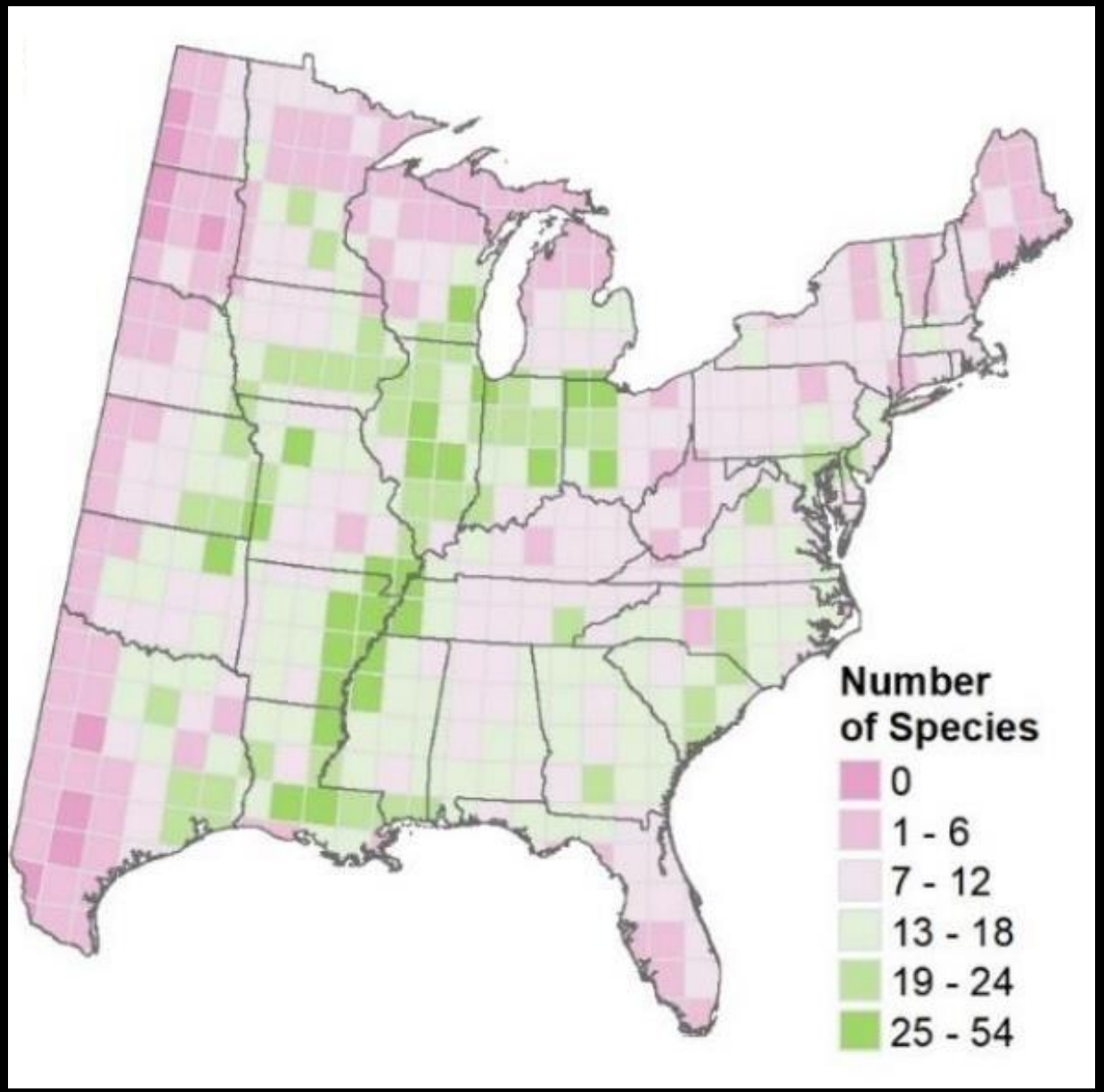
Adaptive Silviculture for Climate Change (ASCC):

