Modeling Wind Disturbances in Forest Habitats

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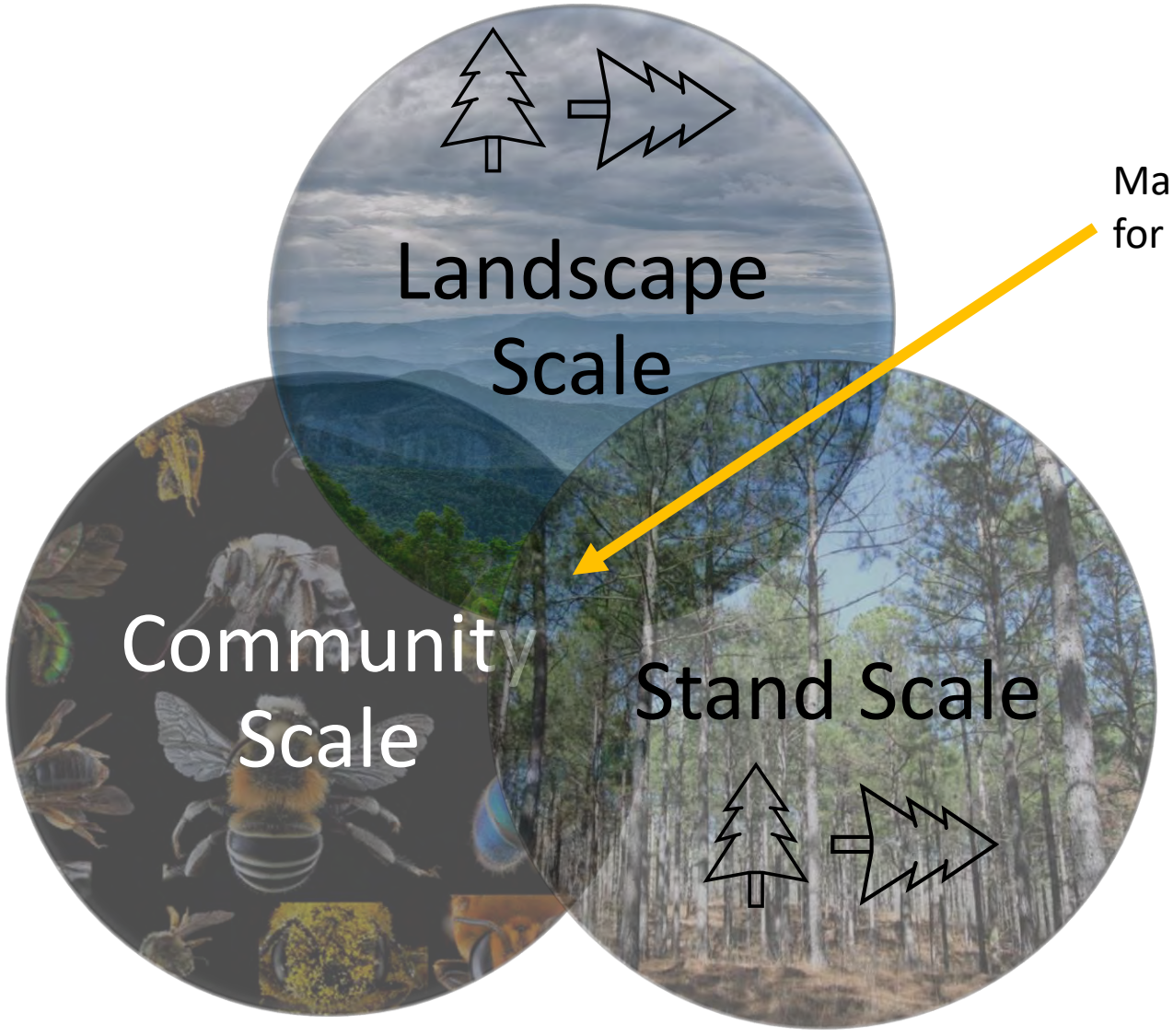
DEPARTMENT OF FORESTRY

