



# Predictive provenancing: can southern sourced seeds be used in Midwest restoration efforts?

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# How to best source seed?

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- Managers make best attempt at obtaining local genotypes
  - “Local” is different for everyone
  - Chicagoland report: 25 – 200 mile radius (Saari et al. 2011)
- Local adaptation
- With changing climate and restricted gene flow, need to provide for adaptive potential
- **National Native Seed Strategy – Objective 2.1**
  - Characterize genetic variation of restoration species to delineate seed zones and provide seed transfer guidelines for current and projected environmental conditions



# Predictive provenancing

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- Transfer of plants adapted to environments with similar predicted conditions of recipient site
  - Potential to foster climate adaptive populations
  - Not much empirical testing for non-timber species
- How will they perform in current conditions?
  - Extreme weather events
  - Frosts, differing phenology (pollinator mismatch)

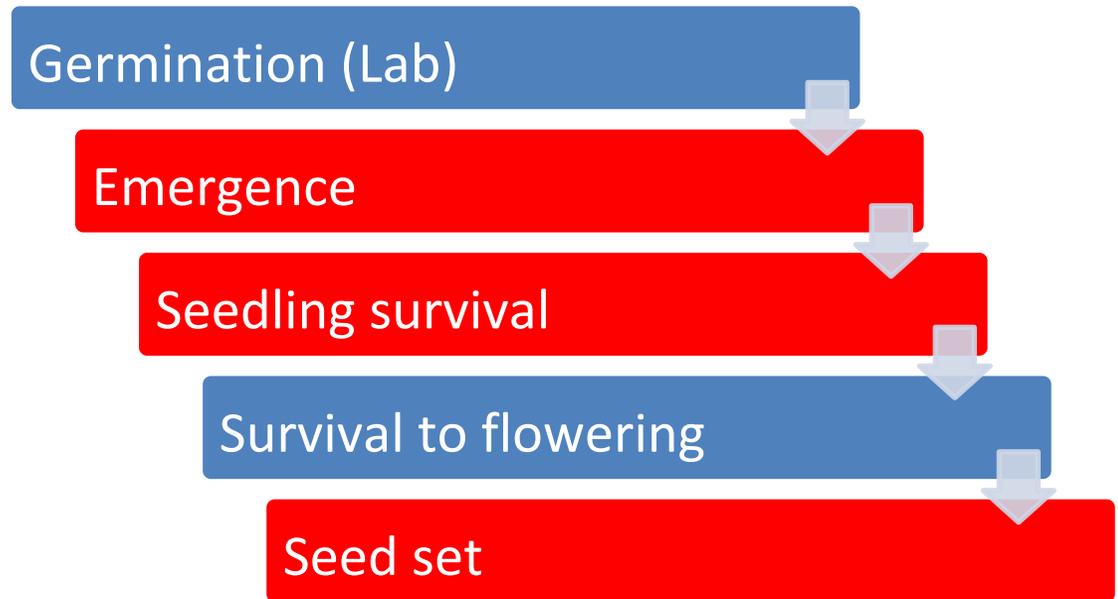
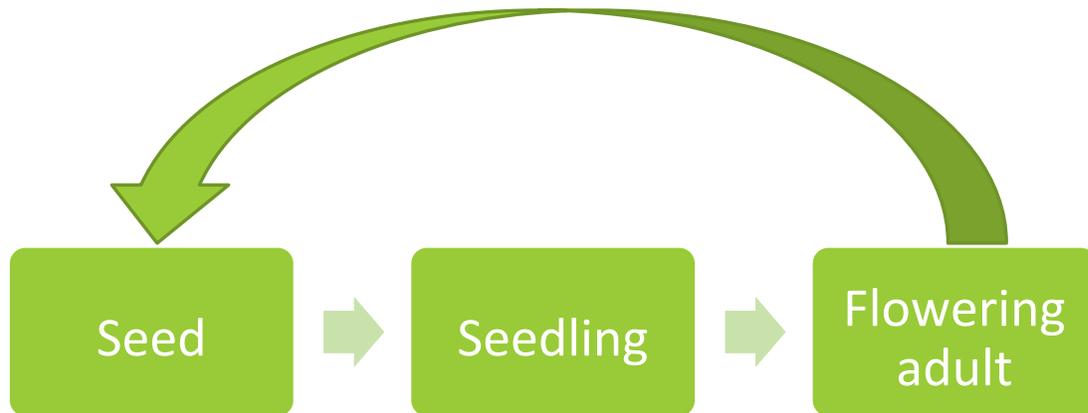


*Pinus albicaulis* – Whitebark pine  
Bower & Aitken (2008)

# Study objectives

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- Are southern sources suitable to use? If so, how much?
- Compare fitness and phenology of potential sources for three short-lived prairie species



# Species

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- ***Chamaecrista fasciculata***  
(Partridge pea)

- Fabaceae

- Annual



- ***Rudbeckia hirta***  
(Black-eyed Susan)

- Asteraceae

- Biennial or short-lived perennial



- ***Lobelia inflata***  
(Indian tobacco)

- Campanulaceae

- Annual





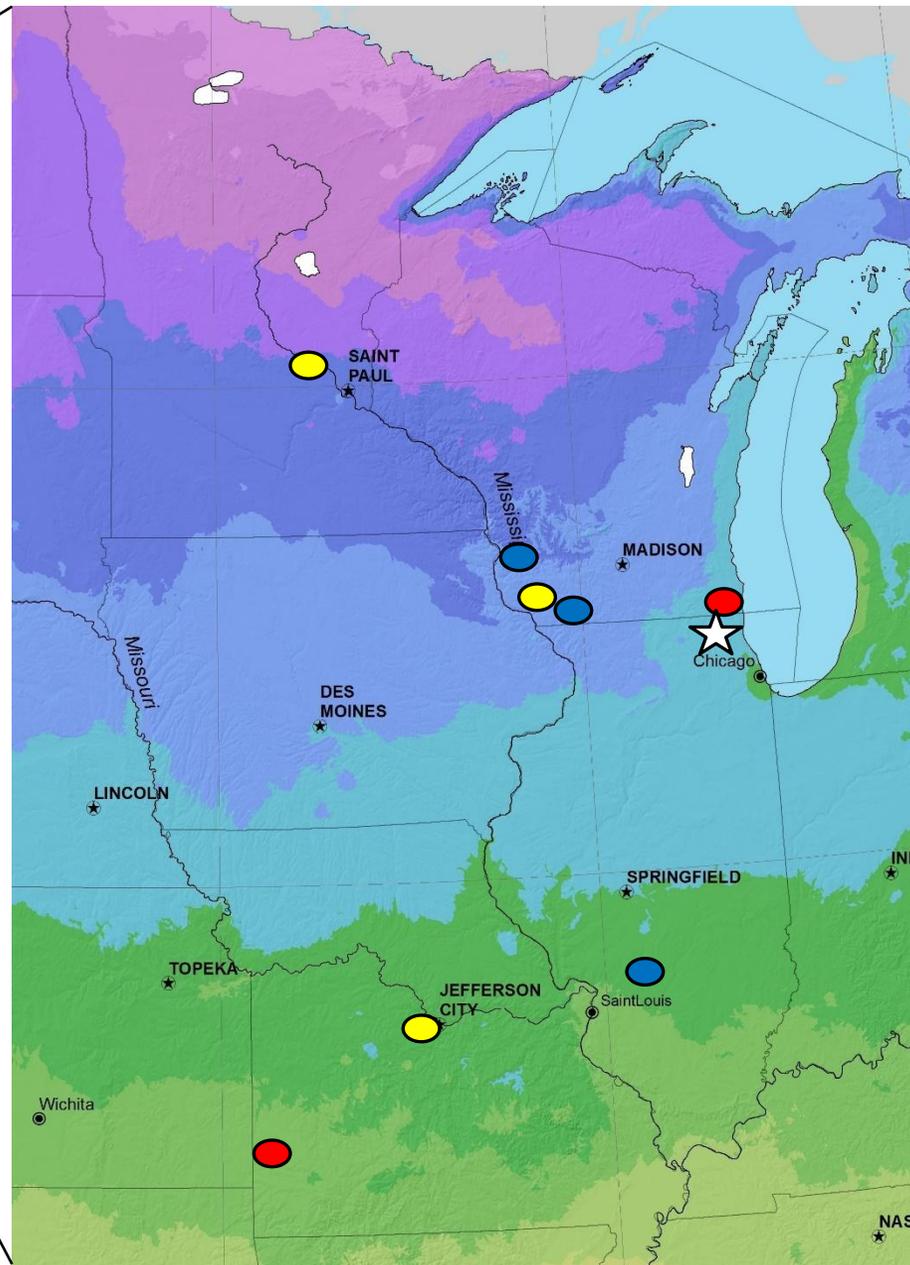
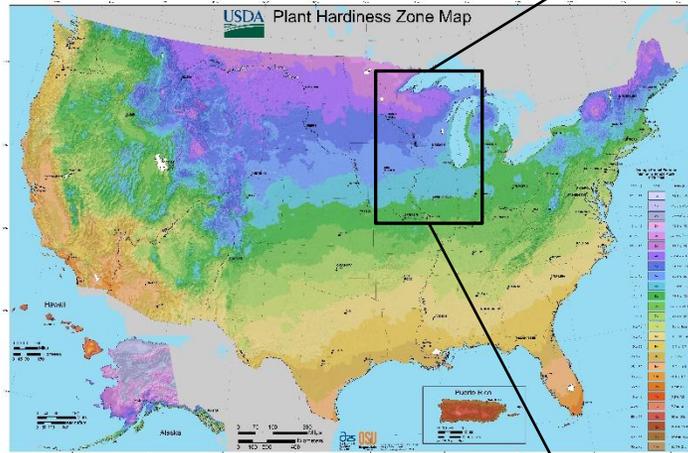
# Common garden

