Amount (not spatial arrangement) of grass cover differs between grazed-ungrazed settings

Kelsey L. Hawkes, Mitchel P. McClaran, Amber Dalke

School of Natural Resources and the Environment, University of Arizona

1. Introduction

- Grass cover is a long-standing and widely applied indicator of rangeland health on southwestern grasslands because it limits soil erosion by increasing water infiltration rates. Livestock grazing has the potential to decrease cover, and therefore increase the risk of soil erosion.
- Differences in the spatial arrangement of cover, even at the same total cover, can influence erosion if large patches of bare area exist between grasses (associated with a fragmented arrangement), allowing more opportunity for longer distances of overland flow.

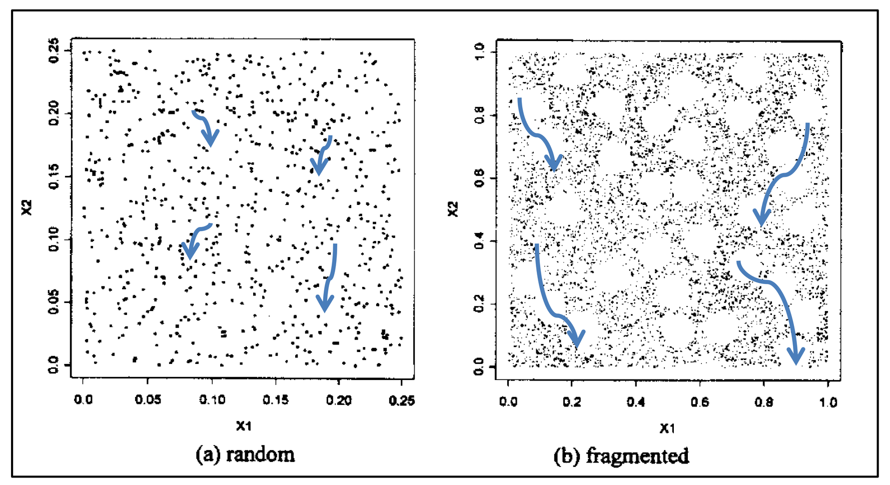

Figure 1: Spatial Arrangement of Basal Cover at the Same Total Cover. Scenes were simulated by Kuehl et al 2001 showing "(a) random" at a 10x10 m scale, and "(b) fragmented" on a 30x30m scale. Blue arrows represent potential unimpeded water flow distances.

- A relatively new indicator called "fetch" attempts to detect fragmented spatial patterns of cover by examining the asymmetry of fetch measures, assuming that greater asymmetry represents a more fragmented spatial arrangement, or a greater deviation from random. Fetch is defined as the distance between two points, e.g. the distance between two grass individuals.

2. Objectives

a. Compare grass cover and asymmetry between long-term (>80 years) ungrazed and adjacent moderately grazed areas (1-2 cattle/100 acres) to determine if grazing has an effect on amount of cover or spatial arrangement of cover.

b. Attempt to detect fragmented spatial arrangement of cover between grazed and ungrazed settings by observing the relationship between asymmetry of fetch and amount of grass cover.

c. Validate the relationship between fetch distance and amount of cover, expecting that the maximum fetch, and therefore overall size of bare patches, will decrease with increasing cover.

d. Determine if grazing has an effect on the maximum, median, and minimum fetch values (factors of the equation for calculating Asymmetry) relative to percent cover.

3. Methods

- In 2011, data were collected from the Santa Rita Experimental Range across two ecological sites (Sandy Loam Upland and Sandy Loam Deep, 12-16" Precipitation Zone).
- Perennial grass basal cover and fetch were measured along 100-foot transects inside (n=30) and outside (n=30) long-term livestock exclosures (n=13).
- Percent basal cover was measured using line-intercept.
- Fetch was measured from each 4-foot interval along the transect to the base of the nearest perennial grass (See Figure 2 and photo).