Modeling Wind Disturbance in Forest Habitats: Multiple scales of investigation

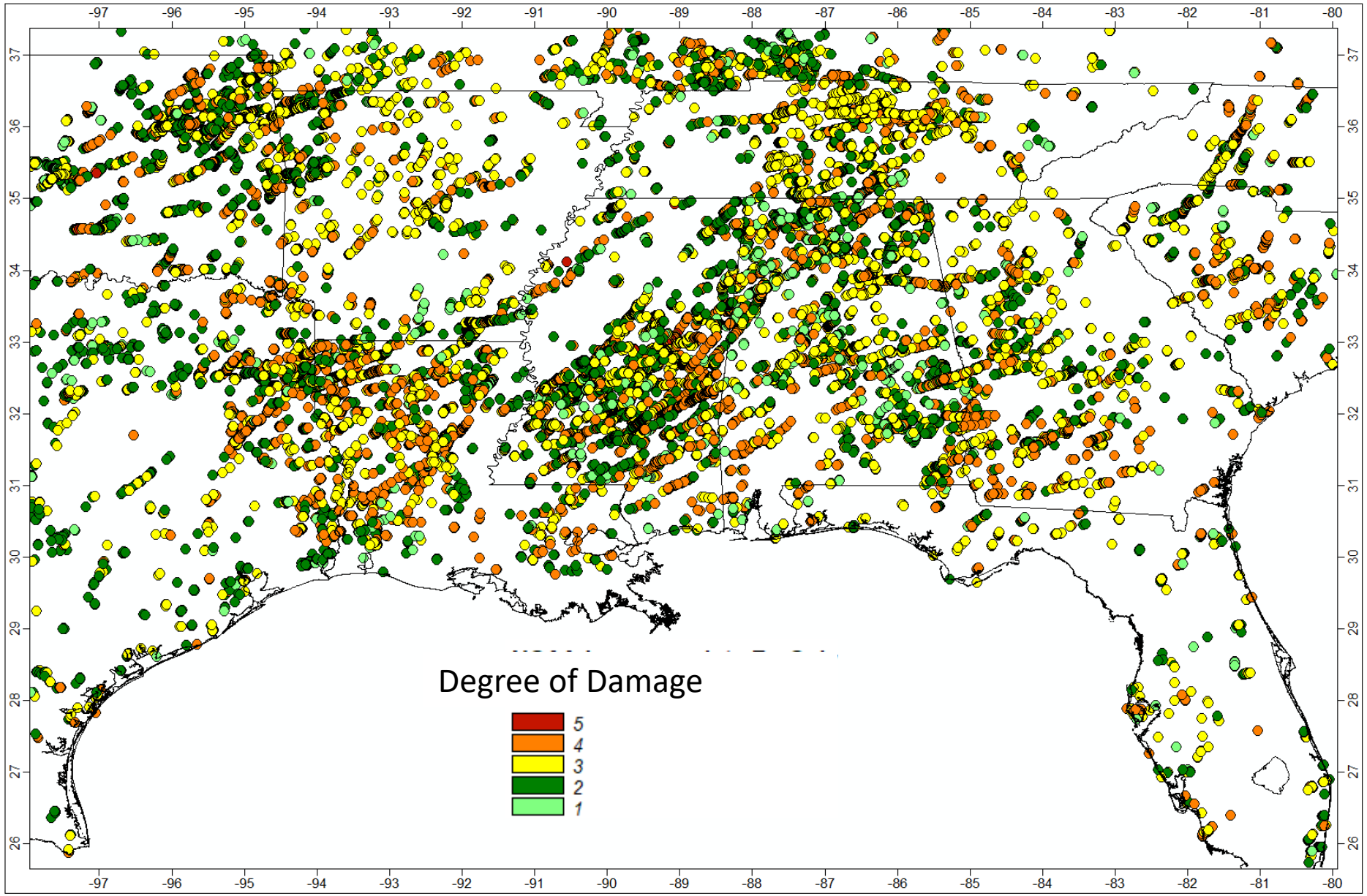
Primary Goals:

- Develop prediction models of forest damage
- Understand how biotic communities respond to wind disturbance



Modeling Wind Disturbance in Forest Habitats: Multiple scales of investigation

Tree damage severity: data from NOAA post-damage assessments, tree damage scaled from 1 – 5 (2012 – 2020)
Based on Tornados and Severe Thunderstorms (winds gusts equal or exceed 58 miles an hour)



- Category 1: small limbs broken (up to 1” diameter)
- Category 2: large branches broken (1”-3” diameter)

- Category 3: Trees Uprooted

- Category 4: Trunks snapped

- Category 5: Trees debarked with only stubs of largest branches remaining

- Category 1: Small limbs broken (up to 1” diameter)
- Category 2: Large branches broken (1”-3” diameter)