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- Rollins Savanna
  - Lake County Forest Preserves, IL
- 3 replicate plots for each species x source combination
  - Seeded at  $\sim 500$  PLS/m<sup>2</sup>
  - December 2015



# Common Garden Experiment Grayslake, IL



USDA Plant Hardiness Zone Map

- *Chamaecrista fasciculata*
- *Rudbeckia hirta*
- *Lobelia inflata*

Average Annual Extreme Minimum Temperature 1976-2005		
Temp (F)	Zone	Temp (C)
-60 to -50	1	-51.1 to -45.6
-50 to -40	2	-45.6 to -40
-40 to -30	3	-40 to -34.4
-30 to -20	4	-34.4 to -28.9
-20 to -10	5	-28.9 to -23.3
-10 to 0	6	-23.3 to -17.8
0 to 10	7	-17.8 to -12.2
10 to 20	8	-12.2 to -6.7
20 to 30	9	-6.7 to -1.1
30 to 40	10	-1.1 to 4.4
40 to 50	11	4.4 to 10
50 to 60	12	10 to 15.6
60 to 70	13	15.6 to 21.1

# Methods and preliminary results

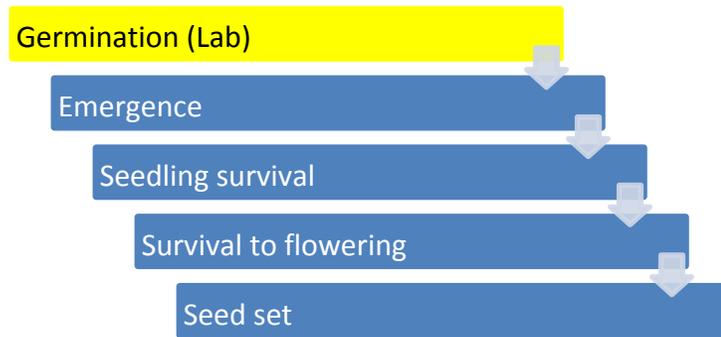
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- Germination success
- Phenology
  - Germination
  - Flowering
- Survival to flowering
- Fitness
  - Biomass – and density
  - Inflorescences



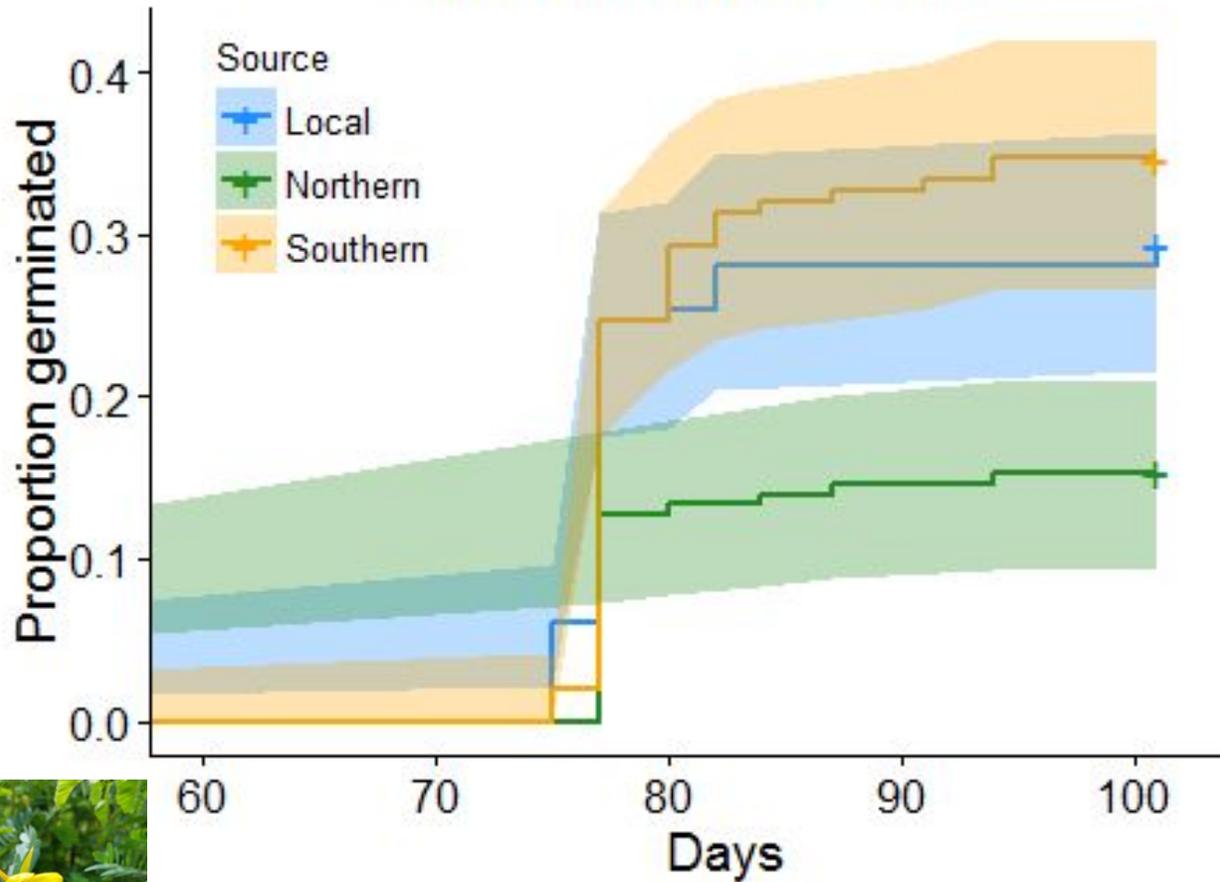
# Germination

- Germination tests in Illinois conditions
  - Cold, moist stratification: 10 weeks
  - Incubation at 20/10 °C
- Seedlings grown up in growth chambers
  - 8 weeks at 25 °C
- Transferred to greenhouse

