

Estimating invasive potential of *Echinacea pallida* and its hybrids (*E. pallida* x *angustifolia*) in a severely fragmented prairie habitat



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Background

- Non-native plants can negatively affect population growth of native congeners.
- Invasive plants tend to have higher physiological rates than non-invasives (van Kleunen et al. 2010).
- On average, inbred *E. angustifolia* have lower physiological values and lower fitness (Kittelson et al. 2015).
- When non-native plants hybridize with native congeners, they can eliminate pure native plants in that system (Huska et al. 2016).

Study System

- Severely fragmented prairie in Douglas County, Minnesota.
- Less than 1% of native MN prairie remains.
- Of the prairie that remains, most is severely fragmented, and it exists in roadside ditches or small restorations.
- Remnant *Echinacea angustifolia* are subject to genetic isolation and inbreeding depression (Wagenius et al. 2010).
- Echinacea pallida* was accidentally introduced to the system at a single prairie restoration, and has been observed to hybridize with native *angustifolia* in other populations (Sanford-Long 2013).
- Echinacea* are long-lived, vector pollinated, self-incompatible prairie forbs that generally do not flower for 3-7 years.

Experimental Plot 7 (p7)

- Hand-crosses of *E. angustifolia* and *E. pallida* from prairie remnants. Four crosstypes (maternal x paternal)
 - ang* x *ang*; *ang* x *pal*
 - pal* x *ang*; *pal* x *pal*
- Seedlings planted in fall 2013 in 10m x 30m grid 1m apart
- Locations of plants randomized and identity unknown in field

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Methods

- Yearly: counted leaves, rosettes, and recorded longest leaf (cm) of each plant.
- 2018: Recorded photosynthetic rate (A_{max}), transpiration, and conductance with LiCor Li-6400XT.
- Leaf thickness (mm) was also recorded in 2018.

Table 1. Survival of conspecific and hybrid *Echinacea* planted in fall of 2013.

Maternal	Paternal	# Planted	Alive (2018)	Survival %
<i>angustifolia</i>	<i>angustifolia</i>	74	22	29.7%
<i>angustifolia</i>	<i>pallida</i>	28	16	57.1%
<i>pallida</i>	<i>angustifolia</i>	85	59	69.4%
<i>pallida</i>	<i>pallida</i>	107	72	67.3%

Table 2. Morphology of conspecific and hybrid *Echinacea* in 2018.

Maternal	Paternal	Mean leaf count	Mean leaf thickness (mm)	Mean longest leaf (cm)
<i>angustifolia</i>	<i>angustifolia</i>	2.47	0.43	13.3
<i>angustifolia</i>	<i>pallida</i>	3.00	0.50	23.1
<i>pallida</i>	<i>angustifolia</i>	3.10	0.48	23.9
<i>pallida</i>	<i>pallida</i>	3.55	0.54	29.0

