Global change impacts on central Appalachian forests

Day 893 of warming experiment

Christy Rollinson coring a *Quercus alba*

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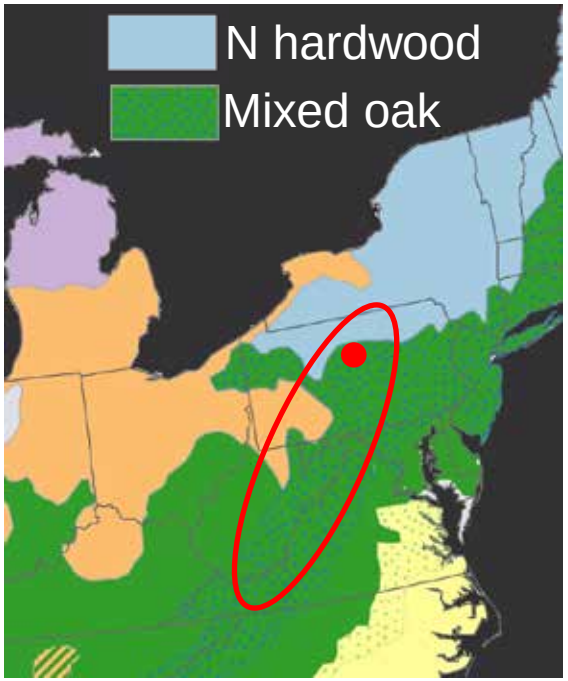
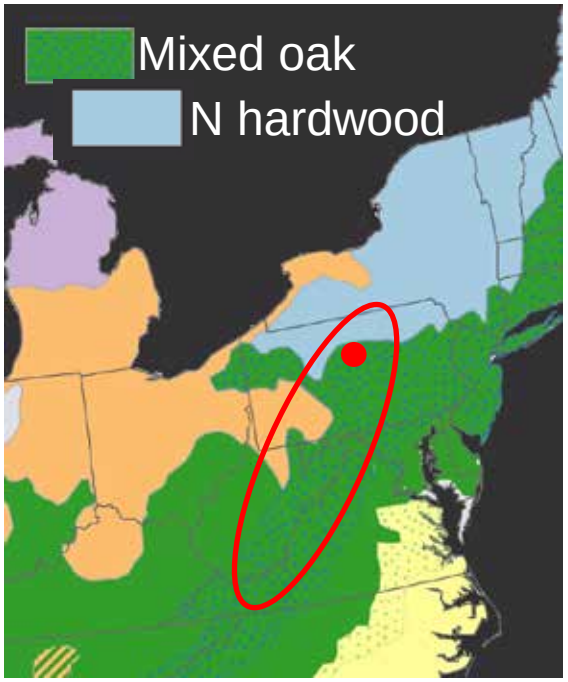
Geographic perspective

- Central Pennsylvania and Central Appalachians
- Ridge and Valley province
- Topographically complex area
- Mixed oak forests
- 80% of forests harvested ~100 years ago



What do we need to understand about forests to ensure their future?

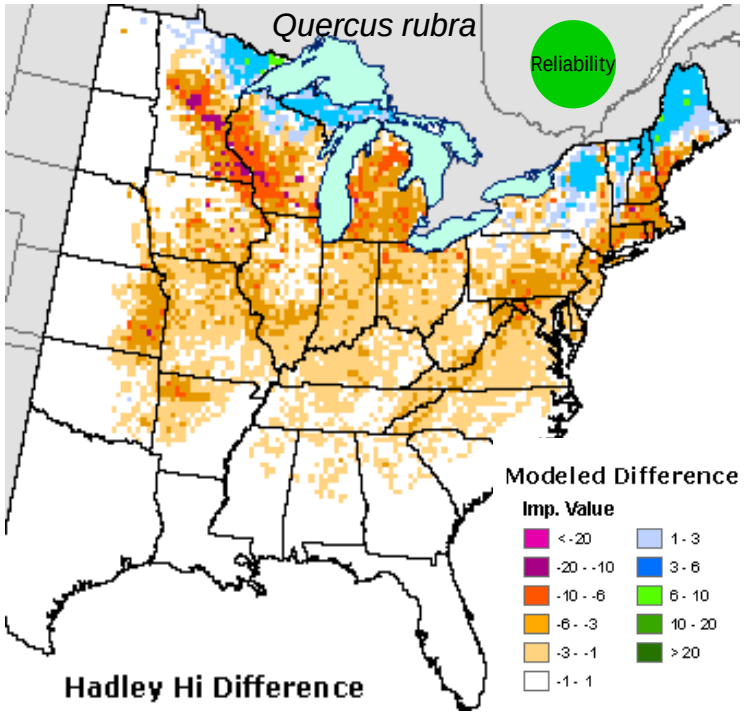


Topics

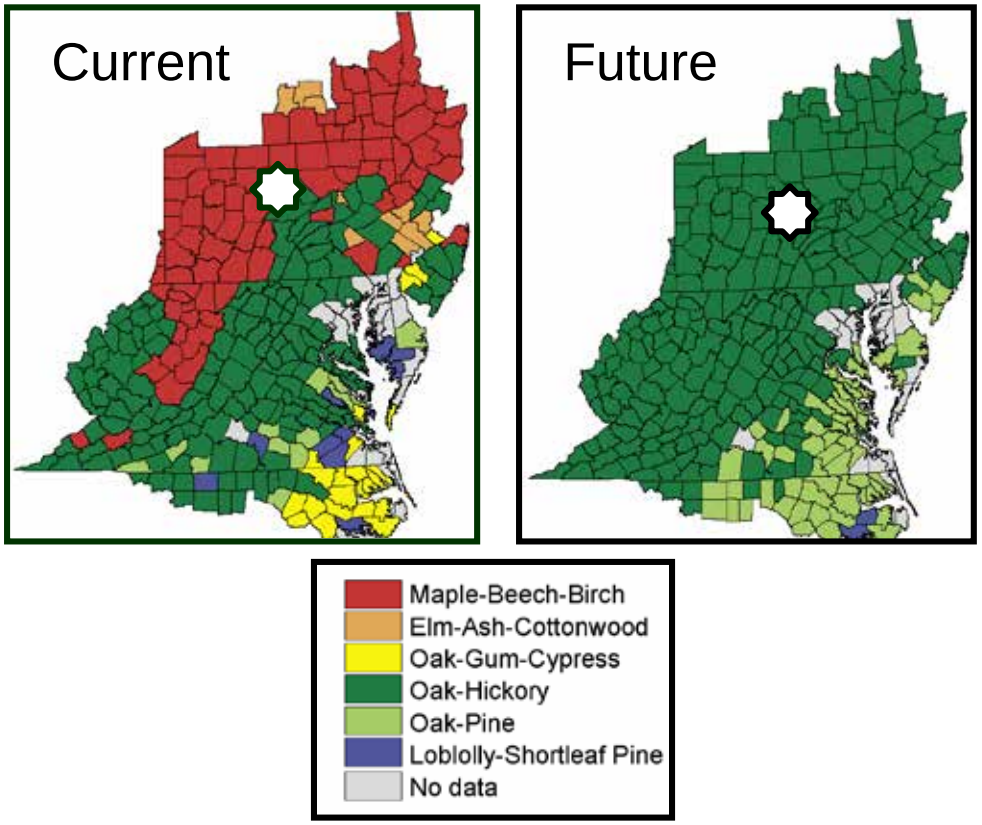
- Climate change and tree regeneration
- Climate and tree growth
- Invasive shrubs
- Topography, bedrock, and forest growth