→ ‘Low’ damage

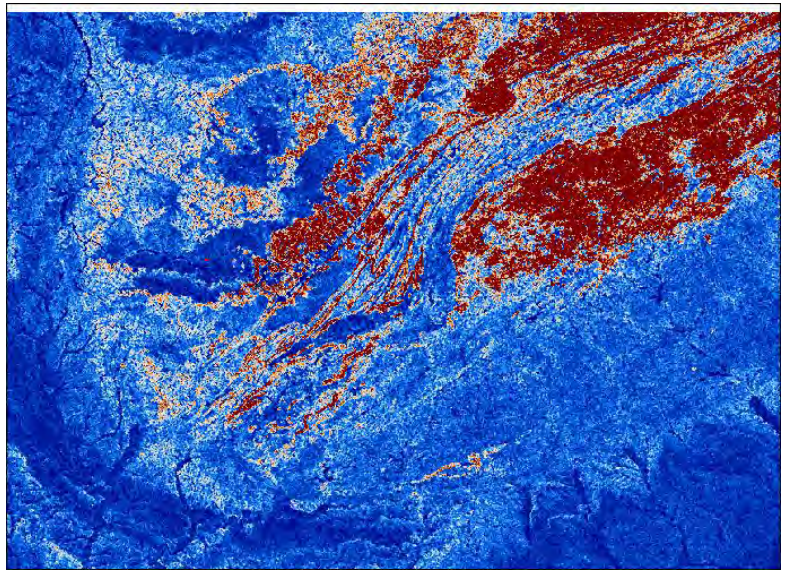
- Category 3: Trees uprooted

→ Uprooting

- Category 4: Trunks snapped
- Category 5: Trees debarked with only stubs of largest branches remaining

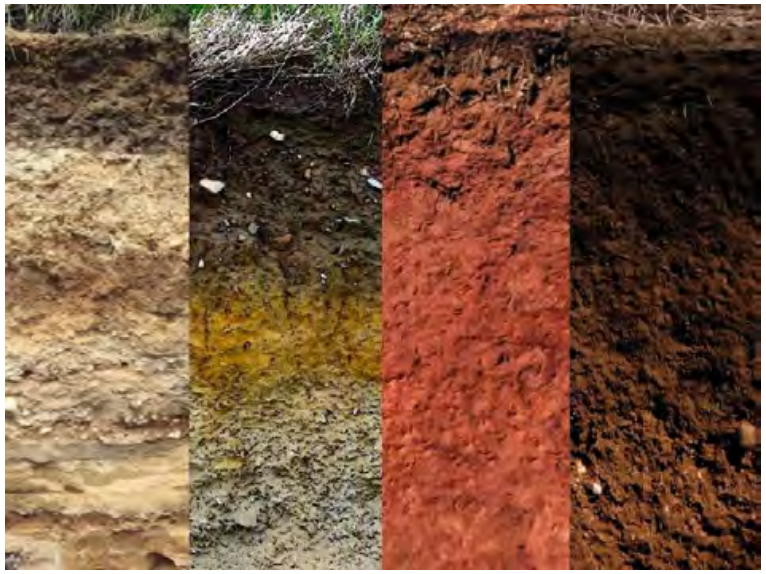
→ Breakage

Predicting tree damage severity at the landscape scale with terrain , climactic, and soil variables



Terrain: Elevation, Slope, Aspect, Terrain Ruggedness Index, etc..

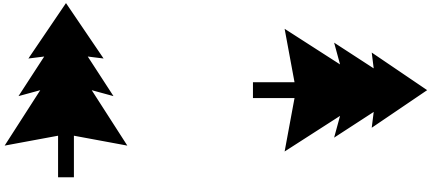
Climate: Temperature, Precipitation, Average windspeeds etc.



Soils: (general) Bulk Density, PH, Bedrock depth, Permeability etc.

