

Fossil Creek Research and Monitoring Inventory

Revision of March 15, 2005

This narrative provides a summary of ongoing or proposed monitoring and other research actions in the Fossil Creek watershed. This summary is intended to be comprehensive and includes work conducted by multiple entities including NAU and federal and state agencies. The monitoring and research summary is intended to provide a better understanding of how the watershed, in its most general definition, responds to decommissioning of APS Childs-Irving facilities, restoration of the Fossil Creek baseflow, and the associated fish restoration.

Please refer to the attached monitoring matrix, which summarizes the actions described below.

On-Going Research & Monitoring

Fossil Creek Fish Monitoring Plan

Prepared by Ian Reid, Acting Coconino National Forest Fisheries Biologist

Introduction

This section documents the analysis and prioritization of biological monitoring opportunities in Fossil Creek prior to the return of full flows in 2005. This document also describes actions to take if exotic fishes are detected during biological monitoring.

Rationale

Effectiveness monitoring is needed to determine if the Fall, 2004, piscicide treatments were successful in killing exotic fishes. Preliminary monitoring did not detect any surviving exotic fishes (Reid, 2004), however, more sampling effort is necessary to ensure project success.

Reach Description

From upstream to downstream it goes Reach 1 extends from the Fossil Springs diversion dam to the big waterfall between the dam and Irving. Reach 2 extends from the big waterfall to the Irving waterfall. Reach 3 extends from the Irving waterfall to the confluence with Sally Mae wash. Reach 4 extends from the Sally Mae confluence to the fish barrier (constructed in Fall, 2004), roughly 2.7 miles below the Sally Mae confluence. In Figure 1 is a low-resolution map of the area.

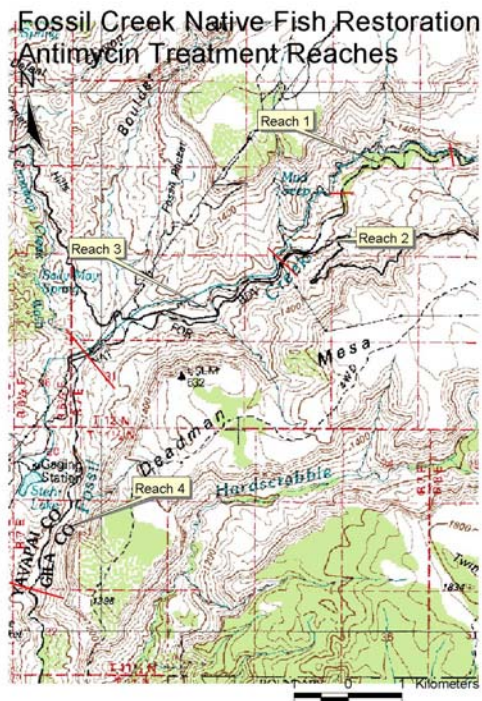


Figure 1: Map illustrating Fossil Creek fish restoration reaches.

Strategies

Habitats: Main-stem habitats were intensively treated with drip stations, backpack sprayers, and sand during chemical renovation. Therefore, the habitats most likely to contain living exotic fishes are off-channel habitats, such as alcoves, oxbows, isolated pools (especially any that were overlooked during treatment) and possibly deep, mainstem pools. Because it is likely that all exotic fishes were killed in the mainstem of Fossil Creek (with the possible exception of deep pools), sampling in the main channel is unlikely to detect any exotic fishes unless a high flow event occurs that would reconnect off-channel habitats to the mainstem.

Locations: Reach 3 had the highest proportion of complex habitats, however, many of these habitats were mainstem pools with excessive cattail growth. Reaches 1 and 2 contained some off-channel habitats and Reach 4 contained the least.

Sampling gears: Because of cold water temperatures in much of Fossil Creek between December and January (Figure 2), exotic fishes, if present, are likely to be relatively inactive and difficult to observe by snorkeling. Likewise, their metabolic rates and subsequent food demands will be low and baited hoopnets or minnow traps might also be ineffective observation tools. Electrofishing in relatively shallow, off-channel habitats could be effective for detecting exotic fishes because of electro taxis that operates independently of water temperatures. However, electrofishing will be ineffective for sampling deep pools, which may require snorkeling or a combination of snorkeling and baited hoopnets.

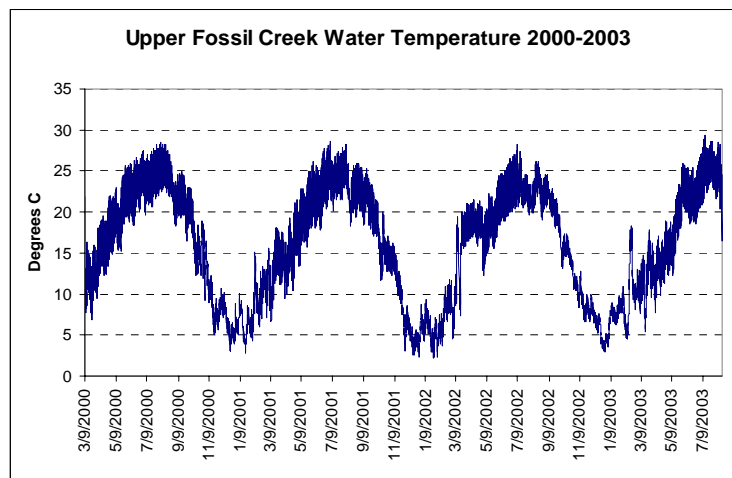


Figure 2: Daily water temperatures of Fossil Creek above Irving. Source: USFWS.