Physiological response of future-adapted seedlings to moderate severity drought

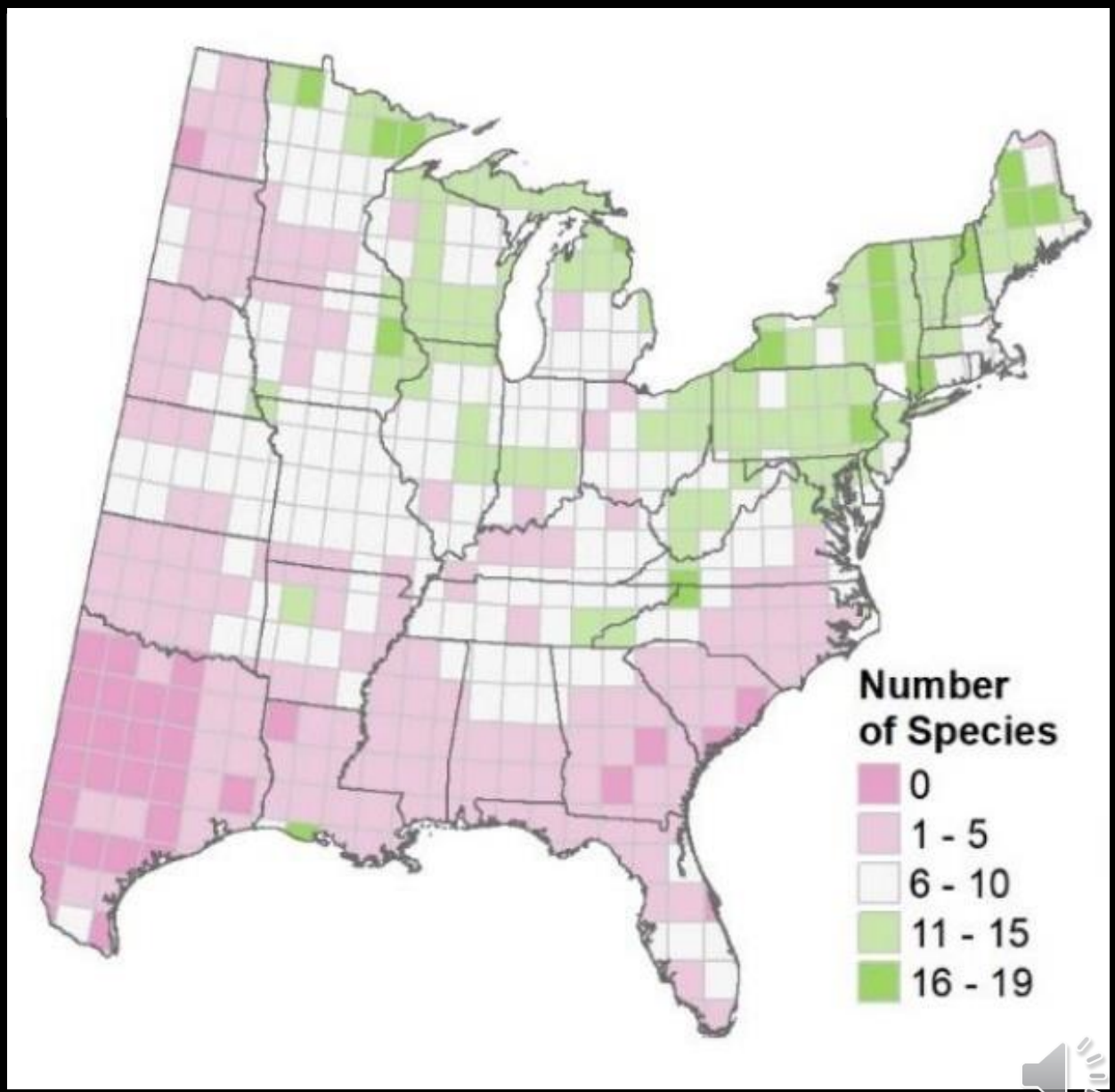
Al Freeman

Tony D'Amato

POPULATION ENRICHMENT



ASSISTED MIGRATION



Iverson et al. 2019

ASCC Adaptation Treatments

Resistance

- Improve defenses of forest against change and disturbance
- Maintain relatively unchanged conditions

Resilience

- Accommodate some degree of change
- Return to prior reference condition following disturbance

Transition

- Intentionally facilitate change
- Enable ecosystem to respond to changing and new conditions

Reduce impacts/maintain current conditions

Forward-looking/promote change

Millar et al. 2007, Swanston et al. 2016, Nagel et al. 2017

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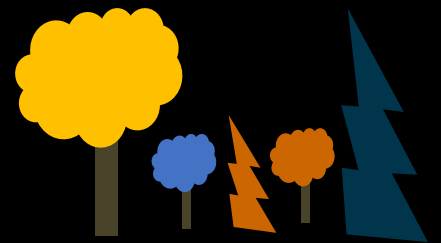

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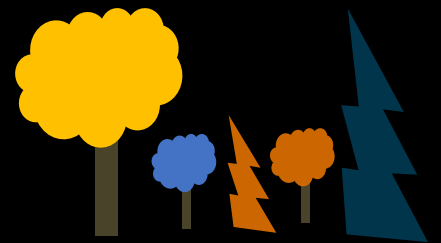
ASCC Adaptation Treatments

RESISTANCE

RESILIENCE

TRANSITION



Identify and implement actions that are
robust across a range of potential future conditions

Reduce impacts/maintain current conditions

Forward-looking/promote change

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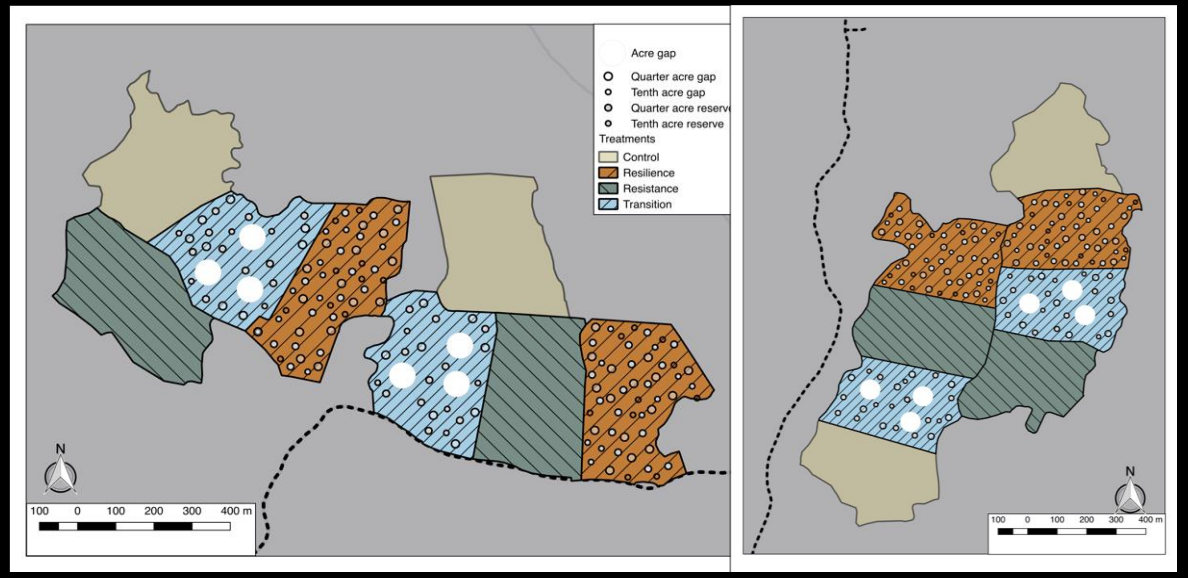
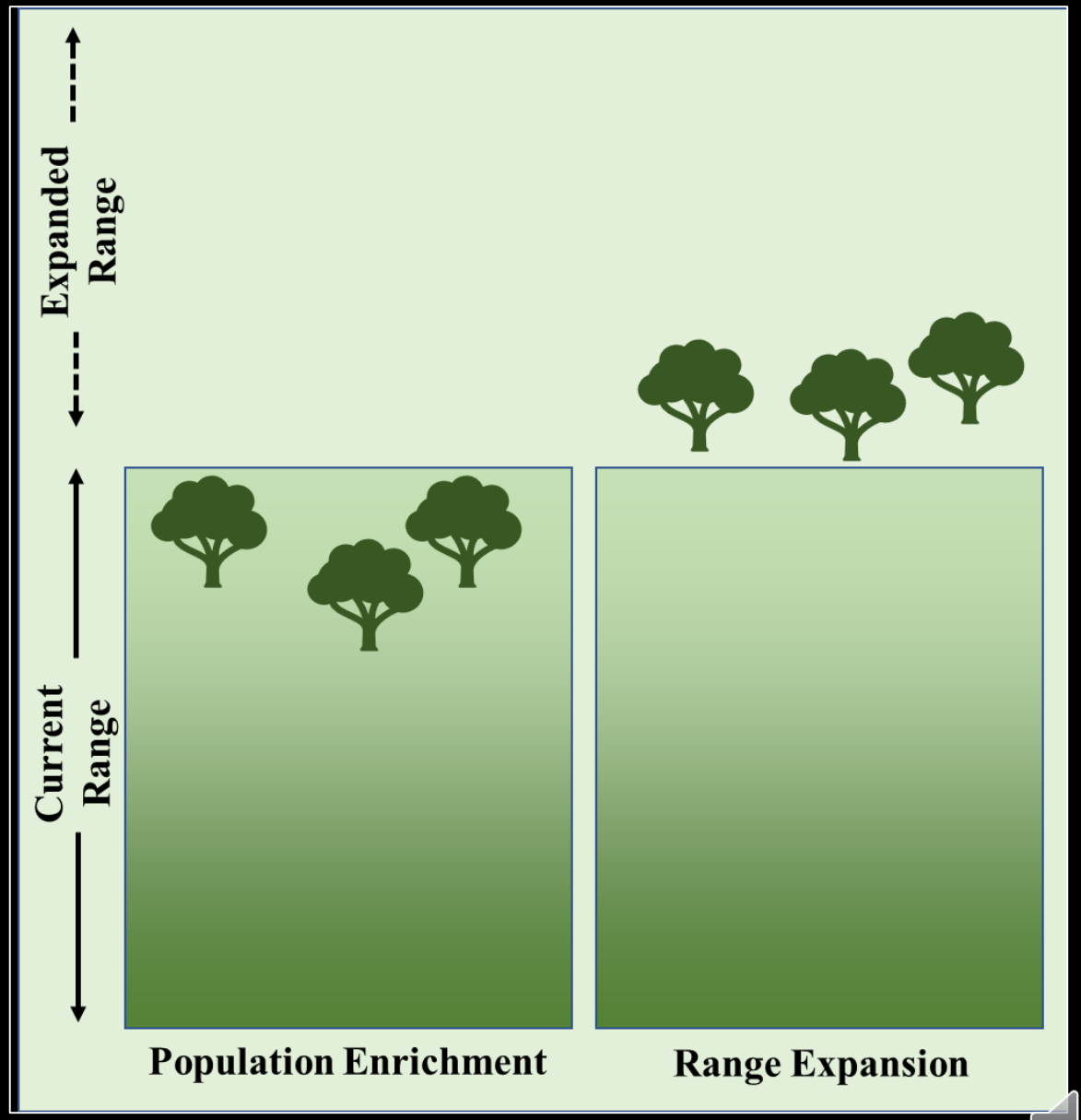
Second College Grant: ASCC Site





