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THE MEASURE OF NEMATODE DIVERSITY IN RESPONSE TO VARYING MANAGEMENT PRACTICES AND FEATURES IN RESTORED AND REMNANT PRAIRIE ECOSYSTEMS

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Environmental Studies Program

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Introduction:

"Tallgrass prairies are the most endangered ecosystem in North America" (Helen et al 2013). "Surveys suggest that since European settlement, declines in area of native prairie range as high as 99.9%"(Sampson, Fred and Fritz Knopf 1994).

Prairie ecosystem services:

- Seed dispersal
- Drought/flood mitigation
- Maintain biodiversity
- Wildlife habitat
- Generate/preserve soils
- Carbon intake
- Control agricultural pests
- Recreation/ aesthetics
- Regulate invasives
- Nutrient cycling
- Detoxify waste
- Protect watersheds

(USDA Forest Service).

Given these benefits, restoring prairies and maintaining native areas should be an important conservation priority.

Evaluating the success of a prairie restoration may be more complex than it seems. Most prairie assessments include evaluative measurements using the Floristic Quality Index, Shannon's and Simpson's Diversity Indexes, frequency of woody cover, closeness to other prairies, and other above ground metrics (James and DeBacker 2007). Should we be concerned with the diversity belowground? Nematodes, the most abundant animal species on earth, have been used as bio-indicators of soil quality (Neher; Todd). To better understand the dynamics of nematode diversity in native and restored prairies we examine the following question: Is there a relationship between age of a restored prairie and belowground nematode diversity?

Objective:

The purpose of this research is to assess the changes in soil nematode communities following an initial effort to restore tallgrass prairies.

Methods:

Four tallgrass prairie sites were chosen in Lancaster County with differing features in ecology and management:

A. **Homestead National Monument –the second oldest restored prairie in North America.**
B. **Spring Creek Prairie – an Audubon site with native, restored, and degraded prairie.**
C. **Prairie Pines – a privately owned prairie with restored and native prairie.**
D. **Nine-Mile Prairie- one of the largest remnants of Central Tallgrass Prairie.**

Field Sampling:

1. 40x40m grids were established within the prairie using hand held GPS devices.
2. Soil was sampled using a Oakfield tube corer, extracting a 20cm deep core every 10 steps across the grid until 500cc of soil was obtained (Neher 2001).
3. Cores were mixed in a bucket, placed in plastic sampling bags, and stored in a cold room until analysis.

Lab Analysis:

1. Nematodes were isolated from the soil using a modified flotation, sieving, and centrifugation method (Jenkins 1964).
2. Total nematode numbers and number of nematodes in the plant parasitic family Criconematidae were counted using a dissecting stereo-microscope.
3. Nematodes were identified morphologically and molecularly.
4. The Criconematidae were subjected to a high–resolution DNA barcode sequence analysis to determine the number of nematode lineages and haplotypes (genotypes) (Powers et al. 2014).
5. Haplotype diversity is calculated using the following formula:

$$H = \frac{N}{N-1}\left(1 - \sum_i x_i^2\right)$$

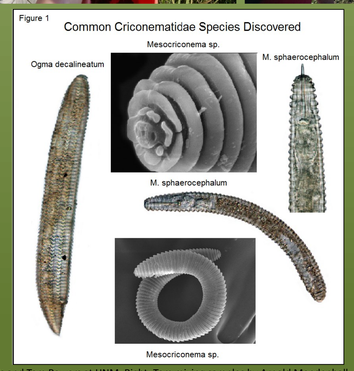
Research Data Table 1

Prairie	Site Description			Total # Different Species	Frequency of Haplotypes (Xi)	Haplotype Diversity H=N(1-ΣXi2)/N-1	Restored(orange) vs. Native (green) (Averaged H)
	Type of Site	Year Type of Management Began	Years since Disturbance	N	ΣXi	H	Haplotype Diveristy Avg,
Homestead National Monument	Restored	1939	76	5	0.52	0.60	0.38
Homestead National Monument	Restored	1939	76	1	1	0.00	
Homestead National Monument	Restored	1939	76	8	0.53	0.54	
Homestead National Monument	Native	1850	165	5	0.44	0.70	0.7
Prairie Pines Preserve	Restored	1960	55	4	0.63	0.50	0.25
Prairie Pines Preserve	Restored	1960	55	4	1	0.00	
Prairie Pines Preserve	Native	1850*	165	1	1	0.00	0.375
Prairie Pines Preserve	Native	1850*	165	8	0.34	0.75	
Spring Creek Audubon Prairie	Restored	2007	8	0	0	0.00	0
Spring Creek Audubon Prairie	Restored	2007	8	0	0	0.00	
Spring Creek Audubon Prairie	Native	1850*	165	7	0.31	0.81	0.495
Spring Creek Audubon Prairie	Native	1850*	165	11	0.83	0.18	
Nine-Mile Prairie	Restored	1945	70	5	0.44	0.70	0.7
Nine-Mile Prairie	Native	1850*	165	7	0.22	0.90	0.84
Nine-Mile Prairie	Native	1850*	165	12	0.37	0.68	
Nine-Mile Prairie	Native	1850*	165	9	0.23	0.86	
Nine-Mile Prairie	Native	1850*	165	8	0.22	0.89	
Nine-Mile Prairie	Native	1850*	165	11	0.21	0.87	
Nine-Mile Prairie	Native	1850*	165	10	0.24	0.84	