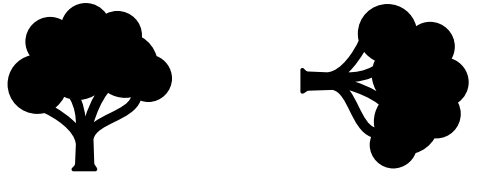
Gamsel for variable selection: combines Lasso regression (regularization) with Generalized Additive Models (GAM)
Multinomial GAM used to generate predictions (probabilities) for each level of damage

Summary of most influential variables

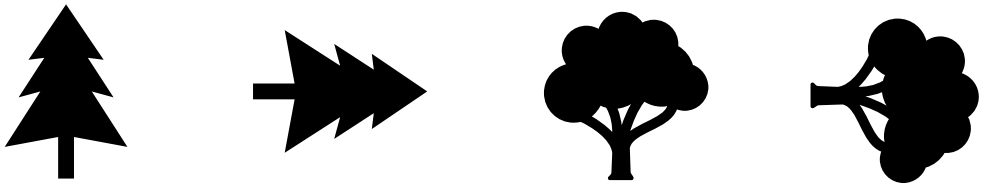


More vulnerable in wetter soils

More vulnerable in areas with deeper bedrock



More vulnerable in acidic, dry soils

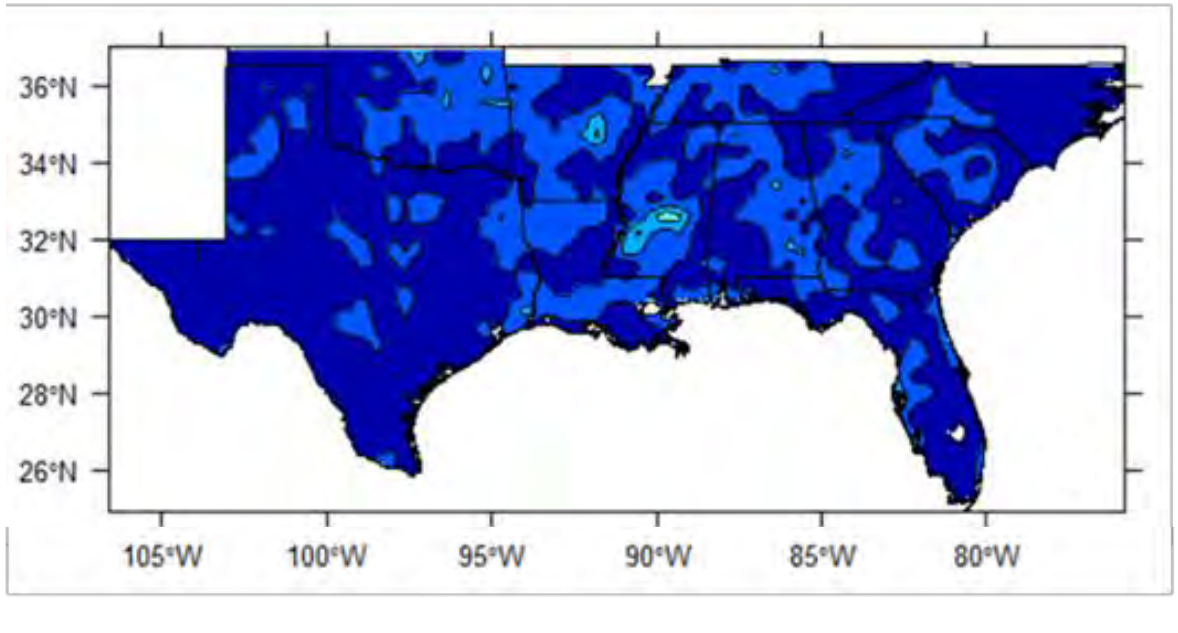


For both pine and hardwood:
Higher soil erodibility factor increases vulnerability
Increasing valley depth decreases vulnerability
Higher average temperatures increase vulnerability