William & Dumroese 2013

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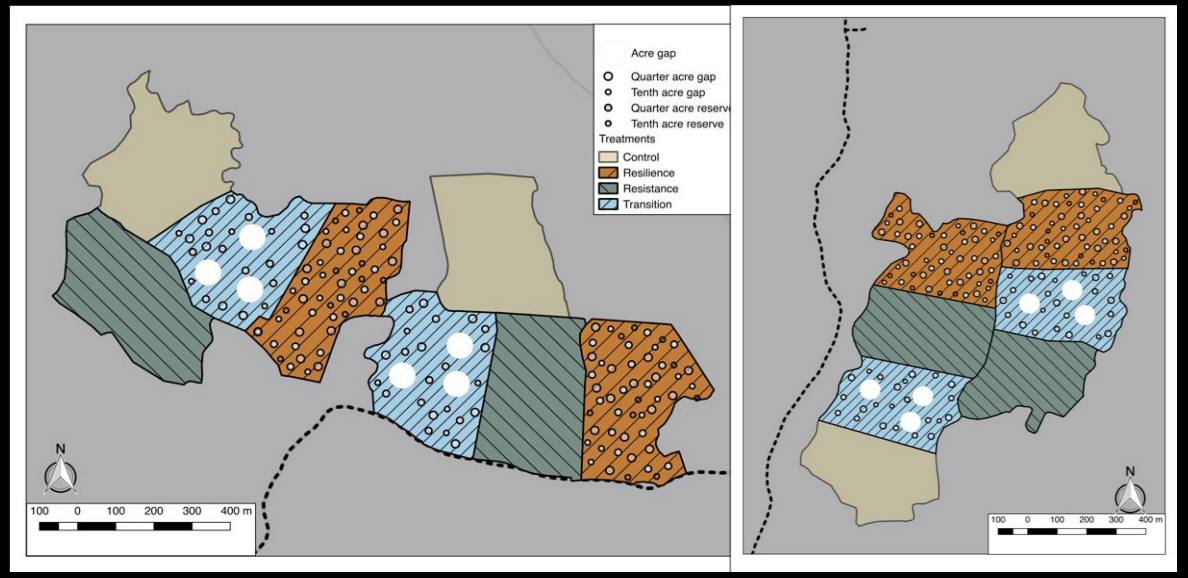
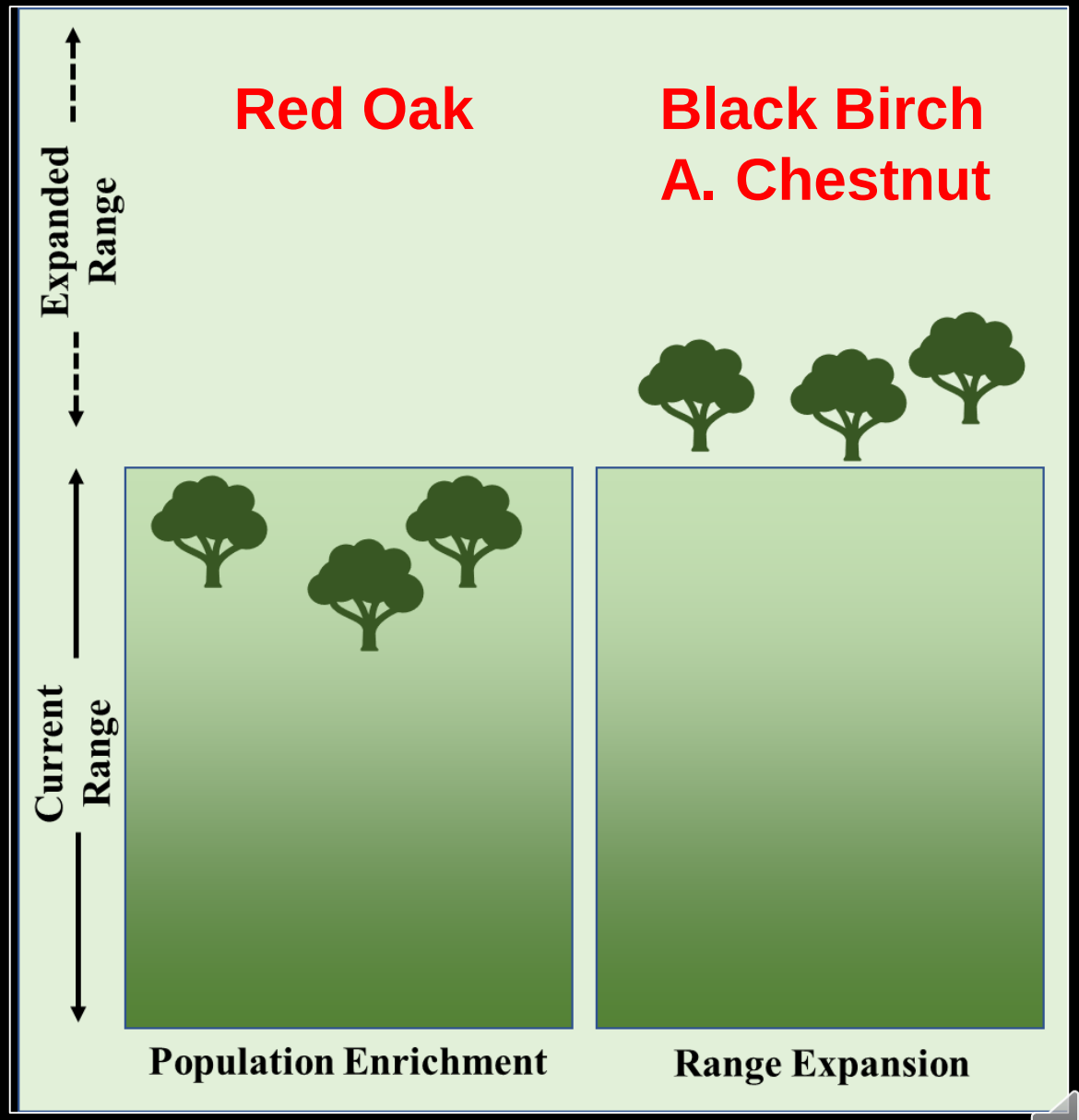




