Brush management and ecosystem services: a quantification of trade-offs on Western rangelands

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Introduction

Encroachment of unpalatable woody plants into North American grasslands has been an on-going phenomenon since the beginning of the 20th century. Land managers have traditionally used brush management (BM) to limit shrub encroachment, restore lost forage production, and improve groundwater recharge. From 2004-2012 alone, $24.3 M was spent on BM on private lands as part of USDA-NRCS conservation programs, generally through the aerial application of herbicides. Substantial investments have also been made on federal lands (BLM, Forest Service). Within these narrow perspectives, BM is not always an economically feasible management tool. However, numerous other ecosystem services (ES) such as plant diversity, primary production, and carbon storage potential are all potentially impacted by BM. An accounting for them would provide a more complete assessment of the viability of BM as a conservation practice.

Objective and Methods

As part of a USDA-funded project involving collaborators from the University of Arizona, Arizona State University, and the USDA Agricultural Research Service, we are examining the impacts of BM on a portfolio of ES (herbaceous diversity, forage production, net ecosystem exchange, carbon sequestration, erosion) at the watershed scale in a southeastern Arizona desert grassland on the Santa Rita Experimental Range encroached by velvet mesquite (*Prosopis velutina*). We collected pre-treatment data of these ES from September 2015 to May 2016 in each of four watersheds prior to applying an herbicide cocktail consisting of clopyralid, aminopyralid, and triclopyr. The herbicide was then applied on two watersheds in June 2016, while retaining the other two watersheds as controls. Following treatment, we continued to track ES responses. We will combine our field data with remotely sensed data from an unmanned aerial vehicle to inform computer simulation models to predict long-term ecosystem responses.

Results and Potential Implications

Herbaceous diversity increased in the treated area, but this was primarily the result of an increased proportion of native and non-native annuals. Although herbaceous primary production increased during the growing season following BM, the contribution of non-native perennials far exceeded that of native perennials. Precipitation in the subsequent year was below-average and primary production decreased on both treated and control sites, but more so on the latter than the former. Taken together, our results suggest that BM-induced enhancement of primary production in wet years may be offset by reductions in primary production in dry years. A single application of our herbicide cocktail was short-lived and not particularly effective in reducing mesquite canopy cover. Our preliminary results indicate that BM in this desert grassland may shift the community composition in favor of non-native perennials and annuals over native perennials, perhaps triggered by periods of precipitation shortfall, with unintended adverse consequences for herbaceous diversity and primary productions.

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