


Response of saproxylic beetles to changing forest conditions of the southeastern United States

Clayton Traylor, PhD

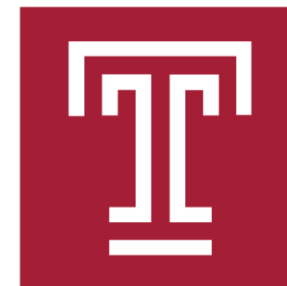
 **Temple University**
College of Science
and Technology



College of Agricultural &
Environmental Sciences
UNIVERSITY OF GEORGIA

My background

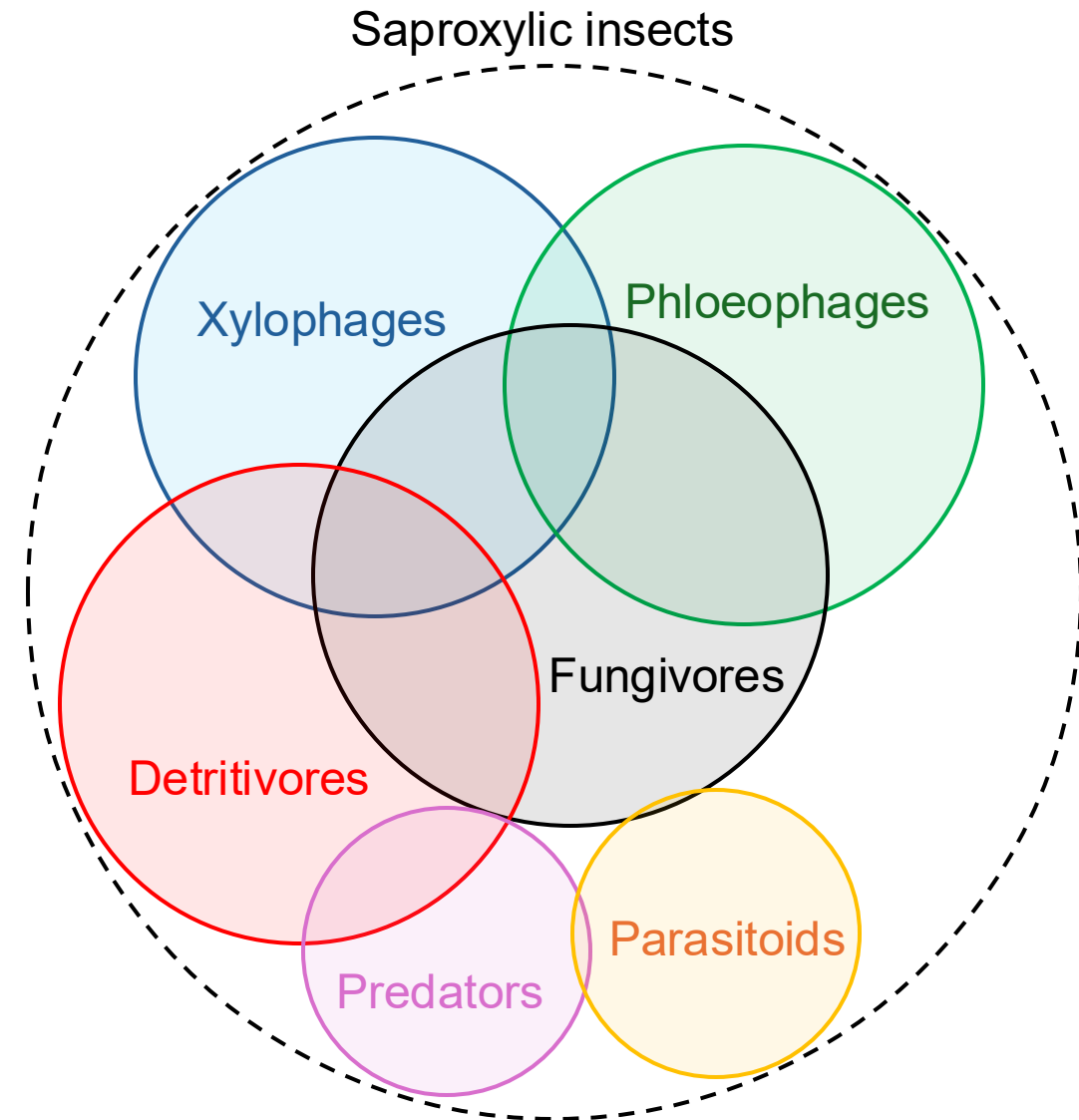
- PhD @ University of Georgia
 - Ecology and conservation of saproxylic insects in a changing world
- Postdoc @ Temple University
 - Spotted lanternfly ecology and impacts
 - Butterfly conservation



Saproxylic organisms

“Any species that depends, during some parts of its life cycle, upon wounded or decaying material from living, weakened or dead trees.”

- Stokland et al. (2012)
Biodiversity in Deadwood





Tom Murray



Judy Gallagher



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Derek Hauffe



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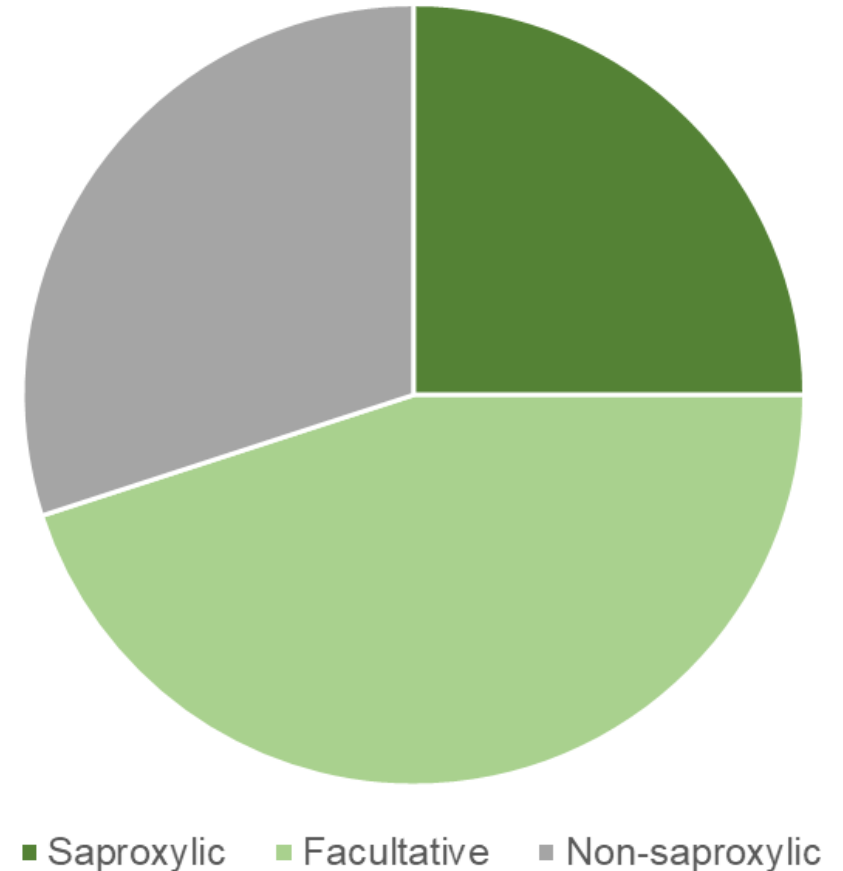
Arthur Scott Macmillan



