

**The Friends of Nachusa Grasslands
2024 Scientific Research Project Grant Report
Due June 30, 2025**

Please answer the following questions with clearly written summaries to give Nachusa Friends' science committee members, officers, and board members a good idea of what you accomplished using your grant money. Unless you object to the Friends doing so, your report will be uploaded into the science section of the Friends' website: nachusagrasslands.org.

1. Please save this form to your desktop with a unique file name that includes "Friends 2023 Science Grant Report" and your last name.
2. Complete the form using the headings in **bold** as your guide.
3. Save the file as a Word document or a PDF.
4. Attach the file to an e-mail, and send it to: nachusafriendsscience@gmail.com no later than June 30, 2025.
5. The subject of the e-mail should be "2024 Scientific Research Grant Report" and your last name.
6. If you have not completed your work, please submit this form anyway by the June 30 deadline and plan to contact Friends after your project is complete so that we may learn from and publicize the outcomes as appropriate.

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2024 grant amount: \$7619

Research Project Topic: Functional and structural impacts of bison grazing intensity on plant communities.

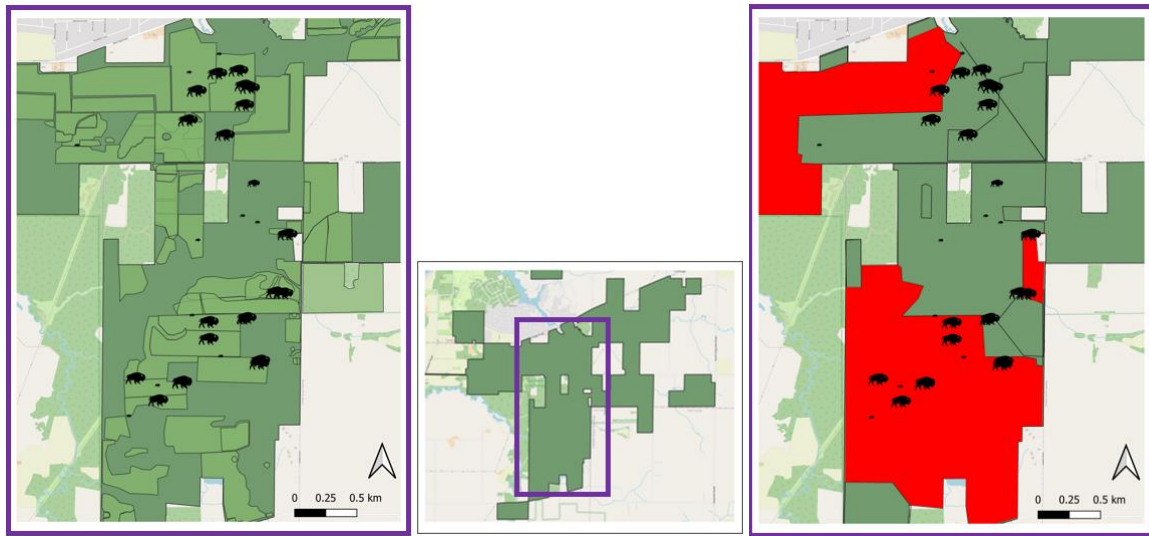
Research Project Purpose: This project explores the impacts that different bison grazing intensities have on plant functional diversity, vegetation structure, and ecosystem function in tallgrass prairie restorations. By studying these impacts in the natural mosaic of varied grazing intensity at Nachusa, we will better understand how grazing can be effectively applied to maximize management objectives and create healthy, functioning ecosystems.

Research Project Outcomes to date:

All statistical results reported here were statistically significant at the 0.05 level.

Bison grazing behavior:

Observations taken once a week in the month of May showed that the bison herd tend to concentrate their grazing in prairie plantings (light green polygons) and in prairie that was burned in the past year (red polygons).



