

Preliminary Report:
Functional responses of a keystone soil engineer to altered rangelands across the Great Plains

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Preliminary findings (4000 characters):

Research conducted at the Tallgrass Prairie National Preserve (TAPR) revealed a total of 14 dung beetle species (Coleoptera: Scarabaeidae) that were associated with three grazing treatments (bison-grazed, cattle-grazed, and ungrazed grasslands) (Table 1, Figure 1). Treatment blocks were replicated twice at TAPR and Konza Prairie Biological Station (Kansas State University, Manhattan, KS), providing a comparison within the Flint Hills ecoregion. Treatment blocks (6 total) included 12 pitfall traps, each of which was baited with herbivore dung (cattle, bison, or rabbit) (Figure 1). Samples were collected every four weeks from May through October, 2023.

Preliminary results reveal that no dung type attracted all 14 species, suggesting multiple grazers are needed to maximize community diversity ($n=14$; Table 2). Higher dung beetle species richness that is inclusive of all functional guilds (dung rollers, dung tunnellers, and dung dwellers) translates into increased carbon sequestration and nitrogen availability, reduced pasture fouling, and increases ecosystem function.

Dung beetle abundance leads to increased dung recycling. Notably, ungrazed areas had much higher numbers (1164 beetles) compared with bison-grazed areas and cattle-grazed areas (418 and 198, respectively) (Table 3). Additionally, for each grazing treatment, preliminary results reveal that the Effective Species Numbers (a measure that best quantifies the diversity) for dung beetles was highest on the ungrazed areas (2.39) compared to bison-grazed and cattle-grazed areas (1.79 and 1.61, respectively) (Table 3). This was an unexpected result, and we are investigating the possible mechanisms that might account for this. We will also compare these results with dung beetle communities sampled at Konza Prairie Biological Station.

Additional analyses will compare dung beetle communities at TAPR and Konza in order to provide suggestions for grassland management. Analyses will examine effects of grazing treatments, bait treatments (cattle dung, bison dung, and rabbit dung), as well as their interactions. Plant biomass samples will be used to examine effects of grazing by bison and cattle and how these may mediate dung beetle communities.

The ultimate goal of the research is to design a sustainable monitoring program that can be used by land managers across the Great Plains. To assess ecosystem integrity and restoration efforts, dung beetles are an ideal bioindicator group because of their sensitivity to habitat change, host specificity, broad geographical distribution, and relative simplicity of collection.

Table 1. Tallgrass Prairie National Preserve dung beetle experimental sites with grazing treatment, location (latitude and longitude) and burning interval (covariate).

Experimental Block	Grazing Treatment	Burned/Unburned 2023	Latitude	Longitude
Tallgrass Bison 1	Bison-grazed	Unburned	N38.44114°	W096.58233°
Tallgrass Bison 2	Bison-grazed	Unburned	N38.44768°	W096.59036°
Tallgrass Cattle 1	Cattle-grazed (Cow/Calf)	Unburned	N38.42518°	W096.57283°
Tallgrass Cattle 2	Cattle-grazed (Stockers)	Unburned (NW area burned; not experimental block)	N38.45560°	W096.58365°
Tallgrass Ungrazed 1	Ungrazed	Unburned	N38.40950°	W096.55689°
Tallgrass Ungrazed 2	Ungrazed	Burned	N38.42992°	W096.55007°

