitat conservation. Indeed, after conducting surveys for yellow-billed cuckoos, Arizona Game and Fish Department concluded that: 1) The surveys should be expanded to encompass all major habitat types; 2) Additional presence/absence data was needed from areas within potentially suitable habitat that were not thoroughly surveyed; and, 3) Nest searching and monitoring should be initiated to gain a better understanding of productivity and nest site behavior (Corman and Magill 2000). The need to better understand the factors that are contributing to the decline of yellow-billed cuckoo populations within the state is reflected in the Arizona Game and Fish Department Heritage Program's selection of the yellow-billed cuckoo as a Sensitive Element in 2001 and 2002.

The yellow-billed cuckoo is a late migrant associated with large tracts of undisturbed riparian deciduous forest where willow, cottonwood, sycamore, or alder occur. Yellow-billed cuckoos in higher elevations may be found in mesquite and tamarisk. The yellow-billed cuckoo feeds almost entirely on large insects, and if food-stressed, may also feed on berries and fruit. Forest Service records indicate that a yellow-billed cuckoo was detected in the Fossil Creek riparian area by Coconino biologist Cathy Taylor. Arizona Game and Fish conducted a survey for the cuckoo at Verde Hot Springs along the Verde River however no cuckoos were detected. Yellow-billed cuckoos could potentially occur in Fossil Creek from Fossil Springs down to the Verde confluence and more surveys need to be conducted.

Sensitive and Management Indicator Species (MIS)

American Peregrine Falcon (Falco peregrinus anatum)

Habitat for peregrine falcon includes rock cliffs for nesting and a large foraging area. Suitable nesting sites on rock cliffs have a mean height of 200 to 300 feet. Peregrines prey mainly on birds found in wetlands and riparian areas within a 10 to 20 mile radius from the nest site. Prey items include mainly birds, especially passerines, doves, and small raptor, as well as bats, and other mammals.

Survey efforts by the Arizona Game and Fish Department in the early 1990's resulted in the identification of two peregrine eyries within the vicinity of Fossil Creek. The Nash Point eyrie occurs 1.5 miles east of Fossil Springs and the Calf Pen eyrie occurs 4.5 miles northeast of Fossil Springs. Another eyrie occurs approximately two miles downstream from the Fossil/Verde confluence. Both eyries within the watershed were monitored by Arizona Game and Fish biologists from 1989 to 1995.

Besides the occupied habitat, additional suitable nesting habitat occurs in the watershed where cliff faces greater than 200 feet in elevation occur. Arizona Game and Fish conducted habitat suitability surveys along the Fossil Creek road; biologists did not consider the cliffs along Fossil Creek from one mile below Fossil Springs to Stehr Lake as suitable nesting habitat. Surveys were not conducted below Stehr Lake yet cliffs in excess of 200 feet do occur there and along other sections of Fossil Creek. Since the peregrine was delisted from the Endangered Species Act, peregrine nests are being discovered in habitat previously thought to be less than suitable. Therefore, it is now believed that peregrine falcons could occur throughout most of Fossil Creek. Environet biologists identified and mapped 7,230 acres of potential nesting habitat along Fossil Creek. Additionally, peregrine falcons may forage all along Fossil Creek, the Verde River, and at Stehr Lake where prey species such as swallows, swifts, and waterfowl may occur.

Common Black Hawk (Buteogallus anthracinus)

The common black hawk can be found in low elevation riparian areas. The black hawk is dependent upon a mature, relatively undisturbed habitat supported by a permanent flowing stream. Groves of tall trees must be present along the stream course for nesting. Black hawks are still hunters, hunting from tree and cliff perches although they will also wade into water and chase after prey including crayfish, amphibians, reptiles, and fish. Streams of low to moderate gradient and less than one foot deep with scattered boulders are ideal for foraging.

The common black hawk has been observed in all reaches of Fossil Creek except the lower reach below Irving. There have been no observations of black hawks at Stehr Lake. Suitable nesting habitat currently occurs from Fossil Springs downstream to the Irving power plant and where significant springs provide for tall trees and foraging habitat.

Bell's Vireo (Vireo bellii)

Bell's vireos occupy dense riparian thickets as well as mesquite and oak thickets near water. Arizona Partner's In Flight list the Bell's vireo as an associate species to the southwestern willow flycatcher and Lucy's warbler. According to Forest Service data, Bell's vireos have been detected at a variety of locations including Fossil Springs, Fossil Spring Botanical Area, Fossil Creek, Stehr Lake, aqueduct spring, and Fossil Creek uplands. Bell's vireos may occur in the watershed wherever mesquite thickets occur near water and along riparian areas, including small springs.

Yellow-breasted Chat (Icteria virens)

The yellow-breasted chat inhabits riparian areas with small trees and dense shrubs. Adults eat an equal portion of berries and insects gleaned from shrubs; young chats eat only insects. The yellow-breasted chat has been observed at Fossil Springs, along Fossil Creek and at Stehr Lake.

Cinnamon Teal (Anas cyanoptera)

The cinnamon teal inhabits marshes, ponds, slow streams, alkaline wetlands in arid areas and shallow lake margins with emergent vegetation. Nests are built on the ground, usually in a marsh or adjacent meadow. Dense, high vegetation is important for nest concealment. The teal's diet is based on the seeds of aquatic vegetation, insects and mollusks. It forages in shallow water along shorelines. Although this species is listed as a Management Indicator Species for the Riparian and Open Water Management Area in the Coconino National Forest Plan, this species has not been sighted in the Fossil Creek area. Stehr Lake likely provides the best habitat.

Lucy's Warbler (Vermivora luciae)

This warbler can be found in mesquite forests of the desert southwest and in mountain foothills. It is particularly fond of willow and cottonwood groves, and breeds in riparian brush and woodlands. Lucy's warblers are cavity nesters, making nests in old woodpecker holes, under loose bark, in natural cavities, in abandoned Verdin (*Auriparus flaviceps*) nests and occasionally in holes located in stream banks. Nests are located 2 to 15 feet above the ground. Lucy's Warblers are insectivores, pursuing their prey by gleaning from foliage or by hawking, sallying from their perch to catch insects in the air. Forest Service data indicates that Lucy's warblers have been sighted at Fossil Springs and in the reach above Irving.

Lincoln's Sparrow (Melospize lincolnii)

Lincoln's sparrow is found in wet areas such as bogs, marshes and wet meadows, in dense willow or alder thickets, along forest edges, in open forests with well-developed under-stories and in clearings. Nests are built on the ground in a tussock of grass or sedge, concealed by vegetation and sometimes just above water. These birds glean their food from the ground, with adults feeding on insects, spiders, grains and seeds, and juveniles feeding only on insects. Although the Fossil Creek area provides some habitat for the Lincoln's sparrow, according to Forest Service data, none have been observed in the Fossil Creek area.

Summer Tanager (Pirangra rubra)

The summer tanager inhabits riparian woodlands, stands of cottonwood and willow and park-like areas. Nests are built on horizontal tree limbs 10 to 35 feet above the ground. Summer tanagers eat insects, spiders and fruit. The summer tanager has been observed at the Fossil Springs, along Fossil Creek, at Childs and at Stehr Lake.

Hooded Oriole (Icterus cucullatus)

The hooded oriole is found in riparian woodlands, particularly mesquite, cottonwood, sycamore and walnut. Nests are also built in willow, ash, or Spanish bayonet, where nests are built from the fibers of the plant. Insects, fruit and nectar make up the diet. The hooded oriole has been observed at Fossil Springs, along Fossil Creek, at Childs and at Stehr Lake

Hairy Woodpecker (Picoides pubescens)

This woodpecker inhabits deciduous and coniferous forests. Nests are dug in live or dead trees 5 to 40 feet above the ground. Trees with dead centers are favored. Sometimes an additional cavity for roosting is constructed. The hairy woodpecker eats insects primarily, but also feeds on sap from sapsucker holes. According to Forest Service data, the hairy woodpecker has only been sighted at the Fossil Springs.

Warbling Vireo (Vireo gilvus)

The warbling vireo inhabits open deciduous and mixed woodlands, riparian forests, and thickets. Nests are built in the horizontal fork of slender tree branches, well away from the trunk, often in aspen or poplar. In the west, warbling vireos nest in shrubs or low trees, within 12 feet of the ground. They feed chiefly on insects, along with spiders and berries. The warbling vireo has only been sighted at Fossil Springs.

Western Wood Pewee (Contopus sordidulus)

The western wood pewee is found in a number of habitat types, including open, mature pine forest; pine-oak-aspen woodlands; wooded canyons; orchards; towns and cultivated valleys. It appears to prefer nesting in deciduous trees, but conifers are used on occasion. Nests are built in living or dead trees, on horizontal limbs far from the tree's trunk or in limb forks. They are typically situated between 15 and 40 feet above the ground. They feed on insects, foraging in the air among the mid-foliage portion of trees. The western wood pewee has been observed at Fossil Springs and along Fossil Creek.

Summary of Special Status Birds

All 17 species of special status birds (4 listed, 4 sensitive, and 9 MIS) are riparian dependent either for all or a portion of their life cycle. Table 17 displays each species requirement for riparian habitat.

Table 17: Special status bird use of riparian habitat.

Species	Nesting	Foraging	Dispersal/ Migration Corridor	Wintering
Bald Eagle	X	X	X	X
Mexican Spotted Owl	X*		X	
Southwestern Willow Flycatcher	X	X	X	
Yuma Clapper Rail	X	X	X	X
American Peregrine Falcon		X		
Common Black Hawk	X	X	X	
Western Yellow-billed Cuckoo	X	X	X	
Bell's Vireo	X	X	X	
Yellow-breasted Chat	X	X	X	
Cinnamon Teal	X	X	X	X
Lincoln's Sparrow	X	X	X	
Lucy's Warbler	X	X	X	
Summer Tanager	X	X	X	
Hooded Oriole	X	X	X	
Hairy Woodpecker	X	X	X	X
Warbling Vireo	X	X	X	
Western Wood Pewee	X	X	X	

* historically

Resident and Neotropical Migratory Birds Occurring in the Fossil Creek Area

Many of the birds in the Fossil Creek area are neotropical migrants, spending only a portion of each year (spring and summer) in this area. These birds travel each year from their wintering grounds in Mexico, Central and South America, and the Caribbean to North America to breed during the spring and summer months. Precipitous declines in neotropical migratory bird populations have occurred over the last twenty years and are caused mainly by habitat loss and modification in the wintering grounds, breeding grounds, and along migrational routes. Due to the abundance of quality riparian habitat in the Fossil Creek area, neotropical migrants not only use the area for nesting but also as a corridor for migration.

See Appendix B for a complete list of bird species observed through 2003 within the watershed according to Forest Service records.

Federally Listed and Candidate Species

The ultimate goal for federally listed species is recovery. The restoration of Fossil Creek may increase habitat quality and quantity for some of these bird species, thereby assisting to some degree in recovery. Return of full flows may allow additional riparian habitat to develop in the long-term on suitable streamside substrates (USDA Forest Service 2003b). This may result in increased width of the riparian area along some parts of Fossil Creek and thus, suitable nesting habitat for the southwestern willow flycatcher may develop over time. While habitat for the yellow-billed cuckoo is currently present along Fossil Creek, restoration of full flows may increase the health of the willow and cottonwood trees currently present and allow for the continued health and presence of these large trees that are used for nesting by this species. Roosting and foraging habitat for the bald eagle may improve along Fossil Creek with the return of full flows. A wider riparian area may result in the use of the Fossil Creek corridor by dispersing Mexican spotted owls.

Recreational activities may result in visual and aural disturbance to listed and candidate bird species that are present in the area. Frequent, long-term, and/or high intensity disturbance can result in abandonment of an area by adult birds, decreased reproduction, increased predation of young and eggs, and decreased foraging success by adults. The yellow-billed cuckoo, for instance, is sensitive to disturbance and avoidance of intense and repeated human disturbance in nesting areas from 20 May through 1 September is recommended (Latta et al. 1999). Recreational activities in the riparian area can cause stream bank compaction, loss of vegetation, and overall loss of habitat quality for listed and candidate bird species. Management of recreational use in the Fossil Creek Watershed, particularly in and adjacent to the riparian area, should be carefully considered. The location of campsites, creek side trails, and access trails should consider the maintenance of habitat for listed species. Because these are listed or candidate species, the protection of individuals and nest sites are required; seasonal restrictions of recreational use in specific areas may need to be implemented.

Sensitive and MIS Species

Many of these birds are neotropical migrants, spending only a portion of each year (spring and summer) at Fossil Creek. Precipitous declines in neotropical migratory bird populations have occurred over the last twenty years and are caused by habitat loss and modification, both on their wintering and breeding grounds. Due to the abundance of quality riparian habitat in the Fossil Creek area, neotropical migrants use the area for nesting as well as a corridor for stop-over during migration. Restoration of full flows may allow for increased habitat quality and quantity for these species.

Conserving and improving the health of the Fossil Creek riparian area and maintaining water quality are the primary goals for these species. As discussed above, recreational use of the area, particularly the sensitive riparian areas can result in loss of habitat quality for sensitive species. The presence of appropriate restroom facilities can help ensure that the water quality of Fossil Creek is maintained. Careful attention should also be paid to the health of ranid frogs in this area. Frogs are some of the best indicators of habitat health, thus carefully watching for fog die-offs, and quickly identifying the cause is recommended. Non-native species such as sport fish, bull frogs and crayfish, and the invasion of exotic plant species have contributed to ranid frog declines (Sredl 1997), as well as the spread of the Chytrid fungus. The removal of non-native fish is expected to result in beneficial effects for frogs in Fossil Creek. Die-offs of ranid frogs, particularly the lowland leopard frog, could have serious effects on the common black hawk, as these amphibians make up a large portion of the black hawks diet (Latta et al. 1999).

Some of these birds are sensitive to recreational disturbance. Human visitation should be minimized to protect the common black hawk, for instance, during the breeding season (approximately March through mid October) (Latta et al. 1999). Recreational activities in the riparian area should be managed carefully to allow the protection of habitat for these sensitive species. Protection of trees used by cavity nesting birds such as the Lucy's warbler is recommended. This may require restrictions on opportunistic fuel wood harvest near recreational camping areas if camp fires are permitted.

Inventory and Monitoring

Little is known about the use of the Fossil Creek watershed by these listed and sensitive bird species. For instance, systematic inventory of the riparian habitat for the yellow-billed cuckoo and common black hawk has not occurred to date although potential habitat is abundant. Surveys for the yellow-billed cuckoo and black hawk are planned in conjunction with the decommissioning activities, starting in 2005. The extent of these surveys is limited to the 4.5 miles upstream of Irving (pers. comm. Matt Johnson, USGS), and thus do not include other potential habitat within the middle and lower reaches of Fossil Creek. We recommend two consecutive years of inventory of all potentially suitable habitat for listed and candidate bird species (using accepted protocols) within the upper, middle, and lower reaches of Fossil Creek be completed by 2010.

While the opportunistic observations of birds in Fossil Creek to date are valuable, habitat is present for many more birds than have been observed thus far. A complete inventory of bird species in the riparian area would provide valuable information about the state of the bird species and communities and would assist in determining changes in the quality or quantity of habitat over time, thus assisting in determining appropriate management actions. In light of this, we recommend conducting baseline inventory for all species within the riparian habitat along all reaches of Fossil Creek. Baseline inventory should consist of point count surveys for breeding birds (three visits between 15 May and 30 June) as well as incidental surveys during the breeding period, spring migration (1 March through 30 April), and fall migration (15 August through 15 October) and wintering period (1 November through 30 February) consisting of a total of nine visits. We also recommend surveys for nocturnal species within the riparian habitat. Surveys for nocturnal birds (i.e., owls) would be conducted using taped broadcasts in all habitats that may be occupied by owls or where historical sightings have been noted. Nocturnal surveys could be coordinated with the other surveys described above. We suggest that the baseline inventory could be prioritized by reach with consideration of the quality of the habitat and the potential for human impacts to habitat.

After inventory for listed and candidate species, and inventory for all species has been completed in a given reach, we recommend designing a monitoring program and conducing basic monitoring within a reach or reaches. Optimally, the monitoring would occur every two years. In general, birds are considered a valuable monitoring tool because their dynamics closely parallel those of the ecosystem, they are sensitive enough to provide an early warning of change, they provide continuous assessment over a wide range of stresses and have dynamics that can be attributed to either natural cycles or anthropogenic stressors (Johnson et al. 2003). Because riparian habitat may change over the next five to 10 years with the return of full flows to Fossil Creek, bird monitoring would document any changes in the bird community that may occur after the baseline inventory is completed. In light of keeping costs for such monitoring to a minimum, the monitoring program could include sub-sampling randomly selected points or habitats within a given reach or throughout the Fossil Creek riparian habitat.

The steps involved in designing a monitoring program should include the following key components, following the suggestions of Noon et al. (1999):

1.) Identification of stressors relating to management goals.
2.) Development of a conceptual model linking stressors to ecological responses.
3.) Identification of avian indicators responsive to environmental stressors.
4.) Estimation of the status and trend of avian indicators/Establishment of sample design.
5.) Definition of response criteria/calculation of benchmark conditions.
6.) Linkage of monitoring results to decision-making.

Funding to complete inventory and monitoring of Fossil Creek is currently limited and grants should be actively pursued to fund the surveys in whole or part. We recommend pursuing funding opportunities such as the National Fish and Wildlife Foundation, Heritage Fund, and the Environmental Protection Agency. In addition, creative solutions should be considered. For minimal cost, volunteers from Northern Arizona Audubon, for instance, could conduct baseline monitoring during the migration and wintering periods. Surveyors would need to utilize a standard protocol, be committed and organized, and keep complete and accurate records. Oversight by a qualified biologist would be required. We recommend against the use of volunteers for the baseline inventory during the breeding season because detecting breeding birds takes special abilities and training as 80% of breeding birds are detected by ear alone. We believe that baseline inventory could be conducted at a minimal cost with the hiring of a project leader and one field technician.

Indicators

The best indication of the restoration of Fossil Creek and the appropriate management of recreational use of the area will be the health of the riparian ecosystem, water quality, and the presence or absence of listed and sensitive species where suitable habitat exists. A comprehensive comparison of the presence or absence of these species prior to and after the return of full flows will not be possible. However habitat changes over time (5-10 years) can indicate the overall health and changes in quantity of specific habitat. In some cases, this can be linked to use by a particular species. An overriding indicator will be the increased knowledge gained of the use of the Fossil Creek area by listed and sensitive species, as well as breeding, migrating, and winter species.

Mammals

Janie Agyagos and Michele James

Game mammals in the Fossil Creek area include elk, mule deer, white-tailed deer, bear, mountain lion, bobcat, gray fox, coyote, javelina, cottontail and jackrabbits, squirrels, and raccoons. Elk are primarily found in mixed conifer and pondersa pine woodlands during the spring, summer and fall months but move into pinyon-juniper woodlands during the winter, especially when deep snows preclude access to forage in the higher country. Deer, mountain lion, bobcat, coyote, fox, cottontails and jackrabbits occur throughout all biotic communities within the Fossil planning area. Javelina occur in desertscrub, grassland, riparian, and chaparral and pinyon/juniper slopes with abundant prickly pear cacti. Raccoons occur primarily within riparian and other vegetative zones within close proximity to riparian areas.

Non-game mammal species include chipmunks, mice, rats, woodrats, skunks, ring-tailed cats, and numerous species of bats. Spotted and striped skunks occur primarily within riparian and other vegetative zones within close proximity to riparian areas. Cliff chipmunks, white-footed mouse, and white-throated woodrat are a few small mammal species that occur within the chaparral and pinyon-juniper habitats. Rock squirrel, cliff chipmunk, western harvest mouse, and brush mouse are other small mammals that likely occur in the Fossil Creek watershed.

Approximately 22 species of bats (including special status species) may occur in the Fossil Creek area (Table 18). Few surveys have been conducted for bats in the Fossil Creek area but several occupied bat roosts are known to occur in cliff dwellings and an abandoned shack. 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. All of the bat species occurring or potentially occurring in the area are insectivorous. Water sources such as earthen stock tanks, springs, seeps, and streams are important for bat foraging due to the abundance of insects found flying above the water.

Table 18. Potential bat species and their habitat requirements.*

Common Name	Scientific Name	Roost Requirements					Habitat						
		S	**R**	**C**	**T**	**F**	**MC**	**PP**	**PJ**	**C**	**DS**	**G**	**R**
California leaf-nosed bat	*Macrotus californicus*			X					X		X		
Yuma myotis	*Myotis yumanensis*	X	X	X				X	X		X	X	X
Cave myotis	*Myotis velifer*	X		X							X		
Occult little brown bat	*Myotis lucifugus occultus*	X		X	X			X					
Long-eared myotis	*Myotis evotis*	X	X	X	X		X	X	X	X			
Southwestern myotis	*Myotis auriculus*							X	X	X	X		
Fringed myotis	*Myotis thysanodes*	X		X	X		X	X	X	X	X	X	
Long legged myotis	*Myotis volans*	X	X	X				X	X		X		
California myotis	*Myotis californicus*			X				X			X		
Western small-footed myotis	*Myotis ciliolabrum*		X	X				X	X	X			X
Pallid Bat	*Antrozous pallidus*							X	X				
Silver-haired bat	*Lasionycteris noctivagans*						X	X	X				
Western pipistrelle	*Pipistrellus Hesperus*			X			X	X	X		X		X
Big brown bat	*Eptesicus fuscus*			X			X	X	X	X	X	X	X
Red bat	*Lasiurus borealis*					X							X
Hoary Bat	*Lasiurus cinereus*						X	X	X				
Spotted Bat	*Euderma maculatum*		X				X	X	X	X	X	X	X
Allen's big-eared bat	*Idionycteris phyllotis*		X	X	X		X	X	X				X
Pale Townsend's big-eared bat	*Corynorhinus townsendii pallescens*			X			X	X	X		X		
Mexican free-tailed bat	*Tadarida brasiliensis*			X				X	X	X	X	X	
Big free-tailed bat	*Nyctinomops macrotis*			X							X		X
Western mastiff bat	*Eumops perotis californicus*		X								X		

Legend for Table

S = Structures such as buildings, barns, bridges
R = Cracks and crevices in cliffs, and under rocks
C = Caves, cliff dwellings, mines, tunnels
T = Hollow trees, snags, underneath loose tree bark
F = Among foliage of trees and leafy shrubs
MC = Mixed Conifer
PP = Ponderosa Pine
PJ = Pinyon Juniper
C = Chaparral
DS = Desert Scrub
G = Grassland
R = Riparian

* Table information obtained from AGFD Heritage Data Management System; Tuttle and Taylor 1994; Hoffmeister 1986; Morrell et al. 1999; Chung-MacCoubrey 1995; and, AGFD 1992.

Special Status Mammals

Southwestern River Otter (Lutra canadensis sonora)

The Southwestern river otter requires permanent flowing water or ponds, overhanging bank vegetation, and haul-out sites suitable for leaving and entering water. The species requires high quality water with low sediment loads with minimum estimated water flows of 10 cubic feet per second. Forage items include fish, amphibians, turtles, crayfish, and other aquatic animals. Otters do not build their own den but may utilize or enlarge cavities in rock piles, dense vegetation, logjams, natural cavities, and abandoned dens of other animals especially beaver. Dens may be up to one half mile from water. Otters may move considerable distances over land when mating.

The Southwestern river otter is historic to the Verde River, Wet Beaver Creek, Oak Creek, and other major tributaries in the Verde Valley. Evidence suggests that a few populations persisted at least into the 1960's and likely to the present. In 1981 and 1982, Arizona Game and Fish Department introduced a Louisiana subspecies (*L. c. lataxina*) into Fossil Creek and the Verde River near the Fossil Creek and East Verde confluences. This introduced species is successfully reproducing and may eventually cause genetic swamping of the native form, if any still exist. U.S. Forest Service and Arizona Game and Fish Department personnel have conducted wildlife surveys along the Verde River from Beasley to Sheep Bridge and have noted otter sightings and scat abundance. Bill Burger with Arizona Game and Fish (pers. comm. to Janie Agyagos, USFS 3/04/02) noted abundant otter sign between Child's and Sheep bridge each summer from 1999 to 2001. Burger also conducted a survey from Beasley Flats to Childs in 2001 and noted otter sign in that reach as well. According to Mike Ross, Tonto National Forest biologist, 18 otters were observed between Childs and Sheep Bridge in 1999, one otter and much scat in 2000, no otters but much scat in 2001, and no otters and little scat in 2002 (personal communication to Janie Agyagos, USFS, 03/06/02).

Otters have not been detected in Fossil Creek, which may be due to unnaturally reduced flows. However, once the decommissioning process occurs, the restoration of natural flows should allow for re-occupancy. Otters will likely initially extend their range up into the lower portion of Fossil Creek but over time it is possible that otters may come to occupy all of Fossil Creek.

Western Red Bat (Lasiurus blossevillii)

In Arizona, the western red bat is thought to be a summer resident only. It occurs statewide, except in desert areas, but primarily along riparian corridors among oaks, sycamores, and cottonwoods at elevations between 2,400 and 7,200 feet. Red bats typically roost in dense clumps of foliage in riparian or other wooded areas. Roost sites are shaded above and tend to be open below, permitting the bats to drop into flight. Red bats feed mainly on flying insects. The chief threats to the red bat in Arizona are its` apparently low numbers and the loss of riparian and other broad-leafed deciduous forests and woodlands.

Habitat for the red bat occurs at Fossil Springs, along Fossil Creek and the Verde River, upland springs that support deciduous riparian tree species, and perhaps at Stehr Lake, although the mature deciduous riparian trees at Stehr Lake are dead or dying.

California Leaf-nosed Bat (Macrotus californicus)

California leaf-nosed bats range through southern California, southern Nevada, southwestern Arizona, and southward to the southern tip of Baja California (Mexico), northern Sinaloa (Mexico), and southwestern Chihuahua (Mexico). They tend to live in the same area year after year, and do not migrate.

The California leaf-nosed bat lives predominantly in Sonoran and Mohave Desert scrub habitats, but is occasionally found in the Chihuahuan and Great Basin deserts. During the day, this species roosts primarily in mines and caves. At night it may rest in open buildings, cellars, bridges, porches, and mines that offer overhead protection but which are open for adequate flight approach. The California leaf-nosed bat is a year-round resident in desert scrub habitats south of the Mogollon Rim in Arizona. Within the 5th code watershed the Forest Service estimates 15,811 acres of desert scrub vegetation.

Spotted Bat (Euderma maculatum)

Historic records suggest that the spotted bat was widely distributed but quite rare over its range, although it may have been locally abundant at certain sites. The historic range of the spotted bat includes Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Wyoming, Texas, Canada and Mexico.

Roost site characteristics are poorly known for this species, but limited observations suggest that spotted bats roost singly in crevices, with rocky cliffs and surface water characteristic of localities where they occur. The diet of the spotted bat consists of moths, June bugs, and grasshoppers as well as other insects.

As of 1986, very few specimens were known from Arizona. Sites varied from southeastern, south central, to northeastern parts of the state. *Euderma maculatum* is rarely and unpredictably encountered in various habitats in scattered localities throughout Arizona, but especially in the extreme northwestern corner. It has been found from low desert areas in southwestern Arizona to high desert and riparian habitat in the northwestern part of the state. It has also been found in conifer forests in northern Arizona and other western states.

Since this bat occurs in a variety of vegetation types where suitable rocky cliffs occur, the majority of the watershed, especially, Calf Pen and Sand Rock Canyons, Fossil Creek between the Fossil Springs and Irving Power Plant, and along the Verde, would provide suitable roosting conditions for this bat.

Allen's Big-eared Bat (Idionycteris phyllotis)

Allen's big-eared bats are found in the mountainous regions of the southwestern United States through central Mexico, where they primarily dwell in caves and abandoned mine shafts within mountainous pine, pine/oak, and pinyon-juniper forests. Its historic range includes Arizona, California, Colorado, New Mexico, Nevada, Utah and Mexico (Federal Register, 1994). Records of capture exist across most of Arizona, with most records from the southern Colorado Plateau, the Mogollon Rim and adjacent mountain ranges within ponderosa pine, pinyon-juniper, Mexican woodland and riparian areas of sycamores, cottonwoods and willows. Allen's big eared bats generally occur at elevations ranging from 2,600 - 9,800 feet, but most specimens are at altitudes between 3,500 - 7,500 feet. Nearly all capture sites have been in the vicinity of rocks, such as cliffs or large boulders, which are their most probable roosting sites. The availability of water holes is a significant factor in habitat selection due to their high rate of evaporative water loss.

Although there are many thousands of acres of ponderosa pine, pine/oak, pinyon-juniper, and riparian woodlands in the watershed, the sporadic water availability may limit roosting activity. There are 12 springs and 22 man-made earthen tanks in the area within ponderosa, pine/oak, and pinyon-juniper vegetation types but many of these springs and tanks dry up at different times during the year. Riparian areas associated with perennial water in Fossil Creek, coupled with the abundant cliffs and the appropriate vegetation, makes for the most suitable habitat in the Fossil Creek area.

Townsend's Big-eared Bat (Corynorhinus townsendii)

In Arizona, this species occurs throughout the state, although it is only infrequently found in the Desert Mountains. During the winter, it is found mostly south of the Mogollon Plateau and northwest of Mohave County. The distribution of this bat tends to be geomorphically determined, and is strongly correlated with the availability of caves or cave-like roosting habitat e.g., old mines. Population concentrations occur in areas with substantial surface exposures of cavity forming rock, and in old mining districts. *Plecotus townsendii* has been found from 1,200 to 5,600 feet. Most records; however, seem to come from above 3,000 feet.

