

Re-kindling old flames: Investigating fire effects on plant reproduction in fragmented tallgrass prairie

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Abstract

Fire stimulates flowering in many herbaceous plant species across fire-dependent ecosystems worldwide, including North American tallgrass prairie. Synchronized reproduction after fire can increase mating opportunities, improve pollination, and contribute to greater seed production in prairie plants like *Echinacea angustifolia* and *Liatris aspera*. Yet, it remains unclear whether the reproductive benefits of fire are consistent among species and across plant populations varying in population size or density. We are conducting a multi-year, landscape-scale experiment to investigate how fire affects multiple components of plant reproduction. Our experiment includes 34 patches of remnant tallgrass prairie in western MN ranging from less than 0.1 acre to more than 100 acres in size. We are experimentally burning patches and quantifying reproductive effort, pollination, seed predation, and total seed production in six perennial plant species: *Andropogon gerardii* (big bluestem), *Asclepias viridiflora* (green milkweed), *Echinacea angustifolia* (narrow-leaved purple coneflower), *Hesperostipa spartea* (porcupine grass), *Liatris aspera* (rough blazing star), and *Lilium philadelphicum* (wood lily). Spring burns increased reproductive effort in all species except *Lilium*. The flowering density of lilies peaked two years after fire. Early results from *Echinacea* and *Liatris* suggest fire improves mating opportunities and pollination across plant populations of varying sizes. Even the smallest *Echinacea* population with just four adult plants experienced improved pollination and saw seed set nearly double after fire. Although the work is ongoing, our research will offer new insights into the density-dependent effects of fire on multiple stages of plant reproduction.



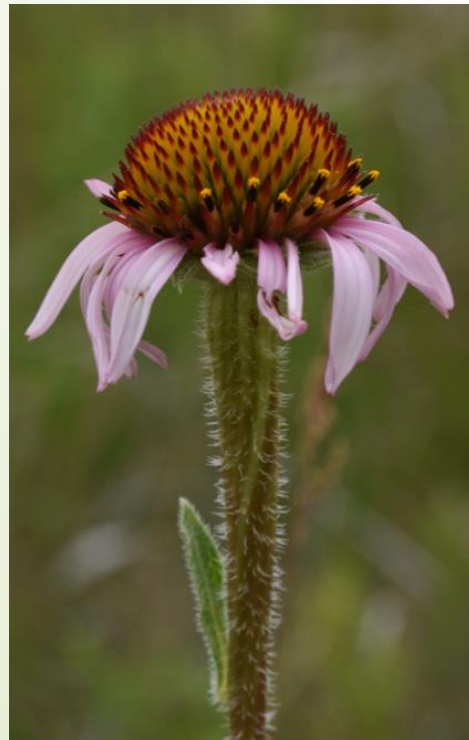
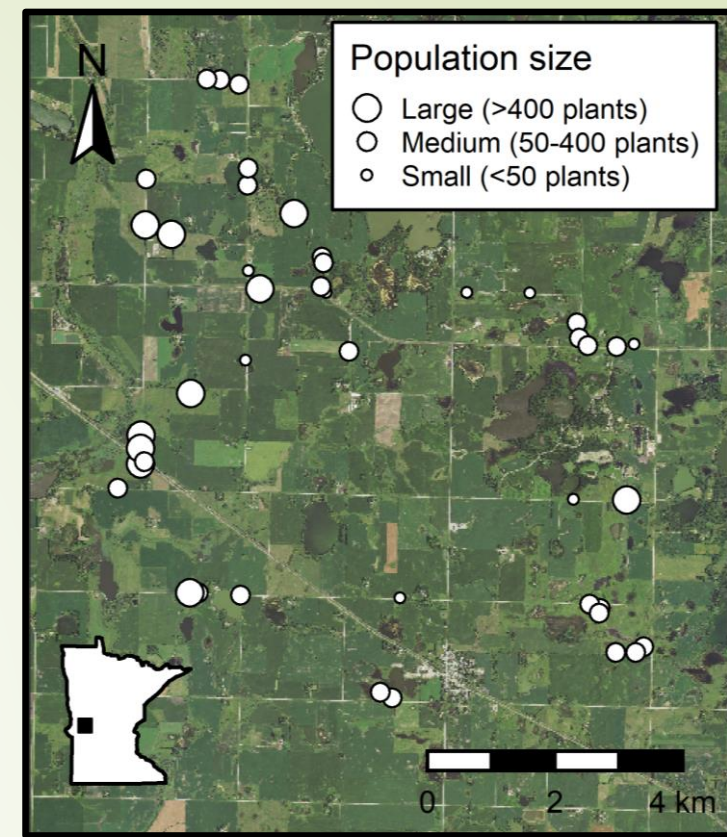
Background

