Species and Functional Trait Diversity Across Soil Nutrient Gradients

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Introduction:

The open oak ecosystems of the Midwestern United States have been largely degraded and destroyed due to shifts in land use, the suppression of fires, and the establishment of invasive species. There has been a great effort in restoration practices as only 0.02% of the original extant remains, essentially all of which has been degraded. In this study, soil nutrient gradients from the open oak ecosystems from the Midwest were evaluated. The gradient concentrations of ammonium, nitrate, and phosphate can serve as an indicator of competition over resources in each ecosystem. As a healthy ecosystem is not limited in essential resources such as soil nutrients, and nutrients are essential for optimal plant functioning, access to these resources may alter the overall diversity and functional traits of plants. This can have an effect on overall ecosystem quality. Functional traits are the morphological, physiological, and phenological characteristics of plants. The purpose of this research is to see if species diversity and functional traits, such as Specific Leaf Area (SLA) which morphological, leaf nitrogen concentration which is a physiological trait, and seed mass, a phenological trait vary across soil nutrient gradients in ongoing restoration projects in open oak ecosystems in the Midwestern United States.

Figure 5: Transect

Figure 6: Plot

Hypothesis:

Along soil nutrient gradients, the functional traits and environment quality will change. Where higher resource availability is found, leaf nitrogen content, specific leaf area and native species richness are likely to be higher. In areas with lower resource availability, it is likely that seed mass will be higher.

Methods:

- Data was collected from 210 m^2 plots from 7 restoration sites that were surveyed in 2021, where all species were identified, and their abundances recorded as percent cover.
- Around 20% of the trait data from this study came from the measurements collected in the field and measured in the lab. The supplemental data was collected from a functional trait database for plant species in Northeastern North America
- Analyzed soil nutrient data (ammonium NH_4, nitrate NO_3, and phosphate PO_4) from every other plot (105 total)
- Weighed, grinded, and prepared leaf tissue from 42 different species from the open oak ecosystem communities from the 210 m^2 plots surveyed from the 7 restoration sites in this study to prepare samples for carbon and nitrogen content.
- Community-weighted mean (CWM) values were calculated for all plots using functional trait and abundance data.

Figure 1: Somme woods

Figure 2: Black Eyed Susan

Figure 3: Somme Woods

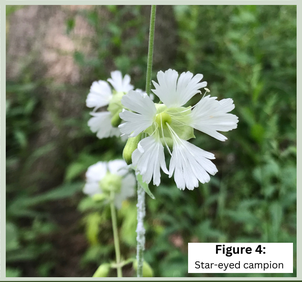
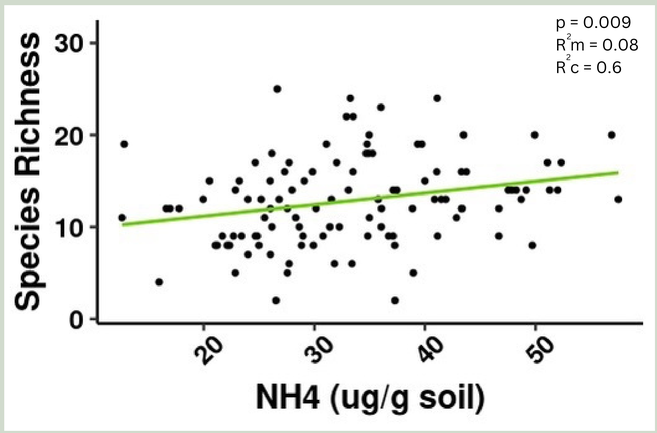
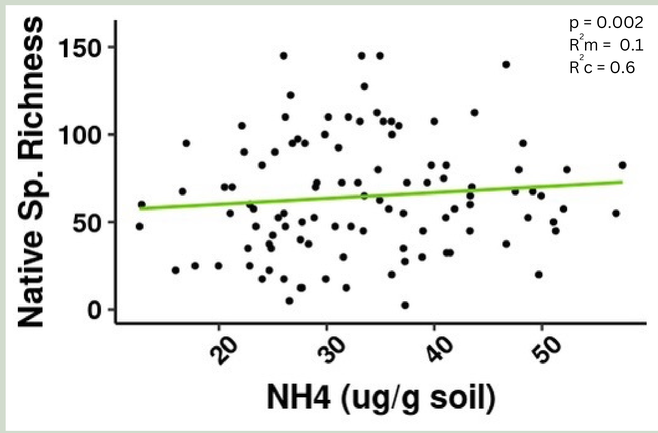
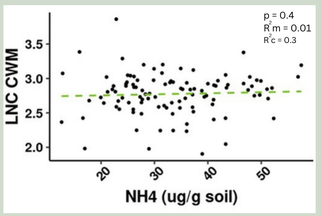


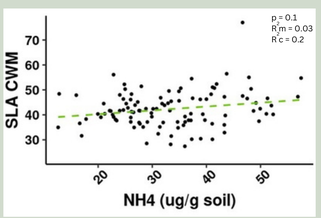
Figure 4: Star-eyed campion

Results:









Discussion & Conclusion:

Significant results were found between the correlation of soil ammonium (NH_4) concentrations and both species richness and native species richness within the plots analyzed for this study. No statistically significant results were found for the correlation between soil ammonium concentrations and any of the functional traits from this study (Specific Leaf Area, seed mass, and Leaf Nitrogen Concentration). Nitrate and Phosphate (NO_3 and PO_4 respectively) were not found to have any significant results for either richness nor any functional trait analyzed. Thus ammonium is a more important resource for this ecosystem than nitrate and phosphate. However, as there were no significant correlations between any soil nutrient and functional trait, it is likely that other abiotic filters, such as light and water, have a larger influence in shaping open oak ecosystems, and is being studied by other members of the ecology lab at the Chicago Botanic Garden.

Citations:

Garnier, E., & Navas, M.-L. (2011). A trait-based approach to comparative functional plant ecology: Concepts, methods and applications for agroecology. A Review. Agronomy for Sustainable Development, 32(2), 365–399. https://doi.org/10.1007/s13593-011-0036-y.

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Acknowledgements: Chicago Botanic Garden, Teagan LeVar, Edgar Sanchez, and we’d like to thank NSF-REU grant DBI-1757800 for support.

Figure 7: Turnbull Woods