Tom Murray

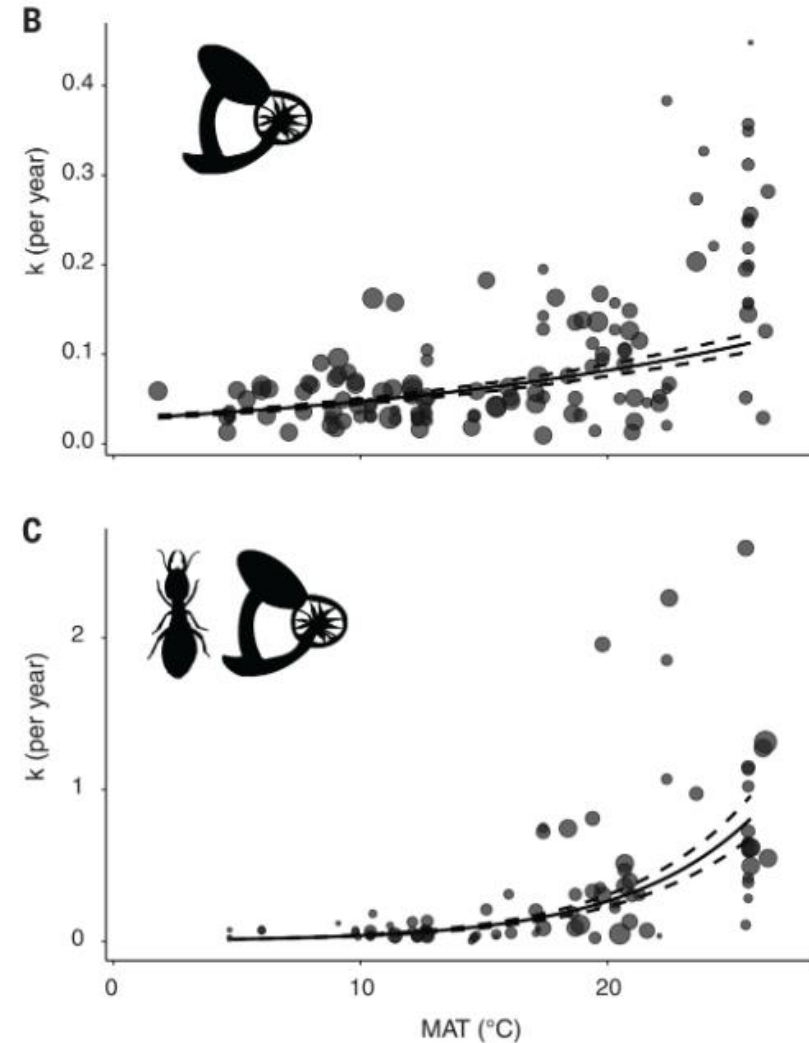
Saproxylic insect biodiversity

- 25% of forest invertebrate species are saproxylic
- Up to 50–70% of invertebrate species benefit from deadwood
- Beetles (Coleoptera) are best known and studied



Insect contribution to wood decomposition

- Microbes perform heavy lifting of wood decomposition
- Globally, 40% acceleration of wood decay when insects are present
 - Termites and large beetles
 - Climate dependent
 - Direct and indirect impacts (consumption and microbe facilitation)



Insect interactions with microbes

- Microbe facilitation
 - Tunnelling & fragmentation increase surface area
 - Targeted dispersal of microbes
 - Unspecific associations
 - Co-evolved symbiosis



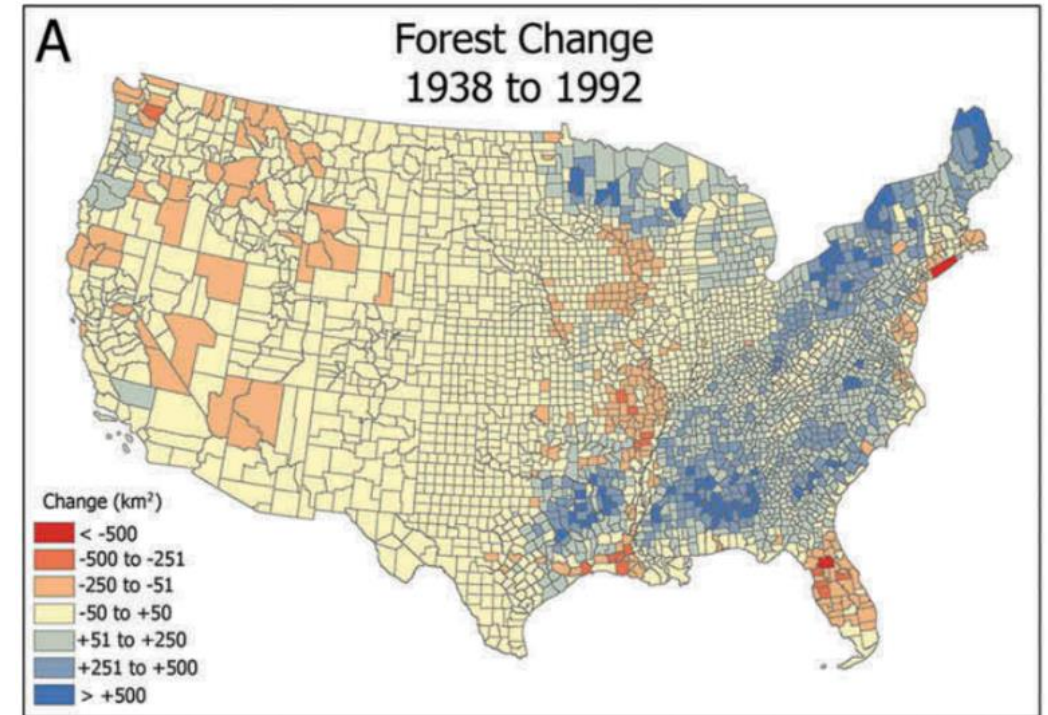
Saproxylic insects are ecological indicators

- Sensitive to change
 - Continuity of forest habitat
 - Amounts and composition of deadwood
 - Structural changes to forests
- My research focuses on responses to changing conditions
 - Land-use change
 - Invasive species



History of southeastern forests

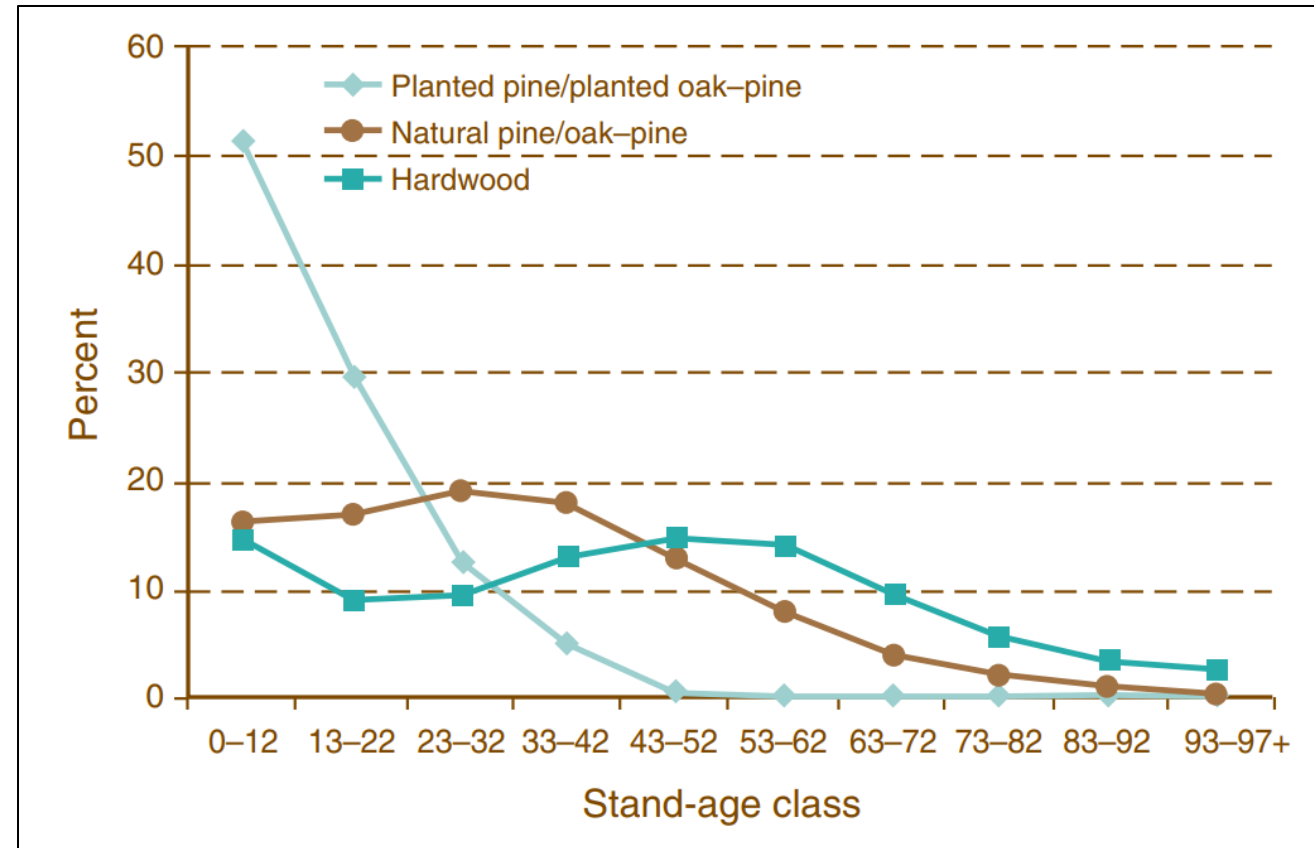
- 1700s-early 1900s:
 - Cyclic forest clearing for agriculture
- After 1920:
 - Agricultural abandonment
 - Natural succession of forest