Climate change and tree species suitable habitat

Northern red oak suitable habitat

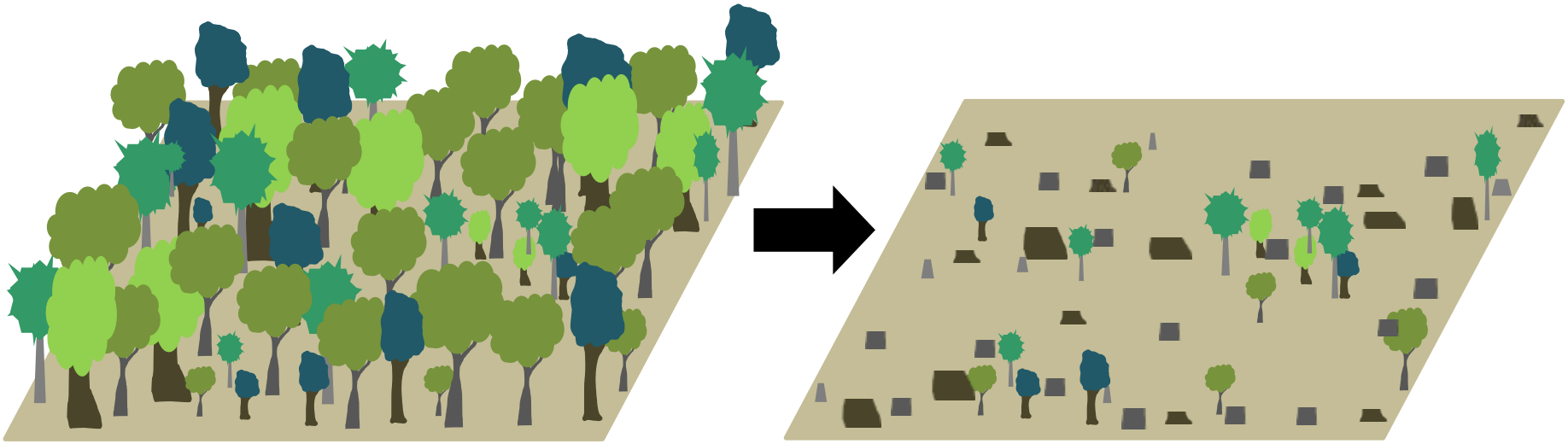


Prasad et al. 2007-ongoing



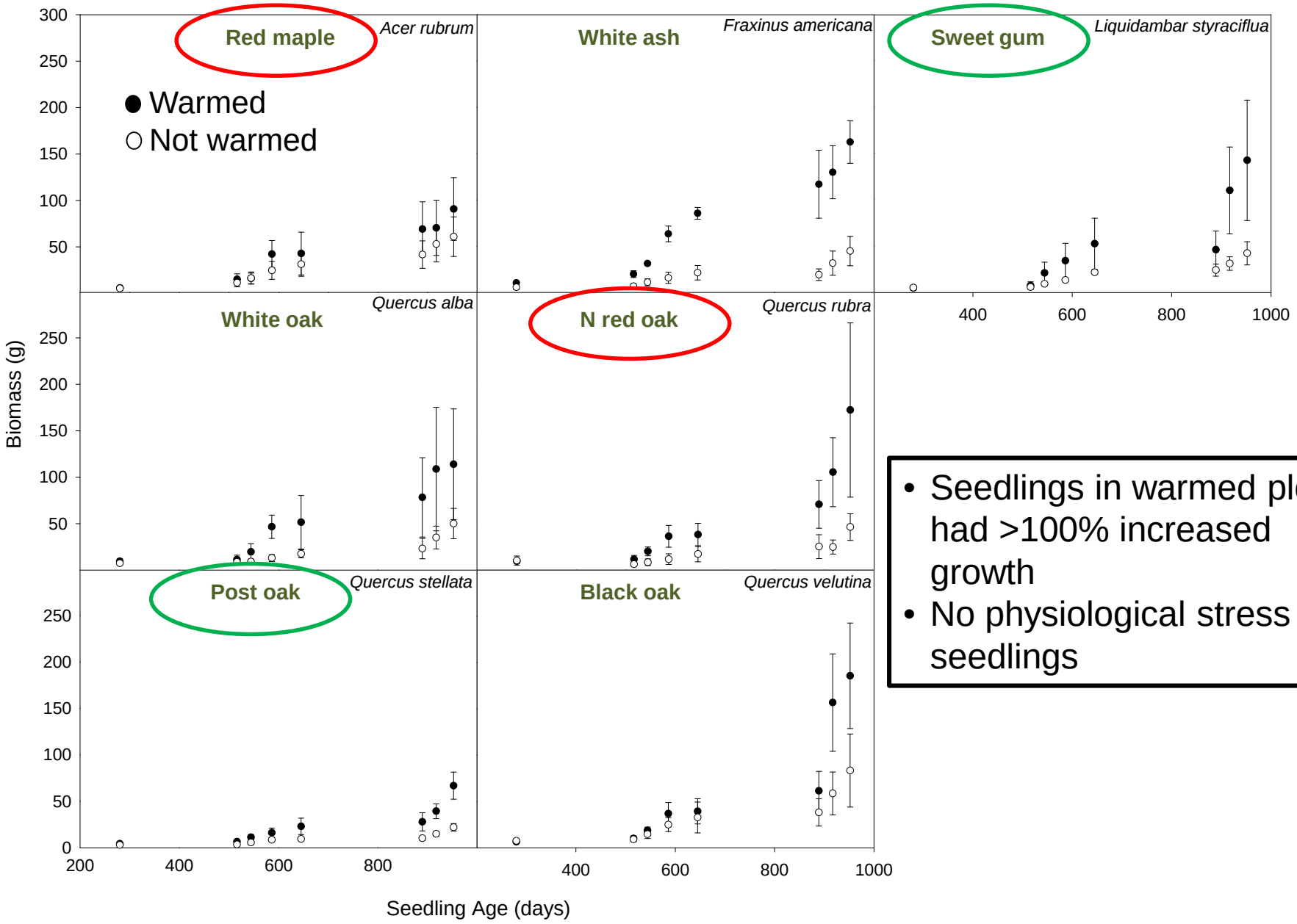
McKenney-Easterling et al. 2000

Climate change impacts on tree regeneration

