

Restoring Wetlands after the Rodeo-Chediski Wildfire

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Abstract

The largest wildfire in Arizona history damaged many important springs and wetlands on the western half of the White Mountain Apache Reservation in the summer of 2002. With support through the Burned Area Emergency Rehabilitation plan for the fire, we conducted assessments of dozens of these wetland sites. Two large wet meadows, Swamp Spring and Turkey Spring, were eroding rapidly in the wake of post-wildfire floods. The erosion was not only sending great volumes of ancient wetland soils to downstream rivers, but the downcutting of the stream channels threatened to leave both meadows so high and dry that they would no longer support culturally important wetland plants and wildlife. We surveyed the sites to evaluate the rate and the depth of the erosion. Several characteristics of the sites rendered them particularly vulnerable to post-fire damage: the steep topography of their surrounding landscapes, sandy soils, overuse of soil-binding vegetation by ungulates, and roads with poor drainage designs in the riparian zone. We designed a suite of restoration treatments to restore the wetlands, including rock riffle structures to regain channel stability, revegetation with sedges and reeds to stabilize the soils, fencing to exclude ungulates, and road rehabilitation measures. We collected plants from Swamp Spring and a wetland near Turkey Spring to grow off-site for eventual transplantation. The lessons learned from these sites will help to guide future wetland protection and restoration efforts on the Reservation and in other severely burned areas.

Introduction

The Rodeo-Chediski wildfire complex burned 189,225 hectares in east-central Arizona in June 2002. The majority of the burned acreage occurred in the steep canyons of the northwest portion of the White Mountain Apache Reservation (Fig. 1). The fires burned at moderate to high severity across the headwaters of three major streams: Canyon Creek, Cibecue Creek, and Carrizo Creek.

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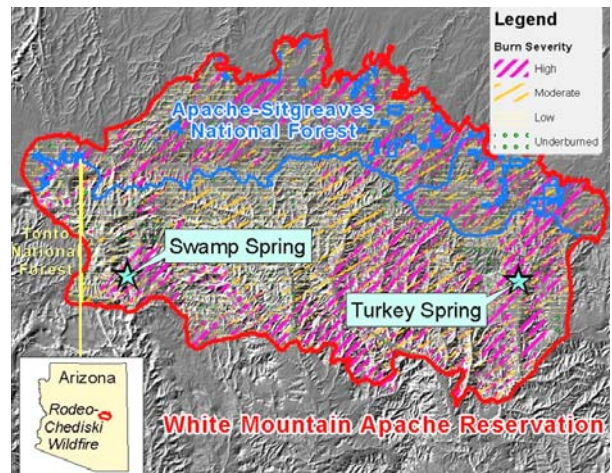


Figure 1: Location of Swamp Spring and Turkey Spring with the area affected by the Rodeo-Chediski wildfire.

As part of the Burned Area Emergency Rehabilitation plan for the wildfire, a crew was established to evaluate conditions at springs and other wetlands that might have been affected by the fires. The crew has evaluated over eighty such wetlands to date. Determining under which circumstances active rehabilitation treatments are warranted is important for land managers in ecosystems that experience severe wildfires (Bisson et al. 2003).

Through these assessments, we determined that two large wet meadow systems, Turkey Spring and Swamp Spring, were suffering from rapid erosion in the wake of post-wildfire floods. The erosion was causing large blocks of wetland soils to slump into the creeks (Fig. 2). This erosion threatened to increase sedimentation of downstream native fish habitats. Degradation of the creeks led to lowering of the water table in the meadows, which in turn impaired habitats for wetland plants, birds, and amphibians. Both sites sustain culturally important plants and animals such as deer, elk and turkeys. Similar wetlands in this region harbor populations of native leopard frogs, which are species of special concern in Arizona.



Figure 2: Members of the White Mountain Apache Tribe's Land Restoration Board examine erosion at the edge of the meadow at Swamp Spring.

Site Conditions

The two sites were similar in watershed area, mean watershed slope, and soil texture (Table 1). Although springs at both sites flow year-round, Swamp Spring has more flow and has developed a much more extensive wet meadow complex.

Table 1: Characteristics of study sites.

	Turkey Spring	Swamp Spring
Watershed area (ha)	71	102
Elevation (m)	1850	1830
Mean watershed slope	26.7%	28.0%
Soil type	Elledge sandy loam	Elledge sandy loam

We surveyed the plants communities at each site to document key wetland species that could be used for restoration treatments. Swamp Spring has a much more diverse plant community, probably due to the larger quantity of water flowing through the meadow (Fig. 3). Key species include several kinds of sedges (*Carex senta*, *Carex aurea*, *Carex lanuginosa*) along with various spikerushes (*Eleocharis* spp.), rushes (*Juncus* spp.), small-fruit bulrush (*Schoenoplectus microcarpus*), and hard-stem bulrush (*Schoenoplectus acutus*). At Turkey Spring, spikerushes and rushes are the dominant cover along with various grasses (including *Andropogon gerardii*). Both sites are dominated by sandy soils, although extensive layers of finely-textured organic hardpans do resist erosion.



