



SMITHSONIAN
ENVIRONMENTAL
RESEARCH CENTER

Smithsonian

Better Reforestation: *BiodiversiTREE* (est. 2013) & *Functional Forests*
(2026)

John D. Parker & Justin Nowakowski (SERC PIs)

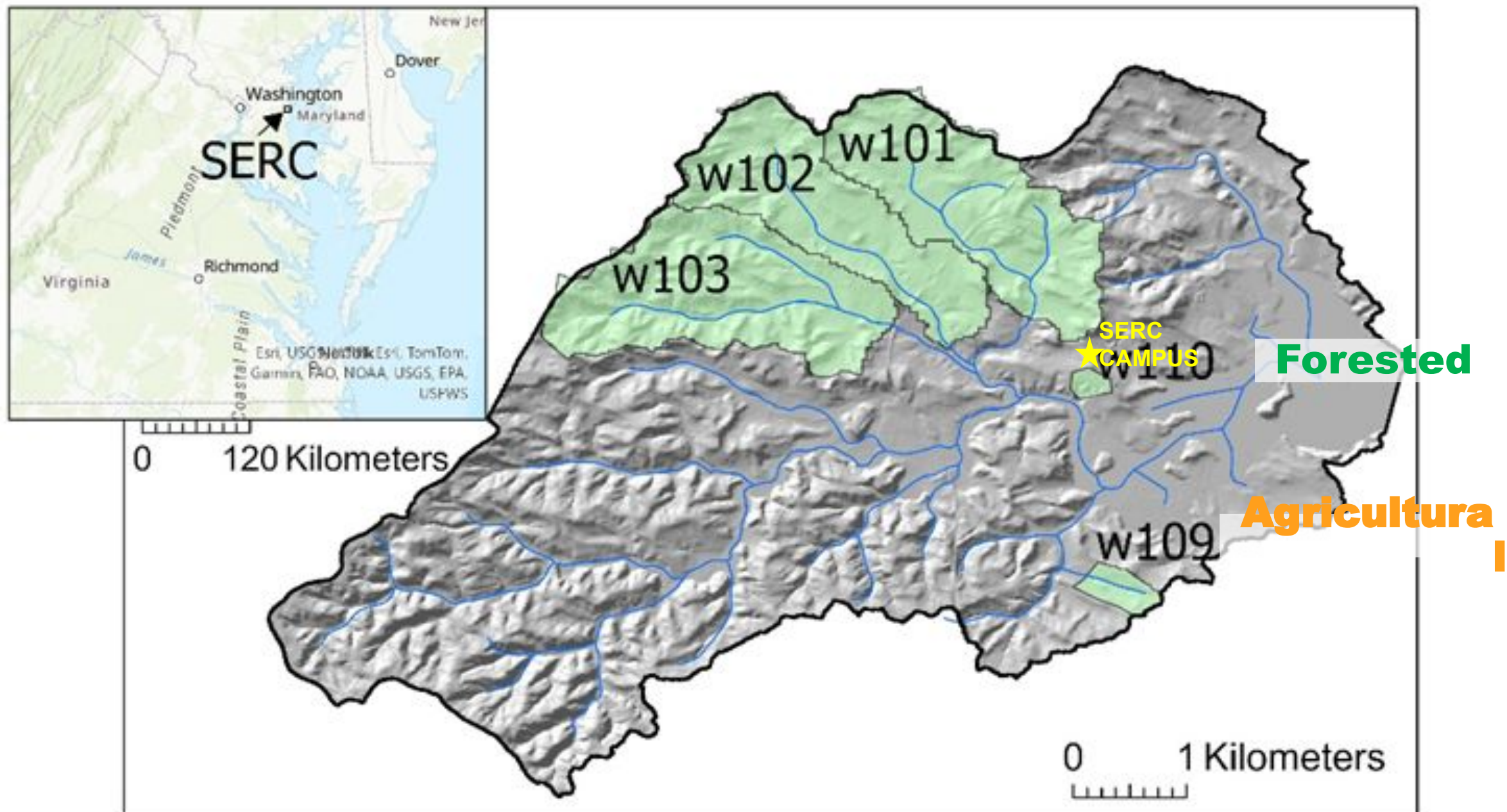
4+ sq miles, 15+ miles of shoreline, farmland, forests, marshes, streams...

***A 'living laboratory' for environmental research since
1965***



SERC RESEARCH PRIORITY: IMPACTS OF LANDCOVER ON WATER QUALITY





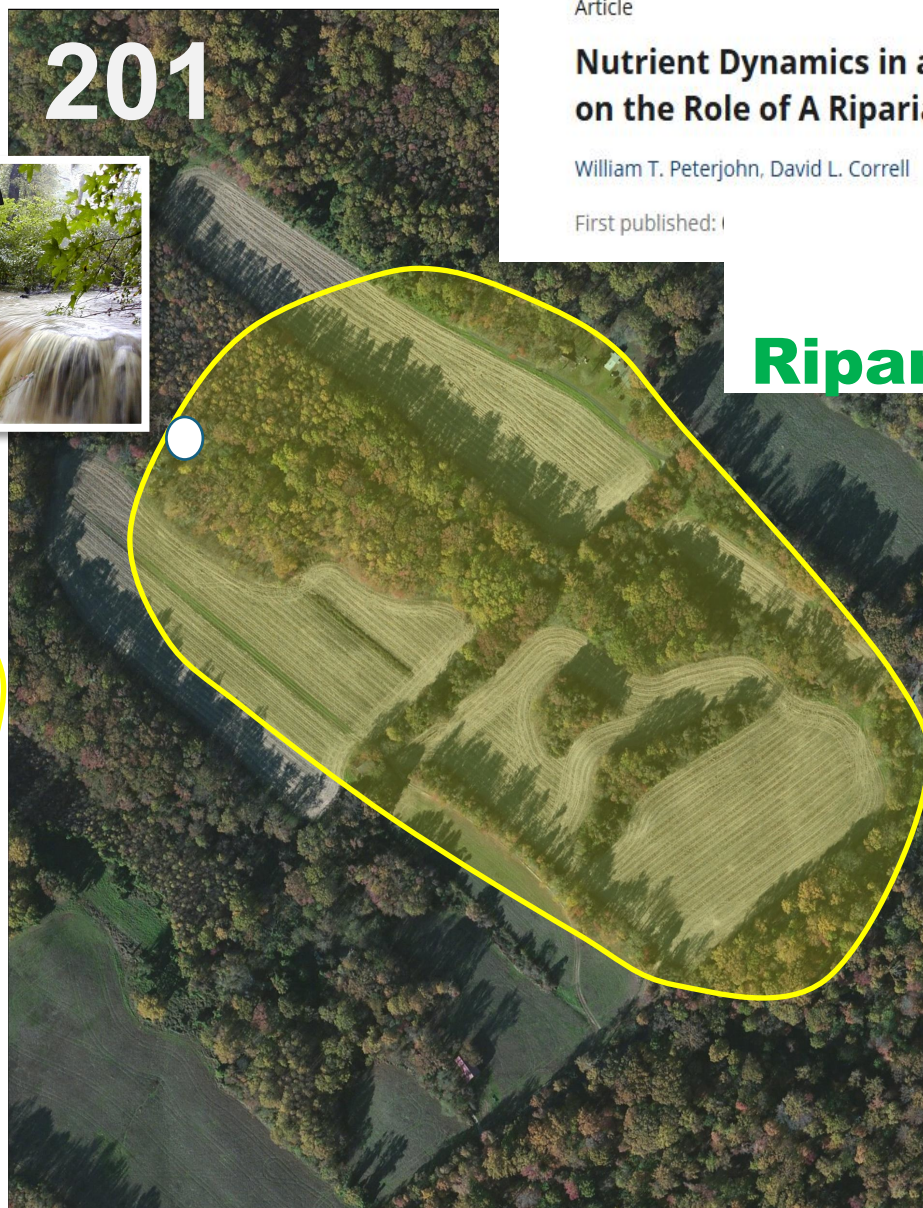
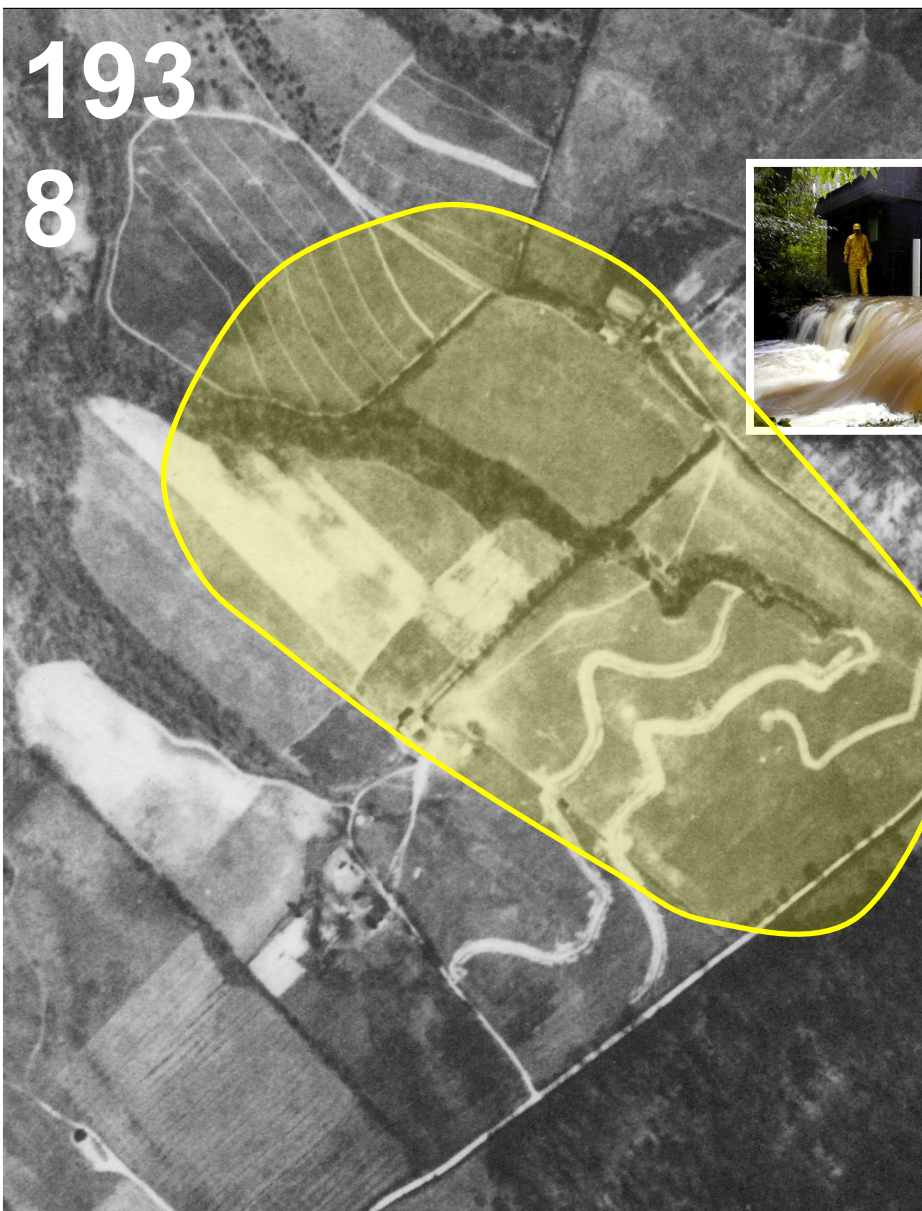
Watershed 109: 40yrs of riparian buffer research