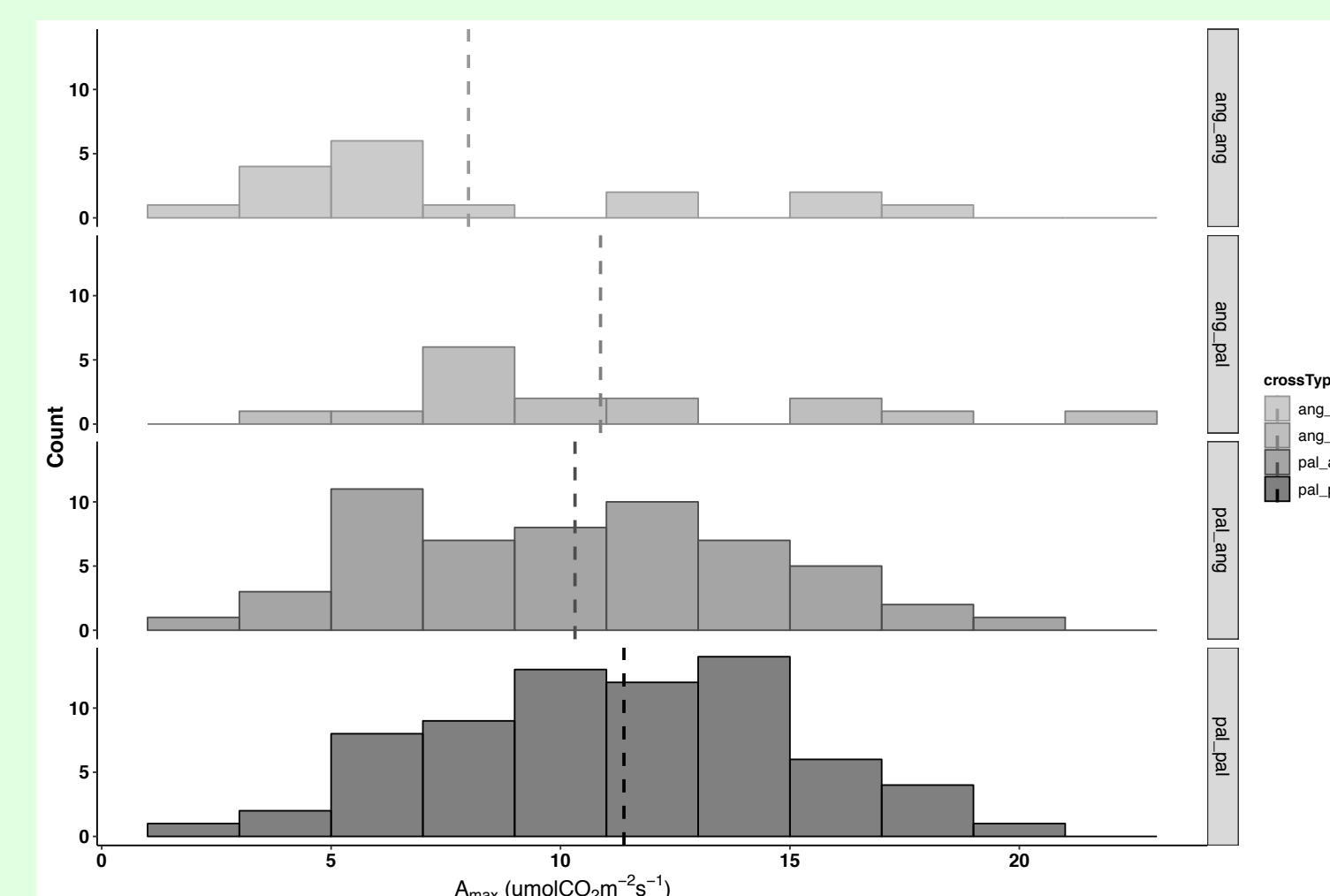


Figure 1. Distributions of photosynthetic rate (A_{max} ; $\mu\text{molCO}_2\text{m}^{-2}\text{s}^{-1}$) among *Echinacea* crosstypes. Dashed lines indicate mean A_{max} for each crosstype.