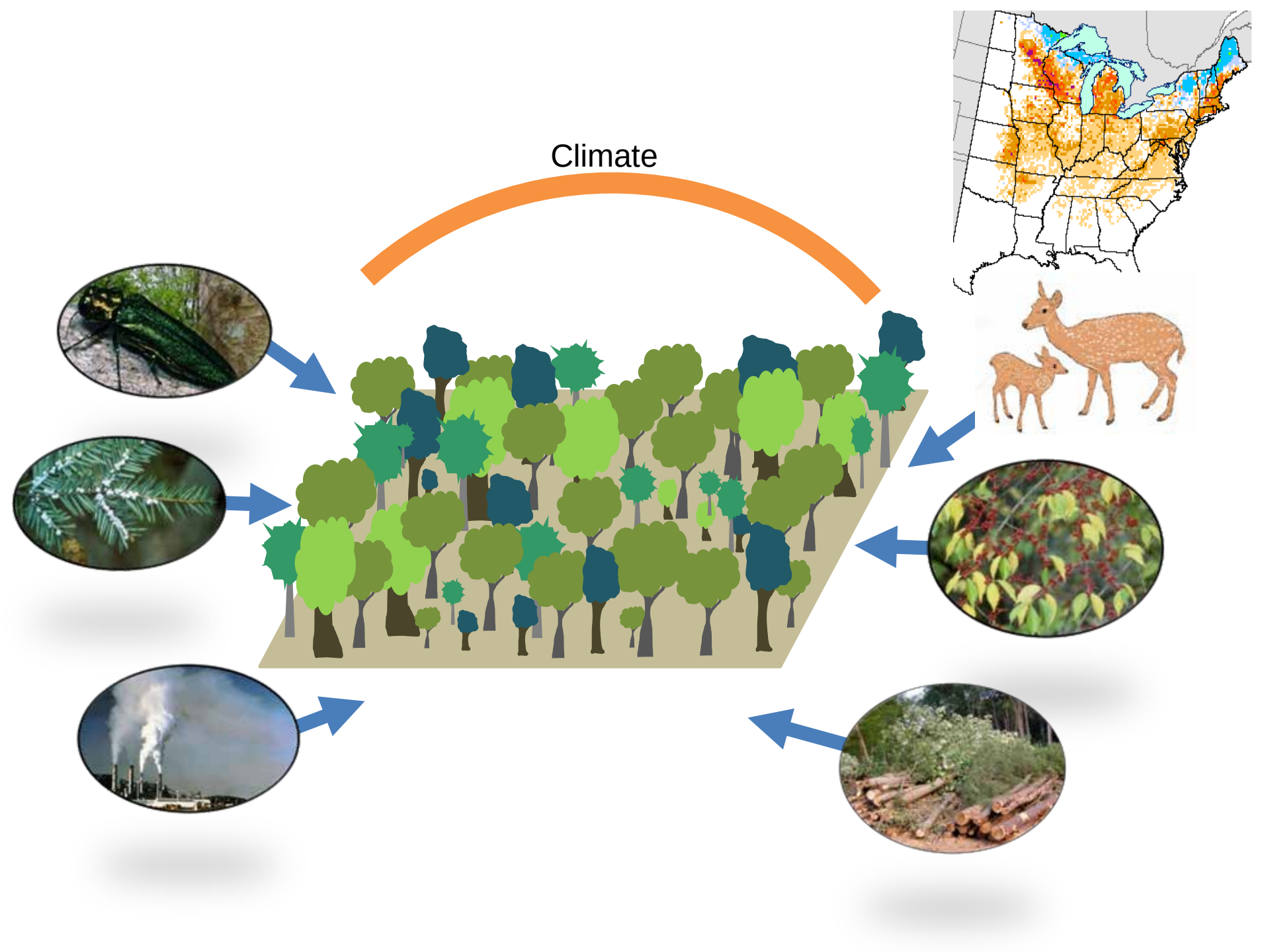


Simulating climate change in a field experiment – 2^0C warmer and 20% wetter

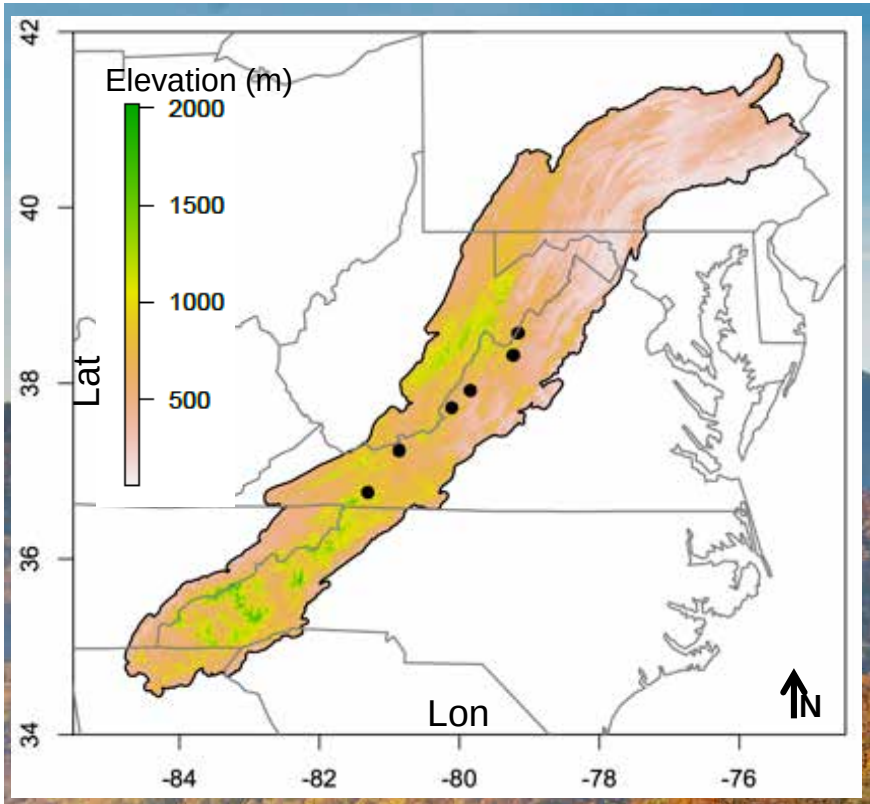
Tree seedling respond to climate change



- Seedlings in warmed plots had >100% increased growth
- No physiological stress in seedlings


