The Critical Role of Soil Microbiota to Sustainable Agriculture: Quantifying short-term microbial and vegetation feedback to intensive grazing

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Introduction

Debate over the best grazing management has remained volatile and inconclusive for decades. Many studies have examined long-term effects of grazing management on soil and vegetation parameters, but few have monitored effects of grazing on the soil microbiological community. **This study will examine the immediate response of soil microbiota to grazing, and integrate the corresponding interactions with vegetation.**

Promotes soil biological activity

Potential grazing management effects on soil

Effective grazing management:
- Sequester atmospheric C into soil profile[5]
- Deposit labile nitrogen (excrement)[6]
- Increase root exudates (defoliated plants mobilize resources to recover)[4]

Ineffective grazing management:
- Encourage regrowth of undesirable forage[7]
- Increase bare ground (and soil temperature)[2]
- Compact the soil[1]
- Decrease root exudates by overgrazing plants[3]

Decreases soil biological activity

Grazing trial in action at Laramie Agricultural Experiment Station

Objectives

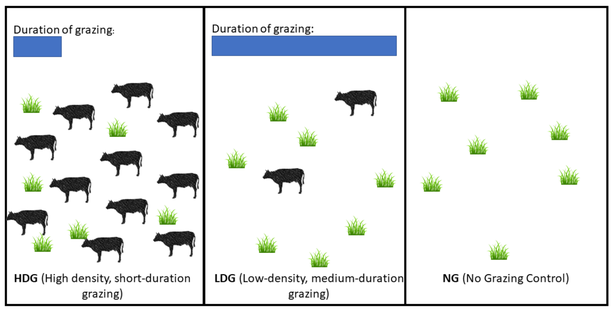
1. Does the soil microbial community change after grazing, and is this response different immediately after disturbance compared to longer term?

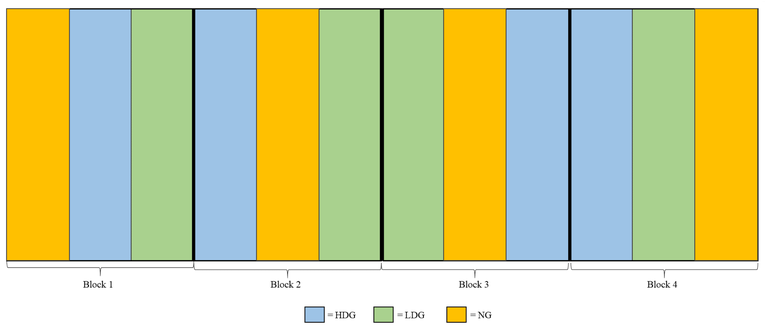
2. Does vegetation recover at different rates depending on the severity of defoliation?

3. Is there a detectable correlation between changes in soil microbial community structure and vegetation recovery following disturbance?

Experimental Design

- Laramie Agricultural Experiment Station (cool-season exotic grasses)
- Soil & vegetation data taken at four time points: 1 week before grazing (baseline data), 24 hours, 1 week, and 4 weeks after grazing
- Twelve adjacent ½-acre pastures randomly assigned to one of three treatments in a randomized complete block design:





Low-density (top) and high-density (bottom) grazing

Methods

Soil microbiological analyses:

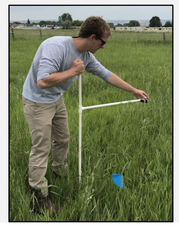
1. **Soil microbial diversity** -- PCR amplification and sequencing of biomarker regions of bacteria and fungi.
2. **Microbial functional diversity** -- extracellular enzyme assays.
3. **Total microbial biomass** -- chloroform-fumigation incubation.

Soil biogeochemical analyses:

1. pH & EC
2. Bulk density
3. Soil texture
4. Dissolved organic carbon & nitrogen
5. Total carbon & nitrogen
6. Soil organic matter

What is NDVI?

NORMALIZED DIFFERENCE IN VEGETATION INDEX (NDVI)
A spectral index that measures the reflectance of plant leaves. Stressed & dead leaves reflect differently than healthy leaves, so NDVI is commonly used to measure plant vigor.



Vegetation regrowth and vigor (greenness):

1. **Temporal changes in vegetation greenness** -- Ground-level Normalized Difference in Vegetation Index (NDVI) images that are taken with an NDVI camera mounted 1m above the ground surface.

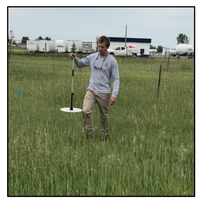
Left image: Graduate student Gordon Custer takes NDVI images mounted 1m above the ground surface

2. **Temporal changes in vegetation biomass and structure** -- Rising plate pasture meter (RPM)

Bottom image: Gordon takes RPM readings at a soil sampling site

What is a rising plate meter?

RISING PLATE METER (RPM)
Measures vegetation structure by dropping a flat disc on the ground. The disc is stopped by the amount & density of vegetation under it, and the height of the disc from the ground is measured in ½-centimeters.

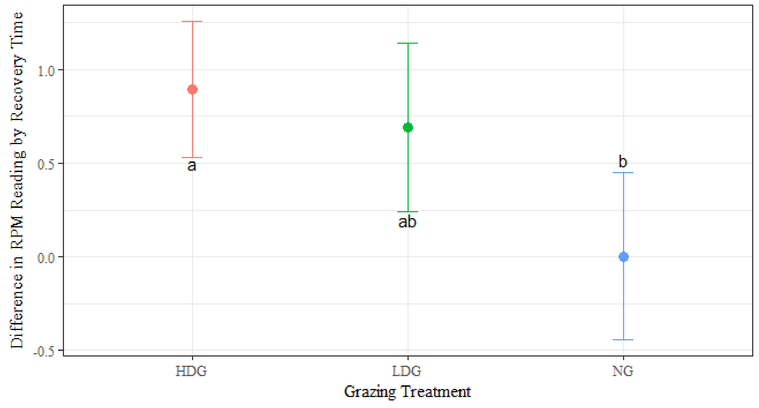


Discussion

HYPOTHESIS:
There is a immediate detectable soil microbial community response to high-intensity, short-duration grazing which will differ from low-intensity, medium-duration grazing and no grazing.

Management Impacts: This study will help to advise land managers to make management decisions aimed at promoting soil biological activity and vegetation growth. In addition, we are testing novel methods to determine effective monitoring methods that producers could implement (NDVI imagery and rising plate meter measurements).

Average Vegetation Recovery Rate



Preliminary results indicate that the high-intensity, short-duration treatment has a faster vegetation recovery rate than the no grazing treatment. *($p < 0.05$)*

Expected results will determine if there is a soil microbial response to grazing management over a short period of time.

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