- Fire stimulates flowering in many prairie plant species
- Synchronized reproduction after fire may improve seed production by increasing mating opportunities and improving pollination
- Successful reproduction is necessary for plant population growth and persistence
- Research questions:
 - How do the effects of fire on plant reproduction vary among populations?
 - To what extent do fire effects on reproductive effort and pollination vary among plant species?



Study location

- 25 square mile region of western Minnesota
- Our study focuses on 34 prairie remnants varying from <0.1 acres to > 100 acres in area
- Narrow-leaved purple coneflower (*Echinacea angustifolia*) has served as our model



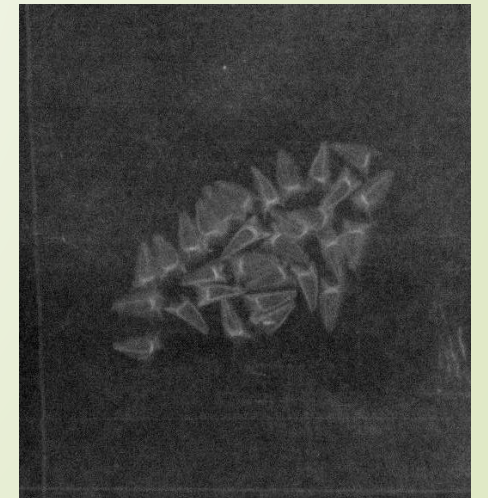
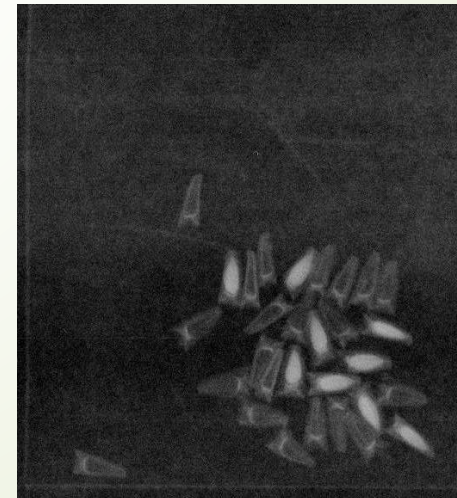
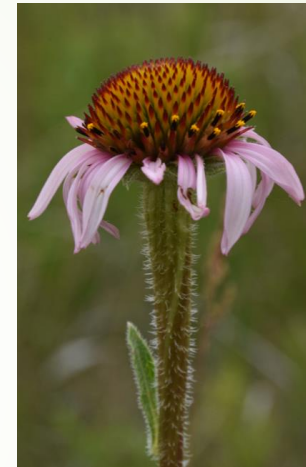
Experimental design

- ▶ We are experimentally burning remnant patches varying in area & Echinacea population size
 - ▶ 11 prairie patches were burned in spring 2021
 - ▶ 9 additional patches will be burned in spring 2022
 - ▶ 14 patches will remain unburned