Article

Nutrient Dynamics in an Agricultural Watershed: Observations on the Role of A Riparian Forest

William T. Peterjohn, David L. Correll

First published: 1



N retention
Cropland = 8%
Riparian forest = 89%

**Cited ~2400x
(48x/year) by
scientists...**

& 139x in policy

**After ~40yrs as corn, how can we
learn something different from
watershed 109?**

Plant trees (for \$\$\$)!!!



**NEARLY ALL FOREST PLANTATIONS ARE
MONOCULTURES
(7% *global total*)**



**REFORESTATION
AS NATURAL
CLIMATE
SOLUTION**

**~1 TRILLION
NEW TREES
PLEGGED**

**ALMOST NO
MONITORING,
MANY FAIL,
MAJORITY ARE
MONOCULTURE
S**

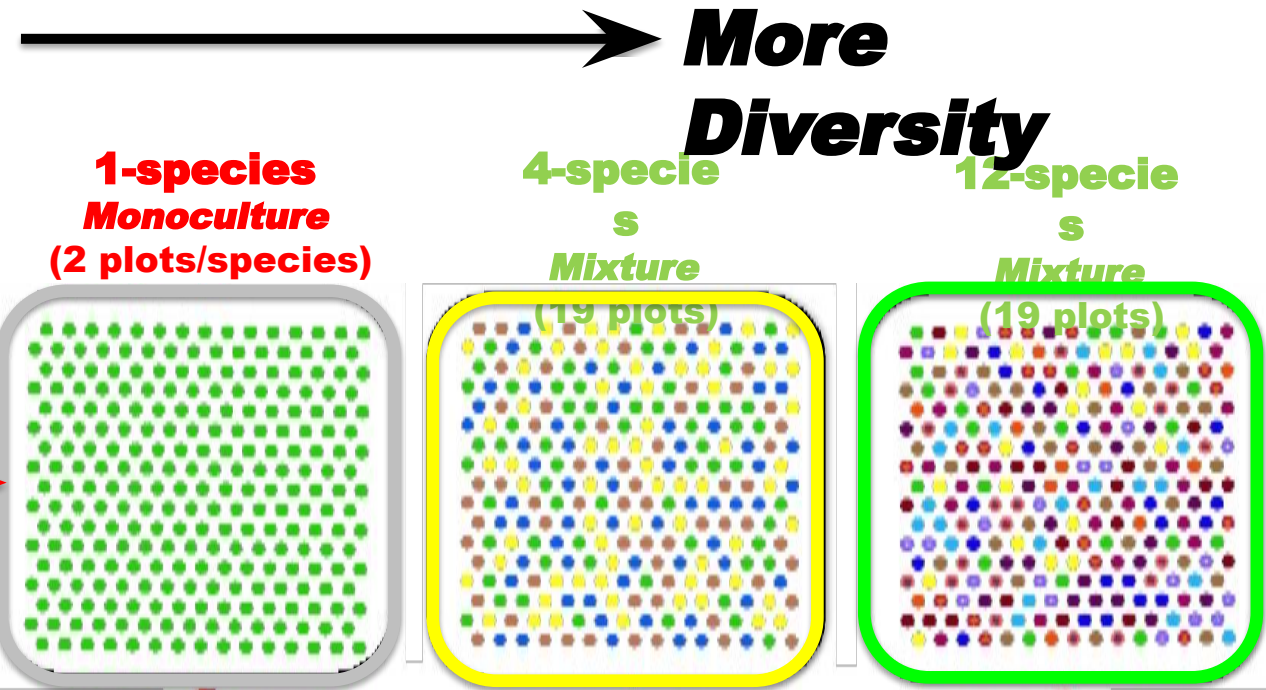
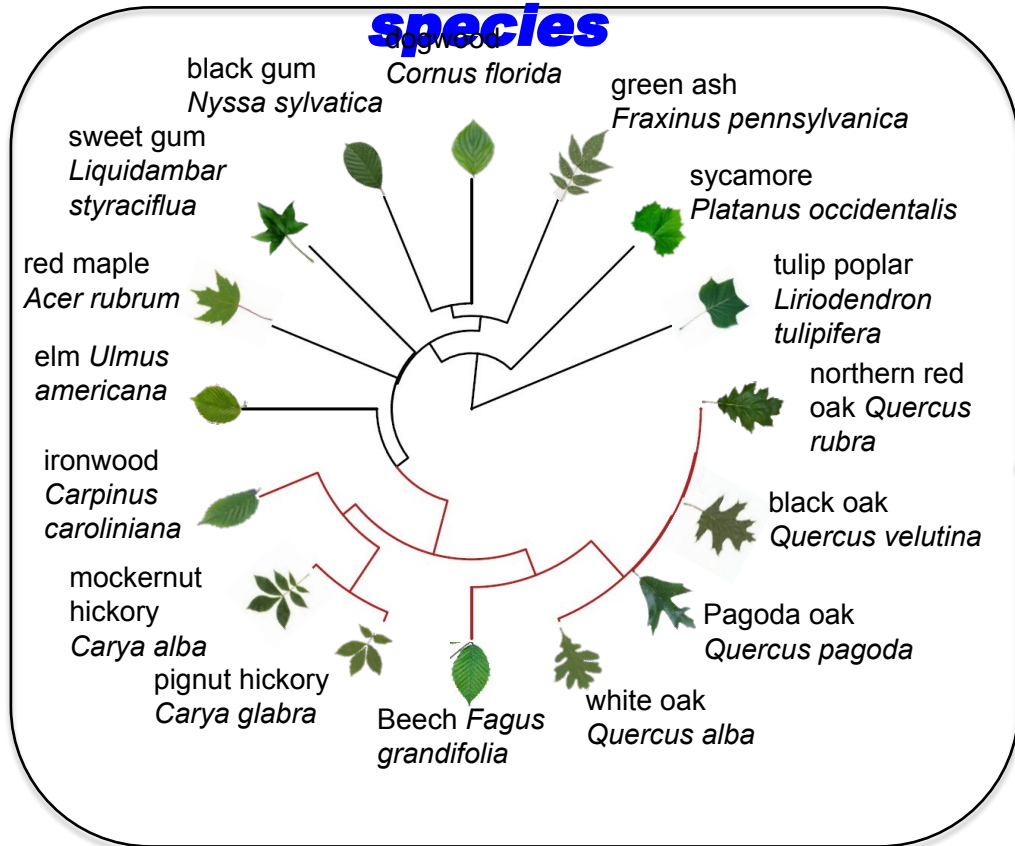




IS TREE **DIVERSITY** IMPORTANT TO RESTORATION SUCCESS?



