Overview

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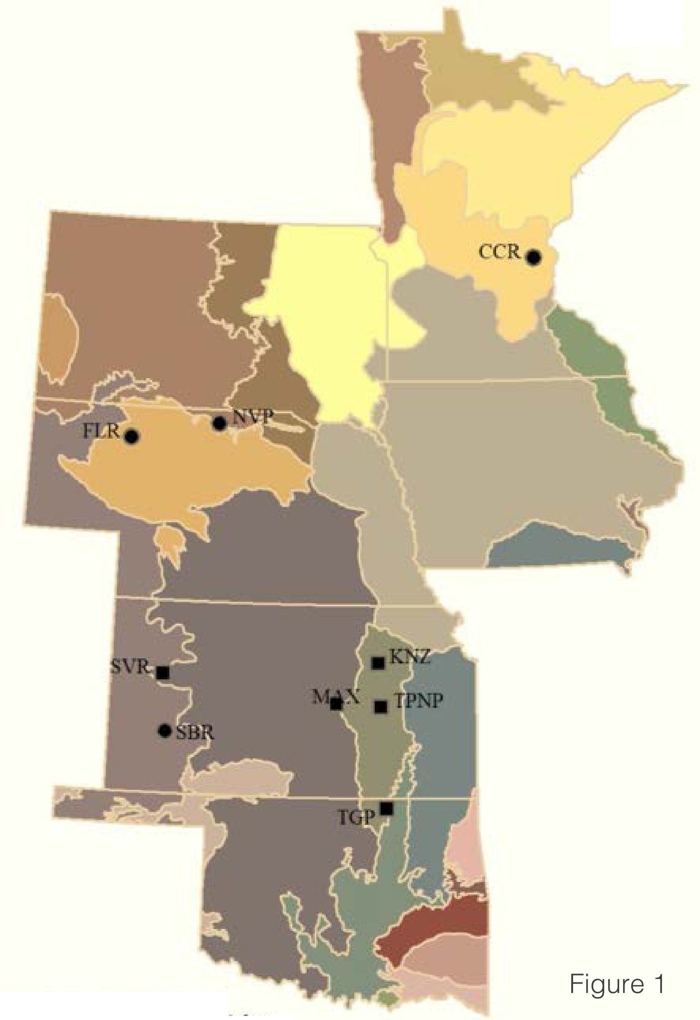


Figure 1

Van Slyke, Barb (n.d.). Photograph of Bison and Calf retrieved from http://lter.konza.ksu.edu/sites/default/files/bison_calf2019.jpg

Introduction: The goal of this study was to measure the effects of bison grazing on soil microbial communities across Great Plains prairie ecosystems. Nine sites were sampled (Figure 1), with samples collected along replicated transects in grazed and ungrazed areas at distances of 0, 0.1, 0.5, 1, 5, and 10 m.

Question: Does bison grazing consistently affect soil microbial community composition and distribution across Great Plains prairies that differ in climate and management history?

Hypothesis: Climate and soil type will be most important in explaining regional differences, and the bison grazing effect at each site will be qualitatively consistent, yet modulated by local factors including management (e.g. vegetation or stocking rate).

Conclusion: Overall, geographic location, climate, and soil type best explained differences in soil bacterial communities among all sites. On average, soil microbial diversity was higher, spatial heterogeneity was lower, and several microbial taxa were consistently more abundant, in areas with bison grazing across all sites. However, the magnitude and direction of the grazing effect varied from site to site, and this variation was best correlated with the number of bison grazing each site, and the amount of bare ground exposure.

Site-specific Conclusions: Konza Prairie is centrally located and slightly more mesic than average, setting it apart from the more arid sites in overall microbial composition. Microbial response to grazing here was similar to regional trends, with the exception of an opposite pattern in distance-dissimilarity. That difference was correlated to the high bare ground cover in ungrazed areas at this site, which also bucks the regional trend.

Read on for more details on the overall and site-specific results.

Summary Data for All Sites and Konza Prairie Biological Station

How does your site compare to others?