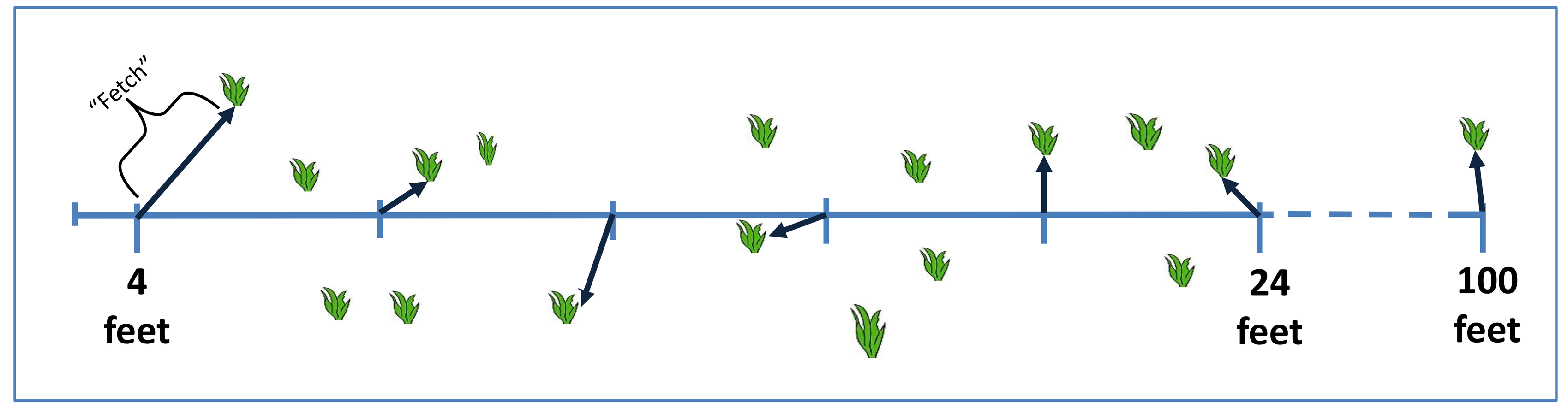

Figure 2 – Schematic for the Point-to-Object Procedure Used to Measure Fetch Along a Transect: Arrows represent fetch distances recorded.

- Asymmetry of fetch data for each transect was calculated using the equation developed by Kuehl et al (2001):

$$\text{Asymmetry} = \frac{\text{Maximum} - \text{Median}}{\text{Median} - \text{Minimum}}$$

- Kuehl et al (2001) used a slightly different method to measure fetch. Instead, they used a line intercept method to measure fetch as the distance between plants along the transect. The sum of all fetch for the entire transect is essentially 1-cover.

4. Results

a. Grass Cover and Asymmetry across Grazing Treatments

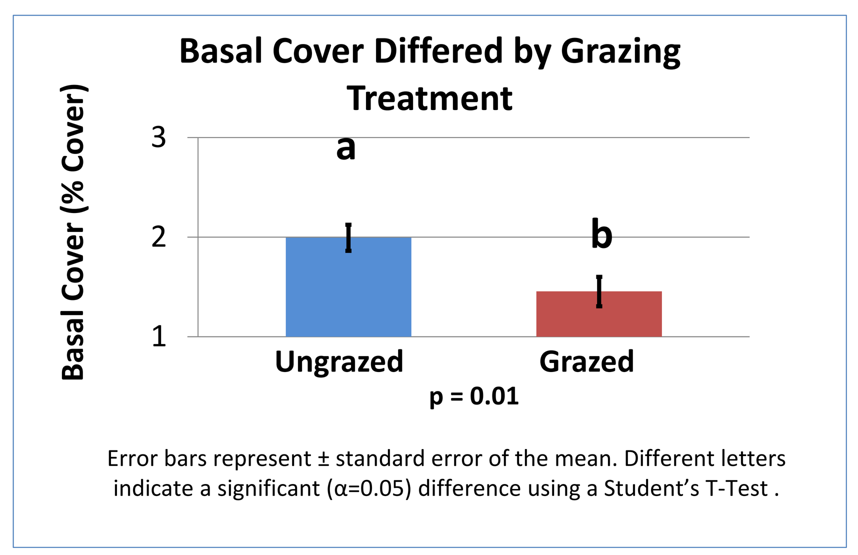

Figure 3: Cover was reduced by 30% in grazed settings.