Grazing Lawn Formation:

Grazing lawns are capable of forming throughout Nachusa, and due to a high abundance of forbs (wildflowers), grazing lawns can take the form of grazing “networks” in which networks of grazed plants are woven around dense clusters of forbs. However, in some areas of Nachusa, grazing lawns manifested in their traditional form of large areas of open and grazed down vegetation.

Plant functional trait response (or “expression):

Most species’ functional traits were unaffected by changes in grazing intensity, but leaf size (area) and leaf strength were the functional traits most commonly affected. The response of each functional trait is incredibly species-specific, meaning that I cannot easily generalize the direction and magnitude of change for each trait. Further, not every trait changed across all levels of grazing intensity.

Seven out of nine of the most common upland prairie plant species showed a change in trait expression in response to different intensities of grazing (Table 1). Four of the species were graminoids, and the other three species were forbs. All four graminoids are found in a bison’s diet, whereas only one of the three forbs are found in a bison’s diet, meaning that the effect of bison grazing intensity on functional trait expression is attributed to both direct (defoliation) and indirect effects of grazing (i.e. dung, urine, competition release).

Species	Functional Trait	Response	Treatment
<i>Andropogon gerardii</i>	Leaf Dry Matter Content	4% decrease	From LG to HG
<i>Carex bicknellii</i>	Leaf Area	21% decrease 17% decrease	From EX to HG From LG to HG
<i>Carex bicknellii</i>	Specific Leaf Area	14% decrease	From EX to HG
<i>Carex bicknellii</i>	Leaf Strength	18% increase	From EX to LG
<i>Lespedeza capitata</i>	Leaf Strength	12% decrease	From EX to HG
<i>Schizachyrium scoparium</i>	Leaf Area	22% increase	From EX to LG
<i>Schizachyrium scoparium</i>	Leaf Dry Matter Content	6% increase	From LG to HG

<i>Schizachyrium scoparium</i>	Leaf Strength	1% increase	From LG to HG
<i>Silphium integrifolium</i>	Leaf Strength	12% increase	From LG to HG
<i>Solidago rigida</i> (<i>Oligoneuron rigidum</i>)	Leaf Area	28% increase	From EX to LG
		49% increase	From EX to HG
<i>Sorghastrum nutans</i>	Leaf Strength	9% decrease	From EX to HG

Table 1: Trait responses to grazing intensity that were statistically significant at the 0.05 level. Grazing intensities are defined as EX (no grazing intensity, i.e. grazing enclosure), LG (low grazing intensity), or HG (high grazing intensity, i.e., grazing lawn).

While most changes in trait expression were relatively small, this does not discount the impact that the response may have for the plant and its growth and success. One result, however, was particularly striking. *Solidago rigida* (*Oligoneuron rigidum*), or Stiff Goldenrod leaf size increased with grazing intensity (Figure 1a). Despite not being directly grazed, Stiff Goldenrod showed a 28% increase in leaf size in low grazing intensity treatment compared to the no grazing intensity treatment, and showed a 49% increase in leaf size from the high grazing intensity treatment compared to the no grazing intensity treatment (Figure 2b). Stiff Goldenrod is responding to indirect effects of grazing intensity, triggering the plant to develop bigger leaves, and with bigger leaves more sunlight is able to be captured which could translate to greater success in growth and reproduction.