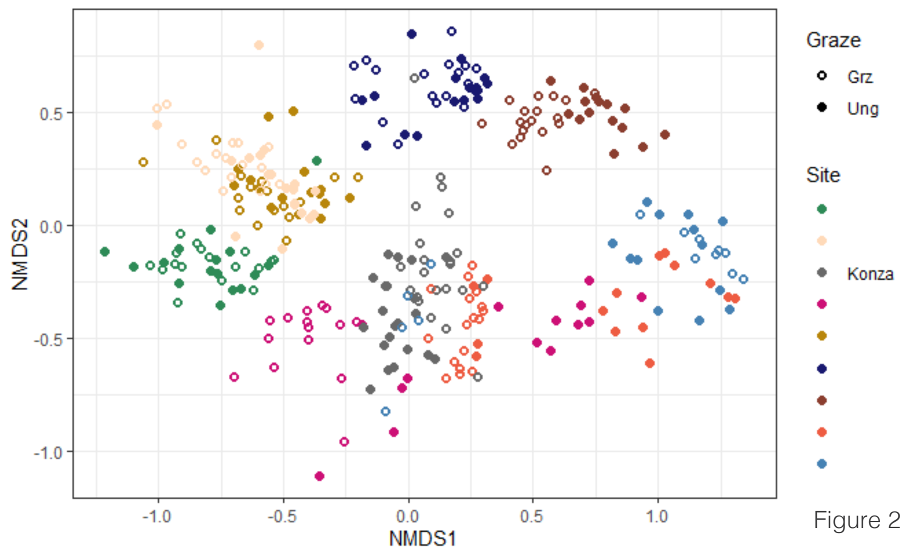


Figure 2

	Averages	Konza
Bison		
# Of Bison	644	300
Years w/ Bison	29.5	33
Stock Rate (Bison/Acre)	24	8
Soil		
Precipitation (mm/yr)	699	899
Evapotranspiration (mm/yr)	716	755
Aridity Index	0.99	1.2
TN (%)	0.19	0.38
TC (%)	2.4	4.5
C:N	13.7	13.8
pH	7.0	6.1

Comparisons are not a representation of individual site quality.

How do your grazed and ungrazed areas compare?

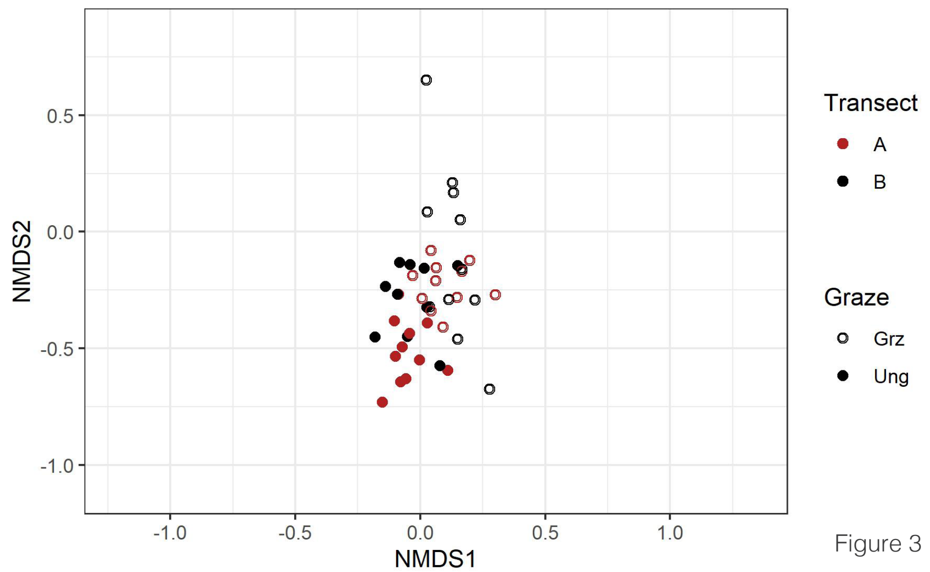


Figure 3

Site Specific Data	Grazed	Ungrazed
Plant Data (% cover)		
Grass Cover	60.3*	86.1
Forb Cover	37.3*	10.8
Plant Litter Cover	33.6*	0.94
Bare Ground Cover	16.3*	60.5
Soil Carbon & Nitrogen		
Total Nitrogen (%N)	0.42*	0.34
Total Carbon (%C)	4.8*	4.2
C:N	13.3*	14.2
pH	6.2	6.1

*significant difference, $P < 0.05$

How to interpret an NMDS graph (Figures 2 & 3): Non-metric Multi-Dimensional Scaling (NMDS) is a statistical analysis that condenses multi-dimensional data into axes that represent significant covariation for exploratory visualization. In this case, 7000+ bacterial and archaeal taxa are collapsed into two dimensions, which represent the two strongest gradients of correlated taxa. The simplest way to interpret these graphs is knowing that samples that share similar microbes group closer together, and samples that are more different are further apart.