16 native tree species



+ N = 5 UNPLANTED NATURAL REGENERATION CONTROL PLOTS

Is tree diversity important to restoration success?

Tree Survival

Tree Growth

Deer Damage

Stand Complexity

Soil Carbon

Soil Microbes

Leaf Insects

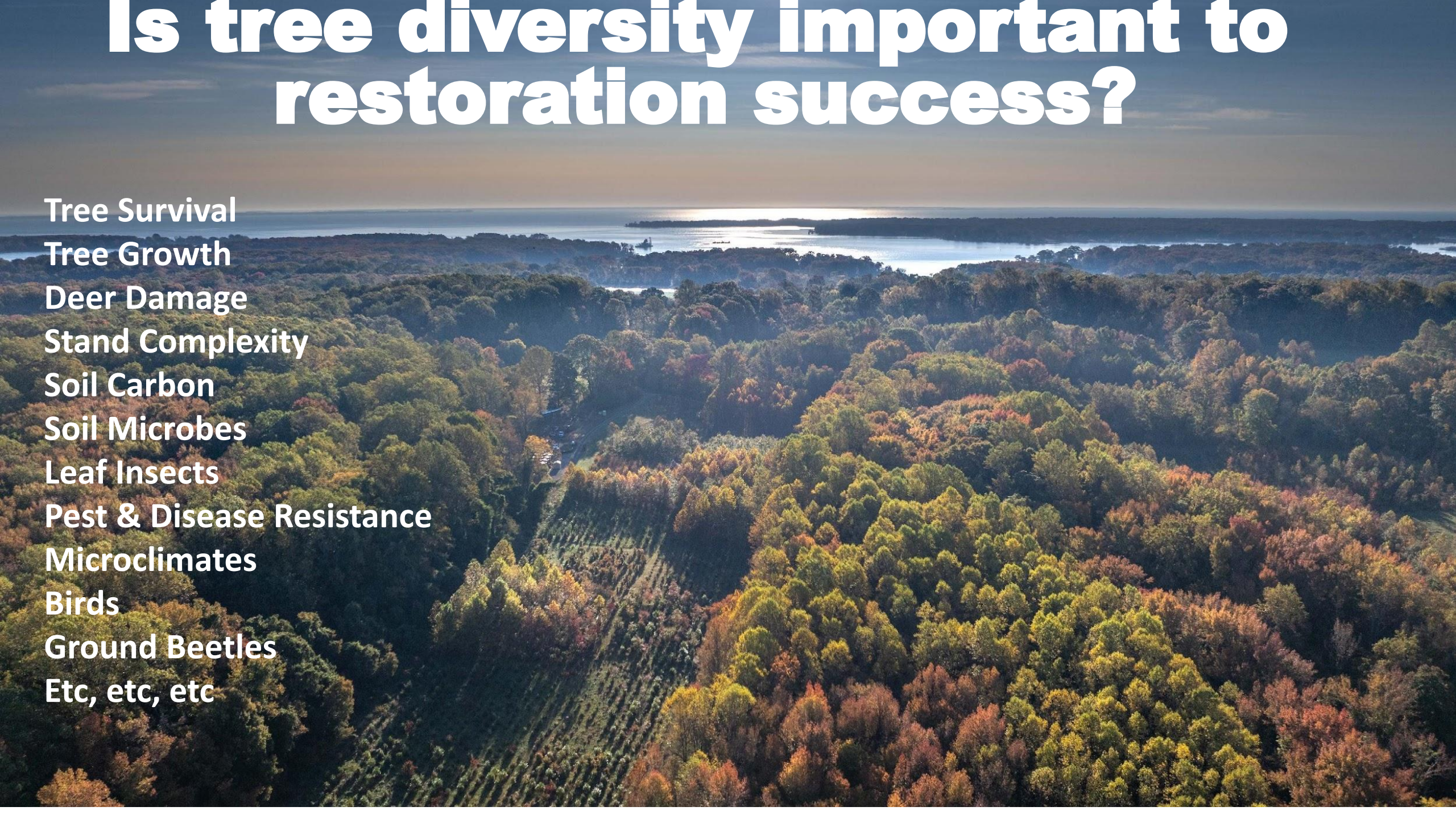
Pest & Disease Resistance

Microclimates

Birds

Ground Beetles

Etc, etc, etc



**Does diversity
↑ survival & growth?**

2013



2015