Townsend's big-eared bats hang from open ceilings of mines and caves during the day. They do not use cracks or crevices, and may use open abandoned buildings as a night roost. In Arizona, they hibernate during the winter in cold caves, lava tubes, and mines mostly in uplands and mountains from the vicinity of the Grand Canyon to the southeastern part of the state, south of the Mogollon Rim. The presence of suitable shelters seems to be one of the important limiting factors for this species. Townsend's big-eared bats may occur throughout the watershed where suitable roost substrate such as caves, cliff dwellings, and flume tunnels, occurs. Townsend's big-eared bats have been detected along the Verde River between West Clear and Fossil Creeks (Sullivan and Richardson 1993).

Arizona Gray Squirrel (Sciurus arizonensis)

The Arizona gray squirrel inhabits deciduous and mixed forests, canyon bottoms and riparian areas of mountain ranges. It is also found in stands of ash, mulberry, walnut, oak, sycamore and pine. Arizona gray squirrels are chiefly arboreal. Nests are made of leaves and, in winter, are sometimes occupied by more than one adult. This species feeds largely on walnuts. It also eats acorns, fungi, juniper berries and the seeds of pine and Douglas fir. The Arizona gray squirrel utilizes mature riparian trees for nest sites. Nesting gray squirrels have been reported at the springs at Fossil Creek (Burbridge and Story 1974).

Restoration Goals

The return of full flows to Fossil Creek is expected to increase the likelihood of occupancy of the Creek by the introduced subspecies (*Lutra Canadensis lataxina*) of river otters. The amount of time it will take after return of full flows for the river otter to move from the currently occupied Verde River into the lower reaches of Fossil Creek is unknown. The Forest Service indicates that it is very likely that river otters may eventually move into the middle and upper portions of Fossil Creek. While the lower reaches of Fossil Creek are remote and less accessible to recreationists, the middle portion is easily accessible and the upper portion (from Irving to the diversion dam) is accessible via a relatively short hike. Recreational use in the more accessible areas is expected to be much higher than in the lower portion of Fossil Creek and may result in disturbance to river otters and impacts to habitat caused by trampling of vegetation and bank compaction. Recreational use in this area will need to be considered carefully and the future occupation of the middle and upper portions of Fossil Creek by river otters must be taken into consideration. In particular, creek side trails and camping, as well as the presence of social trails and the number of access routes into the area should all be carefully considered and limited to an amount appropriate for the species.

In general, bat species and the Arizona gray squirrel will likely benefit from the return of full flows. The western red bat and gray squirrel, for instance, roost and nest in deciduous riparian trees and, with the return of full flows to Fossil Creek, additional riparian habitat will develop in the long-term on suitable streamside substrates (USDA Forest Service 2003b). In the short term, the saturation tolerance of some existing vegetation may be exceeded, and that vegetation would die (FERC 2004a). Because Stehr Lake will eventually dry up after return of full flows, this riparian habitat will not provide roosting or foraging habitat for bats. APS has agreed to install bat grates at the mouths of the flume tunnels as part of the deconstruction process; this will allow bats to use the tunnels for roosts while rendering the tunnels inaccessible to the public (FERC 2004b).

Recreational use in the riparian areas of Fossil Creek are a concern for bats and for the squirrel because this may cause visual and aural disturbance, and may directly impact habitat for species such as the western red bat and gray squirrel that roost and nest in riparian trees (USDA Forest Service 2003a). The Forest Service indicates that excessive smoke from campfires can affect the insect population in the immediate area, thus affecting the prey base for sensitive bat species. Management of recreation use along Fossil Creek must be considered carefully given the importance of the riparian area to sensitive bat species. As with the river otter, creek side trails and camping, the presence of social trails, and the number of access routes into Fossil Creek should be carefully considered and limited to an amount appropriate for these species.

Monitoring

Monitoring for river otters and sign such as that conducted in recent years by the Arizona Game and Fish Department and the Tonto National Forest along the Verde River should continue. Such monitoring should occur yearly if possible and should be extended into the lower reaches of Fossil Creek through at least 2010. Long-term monitoring of Fossil Creek should continue to take place in the lower reaches and be extended into the middle and upper reaches of Fossil Creek dependent upon on-going monitoring results.

Monitoring for sensitive bat species including the western red bat, California leaf-nosed bat, spotted bat, Allen's big-eared bat, and Townsend's big-eared bat should take place within the Fossil Creek watershed in the near future. While habitat for these species is present in the watershed, their presence is currently unknown. Such monitoring would determine if and when they are present and also determine if other bat species inhabit the area. Such monitoring should consist of, at a minimum, use of the Anabat II to record bat sonar, identify species present, and identify roost sites, if possible.

Given that the Arizona grey squirrel is a Forest Service Management Indicator Species, monitoring for the presence of this species within the riparian area of Fossil Creek is recommended. Determining if they are present, and if so, where and to what extent, will allow the Forest Service to manage for the species and its habitat more effectively.

Indicators

The presence of river otters in Fossil Creek may be a positive indication of the size of the fish population, as well as the water quality of the creek and the quality of riparian habitat. Given the native fish restoration efforts of late 2004, it may take some time for the natives to increase to the point that there is enough of a prey base to sustain otters. It is unclear when this may occur, however it is well known that the otters do well on main stem rivers such as the Verde and Oak Creek, and at the Bubbling Ponds hatchery, where fish are abundant.

Assuming that the prey base is adequate, if river otters consistently occupy the middle and upper reaches of Fossil Creek where recreational use is expected to have the most impact on the species, this may be an indication that recreational use is at an appropriate level for the species. Conversely, if river otter do not consistently occupy the middle and upper reaches of Fossil Creek despite the presence of suitable habitat, this may be an indication of recreational use at a level that is incompatible with the habitat needs of this species. Utlitmately, the determination of the suitability of Fossil Creek will be made by the river otters.

Roosting and hibernating bat species are extremely sensitive to disturbance. Their presence and health are indicative of the both the quality of habitat as well as the level of disturbance that is taking place.

Amphibians and Reptiles

Shaula Hedwall, Janie Agyagos, and Michele James

Amphibian and reptiles in the Fossil Creek area include several species of toads, frogs, lizards, and snakes. Amphibians include canyon tree frogs and lowland leopard frogs. Numerous species of lizards occur in the area; collared, fence, earless, side-blotched, and tree. Sonoran mud turtles are present in Fossil Creek (pers. comm. Cecilia Overby to Michele James). Snake species that occur in the area include: various garter snakes such as the black-necked and wandering; whip snakes; king snakes; gopher (bull) snake; and rattlesnakes such as the black-tailed, Arizona black, and Western diamondback. The species discussed below in more detail include only those special status amphibians and reptiles.

Special Status Reptiles and Amphibians

Lowland Leopard Frog (Rana yavapaiensis)

The lowland leopard frog was originally described by Platz and Frost (1984). The lowland is a relatively small (maximum length about 8.6 centimeters) tan, gray-brown, or light gray-green to green above, and yellow below, leopard frog (Stebbins 2003). The lowland leopard frog is distinguished from other Arizona leopard frogs by dorsolateral folds that are broken and inset towards the rear, a dark brown and tight reticulate pattern on the rear of the thigh, and usually no spots on the snout (Stebbins 2003). The historical range of the frog probably included Arizona, southeast California, southwest New Mexico, and northern Sonora and northwest Chihuahua, Mexico. The lowland leopard frog occupies permanent water in rivers, streams, springs, and persistent livestock tanks up to 4,800 feet elevation, but is more commonly found below 3,300 feet elevation. Leopard frogs are seldom found in association with predacious non-native fish species, bullfrogs or crayfish.

A breeding population of lowland leopard frogs is known to inhabit Fossil Creek, from the springs down to the Fossil Springs Diversion Dam. Some parties involved in the Fossil Creek Hydropower Decommissioning Project have expressed concern about the effects of the proposed action, specifically the removal of the Fossil Springs Diversion Dam, on the lowland leopard frog.

Nearly every ranid frog in Arizona, including the lowland leopard frog, has declined over the past two or three decades (Sredl et al. 1997). Although lowland leopard frogs seem to be the most stable ranid frog in Arizona, they have been extirpated from the lower Gila and Colorado Rivers of Arizona and adjacent California (Jennings and Hayes 1994) and may be extirpated from New Mexico (Degenhard et al. 1996). The lack of lowland leopard frog observations during 1993 surveys of large and important locations on the Verde River and Oak Creek raised concern for the viability of lowland leopard frog populations on the Coconino National Forest (Sredl et al. 1995a).

Lowland leopard frogs have been found in a number of locations on the Tonto National Forest, indicating good distribution throughout the Forest (Sredl et al. 1995b). However, on the Coconino National Forest, lowland leopard frogs have been documented in only four areas, one of which is Fossil Creek. The lowland leopard frog population above the Fossil Springs Diversion Dam constitutes over two-thirds of the total number of lowland leopard frogs on the Coconino National Forest. While habitat in varying degrees of suitability occurs below the Fossil Springs Diversion Dam, breeding populations of adult leopard frogs are not detected below the dam.

Arizona Toad (Bufo microscaphus microscaphus)

The Arizona toad occurs in rocky streams, canyons, and floodplains with dense riparian vegetation in elevations between 2,000 and 6,000 feet. They breed in gently flowing waters generally with well-developed riparian vegetation and feed on insects and snails. Sullivan (1991) reported Arizona toads from the Verde River just northwest of Child's Power Plant. Sullivan and Richardson (1993) reported that Arizona toads could potentially occur along the Verde River from West Clear Creek to the East Verde confluences. Although no surveys have been conducted, Fossil Creek offers suitable habitat for the Arizona toad.

Narrow-headed Garter Snake (Thamnophis rufipunctatus)

The narrow-headed garter snake is the most aquatic of the garter snakes, seldom found far from quiet, rocky pools in large streams and rivers. It is primarily a Mexican species, but is found in permanent drainages of the Mogollon Rim and White Mountains of Arizona. Food items include fish (native species preferred), frogs, tadpoles, and salamanders. Although there have no observations of the narrow-headed garter snake in Fossil Creek, suitable habitat currently exists throughout much of the Fossil Creek drainage (pers. comm. Erika Nowak, herpetologist, USGS; Andrew Holycross, herpetologist, ASU). The narrow-headed garter snake may potentially occur in the Verde River from West Clear Creek to Fossil Creek (Sullivan and Richardson 1993), although herpetological surveys have not located the species to date in either West Clear Creek or Wet Beaver Creek (pers. comm. Andrew Holycross).

Mexican Garter Snake (Thamnophic eques megalops)

The Mexican garter snake is usually found in or near streams and ponds in canyons up to 6,200 feet in elevation. This garter snake is most closely linked to shallow slow-moving or impounded waters, though it also occurs in other aquatic environments. The Mexican garter snake's diet consists of leopard frogs, toads, tadpoles, and various native fishes. Lizards and small rodents are taken during occasional terrestrial forays. The Mexican garter snake is known to be associated with leopard frogs which are a major prey species. Mexican garter snakes have been sighted along the Verde River and several of its tributaries but there are no known sightings or specimens from the Fossil Creek drainage. Erika Nowak, USGS herpetologist, has indicated that Fossil Creek riparian is potential habitat for the Mexican garter snake. Andrew Holycross, herpetologist with Arizona State University indicates that the lower few miles of Fossil Creek may provide habitat for the Mexican garter snake if the water is relatively slow moving, not too cold, and contains well-vegetated banks (pers. comm. Andrew Holycross).

Arizona Night Lizard (Xantusia vigilis arizonae)

In central Arizona, the Arizona night lizard ranges from the western slope of the Central Plateau (Weaver, McCloud, and Superstition Mountains, Tonto National Monument, and Valentine), in Haulapai, Harquahala, Kofa, and Castle Dome Mountains, and at other scattered localities (Stebbins 1985). Habitat for this secretive lizard is arid or semiarid lands, where it lives beneath fallen brances of Joshua trees, dead clumps of various other species of yucca, nolina, agave and cardons and is also found in rock crevices, beneath cow chips, soil-matted dead brush and other debris, and beneath logs (Stebbins 1985). Arizona night lizards are seldom found in the open away from cover (Stebbins 1985).

No surveys have been done in the project area for this species and there are no known records of its occurrence. However, it is listed as a fairly common, permanent resident of desert scrub and grasslands on the Coconino National Forest.

Restoration Goals and Objectives

The restoration goals and objectives specifically related to the lowland leopard frog in Fossil Creek include maintaining the existing breeding population of leopard frogs in Fossil Creek above the Fossil Springs Diversion Dam, allowing for the development of riparian habitat downstream of the Fossil Springs Diversion Dam, and reestablishing a sustainable population of lowland leopard frogs below the Fossil Springs Diversion Dam. The native fish restoration project began this process by removing non-native fishes from approximately 9 miles of the creek. In addition, the return of full flows to the creek will result in habitat changes downstream of the diversion dam. It is anticipated that once full flows are restored to Fossil Creek, the buildup of travertine and the resulting formation of pools and aquatic vegetation will allow for populations of leopard frogs below the dam to become established and to persist. However, the lack of locations at historical sites (Sredl et al. 1995a) and the disappearance of leopard frogs from occupied sites combined with the frog's susceptibility to local extirpation and the presence of predators (e.g., crayfish) is reason for concern. Monitoring the development and/or loss of lowland leopard frog habitat is important to the management of the frog in Fossil Creek. In addition, the Fossil Springs Diversion Dam removal may adversely impact frogs currently utilizing the pool above the dam. Monitoring should track the presence/absence and distribution of frogs prior to, during, and after the removal of the dam.

Restoration goals for the sensitive reptiles are to ensure water quality within Fossil Creek and habitat quality both within the creek and within adjacent riparian areas. Of particular concern for the Arizona toad, narrow-headed garter snake and Mexican garter snake, if they are found to be present in Fossil Creek, is the requirement for slow moving backwater areas that are necessary for nursery habitat. It is unknown if the restoration of full flows will allow for the presence of such backwaters. It is very likely that, as travertine dams and pools form after the return of full flows, these backwaters may develop over time. These backwaters need to be at least a meter or more in size, have slow moving water, warmer water, and vegetation on the stream bank (pers. comm. Erika Nowak). There is a significant correlation between the presence of backwaters and young of these species. If these backwater areas are not present, young of the Arizona toad and the two gartner snakes will not be able to survive in Fossil Creek.

A further concern is the very real potential for recreational impacts to these backwater areas. Recreationists are attracted to such areas and this can result in trampling of vegetation and soils, resulting in bank compaction, erosion, and the creation of cut banks (pers. comm. Erika Nowak). Recreation can also increase silt loads which leads to decreased dissolved oxygenation of the interstitial areas where fish lay their eggs and affects the spaces between rocks used for foraging by narrow-headed garter snakes (Nowak and Santana-Bendix 2002). It has been suggested that heavy siltation will negatively affect narrow-headed garter snake populations due to this loss of prey microhabitat (Nowak and Santana-Bendix 2002). A further threat to the narrow-headed garter snake is direct killing by people because this snake looks similar to the poisonous water moccasin (pers. comm. Erika Nowak). A method that has been suggested for use within habitat for the narrow-headed garter snake in Oak Creek, Arizona is the installation of signs at developed areas with pictures of the snakes and information about their status and biology (Nowak and Santana-Bendix 2002).

Although bull frogs have not been observed in Fossil Creek except for near the confluence with the Verde River (pers. comm. Shaula Hedwall, fish and wildlife biologist, U.S. Fish and Wildlife Service), expansion of this non-native frog further into

Fossil Creek has the potential to negatively affect the lowland leopard frog, the Arizona toad, and the narrow-headed and Mexican garter snake.

Monitoring and Indicators: Lowland Leopard Frog

Trends and Implications of Monitoring to Date

The Arizona Game and Fish Department, EnviroNet Inc., the U.S. Fish and Wildlife Service, and the U.S. Forest Service have conducted surveys for leopard frogs in Fossil Springs, Fossil Creek, and stock tanks within the Fossil Creek drainage. All life stages of lowland leopard frogs have been observed in abundance above the dam in the Fossil Springs area. Below the dam, lowland leopard frogs were found near the Coconino National Forest Boundary in 1950, but not in 1985, 1990, 1992, or 1995. Surveys conducted in 1998 by EnviroNet, Inc. did not locate any leopard frogs from the bridge to the Irving Power Plant, nor further upstream to approximately 3,840 feet elevation. Abundant metamorphic stages of tadpoles were observed from a spring at 3,840 feet elevation throughout the stream channel upstream to the Fossil Springs Diversion Dam. In 1998, no crayfish were observed above the 3,840 feet elevation mark where tadpoles were numerous. EnviroNet, Inc. surveys did locate a few immature lowland leopard frogs in a small side pool, upstream of the Fossil Creek confluence with the Verde River. Several lowland leopard frogs were observed by Manuel Santana-Bendix (Northern Arizona University) while conducting reptile surveys in Fossil Creek in 2004 and agency biologists observed several subadult frogs below the Fossil Springs Diversion Dam but above the "sunfish barrier"[17]. Despite these few recent observations, the few numbers of frogs observed below the Fossil Springs Diversion Dam indicates that populations below the dam are currently unsustainable. This is most likely due to the presence of predacious non-native fish and crayfish species.

Recommendations for Future Short- and Long-Term Monitoring

For lowland leopard frogs, the objectives of the "Monitoring and Adaptive Management Strategy for Special Status Species and Habitat Associated with the Childs-Irving Project Decommissioning" (Childs Irving Document Number CI-CP-18, November 15, 2004) prepared by the Forest Service, U.S. Fish and Wildlife Service, and Arizona Public Service are: 1) to monitor the distribution of lowland leopard frogs prior to, during, and after the removal of the Fossil Springs Diversion Dam along the length of Fossil Creek; 2) to monitor the persistence of the existing leopard frog population throughout the decommissioning process; and, 3) to monitor the development of riparian habitat downstream of the Fossil Springs Diversion Dam prior to dam removal. The protocols and process for determining these objectives are outlined in the Monitoring Strategy. If information indicates that the lowland leopard frog is declining and habitat is not developing downstream, the removal of the Fossil Springs Diversion Dam may be modified.

Monitoring and Indicators: Arizona Toad, Narrow-headed Garter Snake, and Mexican Garter Snake

Some baseline inventory work has been completed for reptiles in Fossil Creek (by Manuel Santana-Bendix, NAU), however it is not complete (pers. comm. Erika Nowak). Therefore, the first priority for monitoring of these species is to complete baseline inventory work and determine if these sensitive species are present at Fossil Creek. It is expected that completing the baseline inventory work would take minimal time and expense given that some of this work has already been completed.

Monitoring should take place in the form of determining if nursery habitat for these species is present, to what extent, and determining if such habitat is being impacted by recreational use. Because both the narrow-headed and Mexican garter snake populations are in decline throughout Arizona, monitoring for both the presence of these species and the condition of habitat for these species should be the priority in Fossil Creek (pers. comm. Erika Nowak). Impacts to nursery habitat for these snakes and the Arizona toad is the most significant threat to these species (pers. comm. Erika Nowak).

If inventory and monitoring indicate that these species are present and that this important habitat is impacted negatively by recreational use, we recommend considering fencing and information signing of some of these areas. While we understand that fencing is a time-consuming activity given the potential for large flood flows in Fossil Creek, the long-term viability of these species in Fossil Creek may require such methods.

Because of the significant potential harm to these native species that will result from the presence of bullfrogs, we recommend monitoring of the movement of bullfrogs upstream into Fossil Creek and the implementation of appropriate removal methods if they are found to be expanding further into Fossil Creek.

The presence of the lowland leopard frog and the health of the population will be an indicator of the water quality and relative health of the Fossil Creek riparian area. Frogs are some of the best indicators of habitat health, and thus, careful attention should be paid to the health of the lowland leopard frog in Fossil Creek.

If the Arizona toad, narrow-headed and/or Mexican garter snakes are located in the Fossil Creek drainage, their continued presence will be an indicator of the health and condition of the riparian area and in particular, nursery backwaters.

Janie Agyagos and Michele James

All of the invertebrates discussed in this section are special status species.

Fossil Springsnail (Pyrgulopsis simplex)

Although an aquatic species, the Fossil springsnail is discussed in this section with the other special status invertebrates (it is also discussed to a limited extent in the Macroinvertebrates section of this report). Springsnails of the genus *Pyrgulopsis* typically occur on rock or aquatic macrophytes in moderate current. The Fossil springsnail is typically found only in the headspring and upper sections of the outflows at the various Fossil Springs. Because springsnails are minuscule in size, and have only a partial operculum, they cannot withstand any desiccation, and occur only in water that is perennially flowing. In addition, there is evidently some chemical requirement that causes them to occur only in the very headwaters of a spring. The Forest Service indicates that the Fossil springsnail has experienced no apparent reduction in range or abundance as a result of activities in the Fossil Creek watershed during the past two decades.

Maricopa Tiger Beetle (Cicindela oregona Maricopa), and *A Tiger Beetle (Cicindela hirticollis corpuscular)*

Tiger beetles prefer open sandy areas, often along bodies of water. They construct burrows in the sand which they use for refuge. Tiger beetles lay their eggs in tiny vertical shafts in the sand.

The Maricopa tiger beetle (*Cicindela oregona maricopa*) frequents the edges of lakes and streams (Papp 1979). It is found from California to New Mexico and has been found in 10 Arizona counties including Yavapai. Adults are active from April to October and are found along streams (Bertholf 1983).

The *Cicindela hirticollis corpuscula* subspecies of tiger beetle occurs in the southwest from Texas to California (Bertholf 1983). Although Bertholf does not list Yavapai County among the 7 counties in Arizona where the species has been recorded from the state, it has been found in counties all around Yavapai County, suggesting its possible occurrence in the Fossil Creek area. Adult tiger beetles can be found from April to November.

Terrestrial Ecosystem Survey soil data was queried for a variety of sandy soil types in order to determine potential habitat for both species of tiger beetle. Sandy soils are present along Fossil Creek from where the road crosses Fossil Creek below Irving downstream to its confluence with the Verde River (Zones 4 and 5) and along the entire portion of the Verde River in proximity to Fossil Creek. Sandy soils are also present in the uplands but since these species occur near water, it is not anticipated that they would occur in the upland areas since no springs, seeps, or tanks are present.

Freeman's Agave Borer (Agathymus baueri freemani), Neumogen's Giant Skipper (Agathymus neumoegeni), and, *Aryxna Giant Skipper (Agathymus aryxna)*

The genus *Agathymus* is in the Aegialini tribe of the subfamily Megathyminae, which are collectively known as the giant skippers. These are the only butterflies whose larvae exclusively bore into flesh leaves or roots. Larvae of the Megathyminae have adapted to feeding only on plants of the Agave family.

The larvae of the Aigailini tribe feed exclusively on agaves and are known as the trapdoor giant skippers because of the silken trapdoor that larger larvae construct over the opening to their burrow in an agave leaf. Eggs are laid on or near the host plant. Young larvae bore into the leaf tips and eat pulp within the leaf and then hibernate there. The following season, the third-stage larvae move down to the base of the leaf where they bore in again. They continue eating pulp and later sap in a chamber in the leaf base, silking over the opening in the leaf after each molt. Mature larvae stop eating, remain quiescent for a period of time, then powder the inside of the chamber and construct a silken trap door at the opening to this nest cavity. Here the larvae pupae emerge as adult butterflies. The adult butterfly stage is short, lasting one to two weeks during which time it breeds, lays eggs, and dies. The adult butterflies do not feed on flowers nor do they migrate. They can often be found feeding near mud or manure, or perching on the host plant, other bushes, or on rocks (Scott 1986).

The Freeman's agave borer is found in Mohave and Sonoran desertscrub of central and southwestern Arizona. It inhabits canyons, and requires agave host plants, specifically, *Agave chrysantha* (Pyle 1981).

The Neumogen's giant skipper has been reported from the upper Sonoran deertscrub or lower Transition Zone in open woodland or shrub-grassland habitats, where its host plant is *Agave parryii* and probably *A. chrysantha* (Wallesz 1999; Opler et al. 1995). Larvae are found on small host plants (Scott 1986). Pre-pupating larvae make the trapdoor of the nest cavity on the upper side of the leaf-base. There are confirmed record of the *A. neumoegeni* complex from Coconino and Yavapai Counties (Wallesz 1999).

The Aryxna giant skipper is found in upper Sonoran desertscrub and semi-desert grasslands into petran montane coniferous forests. Habitat for the Aryxna giant skipper is arid but well vegetated desert canyons (Pyle 1981), or canyons with periodic water and open grassy woodlands (Opler et al. 1995). The caterpillar host is *Agave palmeri, chrysantha,* and *deserti.* These species make the trapdoor on the underside of the leaf-base. Adult females never feed and adult males sip water from mud (Opler et al. 1995).

TES soil mapping units were queried for agave host plants. Almost all of the soils within the Fossil Creek watershed support at least one species of agave, therefore, most of the area is potential habitat for these three giant skippers (Table 19). Surveys for these three species have not been conducted, and population status within the watershed is unknown.

Blue-black Silverspot Butterfly (Speyeria nokomis nokomis), Mountain Silverspot Butterfly (S.n. nitocris)

The mountain silverspot and blue-black silverspot are riparian dependent butterflies. The larvae of both silverspots feed on species of Viola while the adults feed on thistle nectar. No surveys have been conducted within the Fossil Creek watershed and the population status is unknown. TES soil map units were queried for Viola and thistle plants. Mapping results show very few areas with soils that could support these host plants (Table 19). Within the watershed, there are three small pockets of potential habitat along Fossil Creek and along Mud Tank Draw.

Obsolete Viceroy Butterfly (Limenitis archippus obsolete)

The obsolete viceroy butterfly is a riparian dependent butterfly. The larvae and adult form of the obsolete viceroy feed on leaves, twigs and other plant parts of host species including willow and cottonwood. No surveys have been conducted within the watershed and the population status is unknown. TES soil map units were queried for willow and cottonwood species. Mapping results show potential habitat for this species occurs all along Fossil Creek, the Verde River, Sally May Wash, Tin Can Canyon, and Boulder Canyon.

Early Elfin (Desert Elfin) (Incisalia fotis)

This hairstreak butterfly favors roadsides with flowers (Borrer and White 1970), dry areas in mountains (Schneck 1990), and desert, rocky canyons, hills, and scrub (Opler et al. 1995). The host plant is cliffrose (Schneck 1990). According to Ferris and Brown (1981), they are locally uncommon among arid plateaus and desert mountains from 6000-7000 feet. In Arizona, the early elfin's range may be restricted to the northern portions of Coconino County (Wallesz 1999), making its presence in the watershed unlikely, however, no surveys have been conducted for this species.

No surveys have been conducted within the Fossil Creek watershed and the population status of this species is unknown. TES soil mapping units were queried for its main host plant, cliffrose.

Comstock's Hairstreak (Desert Green Hairstreak) (Callophrys comstocki)

This hairstreak butterfly occurs in desert ranges of southern California, largely in the Mojave Desert, also in parts of Nevada, Arizona, and Utah. The species favors dry, rocky areas (Schneck 1990) of foothills and canyons of the Upper Sonoran Mountain plateaus from 5000-6000 feet (Ferris and Brown 1981). Opler et al. (1995) give Comstock's hairstreak's habitat as sagebrush scrub and pinyon-juniper woodland. Larval host plants are various wild buckwheats (*Eriogonum*) (Schneck 1990; Ferris and Brown 1981; Opler et al. 1995).

No surveys have been done for this species in the watershed. In Arizona, there are confirmed records only in Navajo and Mohave Counties. TES soil mapping units were queried for this species main host plant, *Eriogonum*.

Spotted Skipperling (Piruna polingii)

The habitat of the spotted skipperling consists of moist meadows and streamsides in low to mid elevation mountains. In southeast Arizona, this species takes nectar avidly along cool, deep canyons and along forested road margins. The species has been seen congregating on moist cliffsides. *Dactylis glomerata* (Poaceae) is a strongly suspected food plant. While extensive plant surveys have occurred in the riparian area associated with Fossil Springs and creek, there has been one survey conducted in the uplands. *Dactylis glomerata* was not found in any plant surveys conducted in the watershed. Despite this, grassing openings with various species of grasses are present throughout the pinyon juniper, ponderosa pine, and mixed conifer vegetation types. Therefore, it appears that there is an abundance of potential habitat for this species in the watershed. The vegetation coverage was queried for pinyon-juniper, ponderosa pine, and mixed conifer to determine potential habitat within the watershed (Table 19).

Netwing Midge (Agathos arizonicus), Hoary Skimmer (Libelula nodisticta), and, *Arizona Snaketail (Ophiogomphus arizonicus)*

Sensitive aquatic invertebrate species that may occur in Fossil Creek include the netwing midge, hoary skimmer, and Arizona snaketail. All require perennial water, however, the hoary skimmer is associated with still water, the netwing midge prefers swift moving waters associated with waterfalls, and the snaketail occurs in stream habitat rather than pond habitats where it burrows underneath debris on the stream bottom. These species may occur in Fossil Creek and the Verde River where the appropriate stream geomorphology is present.

Table 19. Potential habitat for various sensitive invertebrates based on host plant presence within the Fossil Creek planning area. (Table from U.S. Forest Service, Coconino National Forest.)

