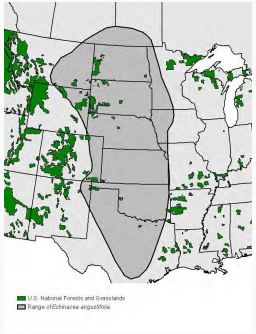
Burn Effects on Echinacea Achene Production and Pollination: Should Have Seed it Coming

By Caitlin McWilliams, in collaboration with The Echinacea Project

What, Where, Why

- Studying Echinacea angustifolia
- Located across midwestern/southern area

Echinacea angustifolia location



Source: *One Hundred Years of Echinacea angustifolia Harvest in the Smoky Hills of Kansas, USA*

- Area of study for Echinacea Project's 2020 paper: **western MN**

Recent Data

In 2020 (after the paper), field work focus shifted from one site in western MN to multiple

✚

In 2021, some of those sites were burned

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Random samples of Echinacea angustifolia in 2020 and 2021 at multiple sites, some of which were burned

What We Know From Related Studies

Fire often increases abundance and richness of flowers and understory plant species

⇨ *The Effects of Thirteen Years of Annual Prescribed Burning on a Quercus Ellipsoidalis Community in Minnesota*

- Quercus Ellipsoidalis community had a **richer understory and a decreased area and density of overstory after burning yearly** from 1965-1979

⇨ *Quantifying the short-term flowering after fire in plant communities of a cerrado grassland*

- **44% more plants flowered in burned areas** of cerrado grasslands and 20 of the species only flowered after fire

⇨ *Eight years of seasonal burning and herbicidal brush control influence sapling longleaf pine growth, understory vegetation, and the outcome of an ensuing wildfire*

- **4 burns from 1999-2005 decreased the overstory** longleaf pine height and area and kept the naturally decreasing understory vines stable

⇨ *Effects of Hardwood Reduction Techniques on Longleaf Pine Sandhill Vegetation in Northwest Florida - Provencher - 2001 - Restoration Ecology*

- **Greater herbaceous groundcover density and species richness in response to fire,** which was determined to be the best hardwood midstory reduction method

What We Know From The Echinacea Project's 2020 Paper

Echinacea Project 2020 Research Paper:

Fire synchronizes flowering and boosts reproduction in a widespread but declining prairie species

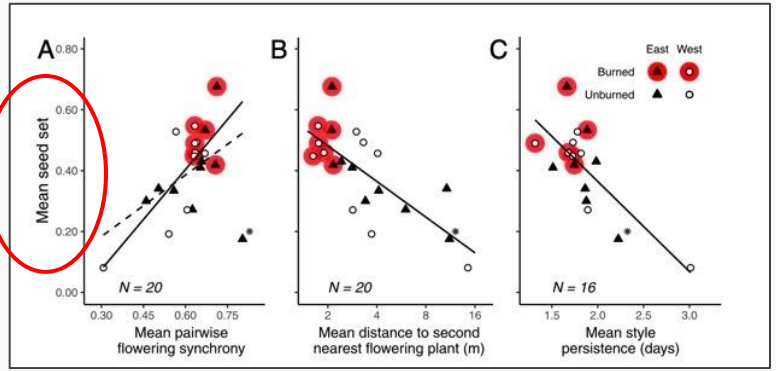
Stuart Wagenius[a,1], Jared Beck[a,b], and Gretel Kiefer[a]

[a]Negaunee Institute for Plant Conservation Science and Action, Chicago Botanic Garden, Glencoe, IL 60022; and [b]Department of Botany, University of Wisconsin–Madison, Madison, WI 53706

Edited by Susan Harrison, University of California, Davis, CA, and approved December 18, 2019 (received for review April 30, 2019)