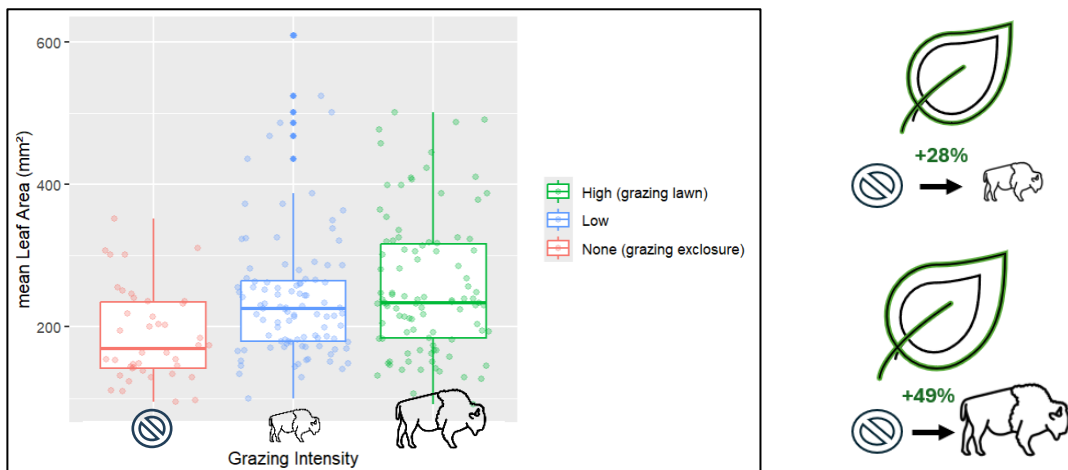
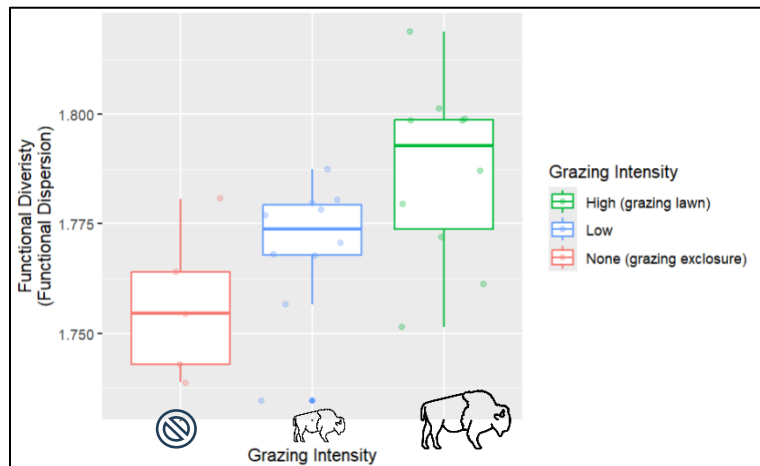


Figure 1a (left): Boxplots showing *Solidago rigida* (*Oligoneuron rigidum*), or Stiff Goldenrod leaf size increased with grazing intensity.

Figure 1b (right): Visual representation of statistically significant results shown in Figure 1a. Green outlined leaf represents the positive increase in leaf size as grazing intensity increased, respectively.

Plant functional diversity:

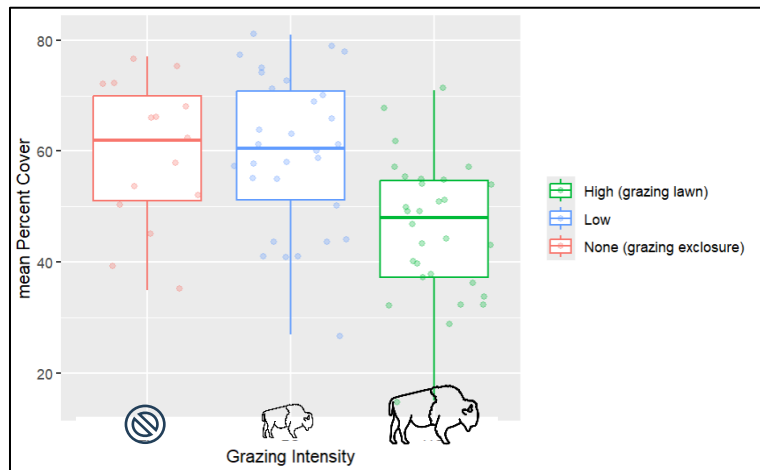
Functional diversity increased by 1.8% from no grazing intensity to high grazing intensity due to the compounding of small changes in trait expression. The range of potential values for functional diversity is small, so despite such a small increase in functional diversity as grazing intensity increased, it is likely that this change carries biological significance for these prairie communities. Variation in how species and their traits respond to grazing created a more functionally diverse community which could sustain greater ecosystem functioning.