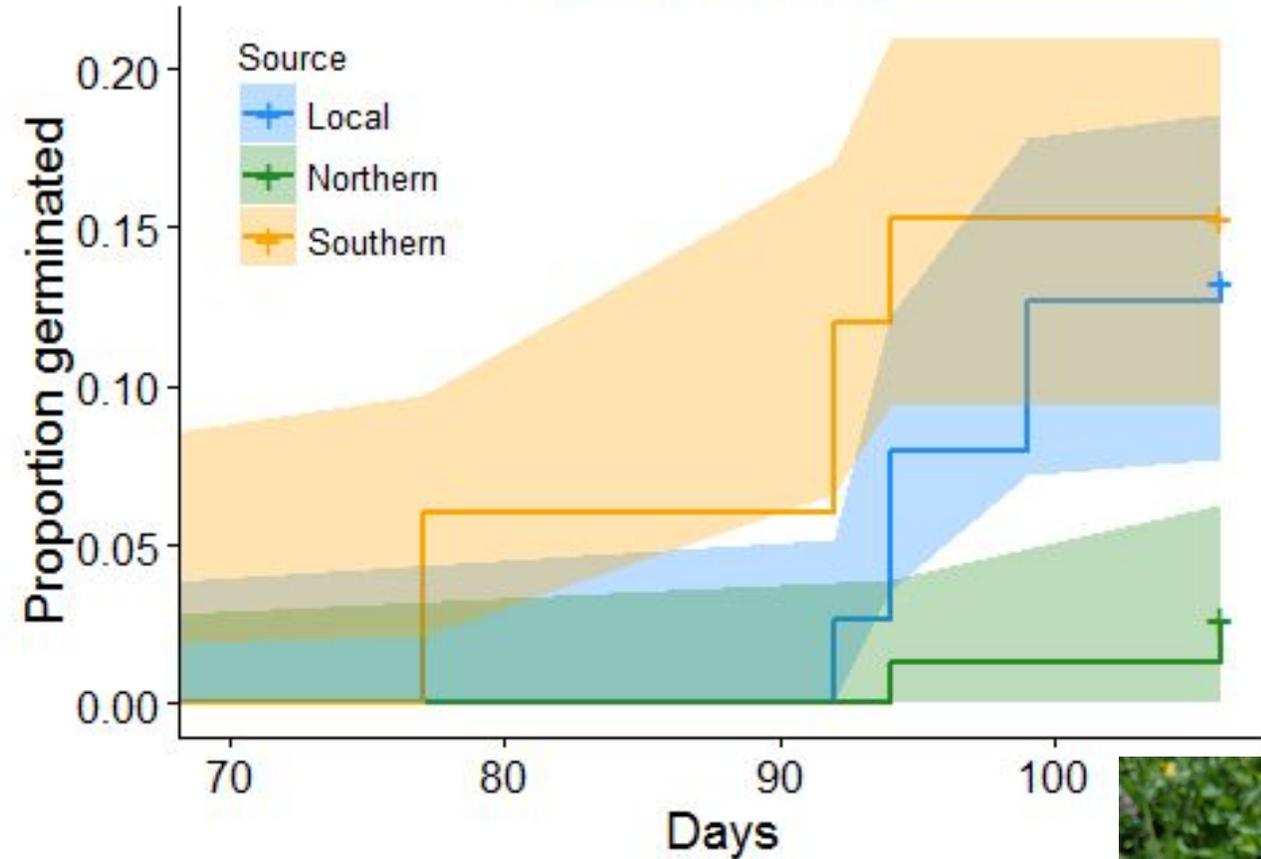


# Germination

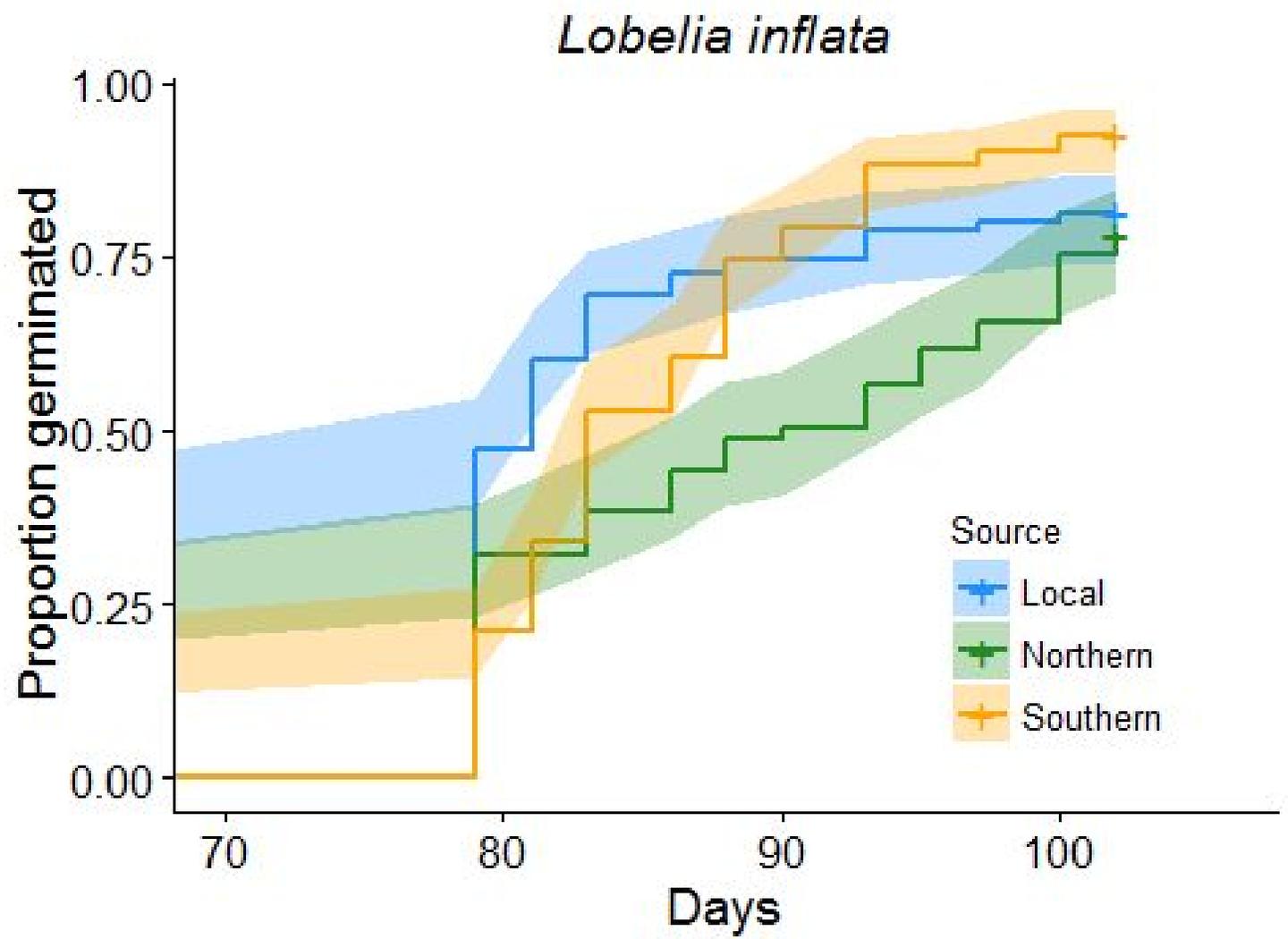
*Chamaecrista fasciculata*



*Rudbeckia hirta*



# Germination



# Emergence and seedling survival

- Backtrack through 10 weeks of pictures
- Track emergence (success and timing) and seedling survival

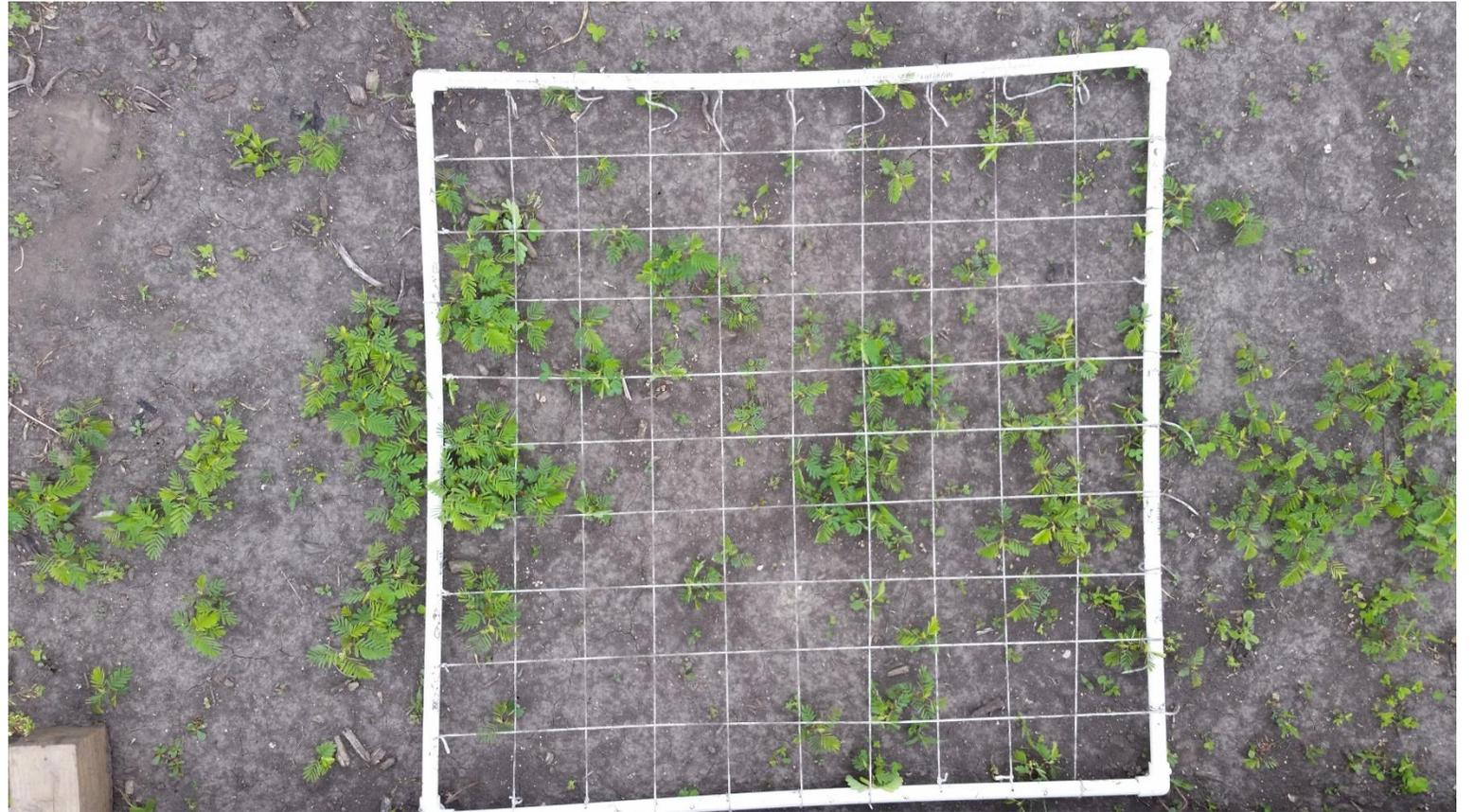
Germination (Lab)