Ramankutty et al. (2010) *Ann. Assoc. Am. Geogr.*;
Sohl et al. (2016) *J. Land Use Sci.* (figure)

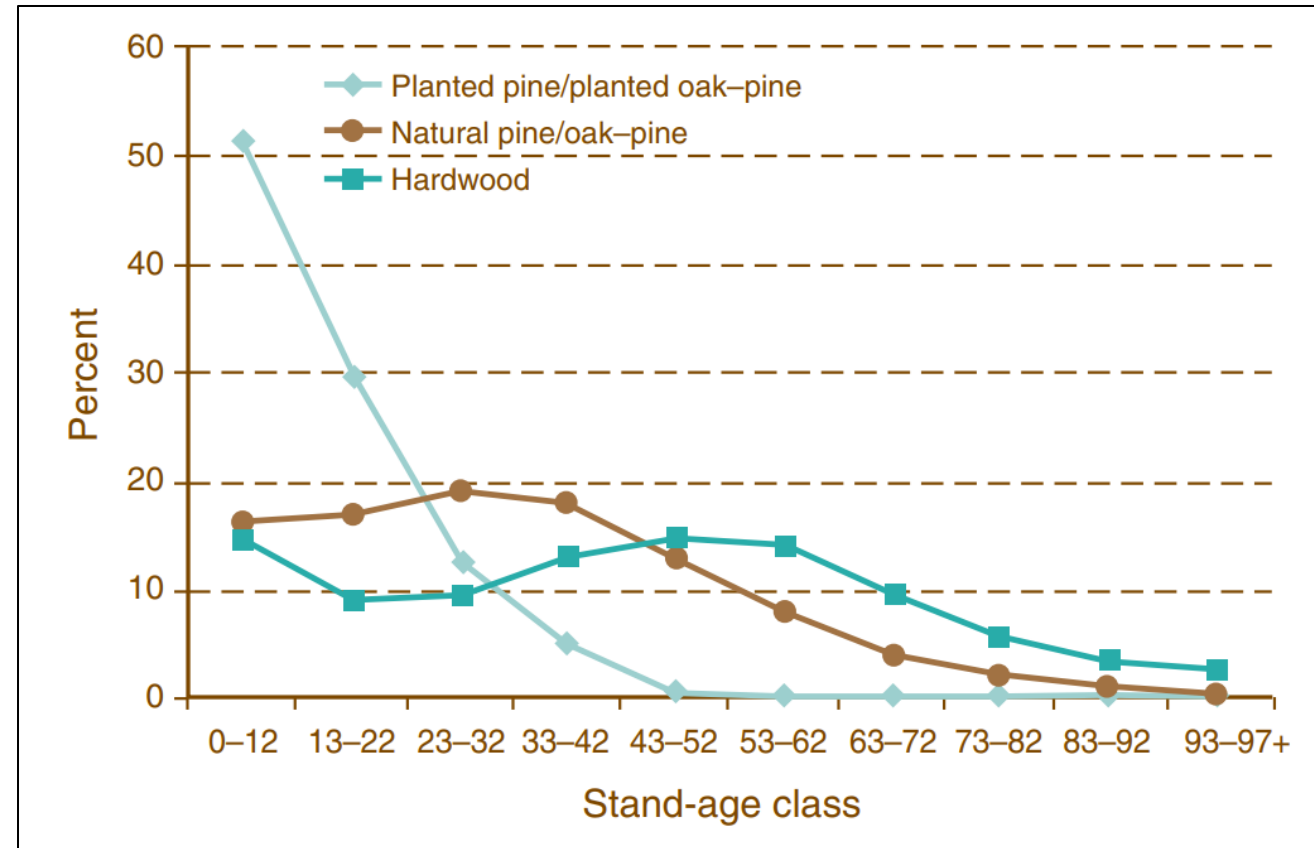
Southeastern forests today and beyond

- Today:
 - Highly forested (>60%)
 - Little forest predates 1930s



Southeastern forests today and beyond

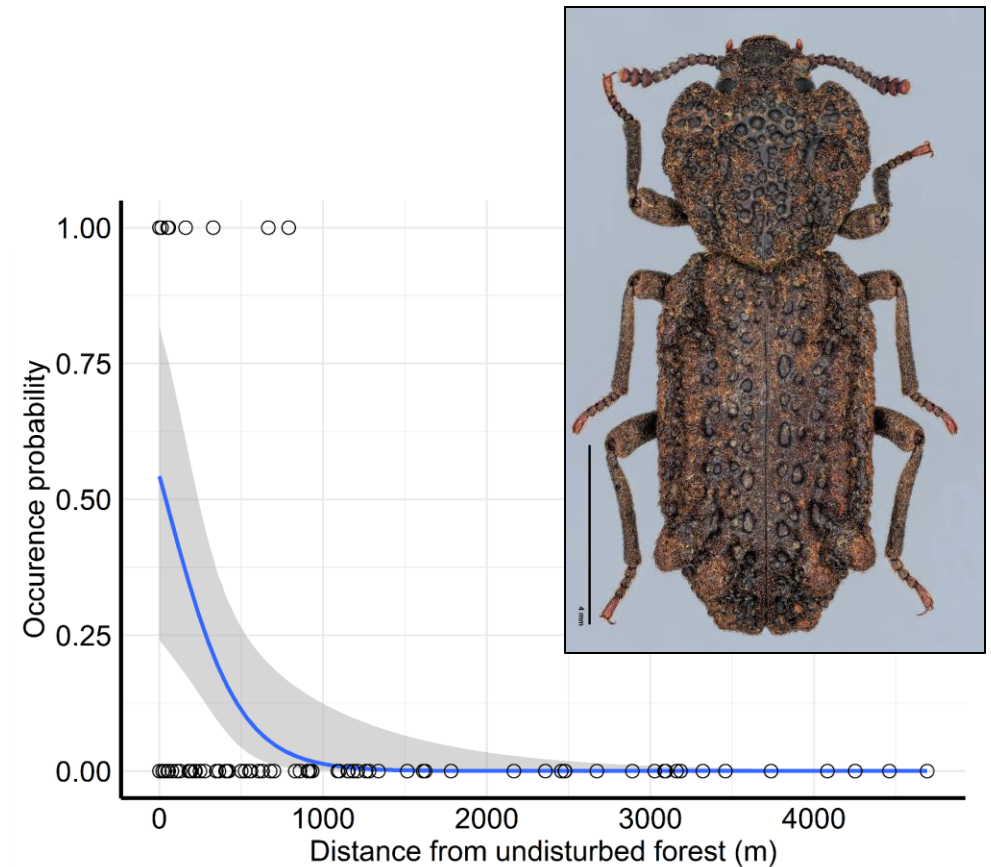
- Today:
 - Highly forested (>60%)
 - Little forest predates 1930s



Are abundant, young forests utilized by saproxylic beetles?

Dispersal limitation

- Young forests lack habitat continuity over time and must be recolonized
 - Important for low-mobility species
- Example: *Phellopsis obcordata*
 - Flightless fungus beetle found only in old-growth forests
- Driver of community wide patterns?
 - Most species can fly
 - May only be relevant in areas with sparse forest cover