Species Name	Habitat in the Planning Area	Percentage of Habitat Within the Planning Area
Maricopa Tiger Beetle	4,632	2.42
Tiger Beetle	4,632	2.42
Freeman's Agave Borer	601	0.31
Aryxna Giant Skipper	19,909	10.40
Neumogen's Giant Skipper	19,308	10.08
Blue-black Silverspot Butterfly	126	0.07
Mountain Silverspot Butterfly	126	0.07
Obsolete Viceroy	741	0.39
Early Elfin	17,016	8.89
Comstock's Hairstreak	12,382	6.47
Spotted Skipperling	21,563	11.26
Netwing Midge	113	0.06
Hoary Skimmer	113	0.06
Arizona Snaketail	113	0.06

Restoration Goals

The Fossil springsnail occurs only at outflow locations of the numerous springs in the Fossil Springs area. The Forest Service indicates that the springsnail has not been impacted by the activities in the watershed over the last 20 years. The range and abundance of this springsnail prior to diversion of flows in Fossil Creek is unknown. Restoration goals for the Fossil springsnail are to ensure no loss of habitat at the springs and to preserve the water quality in and around the springs. Of concern are recreational activities at the various springs which can directly impact the springsnail through handling and stepping upon the rocks to which the snail attaches itself, crushing the snails. Recreational activities can also affect the vegetation around the springs and increase the potential for negative effects to water quality. Access to the springs should be carefully monitored and limited if monitoring indicates impacts to this snail.

Although the presence or absence within the watershed of the majority of the sensitive invertebrates is unknown at this time, aquatic habitat provided by Fossil Creek is of importance to many of these species (two subspecies of tiger beetle, two subspecies of silverspot butterflies, the obsolete viceroy butterfly, spotted skipperling, netwing midge, hoary skimmer, and Arizona snaketail). Restoration goals for these sensitive invertebrates are to ensure water quality within Fossil Creek and habitat quality both within the creek itself and within the riparian area. Recreational activity has the potential to negatively affect water quality as well as riparian vegetation.

Monitoring

Because recreational use at Fossil Springs could potentially negatively affect the sensitive Fossil springsnail, we recommend that monitoring of this species be given a high priority. Monitoring of the Fossil springsnail should occur at regular intervals to determine if recreation is resulting in negative impacts to the snail and its habitat. Because recreational use is expected in increase with the return of full flows to Fossil Creek, we recommend that monitoring begin as soon as possible so that any impacts can be identified and immediate action taken if necessary. We recommend the development of a monitoring protocol and plan specific to the Fossil springsnail by the end of 2006 or earlier.

While habitat is present in the watershed for these 14 sensitive invertebrates, surveys have not been conducted in the area. The first step in monitoring then is to conduct presence/absence surveys. We recommend that these surveys be conducted for the invertebrates most at risk of potential negative effects related to restoration of Fossil Creek, namely recreational activity. Surveys should be conducted in places where recreational activity is currently occurring or where it may occur given the predicted increase in visitation as a result of return of full flows. While we believe such surveys are important, we suggest that monitoring for the springsnail, as discussed above, be given priority.

Indicators

The presence of the Fossil springsnail and health of the population is an indicator of the relative health of the spring outflows in Fossil Creek. In particular, these factors indicate the health of the habitat associated with the springs as well as the overall water quality. If the springsnail population is considered healthy at the spring outflows where recreational use may impact on the species, this will be an indication that recreational use is at a benign or acceptable level. Conversely, if the springsnail population is not healthy despite the presence of suitable habitat and water quality, this will be an indication of recreational use at a level that is incompatible with the habitat needs of this species.

The presence of and health of sensitive invertebrate populations that may be present in the Fossil Creek watershed could be affected by a variety of factors. For those invertebrates that are present in the watershed within or adjacent to Fossil Creek, an indication of their health will be the condition of the riparian area and water quality. Recreational activity occurs both within the riparian area, with the creek itself, as well as within the upland portions of the watershed. The presence of a given invertebrate may assist in determining the health of a particular habitat type within the watershed.

Humans and the Social Environment

Cultural and Archeological Resources

Sharynne-Marie Blood and Scott Wood

Introduction

The historic and cultural resources of the Fossil Creek watershed consist of those prehistoric and historic archaeological sites and historic structures within the watershed, including those areas identified as having traditional or religious significance by the Indian tribes who lived there historically.

Archaeological investigations have been conducted in the Verde Valley and the Fossil Creek drainage beginning in 1890 when Dr. E. A. Mearns, U.S. Army, published a brief account in Popular Science Monthly (Mearns 1890) of Indian ruins in the Verde Valley. In 1891, Cosmos Mindeleff, Bureau of American Ethnology (Mindeleff 1896), followed the River Trail from what is now Horseshoe Dam to Camp Verde, recording prehistoric ruins, irrigation works, and a series of natural and artificial caves ("cavates") along the way. Several of these sites are within or adjacent to the Verde Wild and Scenic River corridor. In 1928, Frank Midvale, Gila Pueblo Foundation, made a similar journey, recording several of the same sites as Mindeleff had along with a number of others (Gladwin & Gladwin 1930). These efforts focused on recording the large masonry ruins that represented a substantial residential occupation in the later prehistoric period. Neither survey could be considered any more than a preliminary reconnaissance.

Since the 1970's, periodic surveys by Forest Service archaeologists from the Tonto and Coconino National Forests in support of trail work, fence construction, and other small scale activities have added to the inventory. Forest Service archaeologists from the two Forests have also made occasional condition inspections of sites within the planning area, focusing on several of the better known and accessible sites.

Since then, the primary archaeological survey of the project area was conducted by Archaeological Consulting Services (ACS) to provide specific planning information for a Memorandum of Agreement that would provide for the continued operation of the Child's-Irving Hydroelectric power project (Macnider et al. 1991). An important result of this archaeological survey was the nomination to and listing on the National Register of Historic Places of the Child's-Irving Hydroelectric power project. The listing acknowledged the importance and significance of the hydropower facilities, not only the elements included as contributing but also the entire historic landscape that dominates the Fossil Creek corridor.

While providing comprehensive information about sites along the flume corridor, the inventory did not provide sufficient information to adequately inform management decisions regarding land use within the entire Fossil Creek Planning Area. In order to better inform this environmental analysis, an archaeological and ethnohistorical study was contracted by the Forest to SWCA, Inc. This study included an archival review of existing literature, interviews with tribal cultural specialists, and field inspections with the tribal cultural specialists of specific sites along Fossil Creek. Additionally, an interpretive plan for the hydropower facilities as well as the prehistoric sites within the planning area was prepared.

Current Knowledge of Historic and Cultural Use

The Fossil Creek planning area is known to contain archaeological evidence of the occupation and agricultural use and modification of the Fossil Creek floodplains, terraces, and hill slopes by people of the prehistoric Southern Sinagua cultural traditions over a period of at least 600 years. It may contain sites of human use and occupation from as long ago as 8,000 to 10,000 years.

It is also expected to contain a number of pre-European contact and historic sites reflecting use by Yavapai and Apache hunters, gatherers, and farmers and by European, Mexican, and Euro-American stockmen who raised or drove cattle and sheep throughout the area. It also contains a significant[18] part of the industrial history of Arizona, as it contains the site of the earliest hydroelectric generating system in the State at the small settlements of Childs and Irving, currently still occupied. The significance of the Childs and Irving power plants has already been recognized by listing the sites in the National Register of Historic Places and the American Society of Mechanical Engineers who recognized the system's historic engineering and construction significance by selecting it as the 11th National Historical Mechanical Engineering Landmark.

Archaeological surveys, including an assessment of the Childs-Irving Hydroelectric System (Macnider et al. 1991) have identified a wide range of features embedded into the Fossil Creek analysis area landscape, including nearly invisible scatters of discarded artifacts and trash, collapsed and buried pit houses, intact cliff dwellings and ruins exceeding 20 rooms in size, and buildings collapsed into masonry rubble piles up to two meters high.

The great majority of these features are prehistoric in date and consist most frequently of collapsed stone masonry structures of various sizes, stone-built water control devices, pit ovens for preparing plant and animal foods, and petroglyphs, rock art hammered into the surfaces of boulders and basalt outcrops (Macnider et al. 1991).

No specifically located ethnographic resources, traditional cultural properties, native plant gathering areas, sacred sites, or other significant Tribal places have been securely identified within the Fossil Creek planning area (Neal 2003). Nevertheless, portions of the Fossil Creek planning area fall within the traditional territories of the Bald Mountain and Fossil Creek Bands of the *Dil zhéé*, or Tonto Apache, as well as different groups of Yavapai. At least eight *Dil zhéé* clans, some mixed with Yavapai, are known to have inhabited portions of the planning area or kept farms there. Several may have originated in the Fossil Creek drainage. In addition, the *Dil zhéé* maintain many place names associated with features in and adjacent to the Fossil Creek planning area (North et al. 2003). Although specific sites with evidence of Apache or Yavapai occupation are fairly well represented in the current inventory, they can be expected to be found in greater numbers with additional survey and closer inspection of known sites for evidence of

Apache or Yavapai reoccupation. Likewise, as additional information can be gathered through interviews with tribal elders, specific locations may yet be identified that correspond to historic farms and camps.

Condition of the Historic and Cultural Resource Inventory of Fossil Creek

In general, it can be said that archaeological knowledge of the cultural resources within the planning area are poorly understood, with less than 3% of the area having been inventoried to current standards.

One hundred sixty-eight (168) archaeological and/or historic sites have been recorded or reported within or immediately adjacent to the Fossil Creek analysis area. The previous inventories were dominated by the larger, more permanent stone masonry residential sites with few other site types represented and the ACS study focused on the hydropower corridor (Macnider et al. 1991).

Twenty-seven of the 168 archaeological sites (16%) are now noted as permanent prehistoric residential settlements, ranging in size from small homesteads of one or two rooms to large masonry room blocks and outliers containing perhaps as many as 40 contiguous rooms. At least six of these are large, early pit house settlements. Another 42 (25%) are said to have been temporary prehistoric residential sites, usually one room structures known as "field houses".

Twenty-three prehistoric artifact scatters without masonry or other visible surface features or indications of subsurface pit houses are recorded and only nine prehistoric sites are described as defensive in either architecture or location. There are also a variety of prehistoric agricultural features associated with many of the residential sites.

There are 38 historic sites, all related to hydroelectric power generation, roads, trails, or ranching. With the exception of one hydropower related site and a few of the prehistoric agricultural sites, all of the historical and cultural sites inventoried in the analysis area, prehistoric and historic alike, are located outside the zone of riparian vegetation and scouring floods on the terraces, ridges, and hills overlooking the creek.

Site condition throughout the analysis area is highly variable. All of the large prehistoric pueblo sites could be characterized as having more than half of their recognizable features vandalized. Site impacts include looting, vandalism, erosion, alteration of site context, disturbance from management activities and recreation, disturbance from APS construction and maintenance activities, damage to tribal values, and disturbance from stock grazing. Overall impressions of the remainder of the inventoried sites suggest that they are generally in good condition.

Given the high level of site integrity and the significance of the settlement history of this area, all inventoried sites within the watershed are currently considered eligible for the National Register of Historic Places, pending further evaluation. Two sites are listed on the National Register, site AR-03-04-01-11, the Irving System, and site AR-03-04-01-12, the Childs Power System. Both sites were nominated and listed together as one Historic District, August 9, 1991.

Goals

The Forest Service is required by law and regulation to protect and preserve historic and cultural resources from damage, excessive deterioration, vandalism, looting, and the alteration of site context. The primary causes of impacts to historic and cultural resources in the Fossil Creek planning area are vandalism and looting. Damage from recreational activities is another potential source of impact. Thus, the primary goals following restoration of full flows to Fossil Creek are protection and preservation of cultural and historic properties from the expected increase in visitation.

Historic and cultural resources are best protected from vandalism and looting by active management, particularly observation and monitoring. This can be provided by Forest Service personnel inspecting sites on a regular basis, or by volunteer organizations such as the Arizona Site Stewards who perform a similar function. Recreational visitors can also keep an eye on each other, although this method requires that visitors be informed and aware of the consequences of looting and vandalism. Where roads and trails provide proximate access to historic and cultural sites, they can be more easily and frequently patrolled and monitored.

Vandalism and looting are impacts arising from intent, generally with foreknowledge that such activity is illegal. Passive methods of protection, including restricting access by physical barriers such as fences or by on-site notification and education signs, are effective only when combined with active observation and monitoring. In remote locations, where there is little concern that illegal activities will be observed, passive measures are easily and anonymously defeated. Contrary to conventional wisdom, lack of access is no deterrent to vandalism or looting.

These conclusions result from many years of observation by Forest Service and other land managers in Arizona over the last 30 years. It also derives from several decades of active participation in the Arizona volunteer Site Stewards program operated by the State Historic Preservation Officer. Since that program began, vandalism has decreased appreciably on the Tonto and Coconino National Forests. This decrease appears to correlate directly with increases in site visitation and monitoring by the Site Stewards. There is also a direct and very dramatic correlation between frequency of site visitation by the public and the reduction of vandalism, even at remote locations, a result of combined efforts by both Forests to interpret sites and expand public education and appreciation of heritage values. Vandalism also decreases in areas that are regularly patrolled by Forest Service Law Enforcement Officers. These observations form the basis for continued support of both the Site Steward program and the development of interpretive visitor facilities at major sites by land managers throughout Arizona. Reducing vehicular access to portions of the Fossil Creek planning area may also reduce the ability of Forest Service personnel and volunteer Site Stewards to monitor the condition of sites within the planning area and to enforce laws protecting them from vandalism and looting. Reduction of access would also result in reduced visitation in general, resulting in fewer potential observers of all kinds. Finally, reduction in vehicular accessibility increases law enforcement response time and costs.

High levels of recreation use may affect the integrity of historic and cultural resources as visitors expand use areas outside the established access points and campgrounds. Informal camping areas within site boundaries can impact site integrity through the introduction of modern trash, the removal of architectural materials to construct fire rings, and the digging of holes for disposing of waste. Other direct effects of camping on sites include the casual collection and displacement of surface artifacts and the establishment of informal trails that can initiate destructive gullying erosion. Camping on archeological sites, digging trenches around tents during the rainy season, digging shallow holes to bury garbage, repeatedly driving tent stakes into the surface of the site has a direct effect on site integrity. Indirect effects of camping on sites may include increased vandalism encouraged by the presence of fire rings and trash as an indicator that the sites might not be closely monitored or maintained. Protection from recreational activities can be achieved by a variety of methods. Active observation is effective, but requires a constant presence of Forest Service personnel in the area. Passive methods do not work nearly as well but are often considered cost effective under restrictive budgets.

It would be possible to provide opportunities for interpreting cultural and historic resources and educating visitors regarding rules of conduct when visiting and the laws and regulations protecting them. Patrol and monitoring of the area by Site Stewards would improve the effectiveness of historic and cultural resource law enforcement in the area.

Monitoring and Indicators

The archaeological monitoring and evaluation program is the management control system governing the implementation of the FCEIS. The program is designed to be the foundation for the long-term protection and enhancement of the primary creek-related values in the planning area. The specific objectives of this program are to determine whether:

- Future desired conditions are achieved;
- Management standards are being followed;
- Management standards are effective in protecting and enhancing the ORVs;
- Intensity of monitoring is commensurate with the risks, costs, and values involved in meeting desired conditions.

The monitoring activities described in Table 20 below are designed to be specific to the Fossil Creek area and are to be conducted in addition to other monitoring activities prescribed in the Coconino and Tonto Forest Plans. Implementation of the following monitoring elements will be based on the availability of funding. If adequate funding is not available some monitoring activities may not take place. Both National Forests involved with management of Fossil Creek will make every effort to identify opportunities that would reduce the actual cost to the government. The following table outlines the key indicators, resource conditions, sampling procedures, and typical resultant management actions that will be conducted on Fossil Creek by creek value.

There are no specific plans or directions for historic and cultural resources within the Fossil Creek planning area proposed by either of the existing Forest plans, though each contains objectives, standards, and priorities for the inventory, evaluation, protection, and enhancement of historic and cultural resources.

Under this management direction historic and cultural sites are to be preserved in place as the first priority for management, stabilized and repaired whenever possible, particularly when they have been damaged by vandalism, and provided with interpretation and other enhancements where appropriate and feasible.

Table 20. Summary of the Forest Service's Fossil Creek planning area monitoring program.

Value to be Maintained and Enhanced	Key Indicator	Resource Condition	Sampling Procedure and Frequency	Management Actions to be Triggered if Conditions are Not Met
Archaeological and Historic Site Integrity	Artifact Loss or Displacement due to Theft or Visitation	Surface artifact assemblage remains substantially intact with no more than 25% of baseline documented surface artifacts removed or destroyed.	Inspections of high probability and frequently visited sites by river rangers, minimum of once per year; Periodic inspections by heritage specialists; Additional inspections by volunteer site stewards as available.	Collect and curate appropriate sample of remaining artifacts and all diagnostic artifacts; Post site with protection message
	Contextual Damage	Standing or coursed masonry walls remain intact without damage from visitor use. Features and rock art remain free from vandalism. Sites remain free of evidence of recreational activities such as fire rings, trash, and unauthorized trails.	Inspections of high probability and frequently visited sites by Law Enforcement Officers, minimum of once per year; Periodic inspections by Heritage Specialists; Additional inspections by volunteer Site Stewards as available.	Stabilize and repair architectural and/or pothunting/vandalism damage; Remove trash, fire rings and obliterate trails; Post site with protection message; Establish temporary, seasonal, or permanent closures to prevent visitation of sensitive sites after repeated contextual damage impacts.
	Natural Damage	Features and cultural deposits remain substantially intact with no more than 10% damaged by natural erosion and no more than 5% removed by natural erosion. Features and cultural deposits remain substantially intact with no more than 25% damaged or removed by animal burrowing, trailing, or feeding.	Inspections of high probability and frequently visited sites by Law Enforcement Officers, minimum of once per year; Periodic inspections by Heritage Specialists; Additional inspections by volunteer Site Stewards as available.	Stabilize and repair erosional or animal caused damage; Redirect runoff away from erosionally sensitive features or cultural deposits; Identify and implement measures to redirect animal attraction to the site

The Yavapai-Apache Nation: A Brief Synopsis of Ancestral Ties to Fossil Creek

Christopher Coder and Vincent Randall

The Yavapai-Apache Nation is the modern amalgamation of two culturally distinct Tribes: (1) the Athapaskan speaking Dilzhe'e People (popularly known as Tonto Apaches) and (2) the surviving remnants of Yuman speaking Wipukapaya and Tolkapaya People, amongst others collectively known today as Yavapai. The Yavapai-Apache Tribe was formed by the federal government in 1934, under the Indian Reorganization Act, and recognized by the Secretary of the Interior as a formal political entity with the approval of the Tribal Constitution in 1937. The official status was changed to Yavapai-Apache Nation in 1992 in order to pay due respect to the two different cultures, which were formed into a single Native American Nation. In 'Old Apache' language, the term Dilzhe'e means, 'to go hunting' or 'going hunting' and that is the reputation these Western Apache People had amongst their surrounding neighbors and trading partners. Yavape'/Yavapai, means 'People of the Sun'.

In a confusing mixed-bag of recognition, there are several tribes around the state, including the descendents of Western Apache and or Yuman speaking "Yavapai" People. The modern San Carlos Apache Reservation was the nineteenth century site selected for the location of the concentration camp containing virtually all the western Apache groups, including the Dilzhe'e, as well as the various bands of Kevewekepaya, Tolkapaya, Wipukapaya and Yavape' (all collectively equal the Yavapai) who were hunted down and rounded up mostly west and south of the Verde River.

At the time of the federal conquests in central Arizona (1865-1873) the Dilzhe'e were in control of the lands east and north of the Verde while the Yuman speaking Wipukapaya held sway in the mountains directly to the west and south in the vicinity of Fossil Creek on the opposite side of the Verde. The Verde River was not construed by these people as a hard and fast boundary, but more as a frontier zone. The river corridor was used by both groups, who despite their linguistic and material differences, had cordial relations at the band and family levels, where they interfaced along the Middle and Upper Verde. Because of several factors held in common – similar procurement zones along the Verde, common trading partners (the Hopi) to the northeast, and common enemies to the south (the Pima, Papago and Maricopa's) – bands of these two People often collaborated because of their small numbers for defense, raiding and retribution.

We do not agree with the "one culture at a time only" model of southwestern cultural history. We believe in a more complicated and multicultural approach to the use of the landscape over time and, of course, this is not the place to elaborate. Suffice it to say families and bands of Yuman speaking Peoples have expanded and contracted into and out of the region for millennia in response to numerous factors and the Western Apaches have been entrenched in the countryside east of the Verde for centuries.

By the time Mexico ceded its Old Imperial Spanish lands to the United States in 1848 (Treaty of Guadelupe Hidalgo) a lot of the Apache world had been at war with Spain and subsequently Mexico for almost 250 years. Central Arizona was an exception to this, being remote from the hegemony of Spain. The Dizhe'e raided regularly into Chihuahua and throughout Sonora to the Pacific coast, but in the safe haven of their home country (including Fossil Creek) they were geographically too remote and beyond the wrath of Spanish retribution.

The Yavapai groups along the north side of the Gila were familiar with the Spaniards, but contact was sporadic and unproductive, whereas their relatives to the north were virtually out of contact with any Europeans or Euro-Americans until the coming of the Mountain men and prospectors into the country north of the Gila and along the Hassayampa River after 1848. After 1848 no one was beyond the logistical and bureaucratic hand of the government in Washington. This fact gained momentum through the 1850's. Immigration from the east was filling up the open range in southern Arizona and because of that central Arizona became a refugium for all sorts of small, but desperate groups trying to avoid the final push of the conquest: Mohaves, Yumas, Southern Paiutes, Navajos, mixed groups of Chiricahua, Mescallero's and other Western Apaches, along with the local Dilzhe'e (Apache) and the various groups of the indigenous People we now call Yavapai. For the sake of modern clarification (or confusion) the government historically referred to virtually all of these ethnically diverse tribes and local bands as some type of 'Apache' regardless of their actual ethnicity.

For centuries prior to the disruption of the conquest, the Dilzhe'e and their Yavapai neighbors lived with a light hand and silent tread on the landscape, which has left an almost invisible physical signature, making it almost impossible to discern their passing within the archaeological record. And this, for better or for worse, is the case in Fossil Creek Canyon and vicinity.

Prior to the round up and forced march to San Carlos, the Dilzhe'e had been entrenched in Fossil Creek for centuries. Many important stories, songs and lessons recognized within western Apache culture emanate from Fossil Creek. And, although we know lower Fossil Creek was used by neighboring bands of Yavapai from across the Verde as a resource zone, there is no one living who can tell us anything definite about it by way of legends or lessons or songs. The ethnographic material as it stands is unreliable and in some cases simply false. It is their ghost.

The Dilzhe'e on the other hand lived throughout the length of the Fossil Creek Canyon for centuries and they call it Tu Do Tliz, which simply means the Blue Water Place. As is mentioned in another section of this report, families descending from numerous Western Apache clans called it home seasonally and throughout the year. Fossil Creek was a Dilzhe'e paradise. Water is abundantly available for small garden plots and it also attracted and harbored populations of game. Neither the Apache (nor the Yavapai) ate fish so that resource was not exploited. There was however lots of game in the uplands and the surrounding countryside and canyons were a cornucopia of useful stone, minerals, plant foods and essential medicines. Materials used in weaving beautiful watertight baskets and the construction of, cradleboards, domestic structures (kowas/gowas) and other personal items were plentiful.

When the remaining Dilzhe'e and surviving Yavapai's were unilaterally removed from the Rio Verde Reserve and forced to San Carlos in the late winter of 1875, several Apache families stayed behind and hid out in Fossil Creek living quietly and invisibly in that old sanctuary until their relatives returned a generation later around 1900. By then of course everything had changed and instead of living the old lifestyle the men went to work around the state on numerous public construction projects such as Roosevelt Dam, Cherry Creek Road and, as would be expected, the Fossil Creek hydro-electric facility.

Today we know from numerous trips with Tribal elders into Fossil Creek the locations of dozens of Apache places, from garden plots and home sites to card playing spots and the places where stories such as Frog Boy and Where People Walked Off of the Rocks into the Clouds originated. We know where the Smith children were placed on the roof of the summer ramada, while the family dogs fought off a mountain lion all night. There is barely a trace remaining on the surface marking the passing of these events as 'archaeological evidence', yet it all took place just the same.

Even when Apache (and for that matter Yavapai) camps are occasionally located they are often construed or recorded as 'archaic' or 'lithic scatters', or 'concentration of fire cracked rock'. Most (but not all) western Apache material culture that is diagnostic is perishable, being made from bone, wood, sinew, buckskin, rawhide, hair or plant fibers.

The half-life of anyone of these items on the surface is negligible compared to a Sinagua room block, Anasazi granary or pot cache. The clues left by these People are often as subtle as compacted ground and some replacement vegetation and that is the bulk of their physical legacy within Fossil Creek country. The trails still criss-cross the landscape, many of the plants and animals remain, but precious little if anything exists that is truly Dizhe'e or from earlier incursion by Yavapai families. And curiously to Anglo culture, that is the way the Old Apaches wanted it. They respected the rhythms and nuance of the natural world to the point of utilizing it only to the extent they could survive (quite successfully) within it, without altering it. It is the ultimate compliment of a successful culture to its source of sustenance and a reflection on their world-class stewardship. The decommissioning is a tribute to that noninvasive lifestyle, which can be a lesson to us all.

Recreation

Matthew F. Jedra and Martha E. Lee

Introduction

Information on current recreation conditions at Fossil Creek comes primarily from a 2002 report by Christa Roughan from the Red Rock Ranger District of the Coconino National Forest. This report reflects the most current data available on Fossil Creek recreation opportunities, activities, and resource conditions. Preliminary data collected from the visitor survey distributed from August 2004 through December 2004 is also included to supplement and update Forest Service information.

This section is divided into three components: current trends in recreation opportunities, use, and impacts; monitoring; and indicators. The information compiled in this report will provide baseline data for future management of recreation at Fossil Creek.

Current Trends

Recreation Opportunities

Figure 14 presents the Recreation Opportunity Spectrum (ROS) map of Fossil Creek. This map is based on the 1992 Coconino National Forest's most current ROS inventory of recreation opportunities on the forest. The ROS inventory for the Tonto National Forest – managed portion of the Fossil Creek area will be added at a later date. In addition to the ROS, natural springs and streams of the Fossil Creek are added to the map. Fossil Creek appears in red on the ROS map.

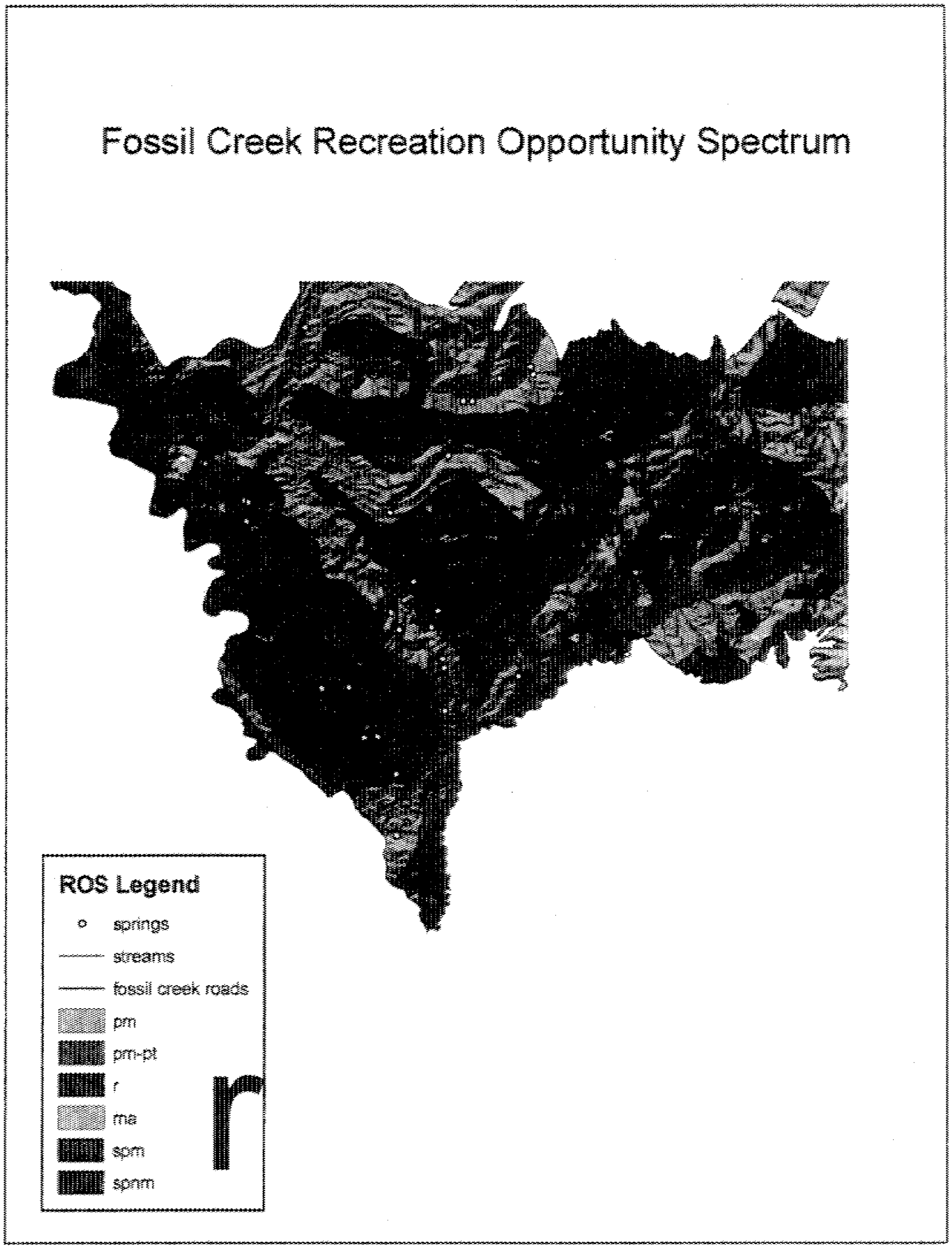


Figure 14. Recreation Opportunity Spectrum (ROS) inventory for the Fossil Creek recreation area (U.S. Forest Service 1992). The ROS classes are defined as; pm = primitive, pm-pt = primitive transition, r = roaded, rna = roaded natural area, spnm = semi-primitve non- motorized, and spm = semi-primitive motorized opportunities.

