

**The Friends of Nachusa Grasslands
2023 Scientific Research Project Grant Report
Due June 30, 2024**

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 2022 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, 2024.
5. The subject of the e-mail should be "2023 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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2023 grant amount: \$6,558

Research Project Topic: Vegetative Succession and Seed Fate in Bison Wallows

Research Project Purpose:

Bison have the potential to alter vegetative composition by creating localized disturbances in the forms of wallows – depressions created when bison roll around on the ground, crushing vegetation and throwing up dust. They tend to have a higher percentage of grasses and ruderal species than surrounding prairie (Gibson 1986; Trager et al 2004; personal observation) and may facilitate invasion by non-native species (Rosas et al 2008; Sigaud et al. 2020). In a confined habitat like Nachusa, repeated disturbances could eventually lower overall floristic quality, particularly in prairie remnants. Conversely, the natural disturbances could be an opportunity to seed in rare species that do not tolerate competition, or to plant diverse mixes to improve lower quality sites.

The purpose of this project was to examine vegetative succession, floristic quality and composition, and seed bank in bison wallows within different prairie ages. It also tested the use of time-lapse cameras to examine seed predation and dispersal - with particular focus on ants. The project was intended to investigate bison impacts on high quality prairies, whether they might be a source of entry for rare disturbance-needing plant species or for invasive species, how they alter the soil and hydrology, and whether management strategies should be implemented in response to wallows. One rare species of particular interest is pink milkwort (*Polygala incarnata*) currently restricted to one knob at Nachusa and known only from one other site in Illinois. This species does not tolerate competition and is thought to be ant dispersed.

The goals of this study were to: 1) Determine vegetative composition and succession of bison wallows in a confined managed landscape; 2) Determine the fate of seeds in and around bison wallows; and 3) Assess whether the natural seedbank should be supplemented with planting and, if so, what species should be planted in bison wallows.

Research Project Outcomes to date:

A database of wallow “signatures” (e.g., rock outcrops, bare ground) was created from aerial imagery both before and after bison introduction in 2014 (2012, 2014, 2017, 2019, 2021). Sites that indicated disturbance were noted with a point in GIS. Using these points, as many sites as possible (388 over four days) were ground-truthed and their perimeter mapped using a Trimble Global Navigation Satellite System unit with a presumed accuracy of +/- 0.5m. While not exhaustive, this dataset can be used by future researchers to represent conditions at a point in time.

From the mapped wallows, 25 wallows were selected from fields representing different management histories (e.g., remnant prairie, old restoration, recent restoration), with one active and/or one inactive wallow in each field. Quantitative vegetation sampling was conducted inside, on the edge, and up to 2m outside of each wallow in June and September of 2023. Additional plant species were recorded in June 2023 and April 2024. Because bison heavily grazed these sites, grass identification proved challenging in all seasons, as did some forbs. Species identification and data cleaning and analysis is still underway, but a preliminary list of predominant species has been generated. For example, in June, native ragweed (*Ambrosia artemisiifolia*) was the most commonly encountered species within wallows, followed by non-native Canada bluegrass (*Poa compressa*). Non-native clover (*Trifolium* spp.) and grasses (e.g., *Poa pratensis*, *Bromus* spp.) were frequently encountered within and on the edge of wallows, but their cover tended to decrease relative to other species outside wallows. Native species were frequently observed on the edges of wallows, but this is unsurprising given that the wallows tended to expand throughout the season (due to increased use as well as erosion). A major discovery is that rare/conservative species (e.g., *Castilleja sessiliflora*, *Penstemon grandiflorus*, *Polytaenia nuttallii*) will occur around bison wallows but that *all* vegetation can be *heavily* impacted within wallows, including non-native and invasive species. Due to the size and confinement of the herd, bison rarely abandon wallows and are more likely to expand or create new wallows, which leads to extensive denuding and

erosion. As expected from literature, wallows tend to be on slopes (average 8.6%), which often have the most sensitive plant communities.

Bison wallowing led to significant soil compaction and erosion. Soil from within and adjacent to each wallow was textured and measured for bulk density. Nearly all soil was loamy fine sand or fine sandy loam. Bison wallowing was found to increase soil bulk density compared to adjacent habitat. Preliminary analysis shows no significant difference between active and inactive wallows, which indicates that wallowing impacts may be long-term, although increased activity in nearly all wallows over the course of the study confounded this analysis. That is, “inactive” wallows became increasingly disturbed. Further analysis in Fall 2024 will attempt to tease out the effects of this increased activity. Notably, six samples from active wallows were over 1.6 g/cm³, densities that can reduce plant growth in sandy soils. No samples from “inactive” wallows or adjacent reference soils exceeded 1.6 g/cm³.

Interestingly, wallows at Nachusa differ from many bison-reintroduction sites (e.g., Konza Prairie) in that they tend to not remain saturated or inundated for long periods of time compared to the surrounding habitat. Only 37 of the 388 wallows that I mapped in April 2023 were “wet” (i.e., moist or holding water over at least one-third of the area). Within the study wallows (which were purposely selected to exclude wet wallows), the only wetland species that was unique to the wallows (compared to adjacent habitat) was beggarticks (cf *Bidens frondosa*), and only one individual was observed on two occasions. This observation confirmed what was suspected by Elizabeth Bach based on the soil texture. Nachusa soils are very sandy while other sites tend to have higher clay content.