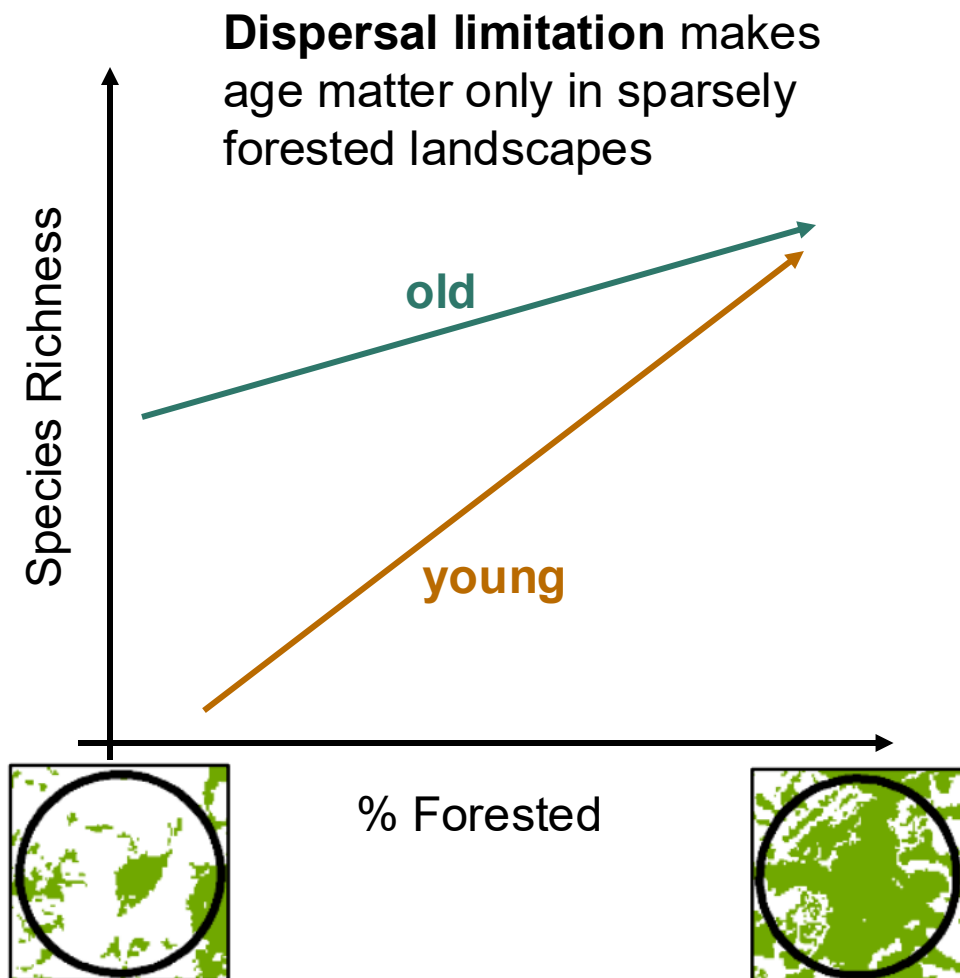


Habitat limitation

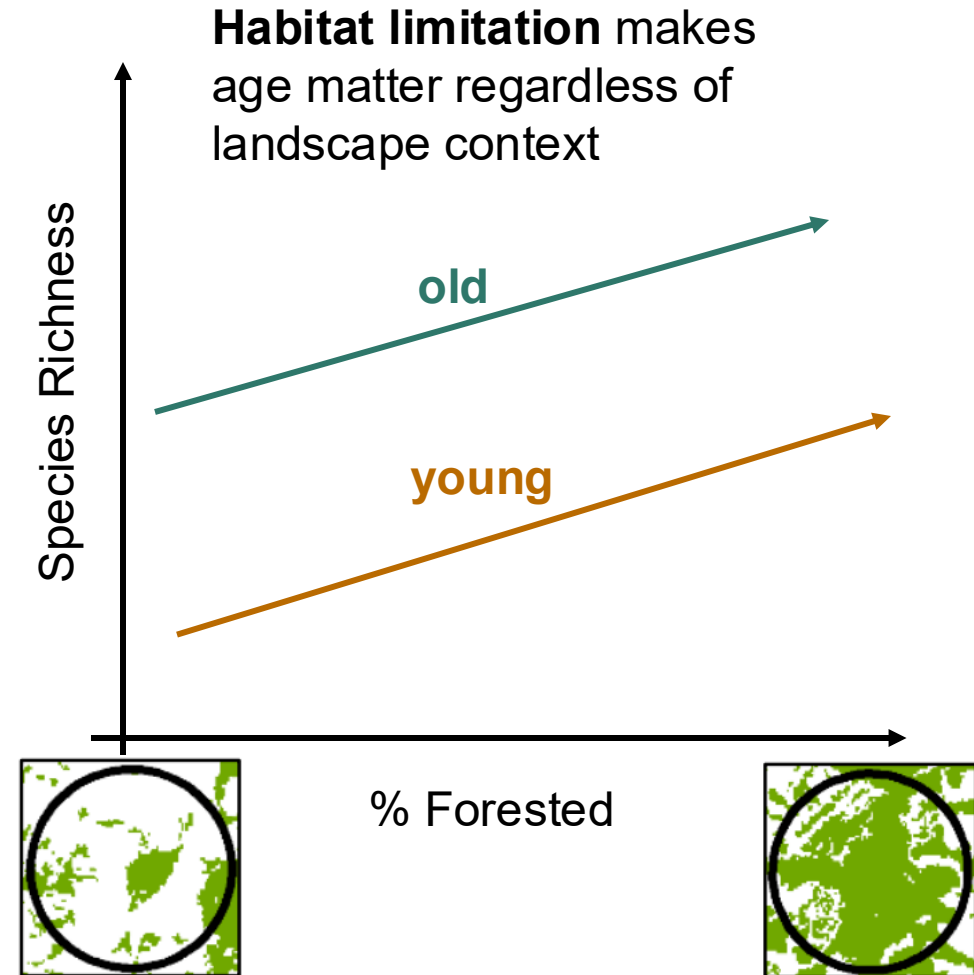
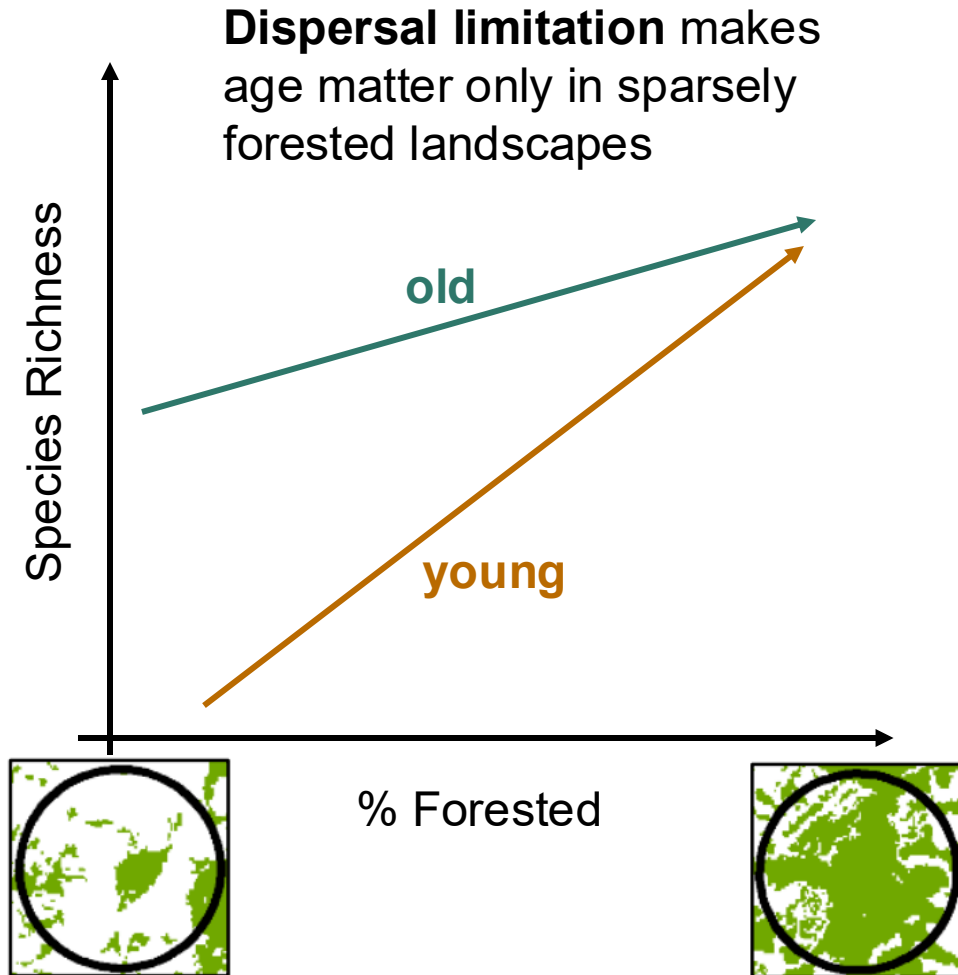
- Large, unique, or diverse habitats lacking in young forests
 - Large snags
 - Rot hollows
- Support specialist species
- Accumulation takes time