Coordination: Given the time constraints and other, conflicting priorities of the agencies involved with the Fossil Creek native fish restoration project, agencies need some flexibility in scheduling and implementing this monitoring. However, participating agencies should provide the other agencies with detailed descriptions of their monitoring efforts (i.e. locations, sampling gear, effort, findings) as soon as possible after returning from the field so monitoring efforts are not needlessly duplicated.

Detection: If exotic fishes are detected, protocol should be followed as outlined in USDA FS 2004 (pp. 27-28). Specifically, fish should be removed by mechanical methods (e.g. seining, trammel- or gillnets, or electrofishing where possible) and chemical re-treatment assessed if the number and distribution of exotic fish is thought to exceed the limits of mechanical removal.

Analysis and Recommendations

The sampling effort spent in Fossil Creek to detect exotic fishes before full flows return, which is anticipated for March or April of 2005, will be contingent on employee availability and potentially weather and environmental conditions (high flows). Because the number of exotic fishes that survived chemical renovation, if any, is likely very small, extensive monitoring will probably be needed to detect these fish.

Backpack electrofishing in off-channel habitats in Reaches 1-3 should be a high priority in early January of 2005. Of these three reaches, Reach 3 should be the highest priority because Reaches 1 and 2 have already been electrofished (Reid 2004). The main channel should not be electrofished as there is a very low probability of fish occurring in these habitats and being susceptible to electrofishing, and because of the presence of native fishes already potentially stressed by extensive handling. In late February of 2005, after stream temperatures have warmed, snorkeling deep pools and using baited traps in off-channel or complex habitats in Reaches 3 and 4 could also be used to diversify sampling methods. This monitoring would add to the trapping effort already conducted in Reach 3 (Reid 2004).

References

Reid, I. S., 2004, Fossil Creek Piscicide Treatment Effectiveness Preliminary Monitoring Report, available from: Coconino National Forest, 1824 S Thompson St., Flagstaff, AZ 86001, 2 pp.

USDA Forest Service, 2004, Native fish restoration in Fossil Creek: Final Environmental Assessment, available from: Coconino National Forest, 1824 S Thompson St., Flagstaff, AZ 86001, 119 pp. + appendices.

Monitoring and Adaptive Management Strategy for Special Status Species and Habitat Associated with the Childs Irving Project Decommissioning

Prepared by Janie Agyagos, Cecelia Overby, and Justin Jimenez – all with the U.S. Forest Service

Here we identify objectives, methodologies, and strategies for monitoring special status species associated with the Childs-Irving Decommissioning and determine appropriate monitoring protocols or inventory procedures for special status species and define adaptive management needs and options applicable to lowland leopard frogs.

Monitoring Objectives

1. Monitor the presence/absence and distribution of lowland leopard frogs prior to, during and after the removal of the Fossil Springs Dam (ending 12/31/2009) along the entire length of Fossil Creek.
2. Monitor the persistence of the existing population of lowland leopard frogs above Fossil Springs Dam prior to, during and after the removal of the Dam (ending 12/31/2009).
3. Monitor the development of replacement riparian habitat for the lowland leopard frog downstream of the Fossil Springs Dam prior to dam removal (ending 12/31/2009).
4. Monitor the presence/absence and nesting sites of common black-hawks and yellow-billed cuckoos during deconstruction activities within riparian areas of Fossil Creek and Stehr Lake.

Objective 1. Monitor the presence/absence and distribution of lowland leopard frogs

The protocol that is recommended for this monitoring is the standard visual encounter survey (VES) protocol. This survey should be completed from Fossil Springs Dam to the confluence of Fossil Creek and the Verde River and should be completed annually from 2004 and 2007. Due to time constraints, agency biologists have already completed the 2004 surveys and have absorbed the costs associated with those surveys. The survey should be completed from Fossil Springs Dam to the fish barrier in 2005, 2006, 2008 and 2009. Although a complete survey of the entire reach would be desirable, it is not practical. Instead samples should be stratified by stream reach as follows: (1) from Fossil Springs Dam to the road crossing below Irving, (2) from the road crossing to the fish barrier, and (3) from the fish barrier to the confluence with the Verde River. Each annual survey should include 2 day passes of sampled reaches. Night surveys are highly desirable to complete, but safety considerations make extensive night surveys impractical. Instead, at least one sample point should be identified in each of the three reaches and visited once a designated sample year at night during the peak breeding season.

