Yale SCHOOL OF THE ENVIRONMENT

Ucross High Plains Stewardship

FELLOWSHIP BRIEF

Impacts of Climate Change on Sagebrush Plant Communities Under Variable Grazing Pressures

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The Need.

Associated with rising temperatures, projected future precipitation patterns are expected to create novel climates that influence the distribution of vegetation. This is especially true in drylands across the American West, where timing of precipitation throughout the year changes the distribution of soil moisture which is directly related to the competitive advantage of grasses or shrubs. The composition of plant communities is also influenced by livestock and wildlife grazing. Herbivore-modified plant communities may have increased resilience or resistance to shifts in water availability depending on the density of wildlife or the stocking rate of livestock in the area. Understanding how grazing pressure interacts with projected climate futures has implications for conservation practices and land management decisions. In the Upper Green River Basin (UGRB) of southwest Wyoming these include optimizing sustainable beef production, preserving carbon sinks in native dryland plant communities, and conserving one of the few remaining large mammal migration pathways.

The Project.

This research examines the relationship between precipitation patterns and grazing by studying grazing intensity gradients created around livestock water sources in southwest Wyoming. Livestock and wildlife spend more time closer to water wells, creating a grazing gradient that can be used to examine the effects of grazing intensity on big sagebrush plant communities. Leveraging this natural experiment, we constructed herbivore exclusion plots at 3 different distances, corresponding to light-moderate, moderate, and heavy levels of grazing pressure at 5 livestock water wells in the UGRB. Sites were selected for similar temperature and precipitation regimes to minimize variability between locations. To simulate projected climate futures in the region we will apply artificial rainfall treatments extending the growing season. Annual surveys on biodiversity, productivity, and composition of big sagebrush plant communities provide the basis for understanding the impacts of shifting climates and variable grazing pressure.

The Findings.

Summer 2021 saw the establishment of the paired grazed and exclosure plots and completion of an initial plant community survey along the grazing gradients. All grazing exclosures, soil moisture probes, rain gauges, and wildlife cameras were put in place and are ready for the 2022 summer field season. Preliminary data analysis of the plant survey indicates a significant increase in species richness from the heavily grazed plots to the moderately grazed plots (p-value = 0.00178) and a nearly significant increase in species richness between the heavily grazed plots and the light-moderate plots (p-value = 0.0845) based on an one-way ANOVA using grazing intensity to explain species richness. Plant species richness between moderate grazing and light grazing was not significant.

However, the trend visible in Figure 1 suggests that moderate grazing treatments tended to have higher species on average as compared to the light grazing subplots. This is a multi-year experiment with ongoing data collection. Future analysis will address the impact of grazing and extended growing seasons on sagebrush growth and plant community composition. The initial results lend support to the idea that increased grazing pressure can homogenize plant communities. We are excited about the future of this project and encourage you to reach out for updates.

Figure 1.

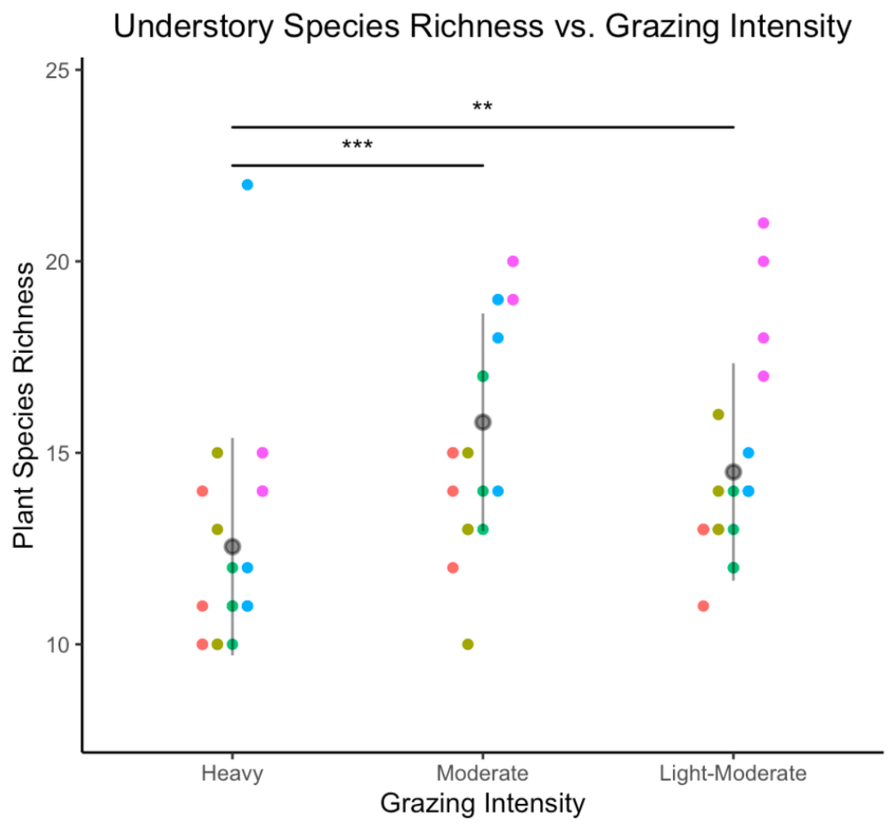

Figure 1. The horizontal axis represents heavy, moderate and light-moderate grazing pressure at increasing distances from the well. The vertical axis is an absolute count of the total unique plant species found within each subplot. Colors represent individual wells and the larger black point is the mean plant species richness across subplots at all five sites. The accompanying vertical lines around the mean are one standard deviation. The horizontal lines indicate significant differences in species richness where moderate grazing is significantly different from heavy grazing (p = 0.00178) and light-moderate is nearly significantly different from heavy grazing (p = 0.0845).

The Impact.

This summer the West experienced heatwaves and subsequent wildfires at higher frequencies and intensities compared to historical averages. Despite news coverage of these extreme events, the consequences of shifting precipitation and steadily increasing temperatures are less understood and consequently overlooked. This study is designed to address this deficiency. As treatments simulating an extended growing season are applied, the resulting changes in productivity and diversity will improve our understanding of how grazing practices interact with region specific climate futures. Does the interaction bolster or weaken plant communities to threats of invasion or significant drops in productivity? This information will be useful in developing land management strategies that benefit ranchers, support conservation organizations, and preserve the sagebrush steppe. For example, understanding that areas surrounding livestock wells are more vulnerable to invasion by nonnative species may support decisions to implement control strategies preventing further spread.

The Student.

Scott is a doctoral student at the Yale School of the Environment where he researches the impact of changing precipitation patterns on plant communities in the Intermountain West. Following his undergraduate degree at Princeton University, Scott worked as a project manager for an NSF-funded ecological study at Ol Pejeta conservancy. While living in central Kenya, Scott developed an interest in mixed-use rangelands, particularly how climate variability influences plant communities and the consequences for wildlife and livestock. His research in Southwest Wyoming focuses on the impacts of shifting precipitation patterns and increased variability for big sagebrush plant communities through a mix of process-based modeling, field experimentation and survey methods.