The recreation opportunities discussed in this section are major activities experienced by visitors to Fossil Creek in 2002. The opportunities mentioned here are a few of the activities that visitors take part in, but are not limited to. Information presented here comes from a 2002 Fossil Creek Watershed Analysis report prepared by the Red Rock Ranger District of the U.S. Forest Service (Roughan 2002).

a. Camping:

Camping is an important form of recreation at Fossil Creek. Majority of the campsites are dispersed, undeveloped, sites near popular swimming holes. These sites occur primarily along Forest Roads 708 and 502. Partying is also a known form of recreation at Fossil Creek. Roughan (2002) found a strong correlation among party locations and dispersed campsites along Fossil Creek.

The proximity of the communities of Pine, Strawberry, and Payson influence the condition of dispersed campsites. Sites closer to Pine and Strawberry on Forest Road 708 on the Tonto National Forest experience more use causing a greater amount of vegetation damage, and increasing the amount of denuded area at each site (Roughan 2002).

b. Swimming:

Water based activities such as swimming and fishing are common among visitors to Fossil Creek. Visitors participate in these activities at numerous locations along Fossil Creek. The majority of the swimming use takes place at the Forest Road 708 bridge. This area has limited parking which results in traffic congestion along Forest Road 708, especially during hot summer months and holidays (Roughan 2002).

c. Wilderness:

Located within the Fossil Creek area is a U.S. Congressionally designated Wilderness called Fossil Springs Wilderness on the Coconino National Forest in Arizona. The Fossil Springs Wilderness was designated in 1984 and includes 10,433 acres. Near the confluence of the Verde River and Fossil Creek is the Mazatzal Wilderness, located on the Tonto National Forest in Arizona. The Mazatzal Wilderness was designated in 1940 and expanded in 1984 and includes 252,500 acres.

d. Trail System:

The trail system within the Fossil Creek area provides hiking and backpacking opportunities into the Fossil Springs Wilderness and the Fossil Springs Botanical Area. Two designated trails are present in the Fossil Creek area, the Flume-Irving Trail (#154) and the Fossil Springs Trail (#18). Both are approximately 4 miles long. The Fossil Springs trail receives a significant amount of use compared to the Flume-Irving Trail due to the easier access to the trailhead (Roughan 2002).The Fossil Springs Trail drops approximately 1,500 ft in 4 miles and is a moderate to difficult hike. The Flume-Irving trail is roughly the same distance and has very little elevation change, less than 500 feet. The Flume-Irving trail is part of Forest Road 154 and provides access to Fossil Springs Wilderness. Forest Road 154/Flume-Irving Trail has three bridges and is primarily used by Arizona Power Company (APS), NAU researchers, and the U.S. Forest Service. APS currently maintains this road.

Throughout the Fossil Creek area there are a number of dispersed social trails throughout the Fossil Creek area that provide access to the creek at various locations. These dispersed trails are within close proximity to Forest Roads 708, 502, and 154 and dispersed campsites. *Social trails are user created trails created by continuous use. Social pathways result from short-cutting or from poorly marked trails or inadequate official trails.*

Recreation Use

a. Trail Use:

Trail registry data was gathered by the USFS Red Rock Ranger District from 1998-2003 at both Fossil Creek trailheads using trail registers located at each trailhead. The National Park Service Standard Trail Adjustment Factor was used to calculate more accurate trail usage (Roughan 2002). This expansion factor adjusts trail registration information to more accurately record the number of users a trail receives when a trail counter is not available. For example, for every trail user who registers, 2.5 people do not. When a trail counter is used, there is no need to use the NPS Standard Trail Adjustment Factor.

Flume-Irving Trail use ranged from 1,604 to 3,068 users between 1998 and 2003 (Table 21). The Fossil Springs Trail usage ranged from 5,922 to 26,651 users during the same time period (Roughan 2002). The Coconino National Forest was closed from June 2002 to July 2002 due to fire closures, thus lowering the number of users to the Flume-Irving and Fossil Springs Trails.

- Flume-Irving Trail #154: The Flume-Irving Trail had peak use by hikers and backpackers in the months of June, July, and September with an average group size of 1 to 2 people. The average annual recreation use was 2,446 visitors (Roughan 2002).

- Fossil Springs Trail #18: The Fossil Springs trail had peak use by hikers in the months of July, August, and September. The backpacker's peak use occurred in the months of April, July, and September, and the average group of visitors ranged from 4 to 8 people. The average annual recreation use was 15,568 visitors (Roughan 2002).

Table 21. Number of trail registrants from 1998-2003 for Fossil Springs and Flume-Irving Trail, Fossil Creek, Arizona.

Trail Name	Year	Day Use Hikers	Overnight Backpackers	Total	NPS Adjustment Factor	Number of Registrants after Adjustment Factor
Flume-Irving	2003	503	299	802	3.4	2719
Flume-Irving	2002	478	331	809	3.4	2743
Flume-Irving	2001	513	392	905	3.4	3068
Flume-Irving	2000	608	139	747	*2.2	1643
Flume-Irving	1999	505	224	729	*2.2	1604
Flume-Irving	1998	739	579	1318	*2.2	2900
Fossil Springs	2004	5655	3277	8932	*2.2	19,650
Fossil Springs	2003	2708	1279	3987	5.8	23,125
Fossil Springs	2002	2858	917	3775	5.8	21,895
Fossil Springs	2001	3227	1368	4595	5.8	26,651
Fossil Springs	2000	2315	377	2692	*2.2	5922
Fossil Springs	1999	2279	998	3277	*2.2	7209
Fossil Springs	1998	2474	1438	3912	*2.2	8606
Total		**24,349**	**11,319**	**35,678**		**125,016**

*National Park Service (NPS) Standard Trail Adjustment Factor. In the NPS Adjustment Factor column, please note that when it is a different number than 2.2, we had a trail counter placed at the trail to help record more accurate trail usage. For example, when the number is 5.8, for every 1 person who registers, 5.8 trail users do not.

b. Visitor Surveys

i. Childs Campground and Stehr Lake 2001 Visitor Survey

The Forest Service conducted a recreation user survey from July 2001 to October 2001 at the Child's Campground and Stehr Lake. Surveys were distributed randomly during the week and weekend. A total of 75 surveys were obtained during this time period (Roughan 2002) (see Appendix C for a copy of the survey questionnaire and a complete summary of survey results).

Results showed that day use on Monday through Friday was predominately visitors from the surrounding communities of Strawberry, Pine, and Camp Verde (Roughan 2002). Saturday and Sunday attracted more visitors from Phoenix, Flagstaff, and other surrounding communities. The most popular recreation activities at Stehr Lake and Child's Campground were camping, swimming, day hiking, and wildlife/nature viewing.

Eighty-eight percent of the visitors lived in Arizona, and 12 percent were from another state (Roughan 2002). Among fifty-five percent of Arizona visitors were from the Verde Valley or Pine/Strawberry areas and thirty-three percent were from other areas in Arizona (Roughan 2002). The majority of the visitors were in the 18-25 year old age group, thirty-six percent; followed by the 40-55 year old age group, twenty-seven percent, and then the 26-39 year old age group twenty-four percent (Roughan 2002). A majority of visitors stayed for two days, visited once a month, and visited the Verde Hot Springs numerous times.

ii. Fossil Creek 2004 Visitor Survey – Preliminary results

Northern Arizona University, School of Forestry began a recreation user survey in August 2004. The purpose of the survey was to obtain current information on Fossil Creek visitor demographics, preferred communication strategies, responses to proposed management strategies, recreation activities, and reasons for coming (see Appendix C for a copy of the survey questionnaire). Surveys are distributed to weekend visitors on-site at locations between Fossil Springs and Stehr Lake. As of early November 2004 approximately 258 surveys have been handed out, with 118 returned and analyzed. The survey will continue through December 2004 and begin again in Spring 2005. Highlights of the August – November 2004 survey results are included here. See Appendix C for a more complete summary of the preliminary results.

Fifty-two percent of Fossil Creek use occurs between the Irving Power Plant and the Fossil Springs Diversion Dam area. Forty-two percent of visitors stay for more than one day and 62 percent of visitors are returning visitors to Fossil Creek. Seventy-one percent of visitors access Fossil Creek from the town of Strawberry via Forest Road 708. Ninety-eight percent of the visitors are from Arizona and come with family and/or friends.

Most important reasons for visiting Fossil Creek include to view the scenery, to enjoy the sounds and smells of nature, to see Fossil Creek, to get away from life's demands, to be with family or friends, to experience tranquility, and to relieve stress and tension. The most popular recreation activities at Fossil Creek include sightseeing, walking, swimming, wading in Fossil Creek, and day hiking.

Forty-five percent of visitors support the removal of non-native fish, sixteen percent do not support the removal of non-native fish, and thirty-nine percent do not feel strongly one way or the other. Fifty-five percent of visitors support the removal of the Fossil Springs Diversion Dam to restore full flows, 30 percent do not support the removal of the dam, and 16 percent do not feel strongly one way or the other.

Recreation Impacts

In 2002 the Forest Service conducted a dispersed campsite impact inventory throughout the summer and into the fall at Fossil Creek. This research was conducted along Forest Roads 708, 708A, 500, 9D, 502, 9206W, 502A, and 154 along with the Fossil Springs Wilderness. A total of 211 campsites were inventoried (Roughan 2002):

107 campsites Forest Road 708 and 708A
6 campsites along Forest Road 500
2 campsites along Forest Road 9D
52 campsites along Forest Road 502
11 campsites along Forest Road 502 A

2 campsites along Forest Road 9206W
29 campsites in the Fossil Springs Wilderness
2 campsites below the Fossil Springs Diversion Dam

Each of the 211 campsites in the Fossil Creek area were evaluated as to the amount of impact to the surrounding environment. Each campsite was assigned a value based on the level of environmental impact. The campsites were rated as a 1 (low impact), 2 (moderate impact), and 3 (high impact). This rating was used to evaluate all 211 campsites based on eleven indicators: vehicle access, camp location, loss of ground vegetation, developments, site cleanliness, isolation, distance from Forest Road, tree damage, amount of root exposure, and the amount of toilet paper and human feces (Roughan 2002). Other information collected at each campsite included size of camp area and total denuded area, measured in square feet. In addition to, photo points, Global Position System (GPS) locations, compass bearings and a rough sketch of each site (Roughan 2002). Each campsite was individually tagged and given an identification number.

To analyze the results, a point system was assigned to each of the indicators, ranging 10-16 (low impact), 17-23 (moderate impact) to 24-30 (high impact) campsites (Roughan 2002). Based on the data collected from all 211 dispersed campsites, 85 were rated as low impact, 120 were rated as moderately impacted, and 6 were highly impacted.

The highest indicators measured on the 211 campsites were vegetation loss and the amount of toilet paper present at each campsite. The largest campsite has 12,080 square feet of denuded area. This site is located within riparian vegetation on Forest Road 708 in Hackberry Canyon. The second largest campsite is also located in riparian vegetation near Sycamore Spring. This campsite had 11,070 square feet of denuded area. The total amount of denuded area caused by dispersed camping in Fossil Creek in 2002 was approximately 8 acres or 347,785 square feet (Roughan 2002).

Monitoring

The recreation monitoring program at Fossil Creek is a collaborative effort between recreation managers on the Red Rocks Ranger District of the U.S. Forest Service (FS), and Northern Arizona University (NAU). The program is designed to build on existing Forest Service data about Fossil Creek visitors and visitor use. The program includes three information gathering and monitoring projects:

(1) a 20 question visitor survey gathering information on Fossil Creek visitors such as preferred information communication strategies, responses to proposed recreation management strategies, recreation activities, reasons for visiting Fossil Creek, and environmental stewardship (preliminary results presented above);

(2) a campsite impact and monitoring effort initiated by the Forest Service in 2002 (and described above) wherein campsites and other high use areas are mapped and permanent resource condition monitoring plots established; and

(3), a literature review focusing on identifying strategies for successfully implementing a Fossil Creek recreation monitoring and management plan including recommendations for education, engineering, and enforcement strategies based on a review of published literature and land management agency documents.

We will collaborate with the Forest Service and other Pulliam research partners on an information and education campaign designed to disseminate information about on-going Fossil Creek research and management within the Fossil Creek area and at planned public participatory meetings.

Indicators

Indicators useful for assessing change in recreation use conditions that will be measured as part of the on-going monitoring effort include: 1) the amount and type of recreation impacts occurring; 2) the number and distribution of Fossil Creek visitors, as measured by U.S. Forest Service trail registers; 3) visitor perceptions of Fossil Creek recreation experiences (types and extent of problems encountered, for example); and 4) visitor perceptions of Fossil Creek management decisions (changes in level of support, for example).

Grazing in the Fossil Creek Watershed

Compiled by Michele James

The following information is a summary of the existing grazing allotments with the Fossil Creek Watershed. Within the Coconino National Forest, four allotments are located partially within the 5th code watershed, and the information in this section, except where noted, is summarized from a September 30, 2002 U.S. Fish and Wildlife Service biological opinion (USFWS 2002a). Within the Tonto National Forest, three allotments are present within the 5th code watershed. Summaries of the Tonto allotments are from Christine Thiel, Supervisory Range Management Specialist, Payson and Pleasant Valley Ranger District, Tonto National Forest (electronic communication dated March 14, 2005).

Table 22 summarizes available information for each allotment.

Table 22. Acres, permitted use, type of grazing system, vegetation type, range condition and trend, and soil condition of grazing allotments in the Fossil Creek watershed.

Allotment:	13-Mile	Hackberry/ Pivot Rock	Fossil Creek	Deadman Mesa*	Cedar Bench	Hardscrabble**	Ike's Backbone***
Acres (Total/Capable):	31191/18996	80314/N/a	38482/N/a	32347/15388	32198/21160	20845/N/a	46271/N/a
Permitted use:	N/a cow/calf yearlong	760 head yearlong	477 cattle year long, 8 cattle & 5 horses temporary	150 adult cattle, winter use: 10/21-5/31	500 cattle, winter use: 11/1-5/31	140 adult cattle yearlong	280 cattle
Grazing system:	24 pastures year round, 40% utilization	51 pastures year round, 50% utilization	18 pastures year round, 60-70% utilization	8 pastures, rest rotation/deferred, <50% utilization on uplands	7 pastures, 30-40% key forage species in uplands	7 pastures yearlong, 30-40% utilization on key forage species in uplands	19 pastures
Vegetation type:	N/a	N/a	N/a	Pinyon-juniper woodland	Grasslands, Pinyon/juniper, ponderosa pine, riparian	N/a	N/a
Range condition & trend:	81% poor, 19% fair Stable to upward	42% poor, 13% fair, <1% very poor Stable to upward	Summer portion: 78% good to fair with upward trend, winter portion: N/a.	N/a	12% fair, 62% poor, 25% very poor	14% good, 29% fair, 43% poor, 14% very poor	N/a
Soil condition:	N/a	N/a	N/a	41% satisfactory	33% fair 67% poor	14% good, 72% fair, 14% poor	N/a

* Allotment in non-use status, and vacant with not current permittee.
** Allotment currently in non-use status.
*** Allotment combined with Skeleton Ridege Allotment; numbers presented are for both allotments.
N/A = Data not available.

Coconino National Forest

Allotments that fall partially within the Fossil Creek 5th code watershed on the Coconino National Forest include: Thirteen-mile Rock, Hackberry Pivot Rock (two allotments, treated as one), Fossil Creek, and Ike's Backbone (managed by the Tonto National Forest in combination with the Skeleton Ridge Allotment). Below is a brief summary of existing conditions as presented by the Forest Service for these four allotments.

Thirteen-mile Rock Allotment

This grazing Allotment Management Plan (AMP) and permit is in effect through December 21, 2010. It is 31,191 acres in size and falls within the following 5th code watersheds: Fossil Creek, Horseshoe Reservoir and West Clear Creek. The type of grazing system is described as: year-round on allotment in three zones (winter, transition, summer); 24 pastures; winter pastures grazed with intensive deferred rotation; summer and transition pastures grazed with singe herd, intensive rest-half/graze-half management strategy on alternative years; 40% utilization. The range condition and trend of the Allotment was described in 1999 as follows: 15,384 acres poor condition and 3,612 acres fair condition; 71% of Parker three-step clusters have fair to poor range condition. The Forest Service indicates that this allotment is in a stable to upward trend.

The AMP includes a plant phenology-based grazing strategy, a pattern of grazing use and permitted livestock numbers, and maintenance of existing range structures. Additionally, the AMP includes the addition of new range structures, soil and vegetation improvements, pinyon-juniper grassland maintenance, browse species maintenance and improvement, riparian vegetation monitoring and potential restoration at Cottonwood Spring, and general allotment monitoring. The AMP is described more specifically below:

• Maximum forage utilization levels would not exceed 40 percent average use within each pasture. This utilization level includes use by wildlife (e.g., elk). Livestock would be moved to the next pasture scheduled for grazing if the grazing use approaches 40 percent. Where livestock have access to West Clear Creek during the winter dormant period, a 20 percent or less utilization of woody species would be allowed if all three age classes of riparian vegetation are present. Only five percent use is allowed in riparian areas if the middle age class is absent.

• Livestock use would continue to be managed under the current plant phenology-based strategy with the graze-half/rest-half pattern in the high- and mid-elevation pastures and annual use in the low-elevation pastures. Pastures would be grazed for 20 days or less during the growing season and up to 60 days during the dormant season. The approximate duration of grazing for each pasture is planned during development of the annual operating plan (AOP) based on anticipated plant growth and resource needs; the actual duration of grazing could vary from the AOP schedule, depending on the actual plant growth stage encountered in each pasture.

• Wildlife breeding areas and key wintering habitat needs, soil conditions, and vegetative groundcover (plants and litter) would be specifically considered when planning annual livestock grazing use. During drought years, livestock would not be allowed to use pastures scheduled for rest that year.

• The Winter Unit would continue to be grazed for 60 days during the dormant season (January through February) each year until the proposed pasture-division fence is installed. When the division fence is complete, the grazing period would be reduced to approximately 30 days in each pasture during the dormant season. Existing livestock trails would be used to move livestock to the less steep country for grazing when livestock are moved into the Winter West Pasture in February.

• Livestock would be moved through the Winter West and Winter East Pastures during June within a maximum of 10 days using existing livestock trails. Livestock would be driven through the pasture and would not be allowed access to West Clear Creek.

• Livestock would be grazed in the Heifer Pasture for approximately 20 days in March. The two restricted access points to West Clear Creek would be used as the water sources for the herd during this grazing period. The herd would then be moved to the Wingfield Mesa group of five pastures.

• During June, livestock would be driven through the Heifer Pasture toward the summer grazing pastures over a maximum of five days. The main herd would move through the pasture in one to two days. The gates to the two restricted livestock access points on West Clear Creek would be closed during that time. If newborn calves cannot move through the pasture with the herd within the anticipated one to two-day move, the calves and their mothers would be allowed to stay for an additional two to three days while the remainder of the herd is moved through the Winter Unit(s). The gates to the water lanes would be opened while the calves and their mothers are allowed to stay in the Heifer Pasture. The calves and their mothers would be moved out of the Heifer Pasture to rejoin the main herd within three days.

• The Toms/Good Enough Pasture would be grazed every other year when the northern tier of pastures is being grazed to synchronize the graze-half/rest-half strategy with the four allotments to the north of the Thirteen-mile Rock Allotment.
• The Bob's and Cactus Pastures would not be grazed.

• Three of the four Wingfield Mesa pastures would be grazed under a rest-rotation strategy for 100 days each spring, with the sequence of use and rest altered each year among the pastures. The growth rate of cool season grasses would be monitored to determine the allowed length of the gazing period in each pasture.

Hackberry Pivot Rock Allotment

The AMP for these two allotments (Hackberry and Pivot Rock) expires on December 31, 2006. The allotments are 80,314 acres in size and 760 head of cattle are permitted. Fifth code watersheds in which these allotments fall partially or wholly include Fossil Creek, West Clear Creek, and Horseshoe Reservoir. The type of grazing system is described as: year-round on allotment in three zones (winter, transition, summer); 51 pastures; intensive rotation system with use based on plant phenological growth criteria; 50% utilization. The range condition and trend of these allotments is described as follows: Pivot Rock: (1962 to1983) 42% poor, 13% fair, <1% very poor; remainder rates as non-range and is closed to grazing; (1983) stable or upward trend in most transects; Hackberry: (1964 and 1967) majority of acres in poor and very poor condition; no range transect data to determine trend.

This allotment ranges in elevation from 2,800 feet along the Verde River to over 7,600 feet along the Mogollon Rim. Livestock are managed under the principles of Holistic Resource Management, with livestock movement, control, and use directly tied to plant growth. As an annual iteration of the AMP, the Annual Operating Instructions (AOI) specify pasture use and livestock numbers during a specific year. The AMP implements objectives for the allotment, which include improved watershed conditions through greater control of the livestock. The AMP, and thus the AOI, incorporate pasture rest from livestock grazing on an annual basis during the growing season in the winter/spring pastures, and within specified pastures in the summer/fall use areas. The allotment is grazed as separate seasonal zones – the winter/spring area pastures (Sonoran desert scrub/ pinyon-juniper) and the summer/fall area pastures (ponderosa pine). The AMP/AOI specify grazing all the winter/spring pastures (Hackberry portion of the allotment) from late October to late May. The summer/fall pastures (Pivot Rock portion of the allotment) are grazed from late May through late October. This grazing strategy, specified in the 2001 AOI, results in:

- complete rest from livestock grazing on three pastures in the summer/fall use areas (Baker, Huffer, and Potato);
- complete growing season rest or deferral in the winter/spring use area;
- pastures are grazed for short time periods (2 to 37 days), and most pastures are grazed once during the year, except when a lack of other access forces use of a previously grazed pasture as a pass-through to another pasture;
- growing season deferment on those summer/fall use pastures which are grazed by livestock during September and October.

Livestock management is tied directly to plant growth. When plants are in the dormant stage, grazing periods can be for as long as 2 months. During fast growth, most grazing periods are generally 20 days or less. These grazing periods reduce and/or eliminate the chance of overgrazing by domestic livestock.

In addition to the phenology-based management, in areas where there are two grazing ungulates in competition (cattle and elk), some pastures in the summer/fall area (Pivot

Rock Management Unit) are rested every other year, while others are deferred through the growing season every year. This allows for livestock and rest to be used as tools to help manipulate elk grazing patterns. That is, elk move into areas grazed by livestock once plant regrowth starts attaining the highest plane of nutrition from the new plant growth. At the same time, the rested pastures contain enough old feed to discourage elk from grazing on the new plant growth in those pastures. Fencing and topographic features prevent livestock from accessing the Verde River, which flows on the west side adjacent to the Hackberry management unit and is the allotment boundary. As a result of the fence construction along the Verde River, the allotment's permitted livestock are excluded from access to the Verde River, except for an emergency access for water. However, the steep slopes on the allotment prevent an even distribution of grazing throughout individual pastures, resulting in disproportionate use of riparian areas and riparian pastures.

A short segment (1/4 mile) of fence was constructed in the Potato Pasture in 1999 that, with the exclosure constructed in 1997 and the existing watershed exclosure in Potato Draw, splits this Pasture into the North and South Potato pastures. This will simplify management and increase flexibility in the Pivot Rock Management Unit. A livestock exclosure was constructed around Potato Lake in 2000, tying in to the fence discussed above, and totally excluding livestock from Potato Lake. A livestock exclosure was constructed in the Potato pasture in 1997, which excludes livestock grazing in the headwaters of East Clear Creek. In addition, short sections of drift fence were constructed in 1997 in the Kehl and Clear Creek pastures, downstream from the Potato Pastures, which will prevent cattle access to East Clear Creek. A mile of fence separates the Kehl and Clear Creek pastures. This fence crosses East Clear Creek near the junction of Poverty Draw and East Clear Creek. Due to past improvements, cattle can now cross East Clear Creek in only one location.

Fossil Creek Allotment

Extending above and below the Mogollon Rim, the Fossil Creek Allotment is 15 miles across from west to east. The Allotment's southern boundary is Fossil Creek proper, with the southern pastures extending to the banks of the Verde River. Elevations on the allotment range from 2,800 feet at the Verde River to 6,200 feet at the northeast corner near Salomon Lake. The Allotment is 38,482 acres in size. The permit for this allotment expires on December 31, 2005. Permitted use is 477 cattle and 8 cattle and 5 horses under a temporary permit. Fifth code watersheds include Fossil Creek, Horseshoe Reservoir and West Clear Creek. The type of grazing system is described as: year-round on allotment in three zones (winter, transition, summer); 18 pastures; intensive rotation system with use based on plant phenological growth criteria; 60-70% utilization. Range condition and trend were described in 1999 as follows: summer portion of allotment showed 78% of vegetation in good to fair conditions with upward trends. No data are available on winter range.

The Fossil Creek Allotment's vegetation follows traditional elevation regimes, with ponderosa pine stringers in the high elevations to grasslands and desert scrub at the low elevations. The allotment has three distinct management zones: the Winter Use Zone in the Verde Valley (2,800- 5,000 foot elevation); the Transition Use Zone in the pinyon/juniper woodlands (5,000-5,900 foot elevation) and the Summer Use Zone in the ponderosa pine (5,900-6,200-foot elevation). The allotment contains an estimated 340 acres of riparian habitat along several streamcourses.

The allotment's livestock are managed under the principles of Holistic Resource Management, with livestock movement, control, and use tied directly to plant growth. All pastures are grazed each year, with deferred rest. Pastures within the summer and winter ranges are rotated each year where each pasture is used at a different time of season when possible. This intensive management program, with its short-duration grazing periods, eliminates overgrazing and reduces the potential re-grazing of forage plants before full plant recovery occurs.

During the winter months of plant dormancy, the main herd grazes for approximately 35-40 days. There are 15-20-day grazing periods during active plant growth periods of the spring and summer months. Exceptions to these grazing periods do occur, particularly when dealing with small numbers of bulls and/or heifers during dormant growth periods (winter months), where g razing periods may extend from 60 to 90 days.

Livestock grazing occurs within riparian habitats during the dormant growing season within the Stehr Lake Pasture on a three-quarter mile portion of Fossil Creek and on the northeast side of Stehr Lake. To protect riparian habitat, sensitive stream conditions, and threatened, endangered, and sensitive species associated with the riparian area, grazing in the Stehr Lake Pasture occurs for only 15 days during January/February dormant growth periods. For the first time since the 15-day restriction has been imposed, cattle will rotate from Surge Tank to Boulder Pasture, trailing back through Stehr Lake Pasture. This trailing through Stehr Pasture is anticipated to occur over a 3- to 5-day period, with the majority of the herd moving within 1-2 days and the remnant numbers trailing over the next 2-3 days.

Following the 1998 Ongoing Grazing Consultation mitigation requirements, a Forest interdisciplinary team (including grazing permittee representatives) made an on-site evaluation of livestock access to Fossil Creek. The team found four access points for livestock entry to the creek. Two of the four access sites were fenced in December 1999 to protect the riparian habitat.

Ike's Backbone and Skeleton Ridge Allotments

These allotments are managed together by the Tonto National Forest, although the Ike's Backbone Allotment is located on the Coconino National Forest (pers. comm. Jerry Stefferud). The following limited information on the Ike's Backbone and Skeleton Ridge Allotments is from the Verde Wild and Scenic River Comprehensive Management Plan Final Environmental Assessment (June 2004).

The grazing permit for Ike's Backbone Allotment is held by the Skeleton Ridge Allotment permittee and the two allotments are managed together. The allotments are

46,271 acres in size and contain 19 pastures. Permitted livestock numbers total 280. Four pastures and a holding pasture allow livestock to access the Verde River in the winter and spring on the Skeleton Ridge Allotment. One pasture on the Ike's Backbone Allotment previously allowed livestock Verde River access, but is now fenced. About 20 cattle annually cross the Verde River from the Skeleton Ridge Allotment to graze Ike's Backbone in April and return to Skeleton Ridge in September.

Tonto National Forest

Allotments that fall partially within the Fossil Creek 5th code watershed on the Tonto National Forest include: Deadman Mesa, Cedar Bench, and Hardscrabble. Below is a brief summary of existing conditions as presented by the Forest Service for these three allotments.

Deadman Mesa Allotment

This allotment is 32,347 acres in size, of which 15,388 acres are considered capable (USFWS 2002b). The major vegetation type is pinyon-juniper woodland. The allotment has been vacant (in non-use status) since 2000 according to a Non-use Agreement for 183 AUMs. This Non-use Agreement will be resolved once the area has returned to a normal precipitation pattern (USFWS 2002b). The allotment is considered vacant with no current permittee.

This is a winter allotment with a term permit of 150 adult cattle, from October 21 – May 31. It is managed as a rest rotation/deferred system and contains eight allotments. The AMP for this allotment was approved on February 26, 1988.