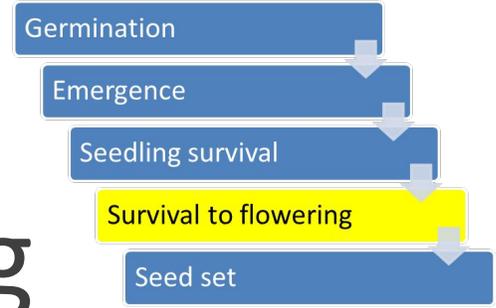
Emergence

Seedling survival

Survival to flowering

Seed set

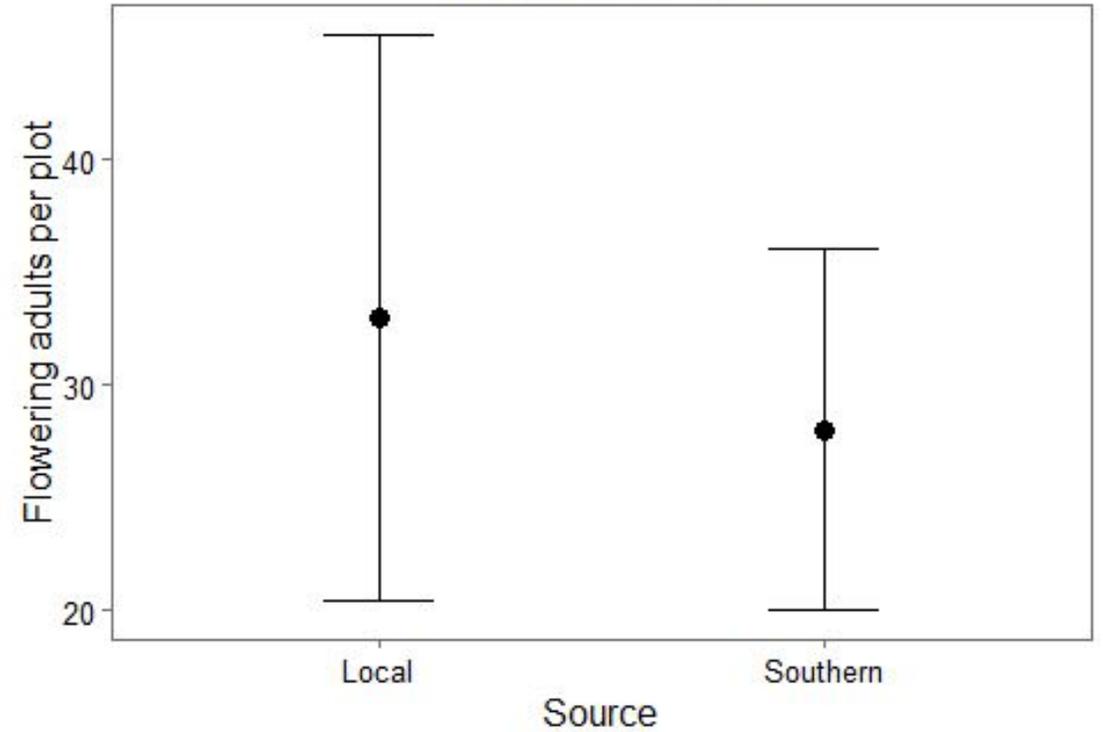
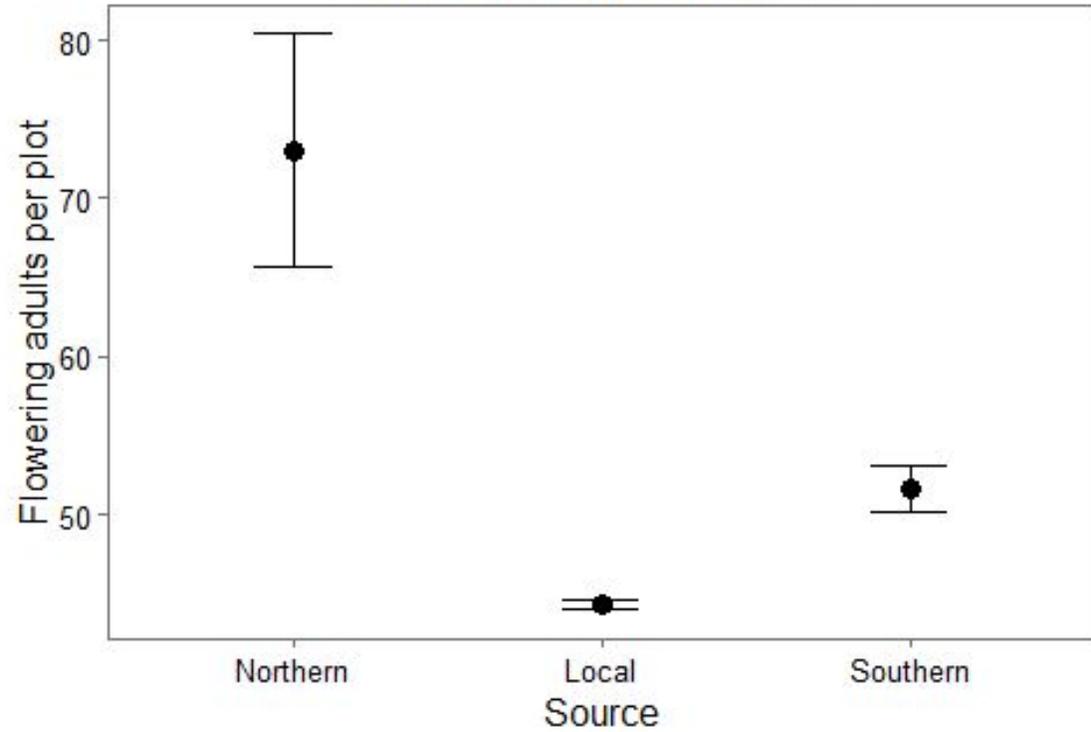




