

Edge Effects on *Echinacea angustifolia* Population Fragments

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July 14, 2016

Abstract

Echinacea angustifolia is native to the prairies and plains of North America, which have been highly fragmented. Many factors affect fragmented populations negatively, and one possible harmful effect of fragmentation is the greater edge to center ratio in the resulting smaller populations. Edge effects could negatively affect the fitness of *Echinacea angustifolia*. This research will use style persistence as a measure of pollen limitation which is related to reproductive fitness. Using style persistence as a measure of reproductive fitness, this research will quantify the relationship between distance from a habitat edge and reproductive fitness.

Introduction and Background

Echinacea angustifolia is a long-lived, herbaceous perennial plant species in the family Asteraceae. It is a self-incompatible species and relies on insect pollination for reproduction. Successful pollination through a compatible pollen grain can be easily observed on this species through the measure of style persistence. Styles will persist, visibly protruding from their florets, up to ten days if not pollinated, but once pollinated by compatible pollen, styles will wither within 24 hours. Style persistence is a measure of pollen limitation, either through lack of compatible or any pollen. As pollen limitation increases, seed set and fecundity decrease indicating lower annual reproductive fitness when average style persistence is longer (Wagenius 2004).

Edge effects are the effects a transition between two different adjacent communities has on the organisms living near the border between the communities (Lienert and Fischer 2003). Edge effects can influence plant fitness through various means. Research on forest and wetland species found seed set and pollination decline along the edges of populations (Aizen and Feinsinger 1994, Lienert and Fischer 2003). Based on population size, edge to center ratio of a population can differ with smaller populations exhibiting a greater edge to center ratio. In very small populations, the entire population can be classified as an edge. Edge effects, when added to other potential factors harming fragmented populations including inbreeding and isolation, may further be decreasing fitness of individuals.

The plains of North America consist of highly fragmented prairie communities, and in small populations, edge effects may be especially pronounced since edge to center ratio is smaller than non-fragmented populations. *Echinacea angustifolia* is negatively affected by habitat fragmentation and isolation of both plants and populations. Isolation, distinct from edge effects, is measured by distance of an *Echinacea* plant or population to its nearest neighbors. Isolated plants and populations may attract fewer pollinators due to decreased resources for pollinators (Ison and Wagenius 2014). In *Echinacea* populations, the more highly isolated plants and populations, the more pollen is limited, however it is not known how edge effects may affect populations (Wagenius 2006). If effects produced along population edges decreases the pollination and reproductive fitness of plants, the many fragmented populations of *Echinacea angustifolia* may be in more danger of population decline and extinction than already thought. This research will quantify the relationship between reproductive fitness, as measured by style persistence, between *Echinacea angustifolia* at the edge of populations and at the center to determine if edge effects affect *Echinacea angustifolia* populations.

Goals of research

This study will test the hypothesis that style persistence differs between the edge and the center of fragmented populations of *Echinacea angustifolia*.

Research Plan

Objectives

The object of this research is to determine the extent to which edge effects influence reproductive fitness of *Echinacea angustifolia*. The standard protocol will be used to determine style persistence of all *Echinacea angustifolia* flower heads (Wagenius 2004). Data will be collected on plants throughout the flowering season. Throughout this time, methods to quantify the data will be researched.

Materials and methods

Style persistence will be collected on all flowering heads from all remnant *Echinacea angustifolia* populations within the study site. The standard protocol will be used to measure style persistence and data will be collected every two to three days throughout the flowering season. Habitat edges will be classified as either narrow edges, such as fields or roads that do not provide suitable pollen gathering sites for the native generalist bees that pollinate *Echinacea angustifolia*, or inherent edges, such as the transition from a prairie to a forest. The distance from

habitat edge to *Echinacea* plant will be found using GPS. Any trends between style persistence and distance from the habitat edge will be analyzed using regression. The relationship between average style persistence of each flowering *Echinacea* head and distance from the nearest habitat edge, narrow or inherent, will be visualized through regression.

Projected outcomes

In other reviewed research, edge effects did impact the fitness or seed set of the plant species studied (Aizen and Feinsinger 1994, Lienert and Fischer 2003). We predict that *Echinacea angustifolia* average style persistence will be longer near the edge of habitats than the center.

Significance

Intellectual Merit

The proposed research will further knowledge on the impact edge effects have on fragmented populations. There has been little analysis on North American plant species and how edge effects impact them, so this research will broaden our knowledge of this topic (Cadenasso and Pickett 2001). If *Echinacea* near habitat edges experience reduced reproductive fitness caused by edge effects, there is yet another way human fragmented habitats are decreasing fitness of the plants to consider when trying to conserve prairie remnants. The Echinacea Project has analyzed style persistence data based on isolation, but if fragmentation produces significant edge effects, this should also be taken into consideration for future analysis.

Broader Impacts

As I conduct research through the stages of writing a proposal, collecting data, analyzing data and presenting the data in the form of a poster and a paper, I will gain valuable experience and knowledge that I will use throughout my schooling. Using R to analyze data in new ways will broaden my knowledge of a program used in many areas of study, and I will gain experience presenting my research in poster form.

References

- Aizen, M. A., and P. Feinsinger. 1994. Forest Fragmentation, Pollination, and Plant Reproduction in a Chaco Dry Forest, Argentina. *Ecology* 75:330–351.
- Cadenasso, M. L., and S. T. A. Pickett. 2001. Effect of Edge Structure on the Flux of Species into Forest Interiors. *Conservation Biology* 15:91–97.

Ison, J. L., and S. Wagenius. 2014. Both flowering time and distance to conspecific plants affect reproduction in *Echinacea angustifolia*, a common prairie perennial. *Journal of Ecology* 102:920–929.

Lienert, J., and M. Fischer. 2003. Habitat fragmentation affects the common wetland specialist *Primula farinosa* in north-east Switzerland. *Journal of Ecology* 91:587–599.

Wagenius, S. 2004. Style Persistence, Pollen Limitation, and Seed Set in the Common Prairie Plant *Echinacea angustifolia* (Asteraceae). *International Journal of Plant Sciences* 165:595–603.

Wagenius, S. 2006. Scale dependence of reproductive failure in fragmented *Echinacea* populations. *Ecology* 87:931–941.

Timeline for the proposed research

June-August: Collect style persistence data

July: GPS habitat edges and prepare for data analysis

August 1-7: Begin written report (Introduction and non-statistical methods)

Week after flowering ends: Using R, analyze data

August 15-28: Finalize report and poster

Data management plan

Maps of all fragments at which style persistence data has been collected will be used along with locations of habitat edges that will be collected this summer. Data will be collected on location of each flowering plant and style persistence of each flowering head. Data will be collected and stored electronically. Data will be stored on multiple devices and on the cloud using Dropbox.

Analysis will be conducted in R. The final project report will be posted on the *Echinacea* Project website, and opportunities to present to poster will be sought.

Environmental impacts

There should be no significant environmental impact to either the land or plants, since this research is based solely upon observation of *Echinacea angustifolia* heads.