

Incorporating Ecological and Nonecological Concerns in the Restoration of a Rare, High-Elevation Bebb Willow Riparian Community

Laura E. DeWald
Abe E. Springer

Abstract—Activities were initiated by The Nature Conservancy, the USDA Forest Service, and the Northern Arizona University School of Forestry and Department of Geology in 1996 to restore hydrologic and ecological function to a high-elevation Bebb willow (*Salix bebbiana*) and mixed grass riparian community in Hart Prairie, near Flagstaff, AZ. Initial restoration removed small water diversions above the willow community to restore hydrologic flow to the downslope community. Because of the small scale of this effort, the watershed, recreation, and wildlife in the area were not affected. Subsequent monitoring indicated that although restoration increased water availability and improved Bebb willow water status, soil moisture conditions were still below those needed for willow seed germination and seedling growth. Therefore, the long-term sustainability of the Bebb willow community is still at risk. Current restoration plans are to manipulate the upslope watershed to provide additional water needed for willow regeneration. This restoration will include removing stock tanks, thinning trees encroaching into the meadow above the willows, and burning to restore the upslope area to its historic nonforested, prairie condition. These plans could significantly impact aesthetics, wildlife, and recreation in the area. In addition, Indian Tribes who consider the San Francisco Peaks to be sacred and the general public may have concerns with these restoration activities. This paper discusses our efforts to address these issues while still providing sufficient ecosystem restoration for long-term sustainability of the Bebb willow-mixed grass community.

Introduction

In Arizona, upland riparian communities located at elevations above 2,500 m consist of small plant stringers occupying channels of first- and second-order streams (Debano and

Schmidt 1990). They are largely supported by shallow ground water, and are typically in meadows at the base of watersheds dominated by mixed conifers and ponderosa pine (*Pinus ponderosa* Laws.). The upland riparian community at Hart Prairie near Flagstaff, Arizona, has a Bebb willow (*Salix bebbiana* Sarg.) and trembling aspen (*Populus tremuloides* Michx.) overstory with a grass understory. This type of upland riparian community is rare in Arizona and supports high levels of wildlife and plant community diversity. Both aspen and Bebb willow are listed by the USDA Forest Service (USFS) as species of concern due to their biodiversity, aesthetic, and wildlife habitat values. Upland riparian communities such as Hart Prairie make important contributions to the biodiversity necessary for resilient and healthy ecosystems at the regional/landscape level (Noss 1990). Unfortunately, many of these communities, including Hart Prairie, do not have adequate regeneration to sustain themselves and are thus considered unhealthy (Briggs and others 1994).

Abundant shallow ground water supplied through perched aquifers is the critical factor for maintaining healthy upland riparian communities such as at Hart Prairie. These perched aquifers occur discontinuously across the Colorado Plateau. They have limited storage and require annual recharge through runoff and infiltration from heavy snowpacks and consistent precipitation. In high elevation areas in the Western United States, approximately 70 to 90 percent of annual streamflow originates from these types of events (Troendle 1983). Drought, surface water diversions such as stock tanks and dams, and water loss through increased tree transpiration modify hydrologic function by changing the quantity and timing of the water recharge to these perched aquifers and the subsequent water delivery to riparian ecosystems at the base of watersheds. These factors are likely causing a decline in the health of the Bebb willow riparian community at Hart Prairie (Avery 1991; Church 2000; Gavin 1998).

Initial Restoration Efforts

Restoration of hydrologic and ecological function to the Hart Prairie Bebb willow riparian community began in 1996–1997 through a cooperative project involving The Nature Conservancy (TNC), USFS and the Northern Arizona University (NAU) School of Forestry and Department of Geology. This restoration project was funded by the Arizona Water Protection Fund (grants 95-006WPF and 96-0019WPF) and NAU School of Forestry. The restoration involved digging out two small earthen dams that were diverting water out of its original channel away from the