Study Location in Staffanson Prairie Preserve

MinnesotaSeasons.org



Increase in Mean Seed Set in Burned Areas

What is Not Known

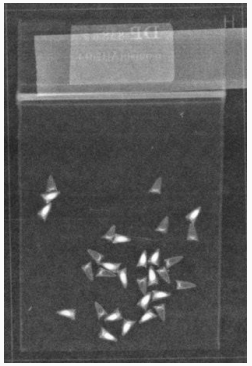
- Burn effect on sites beyond Staffanson
- Present-day data, including 2020 and 2021

I wish to determine how the **burn statuses of sites** in 2021 influence the comparison of echinacea plant **achene and seed number** between the two years

Hypothesis

Prescribed burning will be a statistically significant predictor of the number of achenes and seeds at the western MN sites in 2020 and 2021.

An Echinacea **head** that contains **achenes** between the spiky bracts



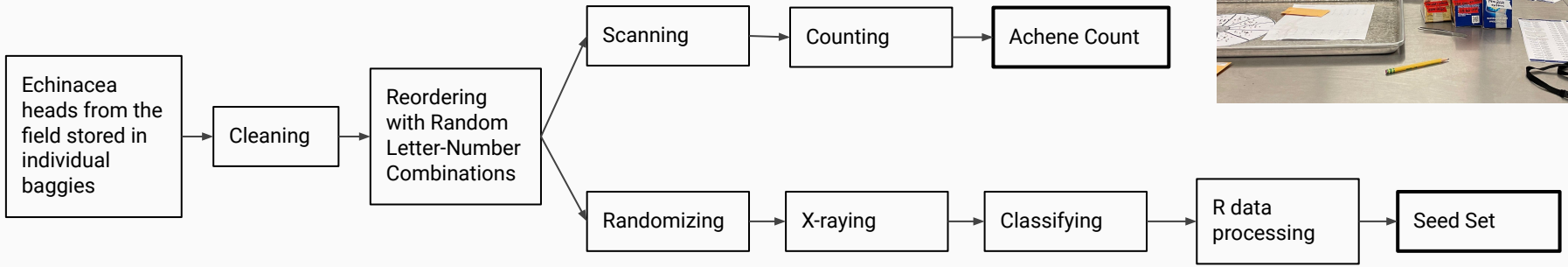
An x-ray image of Echinacea **achenes.** Those that show up more brightly were pollinated and have **seeds** in them.

Null Hypothesis: Any results indicating a burn effect will most likely be due to random sampling

