Plant Diversity and Soil Quality in a Prairie Restoration

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Introduction

- Plant diversity and soil quality are critical concerns for successful prairie restoration, but linkages between them are seldom explored.
- Plant diversity may improve soil quality by increasing soil C storage (Yang et al., 2019).
- We hypothesize that soil quality will be greater with greater plant diversity and we explore which soil quality properties are most impacted by plant diversity in an experimental prairie.

Methods

- An experimental prairie was created in 2015 (Figure 1). The prairie included three levels of plant diversity (high, medium, and low) on 454 plots (1 m^2). The prairie was weeded and burned for five years.

Figure 1. Aerial photograph of the experimental prairie at The Morton Arboretum in Lisle, IL USA.

- In 2020, intact soil cores (2.5 cm diameter) were taken from each plot to a 1-m depth. Soil pedons were described following standard soil description protocols (Schoenberger et al., 2012).
- Five properties were assessed to compute a soil quality index (SQI):
  (1) depth of surface organic enrichment or the mollic epipedon
  (2) color of the mollic epipedon (Munsell value and chroma)
  (3) structure type and grade of the mollic epipedon
  (4) depth to redoximorphic concentrations
  (5) depth to redoximorphic depletions
- Each measured property was scored (0-1) with a soil quality scoring function. A weight for each property was assigned related to the relative importance of that property for soil quality. A soil quality index (SQI) was computed for each pedon:
  SQI = mollic depth (0.5) + structure (0.2) + color (0.2) + concentrations (0.03) + depletions (0.07)
- An ANOVA was conducted to test if SQI differed by plant diversity. Means were tested with Tukey-Kramer mean separation test.

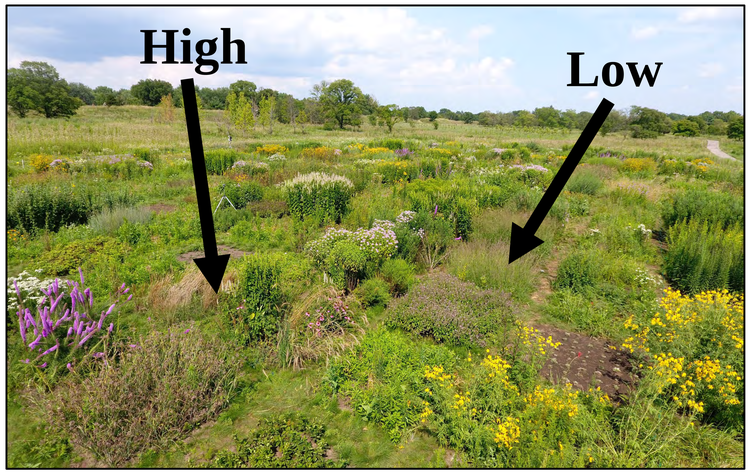


Figure 2. High and low plant diversity plots.

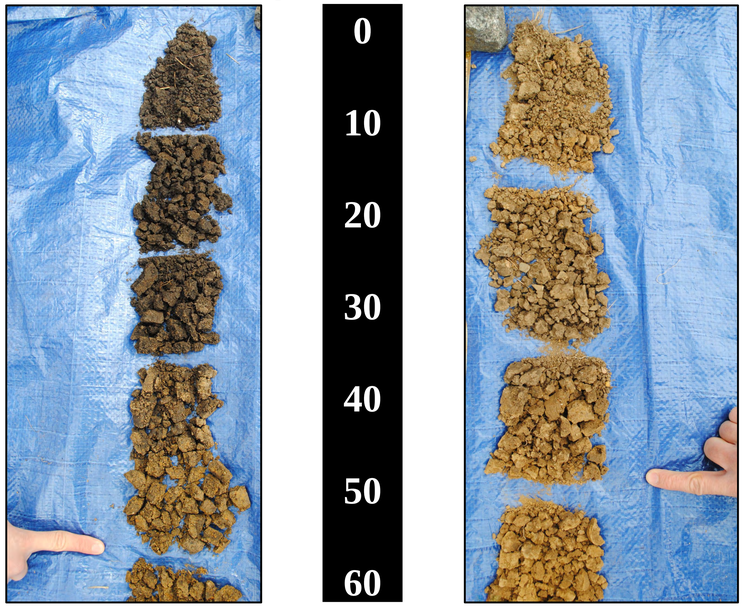


Figure 3 and 4. Soils from high (L) and low (R) plant diversity plots.

Property	High	
	Value	Score
Depth	55 cm	0.71
Structure	GR-3	0.92
Color	10YR 3/2	0.85
Conc.	100 cm	0.95
Depl.	120 cm	1.00
SQI = 0.81		

Property	Low	
	Value	Score
Depth	48 cm	0.35
Structure	SBK-2	0.55
Color	10YR 4/3	0.23
Conc.	60 cm	0.45
Depl.	80 cm	0.50
SQI = 0.34		

Table 1 and 2. Examples of soil values, scores, and SQIs.

Results

Figure 5. Soil quality index by high (H), medium (M), and low (L) levels of plant diversity.

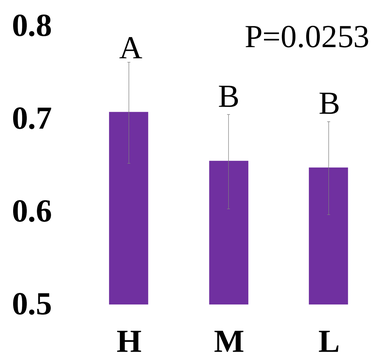
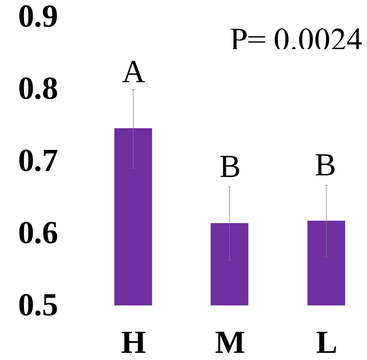


Figure 6. Mollic depth score by high (H), medium (M), and low (L) levels of plant diversity.



- The SQI and depth of the mollic epipedon were significantly greater with high compared to medium and low plant diversity plots (Figures 5 and 6).
- Our hypothesis was supported that soil quality was greater with greater plant diversity (Figure 5).
- The property within our SQI that was most impacted by plant diversity was the depth of the mollic epipedon (Figure 6).

Conclusion

- The depth of the mollic epipedon appears to be the most impacted soil property by plant diversity.
- Deeper mollic epipedons indicate greater soil C storage, thus prairie restorations targeting greater plant diversity might also increase C sequestration.

References

- Yang, Y., Tilman, D., Furey, G., & Lehman, C. (2019). Soil carbon sequestration accelerated by restoration of grassland biodiversity. *Nature Communications*, 10(718).
- Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and Soil Survey Staff. 2012. Field book for describing and sampling soils, Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

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