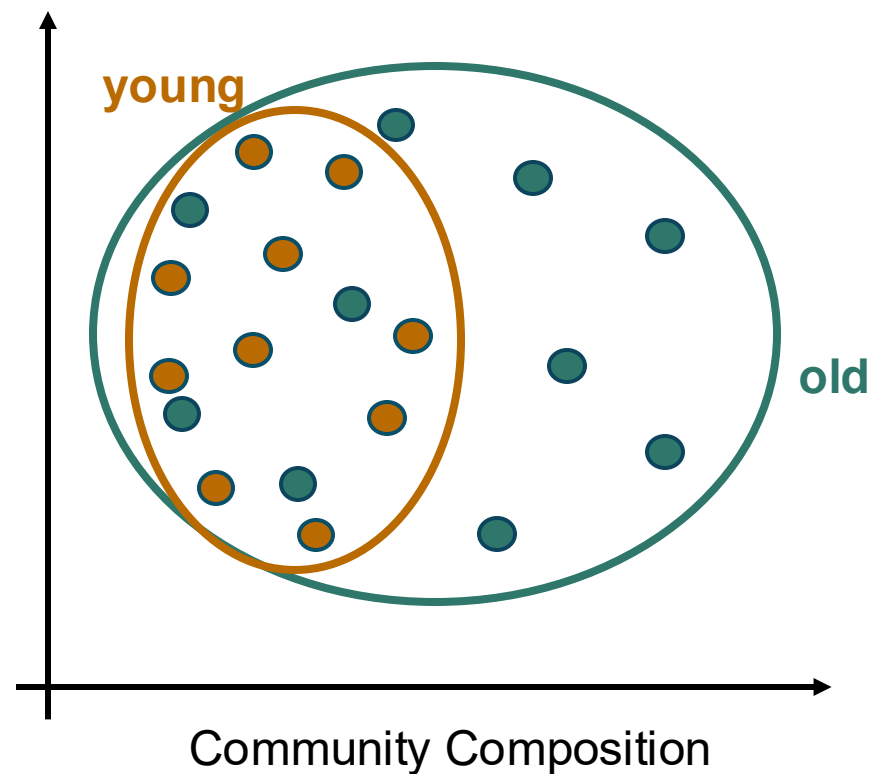
Goal: is forest age important, and why?



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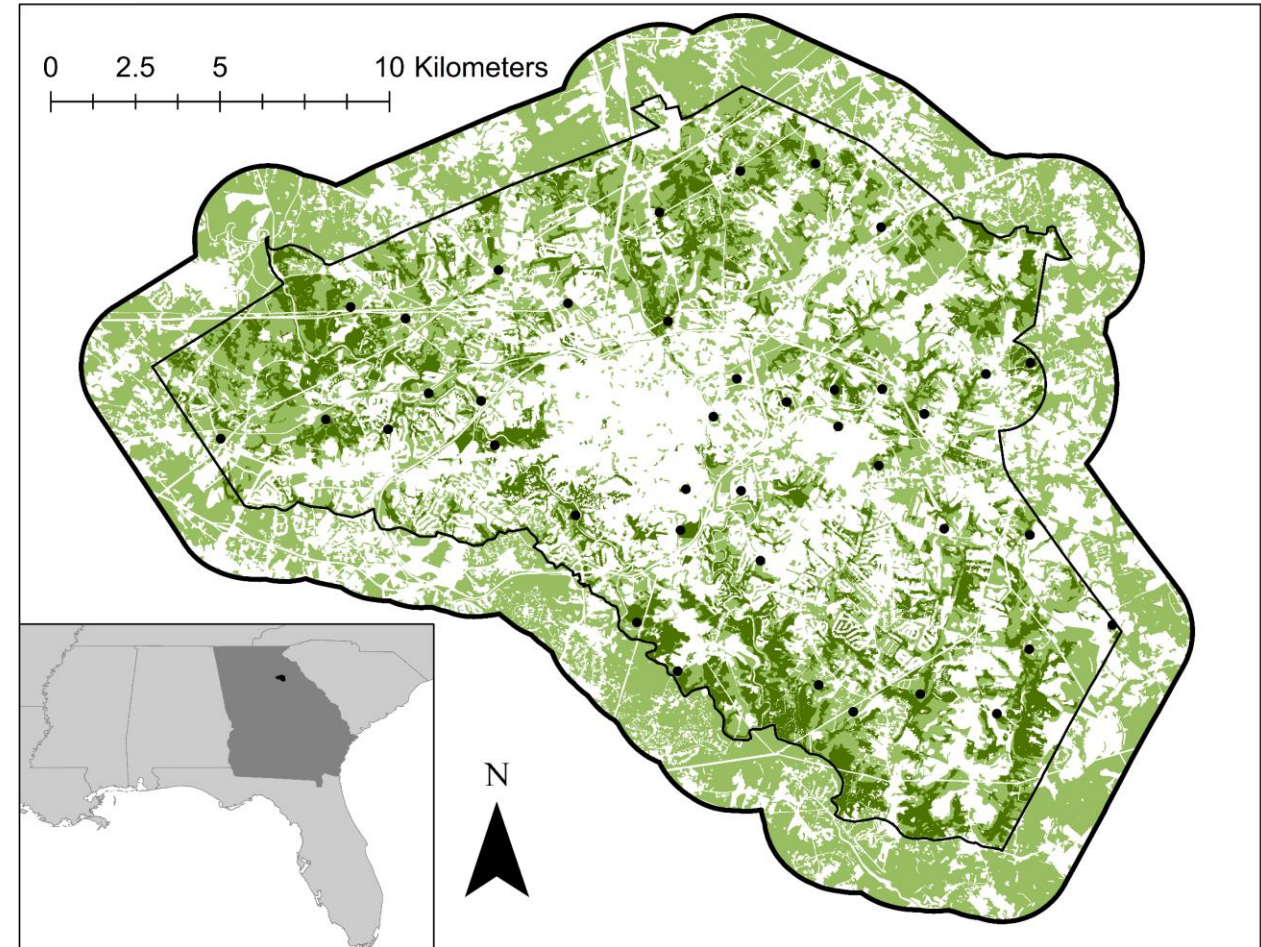
Goal: is forest age important, and why?