Climate

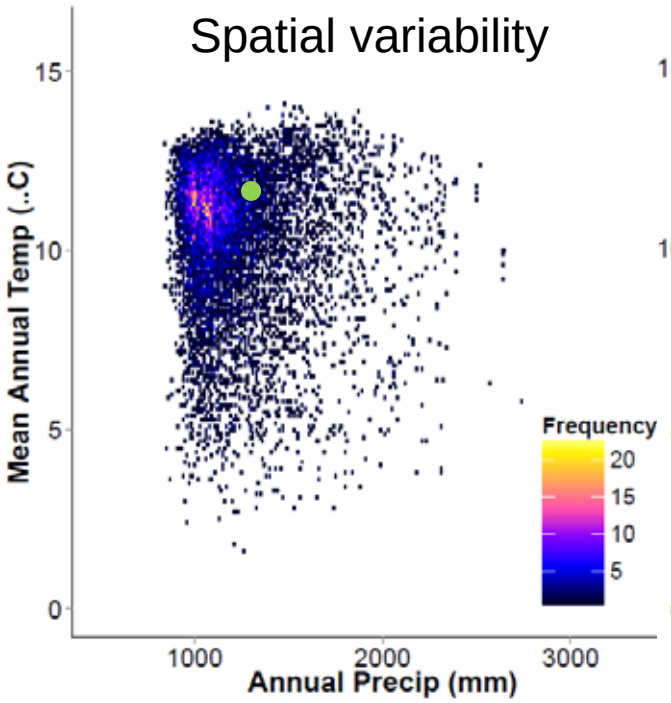
Climate influence on tree growth



Temporal and spatial variability in climate envelopes

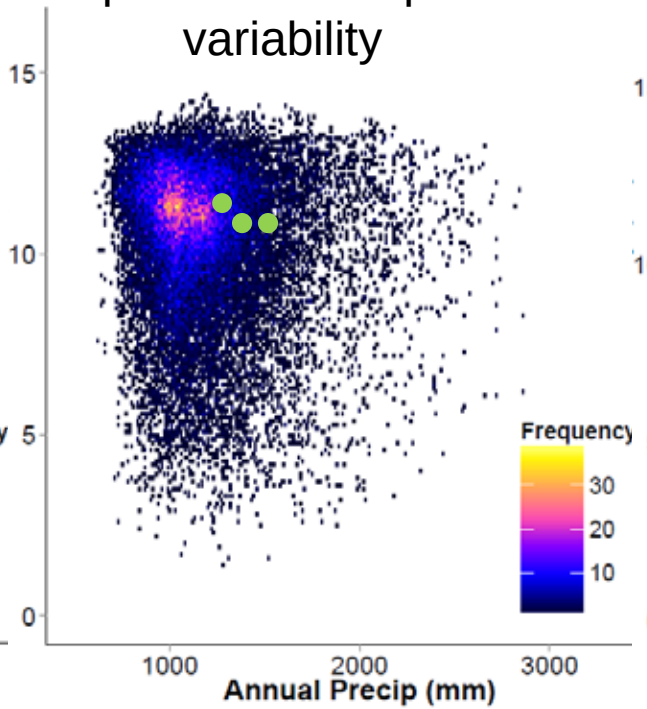
Research plot

Spatial variability



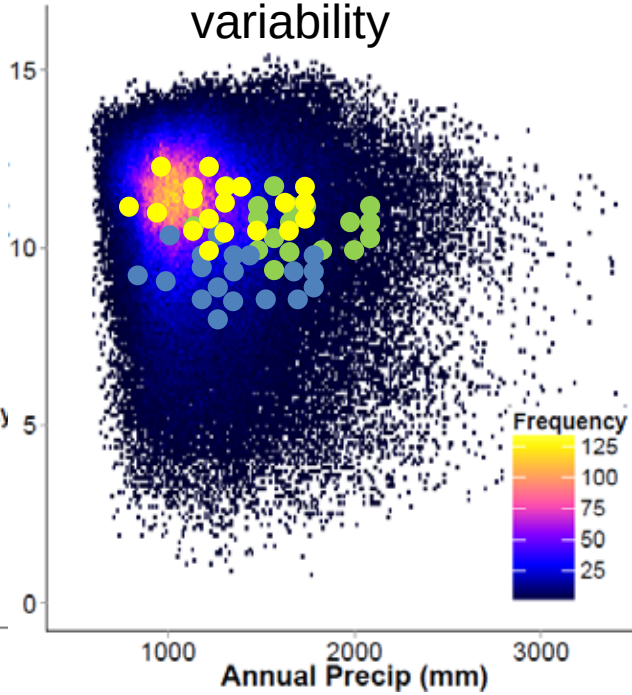
Climate envelope

Spatial and temporal variability



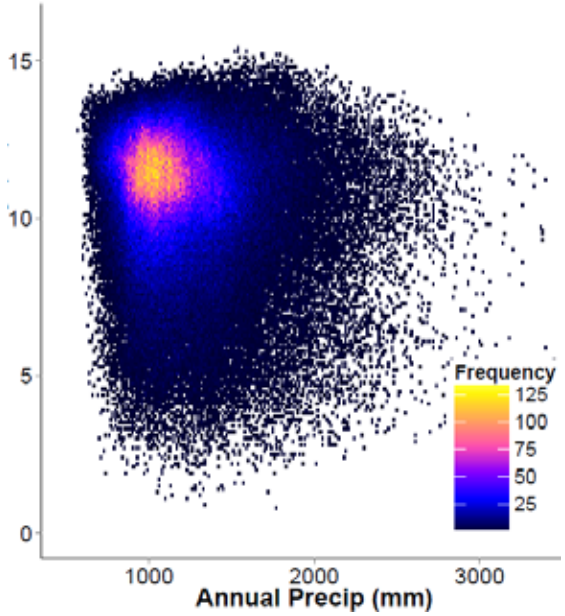
2008, 2009, 2010 climate envelope

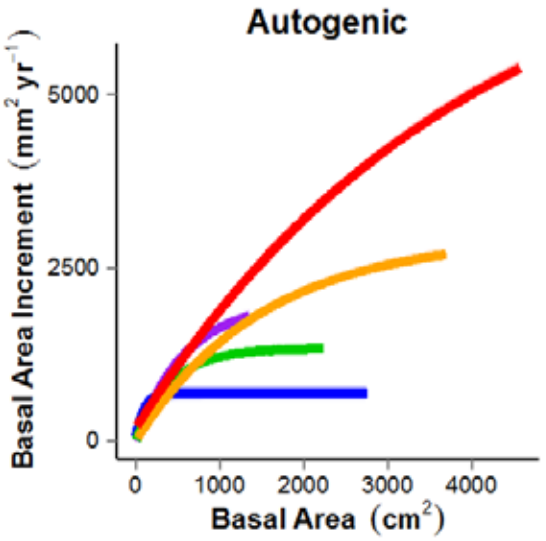
Spatial and temporal variability

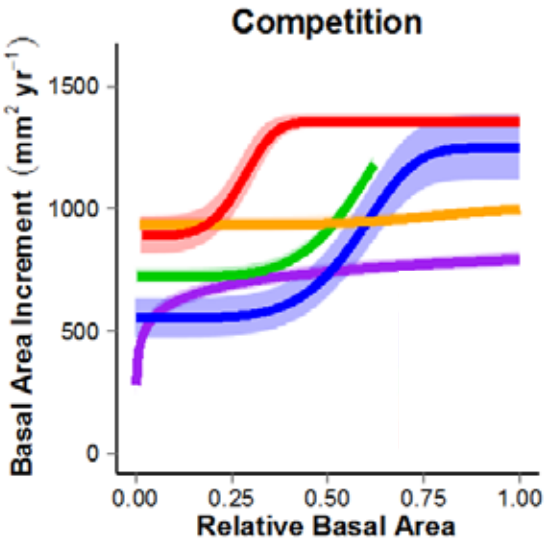


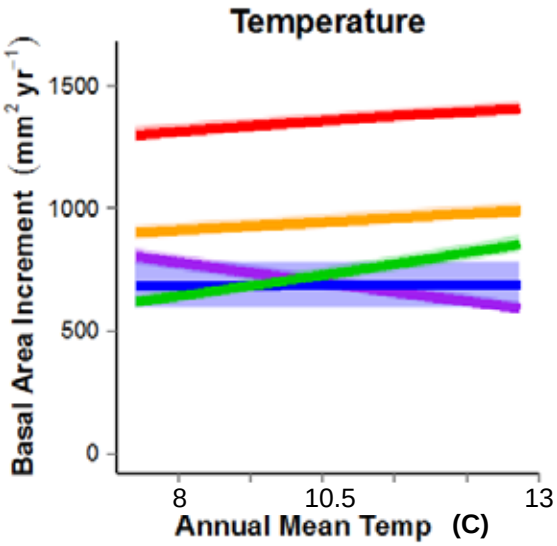
1990-2010 annual climate envelope

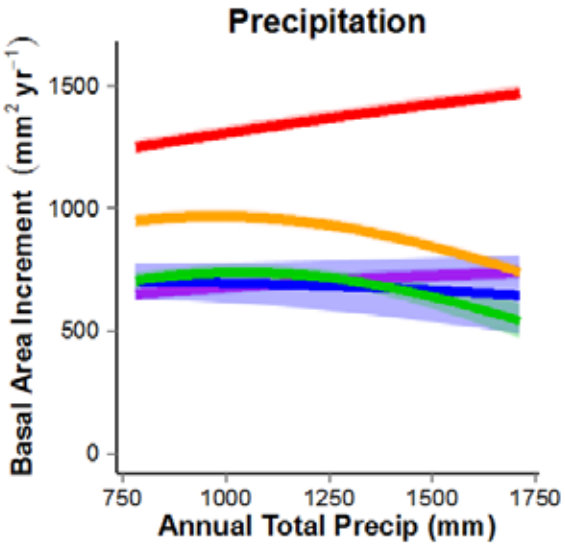
Climate and competition effects on tree growth