# Survival to flowering

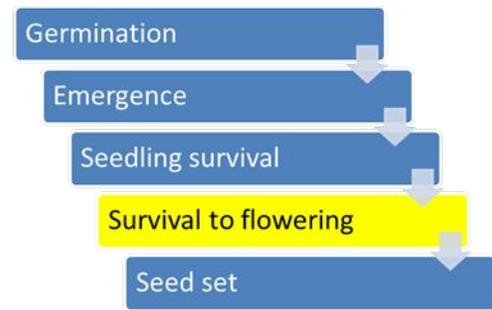
*Chamaecrista fasciculata*

*Rudbeckia hirta*

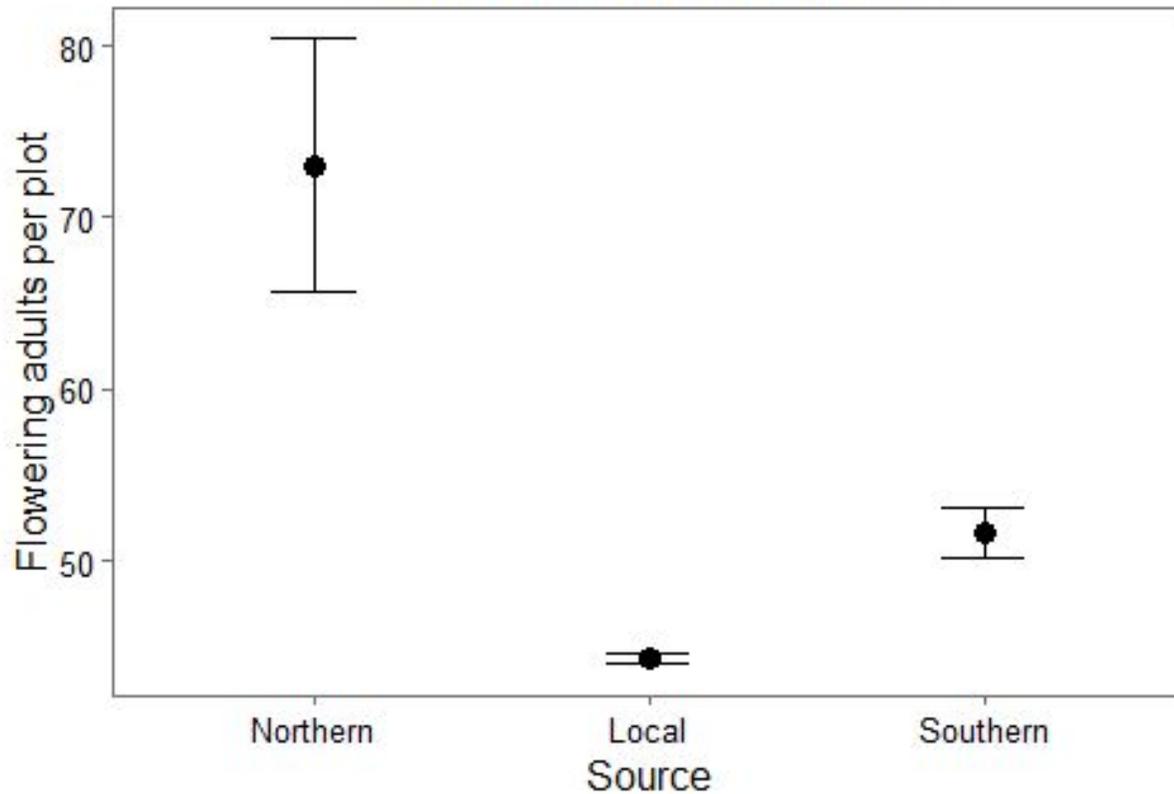




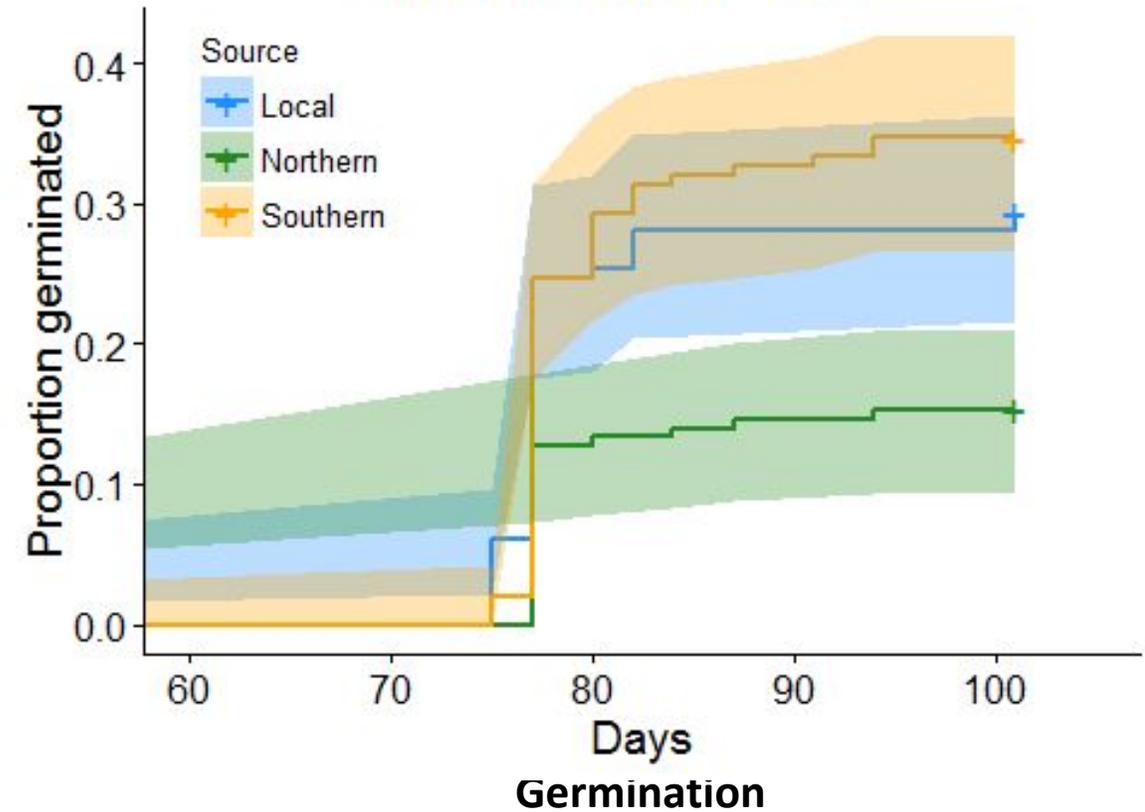
# Survival to flowering



*Chamaecrista fasciculata*



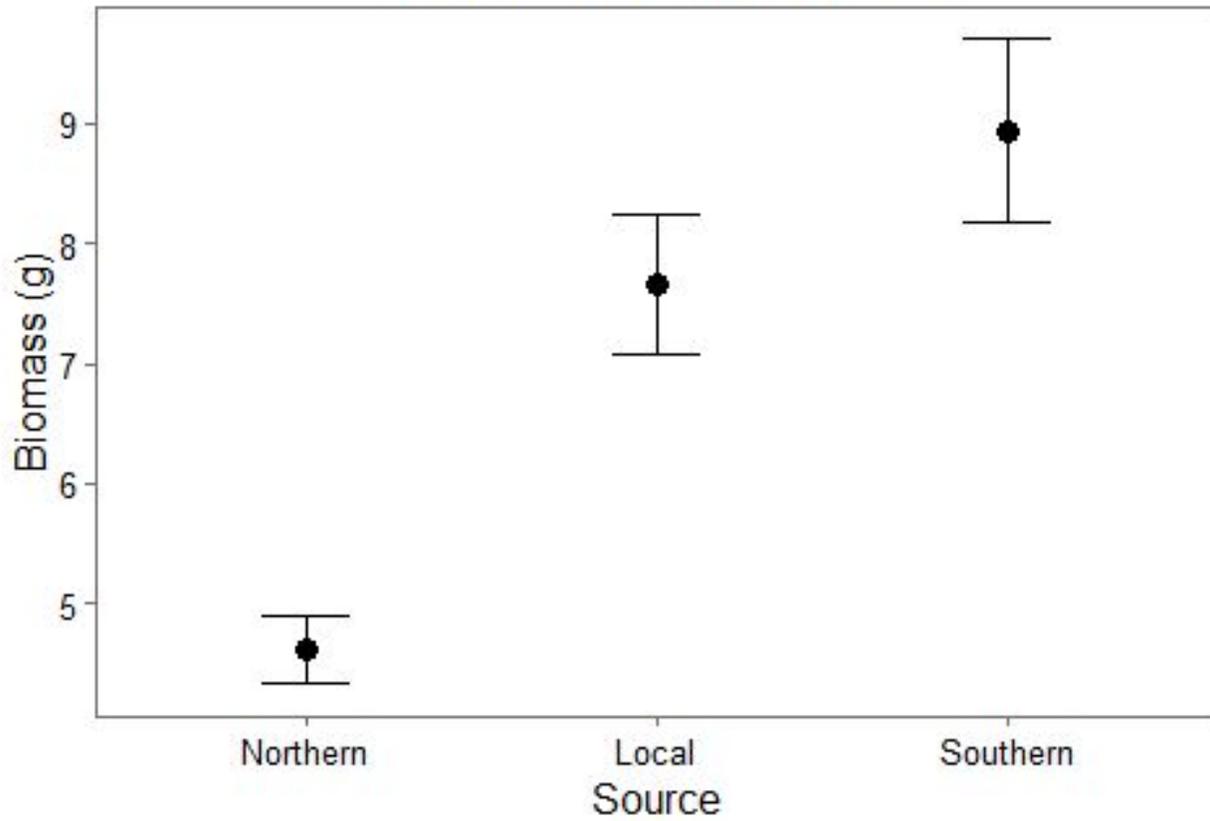
*Chamaecrista fasciculata*