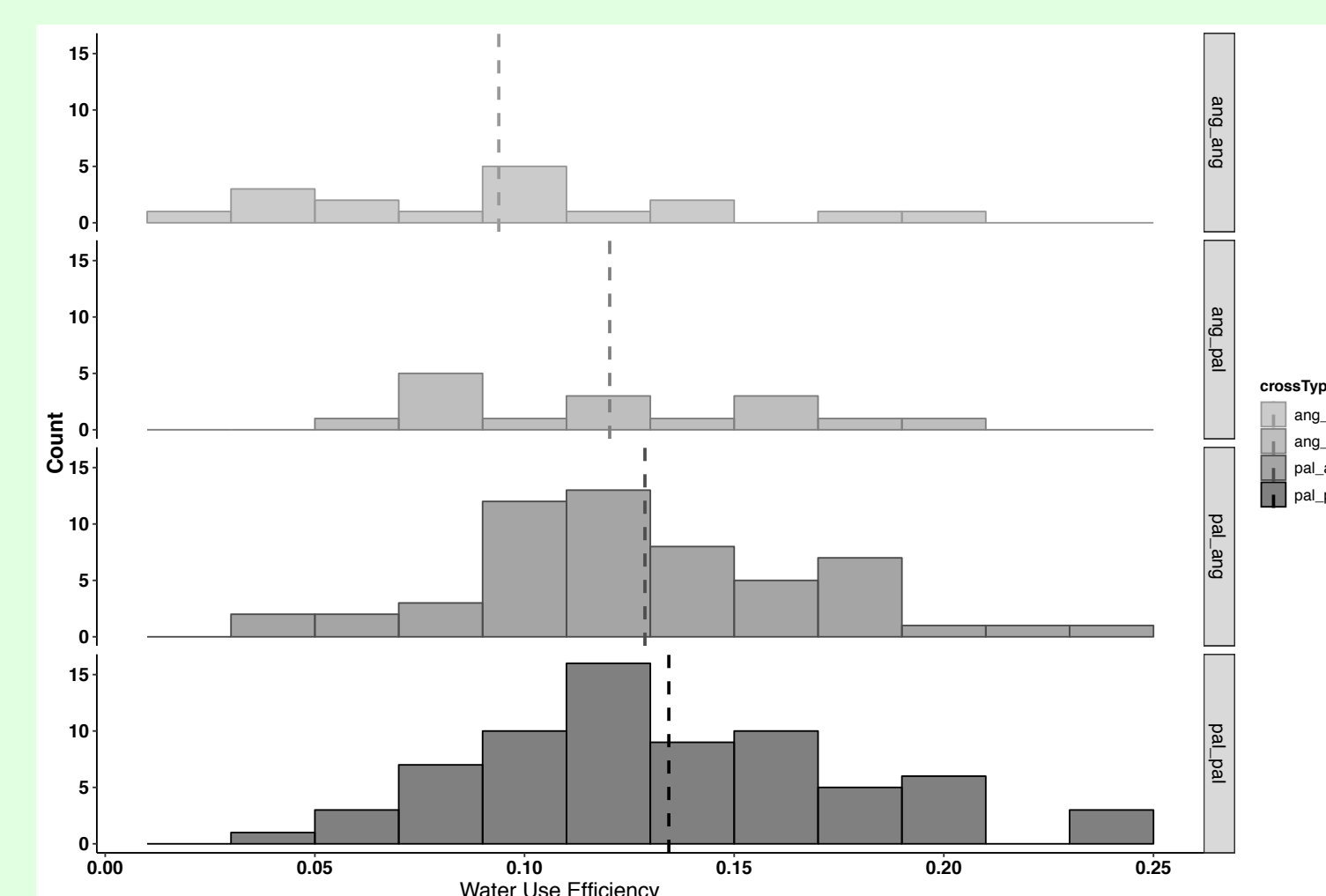


Figure 2. Distributions of water use efficiency by *Echinacea* crosstype. Dashed lines indicate mean water use efficiency for each crosstype. Water use efficiency was calculated by dividing A_{max} ($\text{mol CO}_2\text{m}^{-2}\text{s}^{-1}$) by transpiration ($\text{mol H}_2\text{O m}^{-2}\text{s}^{-1}$)*10.

Results

- The conspecific *Echinacea angustifolia* crosstypes had the lowest average ecophysiological and morphological traits (**Table 2, Figures 1-2**).
- Survivorship of conspecific *angustifolia* was 28%-40% lower than other crosstypes (**Table 1**).
- E. pallida* conspecifics generally recorded the highest physiological and morphological values relative to other crosstypes.
- Physiological and morphological values for hybrids were mostly between the conspecific crosstypes
- In 2018, one *E. pallida* conspecific plant did flower in p7. This is the first record of a plant flowering in the plot.

Discussion

Echinacea angustifolia and *pallida* hybrids do not display hybrid vigor, but both reciprocal hybrids do have higher viability fitness (based on this study) than the native *E. angustifolia*. Because hybrids do have higher viability and survivorship than native *angustifolia*, their potential to affect the native *Echinacea* population is high. This is especially threatening because higher ecophysiology has been associated with higher reproductive capacity (Arntz et al. 2000; Kittelson et al. 2015). Proper management strategies, including cutting heads of flowering *E. pallida* before they produce pollen, may need to be employed to contain the spread of exotic genes throughout the fragmented prairie.

References

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