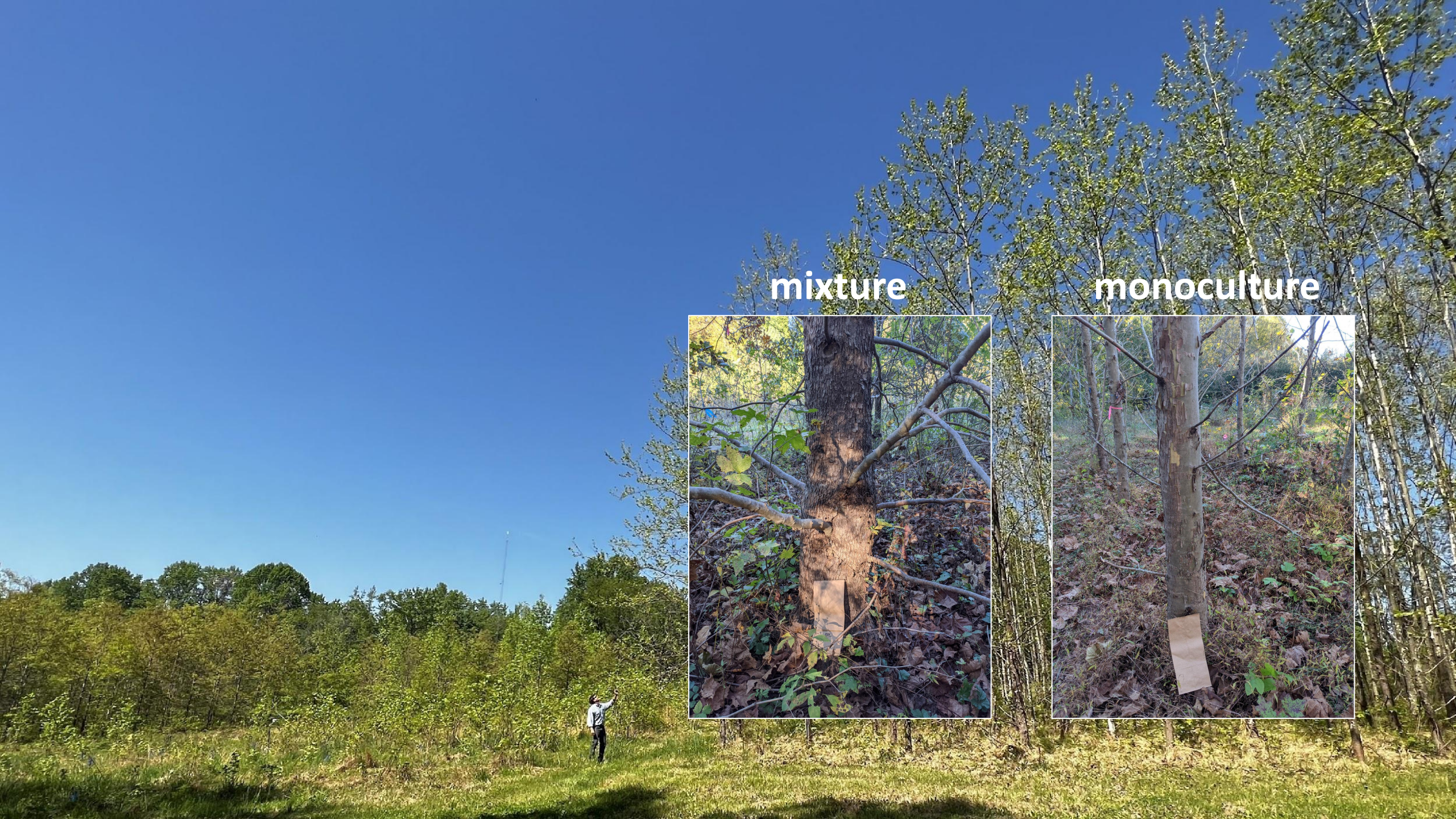


2023

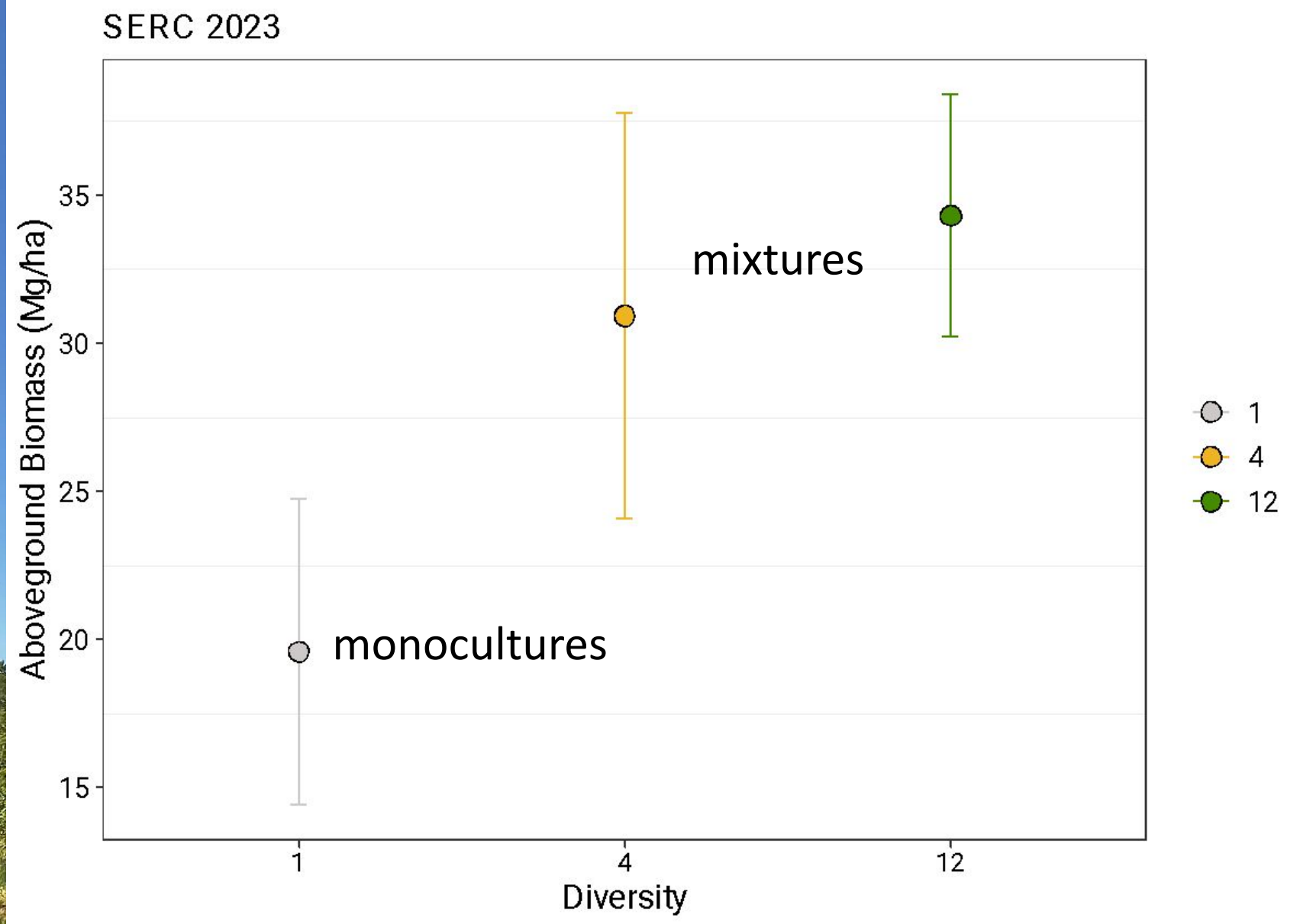


mixture

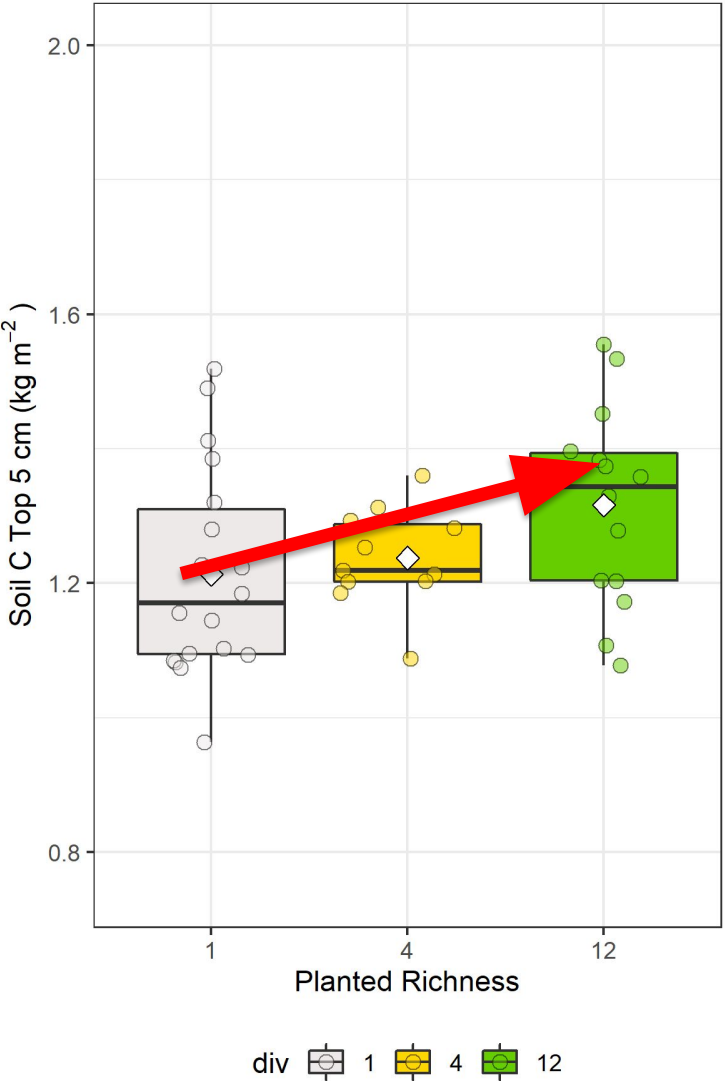
monoculture



Diversity ↑ **FOREST BIOMASS** by 78%



Diversity ↑ soil C content by 15% in upper soil layers



Right core from diverse tree mixtures is enriched with carbon



INSECT DIVERSITY (+45%)



If you build it, they will come: did tree diversity help resist cicada outbreak?