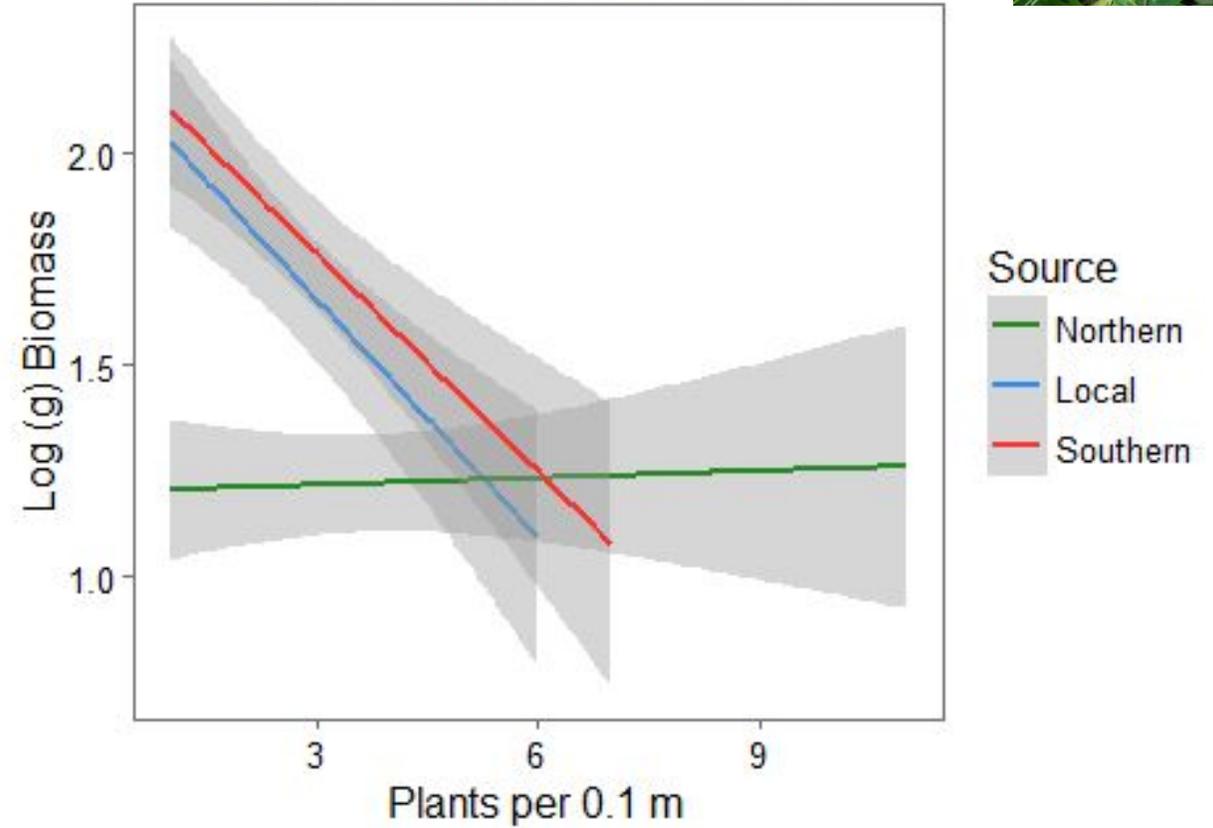
# Biomass and Density



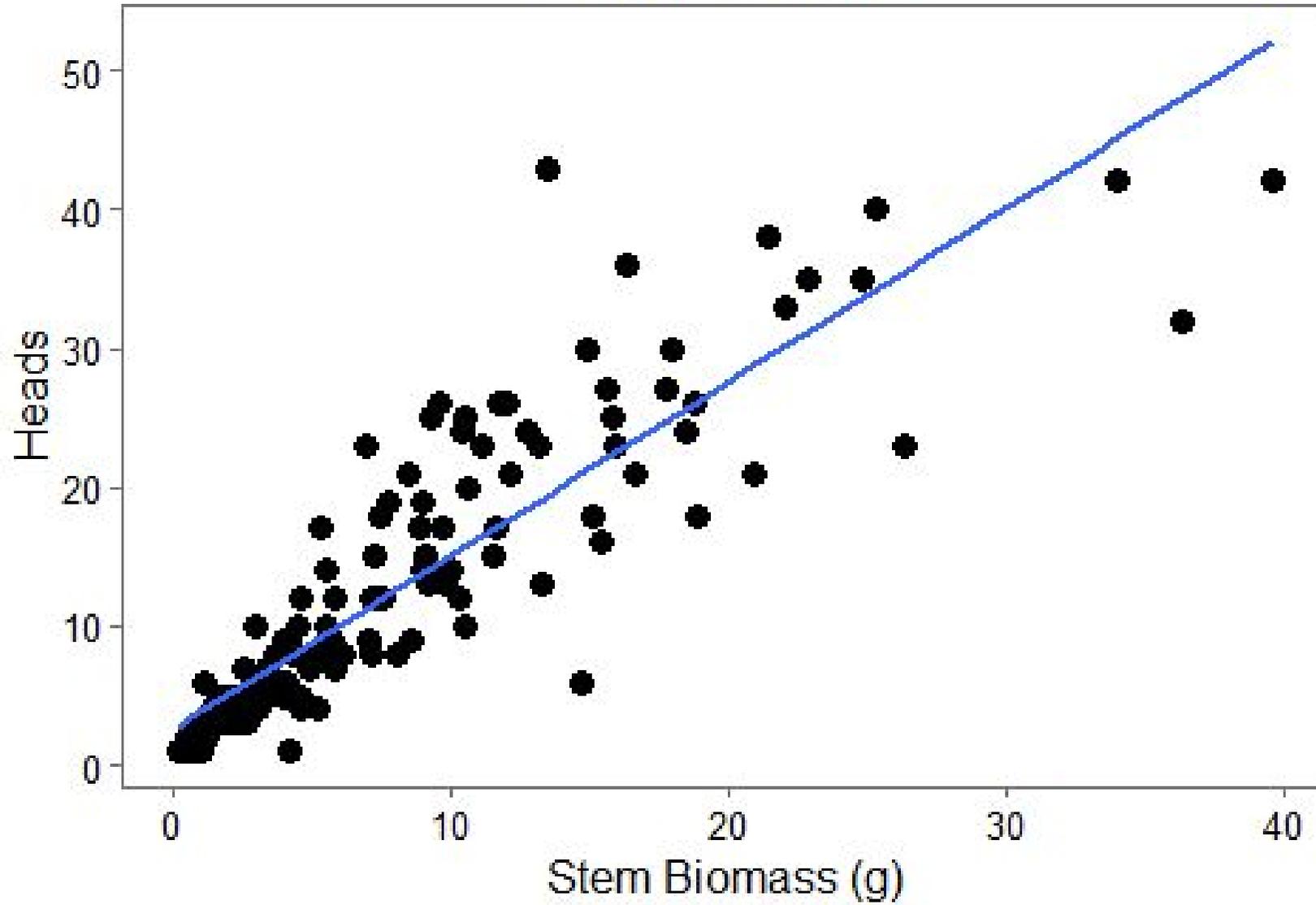
*Chamaecrista fasciculata*



*Chamaecrista fasciculata*



*Rudbeckia hirta*



# Seed set

Ongoing

Pod processing

Head cleaning

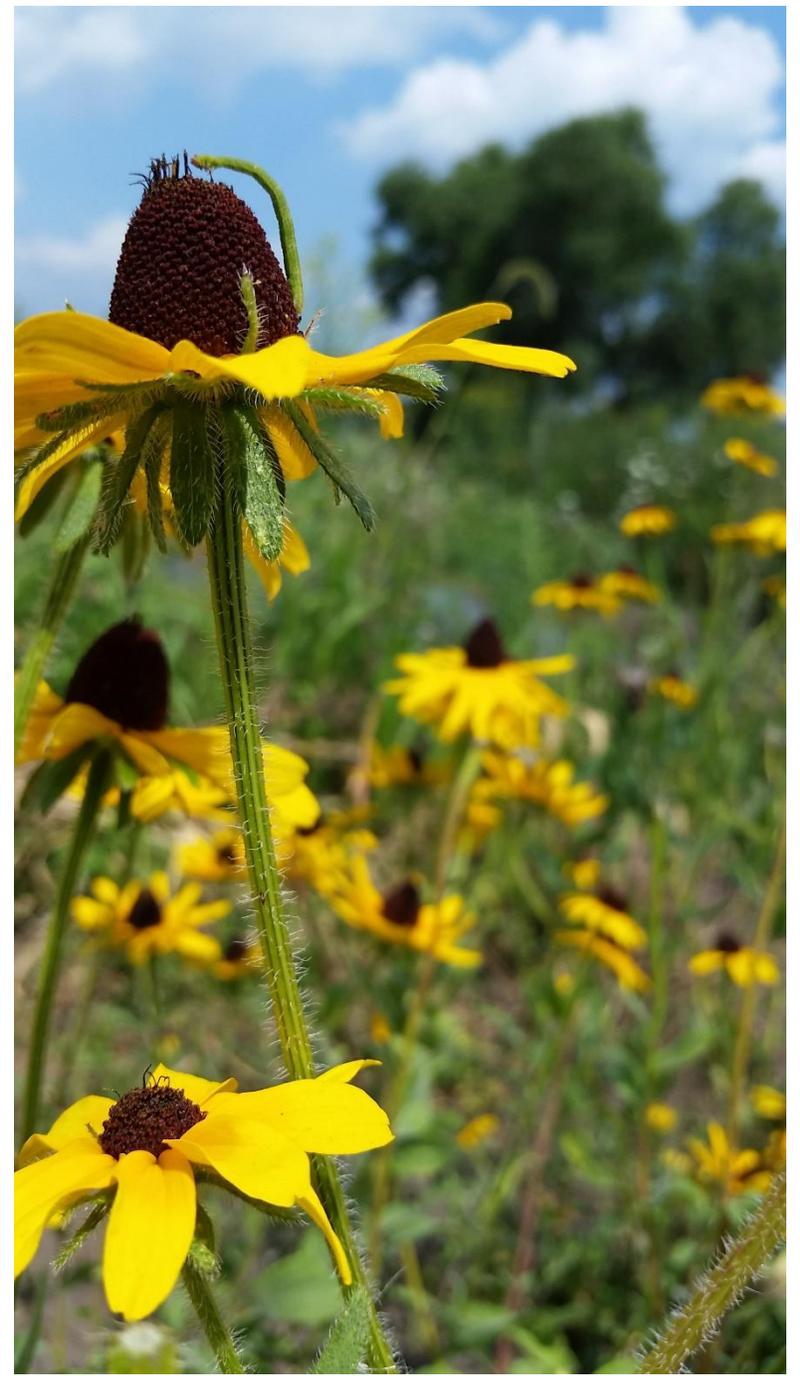
Germination (Lab)