Utilization limits are determined to be (USFWS 2002b):

Streambank – <20% of alterable banks;
Herbaceous – riparian, limit use to <30% plant biomass;
Woody – riparian, limit use to <50% of leaders on plants <4.5 feet tall; and
Uplands – limit use to <50%

The condition of the soils within the allotment is rated as overall unsatisfactory (41% satisfactory) and the riparian condition is rated as satisfactory (USFWS 2002b).

Cedar Bench Allotment

Cedar Bench is an active allotment with a term permit (winter season) of 500 permitted cattle between November 1 and May 31. The AMP for this allotment was approved on December 5, 1986. This allotment is 32,198 acres in size and includes the following vegetation types: grasslands (4,607 acres), pinyon-juniper (20,621 acres), ponderosa pine

(6,540 acres), and riparian (430 acres). There are seven main pastures within this allotment.

Utilization standards are set at: 30-40% on key forage species in the uplands; 50% of current year's growth on browse; 30% on riparian herbaceous species biomass, 50% of leaders browsed on the top 1/3 of woody species; and, streambank alteration is limited to less than 20% of alterable banks.

Range condition as measured in 1982/1985 is reported as:

Fair Condition – 2,574 acres (33% of allotment vegetation and soils visually estimated to be in fair condition);
Poor Condition – 13,204 acres (67% of allotment vegetation and soils reported visually to be in poor condition);
Very Poor Condition – 5,382 acres (visual estimates indicate that no key areas remain in very poor condition).

Since the 2002/2003 season, the Forest Service reports that this allotment was grazed by 65 adult cattle.

<u>Hardscrabble Allotment</u>

Harscrabble is an active allotment with a term permit (140 adult cattle yearlong). It is 20,845 acres in size. This allotment is currently in non-use. It was de-stocked in late spring 2002 due to the drought and has not been restocked with cattle since. In addition, in 1986, a non-use agreement was developed for resource improvement. This agreement reduced the allotment by 16%. This non-use agreement is still in effect. The allotment has three winter pastures and four summer pastures. Pastures are scheduled to be used per the approved AMP (approved August 20, 1986) for 1.5 to 4 months depending on season of use, size of pasture, and available forage.

Utilization standards are set at: uplands – herbaceous, 30-40% on key forage species; 50% on woody browse species of current year's growth; 30% on riparian herbaceous; woody riparian limited to 50% of leaders browsed on top 1/3 of plant less than 6 feet in height; streambank alteration is limited to less than 20% of alterable banks.

Range condition as measured in 1985 is reported as:

Good Condition – 2,918 acres vegetation condition (14%) and 2,918 acres soil condition (14%);
Fair Condition – 6,045 acres vegetation condition (29%) and 15,008 acres soil condition (72%);
Poor Condition – 8,963 acres vegetation condition (43%) and 2,918 acres soil condition (14%);
Very Poor Condition – 2,918 acres vegetation condition (14%) and zero acres soil condition.

What's Next?

Research and Monitoring at Fossil Creek

The primary purpose of the State of the Watershed Report is to provide information about Fossil Creek to those involved in and interested in the current and future management of this unique area of central Arizona. The Report summarizes baseline conditions that can be used to track changes to the environment over time. As such, this Report will need to be updated as information is gathered about changes in the physical, biological and social environment, now that full flows have been returned to Fossil Creek.

Baseline information has been collected from Fossil Creek watershed. Much of it is presented in this report or will be published in journals in the near future. However, continued research and monitoring of physical, biological, and social changes at Fossil Creek is imperative. Such research and monitoring will: allow for a greater understanding of the effects of restoration on the unique resources of Fossil Creek; will assist the U.S. Forest Service in their management of this area; and, will inform decision-making in similar restoration efforts elsewhere.

Below, we provide a summary of planned and desired research and monitoring as discussed in each section of the Report:

Physical and Biological Environment

Climate

- In 2002, lower amounts of precipitation occurred throughout the Fossil Creek watershed, resulting in lower than normal amounts of recharge. Although not measured, it is possible that lower amounts of recharge could eventually impact the flow at Fossil Springs. Stream flow rates below, but close to Fossil Springs should be monitored to determine the effect of drought, climate change, and/or groundwater development.

Soils

- Soil condition class ratings should be refined through on-site investigation to validate soil condition or rate soil condition on a large-scale (small acreage basis).
- The soil section offered the conclusion that the incremental impact of continued recreational use along Fossil Creek, especially along the middle reach, likely results in decreased streambank vegetation, increased sediment and peakflows as compared to natural conditions with satisfactory soils and well-vegetated streambanks. This recreational use, in combination with historic and current grazing strategies in the watershed contributes to soil degradation. The physical and biological conditions of the soil system are at risk or do not support additional disturbance. Therefore, monitoring of soil condition, streambank vegetation, stream sediment and peak flows in the short- and long-term is recommended.

Hydrology, Watershed and Channel Conditions, Water Rights

- As the climate changes or other changes to recharge or discharge to the aquifer occur either naturally or potentially by actions of humans (such as fire management, grazing, and the increasing utilization of wells within the "C-aquifer" system), it is important to understand how the geology is connected to the sustainability of Fossil Springs. Long-term monitoring is desirable, but is not presently the responsibility of any party or parties. Beginning in summer 2005, a NAU civil and environmental engineering Master's student will be identifying and evaluating suitable locations, technologies and strategies for both low-flow and high-flow stream gauging on Fossil Creek.
- The Fossil Springs Diversion Dam will be lowered at least 14 feet in 2007, releasing a significant portion of the nearly 25,000 cubic yards of sediment present stored behind the dam. This sediment movement will be accompanied by environmental and ecological impacts, both upstream and downstream of the dam. These impacts will be monitored and evaluated by NAU civil and environmental engineering researchers. Changes in sediment thickness will be monitored with a series of cross-sections and topographic surveys, both upstream and downstream of the Fossil Springs Diversion Dam. Pebble counts will be used to assess sediment grain-size distributions and their variability in space and time.

Spring Characterization and Groundwater

- The individual spring orifices (of which there are over 60) of Fossil Springs are being located and characterized as part of on-going studies by NAU. Once these are located, it will be possible to identify and track changes to their location or discharge through time.
- The goal of management for the springs of Fossil Creek is to sustain a baseflow of spring discharge necessary and sufficient to maintain the associated aquatic and riparian ecosystems, and the travertine processes. A request to maintain baseflow in Fossil Creek is part of the U.S. Forest Service instream flow assessment.
- As identified above, there is a critical need to establish a gauging station on Fossil Creek immediately downstream of the last spring orifice to monitor trends in the baseflow of Fossil Springs.
- Although comprehensive biological surveys have not been completed of the over 60 individual spring orifices, it is likely that specific microhabitats and specific species are dependent on each of the orifices in the spring complex.
- After characterization of the individual spring orifices in the Fossil Springs complex, NAU will build a three-dimensional hydrogeologic framework model for the aquifer which contributes flow to Fossil Springs. The framework model will serve as the base for future numerical groundwater flow models for Fossil Springs which can help understand how changes in management to the aquifer or the watershed may influence the quantity and quality of water discharging from the springs.

Water Quality

- In conjunction with the University of New Mexico, NAU is examining the geochemistry of travertine-depositing springs of the Arizona Transition Zone (which includes Fossil Springs).
- It is desirable to establish a baseline monitoring program to detect changes in the water chemistry of Fossil Springs. This monitoring will include major cation and anions to examine the change in carbonate chemistry and the potential for changes in travertine formation, as well as other important dissolved constituents.

Vegetation

Few monitoring recommendations are made in this section because it was felt that vegetation management fell under the purview of the U.S. Forest Service. However, it is clear that the following vegetative factors should be monitored in both the short- and long-term:

- Changes in riparian vegetation composition and width both above and below the Fossil Springs Diversion Dam after removal of the top 14 feet in 2007.
- Spread of exotic species/noxious weeds within the watershed and within the Fossil Creek drainage.

Aquatic Habitat and Fish

Fish

- There is a critical need for monitoring for non-native fish following the construction of the fish barrier at Fossil Creek and the completion of the native fish restoration project. This monitoring should determine if the barrier prevents upstream migration of non-native fish and assess whether non-native fish are being transplanted back into Fossil Creek by humans.
- Monitoring of the recovery of native fish in Fossil Creek should also occur. Such monitoring should address the density of both native and non-native fish using the same standardized methods used in pre-removal surveys.
- Research that will help interpret native fish responses in Fossil Creek include quantification of invertebrate assemblages (including crayfish) and food-base standing mass, experiments studying whether native chub are able to control non-native crayfish, and stable isotope studies to test if the trophic position of native fish increases once non-natives are removed.

Macroinvertebrates

- Monitoring invertebrates following restoration of full flows is an essential component of documenting food web and ecosystem recovery. Methods used to collect pre-treatment data should be used again and focus on the same sites, using pre-restoration data and sites above the diversion dam as controls. Future monitoring should focus on documenting changes in composition and distribution.
- Monitoring of the recovery of macroinvertebrates after impacts caused by the piscicide used in the native fish restoration project is also important.

- Comparison of invertebrate assemblages in newly formed travertine zones to the current, remnant travertine will assist in determining whether returning full flows helped promote native macroinvertebrate assemblages.
- Certain species should be specifically monitored and used as indicators. These include the endemic Fossil Springsnail and the Page Springs caddisfly. Specifically, monitoring should determine if flow restoration increase dispersal of these species and increase gene flow among populations.
- The exotic freshwater clam, *Corbicula fluminea*, known from the lower reaches of Fossil Creek, should be monitored to determine if it is actively moving upstream.

Leaf Litter Decomposition

- Monitoring should determine if the return of full flows to Fossil Creek results in higher overall leaf litter decomposition rates below the diversion dam.
- Monitoring should determine if higher rates of decomposition occur in relation to an expanded travertine zone after return of full flows.
- Monitoring should determine if leaf letter processing rates are lower than expected due to slower recovery of macroinvertebrate populations after piscicide (antimycin) treatment.
- After removal of the diversion dam in 2007, monitoring should determine if increased sediment loads cause a temporary reduction in leaf litter decomposition.

Crayfish

- Monitoring of crayfish should continue at the sites NAU has established. Mark and recapture protocols should be used over standard trapping as they provide a more accurate estimate of population size.

Terrestrial Species

Birds

- By 2010, complete two consecutive years of inventory of all potentially suitable habitat for listed and candidate bird species (including the yellow-billed cuckoo and common black hawk), using accepted protocols, within the upper, middle and lower reaches of Fossil Creek.
- A complete inventory of bird species in the Fossil Creek riparian area would provide valuable information about the bird communities and would assist in determining changes in the quality or quantity of habitat over time. Baseline inventory (prioritized by reach) should consist of point count surveys for breeding birds as well as incidental surveys during the breeding period, spring and fall migration, and wintering period. Surveys for nocturnal species should also be conducted.
- After completion of above inventories, a monitoring program should be developed to document bird community changes over the next five to ten years. In order to keep the costs to a minimum, the monitoring program could include sub-sampling of randomly selected points or habitats with a given reach or throughout the Fossil Creek riparian habitat.

- As funding for the above outlined monitoring and inventory is limited, grant funding opportunities should be pursued.

Mammals

- Yearly monitoring of the lower reaches of Fossil Creek for river otters should occur through at least 2010. Long-term monitoring for this species should continue in the lower reaches and extend to the middle and upper reaches depending upon on-going monitoring results.
- Monitoring of sensitive bat species including the western red bat, California leaf-nosed bat, spotted bat, Allen's big-eared bat, and Townsend's bit-eared bat should take place within the Fossil Creek watershed in the near future. Such monitoring should determine if these species are present and if other bat species are present. Such monitoring should consist of, at a minimum, use of the Anabat II to record bat sonar, identify species present, and identify roost sites, if possible.
- Determination of the presence of the Arizona grey squirrel in the riparian area of Fossil Creek is recommended.

Amphibians and Reptiles

- The distribution of lowland leopard frogs should be monitored prior to, during, and after the removal of the Fossil Springs Diversion Dam along the length of Fossil Creek.
- Monitoring of the persistence of the existing leopard frog population should take place throughout the decommissioning process.
- Complete the baseline inventory work for reptiles (Arizona toad, narrow-headed garter snake, and Mexican garter snake) in the Fossil Creek area. Some of this work has already been conducted, thus minimal time and expense is expected to complete this work.
- Reptile monitoring should determine if nursery habitat for the species is present, to what extent, and should determine if recreational use is impacting them.
- Because both the narrow-headed and Mexican garter snake populations are in decline throughout Arizona, monitoring for the presence of these species and the condition of habitat should be a priority.
- Bullfrog movement upstream into Fossil Creek should be monitored.

Invertebrates

- Monitoring of the Fossil Springsnail should be given a high priority because of the potential negative effects of recreational use. Monitoring should occur at regular intervals and should begin as soon as possible.
- A monitoring plan for the Fossil Springsnail should be developed by the end of 2006 or earlier.
- Presence/absence surveys should be conducted for sensitive invertebrates. Priority for determining presence/absence should be given to those invertebrates most at risk of potential negative effects related to restoration of Fossil Creek (namely recreational activity).

Humans and the Social Environment

Cultural and Archeological Resources

- A series of monitoring activities specific to the Fossil Creek area are outlined in the Report. These monitoring elements are designed to maintain or enhance archeological and historic site integrity. These elements are to be implemented by both the Coconino and Tonto National Forests, in addition to monitoring prescribed in the Forest Plans. However, the implementation such monitoring is based on the availability of funding.

Recreation

- Recreation monitoring will continue in the Fossil Creek area, including visitor surveys and campsite impact and monitoring.
- A recreation monitoring and management plan will be created to provide recommendations for education, engineering, and enforcement strategies within the Fossil Creek area.
- Gaining information on visitor perceptions of Fossil Creek recreation experiences and management decisions will be important indicators of how to manage future recreation at Fossil Creek.

Grazing

Grazing monitoring falls under the jurisdiction of the U.S. Forest Service. Allotments within the Fossil Creek watershed are located on both the Coconino and Tonto National Forests. In general, monitoring of these allotments include the following:

- Monitoring of site conditions will be ongoing.
- Impacts on soil and vegetation conditions will be used to assess the continuation of allotment use.
- Allotment use may be restricted when drought conditions persist to protect the site conditions.

Conclusion

Research and monitoring as summarized in this section and in the body of the State of the Watershed Report will assist in determining short- and long-term changes in the physical and biological conditions, as well as the sociological adjustments related to human use and recreation at Fossil Creek. The authors hope that both monitoring and research will remain a priority for all involved institutions, organizations, governments, and agencies.

As has been demonstrated through the Fossil Creek native fish restoration project, a multi-agency/organization partnership offers a valuable tool that facilitates the monitoring and research necessary to evaluate the success of and future needs and applications in watercourse and watershed rehabilitation and restoration actions.

Finally, the results of research and monitoring by all engaged entitites will provide valuable information to assist the Forest Service in their management and stewardship of the Fossil Creek area and watershed.

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APPENDICES

Appendix A.

Greater Fossil Creek Plant List

(Adapted from the USFS Fossil Creek Database))

Scientific Name	Common Name	Family	Observation Location
Abies concolor	White fir	Pinaceae	Fossil Creek Riparian
Abutilon incanum	Indian mallow	Malvaceae	Fossil Creek Upland
Acacia greggii	Catclaw acacia	Fabaceae	Fossil Springs Botanical Area
Acer grandidentata	Bigtooth maple	Aceraceae	Fossil Springs Riparian
Acer negundo	Box elder	Aceraceae	Fossil Springs Riparian
Acer negundo var. interius	Box elder	Aceraceae	Fossil Springs Riparian
Acer pseudoplatanus	Sycamore maple	Aceraceae	Fossil Springs Riparian
Acer grandidentatum	Big-tooth maple	Aceraceae	Fossil Springs Botanical Area
Acourtia wrightii	Brown-foot	Asteraceae	Fossil Creek Upland
Adiantum capillus-veneris	Maidenhair fern	Pteridaceae	Fossil Creek Riparian
Aegilops cylindrica	Jointed goatgrass	Poaceae	
Agave chrysantha	Yellow-flowered agave	Agavaceae	Fossil Creek Upland
Agave parryi	Parry's agave	Agavaceae	Fossil Springs Botanical Area
Agave sp.	Agave	Agavaceae	Fossil Creek Riparian
Ailanthes altissima	Tree-of-heaven	Simaroubaceae	
Allionia incarnata	Trailing four-o-clock	Nyctaginaceae	Fossil Springs Riparian
Allionia incarnata	Trailing four o' clock	Nyctaginaceae	Fossil Springs Botanical Area
Allionia incarnata	Trailing-four-o'clock	Nyctaginaceae	Fossil Creek Upland
Allium sp.	Onion	Liliaceae	Fossil Springs Botanical Area
Alnus oblongifolia	Arizona alder	Betulaceae	Fossil Springs Riparian
Alnus oblongifolia	Arizona alder	Betulaceae	Fossil Creek Riparian-East Bank-Spring
Aloysia wrightii	Wright's beebrush	Verbenaceae	Fossil Springs Botanical Area
Ambrosia sp.	Ragweed	Asteraceae	Fossil Creek Riparian
Amsinckia intermedia	Fiddleneck	Boraginaceae	Fossil Springs Botanical Area

Anemone tuberosa	Desert anemone	Ranunculaceae	Fossil Springs Botanical Area
Anisacanthus thurberi	Desert honeysuckle	Acanthaceae	Fossil Creek Riparian
Aquilegia chrysantha	Yellow columbine	Ranunculaceae	Fossil Springs Riparian
Aquilegia sp.	Columbine	Ranunculaceae	Fossil Springs Riparian
Arabis perennans	Perennial rockcress	Brassicaceae	Fossil Creek Upland
Arctostaphylos pringlei	Pringlei manzanita	Ericaceae	Fossil Springs Botanical Area
Arctostaphylos pungens	Pointleaf manzanita	Ericaceae	Fossil Springs Botanical Area
Argemone pleiacantha	Bluestem pricklepoppy	Asteraceae	Fossil Creek Upland
Artemisia ludoviciana	Silver wormwood	Asteraceae	Fossil Creek Upland
Arundo donax	Giant reed	Poaceae	
Asclepias asperula capricornu	Antelope-horn	Asclepiadaceae	Fossil Creek Upland
Aster sp.	Aster	Asteraceae	Fossil Creek Riparian
Astragalus wootoni	Milkvetch, locoweed	Fabaceae	Fossil Springs Botanical Area
Astrolepis sinuata	Wavy-cloak fern	Pteridaceae	Fossil Creek Upland
Atriplex canescens	Four-wing saltbush	Chenopodiaceae	Fossil Creek Upland
Avena fatua	Wild oats	Poaceae	
Baccharis arothroides	Desert-broom	Asteraceae	Fossil Creek Upland
Baccharis brachyphylla	Short leaved baccharis	Asteraceae	Fossil Creek Upland
Baccharis glutinosa	Seepwillow	Asteraceae	Fossil Creek Riparian
Baccharis pteroniodides	Hierba de pasmo	Asteraceae	Fossil Creek Upland
Baccharis salicifolia	Seep willow	Asteraceae	Fossil Springs Botanical Area
Baccharis salicifolia	Seep willow	Asteraceae	Fossil Creek Riparian
Baccharis sarothroides	Desert broom	Asteraceae	Fossil Creek Riparian
Baileya multiradiata	Desert-marigold	Asteraceae	Fossil Creek Upland
Berberis fremontii	Fremont barberry	Berberidaceae	Fossil Springs Botanical Area
Berberis haematocarpa	Desert barberry	Berberidaceae	Fossil Creek Upland
Bothriochola barbinodis	Cane bluestem	Poaceae	Fossil Springs Botanical Area
Brickellia grandiflora	Tasselflower brickellbush	Asteraceae	Fossil Springs Botanical Area
Bromus japonicus	Japanese brome	Poaceae	
Bromus madritensis	Foxtail chess	Poaceae	
Bromus diandrus	Ripgut brome	Poaceae	

Bromus tectorum	Cheatgrass	Poaceae	
Caesalpinia gilliesii	Bird-of-paradise	Fabaceae	Fossil Creek Upland
Calliandra humilis	Dwarf fairy-duster	Fabaceae	Fossil Creek Upland
Canotia holacantha	Canotia	Celastraceae	Fossil Springs Botanical Area
Capsella bursa-pastoris	Shepherd's purse	Brassicaceae	Fossil Springs Botanical Area
Carex sp.	Sedge	Cyperaceae	Fossil Creek Riparian
Castilleja integra var. integra	Indian-paintbrush	Scrophulariaceae	Fossil Creek Upland
Ceanothus greggii	Greg ceanothus	Rhamnaceae	Fossil Springs Botanical Area
Ceanothus integerrimus	Deerbrush	Rhamnaceae	Fossil Springs Botanical Area
Ceanothus sp.		Rhamnaceae	Fossil Creek Riparian
Celtis reticulata	Net-leaf hackberry	Ulmaceae	Fossil Creek Upland
Centaurea solstitialis	Yellow starthistle	Asteraceae	
Cercocarpus montanus	Mountain-mahogany	Rosaceae	Fossil Creek Upland
Chaetopappa ericoides	Upland-daisy	Asteraceae	Fossil Creek Upland
Chamaesyce polycarpa	Small-seeded sand mat	Euphorbiaceae	Fossil Creek Upland
Chara sp.	Muskgrass	Characeae	Fossil Creek Riparian
Cheilanthes sp.	Fern	Polypodiaceae	Fossil Springs Botanical Area
Chenopodium fremontii	Fremont goose-foot	Chenopodiaceae	Fossil Creek Upland
Chilopsis linearifolia	Desert willow	Bignoniaceae	Fossil Creek Riparian
Chorispora tenella	Blue mustard	Brassicaceae	
Cirsium neomexicanum	New Mexican thistle	Asteraceae	Fossil Creek Upland
Cirsium sp.	Thistle	Asteraceae	Fossil Springs Botanical Area
Cirsium vulgare	Bull thistle	Asteraceae	
Claytonia perfoliata	Miner's lettuce	Portulacaceae	Fossil Springs Botanical Area
Clematis ligusticifolia	White virgin's bower	Ranunculaceae	Fossil Springs Botanical Area
Cleome lutea	Yellow bee plant	Cleomaceae	Fossil Springs Botanical Area
Comandra umbellata	Bastard-toadflax	Santalaceae	Fossil Creek Upland
Conium maculatum	Poison hemlock	Apiaceae	Fossil Creek Riparian-Spring 15
Convolvulus equitans	Hoary bindweed	Convolvulaceae	Fossil Creek Upland
Cordylanthus laxiflorus	Yellow bird-beak	Scrophulariaceae	Fossil Creek Upland
Cortaderia selloana	Pampas grass	Poaceae	
Corydalis aurea	Golden corydalis	Fumariaceae	Fossil Springs Botanical Area

Coryphantha vivipara var. arizonica	Pincushion cactus	Cactaceae	Fossil Creek Upland
Cryptantha barbigera	Bearded cryptantha	Boraginaceae	Fossil Creek Upland
Cupressus arizonica	Arizona cypress	Cupressaceae	Fossil Springs Botanical Area
Cuscuta indecora	Pretty dodder	Convolvulaceae	Fossil Creek Riparian
Cynodon dactylon	Bermuda grass	Poaceae	
Cynodon dactylon	Crab grass	Poaceae	Fossil Creek Riparian
Cynodon dactylon	Bermuda grass	Poaceae	Fossil Springs Botanical Area
Cynodon sp.	Grass	Poaceae	Fossil Creek Riparian
Dalea albiflora	Scruffy prairie clover	Fabaceae	Fossil Springs Botanical Area
Dalea formosa	Feather dalea	Fabaceae	Fossil Springs Botanical Area
Datura meteloides	Sacred datura	Fabaceae	Fossil Springs Riparian
Datura meteloides	Sacred datura	Solanaceae	Fossil Springs Botanical Area
Datura meteloides	Sacred datura	Solanaceae	Fossil Creek Upland
Daucus carota	Wild carrot	Apiaceae	Fossil Springs Botanical Area
Delphinium scaposum	Barestem larkspur	Ranunculaceae	Fossil Springs Botanical Area
Delphinium sp.	Larkspur	Ranunculaceae	Fossil Creek Riparian
Descurainia pinnata	Tansy mustard	Brassicaceae	Fossil Springs Botanical Area
Desmodium neomexicana	New Mexico tickclover	Fabaceae	Fossil Springs Riparian
Dichelostemma pulchellum	Bluedicks	Liliaceae	Fossil Springs Botanical Area
Drypanocladus sp.	Moss		Fossil Springs Riparian
Echinocereus coccineus	Claret-cup cactus	Cactaceae	Fossil Creek Upland
Echinocereus fasciculatus	Hedgehog cactus	Cactaceae	Fossil Creek Upland
Echinocereus triglochidiatus	Claret cup cactus	Cactaceae	Fossil Springs Botanical Area
Echinochloa crusgali	Barnyard grass	Poaceae	Fossil Springs Botanical Area
Echinochloa crusgalli	Barnyard grass	Poaceae	Fossil Springs Riparian
Eleocharis sp.	Spikerush	Cyperaceae	Fossil Creek Riparian
Elymus elymoides	Squirrel-tail	Poaceae	Fossil Creek Upland
Elymus glaucus	Blue wild-rye	Poaceae	Fossil Creek Upland
Elymus sp.	Foxtail	Poaceae	Fossil Creek Riparian
Elymus sp.	Wild rye	Poaceae	Fossil Creek Riparian
Ephedra viridis	Joint fir	Ephedraceae	Fossil Springs Botanical Area

Ephedra viridis var. viscida	Mountain joint-fir	Ephedraceae	Fossil Creek Upland
Epilobium brachycarpum	Fireweed	Onagraceae	Fossil Creek Riparian
Epipactis gigantea	Helleborine	Orchidaceae	Fossil Creek Riparian
Epipactis gigantea	Helleborine	Orchidaceae	Fossil Springs Botanical Area
Equisetum arvense	Horsetail	Equisetaceae	Fossil Springs Riparian
Equisetum arvense	Horsetail	Equisetaceae	Fossil Creek Riparian
Equisetum arvense	Horsetail	Equisetaceae	Fossil Creek Riparian-East Bank-Spring
Equisetum arvense	Horsetail	Equisetaceae	Fossil Springs Riparian
Equisetum arvense	Horsetail	Equisetaceae	Fossil Springs Botanical Area
Equisetum laevigatum	Horsetail	Equisetaceae	Fossil Springs Botanical Area
Equisetum sp.	Horsetail	Equisetaceae	Fossil Creek Riparian
Equisetum sp.	Horsetail	Equisetaceae	Fossil Creek Riparian
Eragrostis intermedia	Plains lovegrass	Poaceae	Fossil Springs Riparian
Eragrostis intermedia	Plains lovegrass	Poaceae	Fossil Springs Botanical Area
Eragrostis lehmanniana	Lehmann's lovegrass	Poaceae	
Eragrostis lehmanniana	Lehmann lovegrass	Poaceae	Fossil Creek Upland
Eriastrum diffusum	Miniature wool star	Polemoniaceae	Fossil Creek Riparian
Ericameria laricifoia	Turpentine-bush	Asteraceae	Fossil Creek Upland
Erigeron divergens	Spreading fleabane	Asteraceae	Fossil Creek Upland
Erigeron divergens	Spreading fleabane	Asteraceae	Fossil Springs Botanical Area
Erigeron flagellaris	Running fleabane	Asteraceae	Fossil Springs Botanical Area
Erigeron flagellaris	Running fleabane	Asteraceae	Fossil Creek Upland
Eriodictyon angustifolium	Yerba santa	Hydrophyllaceae	Fossil Springs Botanical Area
Eriodictyon angustifolium	Yerba santa	Hydrophyllaceae	Fossil Creek Upland
Eriogonum abertianum	Wild buckwheat	Polygonaceae	Fossil Creek Upland
Eriogonum fasiculatum	Flat-top buckwheat	Polygonaceae	Fossil Creek Riparian
Eriogonum wrightii	Wright false-buckwheat	Polygonaceae	Fossil Creek Upland
Eriogonum wrightii	Wild buckwheat	Polygonaceae	Fossil Springs Botanical Area
Erioneuron pulchellum	Fluffgrass	Poaceae	Fossil Creek Upland
Erodium cicutarium	Redstem filaree	Geraniaceae	
Erodium cicutarium	Filaree	Geraniaceae	Fossil Creek Riparian

Erodium cicutarium	Filaree	Geraniaceae	Fossil Creek Upland
Erodium cicutarium	Filaree	Geraniaceae	Fossil Springs Botanical Area
Erysimum asperum var. capitatum	Wallflower	Brassicaceae	Fossil Springs Botanical Area
Euphorbia lurida	Euphorbia	Euphorbiaceae	Fossil Springs Botanical Area
Euphorbia sp.	Spurge	Euphorbiaceae	Fossil Creek Riparian
Fendlera rupicola	Fendlerbush	Saxifragaceae	Fossil Springs Botanical Area
Ferocactus cylindraceus	California barrel cactus	Cactaceae	Fossil Creek Upland
Ferocactus wislizenii	Candy barrel cactus	Cactaceae	Fossil Creek Riparian
Festuca arundinacea	Tall fescue	Poaceae	
Festuca sp.	Fescue	Poaceae	Fossil Springs Botanical Area
Ficus carica	Fig	Moraceae	Fossil Springs Botanical Area
Ficus carica	Fig	Moraceae	Fossil Springs Riparian
Ficus carica	Fig	Moraceae	Fossil Creek Riparian-Spring 28
Forestiera pubescens	Desert olive	Oleaceae	Fossil Springs Botanical Area
Forestiera pubescens	Desert-olive	Oleaceae	Fossil Creek Upland
Fouquieria splendens	Ocotillo	Fouquieriaceae	Fossil Creek Riparian
Fouquieria splendens	Ocotillo	Fouquieriaceae	Fossil Creek Upland
Fraxinus anomala	Ash	Oleaceae	Fossil Springs Botanical Area
Fraxinus anomala var. lowellii	Lowell ash	Oleaceae	Fossil Creek Upland
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Springs Riparian
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-East Bank-Spring
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 22
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 21
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 20
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Springs Botanical Area
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 19
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 17
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 16
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 14

Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 11
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 24
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 25
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 26
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 27
Fraxinus velutina	Velvet ash	Oleaceae	Fossil Creek Riparian-Spring 28
Gaillardia pulchella	Blanket flower	Asteraceae	Fossil Springs Botanical Area
Galium aparine	Bedstraw	Rubiaceae	Fossil Creek Upland
Galium aparine	Bedstraw	Rubiaceae	Fossil Creek Riparian
Galium aparine	Bedstraw	Rubiaceae	Fossil Springs Botanical Area
Galium sp.		Rubiaceae	Fossil Springs Botanical Area
Galium stellatum	Desert bedstraw	Rubiaceae	Fossil Creek Upland
Galium stellatum	Desert bedstraw	Rubiaceae	Fossil Springs Botanical Area
Galium stellatum	Desert bedstraw	Rubiaceae	Fossil Springs Riparian
Garrya flavescens	Quinine bush	Garryaceae	Fossil Springs Botanical Area
Garrya sp.	Silk tassel bush	Garryaceae	Fossil Creek Riparian
Garrya wrightii	Wright's silk tassel	Garryaceae	Fossil Creek Upland
Garrya wrightii	Wright's silk tassel	Garryaceae	Fossil Springs Botanical Area
Gaura coccinea	Scarlet gaura	Onagraceae	Fossil Creek Upland
Geranium caespitosum	Wild geranium	Geraniaceae	Fossil Springs Botanical Area
Geranium caespitosum	Wild geranium	Geraniaceae	Fossil Springs Riparian
Geranium fremontii	Geranium	Geraniaceae	Fossil Springs Botanical Area
Geranium sp.	Wild geranium	Geraniaceae	Fossil Springs Botanical Area
Geranium sp.	Wild geranium	Geraniaceae	Fossil Creek Riparian
Geranium sp.	Wild geranium	Geraniaceae	Fossil Springs Riparian
Geranium sp.	Wild geranium	Geraniaceae	Fossil Creek Riparian-East Bank-Spring
Gilia flavocincta	Lesser yellowthroat gilia	Polemoniaceae	Fossil Springs Botanical Area
Gilia gilliodes	Sticky false gilyflower	Polemoniaceae	Fossil Creek Riparian
Gleditsia triacanthos	Honeylocust	Fabaceae	
Gnaphalium canescens	Cudweed	Asteraceae	Fossil Creek Upland
Gutierezia sarothrae	Broom snakeweed	Asteraceae	Fossil Creek Upland
Gutierrezia microcephala	Snakeweed	Asteraceae	Fossil Springs Botanical Area

Happlopappus gracilis	Goldenweed	Asteraceae	Fossil Springs Botanical Area
Hedeoma drummondii	Drummond's false pennyroyal	Lamiaceae	Fossil Creek Upland
Helianthus annuus	Common sunflower	Asteraceae	Fossil Springs Riparian
Helianthus annuus	Common sunflower	Asteraceae	Fossil Springs Botanical Area
Heliomeris longifolia var. annua	Annual golden-eye	Asteraceae	Fossil Creek Upland
Hilaria belangeri	Curly mesquite grass	Poaceae	Fossil Creek Upland
Hordeum murinum ssp. leporinum	Mediterranean barley	Poaceae	
Hordeum leporinum	Barley	Poaceae	Fossil Springs Botanical Area
Hymenopappus filifolius var. lugens	Lace-daisy	Asteraceae	Fossil Creek Upland
Ipomopsis aggregata	Sky-rocket	Polemoniaceae	Fossil Creek Upland
Iris sp.	Iris	Iridaceae	
Iris missouriensis	Rocky Mountain iris	Iridaceae	Fossil Creek Riparian
Iris missouriensis	Rocky Mountain iris	Iridaceae	Fossil Springs Botanical Area
Juglans major	Arizona walnut	Juglandaceae	Fossil Creek Riparian-East Bank-Spring
Juglans major	Arizona walnut	Juglandaceae	Fossil Creek Riparian-East Bank-Spring
Juglans major	Arizona walnut	Juglandaceae	Fossil Creek Riparian-East Bank-Spring
Juglans major	Arizona walnut	Juglandaceae	Fossil Creek Riparian
Juglans major	Arizona walnut	Juglandaceae	Fossil Creek Riparian-East Bank-Spring
Juglans major	Arizona walnut	Juglandaceae	Fossil Springs Botanical Area
Juglans major	Arizona walnut	Juglandaceae	Fossil Springs Riparian
Juglans major	Arizona walnut	Juglandaceae	Fossil Creek Upland
Juglans major	Arizona walnut	Juglandaceae	Fossil Creek Riparian
Juglans major	Arizona walnut	Juglandaceae	Fossil Creek Riparian-East Bank-Spring
Juncus sp.	Rush	Juncaceae	Fossil Springs Botanical Area
Juncus sp.	Rush	Juncaceae	Fossil Springs Riparian
Juncus torreyi	Bur rush	Juncaceae	Fossil Creek Riparian
Juniperus coahuilensis	Coahuila juniper	Cupressaceae	Fossil Creek Upland

Juniperus deppeana	Alligator juniper	Cupressaceae	Fossil Creek Riparian
Juniperus deppeana	Alligator juniper	Cupressaceae	Fossil Creek Upland
Juniperus deppeana	Alligator juniper	Cupressaceae	Fossil Springs Botanical Area
Juniperus deppeana	Alligator juniper	Cupressaceae	Fossil Springs Riparian
Juniperus osteosperma	Utah juniper	Cupressaceae	Fossil Springs Riparian
Juniperus osteosperma	Utah juniper	Cupressaceae	Fossil Creek Riparian
Juniperus osteosperma	Utah juniper	Cupressaceae	Fossil Springs Botanical Area
Juniperus sp.	Juniper	Cupressaceae	Fossil Creek Riparian
Keckiella antirrhinoides	Bush-penstemon	Scrophulariaceae	Fossil Creek Upland
Koeberlinia spinosa	Allthorn	Capparaceae	Fossil Creek Riparian
Krameria parvifolia	Range ratany	Krameriaceae	Fossil Creek Riparian
Lactuca graminifolia	Grassleaf lettuce	Asteraceae	Fossil Springs Riparian
Lactuca gramnifolia	Grassleaf lettuce	Asteraceae	Fossil Springs Botanical Area
Lactuca serriola	Prickly lettuce	Asteraceae	
Lamium amplexicaule	Dead nettle, henbit	Lamiaceae	
Lappula redowski	Stickseed	Berberidaceae	Fossil Springs Botanical Area
Lathyrus latifolius	Perennial sweetpea	Fabaceae	
Lepidium lasiocarpum	Sand peppergrass	Brassicaceae	Fossil Creek Upland
Leptochloa dubia	Green sprangletop	Poaceae	Fossil Creek Upland
Leptodictyum riparium	Moss		Fossil Creek Riparian
Leucelene ericoides	Baby aster	Asteraceae	Fossil Springs Botanical Area
Lithospermum incisum	Fringed gromwell	Boraginaceae	Fossil Springs Botanical Area
Lobelia cardinalis	Cardinal flower	Campanulaceae	Fossil Springs Riparian
Lobelia cardinalis	Cardinal flower	Campanulaceae	Fossil Creek Riparian
Lobelia cardinalis s. graminea	Cardinal flower	Campanulaceae	Fossil Springs Botanical Area
Lonicera albiflora var. dumosa	Honeysuckle	Caprifoliaceae	Fossil Springs Botanical Area
Lotus humistratus	Hill-locust	Fabaceae	Fossil Creek Upland
Lotus rigidus	Desert rock-pea	Fabaceae	Fossil Creek Upland
Lotus rigidus	Desert rock-pea	Fabaceae	Fossil Creek Riparian
Lotus wrightii	Wright deer-vetch	Fabaceae	Fossil Creek Upland
Lycium pallidum	Wolfberry	Solanaceae	Fossil Creek Upland

Lycium pallidum	Wolfberry	Solanaceae	Fossil Springs Botanical Area
Machaeranthera canescens	Hoary-aster	Asteraceae	Fossil Creek Upland
Machaeranthera canescens	Hoary-aster	Asteraceae	Fossil Springs Botanical Area
Machaeranthera gracilis	Little yellow-aster	Asteraceae	Fossil Creek Upland
Machaeranthera tanacetifolia	Tansyleaf spine aster	Asteraceae	Fossil Springs Botanical Area
Machaeranthera tanacetifolia	Tansyleaf spine aster	Asteraceae	Fossil Creek Upland
Mahonia trifoliolata	Algerita	Berberidaceae	Fossil Creek Riparian
Malva parviflora	Cheeseweed, little	Malvaceae	
Marrubium vulgare	Horehound	Lamiaceae	Fossil Creek Upland
Marrubium vulgare	Horehound	Lamiaceae	
Marrubium vulgare	Horehound	Lamiaceae	Fossil Springs Botanical Area
Matelea producta	Trailing-hearts	Asclepiadaceae	Fossil Creek Upland
Maurandella antirrhiniflora	Climbing snapdragon	Scrophulariaceae	Fossil Creek Upland
Maurandya antirrhiniflora	Climbing snapdragon	Scrophulariaceae	Fossil Springs Botanical Area
Medicago polymorpha	Burclover	Fabaceae	Fossil Springs Botanical Area
Medicago polymorpha	Burclover	Fabaceae	
Medicago sp.		Fabaceae	Fossil Creek Riparian
Melampodium leucanthum	Black-foot	Asteraceae	Fossil Creek Upland
Melampodium leucanthum	Blackfoot daisy	Asteraceae	Fossil Springs Riparian
Melampodium leucanthum	Blackfoot daisy	Asteraceae	Fossil Springs Botanical Area
Melilotus alba	White sweet clover	Fabaceae	Fossil Springs Riparian
Melilotus alba	White sweet clover	Fabaceae	Fossil Springs Botanical Area
Melilotus alba	White sweet clover	Fabaceae	Fossil Creek Riparian
Melilotus indicus	Sour clover	Fabaceae	Fossil Springs Botanical Area
Melilotus officinalis	Yellow sweet clover	Fabaceae	Fossil Springs Riparian
Melilotus officinalis	Yellow sweet clover	Fabaceae	
Melilotus officinalis	Yellow sweet clover	Fabaceae	Fossil Creek Upland
Melilotus officinalis	Yellow sweet clover	Fabaceae	Fossil Springs Botanical Area
Melilotus sp.	Sweet clover	Fabaceae	Fossil Creek Riparian
Menodora scabra	Twinberry	Oleaceae	Fossil Creek Upland
Mentizelia multifora .	Blazing-star	Loasaceae	Fossil Creek Upland
Mentzelia pumila	Desert blazing star	Loasaceae	Fossil Springs Botanical Area

Mentzelia pumila	Desert blazing star	Loasaceae	Fossil Springs Riparian
Mimosa biuncifera	Wait-a-minute bush	Fabaceae	Fossil Springs Botanical Area
Mimulus guttatus	Monkey flower	Scrophulariaceae	Fossil Creek Riparian
Mimulus guttatus	Monkey flower	Scrophulariaceae	Fossil Springs Riparian
Mimulus guttatus	Monkey flower	Scrophulariaceae	Fossil Springs Botanical Area
Mimulus guttatus	Monkey flower	Scrophulariaceae	Fossil Creek Upland
Mimulus rubellus	Monkey flower	Scrophulariaceae	Fossil Springs Botanical Area
Mirabilis bigelovi	Ribbon four o' clock	Nyctaginaceae	Fossil Springs Botanical Area
Mirabilis multiflora	Colorado four o'clock	Nyctaginaceae	Fossil Springs Botanical Area
Mirabilis multiflora	Colorado four o'clock	Nyctaginaceae	Fossil Creek Upland
Mirbilis pumila	Little four o'clock	Nyctaginaceae	Fossil Creek Upland
Montia chamissoi	Chamisso's montia	Portulacaceae	Fossil Springs Botanical Area
Morus microphylla	Texas mulberry	Moraceae	Fossil Creek Upland
Morus microphylla	Texas mulberry	Moraceae	Fossil Creek Riparian
Muhlenbergia emersleyi	Bullgrass	Poaceae	Fossil Creek Upland
Muhlenbergia porteri	Bush muhly	Poaceae	Fossil Creek Upland
Muhlenbergia rigens	Deergrass	Poaceae	Fossil Creek Riparian
Muhlenbergia rigens	Deergrass	Poaceae	Fossil Springs Riparian
Muhlenbergia rigens	Deergrass	Poaceae	Fossil Creek Riparian
Muhlenbergia rigens	Deergrass	Poaceae	Fossil Springs Riparian
Muhlenbergia rigens	Deergrass	Poaceae	Fossil Springs Botanical Area
Nicotiana trigonophylla	Desert tobacco	Solanaceae	Fossil Creek Upland
Nicotiana trigonophylla	Desert tobacco	Solanaceae	Fossil Springs Botanical Area
Nolina microcarpa	Beargrass	Agavaceae	Fossil Springs Botanical Area
Nolina microcarpa	Beargrass	Agavaceae	Fossil Creek Upland
Nolina microcarpa	Beargrass	Agavaceae	Fossil Creek Riparian
Opuntia acanthocarpa	Staghorn cholla	Cactaceae	Fossil Creek Upland
Opuntia chlorotica	Pancake prickly pear	Cactaceae	Fossil Creek Upland
Opuntia engelmannii	Engelmann prickly pear	Cactaceae	Fossil Creek Upland
Opuntia leptocaulis	Desert Christmas cactus	Cactaceae	Fossil Creek Upland
Opuntia leptocaulis	Desert Christmas cactus	Cactaceae	Fossil Springs Botanical Area

Opuntia phaeacantha	Brown-spined prickly pear	Cactaceae	Fossil Springs Botanical Area
Opuntia phaeacantha	Brown-spined prickly pear	Cactaceae	Fossil Creek Upland
Opuntia sp.	Prickly pear	Cactaceae	Fossil Creek Riparian
Oxalis albicans ssp. pilosa	Canyon sorrel	Oxalidaceae	Fossil Creek Upland
Oxalis albicans ssp. pilosa	Canyon sorrel	Oxalidaceae	Fossil Springs Botanical Area
Parietaria hespera	Pellitory	Urticaceae	Fossil Springs Botanical Area
Parietaria hespera	Pellitory	Urticaceae	Fossil Creek Upland
Parthenium incanum	Mariola	Asteraceae	Fossil Creek Upland
Parthenocissus quinquefolia	Virginia creeper	Vitaceae	Fossil Springs Riparian
Parthenocissus quinquefolia	Virginia creeper	Vitaceae	Fossil Creek Upland
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Springs Botanical Area
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-Spring 28
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-Spring 27
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-Spring 26
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-Spring 17
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-Spring 24
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-Spring 23
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-Spring 18
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-Spring 19
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Springs Riparian
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-Spring 25
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-East Bank-Spring
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-Spring 11
Parthenocissus vitacea	Woodbine	Vitaceae	Fossil Creek Riparian-Spring 15
Pascopyrum smithii	Western wheatgrass	Poaceae	Fossil Creek Upland
Pellaea truncata	Cliff-brake	Polypodiaceae	Fossil Creek Upland
Penstemon linarioides	Linaria-leaf penstemon	Scrophulariaceae	Fossil Creek Upland
Penstemon eatoni	Eaton firecracker	Scrophulariaceae	Fossil Springs Botanical Area
Penstemon eatoni	Eaton firecracker	Scrophulariaceae	Fossil Creek Upland
Penstemon microphyllus	Bush penstemon	Scrophulariaceae	Fossil Creek Riparian

Penstemon pseudospectabilis	Mojave penstemon	Scrophulariaceae	Fossil Creek Upland
Penstemon pseudospectalbilis	Desert penstemon	Scrophulariaceae	Fossil Springs Botanical Area
Penstemon sp.	Penstemon	Scrophulariaceae	Fossil Springs Riparian
Penstemon sp.	Penstemon	Scrophulariaceae	Fossil Creek Riparian-Spring 16
Penstemon sp.	Penstemon	Scrophulariaceae	Fossil Creek Riparian
Penstemon sp.	Penstemon	Scrophulariaceae	Fossil Creek Riparian-East Bank-Spring
Penstemon sp.	Penstemon	Scrophulariaceae	Fossil Creek Riparian-East Bank-Spring
Penstemon sp.	Penstemon	Scrophulariaceae	Fossil Creek Riparian
Perityle ciliata	Fringed rockdaisy	Asteraceae	Fossil Springs Botanical Area
Perityle ciliata	Fringed rockdaisy	Asteraceae	Fossil Springs Riparian
Phacelia cryptantha	Hiddenflower phacelia	Hydrophyllaceae	Fossil Creek Riparian
Phacelia sp.	Phacelia	Hydrophyllaceae	Fossil Springs Botanical Area
Phalaris minor	Littleseed canarygrass	Poaceae	
Phaseolus angustissimus	Slimleaf limabean	Fabaceae	Fossil Creek Upland
Phaseolus angustissimus	Slimleaf limabean	Fabaceae	Fossil Creek Riparian
Phaseolus angustissimus	Slimleaf limabean	Fabaceae	Fossil Springs Botanical Area
Phoradendron coryae	Oak mistletoe	Viscaceae	Fossil Creek Upland
Phoradendron juniperinum	Juniper mistletoe	Viscaceae	Fossil Creek Upland
Phoradendron juniperinum	Juniper mistletoe	Viscaceae	Fossil Springs Botanical Area
Phoradendron villosum var. coryae	Mistletoe	Viscaceae	Fossil Springs Botanical Area
Pinus edulis	Pinyon pine	Pinaceae	Fossil Springs Riparian
Pinus edulis	Pinyon pine	Pinaceae	Fossil Springs Botanical Area
Pinus edulus	Pinyon pine	Pinaceae	Fossil Creek Riparian
Pinus monophylla	Singleleaf pinyon	Pinaceae	Fossil Springs Botanical Area
Pinus monophylla	Singleleaf pinyon	Pinaceae	Fossil Creek Riparian
Pinus ponderosa	Ponderosa pine	Pinaceae	Fossil Springs Riparian
Pinus ponderosa	Ponderosa pine	Pinaceae	Fossil Creek Riparian
Pinus ponderosa	Ponderosa pine	Pinaceae	Fossil Springs Botanical Area
Pinus sp.	Pine	Pinaceae	Fossil Creek Riparian

Plantago major	Common plantain	Plantaginaceae	
Plantago major	Common plantain	Plantaginaceae	Fossil Springs Botanical Area
Plantago patagonica	Silky plantain	Plantaginaceae	Fossil Creek Upland
Plantago sp.	Plantain	Plantaginaceae	Fossil Creek Riparian
Platanus wrightii	Arizona sycamore	Platanaceae	Fossil Springs Botanical Area
Platanus wrightii	Arizona sycamore	Platanaceae	Fossil Springs Riparian
Platanus wrightii	Arizona sycamore	Platanaceae	Fossil Creek Riparian
Platanus wrightii	Arizona sycamore	Platanaceae	Fossil Creek Upland
Poa fendleriana	Muttongrass	Poaceae	Fossil Springs Riparian
Poa fendleriana	Muttongrass	Poaceae	Fossil Springs Botanical Area
Poa fendleriana	Muttongrass	Poaceae	Fossil Creek Riparian-East Bank-Spring
Poa sp.	Bluegrass	Poaceae	Fossil Creek Riparian
Polygonum coccineum	Smartweed, knotweed	Polygonaceae	Fossil Springs Botanical Area
Polygonum coccineum	Smartweed, knotweed	Polygonaceae	Fossil Springs Riparian
Polypogon monspeliensis	Rabbitfoot	Poaceae	Fossil Springs Botanical Area
Polypogon monspeliensis	Rabbitfoot	Poaceae	Fossil Springs Riparian
Polypogon monspeliensis	Rabbitfoot	Poaceae	Fossil Creek Riparian
Polypogon viridis	Beard grass	Poaceae	Fossil Creek Upland
Populus fremontii	Fremont cottonwood	Salicaceae	Fossil Springs Riparian
Populus fremontii	Fremont cottonwood	Salicaceae	Fossil Springs Botanical Area
Populus fremontii	Fremont cottonwood	Salicaceae	Fossil Creek Upland
Populus fremontii	Fremont cottonwood	Salicaceae	Fossil Creek Riparian
Potamageton sp.	Pondweed	Haloragaceae	Fossil Creek Riparian
Prosopis glandulosa	Western honey mesquite	Fabaceae	Fossil Springs Botanical Area
Prosopis velutina	Mesquite	Fabaceae	Fossil Creek Riparian
Prosopis velutina	Velvet mesquite	Fabaceae	Fossil Springs Botanical Area
Prosopis velutina	Velvet mesquite	Fabaceae	Fossil Creek Upland
Prunella vulgaris	Selfheal	Lamiaceae	
Prunus virginiana	Common chokecherry	Rosaceae	Fossil Creek Riparian
Prunus virginiana	Common chokecherry	Rosaceae	Fossil Springs Botanical Area
Psoralidium tenuiflorum	Scurvy pea	Fabaceae	Fossil Creek Upland
Ptelea trifoliata	Narrowleaf hoptree	Rutaceae	Fossil Creek Riparian-Spring 14

Ptelea trifoliata	Hop bush	Rutaceae	Fossil Springs Riparian
Ptelea trifoliata	Hop tree	Rutaceae	Fossil Springs Botanical Area
Pteridium aquilinum	Bracken fern	Polypodiaceae	Fossil Creek Riparian
Purshia stansburiana	Cliffrose	Rosaceae	Fossil Creek Upland
Purshia stansburiana	Cliffrose	Rosaceae	Fossil Springs Botanical Area
Quercus arizonica	Arizona white oak	Fagaceae	Fossil Springs Botanical Area
Quercus chrysolepsis	Canyon live oak	Fagaceae	Fossil Springs Botanical Area
Quercus emoryi	Emory oak	Fagaceae	Fossil Springs Botanical Area
Quercus gambelii	Gambel oak	Fagaceae	Fossil Creek Upland
Quercus gambelii	Gambel oak	Fagaceae	Fossil Springs Botanical Area
Quercus dunnii	Palmer oak	Fagaceae	Fossil Creek Upland
Quercus rugosa	Netleaf oak	Fagaceae	Fossil Springs Botanical Area
Quercus turbinella	Shrub live oak	Fagaceae	Fossil Creek Riparian
Quercus turbinella	Scrub live oak	Fagaceae	Fossil Creek Upland
Quercus turbinella	Shrub live oak	Fagaceae	Fossil Springs Botanical Area
Ranunculus cymbalaria	Desert crowfoot	Ranunculaceae	Fossil Springs Botanical Area
Ranunculus cymbalaria	Desert crowfoot	Ranunculaceae	Fossil Springs Riparian
Rhamnus californica	California buckthorn	Rhamnaceae	Fossil Creek Riparian-Spring 17
Rhamnus californica	California buckthorn	Rhamnaceae	Fossil Creek Riparian
Rhamnus californica	California buckthorn	Rhamnaceae	Fossil Springs Riparian
Rhamnus californica	California buckthorn	Rhamnaceae	Fossil Springs Botanical Area
Rhamnus californica	California buckthorn	Rhamnaceae	Fossil Creek Riparian-East Bank-Spring
Rhamnus californica	California buckthorn	Rhamnaceae	Fossil Creek Riparian-Spring 19
Rhamnus californica	California buckthorn	Rhamnaceae	Fossil Creek Riparian-Spring 25
Rhamnus californica	California buckthorn	Rhamnaceae	Fossil Creek Upland
Rhamnus crocea	Hollyleaf buckthorn	Rhamnaceae	Fossil Creek Riparian
Rhamnus crocea	Hollyleaf buckthorn	Rhamnaceae	Fossil Springs Botanical Area
Rhamnus crocea	Red berry buckthorn	Rhamnaceae	Fossil Creek Upland
Rhus glabra	Smooth sumac	Anacardiaceae	Fossil Creek Riparian-East Bank-Spring
Rhus glabra	Smooth sumac	Anacardiaceae	Fossil Creek Riparian
Rhus glabra	Smooth sumac	Anacardiaceae	Fossil Springs Botanical Area
Rhus glabra	Smooth sumac	Anacardiaceae	Fossil Springs Riparian

Rhus ovata	Sugar sumac	Anacardiaceae	Fossil Creek Upland
Rhus ovata	Sugar sumac	Anacardiaceae	Fossil Springs Botanical Area
Rhus trilobata	Skunk bush	Anacardiaceae	Fossil Creek Riparian
Rhus trilobata	Skunk bush	Anacardiaceae	Fossil Springs Botanical Area
Ribes aureum	Golden currant	Saxifragaceae	Fossil Springs Botanical Area
Robinia neomexicana	New Mexico locust	Fabaceae	Fossil Creek Upland
Robinia neomexicana	New Mexico locust	Fabaceae	Fossil Springs Botanical Area
Robinia neomexicana	New Mexico locust	Fabaceae	Fossil Creek Riparian
Rorippa nasturtium aguaticum	White watercress	Brassicaceae	Fossil Springs Riparian
Rorippa nasturtium-aquaticum	White watercress	Brassicaceae	Fossil Creek Riparian-Spring 27
Rorippa nasturtium-aquaticum	White watercress	Brassicaceae	Fossil Creek Riparian-East Bank-Spring
Rorippa nasturtium-aquaticum	White watercress	Brassicaceae	Fossil Creek Riparian-Spring 16
Rorippa nasturtium-aquaticum	White watercress	Brassicaceae	Fossil Creek Riparian-Spring 21
Rorippa nasturtium-aquaticum	White watercress	Brassicaceae	Fossil Creek Riparian-Spring 25
Rorippa nasturtium-aquaticum	White Watercress	Brassicaceae	Fossil Creek Riparian
Rorippa nasturtium-aquaticum	White watercress	Brassicaceae	Fossil Creek Riparian-Spring 23
Rorippa nasturtium-aquaticum	White watercress	Brassicaceae	Fossil Creek Riparian-Spring 28
Rorippa nasturtium-aquaticum	White watercress	Brassicaceae	Fossil Creek Riparian-Spring 11
Rorippa nasturtium-aquaticum	White watercress	Brassicaceae	Fossil Creek Riparian-Spring 26
Rorippa nasturtium-aquaticum	White watercress	Brassicaceae	Fossil Creek Riparian-Spring 22
Rorippa nasturtium-aquaticum	White watercress	Brassicaceae	Fossil Creek Riparian-Spring 17
Rorippa sp.		Brassicaceae	Fossil Creek Riparian
Rosa woodsii	Wood rose	Rosaceae	Fossil Springs Botanical Area
Rubus arizonensis	Arizona dewberry	Rosaceae	Fossil Creek Riparian
Rubus arizonensis	Arizona dewberry	Rosaceae	Fossil Springs Botanical Area

Rubus arizonensis	Arizona dewberry	Rosaceae	Fossil Creek Upland
Rubus arizonensis	Arizona dewberry	Rosaceae	Fossil Springs Riparian
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 28
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-East Bank-Spring
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 26
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 27
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 25
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 13
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 18
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 24
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 17
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 14
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 16
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 19
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 22
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 23
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 15
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 20
Rubus procerus	Himalaya berry	Rosaceae	Fossil Creek Riparian-Spring 21
Rubus procerus	Himalaya berry	Rosaceae	Fossil Springs Riparian
Rubus sp.	Blackberry	Rosaceae	Fossil Springs Riparian
Rumex crispus	Curly dock	Polygonaceae	Fossil Springs Botanical Area
Salix bonplandiana	Willow	Salicaceae	Fossil Springs Botanical Area
Salix exigua	Coyote willow	Salicaceae	Fossil Springs Botanical Area
Salix gooddingii	Goodding willow	Salicaceae	Fossil Springs Botanical Area
Salix gooddingii	Goodding willow	Salicaceae	Fossil Springs Riparian
Salix gooddingii	Goodding willow	Salicaceae	Fossil Creek Riparian
Salix gooddingii	Goodding willow	Salicaceae	Fossil Creek Upland
Salix laevigata	Willow	Salicaceae	Fossil Springs Riparian
Salix sp.	Willow	Salicaceae	Fossil Creek Riparian
Salsola kali	Russian thistle	Chenopodiaceae	
Sapindus saponaria	Western soapberry	Sapindaceae	Fossil Creek Upland
Sapindus saponaria	Western soapberry	Sapindaceae	Fossil Springs Botanical Area