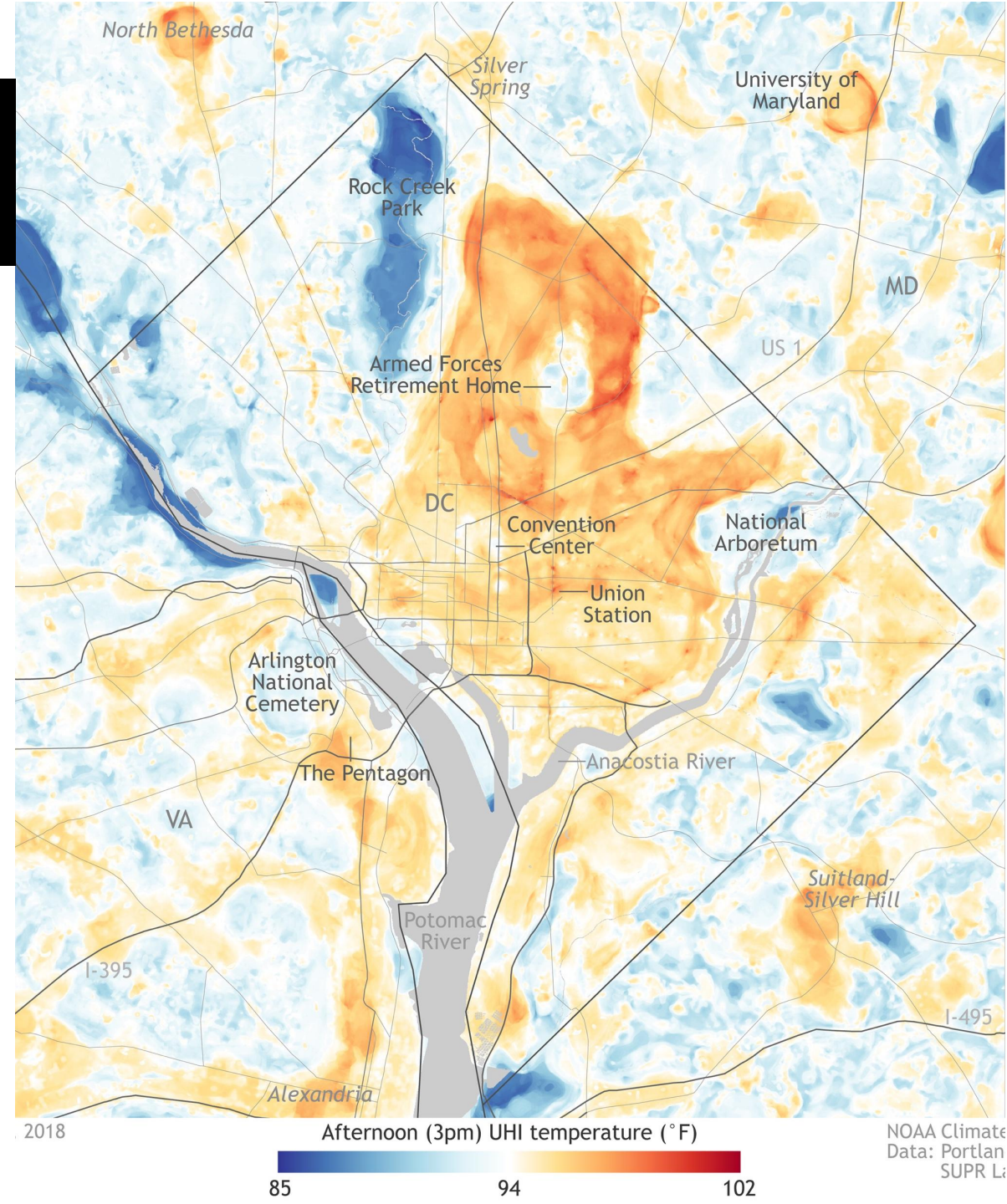
THEY'RE
www.cicadainvasion.com
COMING!