William & Dumroese 2013

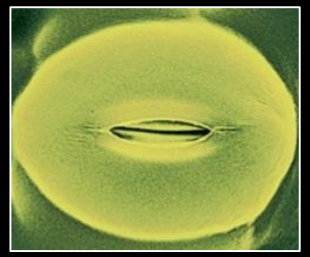
Determining Adaptive Capacity

Contrasting strategies for dealing with water stress

Isohydric

Black Birch
(Betula lenta)

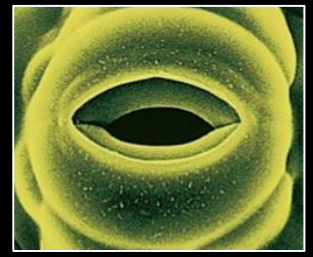
Tight stomatal control
- Reduced water stress
- Lower carbon gain



Anisohydric

Northern Red Oak
(Quercus rubra)

Loose stomatal control
- Increased water stress
- Higher carbon gain



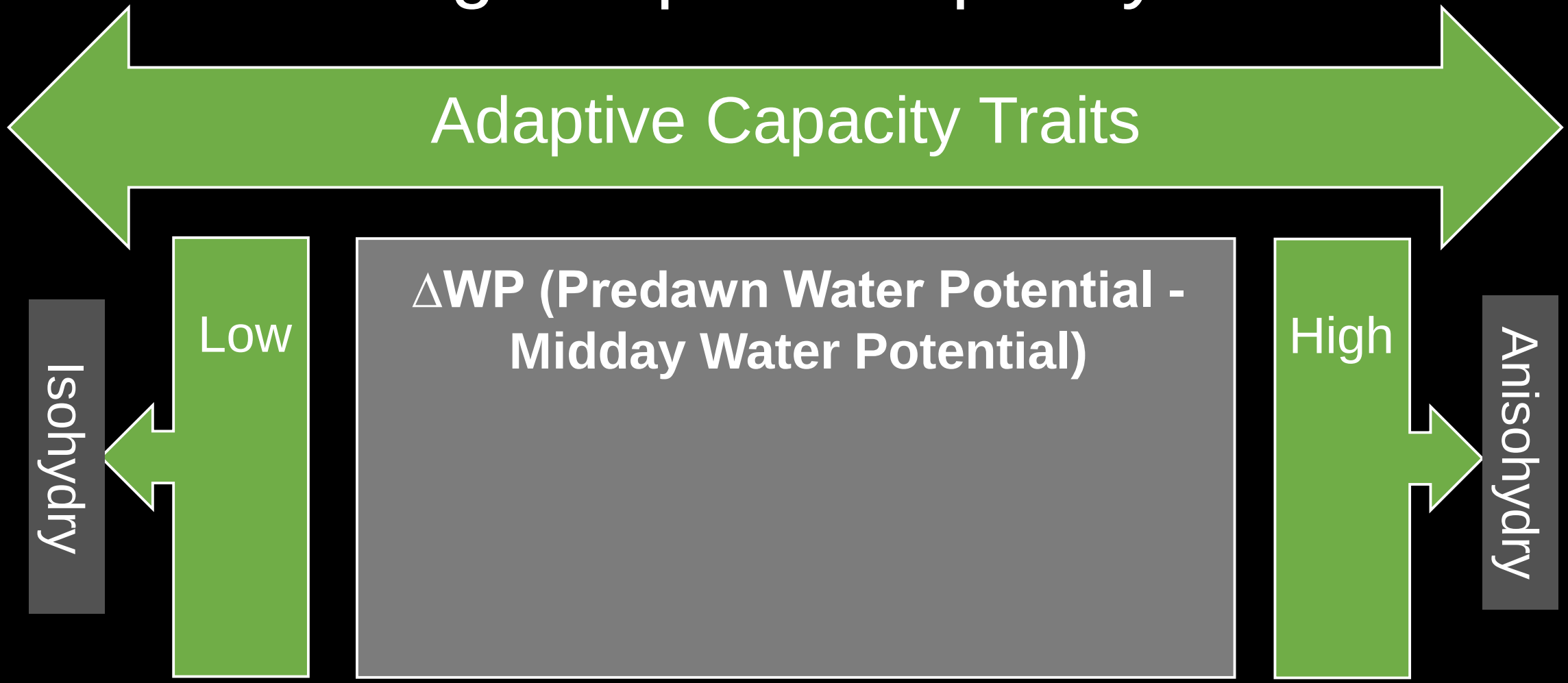
Determining Adaptive Capacity

- What is the physiological response to moderate to severe drought of tree species experiencing population expansion (Red Oak) vs. range expansion (American chestnut and Black Birch)
    - Water Potential