Nested pattern due to reduced habitat quality or dispersal limitation

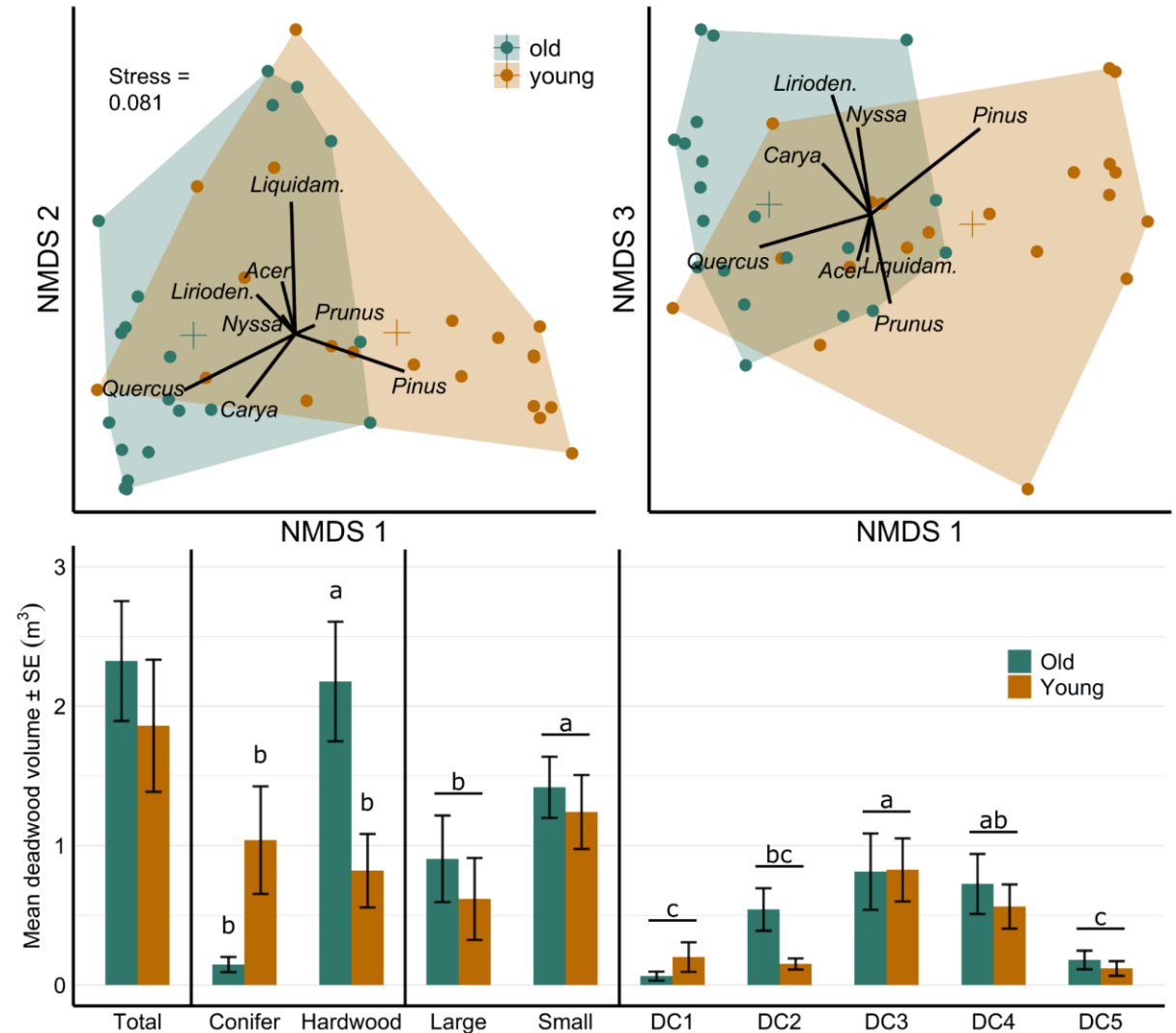
Study region and design

- Clarke County, GA
 - 1938: 32% forest
 - 2017: 53% forest
 - Only 1/3 of this existed in 1938
- 40 sites
 - Old (mature in 1938)
 - Young (regrown after 1938)
- Age groups evenly distributed over a forest cover gradient



Forest conditions

- Measured forest structure and composition
- Similar forest structure between ages
 - Including deadwood
- Composition followed successional trajectories
 - Young (pine) to old (oak) forests



Field and lab work

- Sampling
 - Flight traps
 - March–September 2020
 - 5 m aboveground
 - Ethanol lure
 - Litter sifting



Saproxylic classification

- Limited by extremely poor natural history information
- Created a regional list of beetles with deadwood associations from the southeastern USA
 - List of ~1,400 taxa with associations
 - Natural history review of ~300 species



Winston Cornish (UGA '24)



ZooKeys 1232: 1–95 (2025)

DOI: 10.3897/zookeys.1232.143989

Research Article

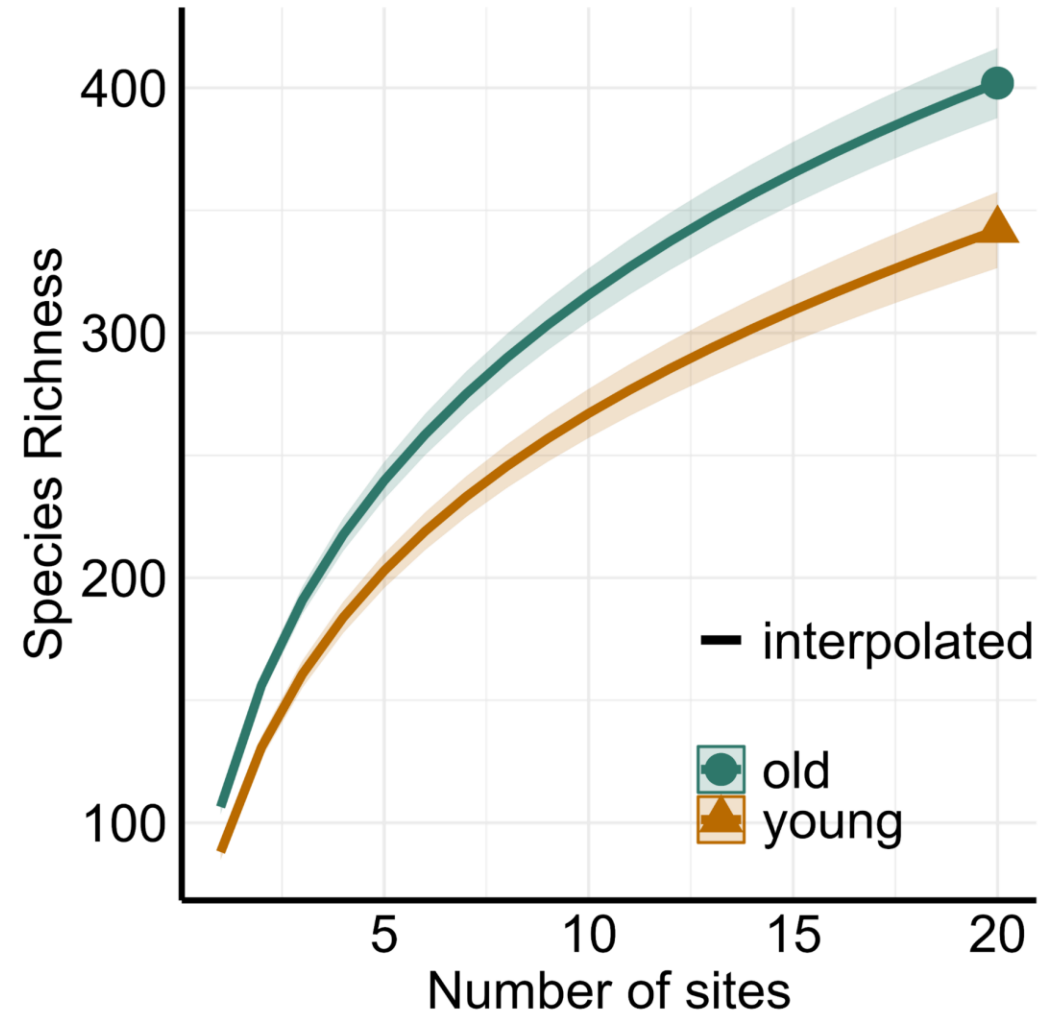
Progress toward a list of saproxylic beetles (Coleoptera) in the southeastern USA

Clayton R. Traylor^{1,2}, Michael D. Ulyshen³, J. Winston Cornish¹, Gabriel Tigreros^{1,4}, Joseph V. McHugh¹

Traylor et al. (2025) *ZooKeys*

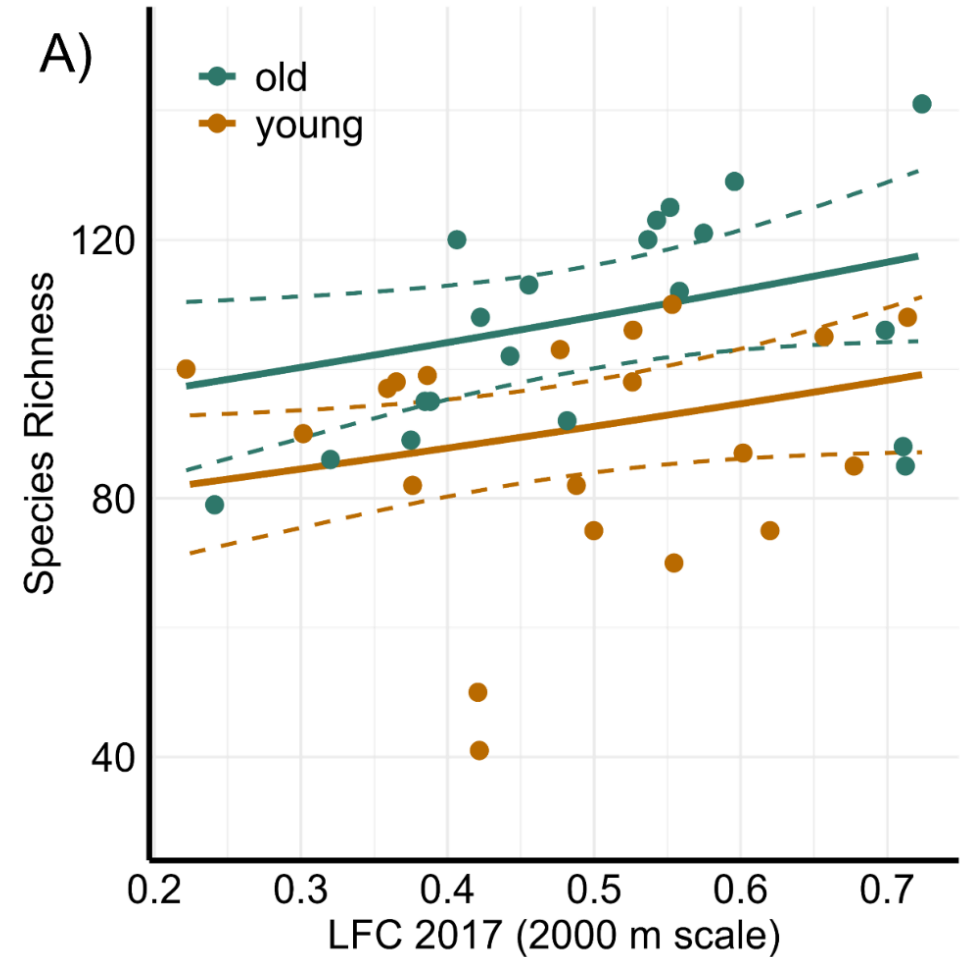
Results:

- 472 saproxylic species
 - 50,129 individuals
 - 55 families
- Higher richness regionally in old forests



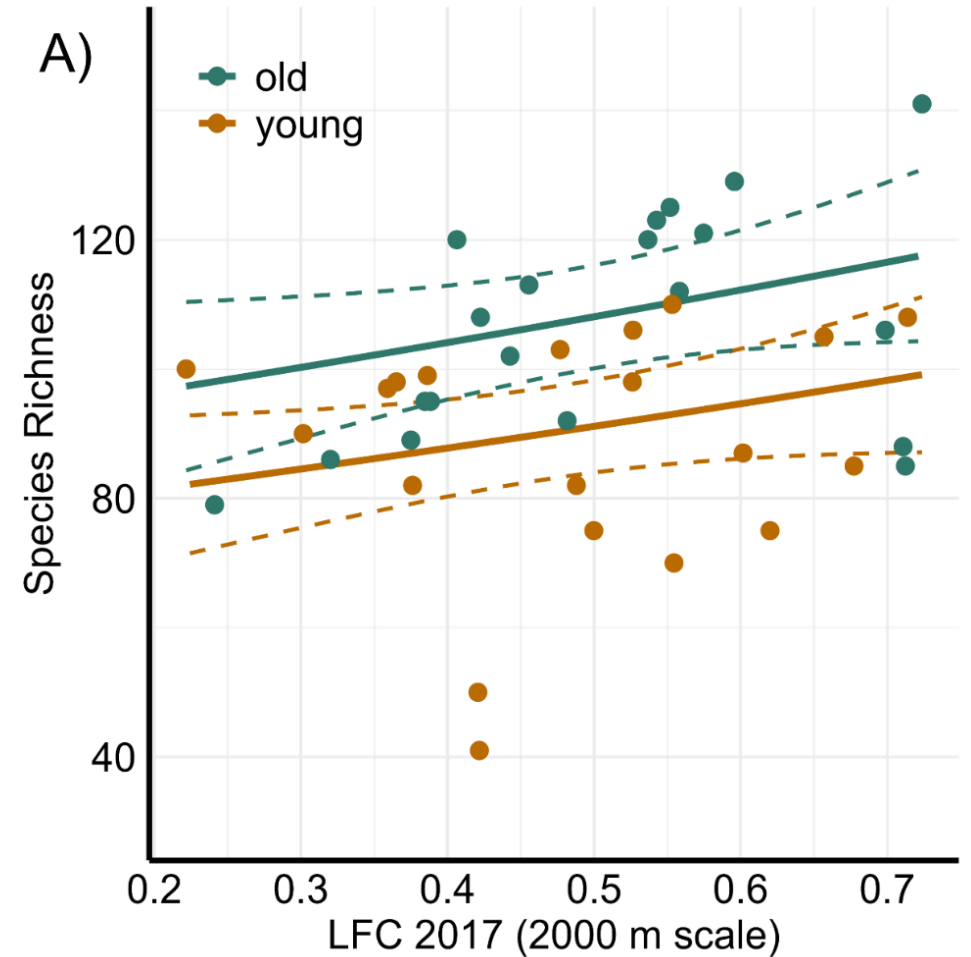
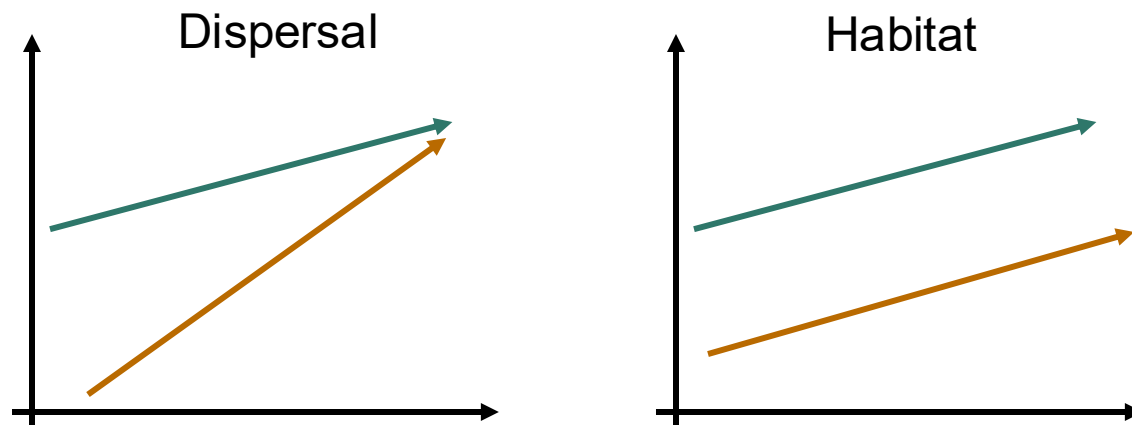
Results: local richness

- Higher richness in old forests
- Positive influence of LFC, but weak support of the interaction with age



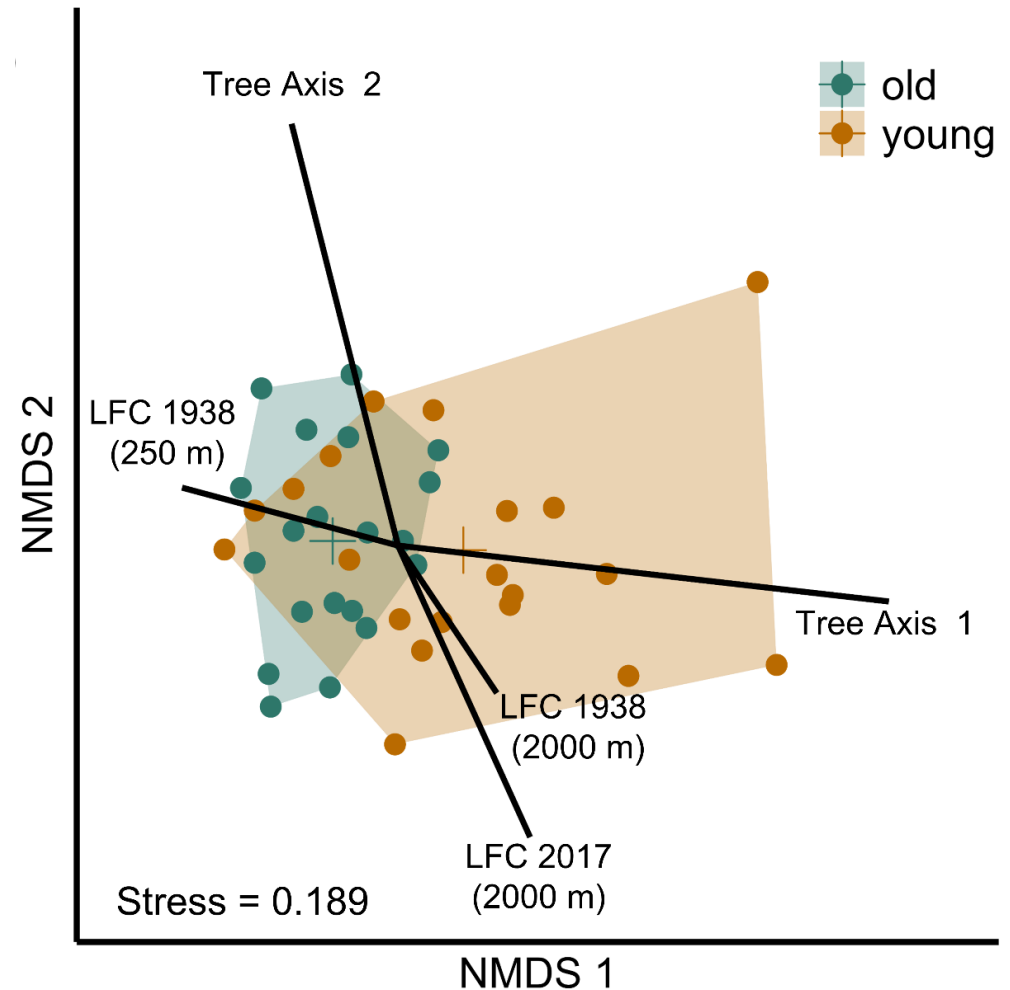
Results: local richness

- Habitat limitation: Old oak forests have more microhabitats
 - More specialist species
- No widespread dispersal limitation
 - But some species exhibit limitation