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Laura E. DeWald is an Associate Professor in the School of Forestry at Northern Arizona University. She has a B.S. in forestry from Michigan Technological University, an M.S. in forestry from Pennsylvania State University, and a Ph.D. from Virginia Polytechnic Institute and State University. She held postdoctoral appointments in forestry at the University of Minnesota and University of Florida. She researches forest ecological and conservation genetics, conservation biology, and riparian restoration. Abe E. Springer is an Associate Professor in the Department of Geology at Northern Arizona University. He has a B.A. in geology from The College of Wooster, and an M.S. and Ph.D. in hydrogeology from The Ohio State University. He researches ground-water flow systems and their relationships to riparian ecosystems and restoration.

downslope Bebb willow riparian area. The original channel was reconstructed by removing debris that had accumulated in it, and rock weirs were constructed in the channel to slow high-flow water velocities. Drainages that had been diverting water from the original channel were blocked using sediment and rocks removed from the original channel. In addition to the channel work, restoration activities included constructing wire fences around some of the Bebb willow populations to protect them from overgrazing by deer and elk. The fencing and channel restoration activities were all completed using hand tools.

An extensive monitoring network was established to measure hydrologic and Bebb willow responses to the restoration. This monitoring network included a drilling series of shallow wells, setting up soil moisture monitoring points, and inserting a metal "H"-flume at the base of the watershed to measure surface and subsurface water movement within and out of the base of the watershed. A permanent weather station was set up in a nonforested area of the meadow near the top of the Bebb willow riparian community to collect a variety of weather data, and an electric fence surrounding the weather tower was constructed to protect the electronics from deer and elk. Finally, Bebb willow water status and regeneration were also measured. Details of these restoration and monitoring activities are described in Gavin (1998) and Church (2000).

Because restoration of the channel primarily involved redistribution of soil and rocks already present, and it did not change the visual appearance of the area, water sources for wildlife were not decreased and there were no impacts to hikers, bicyclists, and skiers in the area. However, there have been concerns expressed by the public regarding the monitoring equipment. The "H"-flume measuring streamflow at the base of the watershed has been tampered with, and the 7-foot tall, silver-colored weather tower with its electric fence is an eyesore. In response to the public's concerns, the exterior of the weather tower and the fence posts around it were painted to blend better into the environment to improve aesthetics of this monitoring station. In addition, alternative fencing is being considered.

Results of the monitoring activities indicated that the initial restoration only partially restored hydrologic function (Church 2000; Gavin 1998). Moisture conditions in the riparian system *have* improved, but they were still below those needed in the late spring for successful Bebb willow seed germination and early seedling growth. Church (2000) reported that the Bebb willow trees were producing abundant viable seed (85 percent germination under laboratory conditions), but soils were too dry during seed dissemination to support Bebb willow regeneration. Therefore, although the restoration activities improved conditions for the adult trees, they did not provide for the long-term sustainability of this riparian community.

Past riparian restoration efforts including those at Hart Prairie illustrate the importance of evaluating the condition of a degraded riparian area from a watershed perspective. Because of the close connection between upslope and downstream processes, riparian restoration efforts must avoid the approach that was taken at Hart Prairie where recovery strategies were based solely on an evaluation of the immediate degraded riparian site (Briggs 1996). Addressing isolated components of a watershed such as was done at Hart

Prairie is ecologically incomplete; to be complete, restoration must address conditions in the upslope watershed.

In the case of the Hart Prairie area, a thick cover of grass and high density of ponderosa pine and white pine (*Pinus strobiformis* Engelm.) now dominate the meadow above the Bebb willow riparian community. These conditions are in contrast to historic photographs of Hart Prairie showing a meadow with light grass cover and only a few scattered trees. The increased grass cover and encroachment of woody tree species from the upper watershed into the meadow are the result of fire suppression and grazing. This encroachment of pines is consistent with increases in the number of trees per acre on National Forest lands in Arizona and New Mexico over the past 30 years (Covington and Moore 1994). In high-elevation meadows such as Hart Prairie, the encroaching pine forest competes with the downslope riparian communities for ground water stored in the perched aquifers. Restoration of the upslope area back to historic conditions would involve removing the pine trees where they have encroached into the previously wet meadow, and prescribed burning to reduce grass cover. Experiments in the Beaver Creek watershed in Arizona show that streamflow can be increased for 6–10 years following removal of trees in upslope communities (Baker 1986; Brown and others 1974).

