

Research supporting the restoration of Fossil Creek, Arizona

Students and faculty of Northern Arizona University's College of Engineering and Natural Sciences and School of Forestry are working together with staff and researchers from Arizona Game and Fish Department, Arizona Public Service, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and U.S. Forest Service, Coconino and Tonto National Forests, to investigate the evolving state of the Fossil Creek Watershed. Fossil Creek flows from a complex of travertine-depositing springs 14 miles to the Verde River in the mountains of the Mazatzal Wilderness of central Arizona. For 100 years, the flows from the springs at Fossil Creek were diverted to the Childs-Irving Hydroelectric Facility, but in June, 2005, full flows were restored along the length of the creek. The restoration of full flows at Fossil Creek provides one of the best opportunities for stream and riparian restoration in the Southwest, where over 90% of wetland and riparian areas have been lost or severely degraded over the last century.

Photo by Rod Parnell



October workshop brings together a wide range of stakeholders

On October 26, 2005, 25 land managers, researchers, and members of the local and environmental communities discussed the future of Fossil Creek. Representatives from the Forest Service, U.S. Fish and Wildlife Service, Bureau of Reclamation, Arizona Game and Fish, The Nature Conservancy, the Grand Canyon Wildlands Council, the Yavapai-Apache Tribe, and others met at the Southwestern Academy on Beaver Creek to identify and prioritize what they see are the short- and long-term management, stewardship, and education/outreach needs for Fossil Creek. The results of this discussion provided valuable input in setting future management directions for Fossil Creek. This information can also be used to identify not only the role of land and resource management

agencies in caring for Fossil Creek resources, but also the role of visitors, local residents, and a volunteer "Friends" of Fossil Creek group as partners with land managers in stewardship of Fossil Creek.

Fossil Creek State of the Watershed Report, released July, 2005, is now available on line:
<http://www.verde.nau.edu/fossilcreekproject/research.htm>

Fossil Creek: A National Case Study in River Restoration

Fossil Creek is quickly becoming a national case study in river restoration. Policy makers are looking to scientists to determine the potential for restoration projects to revive native ecosystems. Restoration projects provide large-scale experiments where scientists can test how management actions such as removing dams, returning water to the river, and removing exotic species help native species. Despite spending billions of dollars on stream restoration, few projects in the U.S. have research

programs to evaluate the effects of restoration. Fossil Creek is an exception.

See our article in Arizona Water Resource <http://www.ag.arizona.edu/AZWATER/awr/julyaugust05/image.html>

NAU researchers continue to pursue four interrelated projects to assess the effects of flow restoration in Fossil Creek: 1) Aquatic species, food web structure, stream habitat/travertine formation, and ecosystem processes; 2) Recreation impacts and visitor use; 3) Spring characterization, flow rates and physical locations and 4) Sediment distribution, stream classification and hydrology. Here are up-dates on each of these projects.

Aquatic Ecology and Habitat

The Stream Ecology and Restoration Group at Northern Arizona University has collected one of the largest data sets ever gathered prior to a dam decommissioning. Allen Haden studies native and exotic fish and has shown that prior to restoration, native fish were concentrated above the hydropower dam and diminished downstream as exotic fish took over. Allen continues to see how native fish respond to return of flows and removal of exotics, and has already observed an increase in native fish. Most studies of invasive species simply document the effects of the invasion. Allen has the unique opportunity to document how removal of invaders promotes recovery. Eric Dinger is studying how macroinvertebrates (bugs) respond to restoration. When managers treated the river with antimycin A to kill exotic fish, one of the main concerns was that this chemical would also kill invertebrates. Although the chemical treatment killed a lot of insects, most of them recovered within six months. This study will help managers on other projects weigh the costs and benefits of chemically treating rivers.

With return of flow from Fossil Springs to the channel, travertine formation will increase, creating large waterfalls and deep pools. Environmental geologists Matt Germanson, Rod Parnell, and Adam Schwarz are comparing rates and locations of travertine dam formation before and after flow restoration. They are finding rapidly accelerating rates of dam growth in upper sections of the previously de-watered reach below the dam and erosion and lower deposition rates in dams below the Irving powerplant. Will this help or hinder the plants and animals living in

the stream? Cody Carter, Brenda Harrop and Cathy Gibson have found that travertine may increase productivity by speeding up leaf litter decomposition and promoting the growth of algae. Increased productivity bodes well for native fish and invertebrates that eat algae and leaf litter. Zacchaeus Compson and Mead Meir are testing if travertine dams will help retain leaves keeping them from being swept downstream. More leaves in the river, means more food. Indeed, Haden has found that native fish tend to be concentrated in deep pools created by the travertine dams.

One of the biggest challenges facing Fossil Creek is the increasing abundance of exotic crayfish. Exotic crayfish were not removed alongside exotic bass and sunfish. Ken Adams is studying crayfish and is finding that crayfish are increasing probably due to the removal of exotic bass, which eat crayfish. Ken will be working with managers to test the efficacy of different removal methods.