For each of the 3 reaches, survey effort for each daytime survey is estimated to require one 3-person crew and will take 2 days (including travel time) for a total effort of 6 person-days. Therefore, total annual effort for daytime surveys will require 18 person-days. One night surveys per each of the three reaches could be accomplished by 3 people and would therefore require an additional 3 person-days. It is estimated that this survey will cost \$6000 annually in 2004 and 2007 and \$4000 annually in 2005, 2006, 2008 and 2009. Time and cost estimates are based on experienced agency personnel completing the work, the cost to have the work contracted out is unknown. Specialists from the Arizona Game and Fish (Mike Sredl and Susie MacVean) are most experienced with this protocol if these individuals are not available; personnel from USFS (Janie Agyagos and Cecelia Overby) can provide additional information.

Objective 2. Monitor the persistence of the existing population of lowland leopard frogs

The objective of this study would be to monitor the persistence of the existing population of lowland leopard frogs throughout the project decommissioning process. As with objective 1, the VES survey protocol will be used, with 2 daytime surveys and 1 nighttime survey. The entire reach of Fossil Creek from the Fossil Springs dam site upstream to the springs will be surveyed. This survey would be completed 2004, 2005, 2007, 2008, and 2009. It is estimated that the total annual effort will require 7 person-days and will cost \$2000 per year. Time and cost estimates are based on experienced agency personnel completing the work, the cost to have the work contracted out is unknown. Specialists from the Arizona Game and Fish (Mike Sredl and Susie MacVean) are most experienced with this protocol if these individuals are not available; personnel from USFS (Janie Agyagos and Cecelia Overby) can provide additional information.

Objective 3. Monitor the development of replacement riparian habitat

There are two protocols that are recommended to meet this monitoring objective. The first survey would meet the intent of determining whether physical instream habitat has developed and the recommended protocol is the "Basinwide" methodology (Dolloff, C.A., D.G. Hankin, and G.H. Reeves; USDA FS General Technical Report SE-83, 1993, http://www.srs.fs.usda.gov/pubs/gtr/gtr_se083.pdf). This survey would only include the physical habitat survey as modified by the Stream Inventory Handbook, Level I and II. Southwestern Region USDA Forest Service, April 2003.

- a) It is recommended that Fossil Creek be surveyed from Irving to directly above Fossil Springs Dam (~4 miles). This survey should be completed prior to restored flows (2004) and re-surveyed prior to dam removal (2007). It is estimated that this survey will cost \$6000 (including preparation time, compilation of maps, preparing forms, travel, data input, reporting, etc.) in 2004 and in 2007. Time and cost estimates are based on experienced agency personnel completing the work, the cost to have the work contracted out is unknown. The Forest Service would like to cooperate with APS in conducting the survey as we can provide assistance in the completion of the survey, data input, data analysis and the final report. A

Forest Service contact regarding this protocol and the implementation of this survey is Sean Ferrell.

- b) The second proposed survey would focus on characterizing the riparian vegetation and channel attributes, identify changes in plant community over time and detect trends or change over time. The recommended survey protocol is the Draft Tonto National Forest Riparian Vegetation Trend Monitoring.

After field review it has been identified that cross sections and longitudinal profiles should only be established where changes in the channel are expected to occur from the restoration of full flows. It is expected that channel changes will occur where erosion of the sediment behind the Fossil Springs Diversion Dam will occur, where travertine will form, and where existing travertine will no longer form and would be degraded by flood flows. Based on this criteria, cross section would best be located in Reach 2 just above the dam, Reach 3 just below the dam, in the middle portion of Reach 3 and one just above reach 4. Each of these areas will require one permanent cross-section for a minimum of four cross-sections. It is estimated that a crew of two could complete the cross-section and longitudinal profile work in 4 days at an estimated cost of \$2000. It is estimated that a crew of four could complete the riparian vegetation trend monitoring (500-700 foot distance) associated with one cross-section per day. To complete the riparian vegetation trend monitoring it would require a four person crew for 12 days (including preparation time, compilation of maps, preparing forms, travel, data input, reporting, etc.) at an estimated cost of \$7200. This survey should be completed prior to restored flows (2004) and re-surveyed prior to dam removal (2007). Additional photo monitoring is recommended for 2005-2006 which would require one person for a total of four days at a cost of \$1000. Time and cost estimates are based on experienced agency personnel completing the work, the cost to have the work contracted out is unknown. The Forest Service would like to cooperate with APS in conducting the survey as we can provide assistance in the completion of the survey, data input, data analysis and the final report. A Forest Service contact regarding this protocol and the implementation of this survey is Kristen McBride.

Objective 4. Monitor the presence/absence and nesting sites of common black-hawks and yellow-billed cuckoos

The objective of this survey is to avoid deconstruction activities that could result in aural or visual disturbance of special-status bird species in riparian areas of Fossil Creek and Stehr Lake from February 15 through August 31. This would entail conducting presence/absence surveys and searching for nesting sites. If nesting sites are identified a 0.25-mile activity buffer around the nesting sites for the duration of the species-specific breeding season (March 1 to July 30 for the black-hawk, June 1 to August 31 for the cuckoo).