Ecological Concerns

Complete restoration of the prairie meadow would remove up to 90 percent of the ponderosa and white pines in the area directly upslope from the Bebb willow community (fig. 1), and prescribed burning would reduce grass density and prevent future tree encroachment. In addition, a complete restoration would remove stock tanks in the watershed above the Bebb willow community. In 1998, NAU received funding from the Arizona Water Protection Fund (grant 98-050WPF) for a collaborative effort by NAU, TNC, and the USFS to restore the watershed at Hart Prairie.

The first step in the restoration effort was to map and measure all of the trees encroaching into the meadow. The total amount of water lost to the downslope riparian community from the encroaching trees will be estimated by NAU by combining the tree size data with sapflow data collected during the summer of 2000. This information will be used to compare the amount of water released downslope following different thinning treatments, which will help determine the actual number and which trees to remove. Water lost due to herbaceous vegetation transpiration is being measured by NAU to determine the amount of water that would be released downslope following prescribed burning. This information will also help determine the ecologically best time(s) of the year to burn. For example, if the grasses are using a lot of water during Bebb willow seed dissemination, then a prescribed burn prior to willow seed dissemination would be the best ecological time to burn.

There are five stock tanks currently being evaluated by NAU to determine their effects on the downslope Bebb willow community. This information will be used to direct activities such as deconstruction of tanks, reduction in tank size, and bank and channel reshaping. Tank removal and mitigation will be based on field measurements, historical photographs and maps, and other supporting information.

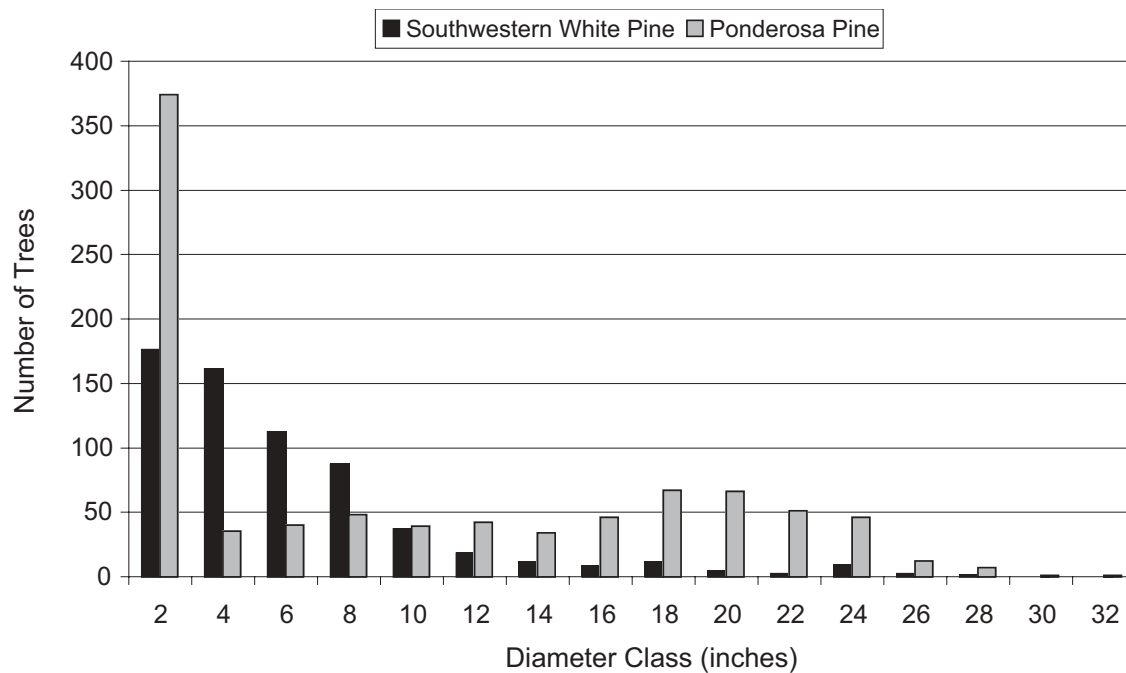


Figure 1—Trees encroaching into the meadow at Hart Prairie, Arizona

The tree and tank removal, and prescribed burning will increase water available to the riparian community, but in contrast to the initial restoration efforts, these watershed activities could also generate considerable public concern due to their potentially significant aesthetic, wildlife, and recreation impacts.