Emergence

Seedling survival

Survival to flowering

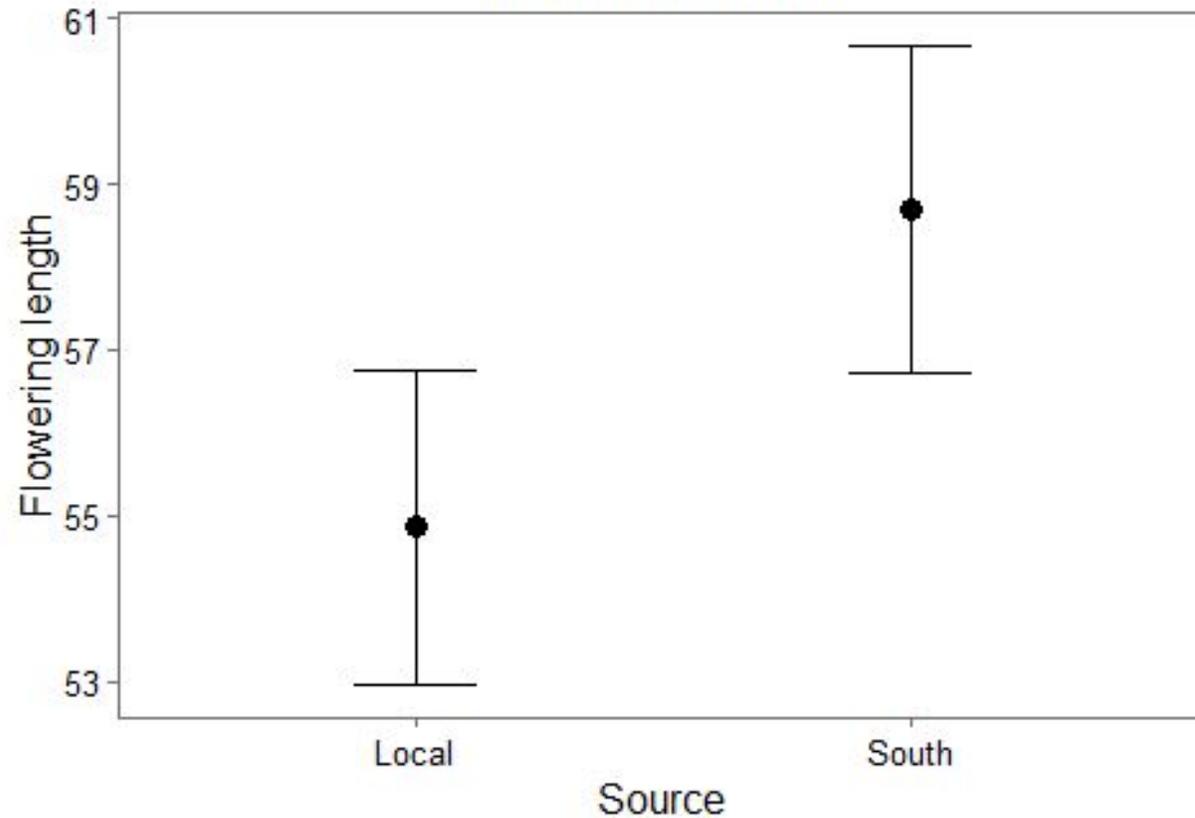
Seed set





# Flowering phenology (Flowering length)

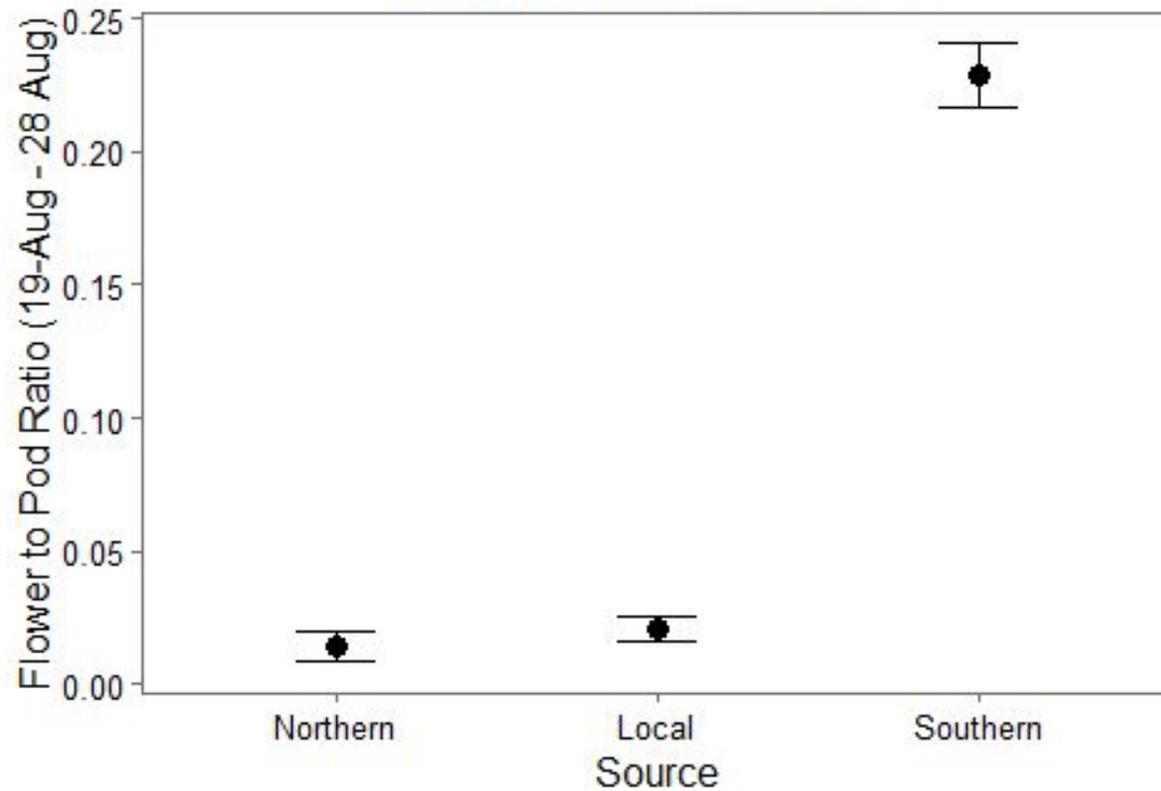
*Rudbeckia hirta*





# Flowering phenology (Flower to pod ratio)

*Chamaecrista fasciculata*



# Conclusions

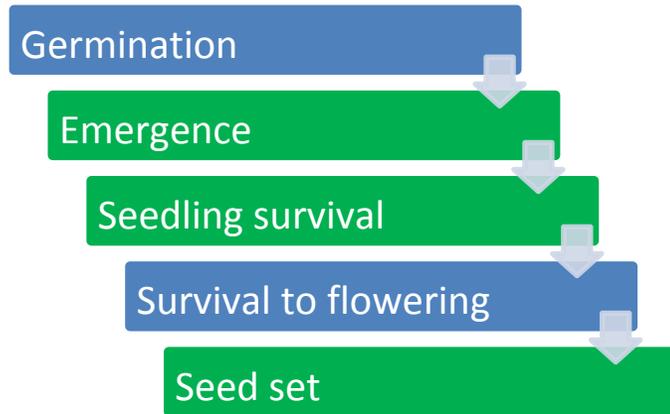
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- **Germination:** Northern sources were slower and had lower success
- **Phenology:** Southern sources have delayed flowering in both species
  - Differences in phenology = effects on fitness?
- Greater differences seen in *C. fasciculata* than *R. hirta*
  - *C. fasciculata*: Northern had highest survival; lowest biomass
  - *R. hirta*: No differences in biomass or inflorescences



# Next steps

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Aster analysis – connect all life stages

- Seed mix design

What effect will phenology have on fitness?

Emergence timing and seedling survival in field are critical part of story

## Phenology

- Compare time to germination in lab with time to emergence in field

Examine weather records from growing season



# Acknowledgements

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- Samantha Root
- Laura Steger
- Bernard Woolridge
- Jacob Zeldin



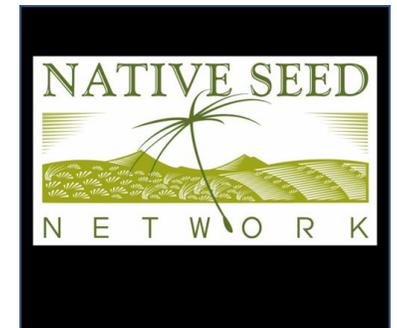
NORTHWESTERN  
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LAKE COUNTY  
FOREST PRESERVES



Institute for  
Applied Ecology





Questions?

# Assumptions and limitations

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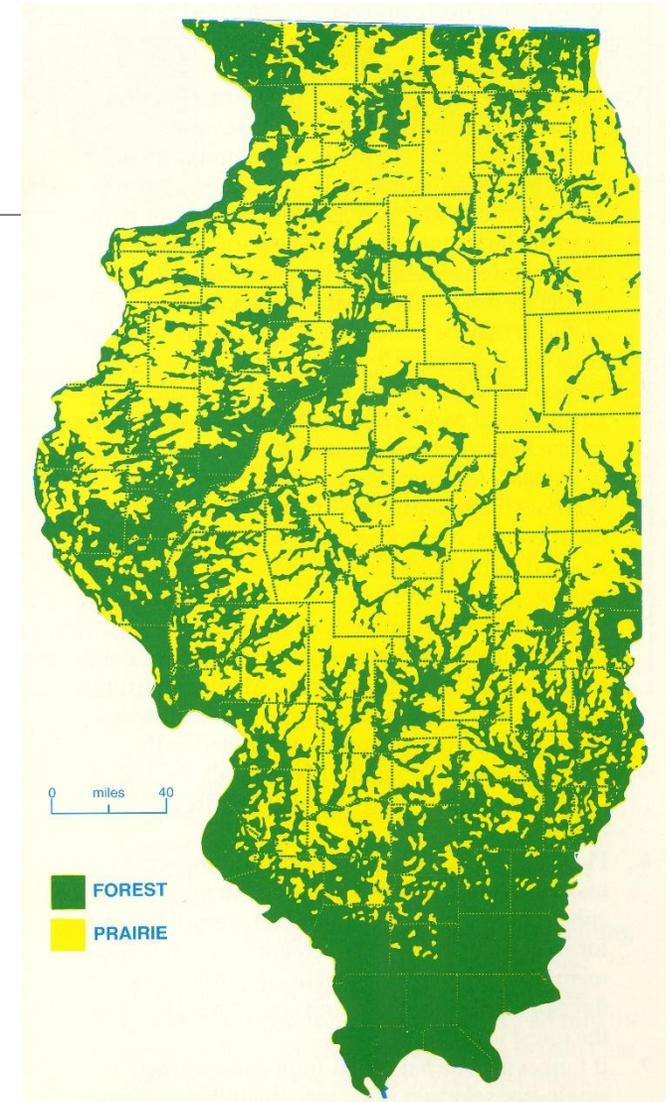
- Limited replication of provenance and common garden site
- Weather is extremely variable
  - Only measuring fitness in one or two growth years
  - Not a stressful year in Chicago
- Commercial seed providers
  - Reliable in geographic source
  - Genetically diverse seeds (not growing clones)



# Assisted gene flow

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- Translocation of individuals to facilitate adaptation to anticipated climate conditions
- Previously used for small, fragmented populations of threatened species
- Historic prairie was large, continuous landscape
  - 1% of historic cover
  - Remnants and restorations are heavily fragmented (agriculture, development)



\*Map credit: Roger C. Anderson

# Species and sources

Species	Northern	Local	Southern
<i>Allium cernuum</i>	Carver Co. MN – Collected	Cook Co. IL – Collected	Franklin Co. MO – Missouri Wildflowers
<i>Chamaecrista fasciculata</i>	Wright Co. MN – Minnesota Native Landscapes	Grant Co. WI – Prairie Moon	Cole Co. MO – Missouri Wildflowers