All riparian habitat and any known or suspected nest sites within 0.25 miles of areas where deconstruction and associated activities will occur should be surveyed for black hawks and yellow-billed cuckoos. The recommended protocol for black hawk surveys is *Nesting Habitats and Surveying Techniques for Common Western Raptors* by Mayo W. Call. Surveys should consist of hiking through the riparian habitat, looking and listening for evidence of black hawk nesting, such as the presence of birds, stick nests, whitewash, and prey remains. For cuckoos, the Arizona Game and Fish Department protocol *Draft Western Yellow-billed Cuckoo Natural History Summary and Survey Methodology* should be implemented.

It is estimated that to complete the surveys for black-hawk and yellow-billed cuckoos it would require 2 people for 5 days annually. This survey only needs to be completed when deconstruction areas are pre-determined to be within the 0.25-mile activity buffer. The estimated annual cost of this survey is \$3000. Time and cost estimates are based on experienced agency personnel completing the work, the cost to have the work contracted out is unknown. The Forest Service would like to cooperate with APS in conducting these surveys as we can provide assistance in the completion of these surveys. Forest Service contacts regarding this protocol and the implementation of this survey are Cecelia Overby and Janie Agyagos.

Summary of Total Estimated Costs of Monitoring

Year	Objective 1	Objective 2	Objective 3a	Objective 3b	Objective 4	Total
2004		\$2,000	\$6,000	\$9,200		\$17,200
2005	\$4,000	\$2,000		\$1,000	**\$3,000	\$11,000
2006	\$4,000			\$1,000	**\$3,000	\$7,000
2007	\$6,000	\$2,000	\$6,000	\$9,200	**\$3,000	\$26,200
2008	\$4,000	\$2,000			**\$3,000	\$9,000
2009	\$4,000	\$2,000				\$6,000
Total	\$28,000	\$10,000	\$12,000	\$20,400	**\$12,000	\$76,400

*Cost estimates are based on experienced agency personnel completing the work; the cost to have the work contracted out is unknown.

** This survey is only required when deconstruction activities are occurring in riparian areas of Fossil Creek and Stehr Lake from February 15 through August 31. If deconstruction activities in the riparian areas of Fossil Creek and Stehr Lake occur in 2007 and 2008 only two years on monitoring will be needed.

Adaptive Management for the Lowland Leopard Frog:

This need would arise if the monitoring demonstrates that lowland leopard frogs are not dispersing and persisting and adequate habitat is not established below the dam prior to dam removal.

Adaptive Management Options for the Lowland Leopard Frog:

- Delay of dam removal until the fall of 2008 as agreed by APS.
- Development of replacement habitat by identifying existing spring areas for lowland leopard frogs to persist while deconstruction activities are occurring and habitat is developing. Although it is preferable that these areas be in the Fossil Creek drainage, preliminary surveys indicate limited opportunities. There are possibly three springs in the Fossil Creek area that may be suitable with slight modifications. These modifications include fencing of one spring, closure of a road and stream channel restoration, and pool establishment at the third. Three additional springs have currently been identified as potential frog habitat in the Hackberry Basin area; however, these occur approximately 3 miles from Fossil Creek. All of these spring areas would need to be fenced to prevent livestock access.
- Flexibility in the amount of dam to be removed beyond the initial 14 feet.

Streamflow

Prepared by Grant Loomis, Tonto National Forest

Since 2000, Tonto National Forest Hydrologists have been measuring Fossil Creek stream flow on a quarterly basis at locations above and below the Fossil Springs. 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.

(GRANT: This is a placeholder that I prepared on your behalf (!) ; would you please review and add a few sentences or paragraphs to document ongoing monitoring and research. Thank you. Charlie).

Travertine

Prepared by Rod Parnell, Northern Arizona University

Fossil Creek is unusual among southwestern streams in its formation of natural travertine dams, created by precipitation from calcium carbonate-laden waters. These natural structures in turn produce deep crystalline pools, ideal for native fish, and shallow dams, ideal habitat for the invertebrates upon which the fish feed. Travertine, which could be described as "Arizona's coral reef", enhances fish and insect diversity because of its unique chemistry and structure. Travertine also promotes growth of algae and decomposer organisms and strengthens the ecosystem by providing more energy to higher levels of organisms in the food chain. The return of full flows after decommissioning of the hydropower plants is expected to increase the travertine deposition rates, allowing for natural diversions and pools to recover to their original state of one hundred years ago.

We are currently documenting and quantifying rates of travertine deposition under low, pre-restoration flows, including experiments to examine individual factors (algal abundance, water depth and velocity, shade vs. direct sun) on travertine formation. From this data, we can predict how rapidly travertine environments will expand with full flows. We have also initiated quarterly water quality sampling and analyzed travertine substrates at eight sites.