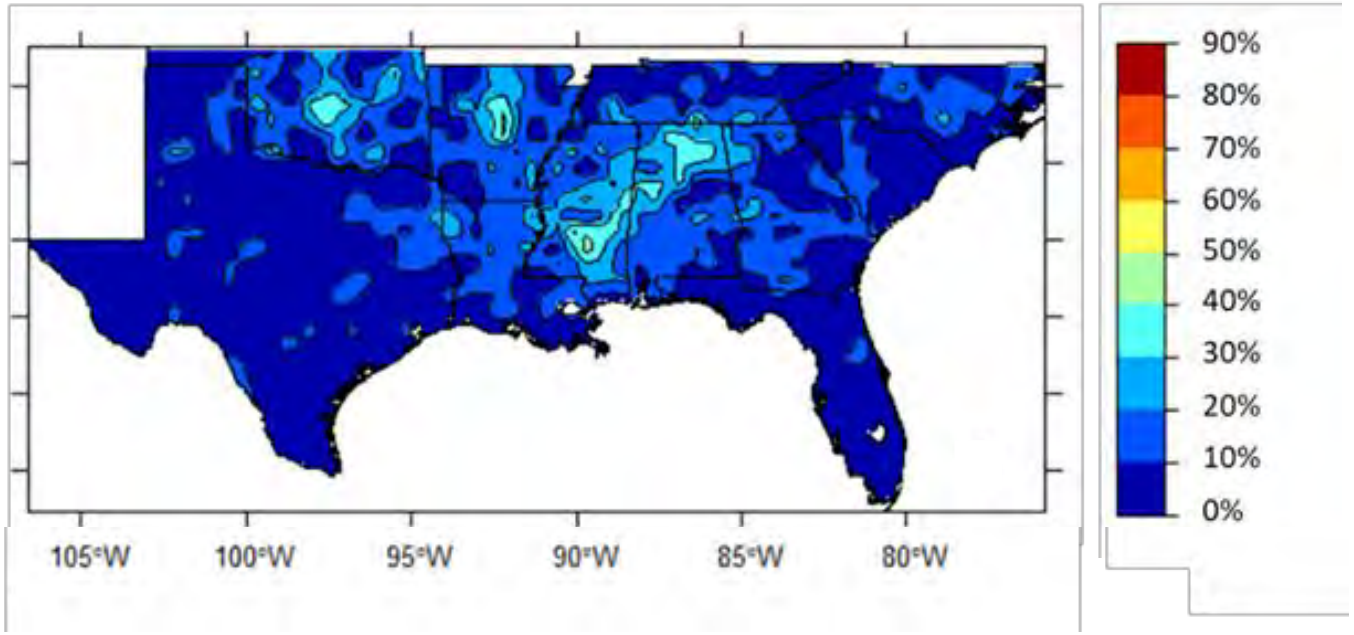
Fortuin, C., C.R. Montes, J.T. Voght, K.J.K. Gandhi (2022). Predicting risks of tornado and severe thunderstorm damage to southeastern US forests. Landscape Ecology, 37 (7), 1905-1919