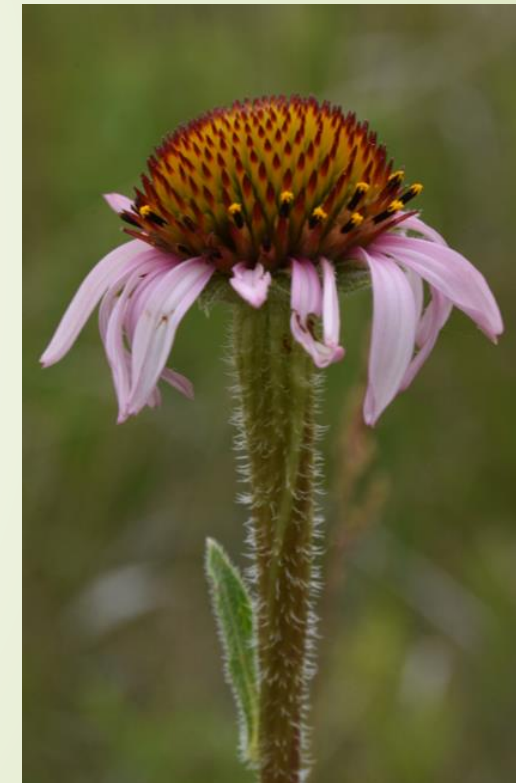
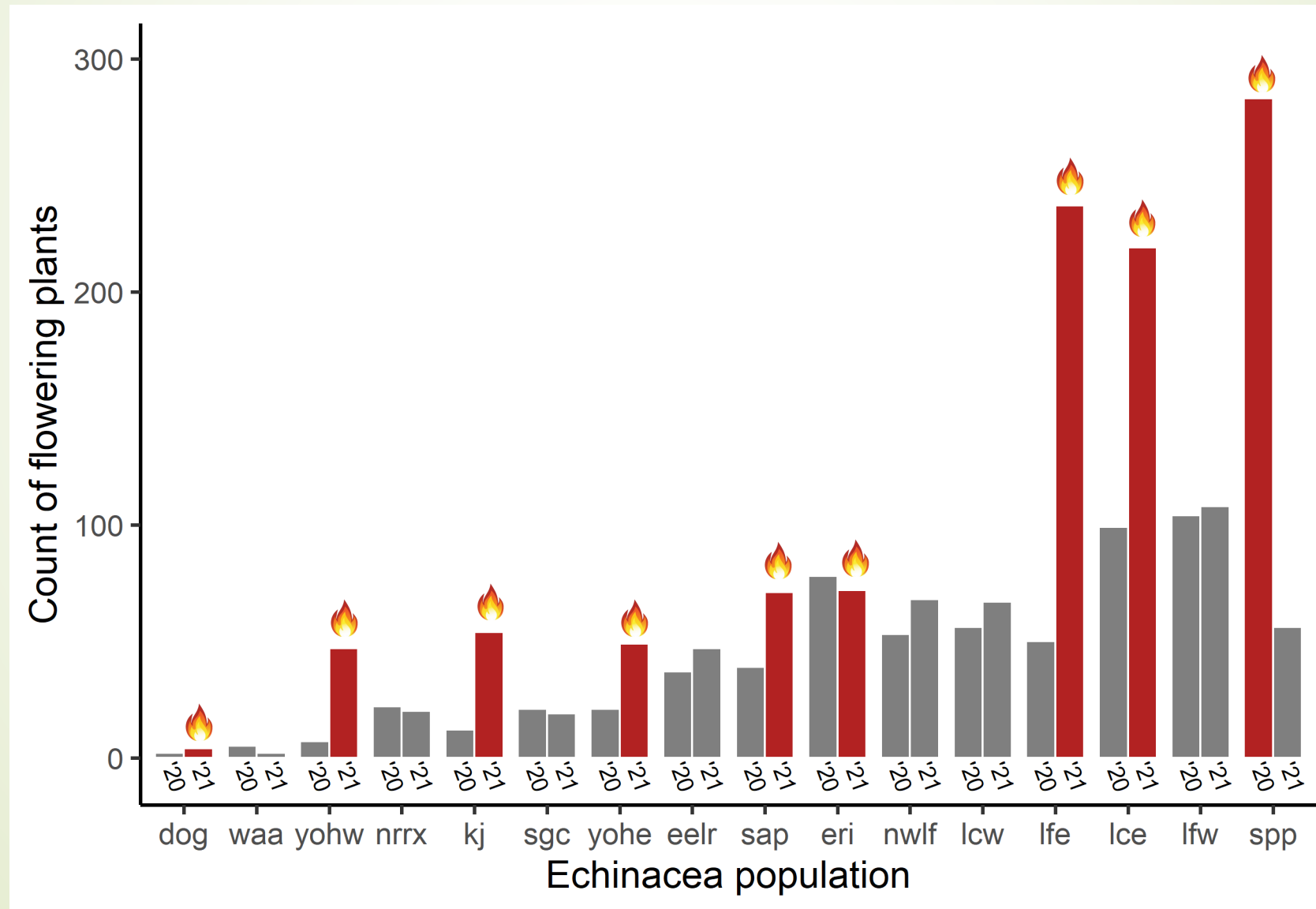