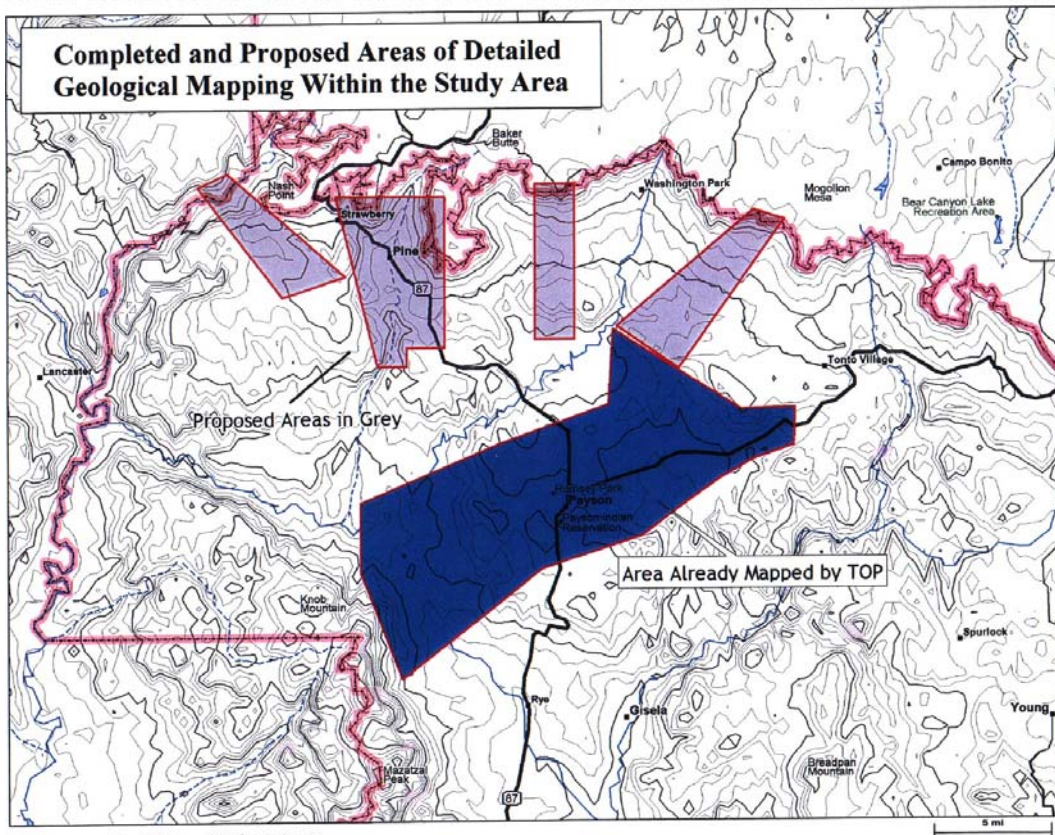
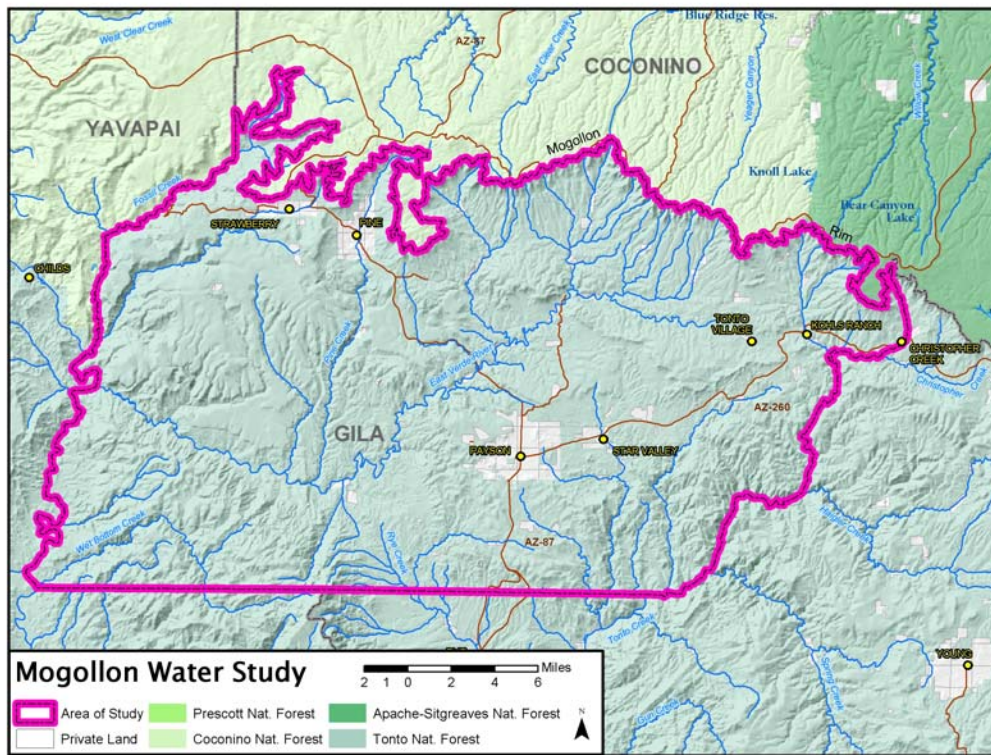
Mogollon Rim Water Resources Management Study - Geological Investigations

by Mike Ploughe, Town of Payson, and Leslie Meyers, USBR

As part of the USBR's Mogollon Rim Water Resources Study, geological and hydrogeological investigations are being completed, with the objective of providing an accurate understanding of the hydrogeological framework of the Mogollon Rim study area, which includes Fossil Creek. The following activities are in progress and should be completed by the end of, 2005.

