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Getting All Wet at the ERI: A Study of How Riparian Restoration Influenced the Aquatic Ecosystem in Fossil Creek, Arizona

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Fossil Creek is located on the edge of the Mogollon Rim between the towns of Strawberry and Camp Verde, Arizona. Aside from its spectacular beauty, crystal-clear water and great year-round hiking and swimming opportunities, this area is special because of the restoration activities that have been taking place there for the past several years.

In June 2005, the local power company, Arizona Public Service, chose to decommission the nearly hundred-year-old Fossil Creek Dam and to help research groups, including Northern Arizona University, in making assessments of the riparian ecosystem before and after dam decommissioning. Fortunately, I was able to be part of these research efforts. My research was coordinated through the Ecological Restoration Institute and the laboratory of Dr. Jane Marks, a professor of biology at NAU.

Fossil Creek Dam after restoration

My project involved two small, riparian pools: one about 1,310 feet above the dam and the other about 325 feet below the dam. We used a statistical analysis approach called a Before-After Control-Impact design to compare these sites 18 months before restoration and 6 months following restoration. Specifically, we looked at water quality and chemistry, leaf litter decomposition, macroinvertebrate community diversity and structure, and fungal biomass. When assessing the ecosystem health of a stream, riparian ecologists consider these factors important in terms of nutrient processing and food web structures, and because they influence aspects of a stream and the surrounding terrestrial environment that humans consider desirable, such as fisheries, wildlife, and water clarity and purity.

The major fieldwork component of this project involved submerging several hundred litterbags (plastic mesh packets containing leaves) in the stream for either 10 or 75 days. Once the litterbags were removed from the stream, we collected all the macroinvertebrates (insects, snails, and large worms) from the leaves and took leaf samples for fungal biomass analysis. Next, we dried, ground, ashed, and weighed the leaves to determine the leaf decay rates. We extracted ergosterol (a chemical unique to aquatic fungus) from the leaf samples and used a method involving high-performance liquid chromatography to determine the fungal biomass on the leaves. We also took annual water quality measurements at each site using a probe. Finally, we analyzed the concentrations of nitrate, ammonium, and phosphate in the water using spectrophotometry.

We found that there were significant differences in certain water quality and chemistry parameters between site/year combinations, specifically in temperature, pH, and total dissolved solids. These findings were consistent with the observation that, prior to the restoration, the water in the creek below the dam was coming from the bottom of the reservoir and seeping slowly through the dam, whereas the water flowed rapidly from the top of the reservoir into the creek following restoration. Fortunately, we measured no significant differences in water quality and chemistry for problematic nutrients such as nitrate, ammonium, and phosphate. This also meant that any other differences we observed were not attributable to these factors.

Curiously, we did not find significant differences in leaf litter decomposition between the sites prior to restoration, even with the very different water flow regimes that existed at these sites. This remained true after restoration, and is one of the most confusing results of the study (Figure 1). This similarity in decomposition rates seems to indicate that leaf litter decomposition was not heavily influenced by damming the creek.