Homestead National Monument: Native site by old school house

Left: Tom Powers and I taking soil cores at HNM Right: Selfie at HNM

Figure 1

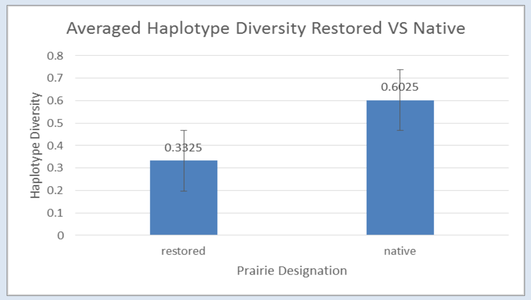


Left: Kris and Tom Powers at HNM. Right: Tom mixing samples by Arnold Mendenhall at SCP

Sampling at Prairie Pines. Left to right: Me, Maggie Olson, Katie Mccollum

Results:

Figure 2.
When comparing total averages for nematode haplotype diversity between restored and native sites, there is a higher average diversity seen in native sites, with error bars overlapping to a small degree.



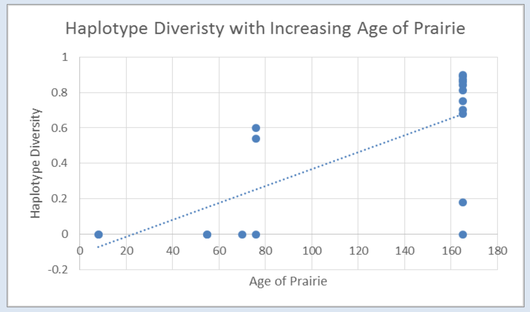
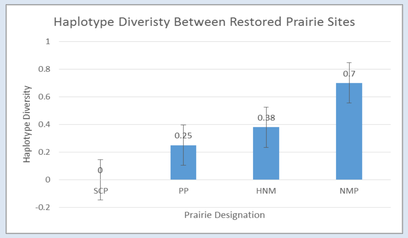


Figure 3.
A positively sloping trend line is seen when comparing haplotype diversity with prairie age. Each prairie site had at least one sample that had no haplotype diversity.

Figure 4.
This graph describes differing haplotype diversity between restored prairie sites. If criconematid diversity reflects restoration success of a prairie, then the restored section of Nine Mile Prairie (Section C) , would be considered the most successful restoration.



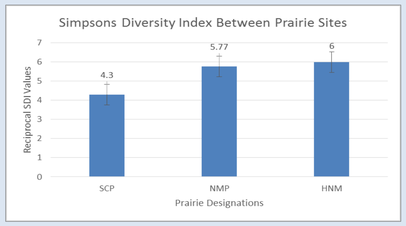


Figure 5.
This graph describes the estimated plant diversity using Simpsons Diversity Index (SDI) between three of the prairie sites. Prairie Pines lacks this evaluation.

Data from: James and Debacker 2007, and Kottas, Kay 2001

Discussion/Conclusions

This study presents evidence that there is a relationship between nematode diversity and the age of a restored prairie. As shown in Figure 2, there is a positive trend of haplotype diversity of criconematid nematodes and increasing age of the prairie restoration. Figure 1 indicated that on an average native prairies have more nematode diversity than restored prairies. Age of restoration, however, may not be the only factor influencing nematode diversity. Figure 5 suggests that plant diversity may also be correlated with nematode haplotype diversity. What is clear in this study is that restorations less than 10 years old and prairies converted to agricultural ecosystems have no diversity and generally no criconematid nematodes.

Not examined in this study was the role of proximity to a native prairie source in restoration success. All of these prairies except Homestead National Monument had restored prairies adjacent to native sites. However, Homestead prairie included sod from native prairie in their restoration, a factor that most likely enhances nematode diversity. More research is necessary to disentangle all the interacting factors that influence belowground nematode diversity in prairie restorations.

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