Echinacea Project Research Proposal
Marie Schaedel
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Modeling Fitness and Heritability in Hybrid Offspring of *E. pallida* and *E. angustifolia*

Background

What remains of the tallgrass prairie that once covered the state of Minnesota is now primarily relegated to scattered patches of native communities that have managed to survive on land deemed unfit for agricultural conversion (Wagenius, 2013). Other prairie remnants exist in highly disturbed and untended locations such as roadsides, as well as in managed restoration areas. The Hegg Lake State Wildlife Management Area in Kensington, Minnesota is part of a restoration project designed to improve duck and waterfowl habitat. In the process of doing so, the Department of Natural Resources planted a mixture of prairie species that included *Echinacea pallida*, a nonnative purple coneflower (Wagenius, 2013). The possibility of interspecific hybridization could have drastic consequences for the genetic integrity of the native *Echinacea angustifolia*. In a related study, Anttila *et al*. documented the effects of the introduction of nonnative cordgrass *Spartina alterniflora* on the native *S. foliosa* in California. The results of the study showed that, while rare, F1 hybrids possessed enhanced fitness due to increased fecundity (Hufford and Mazer, 2003). If the introduction of *pallida* results in genetic swamping, *Echinacea* could experience a similar outcome at Hegg Lake.

Last summer, Shona Sanford-Long expanded on the findings of Kiefer and Goldsmith that cross-pollination between *pallida* and the native *angustifolia* is possible (Wagenius, 2013). Based on the results of a series of interspecific and intraspecific crossing experiments, Sanford-Long determined that compatibility rates were highest in *pallida*/*angustifolia* crosses; this suggests that the introduction of *E. pallida* into prairie remnants could have a profound effect by hybridizing with *E. angustifolia* (Sanford-Long, 2013). In May of this year, Dr. Stuart Wagenius planted the germinated seedlings from the Sanford-Long study in a plot at Hegg Lake.

Genetic swamping resulting from restoration practices is not well studied (Hufford and Mazer, 2003). Currently, there are no data available to support predictions regarding the effects of the introduction of E. *pallida* into remnant E. *angustifolia* populations. Indeed, it will be many years until the true effects of hybridization between these two species will begin to manifest. For example, evidence of hybrid breakdown will likely not be observed until the F2 generation or later (Hufford and Mazer, 2003). However, observations of the one year-old seedlings could yield valuable information regarding physiological characteristics in the hybrid progeny that could indicate differences in fitness. In addition, an examination of patterns of heritability would be valuable in assessing the effects of hybridization in Echinacea populations.

Research Objectives

- Do early observations suggest that hybridization of E. *angustifolia* with E. *pallida* result in increased fitness of the F1 generation?
- Do physiological characteristics vary significantly among the progeny of all possible crosses of *pallida* and *angustifolia*? Is it possible to predict survival rates and fitness characteristics for each of these groups through aster modeling?

- How closely do the observed phenotypes of hybrid offspring correspond to those of their *pallida* and *angustifolia* parents? What does this suggest about the heritability of the traits under study?
- Is there cause to be concerned that genetic swamping has occurred, or is likely to occur?

Methods

I plan to measure a number of structural characteristics in the progeny resulting from *pallida* x *pallida*, *pallida* x *angustifolia*, *angustifolia* x *pallida*, and *pallida* x *pallida* crosses. Possible characteristics for measurement include, but are not limited to:

- Survival
- Presence of herbivory
- Height
- Leaf number
- Length of longest leaf
- Leaf area
- Trichome density

The last three measurements listed will be collected by scanning an image of the longest leaf on each plant using a 900 dpi portable scanner, and analyzing the image using GIMP and ImageJ.

To assess heritability, I will collect analogous measurements on each parent.

All data will be analyzed using the statistical program R.

Datasheets

achene	row	pos	Height	LoLL	Lnum	Larea	TrichDen	Notes
1036	1	1						
819	1	2						
397	1	3						
631	1	4						
658	1	5						
788	1	6						
450	1	7						
192	1	8						
452	1	9						

ParentID	SurvStat	FlowStat	HerbStat	Height	Hnum	LoLL	Lnum	Larea	TrichDen	Notes
17164										
17165										
17166										
17167										
17168										
17169										
17170										
17171										

Works Cited

Hufford, K.M., and Mazer, S.J. (2003). Plant ecotypes: genetic differentiation in the age of ecological restoration. TRENDS in Ecology and Evolution *18*, 147-155.

Sanford-Long, S. (2013). Cross pollination and the potential for hybridization between native and non-native Echinacea (UThink: University of Minnesota).

Wagenius, S. (2013), M. Schaedel, ed. (Kensington, MN).