The Effect of Fire on Spider Assemblages in Central Indiana Forests

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Introduction

The Hardwood Ecological Experiment (HEE) is comprised of multiple biological studies investigating the effects of ecosystem management techniques. Controlled burns are often used in ecosystem management schemes to restart succession; these disturbances may allow for new organisms to establish themselves into a niche in the ecosystem (Drever et al., 2006). However, these burns may kill already established organisms and may change the taxonomic makeup of communities. Moreover, communities will take time to recover from such a disturbance and return to their pre-disturbed state (resilience). The strength of resilience may change depending on the organisms being studied. **In order to measure the impact that fire has on the abundance, diversity, and taxonomic composition of spider assemblages over time (resilience), we collected and identified thousands of spiders from burned and unburned sites at Morgan-Monroe State Forest and Yellowwood State Forest over the past four years.**

Methods

Collection

Time: 23 collection dates between 1/2015 – 3/2019. None in Nov-Dec.
Location of sites: Six sites in Morgan-Monroe State Forest and 18 sites in Yellowwood State Forest
Methods of Capture:

- Sweep netting in between each site (3x/year)
- Leaf-litter collection & Berlese funnels for extraction (5x/year)
- Pitfall traps (2 per site; 5x/year)

Burning

- All sites remained unburned for at least 1 year prior to burning.
- Sites were burned with help from IDNR on a staggered schedule.

Identification

- Identified all adult spiders to species using Ubick et al. (2005), World Spider Catalog (2019), and hundreds of associated species keys.

Statistical Analysis

T-tests (in R):

- Compared abundance in burned vs unburned sites.
- Compared Shannon Diversity Index in burned vs unburned sites.

Non-metric Multidimensional Scaling Analysis (NMDS) (in R):

- Compared taxonomic makeup of spider assemblage in three community types: unburned, 0 - 1 years after burn, and 1 – 2 years after burn.

Results

- We captured and identified 5,188 spiders between 2015 – 2018.
- **Most abundant taxonomic families**: Thomisidae, Salticidae, Phrurolithidae, Linyphiidae, and Araneidae (**Fig. 1**)
- **Most abundant Species:** *Phrurotimpus alarius* (**Fig. 2**) and *Tapinocyba emertoni* (**Fig. 3**)
- **T-test (abundance) in burned vs unburned**:
  - Unburned sites were significantly more abundant in spiders than burned sites (t_{43}=2.97, p<.0001; **Fig. 4**).
- **T-test (Shannon Diversity Indices) in burned vs unburned:**
  - There was no statistically significant difference between burned and unburned sites (t_{13}=.7627, p<.4592; **Fig 5**).

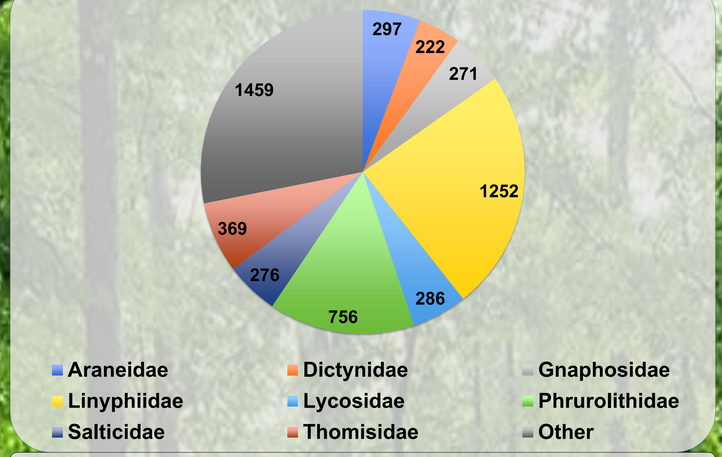

Figure 1: Relative abundance of families

Figure 2: *Phrurotimpus alarius*

Figure 3: *Tapinocyba emertoni*

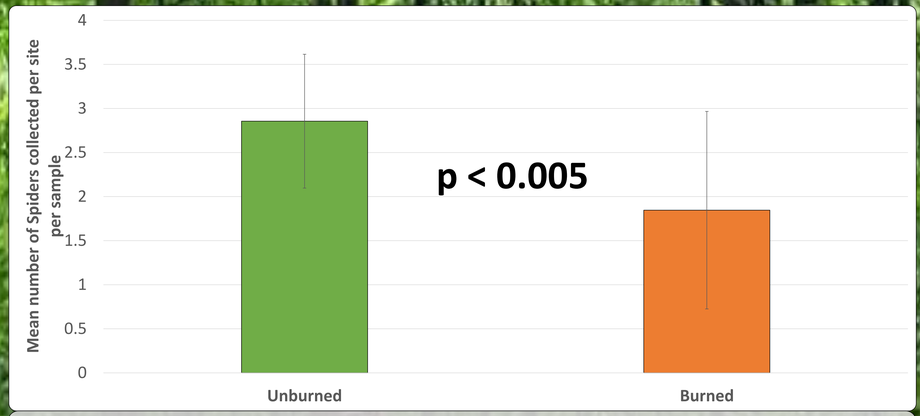

Figure 4: Comparison of the mean number of spiders collected per sample between burned and unburned sites.