DIVERSE PLOTS: 85% LOWER CICADA DAMAGE



**Trees ↑ shade, ↓ heat
(better microclimates)**



DIVERSE MIXTURES = BETTER MICROCLIMATES

Cooler in day
Warmer at night
Higher humidity
Wetter soil



**Dr. Justin
Nowakowski**

Tree diversity enhances cooling through canopy packing

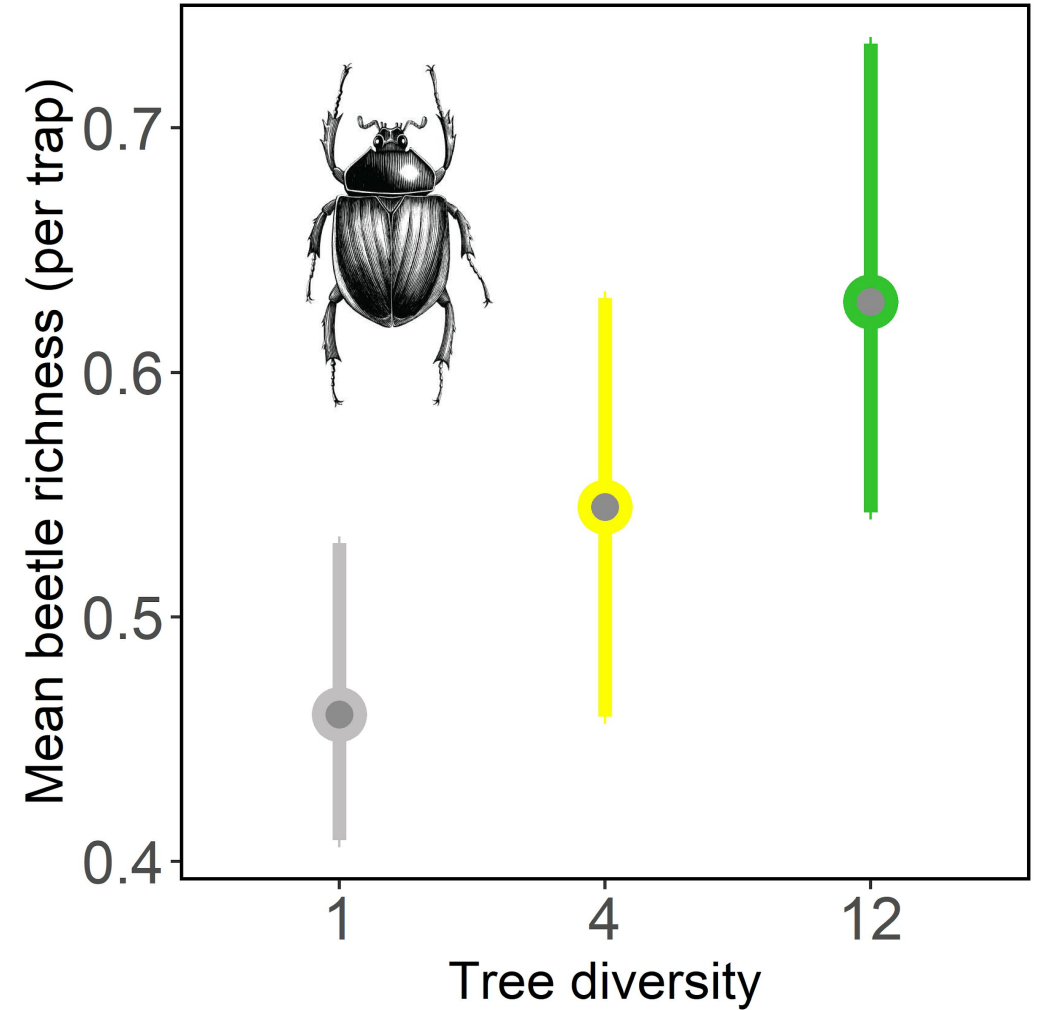


1 species plot



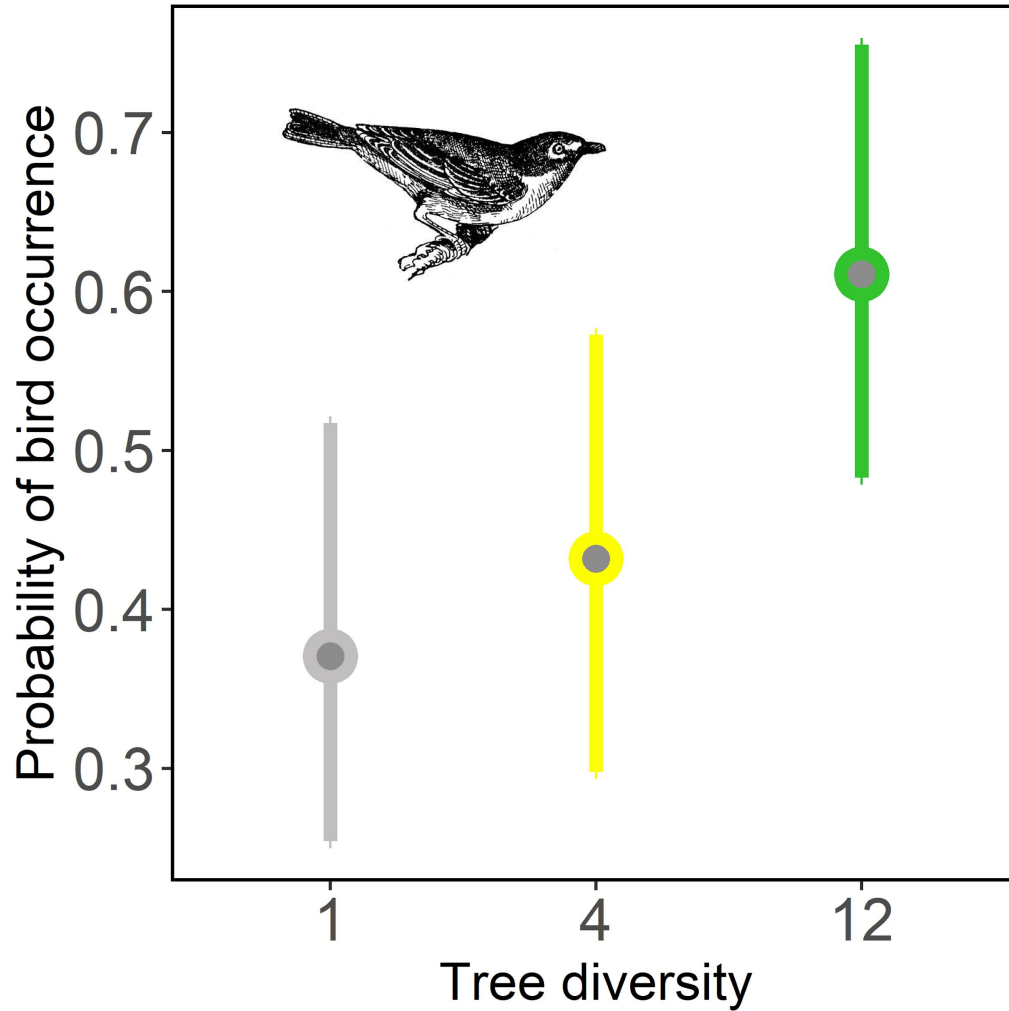
12 species plot

Tree diversity ↑ the beetles



Dr. Justin Nowakowski

Tree diversity ↑ the birds



Dr. Justin
Nowakowski

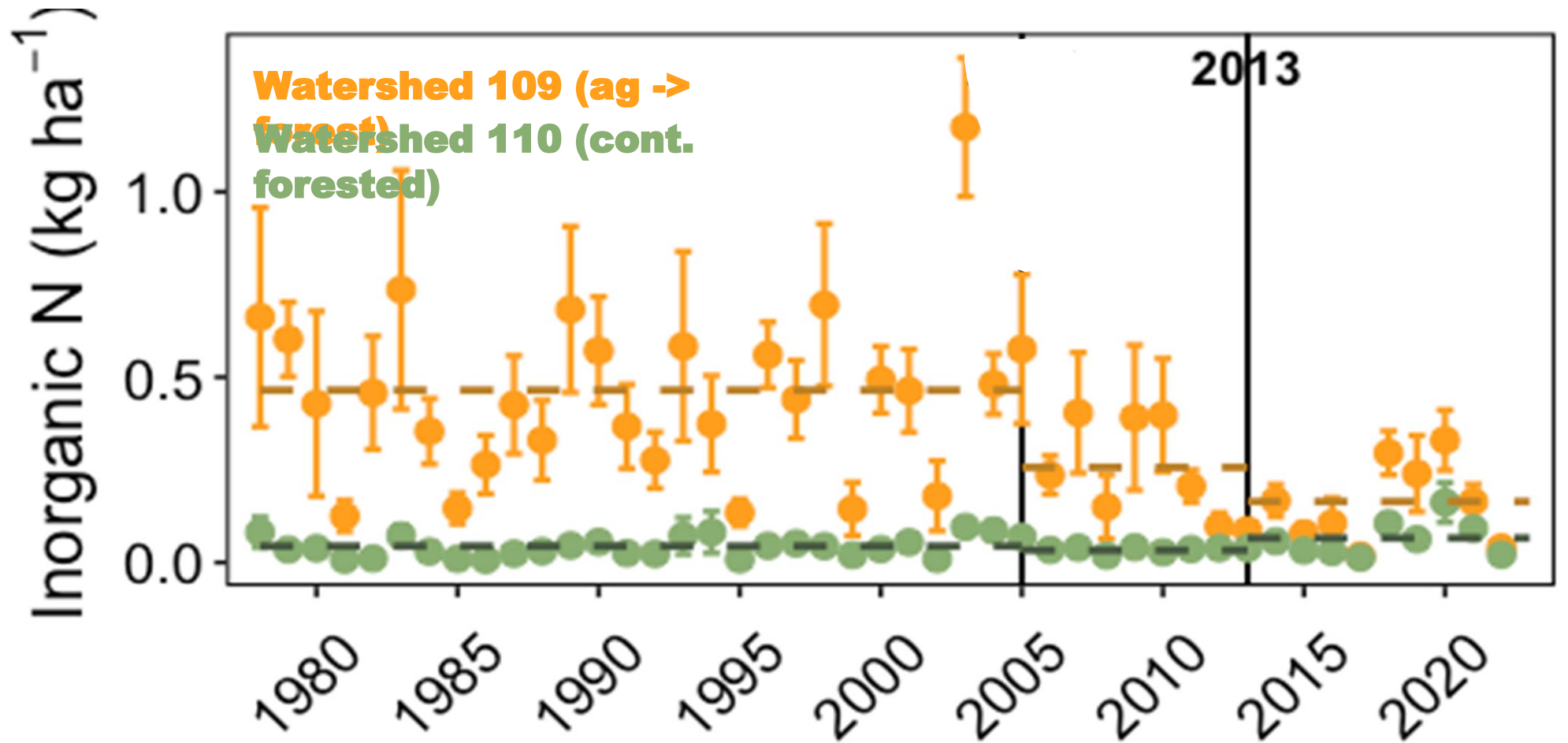
**Watershed
109**



REFORESTATION DRAMATICALLY ↑ N RETENTION



Rebecca Hale,
SERC



Is tree diversity important to restoration success?