Figure 3: Clumps of swamp sedge (*Carex senta*) lie in the wettest parts of Swamp Spring.

We first evaluated the sites following the wildfires in the fall of 2002. A year later, we returned to the two sites to conduct three-dimensional profiles of the channels and adjacent floodplains using a total station

(Fig. 4). These surveys identified major nickpoints where the channels were most unstable, and they served to classify the reaches according to their degree of entrenchment and gradient.

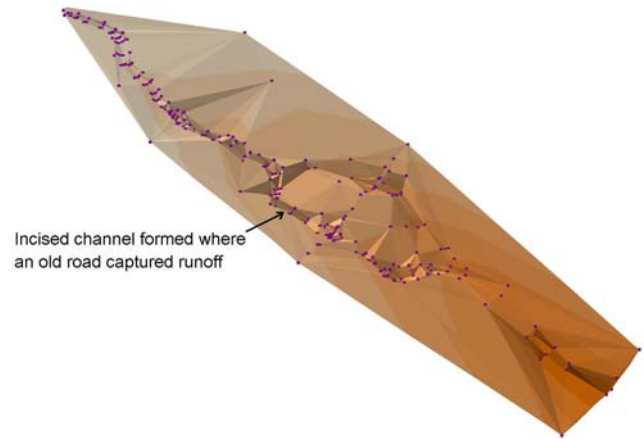


Figure 4: Three-dimensional profile of the Turkey Spring site revealing major nickpoints and location of incised channels.

At Turkey Spring, extensive erosion occurred where old road beds had captured runoff. At Swamp Spring, old culvert crossings appeared to have caused incision of the channel (Fig. 5). This instability appeared to pre-date the fire at both sites, but severe flooding after the fires had greatly accelerated the rate of degradation.



Figure 5: This road crossing at Swamp Spring likely contributed to the extensive downcutting of the meadow by concentrating flows and failing to pass sediments and debris.

We observed rapid channel incision and streambank collapse at both sites since our initial investigations. A primary headcut at Turkey Creek retreated upstream for 50 m (Fig. 6). Extensive bank collapse and incision of the channel occurred at Swamp Spring (Fig. 7).