Soil Microbial Diversity

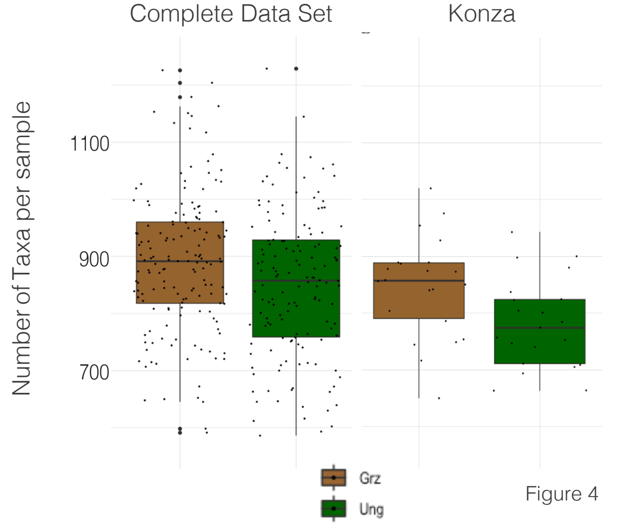
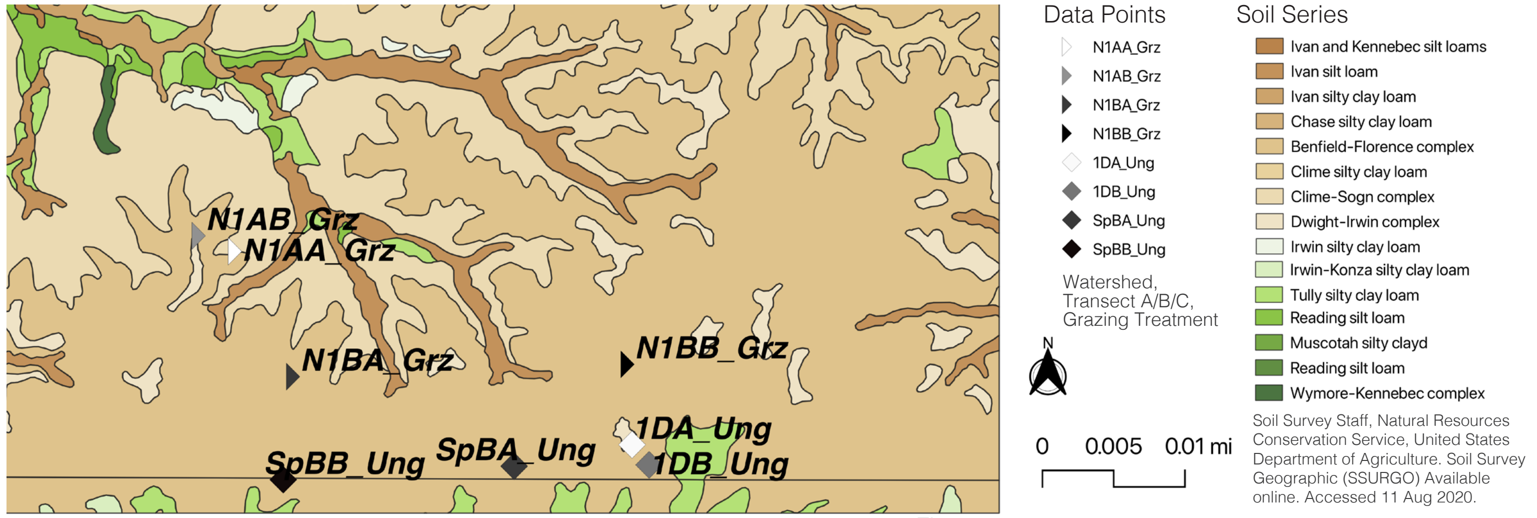


Figure 4

Best taxonomic match	Putative life history of this microbe	Indicator of
Azomonas sp.	Possible free-living (not plant-associated) nitrogen fixer	Ungrazed
Ensifer sp.	Possible plant-associated nitrogen fixing bacterium	Ungrazed
Rhizobaceae member	In a bacterial Family often associated with plant roots	Ungrazed
Nitrosotalea sp.	Possible ammonia-oxidizing archaeon (nitrifier)	Ungrazed
Thaumarchaeota member	In an archaeal Phylum often associated with ammonia-oxidation (nitrification)	Grazed
Methylobacterium sp.	Possible methane-degrading bacterium	Grazed

Seventy taxa were consistently more abundant in grazed or ungrazed areas across all sites, or "indicators". Most do not have putative life-history affiliations due to lack of background information.



Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Available online. Accessed 11 Aug 2020.