<i>Lobelia inflata</i>	Vernon Co. WI – Prairie Moon	Lafayette Co. WI – Dixon Seed Bank	Bond Co. IL – Dixon Seed Bank
<i>Rudbeckia hirta</i> *	*	Kenosha Co. WI – Prairie Moon	Barton Co. MO – Missouri Wildflowers
<i>Sisyrinchium campestre</i>	Winona Co. MN – Shooting Star	Vernon Co. WI – Prairie Moon	Cole Co. MO – Missouri Wildflowers

\* Northern source could not be obtained in time for planting

# Expected results

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- Phenology

- Earlier flowering and emergence should be correlated with shorter growing seasons

- Fitness

- Earlier flowering onset = higher seed set?
- Biomass may be higher in southern sources due to growing season

# Local adaptation varies by species

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## Stronger local adaptation

- More prone to maladaptation

Selfing

Gravity-dispersed

Annuals

Wide range

Long-term occupants



## Weaker local adaptation

- More robust to transplantation

Wind-pollinated

Seed-dispersed

Recent range expansion

Uniform habitats



# Conclusion

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- In *C. fasciculata*,
- Results of germination tests and survival to flowering differ
  - Tracking individuals through pictures will clarify
- Impacts of differing phenology on fitness
  - Germination
  - Emergence
  - Flowering (Onset and duration)

# Outlook for Chicago area

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- Chicago will become warmer and wetter
- Evolutionary constraints may prevent populations from keeping pace with change
  - Fragmented populations
  - Restricted gene flow



<http://www.illinoisinfocus.com/northerly-island.html>

# Conclusion – *Chamaecrista fasciculata*

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## ■ Fitness

- Germination: **southern** source more than 2 times the amount of the **northern** source
- Survival to flowering: **northern** source had 4 times higher rate than the **southern** source

## ■ Phenology

- Germination: All fairly equal
- Flowering: **southern** source ratio was 25 times the **northern** source



# Conclusion – *Rudbeckia hirta*

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## ■ Fitness

- Germination: both sources low, not different
- Survival to flowering: both sources low, not different



## ■ Phenology

- Germination: **southern** source occurred an average of 9 days earlier
- Flowering: **southern** source began an average of 6 days earlier
- Both in line with adaptation to longer growing season



The preceding presentation was delivered at the

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This and additional presentations available at <http://nativeseed.info>