10-year probability

Uprooting

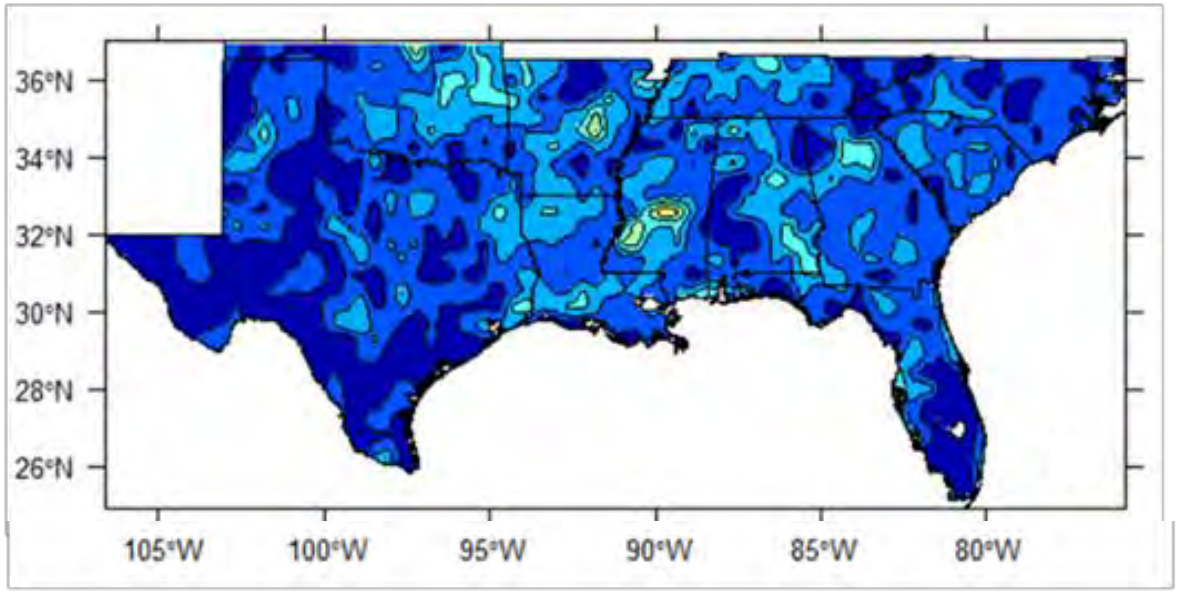


Trunk Breakage

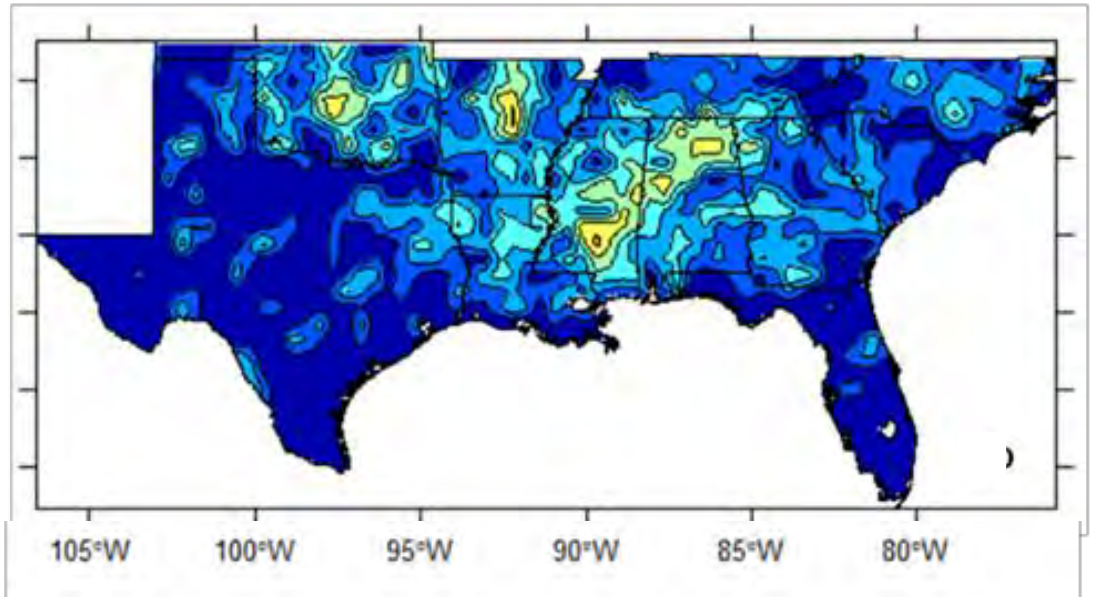


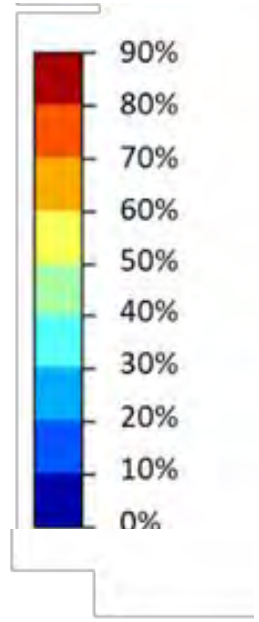
20-year probability

