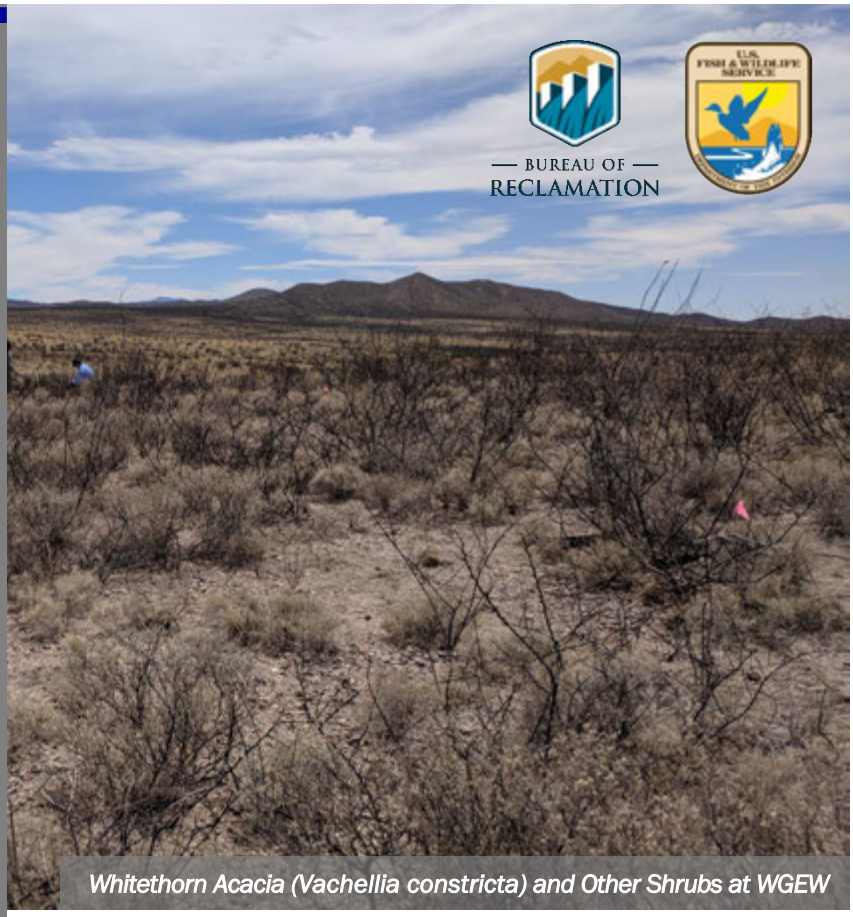
RESTORATION

Impacts of Herbicide Brush Management on Hydrology & Sedimentation at Walnut Gulch Experimental Watershed

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Walnut Gulch Experimental Watershed (WGEW), located in southeastern Arizona, has experienced a proliferation of whitethorn acacia (*Vachellia constricta*) into historical grasslands. Woody species encroachment can increase runoff and soil erosion, leading to the loss of grassland ecosystem services. Changes in erosion and runoff may prevent establishment of grasses allowing shrub dominance. Herbicides leave shrub skeletons in place and may not cause increased runoff and erosion, however, this remains largely untested. Researchers at the University of Arizona and the Agricultural Research Service assessed impacts of herbicide treatment on vegetation cover, runoff, and sediment loss of a shrub-encroached grassland.