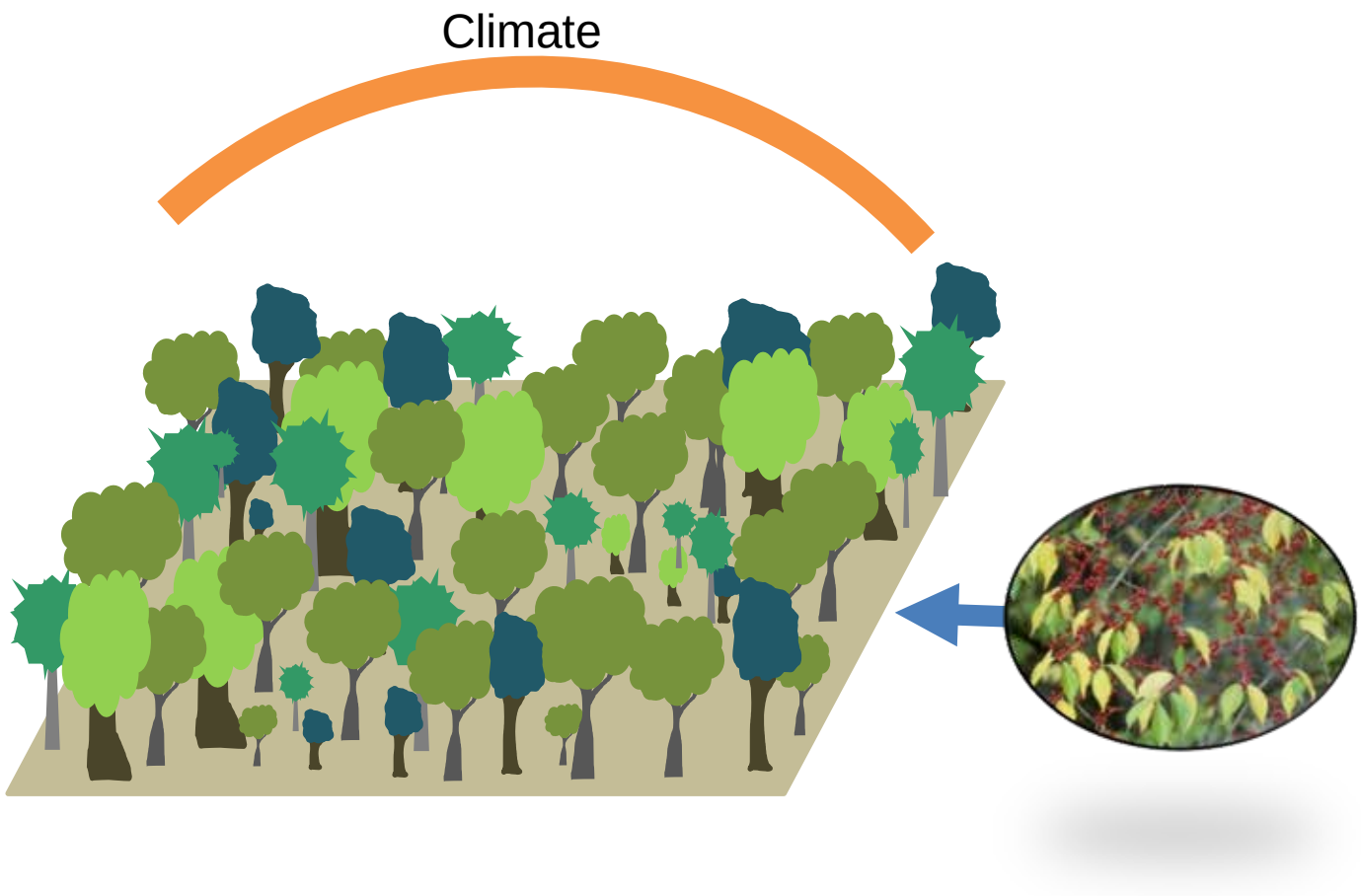






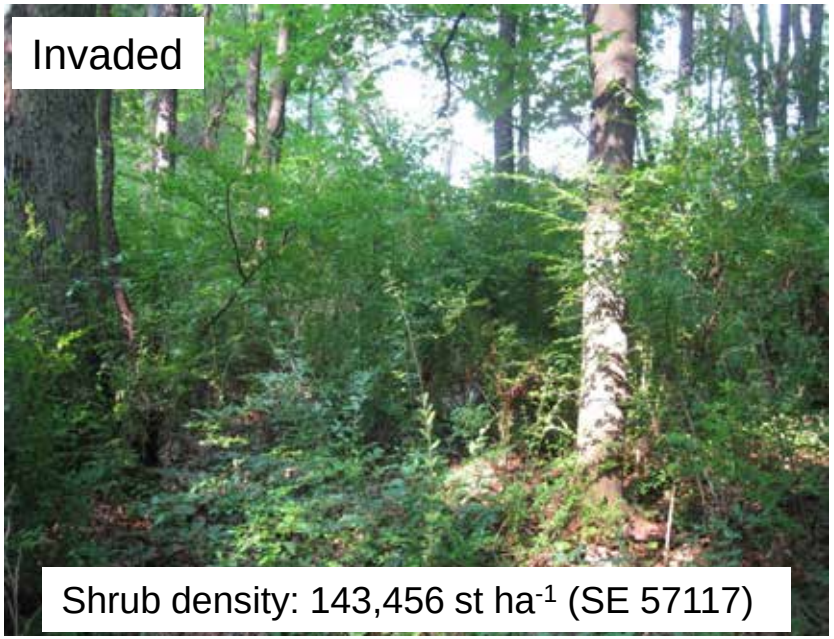
- Northern red oak, chestnut oak, and black gum grow more when warmer
- Northern red oak grows more when wetter
- Competition has the greatest effect on tree growth

Rollinson et al. 2012

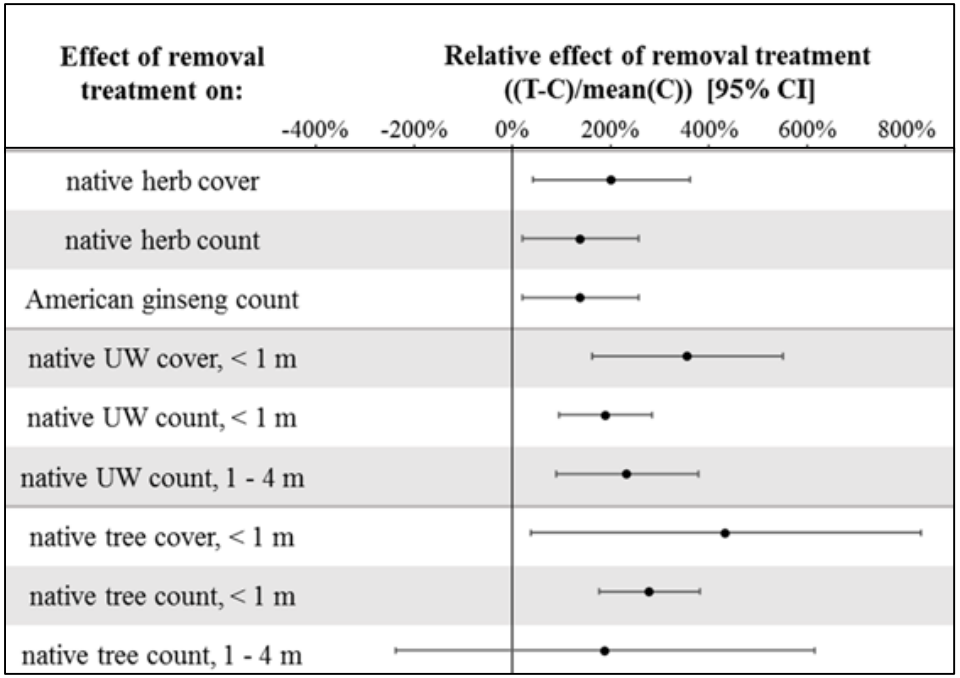


- Species respond positively to warmer temperatures
- Climate influence is modified by competition from other plants