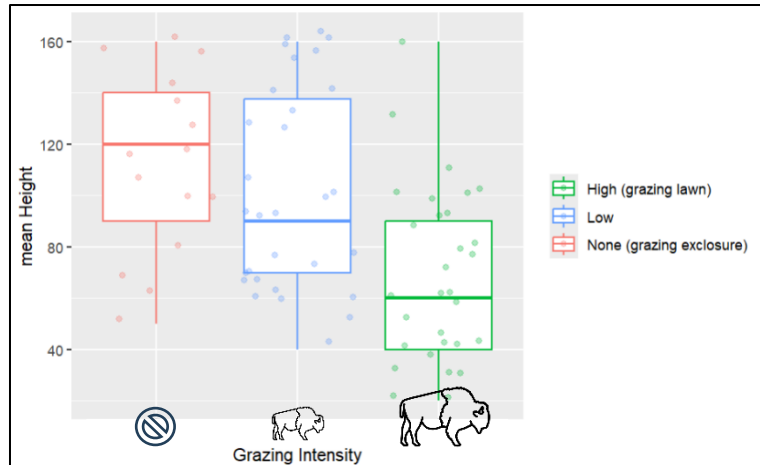
Vegetation structure:

As grazing intensity increased, more vegetation was being eaten and removed causing changes to the vegetation structure of the prairie, and these trends held true across three months of surveys.

For prairie (vegetation) density, vegetation is sparser as grazing intensity increases, meaning there is increased visibility through high intensity grazed prairie when looking through the prairie (field of sight parallel with the ground). There is a 22% decrease in density from no grazing intensity to high grazing intensity, and a 23% decrease in density from low grazing intensity to high grazing intensity. The density of the prairie was comparable between no grazing and low grazing intensity.



For prairie (vegetation) height, vegetation height became shorter as grazing intensity increased. There is a 36% decrease in density from no grazing intensity to high grazing intensity, and a 30% decrease in density from low grazing intensity to high grazing intensity. The height of the prairie was comparable between no grazing and low grazing intensity. On average, the prairie under high grazing intensity was approximately one foot shorter than the other grazing intensities.



Describe how the grant funds you have received from the Friends of Nachusa Grasslands have been used in regard to the above topic, purpose, and/or outcomes:

The grant funds I received from the Friends of Nachusa Grasslands were used to fund summer stipends, travel, supplies, and analyses pertaining to the project. The use of these funds for the project resulted in the outcomes described in the above section. I was able to pay myself a summer salary for most of my working days to support myself during the summer when I am not employed, as well as pay for a part-time field assistant to work alongside me to collect and process a large number of samples. I used the travel funds to support the mileage and gas cost incurred from commuting to Nachusa Grasslands in the month of June. I used the funding to purchase necessary supplies to process and store plant samples, like a digital scanner, coin envelopes, and double-sided tape, as well as supplies for my decomposition experiment (presently ongoing), like cellulose filter paper. The remaining funds were used to pay for carbon and nitrogen content analysis on the leaf samples through an isotope analysis lab run on the Northern Illinois University campus (awaiting results).