Determining Adaptive Capacity

- What is the physiological response to moderate to severe drought of tree species experiencing population expansion (Red Oak) vs. range expansion (American chestnut and Black Birch)
    - Water Potential
    - Photosynthetic capacity

Determining Adaptive Capacity

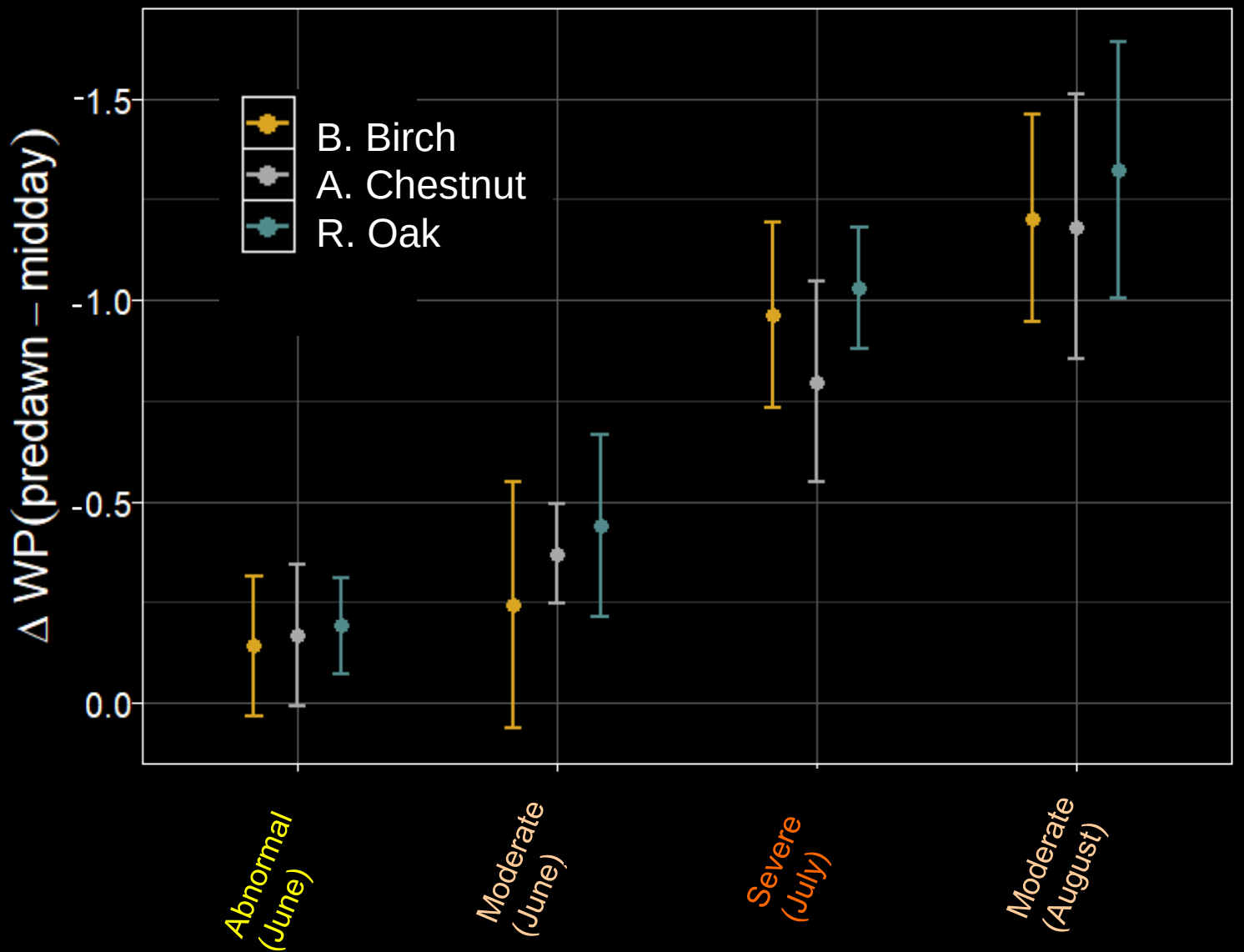