Nonecological Concerns

NAU, TNC, and the USFS conducted planning meetings during 1999–2000 where impacts to the viewshed and recreation from a full watershed restoration were discussed, and modifications to the full restoration were developed to address these concerns. In addition, public comments were collected in response to the USFS Proposed Action describing the restoration, and concerns were collected from the neighbors of TNC. The concerns raised during the planning meetings and by the public are described below, and modifications to the full restoration as a result of these concerns are described in the next section.

The Hart Prairie area is popular with hikers, bikers, and cross-country skiers, and the restoration treatment area is within the Snowbowl ski area and proposed Arizona Trail viewsheds. The removal of the large numbers and sizes of trees involved in the full restoration is expected to have negative aesthetic impacts. In addition to the aesthetics, there are hazards to recreationists associated with downed woody debris and snags that would be created by the tree removal. Smoke from the proposed prescribed burning can create health and aesthetic problems, and 2–3 foot firebreak lines and road construction may also have negative aesthetic effects. In addition, fears were expressed that the prescribed burn would get out of control and destroy private property.

The San Francisco Peaks are considered a sacred place for many of the Native American Tribes in the Southwest, so a consultation process was set up with 13 Tribes to ensure that potential cultural impacts of the proposed restoration were considered. Tribes were also invited to Hart Prairie for a tour and further discussion of the proposed watershed restoration. During this consultation process, it was revealed that the removal of the larger trees and the total number of trees involved in the restoration have raised concerns. In addition, concerns were expressed regarding the time of year when restoration activities would occur; the timing of such activities should be compatible with Native American religious beliefs.

Many concerns were raised that the amount of open water available for the diverse species of wildlife at Hart Prairie will be reduced with the removal of stock tanks. In addition, there was a great deal of opposition to the removal of Snowbowl tank because this tank is used for education and is a favorite spot for recreationists.

Incorporating Ecological and Nonecological Concerns

In order to address concerns of the large numbers and sizes of trees to be removed, the prairie meadow encroached by the pines was divided into subwatersheds that were prioritized in terms of their potential contribution to water loss downslope. A subwatershed directly upslope from the riparian community was identified as the first priority to be thinned. This area represents less than one-third of the total prairie meadow encroached by the pines, resulting in restoration that will remove significantly fewer trees and will therefore result in fewer aesthetic and safety impacts. Some

of the larger trees will be girdled to create snags rather than removed to provide wildlife habitat. In addition, computer-generated, visual simulations are being developed by NAU from the mapping data to compare the current viewshed to viewsheds following different thinning treatments. Locations, numbers, and sizes of trees that would be removed will be included in the visualization of the different thinning treatments. These simulations can be used to help design the tree removal to minimize negative aesthetics and to inform the public about what is being removed and what the viewshed will look like. Finally, “fuzzy” boundaries will be created between the restored area and the areas of the meadow not being restored to further minimize visual impacts. Some of the tanks will be reduced in size rather than removed in order to maintain the wildlife benefits they currently provide, and a “wildlife drinker” will be installed in the area to provide access to water lost due to the stock tank removal. Despite the fact that Snowbowl tank prevents water from entering the channel directly above the Bebb willow community, it will most likely not be modified due to public sentiment not wanting this tank to be removed. Finally, the timing of restoration activities will be compatible with Native American religious beliefs, and attempts will be made to burn when recreational and aesthetic impacts would be minimized.

As a result of addressing nonecological concerns associated with the full ecological restoration, the proposed activities will not fully restore the prairie meadow. However, incorporation of nonecological concerns will still permit restoration of one-third of the meadow and this should provide significant additional water to the downslope Bebb willow riparian community. Prerestoration data are still being collected, and the Tribal consultation and public comment processes are ongoing. Once these processes and the restoration activities are completed, the postrestoration

monitoring will tell us whether further restoration is needed to provide additional water flow to the Bebb willow riparian community.

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