Native species response to invasive shrub removal

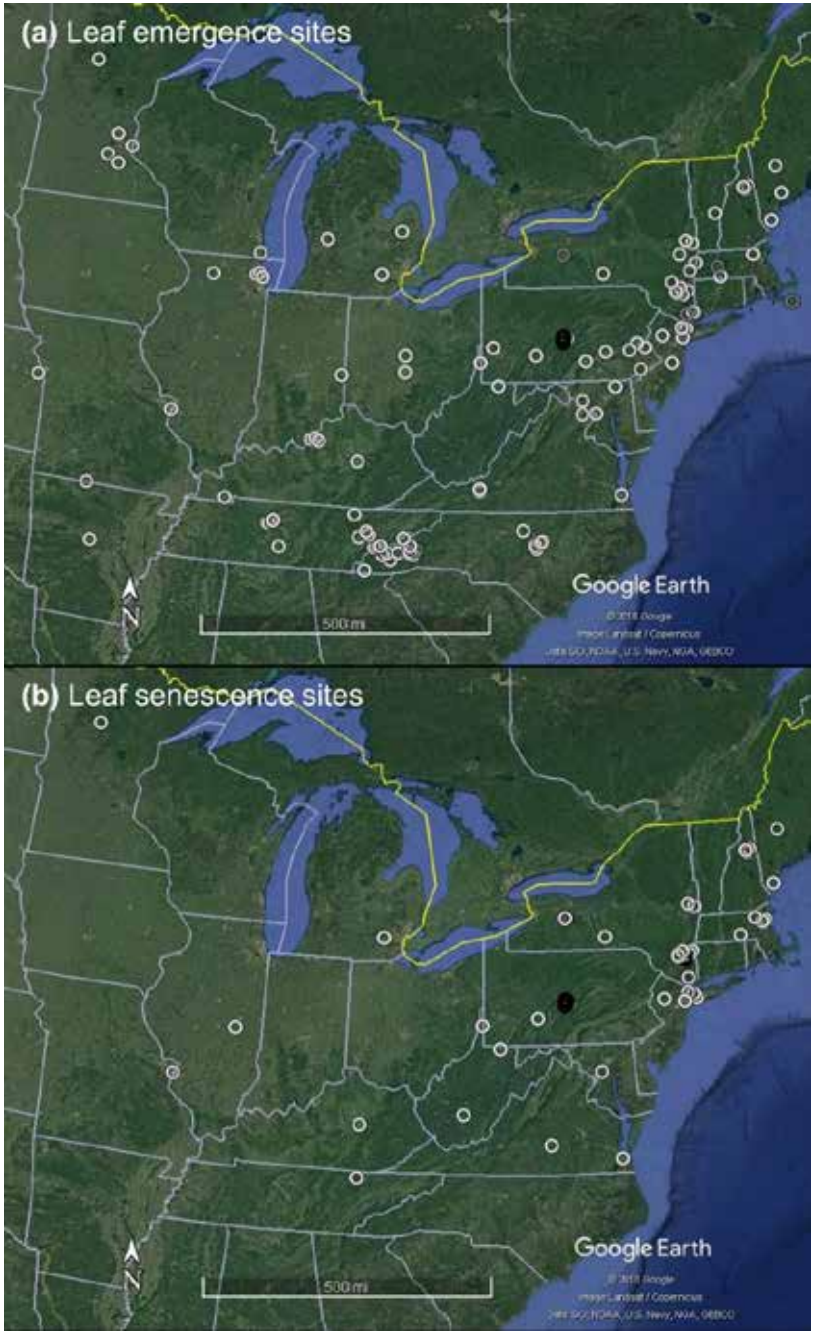


- Positive response of native species to invasive removal



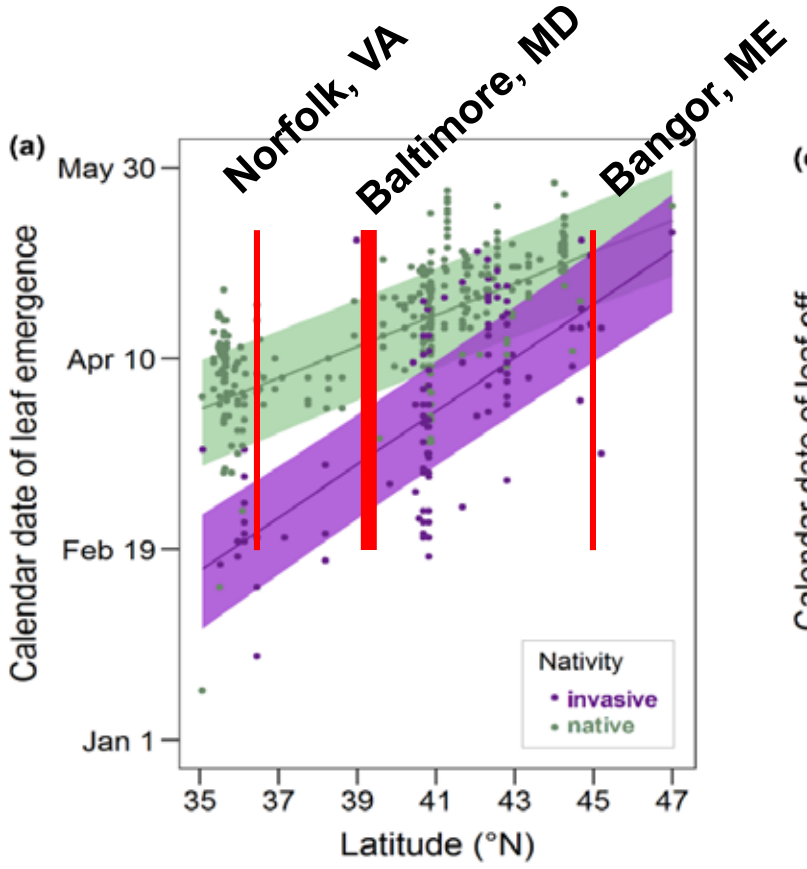
Maynard-Bean and Kaye 2019

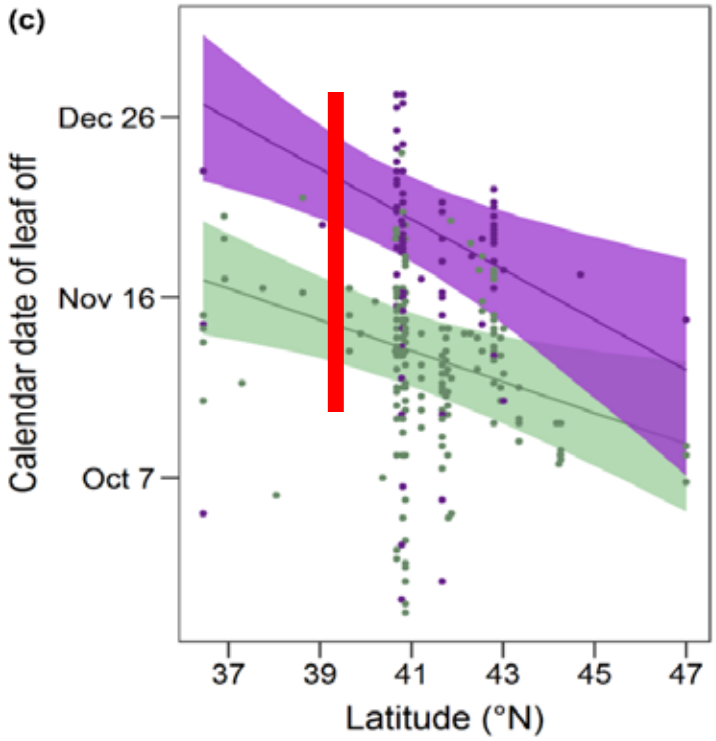
Extended leaf phenology

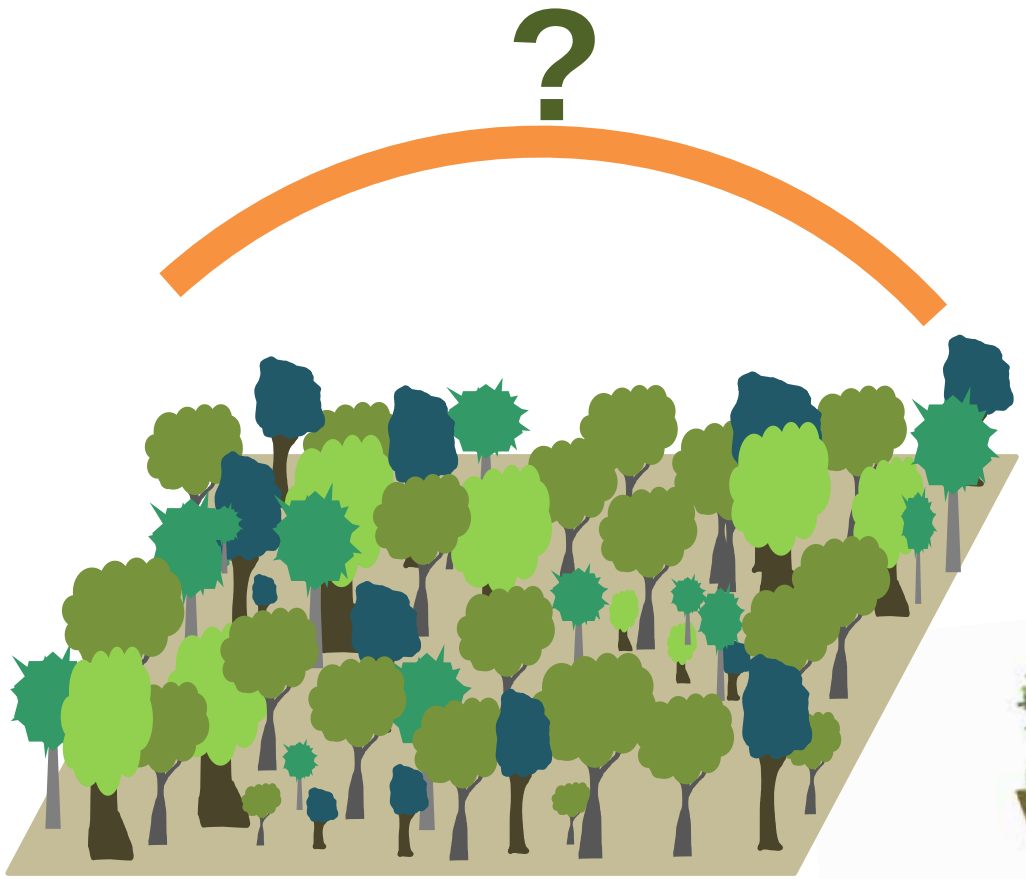


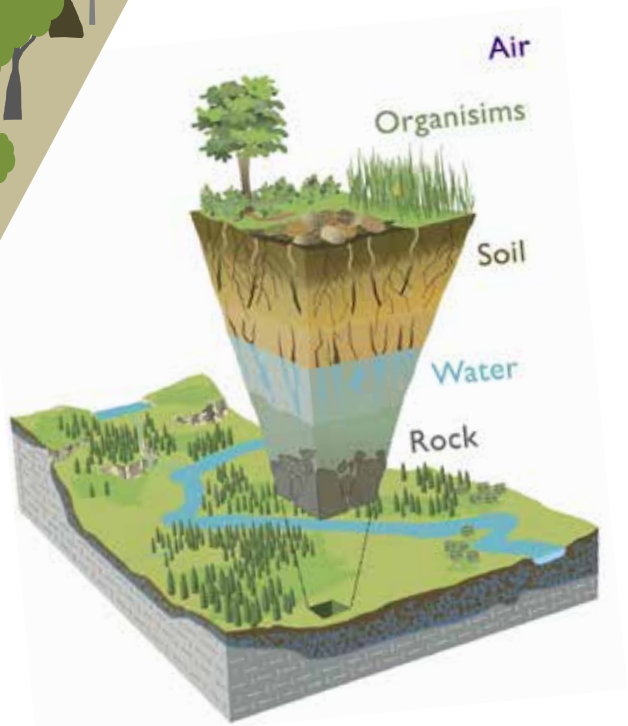
Extended leaf phenology

- Invasive shrub leaf emergence 15 to 38 days earlier
- Leaf off 22 to 39 days later