Seed dispersal tests were planned for 2023 but were limited by equipment, weather, and bison activity. Tests were intended to focus on ant dispersal. Fourteen plant species were tested at different sites depending on surrounding vegetation and site conditions. Seeds were placed in covered petri dishes with small holes to permit access by ants but limit vertebrates and wind. As predicted, seeds with elaiosomes (*Viola sagittata*, *Polygala incarnata*) were preferred during August sampling (removal = 67% and 83% respectively among 6 stations). Time lapse cameras caught ants manipulating other seeds but not removing them. *Viola* and *Polygala* seed removal was lower in October (15% and 5% respectively). This may be due to less ant above-ground activity in general. Seed from the state-listed *Besseyia bullii* was included in the study but it was never observed to be removed by ants. Interestingly, in May 2024, a single individual of *B. bullii* was found within 2m of a wallow where I had scattered 4 seeds in October. Searches for *P. incarnata* are intended for July 2024 around wallows where *P. incarnata* was removed by ants. (None were found at two wallows searched in June 2024.) Ants were collected in pitfall traps at one location in June and July 2023 and opportunistically around Nachusa during dispersal and other studies, but the “dispersers” collected from wallows were generalist species (identification by Laura Rericha-Anchor). More studies are planned for 2024 to physically collect ants as they collect seed and/or observe where they take the seeds.

Seedbank studies were conducted in May-June 2023 with samples collected in April, and again in May-June 2024 with samples collected in October and refrigerated (~40F)

through the winter. Germination was observed during both studies, indicating presence of viable seedbank. Due to difficulty in maintaining consistent moisture in the greenhouse during the 2023 trial, seedlings did not survive to identifiable species in the initial trial. The second trial will conclude June 30, 2024, with additional time to grow out unknown species. Thus far, 218 seedlings have been observed in 99 trays (representing 19 wallows and 14 adjacent reference communities). Nearly 75% of seedlings have been forbs, most abundantly carpetweed (*Mollugo verticillata*) and an as-yet unknown dicot, and 25.6% are graminoids. This difference was higher inside wallows (78.7% versus 21.3%) than outside wallows (66.2% versus 33.8%). No conservative native species have yet been identified. It is possible that an additional round of cold stratification or another year of study would have stimulated germination of native seeds. In Fall 2024, I hope to examine the soil bulk density samples for presence of additional seeds.

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:

Funds from the Friends of Nachusa Grasslands was used to cover portions of my travel and salary while conducting field work for this study (and associated administrative costs through the University of Illinois at Urbana-Champaign). The funds also covered various supplies that were used to conduct the investigations, such as materials for measuring tape and quadrats and posts for mounting the time-lapse cameras. A large portion of the funds were originally intended for the purchase of time-lapse cameras to document ants dispersing seeds, but testing conducted with cameras purchased with other funds indicated that the cameras were not ideal for the purpose intended. Thanks to the generosity of the Friends of Nachusa Grasslands, I was able to redirect those funds for additional travel to the site, expansion of the greenhouse study, purchase of additional scientific equipment such as aspirators to physically collect the ants for species identification, and other expenses such as shipping ants for expert analysis.

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

The question of what should be done regarding vegetation in bison wallows was specifically asked by the Nachusa Science grant. In particular, they wanted to know if they should seed the wallows. This study attempted to investigate the vegetative impacts of bison wallowing, whether recovery was possible, and what management, if any, should be conducted. I have shown so far that restricting or discouraging access would be more effective than seeding due to the significant denuding that occurs from repeated wallowing. In addition, I have collected more information about rare plant species found at Nachusa. In particular, I have observed a preference by ants to collect *Polygala incarnata* but to ignore *Besseyia bullii* and several other prairie plant species. In the course of vegetative sampling, I have also documented new species that have not been included on the species list for Nachusa.

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

Suggestions to discourage wallowing in sensitive areas included reducing burning (because burning tends to increase grazing) and constructing exclosures. Seeding is not recommended as bison will likely only continue to trample the wallows. *Besseyia bullii* may seed readily (as has been indicated by researchers Andrew Davies and Eric Janssen). If *Polygala incarnata* is myrmecochorous, then seed spreading should be conducted when dispersing ants are active (e.g., August, not October).

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

Poster - Friends of Nachusa Science Symposium (April [REDACTED], 2024)

Poster - Botany 2024, Grand Rapids, MI (June 15-19, 2024)

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, but I anticipate submitting to at least one journal (e.g., *Erigenia*, *Castanea*, *Journal of the Torrey Botanical Society*, *Plant Species Biology*, *Arthropod-Plant Interactions*, *Natural Areas Journal*)

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

After speaking with a researcher at the Science Symposium, I am interested in using image classification to identify wallows from old aerial imagery and to set up a process to monitor the wallows in future years. I also hope to follow up with more seed dispersal and ant collecting studies at Nachusa. Collection will be manual with an aspirator rather than remote with cameras. An additional plant species that I intend to investigate is wood betony (*Pedicularis canadensis*), in part due to concern raised by a member of the Native Nursery Network that ants were removing the seed before he could collect it. I will also return to the bison wallows where ants removed *Polygala incarnata* seed to see if any plants emerge in 2024.

Although not directly related to the wallows project, I will continue studies of reproductive ecology of *Polygala incarnata*. I will use the time-lapse cameras and related equipment to at Nachusa and an additional Illinois site where bison are not a concern; these two sites are the only currently known locations of this species in Illinois. This will help managers understand more about the ecology and needs of this regionally rare plant species, continue to protect the last two known remaining populations in the state, and support future initiatives to reintroduce *P. incarnata* at other sites. Continued germination work with *P. incarnata* may provide information about the percent germination that can be expected from seed, to better know how much seed can be collected from the host population, how much is needed to expect germination at a new site, and what seed preparation techniques will maximize germination.

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