Uprooting



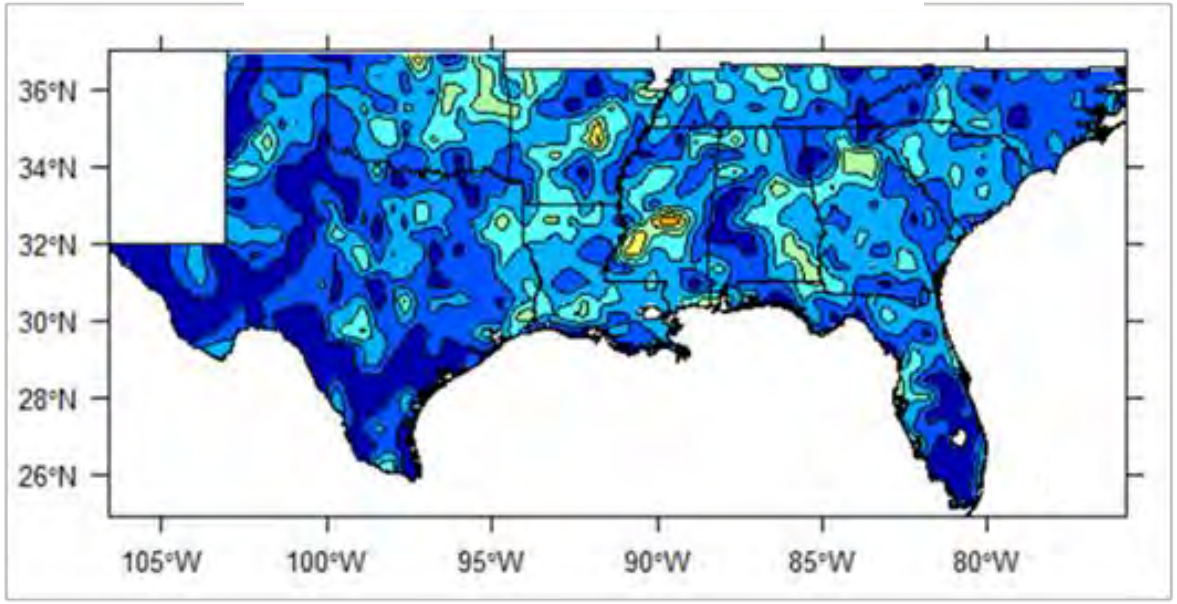
Trunk Breakage



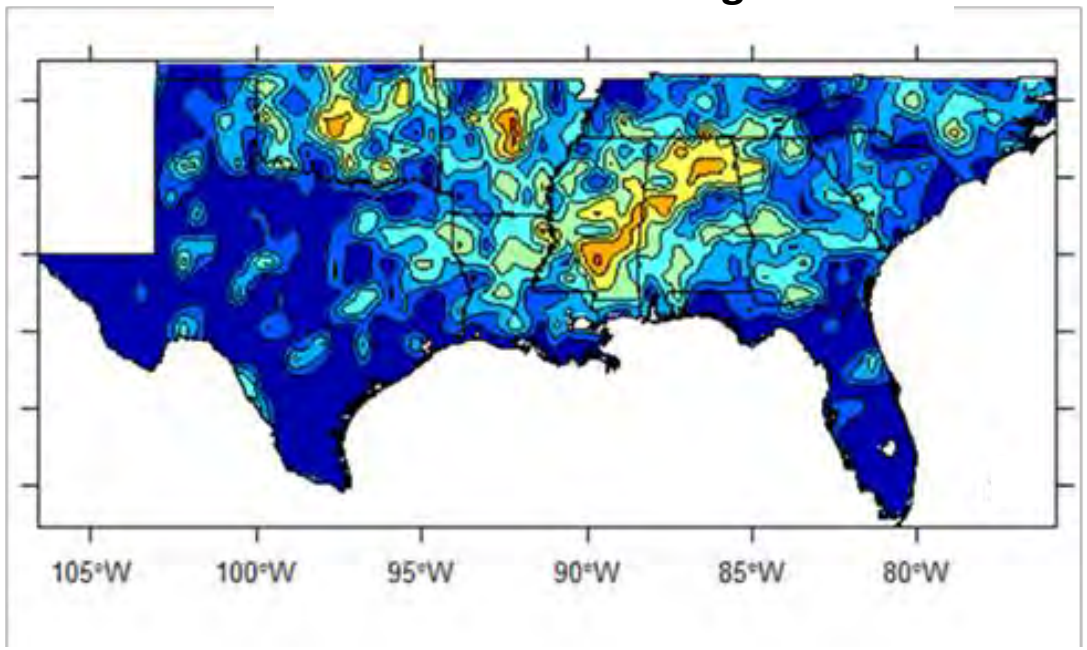


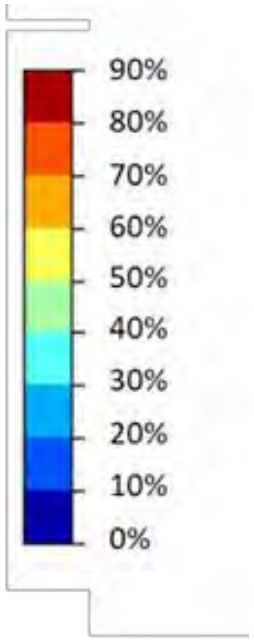
30-year probability

Uprooting