Whitethorn Acacia (Vachellia constricta) and Other Shrubs at WGEW

KEY ISSUES ADDRESSED

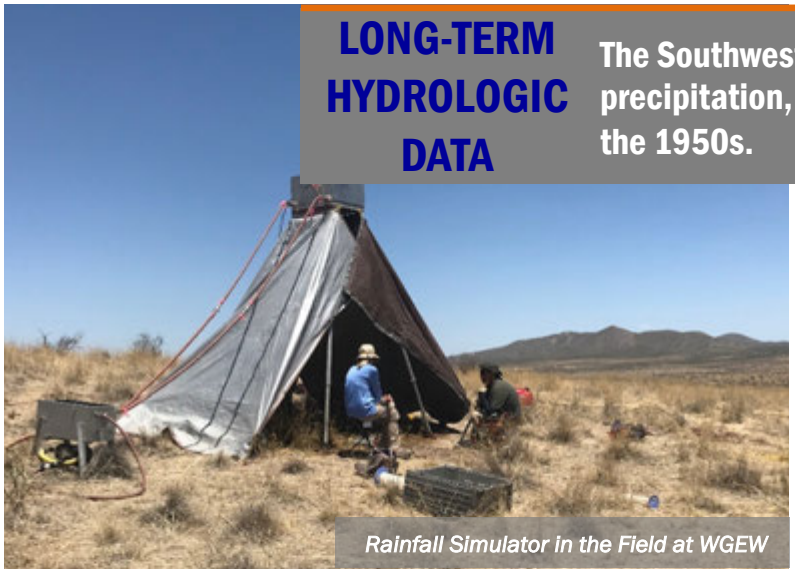
In shrublands, patches of bare ground are larger and more connected than in grasslands, allowing greater movement of water and sediment. These resources can become depleted between 'resource islands' that form when fertile soil accumulates around shrubs. The disparity in water and soil retention between resource islands and surrounding bare ground (interspaces) advantages shrubs over grasses, reinforcing the transition to shrubland ecosystem state. While herbicides are commonly used for shrub management, more field studies are needed to determine if herbicide treatment of shrub encroached grasslands can interrupt the runoff and sedimentation processes that reinforce shrubland conversion.

PROJECT GOALS

- Compare vegetation cover, runoff, and soil loss between herbicide-treated and untreated sites across spatial scales five years after treatment
- Assess if resource accumulation in resource islands is disrupted in treated sites
- Determine which structural characteristics of soil and vegetation are reliable indicators of runoff and erosion vulnerability

LONG-TERM HYDROLOGIC DATA

The Southwest Watershed Research Center houses datasets of precipitation, sedimentation, and runoff for WGEW dating back to the 1950s.



Rainfall Simulator in the Field at WGEW

PROJECT HIGHLIGHTS

Grasses Rebound: Grass cover increased in interspaces and resource islands on treated sites, leading to an overall increase in grass cover from 13% to 61%. Shrub cover was reduced from 40% on untreated sites to less than 1% on treated sites. This marked a transition back to grass dominance on treated sites.

Reduced Runoff and Erosion in Resource Islands: On treated sites, runoff and soil loss were reduced by 72% and 88% respectively in resource islands at fine scales. Infiltration rates, runoff, and sediment loss were similar in interspaces across sites.

Hillslope Scale Impacts: Researchers paired rainfall simulations and overland flow experiments, which provide insights at fine and coarse scales, respectively, with the hillslope-scale Rangeland Hydrology and Erosion Model (RHEM). At the hillslope scale, erosion was reduced in treated sites while runoff was unchanged.

Basal Gaps Predict Cumulative Runoff and Sediment Yield: Basal gap length (the distance between plant bases) predicted runoff and sediment loss, where short lengths were correlated with limited runoff and erosion. This supports the use of basal gap length as a method for assessing impacts of treatments.

LESSONS LEARNED

The site treated with tebuthiuron generally had less runoff and erosion, and more grass cover than untreated sites. These changes were concentrated in resource islands rather than interspaces. Limited responses to treatment in interspaces may indicate that the underlying feedbacks that maintain shrub-dominance were not interrupted by herbicide treatment.

Linking costly field rainfall simulations with RHEM allowed researchers to compare results across broader scales. RHEM is a low-input (e.g., cover, soil texture, slope) tool available to managers to assess the impacts of shrub removal without complex field experiments.

Following treatments, sites were dominated by nonnative Lehmann Lovegrass (*Eragrostis lehmanniana*) and native Bush Muhly (*Muhlenbergia porteri*). Although Lehmann Lovegrass expanded into interspaces between shrub microsites, interspaces were still vulnerable to runoff and erosion five years following treatment.

NEXT STEPS

- Assess long-term outcomes to determine the stability of observed changes
- Assess impacts of herbicide treatment at the watershed scale
- Assess interactions between treatment outcomes and disturbances, like fire
- Investigate the role of macropores (large pores in soil allowing infiltration) that likely mediated the different infiltration response between interspaces and resource islands

Collaborators

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Photos courtesy of Justin Johnson/USDA Agricultural Research Service
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Using Dye to Track Runoff and Erosion