Sarcostemma cynanchoides	Climbing milkweed	Asclepiadaceae	Fossil Creek Riparian
Sarcostemma cynanchoides	Climbing-milkweed	Asclepiadaceae	Fossil Creek Upland
Scirpus acutus	Bulrush	Cyperaceae	Fossil Springs Riparian
Scirpus sp.	Bulrush	Cyperaceae	Fossil Creek Riparian
Scirpus validus	Bulrush	Cyperaceae	Fossil Springs Botanical Area
Senecio douglasii	Douglas groundsel	Asteraceae	Fossil Creek Upland
Senecio neomexicanus	Groundsel	Asteraceae	Fossil Springs Botanical Area
Senecio quercetorum	Groundsel	Asteraceae	Fossil Creek Upland
Senecio sp.	Groundsel	Asteraceae	Fossil Creek Riparian
Setaria leucophila	Bristlegrass	Poaceae	Fossil Springs Riparian
Seteria leucopila	Bristlegrass	Poaceae	Fossil Springs Botanical Area
Seteria sp.	Bristlegrass	Poaceae	Fossil Creek Riparian
Silene antirrhina	Sleepy catchfly	Caryophyllaceae	Fossil Creek Upland
Simmondsia chinensis	Jojoba	Simmondsiaceae	Fossil Creek Upland
Sisymbrium altissimum	Tumble mustard	Brassicaceae	
Sisymbrium irio	London rocket	Brassicaceae	
Solanum elaeagnifolium	Silverleaf nightshade	Solanaceae	Fossil Creek Upland
Solanum elaeagnifolium	Silverleaf nightshade	Solanaceae	Fossil Springs Botanical Area
Solidago sp.	Goldenrod	Asteraceae	Fossil Creek Riparian
Solidago sparsiflora	Few-flowered goldenrod	Asteraceae	Fossil Springs Botanical Area
Solidago sparsiflora	Few-flowered goldenrod	Asteraceae	Fossil Creek Upland
Solidago sparsiflora	Few-flowered goldenrod	Asteraceae	Fossil Springs Riparian
Sonchus asper	Spiny sowthistle	Asteraceae	
Sonchus oleraceus	Sowthistle	Asteraceae	
Sorghum halepense	Johnson grass	Poaceae	Fossil Springs Riparian
Sorghum halepense	Johnson grass	Poaceae	Fossil Springs Botanical Area
Sphaeralcea fendleri	Globemallow	Malvaceae	Fossil Springs Botanical Area
Sphaeralcea laxa	Globemallow	Malvaceae	Fossil Creek Upland
Sporobolus cryptandrus	Sand dropseed	Poaceae	Fossil Creek Upland
Stephanomeria pauciflora	Desert-straw	Asteraceae	Fossil Creek Upland
Stipa neomexicana	New Mexican	Poaceae	Fossil Creek Upland

Stipa speciosa	Desert needlegrass	Poaceae	Fossil Creek Upland
Tamarix chinensis	Salt cedar	Tamaricaceae	Fossil Creek Riparian
Tamarix ramosissima	Tamarisk, Salt cedar	Tamaricaceae	
Tamarix ramosissima	Tamarisk	Tamaricaceae	Fossil Creek Upland
Taraxacum officinale	Common dandelion	Asteraceae	Fossil Springs Riparian
Taraxacum officinale	Common dandelion	Asteraceae	Fossil Creek Riparian-East Bank-Spring
Taraxacum officinale	Common dandelion	Asteraceae	Fossil Creek Riparian
Taraxacum officinale	Common dandelion	Asteraceae	Fossil Springs Botanical Area
Thalictrum fendleri	Meadow rue	Ranunculaceae	Fossil Springs Botanical Area
Thalictrum fendleri	Meadow rue	Ranunculaceae	Fossil Creek Riparian
Thalictrum sp.	Meadow rue	Ranunculaceae	Fossil Creek Riparian
Thermopsis rhombifolia	Goldenpea	Fabaceae	Fossil Springs Botanical Area
Toxicodendron radicans	Poison ivy	Anacardiaceae	Fossil Springs Riparian
Toxicodendron radicans	Poison ivy	Anacardiaceae	Fossil Creek Riparian-Spring 13
Toxicodendron radicans	Poison ivy	Anacardiaceae	Fossil Creek Riparian-East Bank-Spring
Toxicodendron radicans	Poison ivy	Anacardiaceae	Fossil Creek Riparian
Tragia ramosa	Noseburn	Euphorbiaceae	Fossil Springs Botanical Area
Tragopogon dubius	Western salsify	Asteraceae	
Tragopogon dubius	Western salsify	Asteraceae	Fossil Creek Upland
Tridens sp.	Grass	Poaceae	Fossil Creek Riparian
Trifolium sp.	Clover	Fabaceae	Fossil Springs Botanical Area
Trifolium stellatum	Clover	Fabaceae	Fossil Creek Riparian
Typha domingensis	Cattail	Typhaceae	Fossil Springs Riparian
Typha domingensis	Cattail	Typhaceae	Fossil Springs Botanical Area
Typha domingensis	Cattail	Typhaceae	Fossil Creek Riparian
Typha domingensis	Cattail	Typhaceae	Fossil Creek Upland
Typha latifolia	Cattail	Typhaceae	Fossil Creek Riparian
Typha sp.	Cattail	Typhaceae	Fossil Creek Riparian-Spring 15
Typha sp.	Cattail	Typhaceae	Fossil Creek Riparian
Typha sp.	Cattail	Typhaceae	Fossil Springs Riparian
Ulmus pumila	Siberian elm	Ulmaceae	
Verbascum thapsus	Mullein	Scrophulariaceae	Fossil Springs Botanical Area

Verbascum thapsus	Mullein	Scrophulariaceae	Fossil Springs Riparian
Verbascum thapsus	Mullein	Scrophulariaceae	Fossil Creek Upland
Verbascum thapsus	Mullein	Scrophulariaceae	Fossil Creek Riparian-Spring 28
Verbena gooddinggii	Goodding vervain	Verbenaceae	Fossil Creek Upland
Verbena neomexicana	Vervain	Verbenaceae	Fossil Springs Botanical Area
Verbena neomexicana	Vervain	Verbenaceae	Fossil Creek Upland
Vinca major	Greater periwinkle	Apocynaceae	
Viola nephrophylla	Meadow violet	Violaceae	Fossil Springs Botanical Area
Vitis arizonica	Canyon grape	Vitaceae	Fossil Springs Botanical Area
Vitis arizonica	Canyon grape	Vitaceae	Fossil Creek Riparian-East Bank-Spring
Vitis arizonica	Canyon grape	Vitaceae	Fossil Creek Riparian-Spring
Vitis arizonica	Canyon grape	Vitaceae	Fossil Springs Riparian
Vitis arizonica	Canyon grape	Vitaceae	Fossil Creek Riparian-Spring 19
Vitis arizonica	Canyon grape	Vitaceae	Fossil Creek Upland
Vitis arizonica	Canyon grape	Vitaceae	Fossil Creek Riparian
Vitis arizonica	Canyon grape	Vitaceae	Fossil Creek Riparian-Spring 24
Vitis arizonica	Canyon grape	Vitaceae	Fossil Creek Riparian-Spring 25
Yucca angustissima	Narrowleaf Yucca	Agavaceae	Fossil Springs Botanical Area
Yucca baccata	Banana yucca	Agavaceae	Fossil Springs Botanical Area
Yucca baccata var. baccata	Banana yucca	Agavaceae	Fossil Creek Upland
Yucca sp.	Yucca	Agavaceae	Fossil Creek Riparian
Ziziphus obtusifolia	Gray thorn	Rhamnaceae	Fossil Creek Upland
Ziziphus obtusifolia	Gray thorn	Rhamnaceae	Fossil Springs Botanical Area

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APPENDIX B: BIRD SPECIES OBSERVED IN FOSSIL CREEK, LOCATION, AND OBSERVER (From Red Rock Ranger District Database [compiled 2003])

Observation Type	Common Name	Observation Location	Behavior	Observer
Actual	Acorn woodpecker	Stehr Lake		AZ Public Service Co.
Actual	American coot	Stehr Lake		NAAS
Actual	American goldfinch	Fossil Creek Riparian		AZ Public Service Co.
Actual	American Goldfinch	Riparian	Singing male	Taylor
Actual	American goldfinch	Stehr Lake		AZ Public Service Co.
Actual	Anna's hummingbird	Fossil Springs Riparian		NAAS
Actual	Ash-throated flycatcher	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Ash-throated flycatcher	Fossil Creek Riparian		E.L.Smith
Actual	Ash-throated flycatcher	Riparian & uplands	Singing male	Taylor
Actual	Ash-throated flycatcher	RNA and vicinity		Smith/Bender
Actual	Ash-throated flycatcher	Stehr Lake	singing	Agyagos
Actual	Ash-throated woodpecker	Riparian & uplands		AGFD
Actual	Audobon's warbler	Fossil Creek Riparian		AZ Public Service Co.
Actual	Bell's vireo			NAAS
Actual	Bell's Vireo	Aqueduct Spring		Agyagos
Actual	Bell's vireo	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Bell's vireo	Fossil Creek Riparian		E.L.Smith
Actual	Bell's Vireo	Fossil Creek Riparian		Agyagos

Actual	Bell's vireo	Fossil Springs Riparian	Agyagos	
Actual	Bell's vireo	Irving to bridge		Scott Bailey
Actual	Bell's Vireo	Not specified		AGFD
Actual	Bell's Vireo	Riparian & uplands	Singing male	Taylor
Actual	Bell's Vireo	RNA and vicinity		Smith/Bender
Actual	Bell's vireo	Stehr Lake	singing	Agyagos
Actual	Belted kingfisher	Fossil Creek Riparian		E.L.Smith
Actual	Belted kingfisher	Fossil Creek Riparian		AZ Public Service Co.
Actual	Belted kingfisher	Fossil springs		Bill Burbridge
Actual	Belted kingfisher	Fossil Springs Riparian-below dam		NAAS
Actual	Belted Kingfisher	RNA and vicinity		Smith/Bender
Actual	Bewick's wren	Fossil Creek Riparian		AZ Public Service Co.
Actual	Bewick's wren	Fossil Creek Riparian		E.L.Smith
Actual	Bewick's Wren	Fossil Springs Riparian		Agyagos
Actual	Bewick's wren	Fossil Springs Riparian		NAAS
Actual	Bewick's wren	Riparian & uplands	carrying food	AGFD
Actual	Bewick's Wren	RNA and vicinity		Smith/Bender
Actual	Bewick's wren	Stehr Lake	singing	Agyagos
Actual	Black Phoebe	Child's Powerplant		Overby, Agyagos
Actual	Black phoebe	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Black phoebe	Fossil Creek Riparian		AZ Public Service Co.
Actual	Black phoebe	Fossil Creek Riparian		E.L.Smith
Actual	Black phoebe	Fossil Creek/Spring		Robert Magill- AGFD
Actual	Black phoebe	Fossil springs		Bill Burbridge

Actual	Black phoebe	Fossil Springs Riparian		Agyagos
Actual	Black phoebe	Fossil Springs Riparian		NAAS
Actual	Black Phoebe	Fossil/Verde Confluence		Sullivan
Actual	Black phoebe	Irving to bridge		Scott Bailey
Actual	Black phoebe	Riparian		Taylor
Actual	Black Phoebe	RNA and vicinity		Smith/Bender
Actual	Black phoebe	Stehr Lake		Agyagos
Actual	Black phoebe	Stehr Lake		AZ Public Service Co.
Actual	Black-chinned hummingbird	Fossil Creek Riparian		E.L.Smith
Actual	Black-chinned hummingbird	Fossil Springs Riparian		Agyagos
Actual	Black-chinned hummingbird	Not specified	singing male	Taylor
Actual	Black-chinned hummingbird	Riparian	nest with eggs	AGFD
Actual	Black-chinned hummingbird	RNA and vicinity		Smith/Bender
Actual	black-chinned hummingbird	Stehr Lake	male	Agyagos
Actual	Black-chinned sparrow	Flume Rd, 1 mile above Irving		NAAS
Actual	Black-chinned sparrow	Uplands		AGFD
Actual	Black-headed grosbeak	Fossil Creek Riparian		E.L.Smith
Actual	Black-headed grosbeak	Irving to bridge		Scott Bailey
Actual	Black-headed grosbeak	Riparian	fledged young present	AGFD
Actual	Black-headed grosbeak	Riparian	Singing male	Taylor
Actual	Black-headed grosbeak	RNA and vicinity		Smith/Bender
Actual	Black-headed grosbeak	Stehr Lake		AZ Public Service Co.
Actual	Black-throated gray warbler	Uplands	Singing male	Taylor
Actual	Black-throated sparrow	Fossil Creek Upland		Overby, Agyagos

Actual	Black-throated sparrow	Uplands	Singing male	Taylor
Actual	Black-throated sparrow	Uplands		AGFD
Actual	Blue grosbeak	Riparian	Nest building	Taylor
Actual	blue grosbeak	Stehr Lake	male	Agyagos
Actual	Blue-gray gnatcatcher	Irving Powerplant		NAAS
Actual	Blue-gray gnatcatcher	Riparian & uplands	Singing male	Taylor
Actual	Blue-gray Gnatcatcher	Uplands	nest with eggs	AGFD
Actual	Boat-tailed grackle	Stehr Lake		AZ Public Service Co.
Actual	Bridled titmouse	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Bridled titmouse	Fossil Creek Riparian		E.L.Smith
Actual	Bridled titmouse	Fossil Creek Riparian		AZ Public Service Co.
Actual	Bridled titmouse	Fossil Springs Riparian		NAAS
Actual	Bridled titmouse	RNA and vicinity		Smith/Bender
Actual	Broad-tailed hummingbird	Riparian & uplands	Singing male	Taylor
Actual	Bronzed cowbird	Riparian	Singing male	Taylor
Actual	Brown Creeper	Fossil springs		Bill Burbridge
Actual	Brown-crested flycatcher	Fossil Springs Riparian		NAAS
Actual	Brown-headed cowbird	Irving Powerplant		NAAS
Actual	Brown-headed cowbird	Irving to bridge		Scott Bailey
Actual	Brown-headed cowbird	Riparian	singing male	Taylor
Actual	Brown-headed cowbird	Riparian & uplands	pair	AGFD
Actual	Bushtit	Irving Powerplant-trailhead		NAAS
Actual	Bushtit	Riparian & uplands	fledged young present	AGFD
Actual	Bushtit	Uplands		Taylor

Actual	Cactus wren	Stehr Lake		NAAS
Actual	Cactus wren	Uplands		AGFD
Actual	Canyon towhee	Child's Powerplant		Overby, Agyagos
Actual	Canyon towhee	Uplands	courtship	AGFD
Actual	Canyon wren	Above springs		NAAS
Actual	Canyon wren	Fossil Creek Riparian		E.L.Smith
Actual	Canyon wren	Fossil Creek/Spring		Robert Magill- AGFD
Actual	Canyon Wren	Fossil Springs Riparian		Agyagos
Actual	Canyon wren	Fossil/Verde Confluence		Sullivan
Actual	Canyon wren	Riparian & uplands	probable nest site	AGFD
Actual	Canyon wren	Riparian & uplands	Singing male	Taylor
Actual	Canyon Wren	RNA and vicinity	Smith/Bender	
Actual	Cassin's kingbird	Fossil Creek Riparian		E.L.Smith
Actual	Cassin's kingbird	Irving Powerplant		NAAS
Actual	Cassin's kingbird	Riparian & uplands	fledged young present	AGFD
Actual	Cassin's kingbird	RNA and vicinity		Smith/Bender
Actual	Chipping Sparrow	Uplands	pair	Taylor
Actual	Common blackhawk	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Common blackhawk	Fossil Springs Riparian		NAAS
Actual	Common Blackhawk	Fossil Springs Riparian		Agyagos
Actual	Common blackhawk	Irving Powerplant		NAAS
Actual	Common blackhawk	Irving to bridge		Scott Bailey
Actual	Common blackhawk	Uplands		Taylor
Actual	Common black-hawk	Fossil Creek Riparian		AZ Public Service Co.
Actual	Common Raven	Aqueduct Spring		Agyagos

Actual	Common raven	Fossil - Bridge to Boulder Canyon		Scott Bailey		
Actual	Common raven	Fossil Creek Riparian		E.L.Smith		
Actual	Common raven	Fossil Creek Riparian		AZ Public Service Co.		
Actual	Common raven	Fossil Creek Upland		Overby, Agyagos		
Actual	Common Raven	Fossil Creek/Spring		Robert Magill- AGFD		
Actual	Common raven	Irving Powerplant		NAAS		
Actual Taylor	Common raven	Riparian & uplands		AGFD ctual	Common Raven	Riparian & Uplands
Actual	Common raven	RNA and vicinity		Smith/Bender		
Actual	Common raven	Stehr Lake		AZ Public Service Co.		
Actual	Common yellowthroat	Fossil Creek Riparian		E.L.Smith		
Actual	Common Yellowthroat	Stehr Lake	singing	Groschupf, McKinstry		
Actual	Common Yellowthroat	Stehr Lake	2 males	Groschupf, McKinstry		
Actual	Common yellowthroat	Stehr Lake	singing male	Agyagos		
Actual	Common yellow-throat	RNA and vicinity		Smith/Bender		
Actual	Cooper's hawk	Not specified		AGFD		
Actual	Cooper's hawk	Riparian	nest with young	Taylor		
Actual	Cooper's hawk	Stehr Lake	Adult female and immature	Robert Magill- AGFD		
Actual	Cordilleran flycatcher	Fossil Springs Riparian		NAAS		
Actual	Costa's hummingbird	Fossil Creek/Spring		Robert Magill- AGFD		
Actual	Costa's hummingbird	Strawberry SW Block		AGFD		
Actual	Crissal thrasher	Riparian	pair	AGFD		
Actual	Dark-eyed junco	Child's Powerplant	numerous	Overby, Agyagos		
Actual	Eared grebe	Stehr Lake		AZ Public Service Co.		
Actual	Gambel's quail	Fossil - Bridge to Boulder Canyon		Scott Bailey		

Actual	Gambel's quail	Irving Powerplant-3 miles below		NAAS
Actual	Gambel's Quail	Not specified		AGFD
Actual	Gambel's Quail	Stehr Lake	females, males, babies	Agyagos
Actual	Gambel's quail	Stehr Lake		AZ Public Service Co.
Actual	Gambel's quail	Uplands	Pair	Taylor
Actual	Gamble's Quail	Child's Powerplant		Robert Magill- AGFD
Actual	Gila woodpecker	Child's Powerplant		Overby, Agyagos
Actual	Gila woodpecker	Fossil Creek Riparian		E.L.Smith
Actual	Gila woodpecker	Fossil Creek/Spring		Robert Magill- AGFD
Actual	Gila woodpecker	Riparian		AGFD
Actual	Gila Woodpecker	RNA and vicinity		Smith/Bender
Actual	Gila woodpecker	Uplands		Taylor
Actual	golden eagle	Child's Powerplant	Immature	Robert Magill- AGFD
Actual	Golden eagle	Irving Powerplant		NAAS
Actual	gray flycatcher	Child's Powerplant		Robert Magill- AGFD
Actual	Gray flycatcher	Riparian	Singing male	Taylor
Actual	Gray flycatcher	Uplands		AGFD
Actual	Gray vireo	Uplands		AGFD
Actual	Gray vireo	Uplands	Singing male	Taylor
Actual	Gray-headed junco	Fossil springs		Bill Burbridge
Actual	Great blue heron	Child's Powerplant	pair	Overby, Agyagos
Actual	Great blue heron	Fossil Creek Riparian		E.L.Smith
Actual	Great blue heron	Fossil Creek Riparian		AZ Public Service Co.
Actual	Great blue heron	Fossil/Verde Confluence		Sullivan
Actual	Great Blue Heron	RNA and vicinity	Smith/Bender	

Actual	Great blue heron	Stehr Lake		AZ Public Service Co.
Actual	Greater roadrunner	Uplands		Taylor
Actual	Great-horned owl	Uplands	Singing male	Taylor
Actual	Great-tailed grackle	Child's Powerplant	numeous males and females	Overby, Agyagos
Actual	Great-tailed grackle	Irving Powerplant		NAAS
Actual	Great-tailed grackle	Stehr Lake	males and females	Agyagos
Actual	Great-tailed grackles	Stehr Lake	flock of 20	Groschupf, McKinstry
Actual	Great-tailed grackles	Stehr Lake	flock of 20	Groschupf, McKinstry
Actual	Green-tailed towhee	Uplands		Taylor
Actual	Hairy Woodpecker	Fossil springs		Bill Burbridge
Actual	Hairy woodpecker	Fossil Springs Riparian		NAAS
Actual	Hermit thrush	Fossil Creek Riparian		E.L.Smith
Actual	Hermit thrush	RNA and vicinity		Smith/Bender
Actual	hooded oriole	Child's Powerplant		Robert Magill- AGFD
Actual	Hooded Oriole	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Hooded oriole	Fossil Creek Riparian		E.L.Smith
Actual	Hooded oriole	Fossil Creek Riparian		AZ Public Service Co.
Actual	Hooded oriole	Fossil Creek/Spring		Robert Magill- AGFD
Actual	Hooded oriole	Irving Powerplant		NAAS
Actual	Hooded oriole	Irving to bridge		Scott Bailey
Actual	Hooded oriole	Riparian	carrying food	AGFD
Actual	Hooded Oriole	Riparian	Territory	Taylor
Actual	Hooded Oriole	RNA and vicinity		Smith/Bender
Actual	Hooded oriole	Stehr Lake		AZ Public Service Co.

Actual	Hooed oriole	Stehr Lake	1 singing male, 2 females	Agyagos
Actual	House finch	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	House finch	Fossil Creek Riparian		E.L.Smith
Actual	House finch	Fossil Creek Riparian		AZ Public Service Co.
Actual	House finch	Riparian & uplands		AGFD
Actual	House finch	RNA and vicinity		Smith/Bender
Actual	House finch	Stehr Lake		AZ Public Service Co.
Actual	Hutton's vireo	Not specified		AGFD
Actual	Hutton's vireo	Riparian	Pair	Taylor
Actual	Indigo bunting	Stehr Lake	singing	Agyagos
Actual	killdeer	Child's Powerplant		Robert Magill- AGFD
Actual	Ladder backed woodpecker	Fossil Creek/Spring		Robert Magill- AGFD
Actual	Ladder-backed woodpecker	Fossil Springs Riparian		NAAS
Actual	Ladder-backed woodpecker	Not specified		AGFD
Actual	Ladder-backed woodpecker	Riparian & uplands	Singing male	Taylor
Actual	Lark Sparrow	Uplands	pair	Taylor
Actual	Lazuli bunting	Fossil Springs Riparian		NAAS
Actual	Lazuli bunting	Riparian	AGFD	
Actual	Le Conte's thrasher	Riparian & uplands		Taylor
Actual	Lesser goldfinch	Fossil Creek Riparian		E.L.Smith
Actual	Lesser goldfinch	Irving Powerplant		NAAS
Actual	Lesser goldfinch	Irving to bridge		Scott Bailey
Actual	Lesser goldfinch	Riparian		AGFD
Actual	Lesser goldfinch	RNA and vicinity		Smith/Bender
Actual	Lesser goldfinch	Stehr Lake	male	Agyagos

Actual	Loggerhead shrike	Fossil Creek Riparian		E.L.Smith
Actual	Loggerhead shrike	RNA and vicinity		Smith/Bender
Actual	Lucy's warbler	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Lucy's warbler	Fossil Creek Riparian		Agyagos
Actual	Lucy's warbler	Fossil Springs Riparian		AZ Public Service Co.
Actual	Lucy's warbler	Fossil Springs Riparian		NAAS
Actual	MacGillivray's warbler	Fossil Creek Riparian		E.L.Smith
Actual	MacGillivray's Warbler	RNA and vicinity		Smith/Bender
Actual	Magnificient hummingbird	Uplands	Singing male	Taylor
Actual	Mallard	Stehr Lake		AZ Public Service Co.
Actual	Mexican Jay	Riparian		Taylor
Actual	Mockingbird	Fossil Creek Riparian		AZ Public Service Co.
Actual	Mockingbird	Fossil Creek Riparian		E.L.Smith
Actual	Mockingbird	RNA and vicinity	Smith/Bender	
Actual	Mockingbird	Stehr Lake		AZ Public Service Co.
Actual	Mourning dove	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Mourning dove	Fossil Creek Riparian		AZ Public Service Co.
Actual	Mourning dove	Irving to bridge		Scott Bailey
Actual	Mourning dove	Many locations		NAAS
Actual	Mourning dove	Not specified		AGFD
Actual	Mourning dove	Riparian & uplands	Singing male	Taylor
Actual	Mourning dove	Stehr Lake		AZ Public Service Co.
Actual	Mourning dove	Stehr Lake		Agyagos
Actual	northern cardinal	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Northern cardinal	Fossil Creek Riparian	Pair	Agyagos

Actual	Northern cardinal	Riparian	Pair	Taylor
Actual	Northern cardinal	Riparian & uplands		AGFD
Actual	Northern cardinal	Stehr Lake	2 males	Agyagos
Actual	Northern flicker	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Northern flicker	Riparian & uplands	On nest	Taylor
Actual	Northern flicker	Stehr Lake		AZ Public Service Co.
Actual	northern flicker	Stehr Lake		Agyagos
Actual	Northern mockingbird	Child's Powerplant		Overby, Agyagos
Actual	Northern mockingbird	Stehr Lake		NAAS
Actual	Northern mockingbird	uplands	On nest	Taylor
Actual	Northern oriole	Fossil Creek Riparian		AZ Public Service Co.
Actual	Northern oriole	Riparian		AGFD
Actual	Northern oriole	Stehr Lake	male	Agyagos
Actual	Northern rough-winged swallow			Irving Powerplant NAAS
Actual	Northern saw-whet owl	Fossil Springs Riparian	Feeding on bird	Agyagos
Actual	Nothern cardinal	Irving to bridge		Scott Bailey
Actual	Olive-sided flycatcher	Fossil Creek Riparian		E.L.Smith
Actual	Olive-sided flycatcher	Fossil Creek Riparian		AZ Public Service Co.
Actual	Olive-sided flycatcher	RNA and vicinity		Smith/Bender
Actual	Peregrine falcon	Fossil Creek Riparian		E.L.Smith
Actual	Peregrine Falcon	RNA and vicinity		Smith/Bender
Actual	Phainopepela	Fossil Creek Riparian		Agyagos
Actual	Phainopepla	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Phainopepla	Fossil Creek/Spring		Robert Magill- AGFD

Actual	Phainopepla	Fossil Springs Riparian		Agyagos
Actual	Phainopepla	Irving to bridge		Scott Bailey
Actual	Phainopepla	Many locations		NAAS
Actual	Phainopepla	Riparian & uplands	Fledged young present	Taylor
Actual	Phainopepla	Stehr Lake	lots	Agyagos
Actual	Plain Titmouse	Not specified		AGFD
Actual	Plain titmouse	Uplands		Taylor
Actual	Pyrrhuloxia	Child's Powerplant		Robert Magill- AGFD
Actual	Red-shafted flicker	Fossil Creek Riparian		E.L.Smith
Actual	Red-shafted flicker	RNA and vicinity		Smith/Bender
Actual	Red-tailed hawk	Fossil Creek Riparian		AZ Public Service Co.
Actual	Red-tailed hawk	Fossil Creek Upland		Overby, Agyagos
Actual	Red-tailed hawk	Irving Powerplant		NAAS
Actual	Red-tailed hawk	Stehr Lake		AZ Public Service Co.
Actual	Red-tailed hawk	Uplands		AGFD
Actual	red-tailed hawk	Uplands		Taylor
Actual	Red-winged blackbird	Child's Powerplant		Overby, Agyagos
Actual	Red-winged blackbird	Stehr Lake		AZ Public Service Co.
Actual	Red-winged blackbirds	Stehr Lake	five	Groschupf, McKinstry
Actual	Robin	Fossil springs		Bill Burbridge
Actual	Rough-legged hawk	Fossil Creek Riparian		E.L.Smith
Actual	Rough-legged hawk	RNA and vicinity		Smith/Bender
Actual	Ruby-crowned kinglet	Child's Powerplant		Overby, Agyagos
Actual	Rufous hummingbird	Fossil Creek Riparian		AZ Public Service Co.
Actual	rufous-crowned sparrow	Not specified		AGFD

Actual	Rufous-crowned sparrow	Uplands	Singing male	Taylor
Actual	Rufous-sided towhee	Fossil Creek Riparian		AZ Public Service Co.
Actual	Rufous-sided towhee	Uplands	Territory	Taylor
Actual	Say's phoebe	Stehr Lake		Agyagos
Actual	Scott's oriole	Fossil Creek Riparian		E.L.Smith
Actual	Scott's oriole	Irving Powerplant		NAAS
Actual	Scott's Oriole	RNA and vicinity		Smith/Bender
Actual	Scrub jay	Fossil Creek Riparian		E.L.Smith
Actual	Scrub jay	Riparian	fledged young present	AGFD
Actual	Scrub jay	RNA and vicinity		Smith/Bender
Actual	Scrub jay	Uplands		Taylor
Actual	Solitary vireo	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Solitary vireo	Fossil Creek Riparian		E.L.Smith
Actual	Solitary vireo	Fossil Creek/Spring		Robert Magill- AGFD
Actual	Solitary vireo	Fossil Springs Riparian		NAAS
Actual	Solitary vireo	Irving to bridge		Scott Bailey
Actual	Solitary Vireo	RNA and vicinity		Smith/Bender
Actual	Song sparrow	Fossil Creek Riparian		AZ Public Service Co.
Actual	Song Sparrow	Fossil Creek/Spring		Robert Magill- AGFD
Actual	Song sparrow	Strawberry SW Block		AGFD
Actual	Sparrow hawk	Fossil Creek Riparian		E.L.Smith
Actual	Sparrow hawk	RNA and vicinity		Smith/Bender
Actual	Sparrow sp	Child's Powerplant		Overby, Agyagos
Actual	Spotted towhee	Fossil Springs Riparian		NAAS
Actual	Spotted towhee	Irving Powerplant		NAAS

Actual	Starling	Child's Powerplant	numerous	Overby, Agyagos		
Actual	Sulphur-bellied flycatcher	Strawberry SW Block	singing	AGFD		
Actual	Summer tanager	Child's Powerplant		Robert Magill- AGFD		
Actual	Summer tanager	Fossil - Bridge to Boulder Canyon		Scott Bailey		
Actual	Summer tanager	Fossil Creek Riparian		AZ Public Service Co.		
Actual	Summer tanager	Fossil Creek/Spring		Robert Magill- AGFD		
Actual	Summer tanager	Fossil Springs Riparian		NAAS		
Actual	Summer tanager	Not specified	carrying food	AGFD		
Actual	Summer tanager	Riparian	Pair	Taylor		
Actual	Summer tanager	Stehr Lake	male	Agyagos		
Actual	Turkey vulture	Along length of canyon		NAAS		
Actual	Turkey vulture	Fossil Creek Riparian		AZ Public Service Co.		
Actual	Turkey vulture	Fossil Creek Riparian		E.L.Smith		
Actual	Turkey vulture	Fossil Creek Upland		Overby, Agyagos		
Actual	Turkey vulture	Riparian & uplands		AGFD		
Actual	Turkey Vulture	RNA and vicinity		Smith/Bender		
Actual	Turkey vulture	Stehr Lake		AZ Public Service Co.		
Actual	Turkey Vulture	Uplands		Taylor		
Actual fledged young present	Verdin AGFD	Child's Powerplant	pair	Overby, AgyagosActual	Verdin	Riparian & uplands
Actual	Verdin	Uplands	Singing male	Taylor		
Actual	Vermillion flycatcher	Fossil/Verde Confluence		Sullivan		
Actual	Violet-green swallow	All locations		NAAS		
Actual	Violet-green swallow	Fossil - Bridge to Boulder Canyon		Scott Bailey		
Actual	Violet-green swallow	Fossil Creek Riparian		AZ Public Service Co.		