Adapted from Chen et al. 2020

Determining Adaptive Capacity

Adapted from Chen et al. 2020

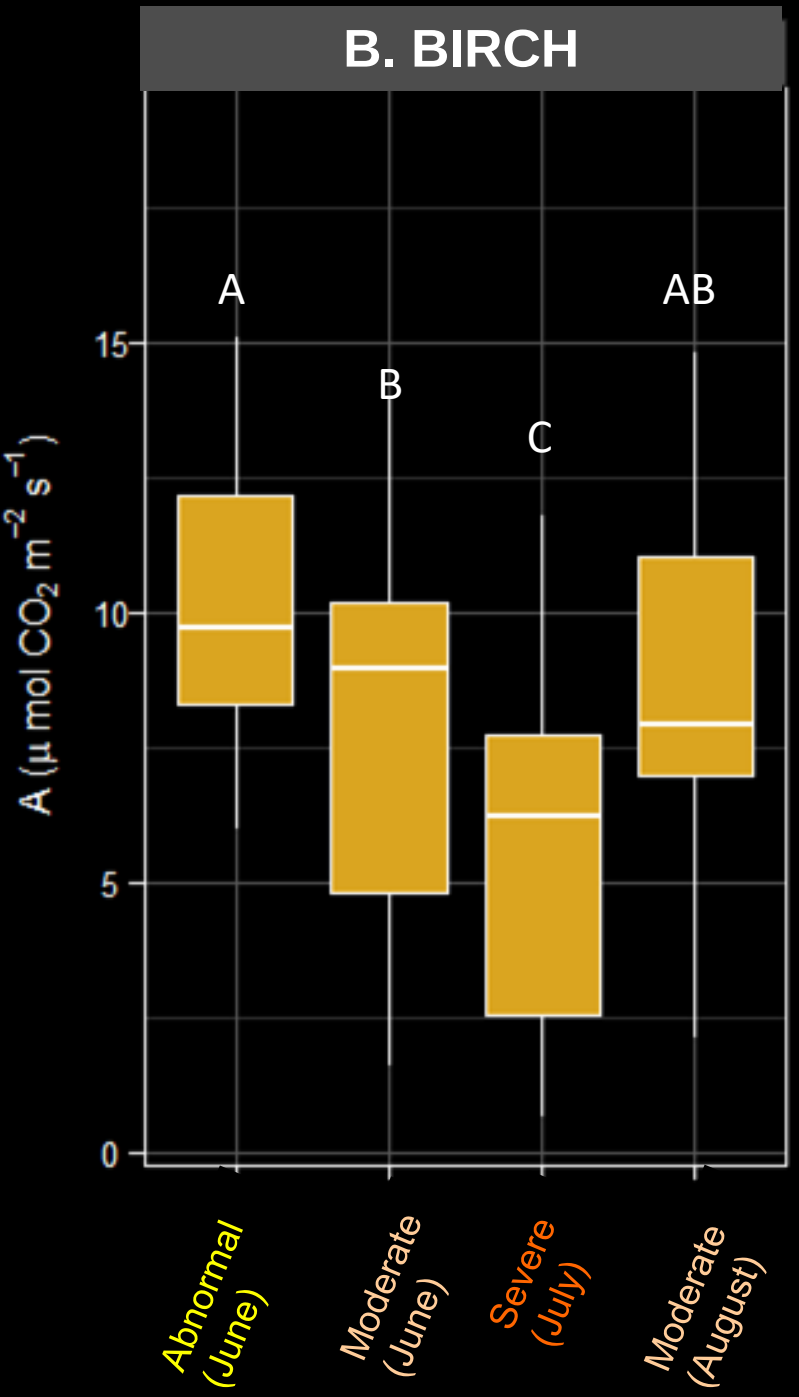
WATER POTENTIAL



ΔWATER POTENTIAL DID NOT VARY BETWEEN SPECIES

HIGHEST ΔWP OCCURRED DURING PERIODS OF MODERATE TO SEVERE DROUGHT

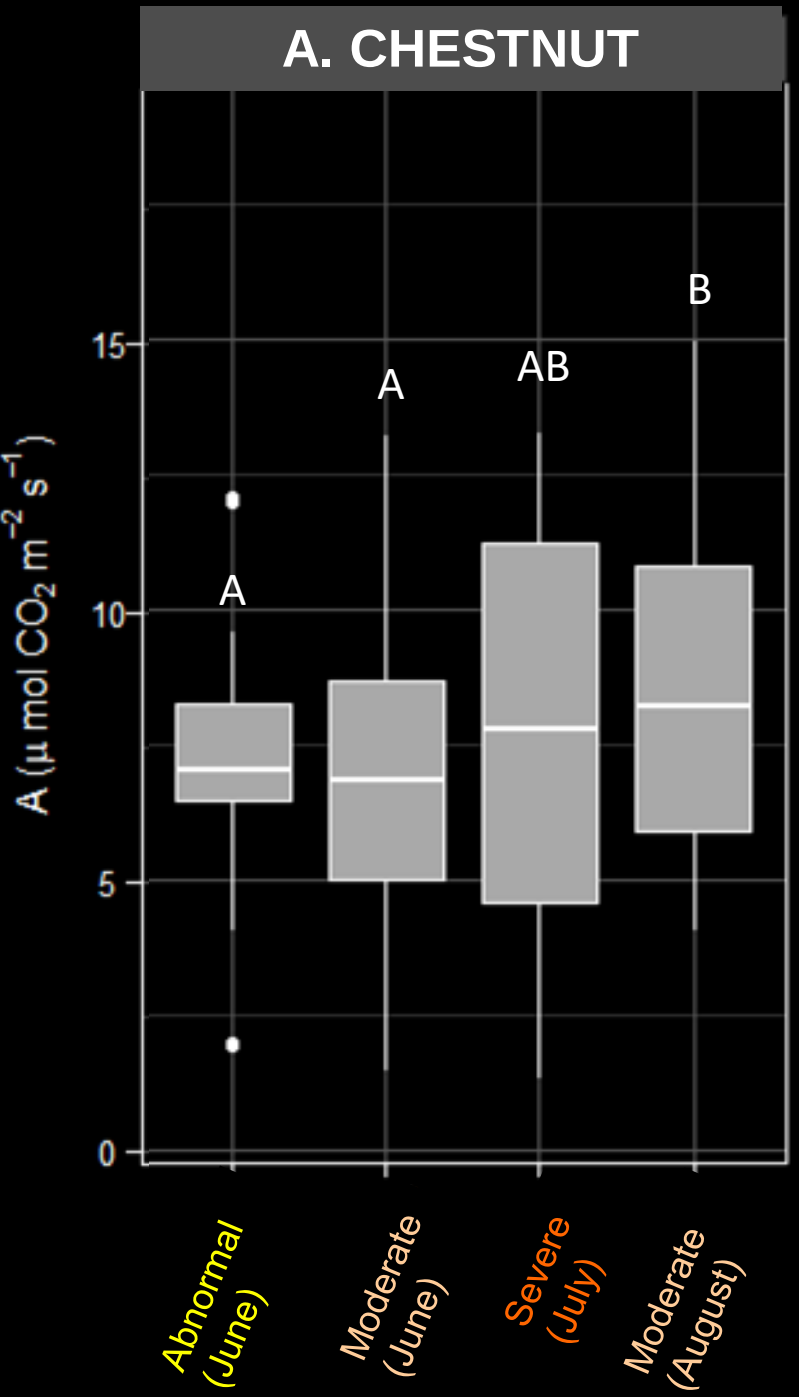