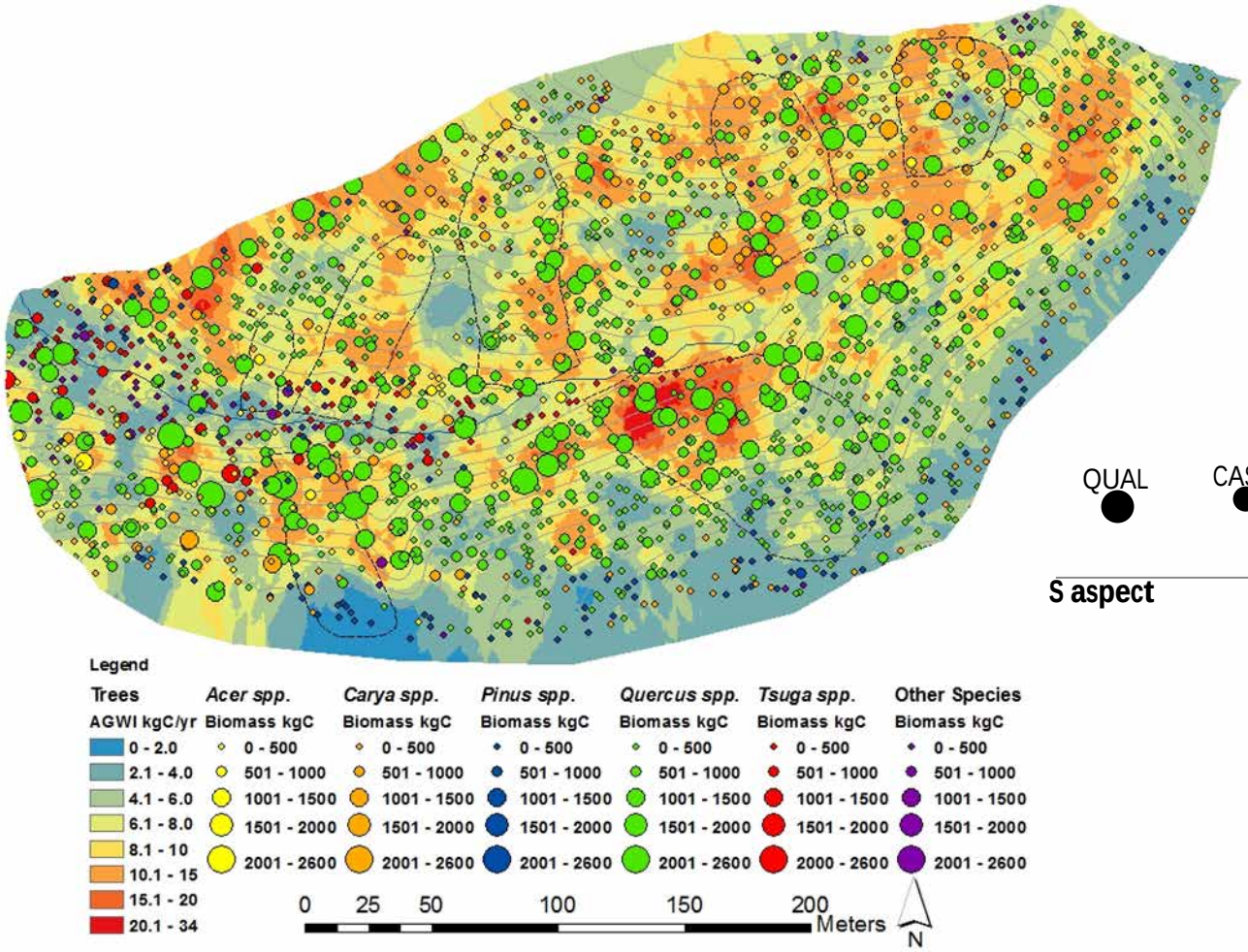


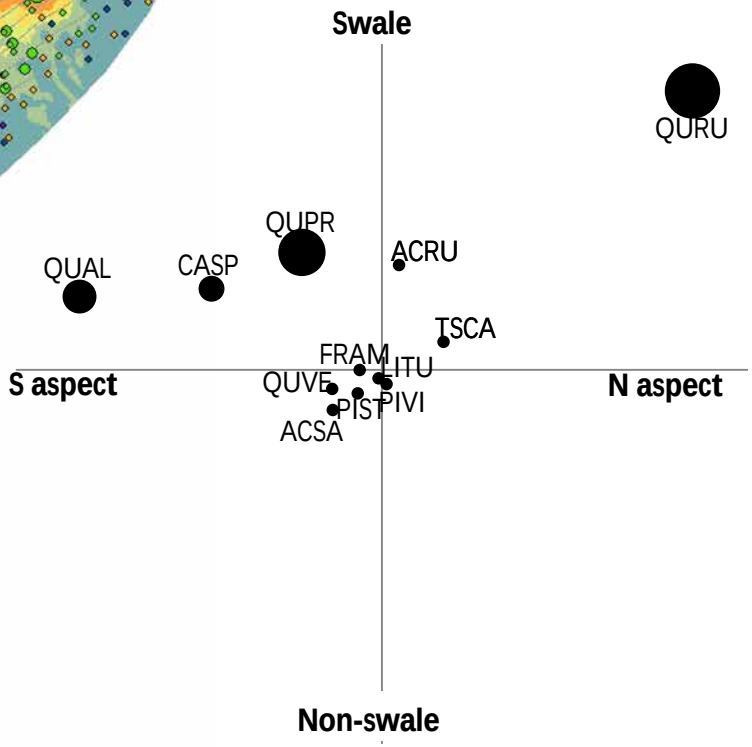


Critical Zone – from bedrock to canopy top

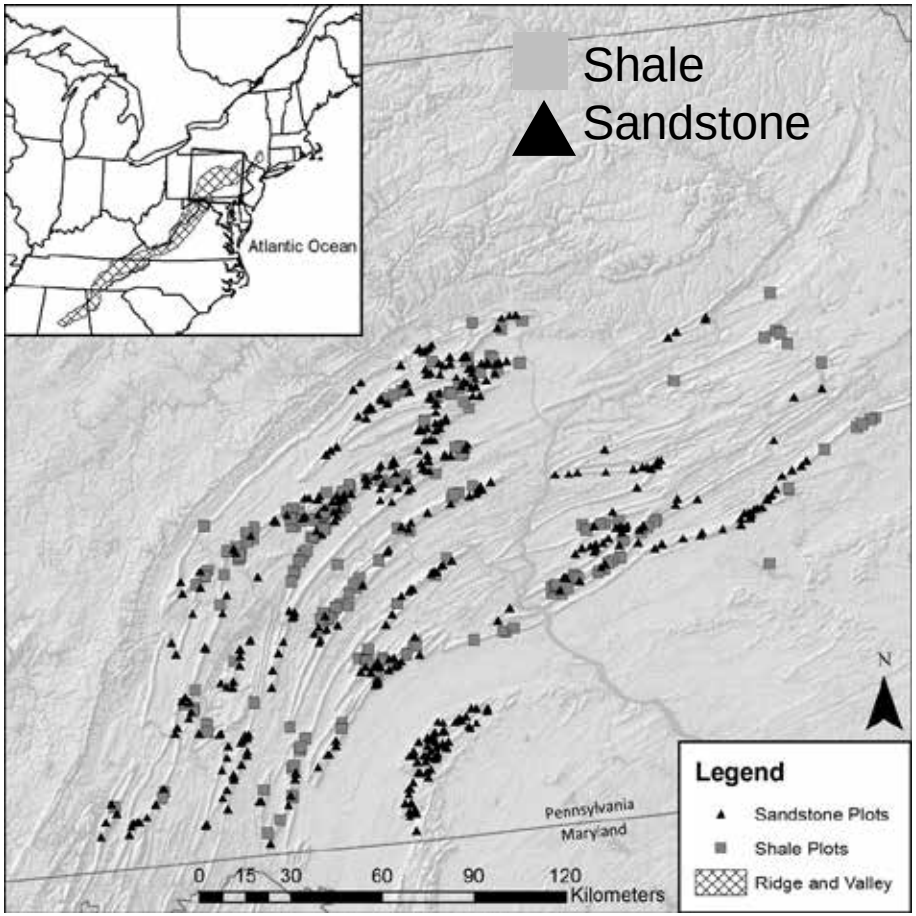
Topography effects on forest productivity

- Carbon uptake 20% greater on south vs north aspects
- 30% greater on swales vs planar slopes
- Northern red oak most productive species, optimized on swales and north aspects



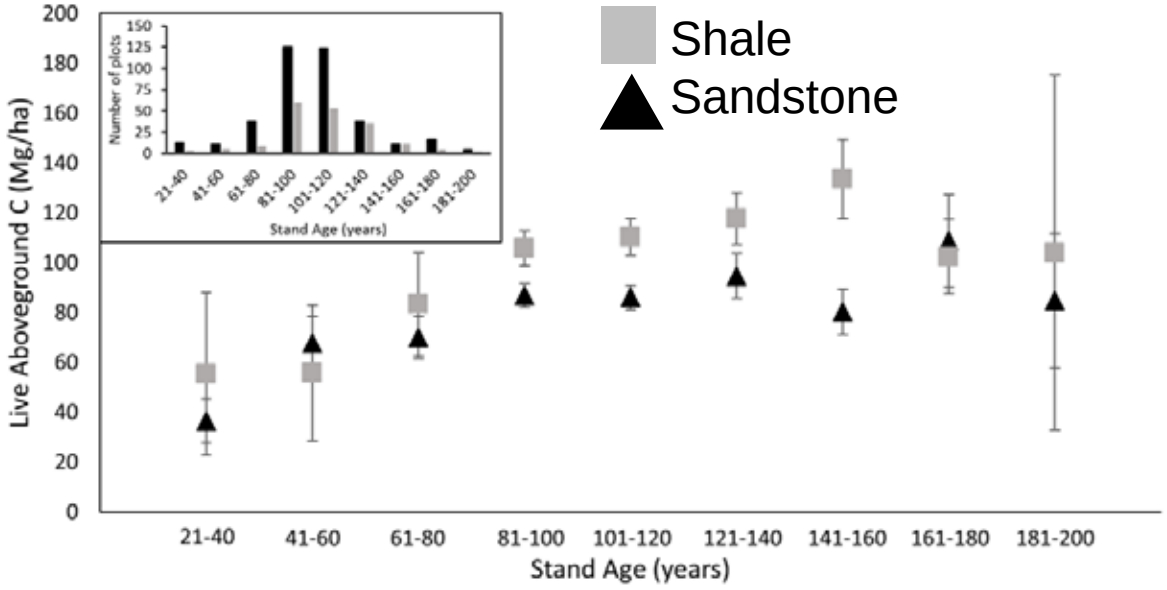


Bedrock effects on forest productivity

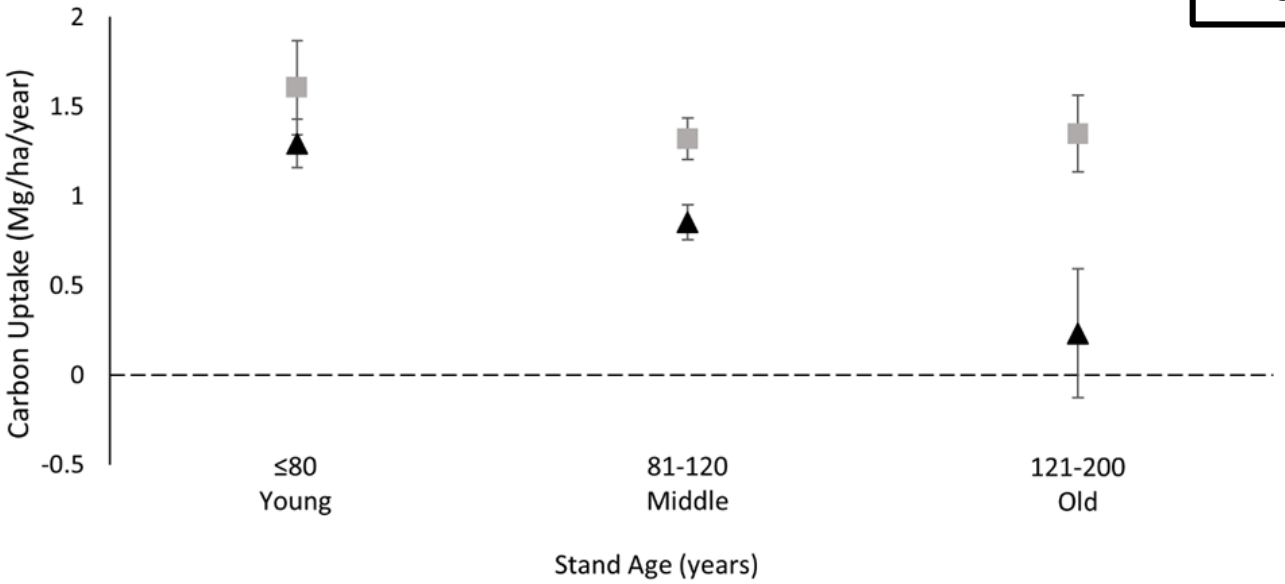


Structural metric	Sandstone (S.E.M.)	Shale (S.E.M.)	p-value
Stem density (trees/ha)	**507.6 (9.4)**	426.3 (11.7)	<0.0001
Basal area (m^2/ha)	25.4 (0.40)	**29.2 (0.56)**	<0.0001
Maximum tree height (m)	23.0 (0.26)	**29.0 (0.39**)	<0.0001
Maximum tree DBH (cm)	48.0 (0.61)	**57.6 (1.02)**	<0.0001

Bedrock effects on forest productivity



- Forests on shale have higher basal area, species richness, and taller trees
- Forests on shale store 25% more carbon and uptake 55% more carbon



Adaptation planning and practices

- Manage competition from other vegetation
- Invasive removal may be more important in southern latitudes and can yield positive results in native species
- Target areas, such as shale in the central Appalachains, for conservation, carbon uptake and storage, and climate adaptation

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nature's notebook
A project of the USA-NPN