- 1) Geological mapping, with a focus on structural geology, as well as lithology. Mapping is being conducted at a scale of 1:24,000 within much of the study area and a regional map at 1:100,000 will be prepared, together with a narrative report. This mapping will compile existing and new data acquired as part of this initiative. Mapping data will be available in ARC-GIS shape file format. Reconnaissance-level geological mapping will also be obtained for the entire study area. (See attached study area map.)
- 2) More detailed geological investigations are wrapping up in a number of sub-areas. This detailed mapping will focus on faults, lithological and/or formation variations, as they relate to the hydrogeology of structural discontinuities. (See attached Geology detail map.) This is of particular interest in the vicinity of Fossil Springs.
- 3) The investigations also include consideration of general groundwater, surface water, and spring chemistry in addition to $^{87}\text{Sr}/^{86}\text{Sr}$ ratios, Hydrogen and Sulfur stable isotopes, and Tritium analyses. These results will aid in defining the sources of water and/or recharge areas. Of late, naturally occurring Arsenic in groundwater and springs is to be considered as well.
- 4) In coordination with ADWR, the Town of Payson hopes to add further data by collecting groundwater elevation data from selected wells within the various aquifers of the study area. A survey of each wellhead elevation will be completed to support the accurate presentation of elevation data. Readings will be collected within a one-month period, in order to provide an accurate "snap shot" of the groundwater systems and to further aid in defining the groundwater sub-basins within the study area. Where possible historical water level records will be utilized to place the "snap shot" into perspective and keep it within the appropriate context.

Ultimately, all of the data being considered will be used to develop and present a conceptual groundwater model for the regions aquifer systems by defining the sub-basins that clearly exist within the study area but are as yet undocumented or poorly understood.



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 Scale: 1 : 300,000 Zoom Level: 0-0 Datum: WGS84 Map Rotation: 0° Magnetic Declination: 12.0°E

Aquatic Species, Food Webs and Ecosystem Processes

Prepared by Jane Marks, Northern Arizona University

The Stream Ecology and Restoration Group has established ten monitoring sites which encompass the ecological and geomorphological variation in Fossil Creek. The sites extend from the springs to the confluence. There are three major components to our work:

a) Aquatic Species Distributions – *What are the current distributions of native and exotic species, and how will they change with restoration?* At each of the sites we monitor benthic macroinvertebrates by taking ten replicate samples in pools using cores and ten replicate samples in riffles using surber samples. Samples are preserved in alcohol and invertebrates are identified and enumerated in the laboratory using a dissecting scope. We estimate crayfish densities at a subset of the sites using mark and recapture techniques and minnow trapping. Fish are monitored at eight sites using snorkel surveys that span 100-200 meters. In collaboration with the USFWS we plan to compliment snorkel surveys with annual hoop net surveys to estimate size structure of fish populations. Species estimates are conducted 2-4 times per year.

b) Food Web Structure - *Have water extraction and exotic species affected feeding patterns of native fish and invertebrates, and will restoration of flow and removal of exotic fish revive native food webs?* We compare food web structure across eight sites using stable isotopes of nitrogen, carbon, and hydrogen to determine who is eating whom and to analyze whether the main source of energy for fish and invertebrates is algae or leaf litter. We sample ten replicate fin clips from each fish taxa and 5-10 replicates of dominant macroinvertebrates and food base items. We are also measuring dissolved inorganic and organic carbon and nitrogen concentrations and stable isotope values at seven sites. Samples are prepared and processed at the Colorado Plateau Stable Isotope Facility.

c) Ecosystem processes – *How will increased travertine deposition, caused by restoration of flow, affect primary and secondary productivity and nutrient cycling?* We are monitoring travertine deposition at six sites by incubating artificial substrates in the river for two months, and measuring deposition rates of organic and inorganic carbon. We monitor decomposition rates at these sites by incubating litter bags filled with a known weight of leaf litter. Samples are harvested at weekly intervals, the remaining leaf litter is dried and weighed, and decomposition rates are estimated using an exponential decay model. Microbial species composition and activity are measured concurrently using molecular techniques. We are measuring ecosystem productivity and nitrogen uptake rates at four of the sites (above the dam, below the dam, below Irving, and below Sally Mae Wash). The ecosystem work is being conducted in collaboration with three NAU research groups led by R. Parnell (geomorphology), M. Watwood (microbiology), and B. Hungate (nitrogen cycling).