Results: community composition

- Distinct communities with age
- Community composition most associated with surrounding tree types (and deadwood types)



Conclusions


- Habitat limits recolonization of recently regrown forest
- Old forests disproportionately important for saproxylic biodiversity
- Both age classes maintain regional biodiversity



Biodiversity
paper →

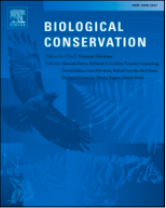
Biological Conservation 285 (2023) 110238

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Forest age drives saproxylic beetle biodiversity in the southeastern United States

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^b Southern Research Station, USDA Forest Service, Athens, GA, USA

Trait paper →

Forest Ecology and Management 553 (2024) 121545

Contents lists available at [ScienceDirect](#)



Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco



Forest age is a primary trait filter for saproxylic beetles in the southeastern United States



Clayton R. Traylor^{a,b,*}, Michael D. Ulyshen^c, Joseph V. McHugh^a, Ryan C. Burner^b

Dominance of non-native ambrosia beetles

- Earlier study: 13,396 ambrosia beetles
 - 98% (13,140) were non-native
 - 2% (256) were native



Rachel Osborn, *Bugwood.org* (Image)

Dominance of non-native ambrosia beetles

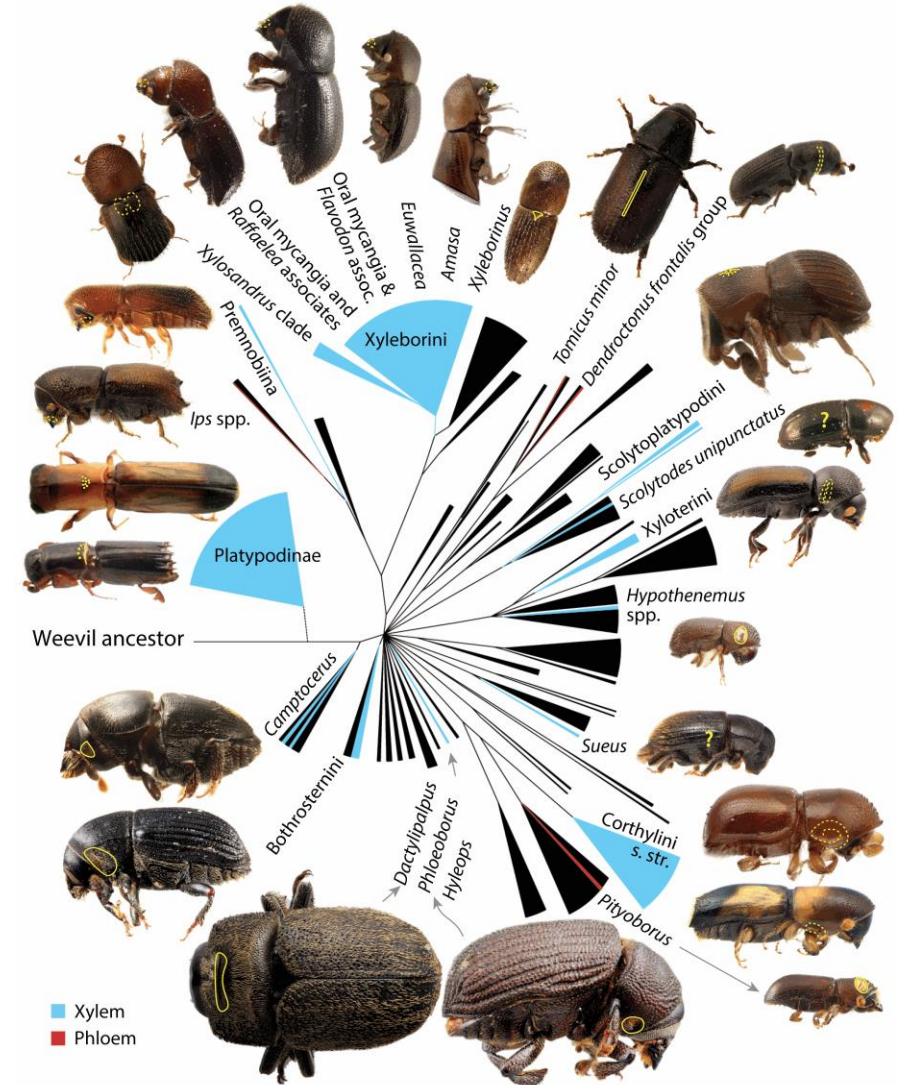
- Earlier study: 13,396 ambrosia beetles
 - 98% (13,140) were non-native
 - 2% (256) were native
- Not an isolated event
 - Exotic species account for 1-96% of abundance in meta-analysis (average = 45%)
 - 9 exotic species account for 51% of >840,000 in a nationwide survey



Hartshorn and Coyle (2021) *Environ. Entomol.*;
Rabaglia et al. (2019) *Am. Entomol.*;
Rachel Osborn, *Bugwood.org* (Image)

Ambrosia beetles

- Ambrosial symbiosis
 - Independent evolution within Scolytinae
 - Beetles get nutrition for entire life cycle
 - Fungi get targeted dispersal within 'mycangia'
 - Co-evolved but often flexible
- Frequently first to arrive at deadwood



Hulcr and Stelinski (2017) *Annu. Rev. Entomol.* (top figure);
Hulcr and Skelton (2023) *Forest Entomology and Pathology*;
Hulcr et al. (2021) *Biol. Invasions* (left figure)

Exotic ambrosia beetle biology & impacts

- “Pest” in orchards and plantations
 - Symptom of stressed trees, not the cause
 - Nonetheless, cause damage and mortality
- Widespread tree mortality in natural settings
 - Rare; caused by pathogenic symbiotic fungi



James Johnson, *Bugwood.org* (top photo); Florida Division of Plant Industry, *Bugwood.org* (bottom photo)

Exotic ambrosia beetle biology & impacts

- “Pest” in orchards and plantations
 - Symptom of stressed trees, not the cause
 - Nonetheless, cause damage and mortality
- Widespread tree mortality in natural settings
 - Rare; caused by pathogenic symbiotic fungi
- **Unknown impact on other saproxylic insects**



James Johnson, Bugwood.org (top photo); Florida Division of Plant Industry, Bugwood.org (bottom photo)

Goal: competition of natives and non-natives

- Do they use the same deadwood resources?
- Are their abundances inversely related?
- Are certain wood conditions driving competitive outcomes?

Methods

- Collate data from 4 experiments
 - Create deadwood in field
 - Leave it to be colonized by insects
 - Bring into lab for emergence
- Different designs, *identical* methods

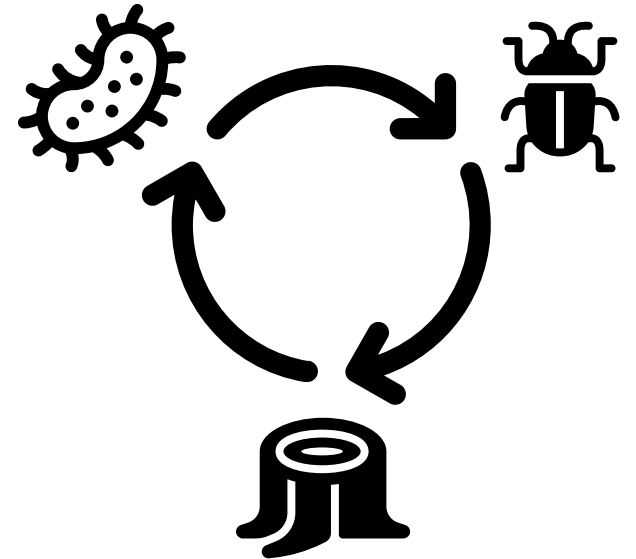


Results – pending for review

- Tested assumptions and hypotheses for competition between native and non-native ambrosia beetles
- Results (redacted) may have implications for biodiversity conservation, biotic homogenization of deadwood communities, and alteration of wood decay rates

Conclusions and opportunities

- What's established:
 - Saproxylic insects are sensitive to anthropogenic history and forest conditions
- What's needed (my vision):
 - Impact of invasive species in ecological contexts
 - Understanding of insect-wood-fungi interactions
 - Ants, termites, ambrosia beetles, etc.



Acknowledgements



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- Mike Ferro (Clemson)
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Questions/Discussion

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Thank you!!