Actual	Violet-green swallow	Fossil Springs Riparian		Agyagos
Actual	Violet-green swallow	Irving to bridge		Scott Bailey
Actual	Violet-green swallow	Not specified		AGFD
Actual	Violet-green swallow	Riparian & uplands		Taylor
Actual	Violet-green swallow	Stehr Lake		AZ Public Service Co.
Actual	Vireo sp	Child's Powerplant		Overby, Agyagos
Actual	Virginia's warbler	Fossil Creek Riparian		AZ Public Service Co.
Actual	Virginia's warbler	Fossil Creek Riparian		E.L.Smith
Actual	Virginia's warbler	Fossil Springs Riparian		NAAS
Actual	Virginia's Warbler	RNA and vicinity		Smith/Bender
Actual	Virginina's warbler	Riparian	Singing male	Taylor
Actual	Warbling vireo	Fossil Creek Riparian		E.L.Smith
Actual	Warbling vireo	Fossil Springs Riparian		AZ Public Service Co.
Actual	Warbling Vireo	RNA and vicinity		Smith/Bender
Actual	Weid's Crested flycatcher	RNA and vicinity		Smith/Bender
Actual	Western bluebird	Child's Powerplant	2	Overby, Agyagos
Actual	Western kingbird	Fossil Creek Riparian		AZ Public Service Co.
Actual	Western kingbird	Irving to bridge		Scott Bailey
Actual	Western kingbird	Riparian	Singing male	Taylor
Actual	Western kingbird	Stehr Lake		AZ Public Service Co.
Actual	Western meadowlark	Uplands	Singing male	Taylor
Actual	Western tanager	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Western tanager	Fossil Creek Riparian		AZ Public Service Co.
Actual	Western Tanager	Fossil Creek/Spring		Robert Magill- AGFD

Actual	Western tanager	Riparian	Singing male	Taylor
Actual	Western tanager	Stehr Lake		AZ Public Service Co.
Actual	Western wood pewee	Fossil Creek Riparian		AZ Public Service Co.
Actual	Western wood pewee	Fossil Creek Riparian		Agyagos
Actual	Western wood pewee	Fossil Creek Riparian		E.L.Smith
Actual	Western wood pewee	Fossil Springs Riparian		Agyagos
Actual	Western wood pewee	Irving to bridge		Scott Bailey
Actual	Western wood pewee	Riparian	Singing male	Taylor
Actual	Western Wood Pewee	RNA and vicinity		Smith/Bender
Actual	Western wood-pewee	Not specified		AGFD
Actual	White-crowned sparrow	Uplands	singing male	Taylor
Actual	White-throated swift	Fossil Creek/Spring		Robert Magill- AGFD
Actual	White-throated swift	Not specified		AGFD
Actual	White-throated swift	Riparian		Taylor
Actual	White-winged dove	Fossil Creek/Spring		Robert Magill- AGFD
Actual	White-winged dove	Riparian		AGFD
Actual	Wied's crested flycatcher	Fossil Creek Riparian		E.L.Smith
Actual	Wilson Warbler	Riparian	Pair	Taylor
Actual	Yellow warbler	Child's Powerplant	Pair	Robert Magill- AGFD
Actual	Yellow warbler	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Yellow warbler	Fossil Creek Riparian		AZ Public Service Co.
Actual	Yellow warbler	Fossil Creek Riparian		E.L.Smith
Actual	Yellow warbler	Fossil Creek/Spring		Robert Magill- AGFD
Actual	Yellow warbler	Fossil Springs Riparian		Agyagos
Actual	Yellow warbler	Fossil Springs Riparian		NAAS

Actual	Yellow warbler	Fossil/Verde Confluence		Sullivan
Actual	Yellow warbler	Irving Powerplant		NAAS
Actual	Yellow warbler	Irving to bridge		Scott Bailey
Actual	Yellow warbler	Not specified		AGFD
Actual	Yellow warbler	Riparian	Pair	Taylor
Actual	Yellow warbler	RNA and vicinity		Smith/Bender
Actual	Yellow Warbler	Stehr Lake		Robert Magill- AGFD
Actual	Yellow warbler	Stehr Lake	singing	Agyagos
Actual	Yellow-bellied sapsucker	Fossil Creek Riparian	AZ Public Service Co.	
Actual	Yellow-billed cuckoo	Riparian		Taylor
Actual	Yellow-breasted chat	Aqueduct Spring		Agyagos
Actual	yellow-breasted chat	Fossil - Bridge to Boulder Canyon		Scott Bailey
Actual	Yellow-breasted chat	Fossil Creek Riparian		E.L.Smith
Actual	Yellow-breasted chat	Fossil Creek/Spring		Robert Magill- AGFD
Actual	Yellow-breasted chat	Fossil Springs Riparian		Agyagos
Actual	Yellow-breasted chat	Riparian	Singing male	Taylor
Actual	Yellow-breasted chat	RNA and vicinity		Smith/Bender
Actual	yellow-breasted chat	Stehr Lake	singing	Agyagos
Actual	Yellow-rumped warbler	Fossil/Verde Confluence		Sullivan
Actual	Zone-tailed hawk	Fossil Creek/Spring		Robert Magill- AGFD
Actual	Zone-tailed hawk	Not specified		AGFD
Actual	Zone-tailed hawk	Uplands		Taylor

Appendix C. Recreation

Fossil Creek Visitor Survey

NORTHERN ARIZONA UNIVERSITY FORESTRY

NORTHERN ARIZONA UNIVERSITY

SCHOOL OF FORESTRY

Dear Fossil Creek Visitor:

Thanks for agreeing to share your opinions about this special area. The questions in this booklet relate to your visit to Fossil Creek when you were contacted by an interviewer and given the survey packet.

This is your opportunity to help direct the future management of Fossil Creek. You are one of a small number of visitors who are being asked to give their opinions about this area. Information from this survey will help recreation managers better manage recreation use on Fossil Creek and provide the type of recreation that best meets visitors' needs while protecting this very special resource.

It should take you about 15-20 minutes to complete the questionnaire. There are no right or wrong answers and your responses will remain confidential. When you have finished the questionnaire, please return it to us in the enclosed postage-paid envelope.

If you have any questions or comments about this survey, please feel free to contact me, the study director:

Dr. Marty Lee
School of Forestry
Box 15018
Northern Arizona University
Flagstaff, AZ 86011
(928) 523-6644
martha.lee@nau.edu

Thank you again for your help!

Sincerely,

Marty Lee
Project Manager

Cover photo taken by Sylvester Allred

Section I. Your Visit to Fossil Creek

1. What type of group are you with? (check one)

____alone
____ family
____ friends
____ family and friends
____ school group
____ other (please describe) ______________________________

2. How many people in your group (including yourself) are in the following age classes?

____ Children (5and under)
____ Youth (6-17 years old)
____ Adult (18-61 years old)
____ Senior (62+ years old)

____TOTAL Group Size

3. How long was your visit to Fossil Creek? (check one)

____2 hours or less
____between 2 and 6 hours (1/2 day)
____between 6-12 hours (1 day)
____more than 1 day → How many days? ________days

4. How did you access the Fossil Creek area? (check one)

____ from Strawberry
____ from the Verde Valley

5. People have many reasons for visiting national forests. A number of these reasons are listed below. Circle the number that best describes the importance of each of the following reasons for why you visited Fossil Creek.

	Extremely Important	Somewhat Important	Not Important
To enjoy the sounds and smells of nature	3	2	1
To feel isolated	3	2	1
To see the dam	3	2	1
To see Fossil Creek	3	2	1
To relieve stress and tension	3	2	1
To bring back pleasant memories	3	2	1
To be with family or friends	3	2	1
To be with people who enjoy the same things I do	3	2	1
To exercise and improve my physical fitness	3	2	1
To view the scenery	3	2	1
To party	3	2	1
To do something creative such as sketch, paint, take photographs	3	2	1
To take risks	3	2	1
To experience a cooler temperature	3	2	1
To experience tranquility	3	2	1
To rest and relax	3	2	1
To camp and have a fire	3	2	1
To go swimming	3	2	1
To hike/backpack	3	2	1
To show visiting friends and relatives	3	2	1
Just curious to see what was here	3	2	1
To experience solitude	3	2	1
To wade in the creek	3	2	1
To get away from the usual demands of life	3	2	1
To visit the Verde Hot Springs	3	2	1

Please list any additional reasons not included in the list above that had a strong influence on your decision to come to Fossil Creek.

____

____

____

6. In which of the following activities did you participate during your visit to Fossil Creek? (check all that apply)

____ Sightseeing
____ Swimming
____ Rock collecting/prospecting
____ Picnicking
____ Driving for pleasure
____ Watching wildlife
____ Camping near vehicle
____ Walking
____ Viewing Indian ruins
____ Target shooting
____ Photography
____ Writing for pleasure
____ Fishing
____ Hot springing
____ Mountain biking
____ Backpack camping
____ Wading
____ Sunbathing
____ Mediation
____ Hiking (day use)
____ Horseback riding
____ Partying
____ Bird watching
____ Nature study
____ Reading for pleasure
____ Hunting
____ Fluming

7. Is this your first visit to Fossil Creek? (Check one)

____Yes → (If Yes) skip to question 8.

____ No → (If No) a. Would you call yourself a … (check one)

____ Frequent visitor (once a month or more)
____ Occasional visitor (visitor 2 or more times/year)
____ Annual visitor (once a year)
____ Infrequent visitor (less than once a year)

b. Since you have been coming to Fossil Creek, have you noticed any changes in recreation use or recreation impacts?

____ No

____ Yes → (If Yes) Please briefly describe:

____

____

____

8. In general, how crowded did you feel during your visit to Fossil Creek? (circle one number)

1	2	3	4	5	6	7	8	9
Not at all crowded		Slightly crowded			Moderately crowded			Extremely crowded

9. Activities designed to restore Fossil Creek to a more natural state are scheduled to begin in fall 2004. The non-native fish in Fossil Creek will be removed and a fish barrier installed to protect the native fish from competition from non-native fish. The Fossil Springs Diversion Dam is scheduled for removal by December 31, 2004 to restore a full flow of water to Fossil Creek.

How do you feel about:

a. the removal of non-native fish from Fossil Creek? (check one)

____ I support removal of non-native fish
____ I do not support removal of non-native fish
____ I do not feel strongly one way or another

b. the removal of the dam to restore full flow to Fossil Creek? (check one)

____ I support removal of the dam to restore full flows
____ I do not support removal of the dam to restore full flows
____ I do not feel strongly one way or another

10. Are you interested in being a member of a volunteer group ("Friends of Fossil Creek" for example) that would work with the Forest Service to manage and protect Fossil Creek? (check one)

____ No
____ Yes → (If Yes) Please put your name and address on a separate piece of paper and return it to us along with your questionnaire. We will give that information to the Forest Service

11. Map question

Section II. Managing Recreation Use of the Fossil Creek Area

12. Fossil Creek managers are interested in any problems you may have encountered during your visit in the place you marked on the map (Question 11). Circle the number that best describes how serious you found each to be.

	Not a problem	Slight problem	Moderate problem	Serious problem	Very serious problem
Litter on the roadside	1	2	3	4	5
Litter in camping areas	1	2	3	4	5
Litter near or in Fossil Creek	1	2	3	4	5
Vandalism	1	2	3	4	5
Too few rules and regulations	1	2	3	4	5
Unleashed dogs in the area	1	2	3	4	5
People shouting and yelling	1	2	3	4	5
Lack of law enforcement	1	2	3	4	5
Dogs with visitors	1	2	3	4	5
Lack of emergency contact information	1	2	3	4	5
Livestock in the area	1	2	3	4	5
Nudity	1	2	3	4	5
People being inconsiderate	1	2	3	4	5
Too few commercial establishments in the area	1	2	3	4	5
Off road vehicles in the area	1	2	3	4	5
Airplanes flying overhead	1	2	3	4	5
Vegetation damage	1	2	3	4	5
Cut tree limbs	1	2	3	4	5

13. Fossil Creek managers are interested in the types of information services you would find most useful for providing information about Fossil Creek. Which of the following ways of receiving information would you prefer? (check all that apply)

____ on-site information kiosks or bulletin boards
____ interacting with Forest Service staff on-site
____ contacting Forest Service offices
____ on the Forest Service website
____ be on a Fossil Creek mailing list
____ brochures, other information available on-site that I can take with me
____ self-guided interpretative trails on-site

____ I am not interested in receiving information about Fossil Creek

14. There are many kinds of services that Fossil Creek managers could provide to Fossil Creek visitors. Below is a list of facilities and services that could be provided at Fossil Creek.

Please indicate how important you think each would be in enhancing recreation on Fossil Creek (circle one number for each)

	Extremely important	**Somewhat important**	**Not important**	**Don't know**
Restroom facilities	3	2	1	DK
Drinking water	3	2	1	DK
Developed campgrounds	3	2	1	DK
Developed picnic areas	3	2	1	DK
Group campsites	3	2	1	DK
Group picnic (day use) areas	3	2	1	DK
Directional signs on the roads	3	2	1	DK
Directional signs on trails	3	2	1	DK
Having Forest Service personnel on-site	3	2	1	DK
Garbage cans at recreation sites	3	2	1	DK
Handicapped access to the creek	3	2	1	DK
Fishing opportunities	3	2	1	DK
Dispersed (undeveloped) campsites	3	2	1	DK
Designated dispersed campsites	3	2	1	DK
Historical interpretation of the Childs and Irving power plants	3	2	1	DK
A system of designated trails in the Fossil Creek area	3	2	1	DK

15. In order to protect Fossil Creek from significant recreation impacts, the Forest Service is considering making some changes in how they manage recreation use on Fossil Creek. We have divided the area into two sections—**Upper Fossil Creek** (from the Irving power plant upstream to and including Fossil Springs but excluding wilderness) and **Middle Fossil Creek** (Irving power plant downstream 2.9 miles to junction of Forest Roads 708 and 502).

Please indicate your level of support for each of the following potential actions by putting an "S" next to actions you would *support* and an "N" next to actions you would *not support*, and a "DK" next to locations you *don't know if you could support.*

Upper Fossil Creek – Irving upstream

____allow day use only

____ prohibit campfires

____ construct a trail system between Fossil Springs and the current dam site

Middle Fossil Creek – Irving downstream 2.9 miles

____ continue to allow camping but only in designated dispersed (undeveloped) camping sites

____ move dispersed (undeveloped) camping away from the creek

____ limit vehicle access near the creek

____ construct a non-motorized trail along Fossil Creek between Irving and the junction of Forest Roads 708 and 502.

____ provide interpretative information on-site on the natural and cultural features of Fossil Creek

Section III. Visitor Information.

These last questions will help us learn about the people who participated in the study. All information is STRICTLY CONFIDENTIAL and WILL NOT be associated with you as an individual.

16. What is your home city and state?

City ______________________________ State ______________________

17. Gender (check one): _____ female _____ male

18. Which best describes your race or ethnic group? (check one)

____African American
____Asian
____Caucasian

____Hispanic
____Native American
____Pacific Islander
____Other

19. Which of the following **best** describes your current employment status? (check one)

____ full-time student
____ part-time student
____ unemployed
____ retired
____ employed full-time
____ employed part-time
____ full-time homemaker/caregiver
____ other (specify) ____________

20. Is there anything else you would like to tell us about your visit to Fossil Creek area that was not covered in this survey?

Thank you very much for your valuable input. Please return the questionnaire in the enclosed postage paid envelope.

Visit Characteristics

Group Type (n=114)

Group Type	Percent
Alone	2
Family	23
Friends	24
Family and friends	22
School group	2
Other*	28

*Primarily Boy Scout groups

Where Visitors Spend the Most Time (n=102)

Fossil Creek Zone	Percent
Irving to Fossil Springs	52
Below Irving to and including FR 708 bridge	11
Below bridge to and including FR 708/502 junction	2
Below FR 708/502 junction to BM 3715	5
Below BM 3715 (Stehr Lake area)	19
Multiple areas above Irving	3
Multiple areas Irving to Stehr Lake	3
Multiple areas above and below Irving	6

Group Size (n=111)

Minimum: 1 person
Maximum: 40 people
Mean: 9 people

Length of Stay (n=117)

Length of Stay	Percent
2 hours or less	6
Between 2 and 6 hours	32
Between 6 and 12 hours	20
More than 1 day	42

Access to the Fossil Creek Area (n=114)

Access Fossil Creek:	Percent
From Strawberry	71
From the Verde Valley	29

First Visit to Fossil Creek (n=100)

First Visit?	Percent
Yes	38
No	62

Reasons for Visiting Fossil Creek (n=110-113)

Reason for Visiting Fossil Creek	Extremely important	Somewhat important	Not important
	- - - - - - - - - percent - - - - - - - - -		
To enjoy the sounds and smells of nature	84	13	3
To feel isolated	41	46	12
To see the dam	15	29	56
To see Fossil Creek	76	22	2
To relieve stress and tension	60	33	7
To bring back pleasant memories	33	40	27
To be with family or friends	65	28	7
To be with people who enjoy the same things I do	56	32	12
To exercise and improve my physical fitness	40	43	17
To view the scenery	90	9	1
To party	6	18	76
To do something creative such as sketch, paint, take photographs	10	33	57
To take risks	6	13	81
To experience a cooler temperature	41	32	27
To experience tranquility	63	30	7
To rest and relax	56	31	13
To camp and have a fire	35	26	39
To go swimming	48	32	20
To hike/backpack	61	27	12
To show visiting friends and relatives	20	35	45
Just curious to see what was here	28	39	33
To experience solitude	36	41	23
To wade in the creek	49	33	19
To get away from the usual demands of life	68	25	7
To visit the Verde Hot Springs	13	27	60
To go fishing and/or hunting	14	16	69

Activities (n=114)

Activity	Percent*
Sightseeing	88
Swimming	70
Rock collecting/prospecting	11
Picnicking	48
Driving for pleasure	17
Watching wildlife	43
Camping near vehicle	31
Walking	72
Viewing Indian ruins	6
Target shooting	6
Photography	37
Writing for pleasure	4
Fishing	17
Hot springing	18
Mountain biking	2
Backpack camping	22
Wading	62
Sunbathing	25
Meditation	21
Hiking (day use)	60
Horseback riding	2
Partying	16
Bird watching	13
Nature study	18
Reading for pleasure	16
Hunting	3
Fluming	17

* Totals more than 100 percent due to multiple responses.

Management of Fossil Creek

Feelings About Removal of Non-Native Fish from Fossil Creek (n=117)

Feelings about Non-Native Fish Removal	Percent
Support removal of non-native fish	45
Do not support removal of non-native fish	16
Do not feel strongly one way or the other	39

Feelings About Removal of the Dam to Restore Full Flow to Fossil Creek (n=115)

Feelings About Dam Removal	Percent
Support removal of the dam to restore full flows	55
Do not support removal of the dam to restore full flows	30
I do not feel strongly one way or the other	16

Problems Visitors May Have Encountered (n=110-114)

Problems	Not a problem	Slight problem	Moderate problem	Serious problem	Very serious problem
	- - - - - - - - - - - - - percent - - - - - - - - - - - - - - - - -				
Litter on the roadside	34	31	17	9	9
Litter in the camping area	19	22	23	16	20
Litter near or in Fossil Creek	24	32	22	11	11
Vandalism	58	22	12	5	3
Too few rules and regulations	76	6	11	2	4
Unleashed dogs in the area	75	12	6	4	3
People shouting and yelling	62	25	7	3	3
Lack of law enforcement	79	8	7	3	4
Dogs with visitors	82	10	4	3	1
Lack of emergency contact information	66	13	12	5	4
Livestock in the area	93	4	3	--	--
Nudity	94	4	1	1	--
People being inconsiderate	66	18	10	3	3
Too few commercial establishments in the area	94	4	1	1	--
Off road vehicles in the area	85	6	5	2	2
Airplanes flying overhead	94	4	1	1	--
Vegetation damage	69	14	14	3	--
Cut tree limbs	68	18	10	3	1

Preferred Sources of Information About Fossil Creek (n=114)

Information Source	Percent*
On-site information kiosks or bulletin boards	59
Interacting with Forest Service staff on-site	24
Contacting Forest Service offices	16
On the Forest Service website	54
Be on a Fossil Creek mailing list	30
Brochures, other information available on-site that I can take with me	45
Self-guided interpretive trails on-site	30
I am not interested in receiving information about Fossil Creek	11

*Totals more than 100 percent due to multiple responses.

Services Preferred at Fossil Creek (n=108-113)

Service or Facility	Not important	Somewhat important	Extremely Important	Don't know
	------------ percent -----------			
Restroom facilities	28	33	39	--
Drinking water	41	33	25	1
Developed campgrounds	71	22	5	2
Developed picnic areas	69	24	6	1
Group campsites	70	21	5	4
Group picnic (day use) areas	68	23	6	3
Directional signs on the roads	45	32	21	2
Directional signs on the trails	44	31	23	2
Having Forest Service personnel on-site	61	30	8	2
Garbage cans at recreation sites	12	27	59	3
Handicapped access to the creek	57	25	8	10
Fishing opportunities	52	22	19	6
Dispersed (undeveloped) campsites	14	33	51	2
Designated dispersed campsites	45	33	17	5
Historical interpretation of the Childs and Irving power plants	37	32	27	4
A system of designated trails in the Fossil Creek area	30	29	38	3

Support for Changes in Recreation Management of Fossil Creek Area (n=99-104)

Management Changes	Support	Do not support	Don't know
----	------ percent ----		
Upper Fossil Creek – Irving upstream			
Allow day use only	23	66	11
Prohibit campfires	28	59	13
Construct a trail system between Fossil Springs and the current dam site	64	22	14
Middle Fossil Creek – Irving			
Continue to allow camping but only in designated dispersed (undeveloped) camping sites	63	24	13
Move dispersed (undeveloped) camping away from the creek	38	43	18
Limit vehicle access near the creek	58	31	11
Construct a non-motorized trail along Fossil Creek between Irving and the junction of Forest Roads 708 and 502	65	20	15
Provide interpretive information on-site on the natural and cultural features of Fossil Creek	79	9	12

Visitor Demographics

Home State (n=117)

State	Percent
Arizona	98
New Mexico	2

Gender (n=114)

	Percent
Male	64
Female	36

Race (n=111)

	Percent
African American	1
Asian	1
Caucasian	87
Hispanic	7
Native American	1
Other	3

Employment Status (n=117)

	Percent
Employed full-time	68
Retired	9
Full-time student	6
Employed part-time	3
Part-time student and employed	3
Full-time homemaker/care giver	2
Self-employed	2
Full-time student and employed	2
Part-time student and employed part-time	2
Other	2
Unemployed	1

Appendix D. Metric to English Conversion Table.

Approximate Conversions from Metric Measures

Symbol	*When You Know*	*Multiply by*	*To Find*	*Symbol*
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares	2.5	acres	(10,000 m^2)
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
	metric ton	1.1	short tons	(1,000 kg)

VOLUME

mL	milliliters	0.03	fluid ounces	fl oz
mL	milliliters	0.06	cubic inches	in^3
L	liters	2.1	pints	pt
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3

TEMPERATURE (exact)

°C	degrees Celsius	multiply by 9/5, add 32	degrees Fahrenheit	°F

Endnotes

[1] The Mogollon Rim is a 1,000-foot escarpment which extends northwestward across Arizona for 200 miles and represents the eroded edge of the Colorado Plateau. This marks the northern edge of the Transition Zone, a belt of rugged mountains and large structural drainages which separates the physiographic provinces of the Colorado Plateau to the north and the Basin and Range to the south (Nelson 2003).

[2] Five outstanding remarkable features associated with Fossil Creek were identified. These include: geologic values, for the unusual travertine deposits; fish, for the headwater reach with an entirely native fish community; wildlife, for the high diversity of habitat and abundance of wildlife species; historic, for its high heritage value associated with both prehistoric and historic sites; and, riparian, for its mostly undisturbed riparian habitat (USDA 1993).

[3] Full flows were not returned to Fossil Creek until June 18, 2005.

[4] On October 8, 2004 FERC issued an Order Approving Surrender of License and Removal of Project Works for the Childs Irving Project. In that order, FERC stated that they will require the removal of the top 14 feet of the Fossil Springs Diversion Dam. They elaborate, stating "APS and the Forest Service propose that they jointly make a final decision on addional removal of the Fossil Springs dam during the project removal process. We will not leave the extent of dam removal unresolved in approving this surrender; therefore, this order will require only the removal of the tope 14 feet of the dam" (October 8, 2004 Order, page 15).

[5] This section excerpted from *Fossil Creek Planning Area Existing Condition, Soils, and Water Quality Report*, Rory Steinke, Coconino National Forest, September 17, 2002. Note that this section summarized information for a watershed boundary that includes a larger portion of the Verde Watershed than the watershed boundary used in this report (see Figure 5).

[6] The information in this report is summarized from the Forest Service draft specialist report for the Fossil Creek Planning Area (2003).

[7] This section is excerpted from *Fossil Creek Watershed Analysis, Affected Environment, Fisheries, Version 1.1*, Coconino National Forest, December 6, 2002, Mark Whitney, Forest Fisheries Biologist. Minor edits and clarifications were made based upon reviewer's comments.

[8] Cypriniform: group of fish within the taxonomic order Cypriniformes that contains the taxonomic families Cyprinidae (minnow, chub, etc.) and Catostomidae (suckers).

[9] Piscivorous: fish-eating.

[10] This section excerpted from *Fossil Creek Watershed Analysis, Affected Environment, Fisheries*, Coconino National Forest, Mark Whitney, Forest Fishery Biologist, December 6, 2002.

[11] Taxon: a general term for a taxonomic group (Family, Genus) whatever its rank.

[12] The Verde River lies within the Gila River Basin of the lower Colorado River Basin.

[13] Melanophore: pigment cell containing melanin (black) (Minkley 1973).

[14] Gonopodium: modified anal fin of males of live-bearing fishes, comprising fin-rays 3, 4, and 5. Used in transfer of spermatophores to genital pore of femal (Minkley 1973).

[15] Antimycin A is an organic compound that was isolated from the bacterium *Streptomyces girseus* in 1945. It was later found to be toxic to fish and was patented as a piscicide in 1964. The formulation used in the Fossil Creek native fish restoration project is Finitol-Concentrate (liquid form of Antimycin A) and Fintrol 15 (antimycin A coated sand) (USDI/USDA 2003). Antimycin acts at a cellular level to interrupt repiration of fishes. It degrades quickly in warm water and with exposure to turbulence and to sunlight. Potassium permanganate is used to neutralize antimycin (USDI/USDA 2003).

[16] Management Indicator Species (MIS) are defined in 36 CFR 219.19 which states that "In order to estimate the effects of each alternative on fish and wildlife populations, certain vertebrate and/or invertebrate species present in the area shall be identified and selected as management indicator species…These species shall be selected because their population changes are believed to indicate the effects of management activities." In addition, the CFR states that "in the selection of management indicator species, the following categories shall be represented when appropriate: Endangered and threatened plant and animal species identified on State and Federal lists for the planning area; species with special habitat needs that may be influenced significantly by planning programs; species commonly hunted, fished, or trapped; non-game species of special interest; and additional plant and animal species selected because their population changes are believed to indicate the effects of management activities on other species of selected major biological communities or on water quality."

[17] The "sunfish barrier" is a term used by those involved in the fall 2004 native fish restoration project. It is a natural "barrier" to sunfish movement and is located approximately 0.5 miles below the Fossil Springs Diversion Dam.

[18] Section 106 of the National Historic Preservation Act, as amended in 1992, establishes the basis for determining effects to cultural and historic sites as eligibility for inclusion in the National Register of Historic Places. Significance, the level of importance a site has in local or national culture or history, is a central concern in the evaluation of such eligibility and is determined by applying the National Register Criteria for Evaluation as defined in 36 CFR Part 60.