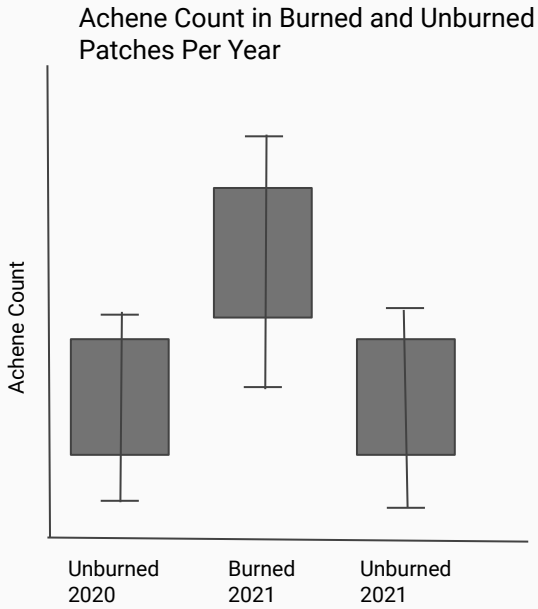
Data Source and Workflow

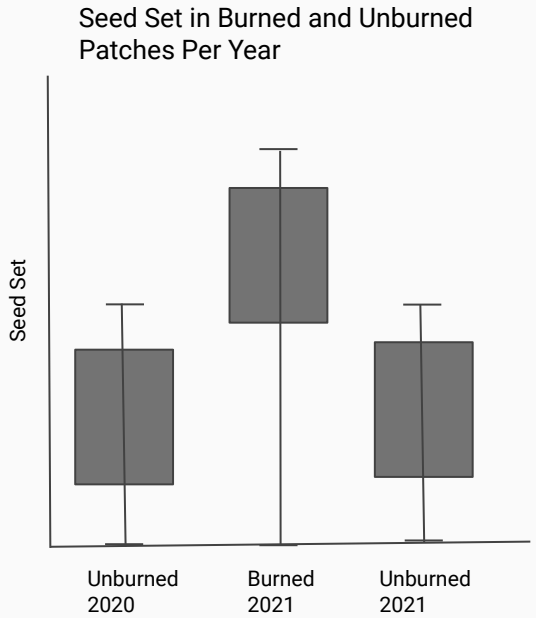
Data Source

- 50 heads randomly chosen each year from the total heads collected at 11 sites (5 of which were burned)
- In 2021, 28 burned heads and 22 unburned
- In 2020, 50 unburned heads



