Prairie fires and reproductive success of the purple coneflower

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INTRODUCTION:

- Regular fires may help maintain biodiversity and community structure of tallgrass prairies by:
  - Preventing growth of non-native plants
  - Cycling nutrients
  - Increasing reproduction by fostering flowering synchrony and mate availability
- A comprehensive understanding of the reproductive impact of fires on native prairie plants is critical to informing ecosystem management
- *Echinacea angustifolia*, the narrow-leaved purple coneflower, is common, long-lived, and flowers many times throughout its life
- **Hypothesis:** For an individual plant flowering across several years, mate availability and reproductive success will be higher in years following a burn

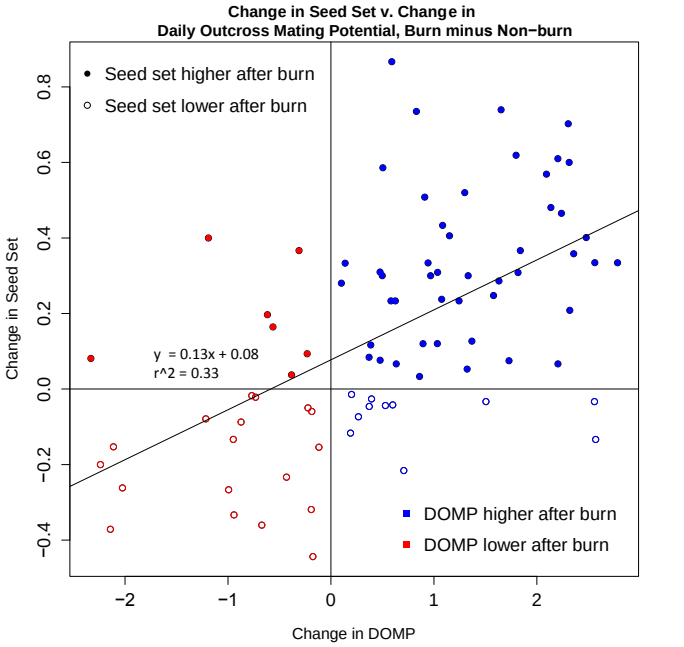
METHODS:

- Data from 58 unique *Echinacea* plants
  - Seed set—proportion of achenes containing a seed, measure of reproductive success
  - Distance to four nearest flowering neighbors
  - First and last dates of flowering
  - Each plant flowered in at least one burn year and one non-burn year between 1996 and 2015
- Daily Outcross Mating Potential (DOMP) used as measure of mate availability for each plant in each year
  - Takes into account spatial isolation and timing of flowering
- Plotted change in seed set from burn to non-burn years vs. change in DOMP from burn to non-burn years and performed linear regression to establish relationship between DOMP and seed set
  - Randomized burn and non-burn years 10,000 times and re-plotted to analyze distribution of data between quadrants along regression line

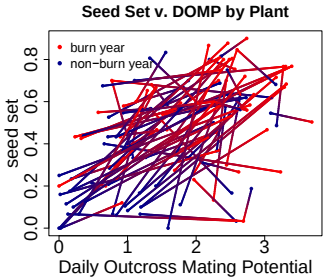
Daily outcross mating potential equation:

$$DOMP_i = \frac{\sum_{j=1}^{4} s_{ij} e^{-\gamma d_{ij}}}{total\ days\ of\ flowering}$$

i = plant of interest
j = 1 to 4 of four nearest neighbors
s = Days of coflowering between plants i and j
d = Distance between plants i and j (meters)
γ= 1/13.3 meters



	Estimate	Standard Error	p-value
Intercept	0.08	0.03	0.01
Slope	0.13	0.02	0.001



Visualization of change in DOMP and seed set: lines connect burn and non-burn years for individual plants.

RESULTS:

- As expected, an increase in daily outcross mating potential is related to an increase in seed set.
- Plants in quadrant I, shown in solid blue, had both increased DOMP and increased seed set in burn years, following the expected pattern of greater mate availability and reproductive success following a burn. Plants in quadrant III, shown in red, had decreased DOMP and decreased seed set in burn years.
- If fire had no effect on mate availability and reproductive success, we would expect that randomizing which years were burn years would have no impact on the distribution of plants between quadrants I and III. However, more plants had both increased DOMP and increased seed set than expected from random assignment of burn and non-burn years ($p = 0.002$, resampled 10,000 times).

CONCLUSIONS:

- Fire improves mate availability, resulting in greater reproductive success for *Echinacea*
- Data on the level of individual plants eliminates the possibility of population-level changes in which plants flower after a fire
- High variance and intercept of regression indicate that this model does not comprehensively explain the impact of fire on reproductive success. Other factors may include:
  - Distances to all other flowering plants
  - Changes in resource availability
  - Changes in pollinator activity

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