Affiliated NAU researchers include:

Stream Ecology and Restoration Group: Dr. Jane Marks, Allen Haden, Eric Dinger, Ken Adams, Cody Carter, Carri LeRoy, Dr. Cathy Gibson

Colorado Plateau Stable Isotope Facility – Dr. Bruce Hungate, Dr. Rick Doucett, Jaina Moan

Geology – Dr. Rod Parnell

Microbial Ecology – Dr. Maribeth Watwood, Brenda Harrop

This work is supported by the National Science Foundation, The Arizona Game and Fish Heritage Program, The Merriam Powell Center for Environmental Research, The Ecological Restoration Institute and The Pulliam Charitable Trust.

Sediment Transport

Prepared by Charlie Schlinger, Northern Arizona University

As part of our work on this project we are completing the following as part of our element of a larger initiative funded by the Nina Mason Pulliam Charitable Trust.

First, we are conducting a detailed stream classification and research on the stream morphology. During 2004-2005, our initial focus is on a reach that begins roughly 1 mile above the Fossil Springs and continues downstream to a point just above Irving. As part of the stream classification, we have identified locations for: sediment sampling and monitoring; surveying of channel cross-section and slope; estimation of roughness parameters. During the middle of 2005, we plan to address reaches upstream and downstream of this initial reach, working toward the confluence of Sand Rock and Calf Pen Canyons, and continuing down toward the confluence of Fossil Creek with the Verde.

Second, we will delineate the watershed and subwatersheds of the main tributaries to Fossil Creek. We will develop profiles using existing data and possibly using new survey data acquired as part of this project. As part of the watershed delineation we will develop a stream profile of the main stem, which we will be used as the basis for evaluation of our stream classification results.

Third, we will conduct pebble counts, surveying of channel cross-section and slope, and estimation of roughness parameters (Mannings n) at monitoring locations.

These planned actions are intended to help us develop a better understanding of Fossil Creek watershed hydrology, channel hydraulics and sediment transport, with an eye toward ongoing and future assessment of impacts of diversion dam lowering on sediment distribution, stream morphology and hydrology in the context of results from this baseline characterization.

As part of this activity, on December 8, 2004, Cooper Aerial kindly acquired aerial photography of Fossil Creek, from the approximate location near the confluence of Calf Pen and Sandrock Canyons to the confluence with the Verde River. The photography, which is not digital, was acquired at a scale of 1:20,000.

NAU Researchers affiliated with this project include:

Dr. Charlie Schlinger, Civil & Environmental Engineering

Lorrie Boy, Graduate Student, Civil & Environmental Engineering

Ed Monin, Civil & Environmental Engineering

Physical and chemical characterization of the springs of Fossil Springs

Prepared by Abe Springer, Northern Arizona University

Although significant monitoring and research has been conducted on the quantity and quality of the combined discharge of the all of the individual sources (spring orifices) of Fossil Springs, little monitoring and research has been conducted on the individual orifices which contribute to the total flow of Fossil Springs. Fossil Springs is a large travertine spring complex with over 20 individual spring orifices which contribute to total discharge.

Accurate locations (cm-scale accuracy) will be determined for each spring orifice with a combination of global positioning system and planar surveying techniques. Each spring will receive a unique designation to aid future monitoring and research. Each orifice will be characterized and classified according to recent work by Springer and others (2004). Discharge for each orifice will be measured with appropriate techniques. Water samples will be collected from a random sampling of the orifices for chemical analyses. Chemical analyses will include major cations and anions, trace elements and trace gases. Chemical analyses will help to better determine the source(s) of Fossil Springs water and the source(s) of the travertine and will serve as a baseline for future monitoring and research.

Fossil Creek Recreation Monitoring Program

Prepared by Martha Lee, Northern Arizona University

The recreation monitoring program on Fossil Creek is a collaborative effort between recreation managers on the Red Rocks District of the Forest Service. The program is designed to build on existing Forest Service data on Fossil Creek visitors and visitor use. The program includes three primary information gathering and monitoring projects:

- a) a visitor survey to gather information on visitor demographics, preferred communication strategies, responses to proposed recreation management strategies, activities, experiences realized, reasons for coming, and environmental stewardship;
- b) continue a campsite impact and monitoring effort started by the Forest Service wherein campsites and other use concentration areas are mapped and permanent resource condition monitoring plots are established;
- c) a literature review focused on identifying strategies for successfully implementing a Fossil Creek recreation management plan including recommendations for education, engineering, and enforcement strategies based on a review of published literature and land management agency documents.