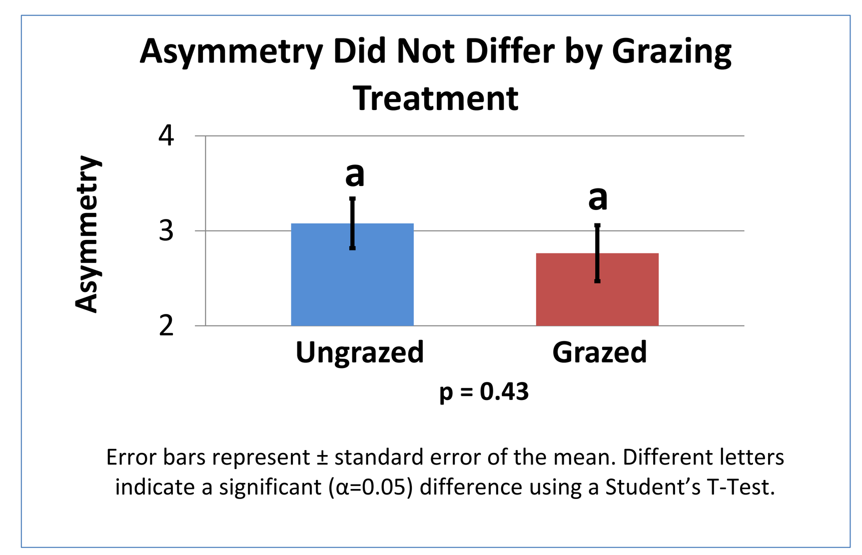

Figure 4: Asymmetry was not altered by grazing influences.

b. Relationship between Asymmetry and Grass Cover

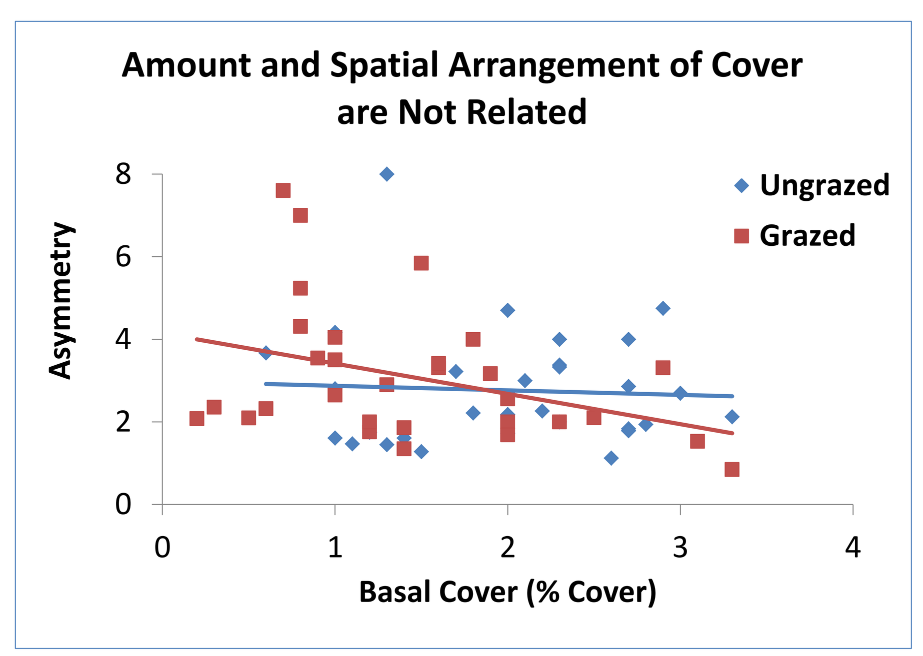

Figure 5: Cover and asymmetry are not related (low R^2 values):

Ungrazed
$y = -0.11x + 2.98$
$R^2 = 0.003$

Grazed
$y = -0.73x + 4.14$
$R^2 = 0.13$

The relationship between Cover and Asymmetry was not affected by grazing (p=0.23; regression analysis).