Quantifying reproductive allocation and outcomes in *Echinacea angustifolia*

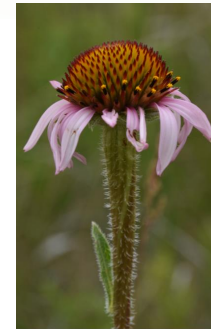
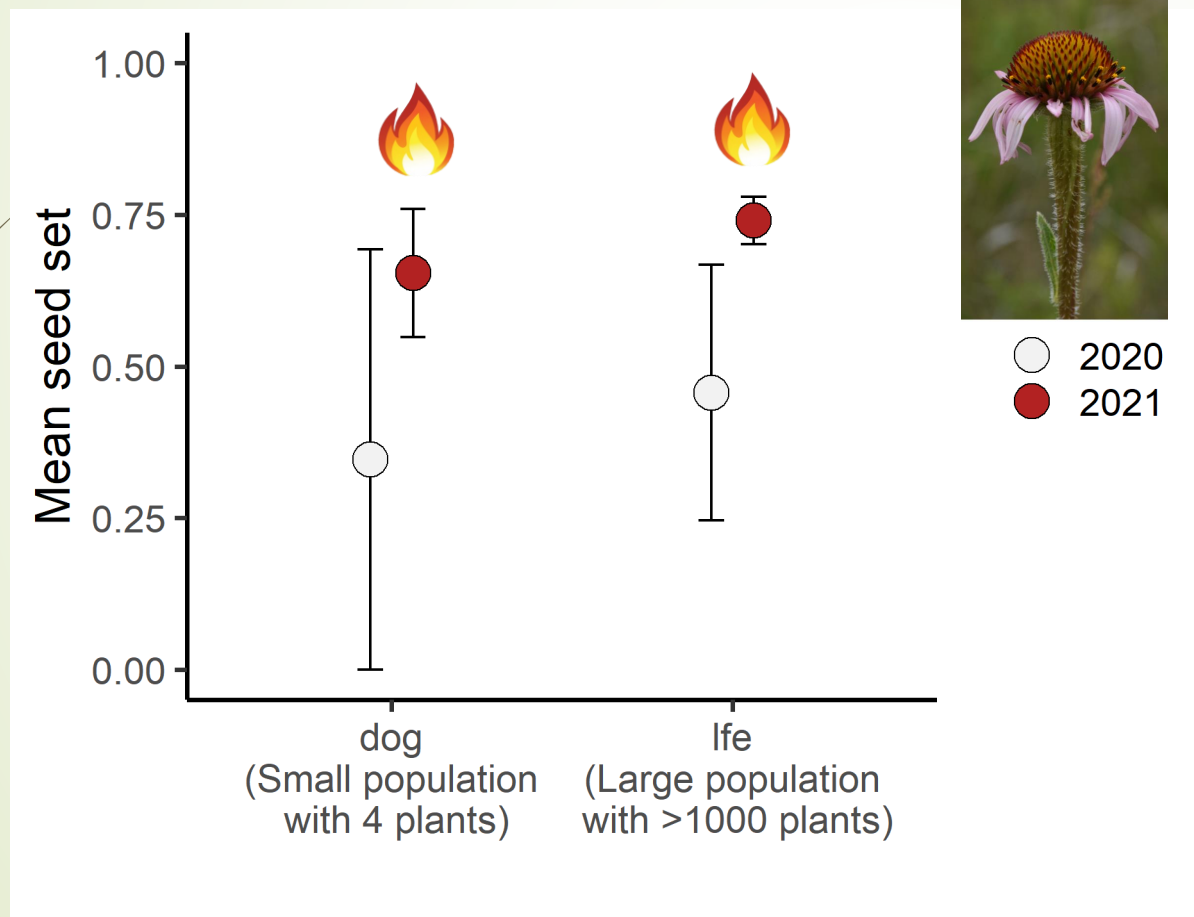
- ▶ Reproductive allocation (density of flowering plants and number of flowers)
 - ▶ We map location of flowering plants
 - ▶ Record number of flowering heads
- ▶ Reproductive outcomes (pollination and seed production)
 - ▶ Reproductive failure is common among prairie plant species
 - ▶ We X-ray a random sample of fruits to determine proportion of fruits that receive pollen and contain embryos (seed set)