We also plan to provide information to users and local residents through collaboration with the Forest Service and other Pulliam research partners on an information and education campaign that includes disseminating information on-site in the Fossil Creek area and at planned public meetings

NAU Researchers affiliated with this project include:

Dr. Martha Lee, Forestry
Matt Jedra, Graduate Student, Forestry

Collecting and Characterizing Sediment Cores from Stehr Lake, Arizona

Prepared by

Jaime L. Toney, NAU Quaternary Sciences Program

Paul T. Gremillion, NAU Civil & Environmental Engineering

Because of its location and unusual hydrology, Stehr Lake, in the Fossil Creek basin of Arizona, provides unusual opportunities for paleolimnological studies. Stehr Lake was created in 1908 through a diversion of water initiated by Childs and Irving hydropower plant. Due to the decommissioning of the Childs Power Plant, the upstream dam will be breached, and the flume that diverts water to Stehr Lake will be dismantled in 2005.

During the 2004 summer, students and faculty from the Quaternary Sciences Program and the Civil and Environmental Engineering Department collected four sediment cores from the lake with a cumulative length of 260cm. These cores capture the entire depositional history of the lake. The cores have been analyzed for several physical parameters, including moisture content, organic content, and magnetic susceptibility and the lithology of the cores has been characterized. During the 2005 summer we plan to analyze the core for pollen to track changes in vegetation with land use changes along the Mogollon Rim. We also anticipate analyzing the cores for chemical parameters that may reveal changes in the geochemistry of the springs feeding Fossil Creek.

Cultural Resource Monitoring by APS

A management plan prepared as part of the Childs-Irving decommissioning preparation addresses cultural resource monitoring and discovery during deconstruction in order to "protect, document and evaluate any inadvertently exposed cultural resources". The final edition of the Historic Properties Management Plan (HPMP) was prepared by SWCA for APS, and is dated October 7 2003.

Due to the sensitive nature of the cultural resources, this HPMP is not widely available and is not reproduced here.

The plan specifically addresses the potential impacts of deconstruction and decommissioning actions on cultural resources and is the sole responsibility of APS.

Cultural Resource Monitoring by Yavapai-Apache Nation

Please contact:
Chris Coder
Yavapai Apache Nation
928-567-7026
ccoder@yan-tribe.org

Fossil Creek Streamflow Gaging

Prepared by Charlie Schlinger, Northern Arizona University

Our planned efforts on a Fossil Creek low-flow gauging project, scheduled to begin on May 1, 2005, will consist of the following actions.

Assess constraints and opportunities for low-flow gauging. The proposed permanent low-flow gauging on Fossil Creek must address the regulations and constraints of the U.S. Forest Service (USFS). The USFS is responsible for land and natural resource management on the Tonto and Coconino National Forests, which abut Fossil Creek to the south and north. In addition, APS remains responsible for certain elements related to the Childs-Irving hydroelectric facilities and will be decommissioning these facilities for years before handing their sites over to the Forest Service. SRP plays a prominent role in low-flow gauging in the Verde watershed and has an interest in low-flow gauging on Fossil Creek and elsewhere in the Verde Watershed. The U.S. Bureau of Reclamation (USBR) and Central Arizona Project (CAP) are involved in construction and operation of a fish barrier on lower Fossil Creek. Typically, the U.S. Army Corps of Engineers (USACE), through the Clean Water Act Section 404 nation-wide permit program or through individual 404 permits, is involved in permitting construction of stream gauging operations. Finally, the U.S. Geological Survey, (USGS), which has long been involved in stream flow gauging, may elect to become involved in the future.

As part of our efforts, we will chart the regulatory and political landscape that is shaped by the interest of these agencies and private sector entities. The objective of our actions will be to identify ways in which co-operation can lead to successful implementation of low-flow gauging on Fossil Creek. In addition, we will identify the regulatory and agency constraints and permits that apply to implementation of a low-flow gauge on Fossil Creek and prepare a chart of necessary actions, in recommended sequence.

Evaluate the entire stream reach for suitable low-flow gauging locations. As a part of their Fossil Creek research, monitoring and outreach, NAU faculty and graduate students in Civil & Environmental Engineering have been classifying and characterizing Fossil Creek, from a point several miles above Fossil Springs to the confluence with the Verde River. Many of the reaches in Fossil Creek are bedrock controlled and provide optimum locations for low-flow gauging. As a follow-on activity to that work and as part of this project, we will evaluate the entire stream reach for suitable low-flow gauging locations, and provide recommendations at the most-suitable location(s). Our evaluation will include field reconnaissance and classification of the entire reach (confluence of Sandrock and Calf Pen Canyons to the Verde River confluence), HEC-RAS modeling of low-flow at promising locations, and photographic and other documentation of the most-suitable location(s).

Identify suitable existing technology. We will complete a literature review of available and emerging technology for low-flow stream flow gauging and recommend one or more preferred alternatives for implementation in Fossil Creek.

Prepare and make recommendations for low-flow gauging. Upon concluding the above actions, we will prepare a written report for distribution to USFS, SRP, USBR & USGS. The report will identify a preferred alternative (consisting of a location and technology) for gaging. The report will include a cost estimate, both for the initial installation and for annual operation and maintenance expenses, including publication and distribution of the gaging data – presumably using a suitable web site. The report will be posted on the Watershed Research & Education Program website.