- Summer salary = \$3,600
- Leaf carbon and nitrogen content analysis = \$1,530
- Field assistant = \$2,000
- Travel = \$335
- Supplies = \$154

Describe how your project has benefited the work and goals of Nachusa Grasslands:

This study was set in the natural mosaic of varied grazing intensity at Nachusa to provide a realistic and foundational understanding of how grazing intensity impacts functional diversity, vegetation structure, and ecosystem function in tallgrass prairie restorations. Based on the results to date, we understand that grazing intensity does have an effect on the functional diversity and vegetation structure aspects, which can be used by managers to determine if their application of grazing does

(or can) meet their goals. As a result of this project, managers will have a more precise idea as to how, when, and where to apply grazing to maximize management objectives as they relate to functional diversity and prairie structure, enabling them to adjust or adapt based on best practices. Further, plant functional diversity, especially in regards to trait expression, has not thoroughly been explored at Nachusa, and by providing information beyond just what species are there, managers have more knowledge at their to be able to build resilient, healthy, functioning ecosystems under different grazing intensities. Functional diversity also speaks to how well a community can support a range of trophic levels, so managers can also address how to bolster resilience and ecosystem diversity in that regard. From the results of this study to date, we better understand what levels of bison grazing intensity could enhance the diversity, structure, and function of prairie restorations.

Describe how your findings can be applied to challenges in management practices for restoration effectiveness and species of concern:

Utilizing a natural experiment to test the effects of varying grazing intensity provides a more realistic look at how these intensities and their effects on prairies manifest. Learning more precisely how the grazing of free-roaming bison affects plant communities can in turn improve the precision of management, giving managers more control over restoration outcomes. This is especially relevant given recent challenges to reduce overgrazing in the South bison unit, and the decision to temporarily concentrate grazing in the North unit for relief. The findings of this project indicate that the intensity of grazing has consequences for how prairies develop, including the growth and success of individual species of plants, the functional diversity of plant communities, and what functions and life the prairie may be capable of supporting as a result of its vegetation structure. The findings of this project elucidate fine-scale mechanics that matter for individual species success as well as larger-scale community and ecosystem changes, providing managers with more information at their disposal to target what matters to them the most. By minimizing uncertainty of treatment application and maximizing the success of restoration outcomes, grazing becomes a more reliable and effective management tool to ensure a diverse, resilient, and functioning ecosystem. Consideration for variable grazing intensity under consistent stocking density could then become an additional tool that managers use to maintain biodiverse and functional prairies. This is also true for the utilization of functional diversity, an incredibly informative but underused metric of health and function. Looking through the lens of functional diversity can provide a more accurate estimate of how ecosystems function, detecting changes in function even when species diversity does not change. Functional metrics can make restoration management more comprehensive and ensure managers get the entire scope of the picture that is ecosystem dynamics.

Please list presentations/posters you have given on your research:

Poster Presentation:

Martinez, M., S. L. Berk, H. P. Jones. 2025. "The Effect of Bison Grazing at Various Intensities on the Carbon to Nitrogen Ratio of *Andropogon gerardii* and *Ratibida pinnata*". Conference on Undergraduate Research and Engagement. Northern Illinois University, DeKalb, Illinois. (In-Person Conference).

Oral Presentation:

Berk, S. L., K. F. E. Hogan, H. P. Jones. 2025. “Functional and structural impacts of bison grazing intensity on plant communities in tallgrass prairie restorations”. Nachusa Grasslands Science Symposium. Franklin Grove, Illinois. (In-Person Conference)

Have you submitted manuscripts to scientific journals? If so, which ones? If not, do you anticipate doing so? (Please send digital copies of published articles to the Friends so that we can learn from your work.)

No manuscripts have been submitted to scientific journals. After the project is complete, I do anticipate doing so.

What follow-up research work related to this project do you anticipate (if any)?

This 2024 project is being continued in 2025. The remainder of my results (carbon and nitrogen data and decomposition data) for the 2024 project will be processed and analyzed in 2025 because they required more time to complete. As a recipient of another Friends grant for 2025, I am performing this research for a second season. The results of 2024 and 2025 may be separated into two separate projects given the change in bison management; the decision to keep the bison in the North unit for a period of time.

Optional: Suggestions for improving the application and award process for future Friends of Nachusa Grasslands Scientific Research Grants:

No suggestions at this time.