Fire stimulates flowering across *Echinacea* populations of varying sizes



Fire improves pollination and seed production in small and large populations



○ 2020
● 2021

- Preliminary data reveals seed set (proportion of fruits containing embryo) increased after fire in a large population (>1000 total individuals) and tends to do the same in a small population (just 4 individuals)
- We continue to process seed heads collected in 2020 and 2021 to learn if this patterns holds across all populations

What about other species?

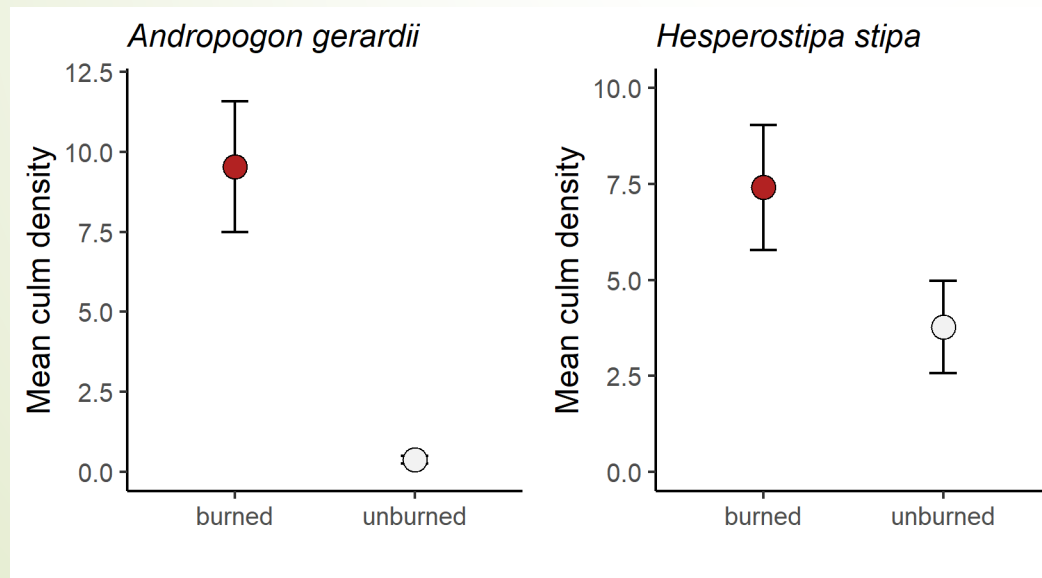
- Does fire have similar benefits for pollination and seed production for other prairie species?
- We are investigating fire effects on reproductive effort and outcomes in five additional plant species
- Stay tuned for results!



A. gerardii



H. spartea



A. viridiflora



L. aspera



L. philadelphicum

Conclusion

- Synchronized flowering after fire can improve pollination, leading to greater seed production
- Preliminary data suggest these benefits apply to very small plant populations where mating opportunities are severely limited, and plants often fail to produce seed
- Fire may be an important tool for improving reproduction and promoting the persistence of fragmented prairie plant populations
- Our ongoing research will reveal how the reproductive benefits of fire vary among populations and plant species in a fragmented prairie landscape





For more information

- To learn more about this research and related projects, please visit the Echinacea Project webpage:
www.echinaceaproject.org/fire
- Please contact Jared via email with questions or for more information:
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investigating ecology and evolution in fragmented prairie habitat since 1995