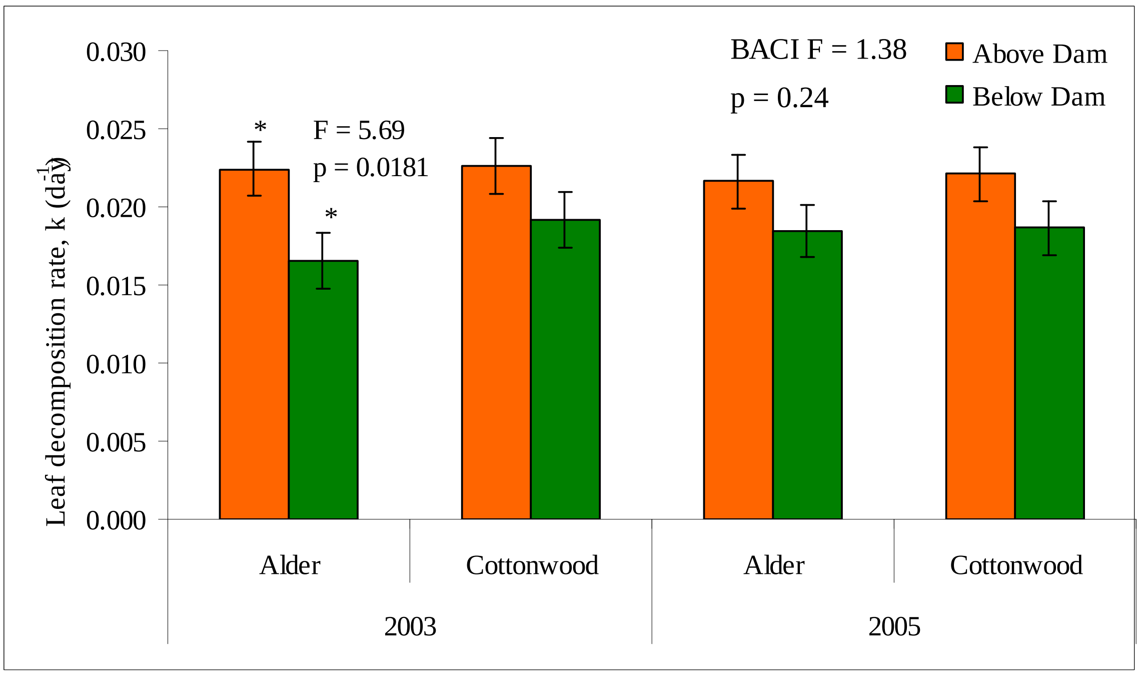

Figure 1. Leaf decomposition of alder and cottonwood leaves at both sites before (2003) and after (2005) decommissioning of the Fossil Creek Dam.

In line with our hypotheses for this study, we found that the macroinvertebrate community structure and fungal biomass were very different between the sites prior to restoration, with the invertebrate community below the dam being much more vulnerable to disturbance and the diversity of the macroinvertebrates and the biomass of the fungus being much lower on litterbags below the dam. Following restoration, the macroinvertebrate community responded very positively, although it is still not quite comparable to the community above the dam (Figure 2). Similarly, the fungal biomass equalized between the two sites only six months post-restoration (Figure 3).

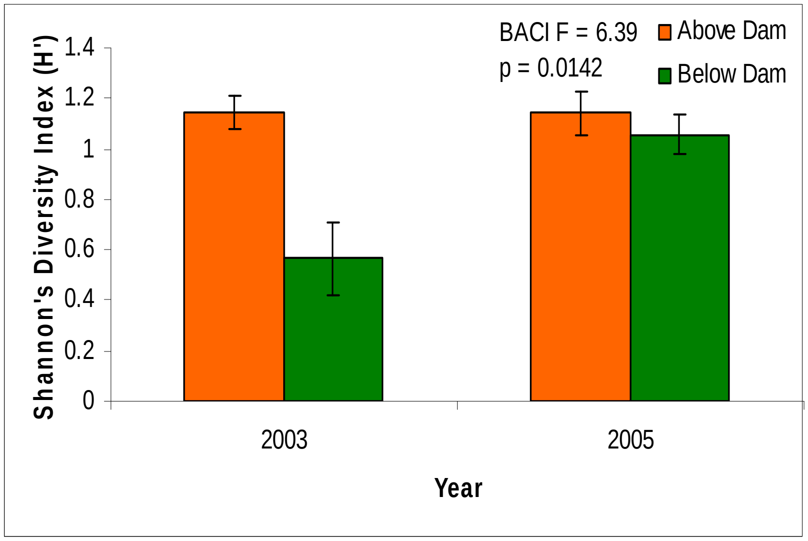

Figure 2. Macroinvertebrate diversity at both sites before (2003) and after (2005) decommissioning of the Fossil Creek Dam.

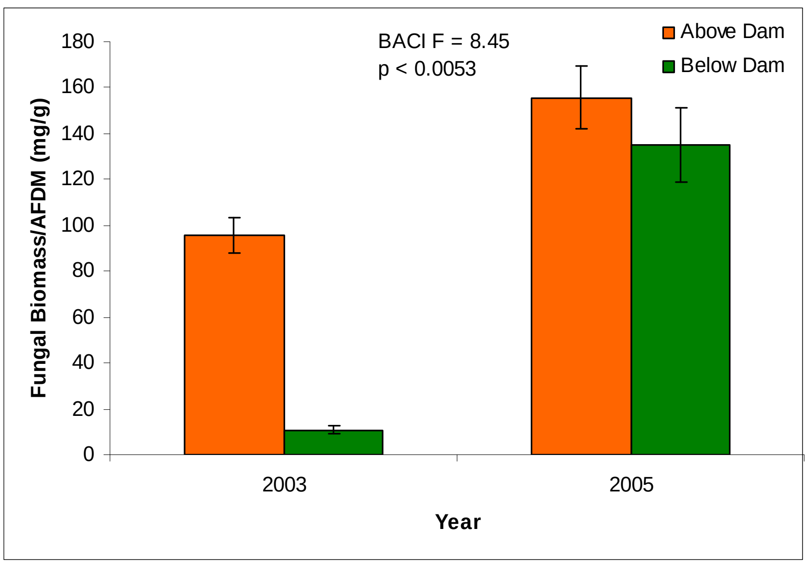

Figure 3. Fungal biomass at both sites before (2003) and after (2005) decommissioning of the Fossil Creek Dam.

Given our findings, Fossil Creek appears to be an ecological restoration success story--one that can hopefully be replicated and used as a model for predicting aquatic ecosystem responses in other, similar restoration projects. Our work is just a small part of the great wealth of information coming from this study area, and it is certainly personally rewarding to contribute to this effort.

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