Tree Survival

Tree Growth***

Deer Damage

Stand Complexity***

Soil Carbon*

Soil Microbes**

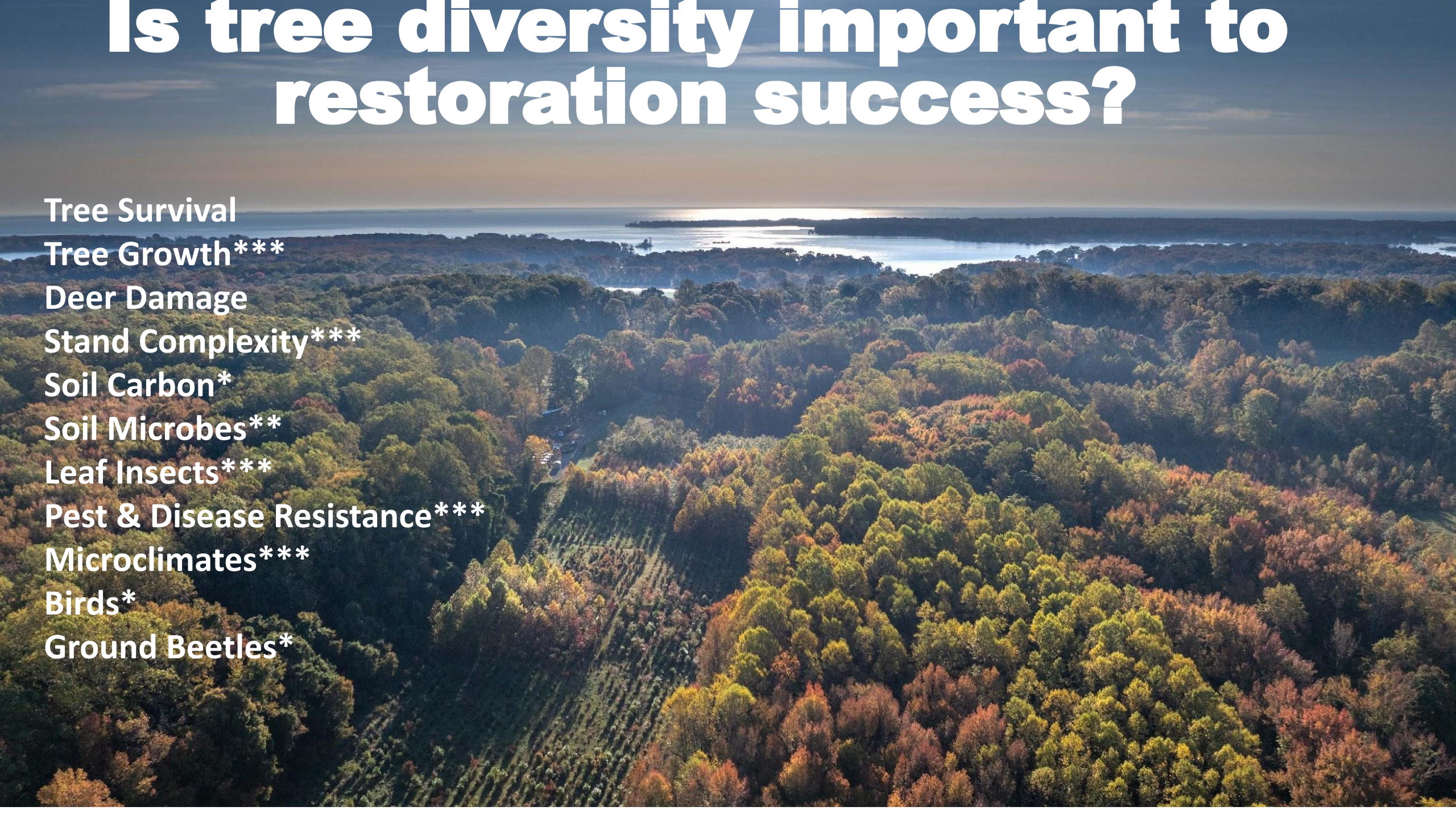
Leaf Insects***

Pest & Disease Resistance***

Microclimates***

Birds*

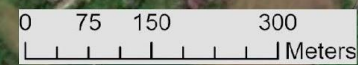
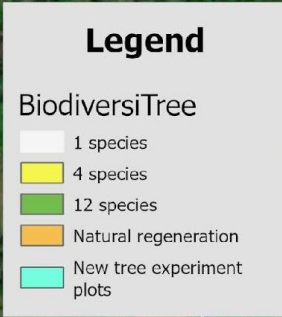
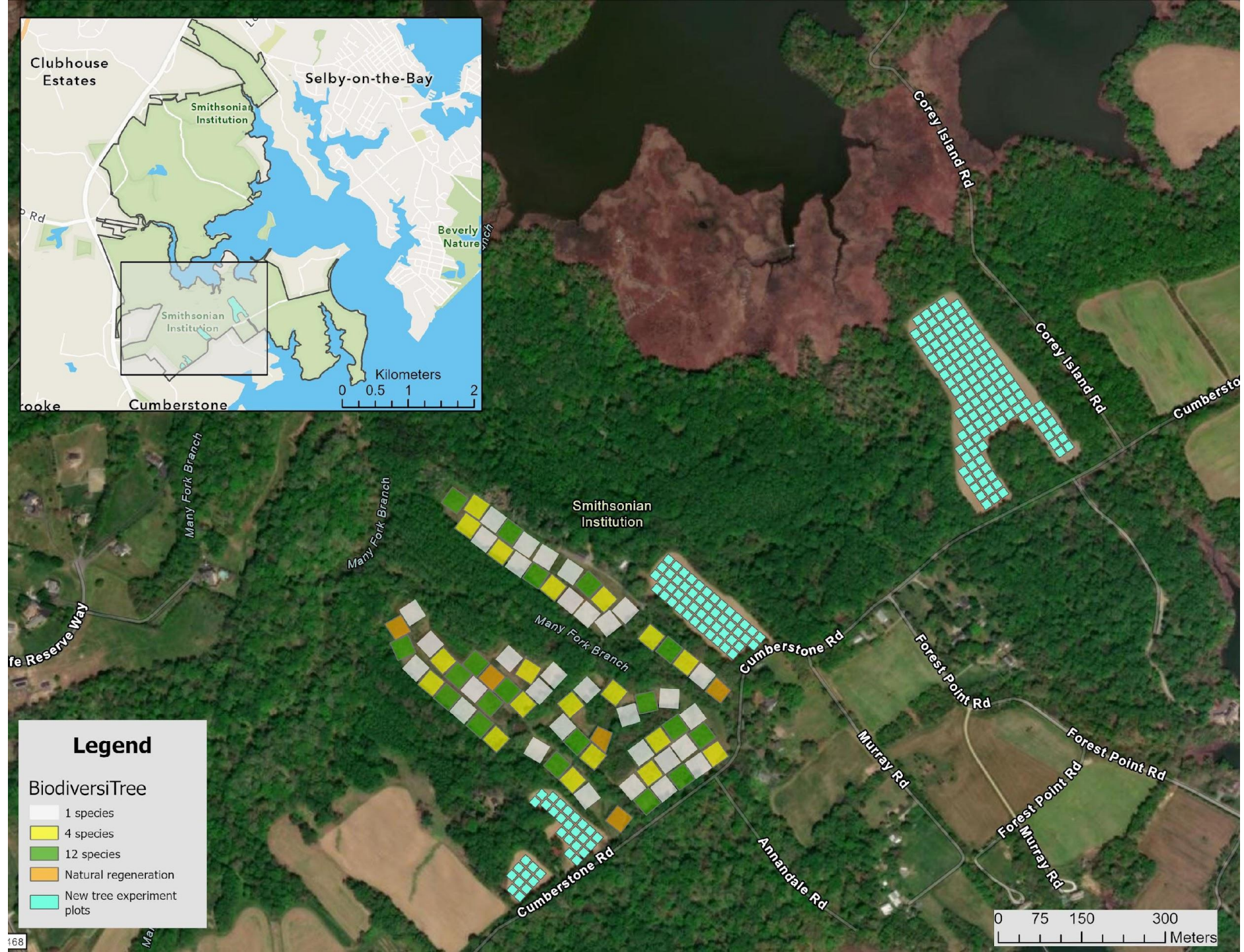
Ground Beetles*



“FUNCTIONAL FORESTS”

New tree planting in the Chesapeake Bay critical zone (spring 2026)

Smart reforestation: “the right *mix of trees* in the right place *for a specific purpose*”

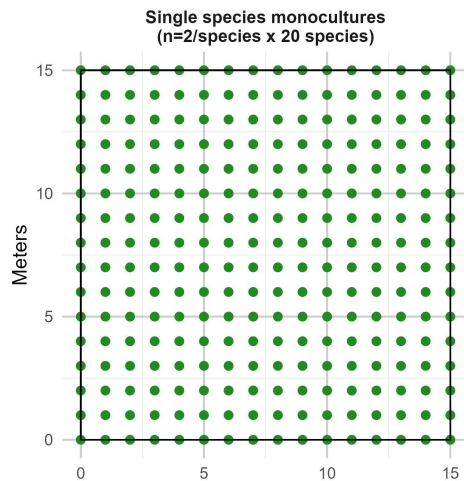
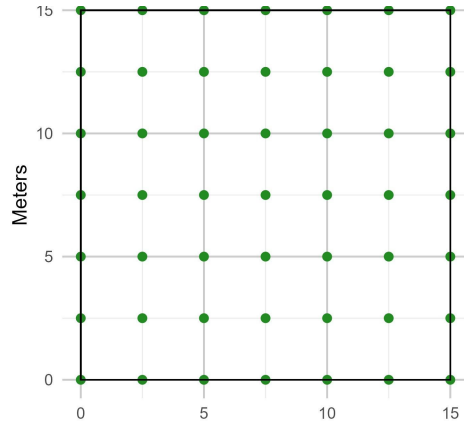


Monocultures vs 5-spp mixtures (seed packet analogy)

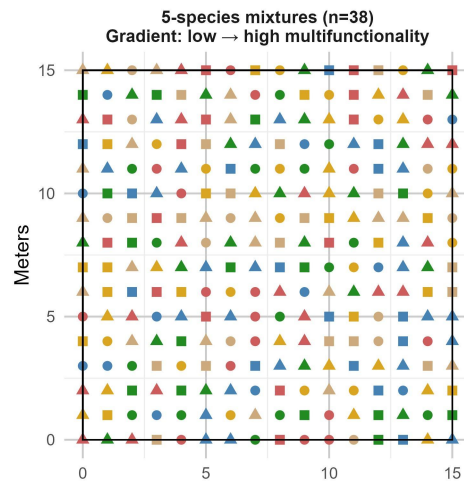
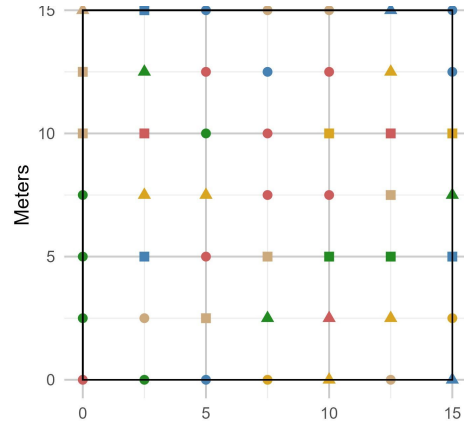
Low density
(2.5m spacing)
2177 trees/ha
~30yr old forest

High density
(1m spacing)
11,380 trees/ha
~1yr old forest

Low diversity
Monocultures
2/species x 20 species



5-spp mixtures
Gradient low->high
multifunctionality



Function

- Timber production
- Wildlife value
- Food forest value
- Deer resistance
- Climate resilience