PHOTOSYNTHETIC CAPACTIY



LOW PHOTOSYNTHETIC RATES DURING SEVERE AND MODERATE DROUGHT

EXHIBITING ISOHYDRIC BEHAVIOR

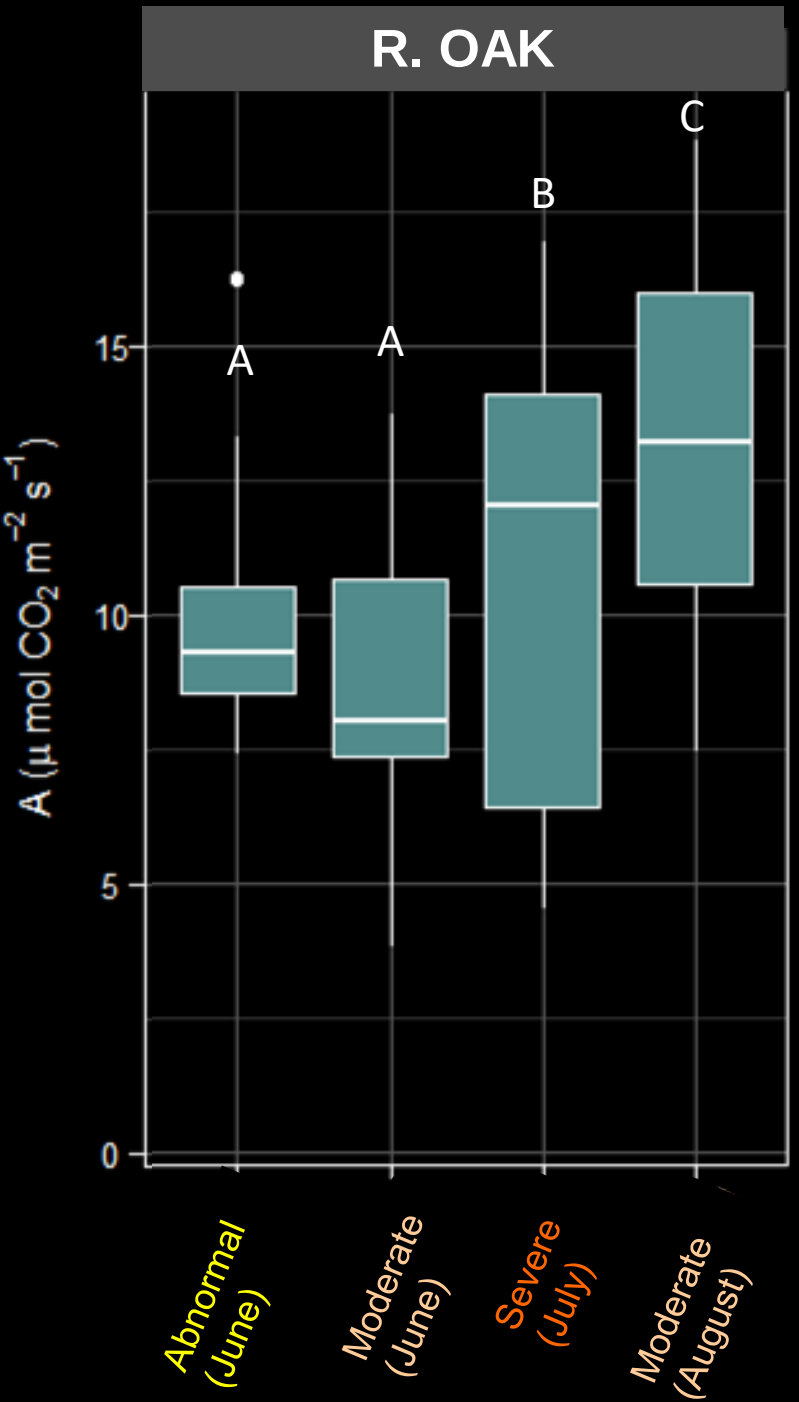
PHOTOSYNTHETIC CAPACTIY



AUGUST AND JUNE PHOTOSYNTHETIC RATES SIGNIFICANTLY DIFFERENT

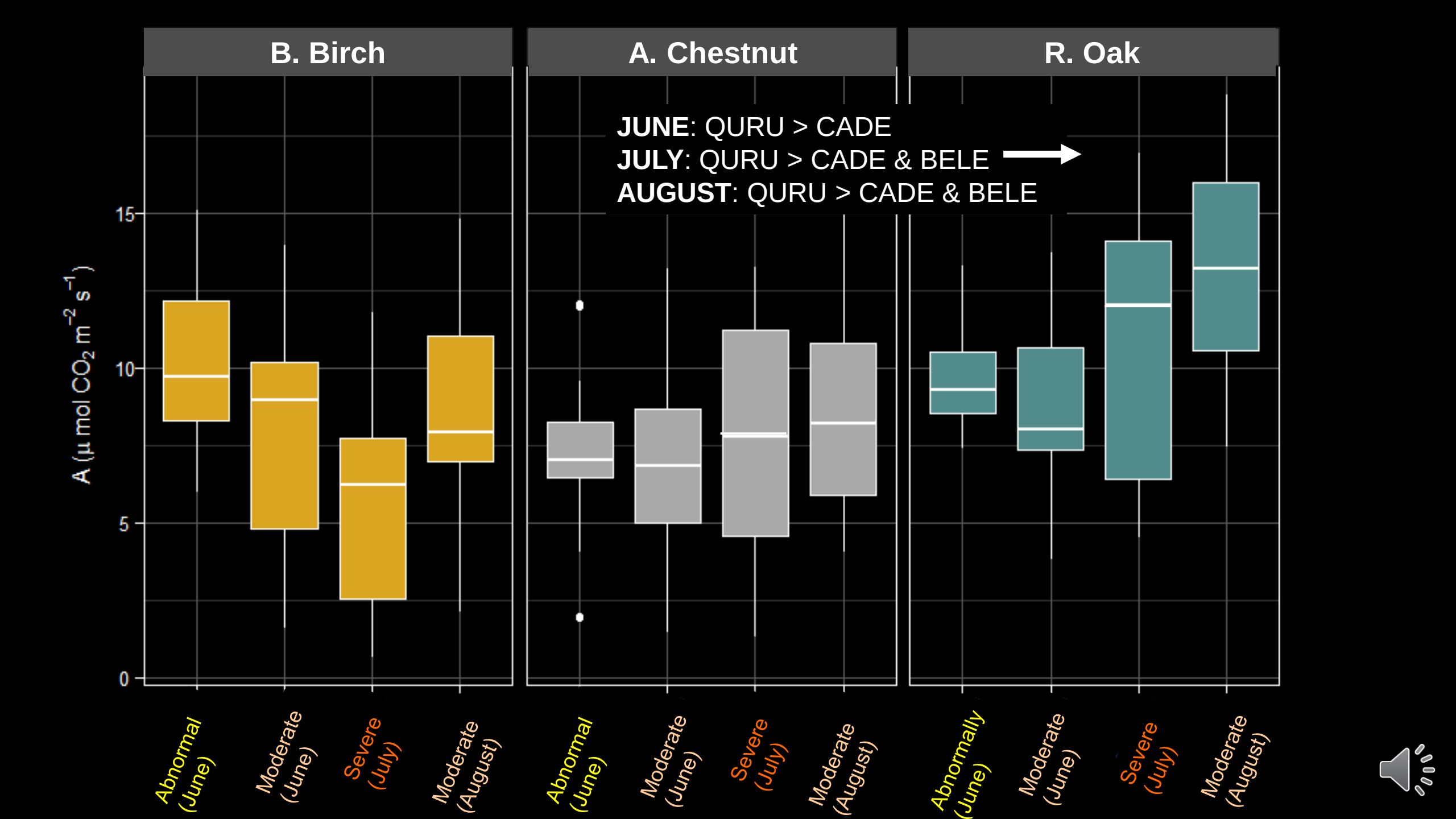
EXHIBITING MODERATE ANISOHYDRIC BEHAVIOR