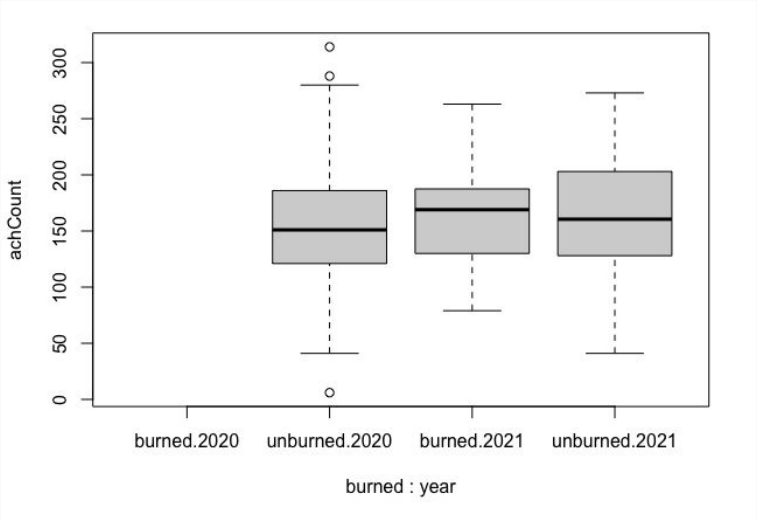
Predicted Graphs From Hypothesis





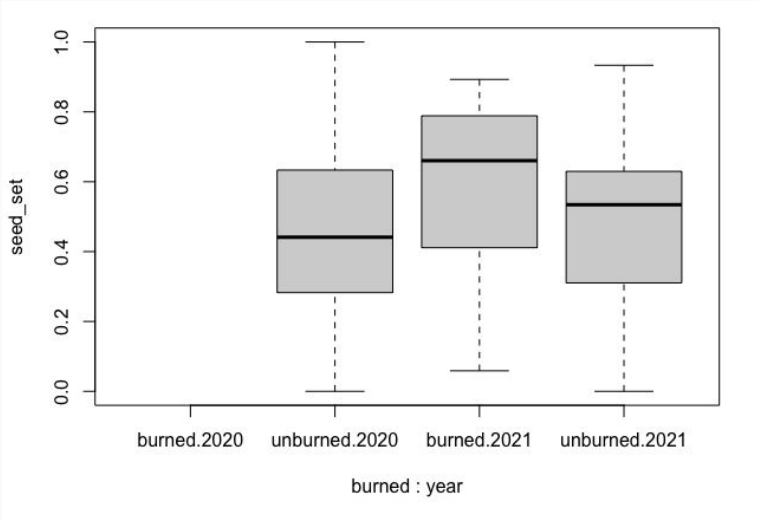
Results

Achene Count in Burned and Unburned Patches Per Year



p-value of Burned variable on achene count= 0.5046

Seed Set in Burned and Unburned Patches Per Year



p-value of Burned variable on seed set = 0.03751

P Values Between Variables

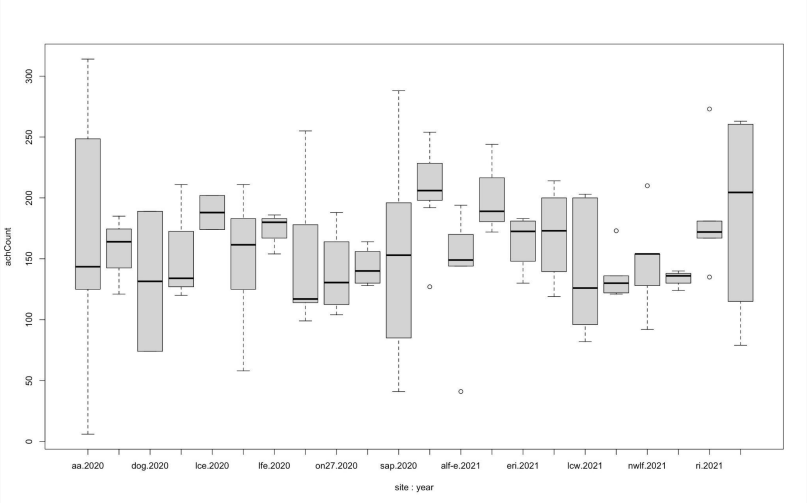
Effectiveness of Different Variables at Predicting Achene Count and Seed Set?

Variable	P Value for Achene Count	**Statistically Significant for Predicting Achene Count?**	P Value for Seed Set	**Statistically Significant for Predicting Seed Set?**
Site	0.8234	**No**	0.0017	**Yes**
Year	0.424	**No**	0.158	**No**
Burn	0.5046	**No**	0.03751	**Yes**

This shows that there is statistically significant effect on seed set from different sites and whether the 2021 sites were burned or not. Therefore, there is a **burn effect on seed set** and a difference should be seen in the seed sets of the sites that were burned in 2021 and those that were not. However, because there is also an **effect on seed set from the individual sites** themselves, it would be more conclusive to examine each site individually for seed set than an average of them.

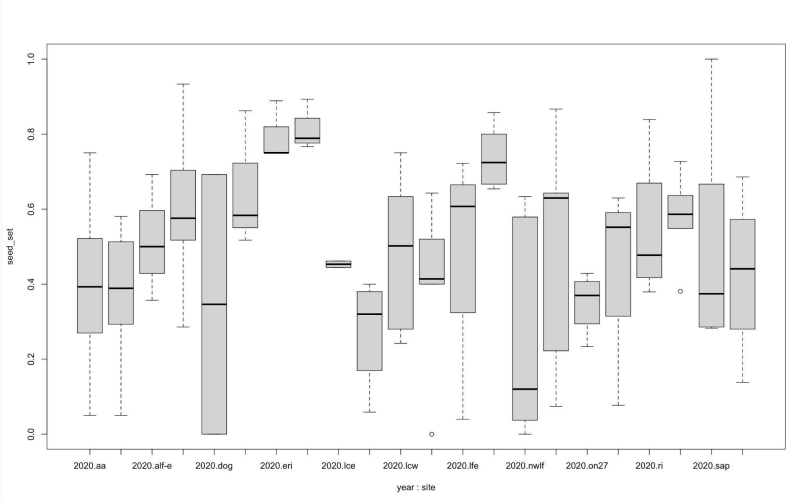
Additional Results Per Site Per Year

Achene Count Per Site Per Year



p-value of Site variable on achene count= 0.8234

Seed Set Per Site Per Year



p-value of Site variable on seed set= 0.0017

Effect of Results on Hypotheses

- The burn effect on seed set is statistically significant, leading to a **rejection of the null hypothesis** regarding seed set**.**
- The burn effect on achene count was not statistically significant, so that aspect of the **null hypothesis cannot be rejected.**
- **In the future,** more work should be done on exploring why burning often leads to a greater seed, but not achene count. It should also be examined why sites perform so variably after a burn, and why some also experience a decrease in seed set.