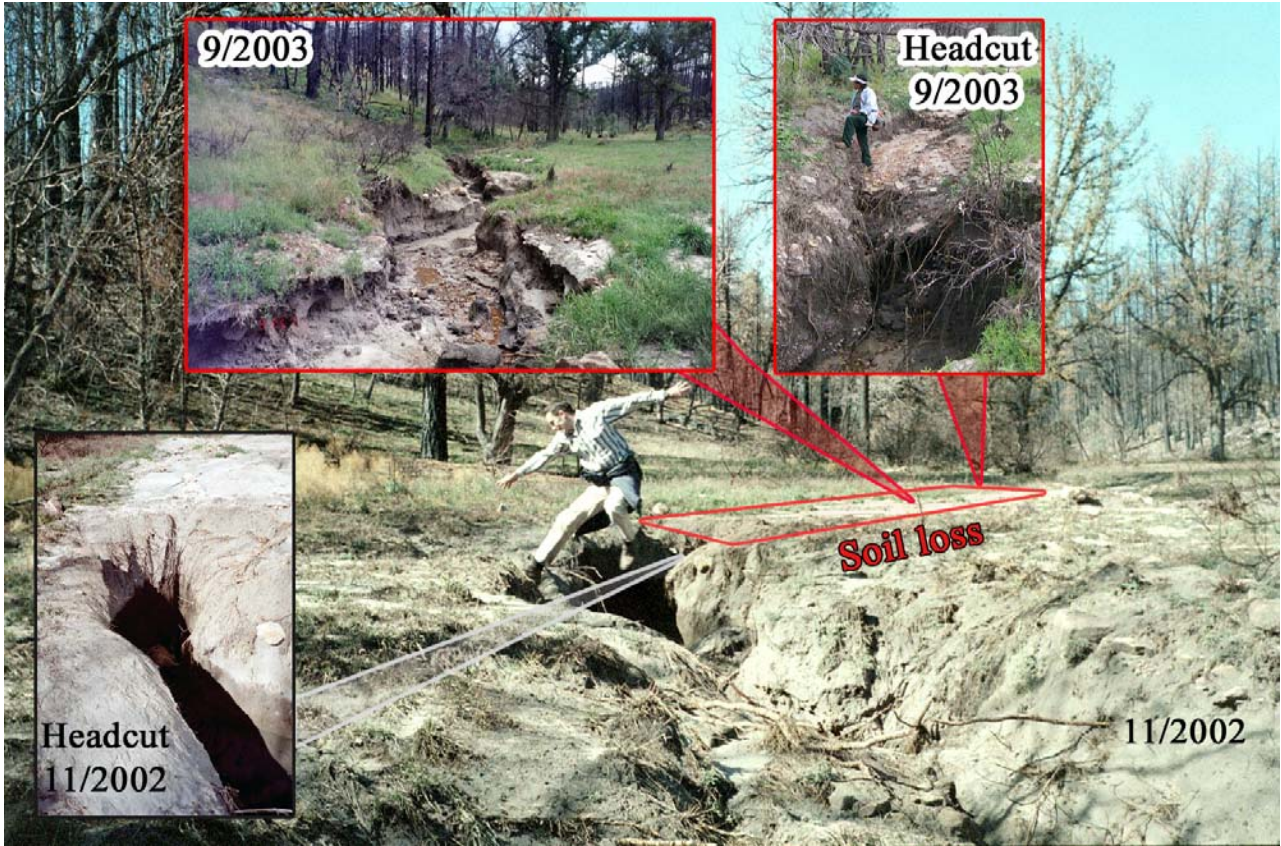


Figure 6: Progression of headcuts at Turkey Spring prior to treatment.



Figure 7: Channel erosion at Swamp Spring in September 2002 (left) and June 2004 (right). The nickpoint in the channel and the far bank were washed out during this period.

Natural rock riffles occur at Swamp Spring where debris flows have deposited large angular boulders in the upper, less incised reaches (Fig. 8). These features demonstrate the potential of these systems to stabilize themselves. However, parts of the channel were located too far from the valley side slopes and the degradation of the main channel was too rapid for the debris flows to stabilize channels throughout the reach.



Figure 8: Debris flows of angular rocks form natural riffles in the upper, unincised reach at Swamp Spring.

Treatments

The treatment design sought to arrest the erosion of the channel through placement of stabilizing bed forms. We applied the rock riffle formation techniques that the White Mountain Apache Tribe and the Rocky Mountain Research Station had jointly developed for use in restoring high-elevation meadows (Medina & Long 2004). Due to the large flows moving through the sites, particularly at Swamp Spring, we had to use very large rock materials to form these features. The main culvert at Swamp Spring was replaced with a low-water crossing formed from over 140 limestone boulders (averaging 1 m X 0.7 m X 0.5 m in dimension). Construction has been staged with the initial low water crossings constructed in May and June, followed by placement of the initial riffle formations at each site in July.

Ponderosa pines (*Pinus ponderosa*) that were killed by the fire were cut along the floodplain of Turkey Spring to prevent them from undermining the streambanks as they fell. We had observed several points where fallen trees had destabilized the streambanks. Tree pruning and removal is also needed at Swamp Spring, where dying boxelders (*Acer negundo*) have contributed to channel instability and maintain too much shade for wetland herbaceous plants to grow vigorously.

As part of construction of the riffle formations, we will need to reduce the slope of the incised channels. However, the placement of riffle formations ensures

that any soil materials sloughed off from the streambanks will remain on-site rather than being exported downstream.

We collected sedge and bulrush wildlings from Swamp Spring to grow out in off-site beds. Sedges are particularly desirable for restoring riparian meadows due to their capacity to bind soils and trap sediments (Steed & DeWald 2003). We also collected reeds (*Phragmites australis*) from a site close to Turkey Spring for growing out. The purpose was to augment the supply of root-binding vegetation for use in revegetating both sites. Reeds are also a culturally important plant that has declined at many wetland areas on the Reservation (Long et al. 2003). We plan to transplant the wildlings to the sites in the late summer to maximize their survival (Steed & DeWald 2003).

Once the heavy channel work has been completed at the sites, fencing will be placed around the perimeter of the wetland areas to exclude livestock and to deter wild ungulates from grazing and trampling the recovering vegetation.

Expected Results

Another restoration project following a previous wildfire had stabilized a spring-fed tributary stream that had been incising (Long & Endfield 2000); however a large riffle formation on the main stem did wash out. That restoration project took place in a substantially larger watershed (580 ha) and used smaller rock materials (cobbles to small boulders) rather than importing larger rock from off-site. Based on that experience and other applications of the riffle formation technique, we expect that these site treatments will stabilize channels at both sites. Sediments should deposit upstream of the riffle formations, creating stable, wet microsites for vegetation to flourish. When the transplants have developed sufficiently, we will replant them along the streambanks above the riffle formations. We will modify the riffle formations by adding or replacing rocks as needed to respond to flood events.

Conclusions

The Swamp Spring and Turkey Spring Projects demonstrate the importance of evaluating wetland conditions after severe wildfires. The steep, erodible terrain affected by the fire was vulnerable to accelerated erosion, especially where unstable trigger points such as old roads existed. Due to the likelihood of continued, long-lasting damage to these ancient and highly productive wetlands, we believed that active rehabilitation measures were warranted. These two sites are being treated with designs that integrate efforts to restore physical and biological stability. The treatments mimic natural recovery processes of small streams, such as the formation of coarse bed forms, retention of fine sediments, and establishment of deep-rooted graminoids. The treatment design also addresses secondary factors contributing to site degradation, including roads that induced channel erosion and excessive use by ungulates. This adaptive project will

require several years of follow-up monitoring to ensure that the treatments restore physical and biological stability.

Acknowledgments

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