For more information please contact Jane.Marks@nau.edu or Rod.Parnell@nau.edu.



bidding a fond farewell to the flume photo by Paul Hancock

Human Dimensions Research

The human dimensions research at Fossil Creek is targeting three areas: current recreation use of Fossil Creek, local community residents, and the long-term stewardship of Fossil Creek. Dr. Marty Lee and graduate students Matt Jedra and Paul Hancock from NAU's School of Forestry are researching visitors and documenting visitor impacts at Fossil Creek. They will query local residents about their use of Fossil Creek and how they would like to see it managed. The third research effort, led by Paul Hancock, is exploring the feasibility of establishing a permanent

stewardship group for Fossil Creek. Specific research questions this group is answering:

- What are the types and amount of recreation impacts currently evident in the campsites located along Fossil Creek, specifically those along the creek between Fossil Springs and Stehr Lake?
- Who are the current visitors to Fossil Creek (e.g., activities, motives for coming, preferred creek locations, socio-demographic characteristics)?
- What are the attitudes of Fossil Creek visitors toward restoration of Fossil Creek, including removing the dam and restoring native fish?
- What are the attitudes of Fossil Creek visitors toward recreation management actions proposed by the U.S. Forest Service in the draft Fossil Creek Management Plan?
- What are the perceptions and attitudes of Pine, Strawberry, Camp Verde, and Payson residents toward removal of the Fossil Creek dam and subsequent restoration of full flows to Fossil Creek?
- To what extent do local residents visit Fossil Creek for recreation and what are their preferred recreation sites, activities, and motives for visiting Fossil Creek?
- What are the short- and long-term management, stewardship, and education/outreach needs for Fossil Creek according to land managers, researchers, local conservation groups, and others interested in the future of Fossil Creek?
- What interest do visitors and local residents have in the formation of a "Friends of Fossil Creek" volunteer group and what do they see as the role of such a group.

For more information, please contact Martha.Lee@nau.edu.

Spring Characterization and hydrogeologic framework

Under the supervision of Dr. Abe Springer in the Department of Geology, NAU undergraduates have assisted with characterization of the individual spring orifices which comprise the Fossil Springs complex. Megan Green, a NAU graduate student in Geology, is building a three-dimensional digital hydrogeologic framework model for the aquifer which supplies Fossil Springs. This framework model is a predecessor to a groundwater flow model to be built in the future. Results of these

activities are the following

Nearly 100 individual spring orifices have been located and accurately surveyed in the Fossil Springs complex.

Detailed chemical water analyses from three separate orifices have been made for major cations and anions, various isotopes, and trace elements. Regional geologic maps have been acquired, field checked, and are being digitized. Well logs and hydrographs from wells in the regional aquifer have been collected and will be incorporated in the framework model.

Fossil Creek stars in PBS documentary

"A River Reborn", a one hour public television documentary, describes the natural and human history of Fossil Creek, and examines the ecological effects of the dam and hydroelectric facilities. Through a series of interviews with scientists, managers, conservation advocates and APS employees, The film reconstructs the 15-year-long process that led to the decommissioning. A River Reborn is being produced by Emmy Award winning producer Paul Bockhorst and will be narrated by Ted Danson. It shows Fossil Creek before and after restoration and demonstrates the important role of science in understanding the potential for river restoration. Fossil Creek is shown to be an encouraging case study in the cooperative resolution of environmental disputes which will be inspiring to environmental problems solvers across the world. Study guides are being produced in conjunction with the video to promote its use in academic and informal education settings. Northern Arizona University, The Museum of Northern Arizona and Paul Bockhorst Productions are collaborating to produce and disseminate the documentary which will be aired in 2006.

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Stream classification, sediment distribution, and hydrology

NAU graduate students Ed Monin and Lorrie Yazzie are working with Dr. Charlie Schlinger of Civil and Environmental Engineering, on the first three actions listed below, while Charlie has the lead on the fourth.

- Mapping and research on stream channel morphology, from the confluence of Calf Pen and Sandrock Canyons to the Verde River.

- Sediment monitoring and research, to determine the timing and transport of sediment presently stored behind the Fossil Springs Diversion Dam, following lowering of the dam, anticipated in 2007. This includes examining lesser fluctuations in sediment distribution at selected cross-sections between the Fossil Springs and Irving.
- Research for siting a stream flow gaging station on Fossil Creek.
- Comparative research of several systems that are undergoing dam removal to develop a compendium of lessons learned. This considers the manner in which sediment stored behind dams moves downstream following dam removal, as well as impacts of the sediment transport. The focus is on the science, policy and practice regarding sediment monitoring and research related to dam decommissioning and removal.

For more information, go to <http://watershed.nau.edu/FossilSpringsDam/index.htm> or

Schlinger, C.M., Welch, S., Ramsey J., Trotta, P., Janecek, J., Auberle, W., 2003, Sediment Transport Evaluation for Dam Removal Scenarios, Fossil Springs Diversion Dam, Arizona, Proceedings of Dam Safety 2003 Conference, Association of State Safety Officials, Lexington, KY.

or contact Charles.Schlinger@nau.edu.

Assessing our Efforts at Fossil Creek

New Environmental Sciences and Policy graduate student Nathan Schott has joined our group and will be examining the effectiveness of our research, monitoring, and adaptive management efforts to date. He is particularly interested in any improvements we could make in the process and recommend to other groups looking to restore regulated aquatic ecosystems. Reach him at nds35@dana.ucc.nau.edu.

Acknowledging those who make our work possible

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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. We anticipate that SRP and/or US Bureau of Reclamation will support construction of one or more streamflow gaging stations on Fossil Creek.

NINA MASON PULLIAM
CHARITABLE TRUST

Do you want more information on Fossil Creek ? See www.watershed.nau.edu/FossilCreekProject