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Identifying Restoration Opportunities under Mesquite Canopies

Elise S Gornish, Sam Johnson

Introduction

Climate change, drought, human development, overgrazing, and encroachment of invasive species all threaten grasslands in southeastern Arizona and northern Mexico. These threats are leading to loss of biodiversity and degradation of these ecosystems. Native bunch grasses are especially valued for their role in reducing erosion and providing forage for wild and domestic rangeland herbivores. Mesquite (*Prosopis* spp.) and Lehmann lovegrass (*Eragrostis lehmanniana*) compete with native grasses for space and water resources, which further expedites loss of native grasses in these historical grasslands (Gornish et al. 2021).

Although mesquite can reduce grass cover when measured at a large spatial scale, mesquite canopies at smaller scales can create beneficial microclimates for native plant seedlings in grasslands. Mesquite trees create nutrient-rich soils under their canopies by increasing nitrogen and soil organic matter (Frost and Edinger 1991) and reduce soil temperatures and evaporation. Perhaps mesquite canopies can be leveraged for restoration purposes.

It is uncertain if mesquite canopies can continue to facilitate growth of native plants during drought, and if so, which plants would benefit most. A more nuanced picture is needed to understand how grazing and precipitation changes impact the dynamics between grasslands and mesquite canopies. Here, we describe the analysis of long-term monitoring data from the Santa Rita Experimental Range (SRER) in southern Arizona to learn which native species fared better under mesquite canopies. We wanted to assess the prevalence of non-native grasses like Lehmann lovegrass under mesquite canopies. To complete these objectives, we looked at transect sampling data from 2011, 2014, and 2017 to identify how managers might leverage the beneficial microclimate beneath mesquite to restore native grasses and other grassland plants that are decreasing in abundance.

Figure 1: Mesquite (*Prosopis* spp.) presence expedites the loss of grasslands in southeast Arizona and Northern Mexico, such as at the Santa Rita Experimental Range (SRER) in Arizona seen here. Photo credit: Austin Rutherford/University of Arizona.

Key Issues Addressed

Previous research shows land uses like grazing can impact which native grasses thrive under mesquite and which do not (Smith and Schutz 1975). Mesquite canopies may alleviate environmental stresses on short-rooted native grasses and forbs by creating milder environmental conditions to grow (Barron-Gafford et al. 2017). Mesquite canopies may also reduce competition between invasive grasses and native grasses by improving environmental conditions for native grass seedling establishment (Hulvey et al. 2017), but more information is necessary to fully contextualize this dynamic. Mesquite canopies seem effective at reducing the presence of Lehmann lovegrass under canopies, but there is a lack of data to support this claim. Decreased presence of Lehmann lovegrass under mesquite canopies might lead to less competition for the space and resources that native

grasses need to grow. Restoration practitioners need more information to understand how invasive species impact the interplay between mesquite canopies and native grasses.

What was found

- **Lovegrass does not love mesquite:**
  Lehmann lovegrass is present in lower densities under mesquite canopies than outside of it. Shading and nutrients from mesquite decrease the prevalence of Lehmann lovegrass.

Figure 2: Rare species, grasses, and shrubs benefit most from mesquite canopy shade at the SRER. Photo Credit: Elise S Gornish/University of Arizona

- **Rare species find refuge under mesquite:**
  As a result of less competition from Lehmann lovegrass and other dominant herbaceous plants, less common plants, such as Rothrock grama (*Bouteloua rothrockii*) on average are found in greater proportion under mesquite canopies than outside them.
- **Grasses and Shrubs Benefit the Most:**
  Native grasses and shrubs, such as jumping cholla (*Cylindropuntia fulgida*) and bush muhly (*Muhlenbergia porteri*) tended to benefit from increased canopy cover of mesquite. Native grasses were found under 95% of mesquite while shrubs were found under 83.7% of mesquite. In comparison, forbs were found under just 3.5% of mesquites. Prior research suggests forbs grow better without shade and tree root growth (Tiedemann 1977).
- **Not every plant likes a lot of mesquite:**
  Some plant species, such as large spike bristlegrass (*Setarai macrostachya*) and burrow goldenweed (*Haplipappus tenuisectus*), thrive in greater quantities under mesquite. However, they decreased once mesquite reached a density of 35% cover. There is a threshold of helpfulness for plants under mesquites.
- **Mesquite Increases Diversity, Decreases Biomass:**
  Although mesquite canopies can provide a beneficial environment for rare plants and native grasses, total herbaceous production decreased as canopy cover increased. This relationship is caused by competition among mesquite, native herbaceous plants, and Lehmann lovegrass. Short-rooted annuals may fare better under mesquite canopies, especially as plant density decreases with mesquite growth over time.

Lessons Learned

Leveraging mesquite canopies for grassland restoration is particularly applicable to smaller properties and land management units because it is easier to manually plant and tend to seeds. Seeding methods used for large areas, like aerial seeding, will not be effective when using mesquite canopy restoration techniques because they lack the necessary precision to see positive results. Aerial seeding and similar methods cannot use a different seed mix under canopies versus in the spaces between mesquites. This reality makes leveraging canopies difficult. Although certain species will do better under mesquite, it is hard to place specific seeds under mesquite canopies when seeding large landscapes - aerial seeding, seed drills, and broadcast seeding tend not to be able to plant one seed mix under mesquite canopies and another in the interspaces between mesquites. In these cases, seeding by hand might be the most effective way to target mesquite canopies.

Factors other than the presence of mesquite canopy cover may impact the success of native grassland restoration. If there is no rain, then plants will not grow. The researchers of the study tried to supplement the observational study by planting native seeds under mesquite but were unable to follow through because drought conditions prevented seeds from establishing. Restoration under mesquite canopies will only go as far as precipitation will allow.

While observational data can help managers select species that respond to short-term influences like yearly changes in precipitation, analysis of long-term data sets can help select species that will be successful under mesquite canopies in the long run. The long-term data set at the SRER are publicly available and can be found at https://cals.arizona.edu/srer/. Working with partners with data analysis skills can allow managers to effectively interpret and make use of these freely available data to see beyond seasonal trends and develop restoration techniques for long-term results.

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AUTHORS

Elise S. Gornish
Extension Specialist - Ecology, Management, and Restoration of Rangelands

Sam Johnson
Student Author - Collaborative Conservation and Adaptation Strategy Toolbox (CCAST) Wyoming College of Law/Haub School of Environment and Natural Resources

CONTACT

Elise S. Gornish
egornish@arizona.edu

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