PHOTOSYNTHETIC CAPACTIY



PHOTOSYNTHETIC RATES INCREASED EACH MONTH

EXHIBITING ANISOHYDRIC BEHAVIOR


B. Birch
A. Chestnut
R. Oak
JUNE: QURU > CADE
JULY: QURU > CADE & BELE
AUGUST: QURU > CADE & BELE
A (μ mol CO2 m-2 s-1)
0
5
10
15
Abnormal (June)
Moderate (June)
Severe (July)
Moderate (August)
Abnormal (June)
Moderate (June)
Severe (July)
Moderate (August)
Abnormally (June)
Moderate (June)
Severe (July)
Moderate (August)

Expected Results

Adapted from Chen et al. 2020

Observed Results

Adapted from Chen et al. 2020

Conclusions

- **Higher survivorship and lower growth found in anisohydric Red Oak**
- **Red Oak and American Chestnut expected to tolerate moderate to severe drought**
- **Black Birch may be more sensitive and susceptible to increased drought frequency and severity**

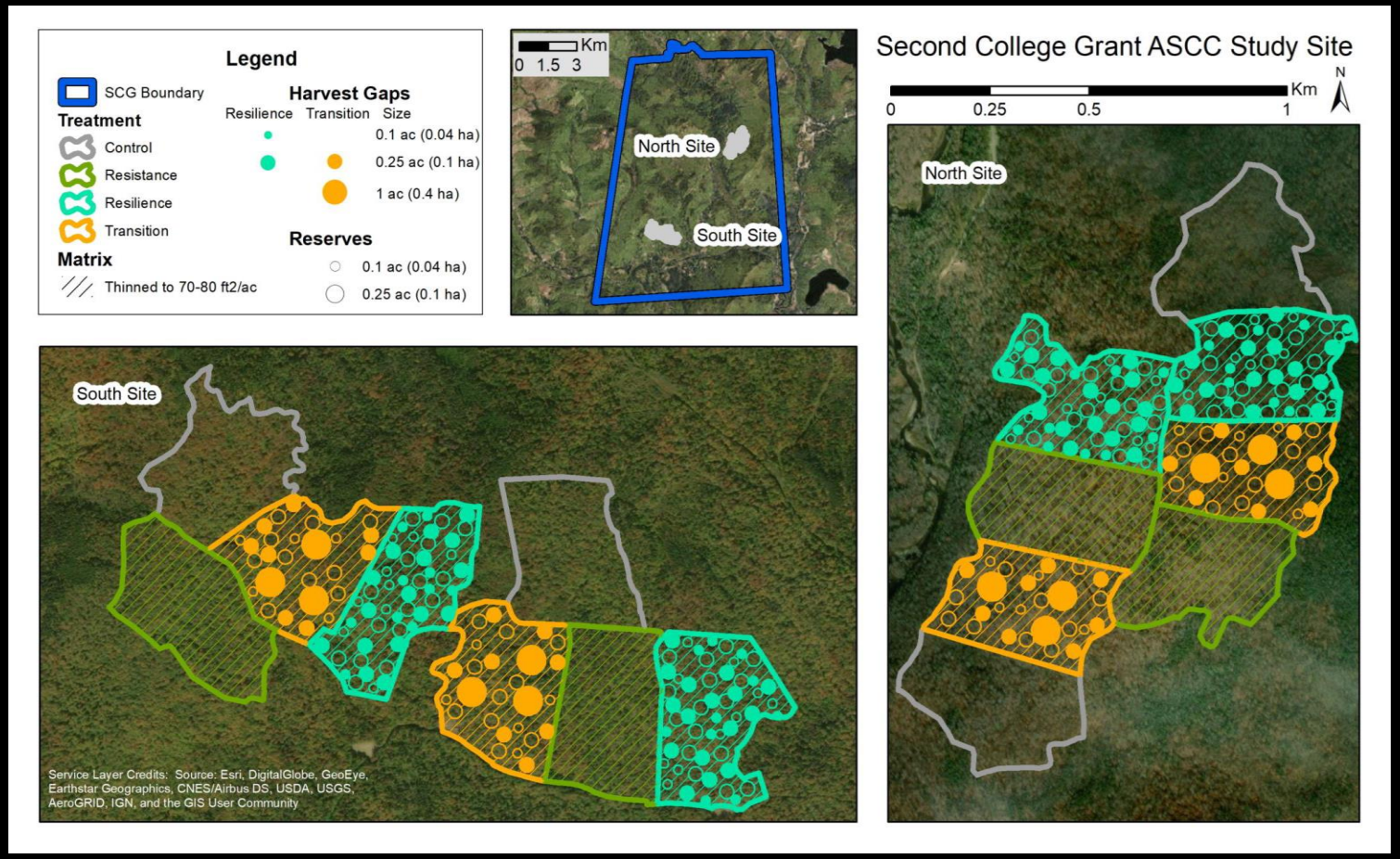
Next Steps:
From the understory to the overstory

- Precipitation Exclusion
  - Black Birch (RE)
  - Red Oak (PE)
  - Basswood (PE)
  - Bitternut Hickory (RE)
  - Black Cherry (PE)

- Determine mortality thresholds for species expected to have population or range expansions

Next Steps:
From the understory to the overstory

- Determine treatment impacts on growth and water relations in overstory species



Acknowledgments

- Tony D’Amato
- Cam McIntire
- Liam Smith
- Kevin Evans
- Jess Wikle
- Pete Clark