Figure 5

Distance Dissimilarity Relationships

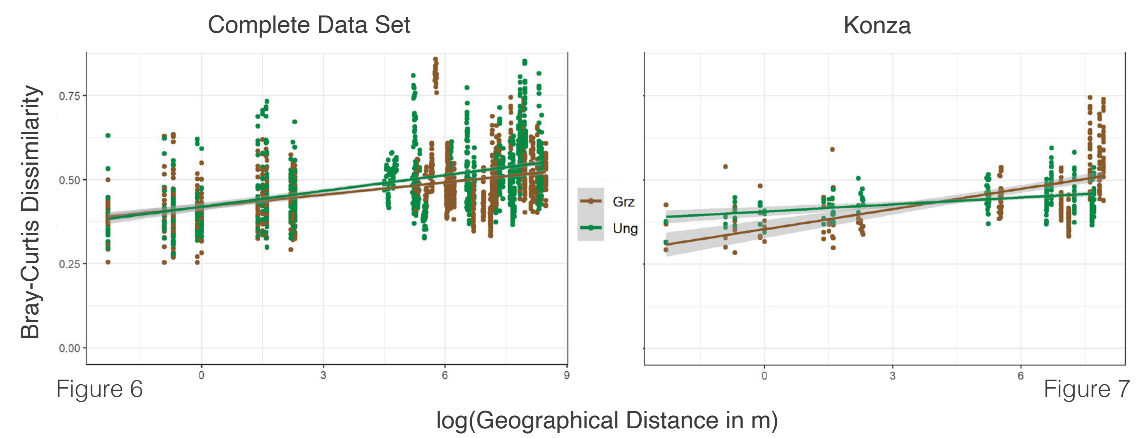


Figure 6

Figure 7

How to interpret a Distance-Dissimilarity graph (Figures 6 & 7):

For most organisms, the further in space, the less similar (more dissimilar) the community composition. We see the pattern exists for soil microbes across all the sampling sites (Fig. 6), and that the slope of the line is lower in grazed areas, which could mean that grazers decrease dispersal limitation, or create soil conditions that allow certain bacteria or archaea to dominate. At most sites (Fig. 7), the same pattern was apparent.

Plant Cover Class Comparisons

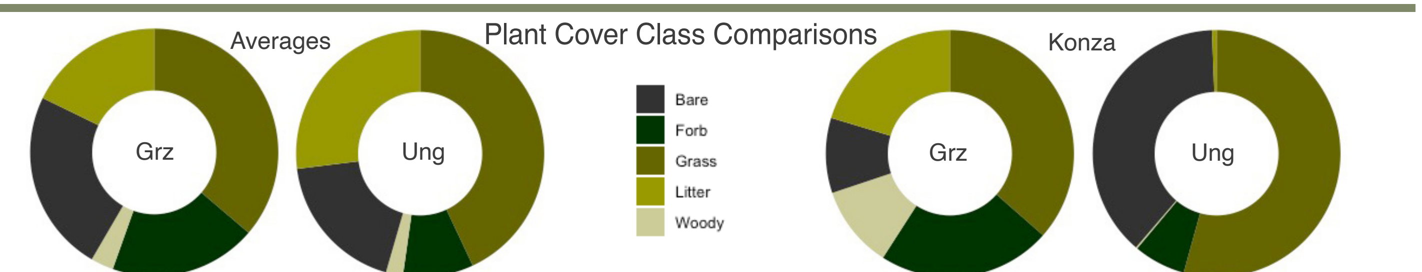


Figure 8

At most sites, there was more bare ground in grazed areas and more grass and dead litter cover in ungrazed areas.

	Explanations
Soil Sampling Details	Mineral soil cores to 15 cm (or as deep as possible), sieved (4 mm) and roots removed before analysis.
Aridity Index	(Mean annual precipitation / Potential evapotranspiration), 30-year Annual Normals, NOAA data. **Konza:** MANHATTAN 6 SSW, KS US NOAA: https://www.ncdc.noaa.gov/cdo-web/datatools/normals
Diversity and "Taxa"	For microbes, "species" cannot be defined in the same way as for plants or animals. "Taxa" here are the highest-resolution units of diversity, analagous to "species"-level groups. Taxa are operational taxonomic units of 97% similar gene sequence in a portion of the 16S ribosomal RNA gene. The taxa this method detects includes most members of the Domains of unicellular life Bacteria and Archaea.
Indicator Life History	"Putative" = possible but unconfirmed. To confirm function, we would need to grow that microbe in the lab!
Plant Cover	Based on the Daubenmire scale: Midpoint of range of cover classes 1 - 7 Bailey, A.W. and Poultan, C.E. (1968). Ecology 49, 1-13.
Soil C and N	Total percent by mass of dry soil, C:N ratio is an index of relative N content (lower = more N)
Soil pH	Measured in 1:1 by volume slurry of field-moist soil : DI water