Low tree density ~30yr or older forest

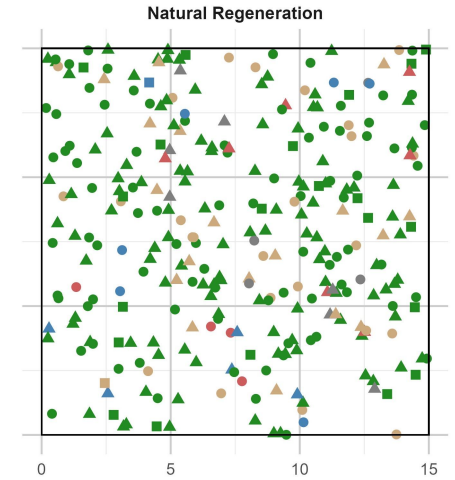
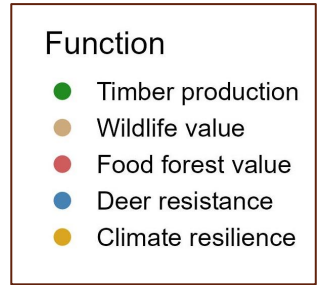
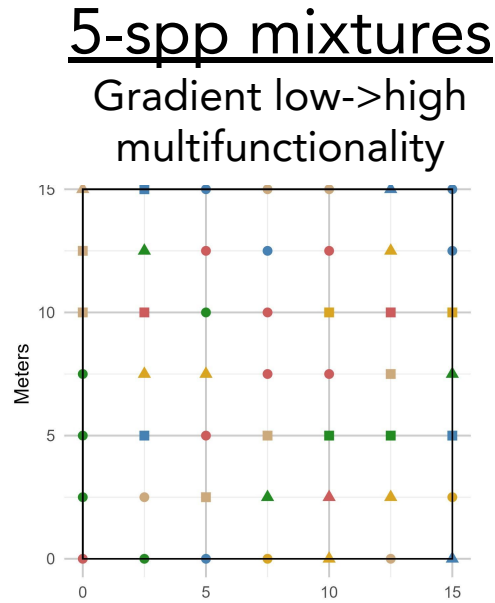
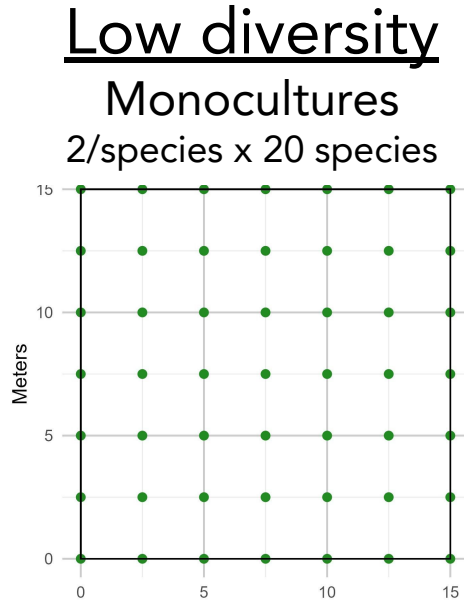


Low tree density = lots of maintenance!

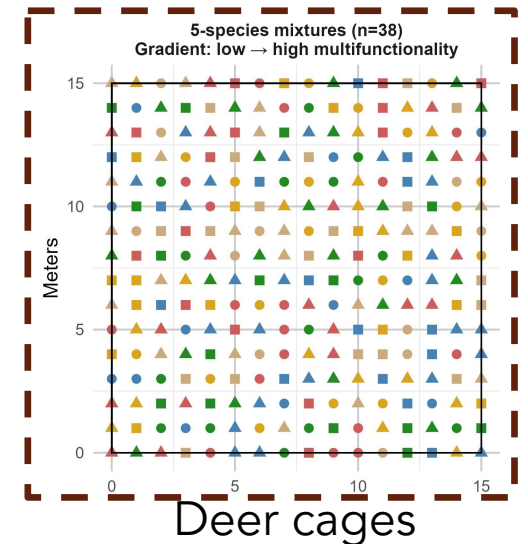
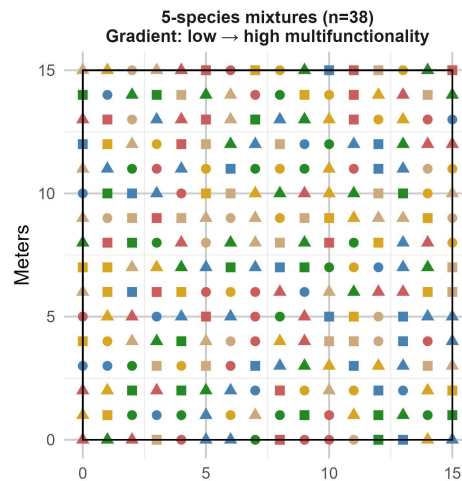
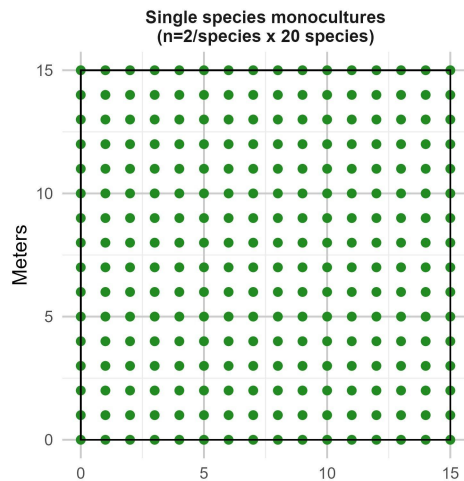


Monocultures vs 5-spp mixtures (seed packet analogy)

Low density
(2.5m spacing)
2177 trees/ha
~30yr old forest



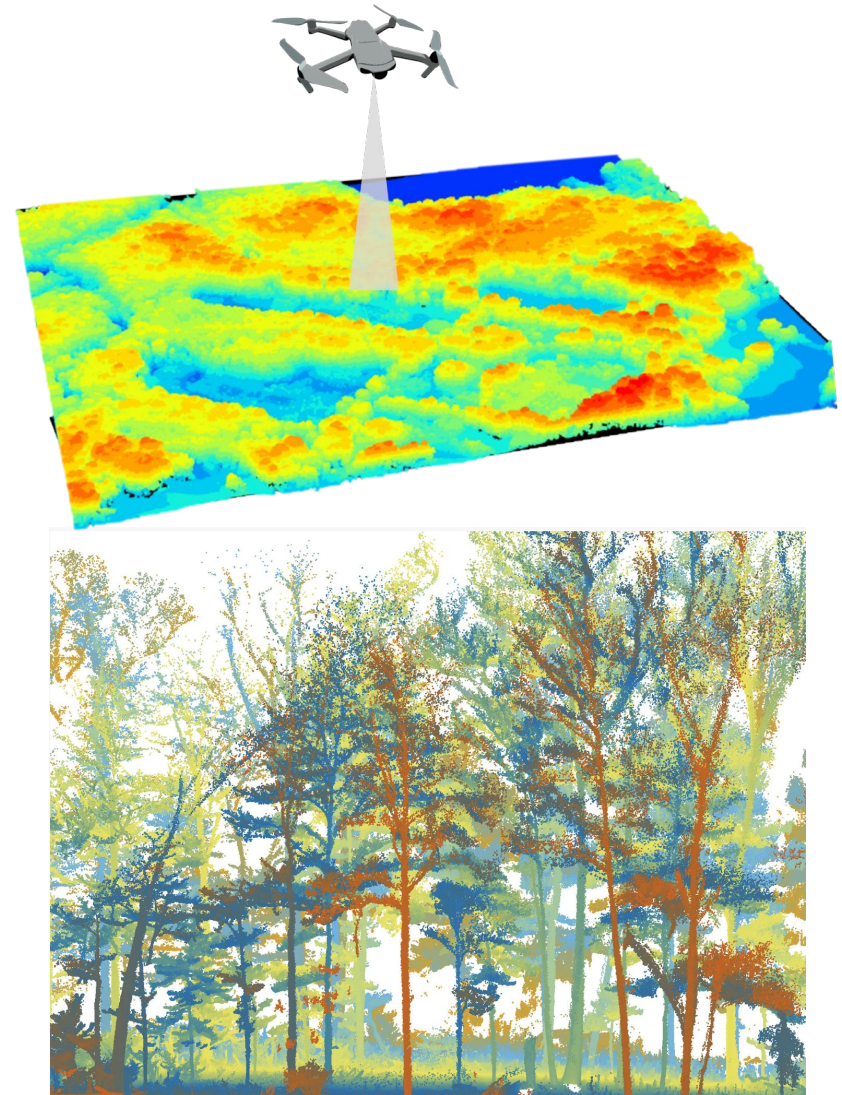
High density
(1m spacing)
11,380 trees/ha
~1yr old forest





Long-term monitoring of outcomes

- Tree survival, growth, recruitment
- Microclimate sensor arrays
- Passive and active monitoring of wildlife (insects, birds, etc)
- Remote sensing models for monitoring stress and biomass change



200 plots & 33,519 trees.....

- + Spending 5 minutes in each plot = 16.6 hours
 - + Minimum 2 workdays to do ANYTHING in each plot.
- + 30 seconds at each tree = 279 hours! (35 workdays)
- + ***We need collaborators!***