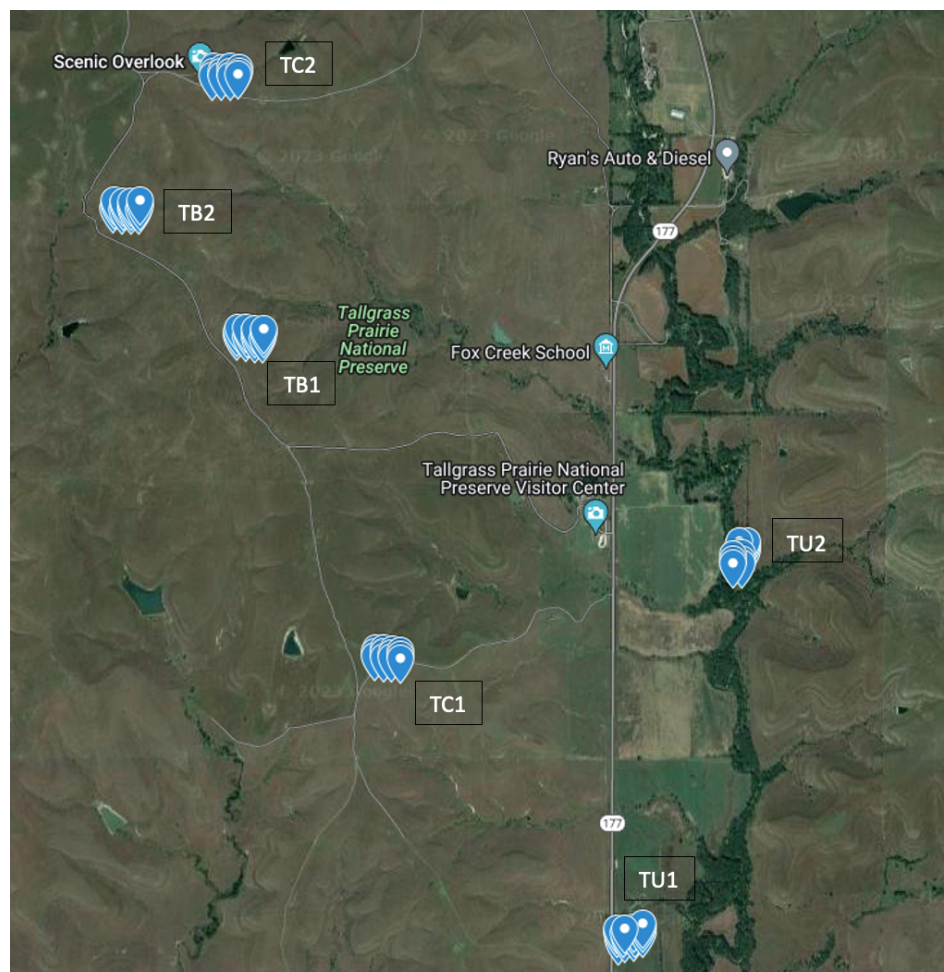


Figure 1. Location of experimental sites at Tallgrass Prairie National Preserve. Experimental blocks are paired, each with 12 baited pitfall traps. Experimental blocks are: TC1 (Tallgrass cattle-grazed block 1), TC2 (Tallgrass cattle-grazed block 2), TB1 (Tallgrass bison-grazed block 1), TB2 (Tallgrass bison-grazed block 2), TU1 (Tallgrass ungrazed block 1), TU2 (Tallgrass ungrazed block 2).

Table 2. Tallgrass Prairie National Preserve dung beetle species and abundances for each grazing treatment.

Species	Bison-grazed	Cattle-grazed	Ungrazed
<i>Ateuchus histeroides</i>	0	0	13
<i>Canthon pilularius</i>	30	13	4
<i>Copris fricator</i>	1	0	7
<i>Copris minutus</i>	0	0	4
<i>Melanocanthon nigricornis</i>	0	0	0
<i>Onthophagus hecate</i>	132	116	411
<i>Onthophagus knausi</i>	0	0	0
<i>Onthophagus oklahomensis</i>	0	0	0
<i>Onthophagus orpheus pseudorpheus</i>	6	6	5
<i>Onthophagus pennsylvanicus</i>	248	61	676
<i>Phanaeus vindex</i>	1	0	2
<i>Pseudocanthon perplexus</i>	0	0	2
<i>Canthon viridis</i>	0	2	38
<i>Dichotomius carolinus</i>	0	0	2

Table 3. Tallgrass Prairie National Preserve dung beetle community measures for each grazing treatment.

	Bison-grazed	Cattle-grazed	Ungrazed
Abundance	418	198	1164
Richness	6	5	11
Shannon Diversity (ln)	0.953	1.01	0.971
Effective Species Numbers (ESN)	1.79	1.61	2.39

Status of Research (Required):

Dung beetle samples and plant biomass samples have been processed. Beetles were identified to species and all individuals were counted. Plant biomass was dried and weighed. Analyses are currently being conducted.

Woodard presented her preliminary research findings at the Kansas Natural Resource Conference in Manhattan, Kansas (Feb. 9, 2024). Data analyses and completion of the MS thesis by Bryanna Woodard is in process. The expected date of completion is 31 July 2024.

Funding Sources and Amounts:

Woodard's research is supported by an Entomological Society of America Student Travel Award (\$1500).

Status of specimens collected:

For species-level identifications, specimen collection is required for dung beetles. Woodard identified all species, and identifications were verified by Jameson (taxon expert for the Scarabaeoidea). Specimens are vouchered in the Wichita State University Biodiversity Laboratory. Comparative collections will be vouchered and publicly accessible at Kansas State University, University of Kansas, University of Nebraska, and Wichita State University. If desired, we will deposit specimens at TAPR.

Confirmation of Research Dates:

Experimental blocks were established in April 2023. Field research was conducted once every 4 weeks from May through October 2023. Experimental blocks were decommissioned in October 2023 (pitfall traps removed, holes filled with soil).