c. Relationship between Max Fetch and Amount of Grass Cover

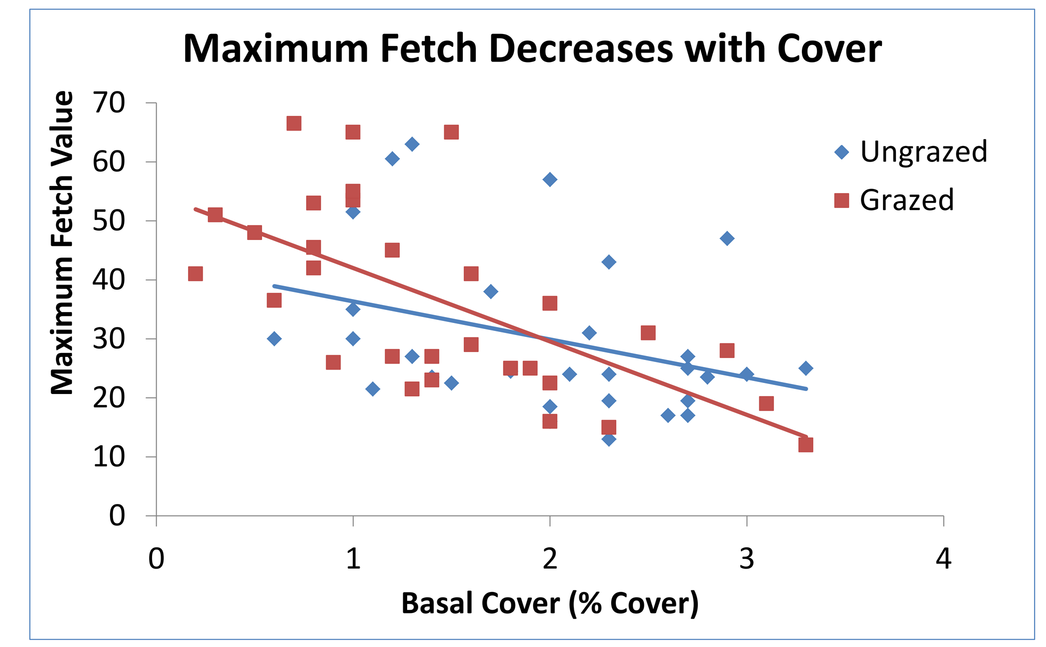

Figure 6 (left): Maximum fetch distances decrease with increasing cover:

Ungrazed
$y = -6.4x + 42.8$
$R^2 = 0.12$

Grazed
$y = -12.4x + 54.5$
$R^2 = 0.48$

d. Grazing Effects on Maximum, Median, and Minimum Fetch Values

- Grazing did not have a detectable significant effect on Maximum (p=0.18), Median (p=0.9), or Minimum (p=0.88) fetch values at these levels of cover based on a regression analysis.

5. Discussion and Future Work

- The rate of soil erosion may be increased in grazed settings as a result of the significant decrease (1.9% vs 1.5%) in amount of grass cover.

  However, erosion increase from spatial fragmentation of cover was not different between grazed and ungrazed areas.

- The low cover values may limit the ability to detect fragmented spatial patterns with the asymmetry value. Asymmetry will clearly distinguish random from fragmented at cover values >3% when using line-intercept method in Kuehl et al (2001).
- My Point-to-Object procedure appears to behave similarly to Kuehl's line-intercept method: median and maximum decreased with cover because the overall size of bare patches (maximum fetch) between grasses decrease with an increase in cover. However, maximum fetch will not decline if cover is fragmented.
- A simulation similar to that of Kuehl et al (2001) would create greater confidence in the Asymmetry values generated by the Point-to-Object method as well as identify the critical value that distinguishes random from fragmented cover.

  The simulation would be helpful to detect whether the Point-to-Object method produces different results than Kuehl's line-intercept.

6. Acknowledgements

- Funding from USDA-CSREES Conservation Effects Assessment Project (CEAP) Program

7. References

- Kuehl, Robert O., Mitchel P. McClaran, and Justin Van Zee (2001). Detecting fragmentation of cover in desert grasslands using line intercept. *Journal of Range Management* 54: 61-66

Contact Information: Kelsey Hawkes, khawkes@email.arizona.edu, Undergraduate in Natural Resources: Rangeland Ecology and Management