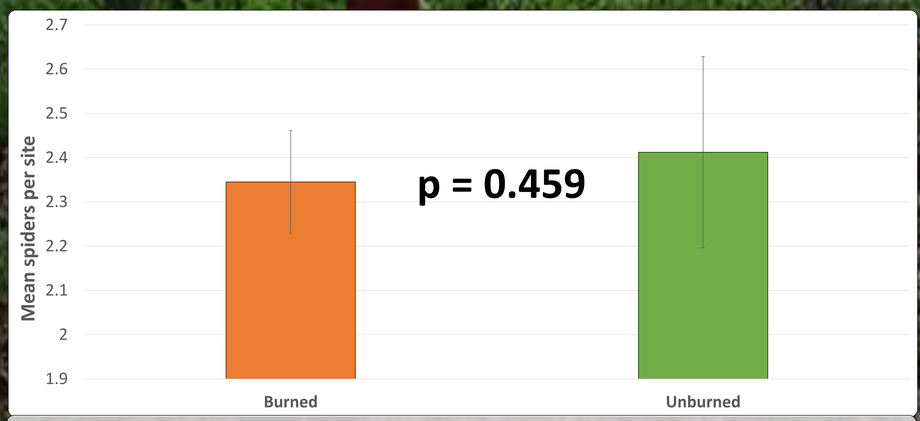

Figure 5: Comparison of the Shannon Diversity Indices between burned and unburned sites

Results (cont.)

NMDS of unburned, recently (0 – 1 years), and distantly burned (1 – 2 years) sites:

- There was a statistically significant difference ($F_{2,20}$= 12.75, p<0.0001) among the spider assemblages at each site type (**Fig. 6**).

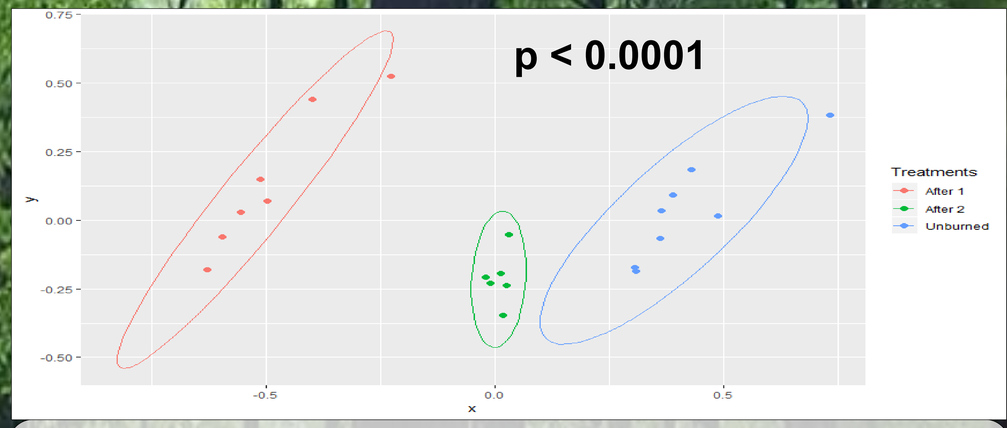

Figure 6: NMDS of spider assemblages within burned and unburned sites; **BLUE = Spider assemblages in unburned sites**; **RED = Spider assemblages in sites burned between 0 – 1 years ago**; **GREEN = Spider assemblages in sites burned between 1 – 2 years ago.**

Conclusions

- Our study found that, over the short-term, spider abundance is negatively affected by fire. However, the general diversity (Shannon-Index) of spider communities is not significaty affected.
- More imporantly, we observed that spider assemblages quickly recovered from the negative impacts of fire, even after only two years (Figure 6). Although not a complete recovery, our data demonstrate that these spider communities are resilient.
- We will continue to monitor the abundance, diversity, and taxonomic composition of spider assemblages in reaction to low-level disturbances. We hope to then create models that can help predict the recovery time resulting from such disturbances. These data may then be used to aid state and federally-run departments and conservation agencies in managing ecosystems of state parks and forests.

Literature Cited

Drever R, Peterson G, Messier C, Bergeron Y, Flannigan M. 2006. Can forest management based on natural disturbances maintain ecological resilience? Canadian Journal of Forest Research 36(9): 2285-2299.

Ubick, D., P. Paquin, P.E. Cushing & V. Roth (Eds.). 2005. Spiders of North America: An Identification Manual. American Arachnological Society, Keene, New Hampshire. 377 pp.

World Spider Catalog. 2019. World Spider Catalog, Version 20.0. Natural History Museum Bern, Switzerland. At: http://wsc.nmbe.ch (Accessed 25 March 2019).

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