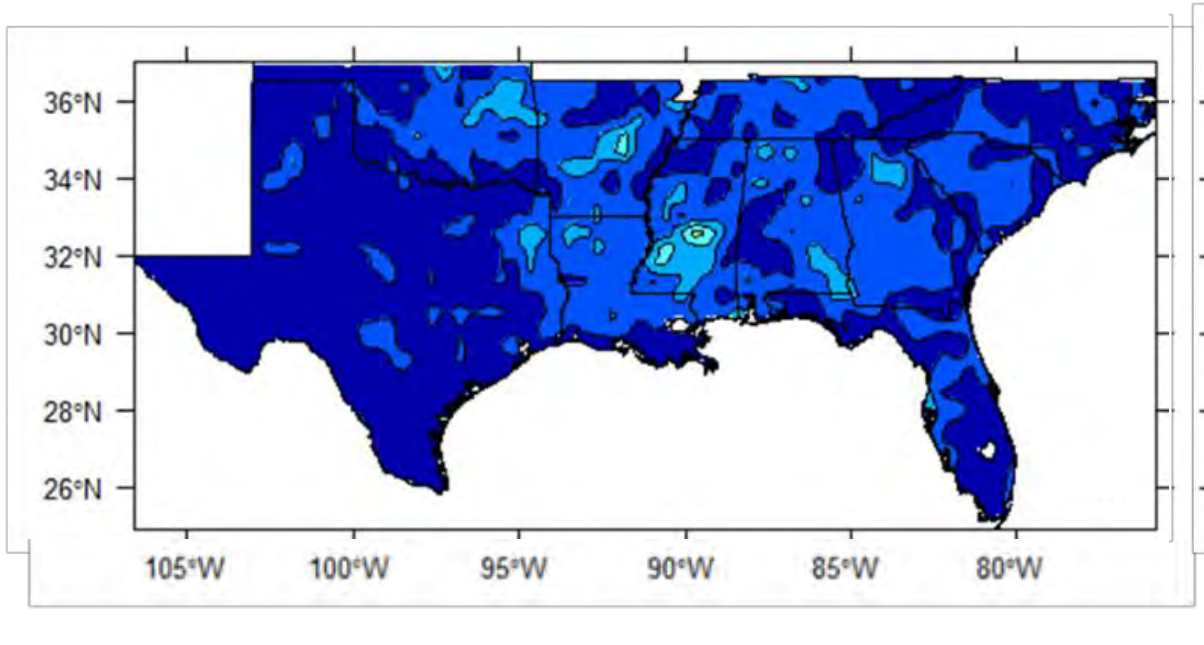
Trunk Breakage





10-year probability

Uprooting



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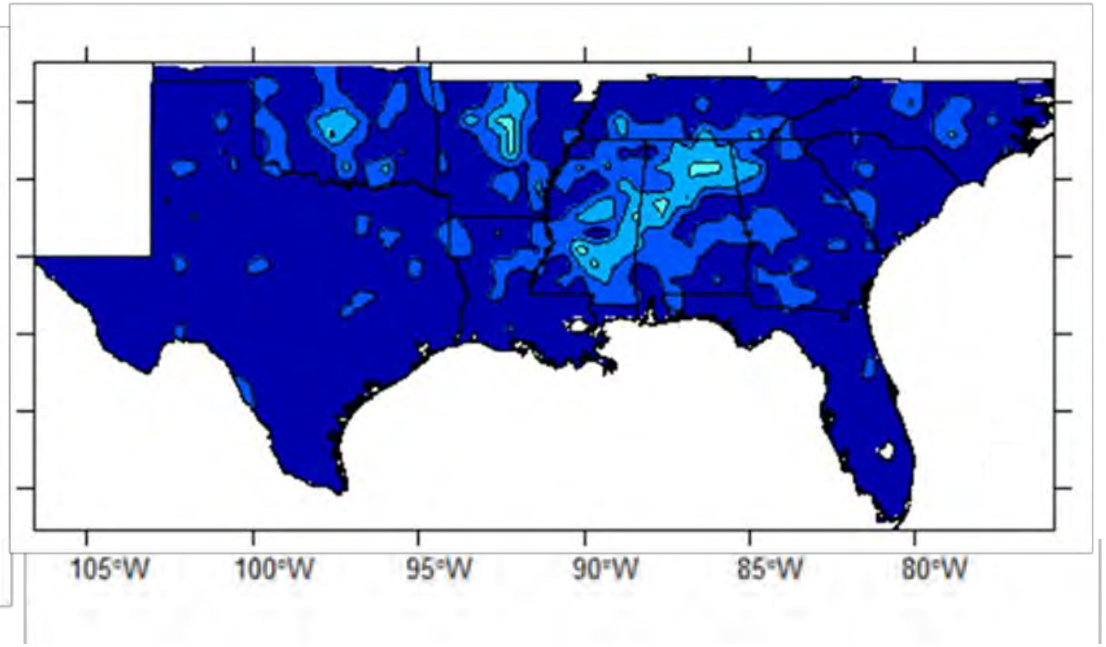
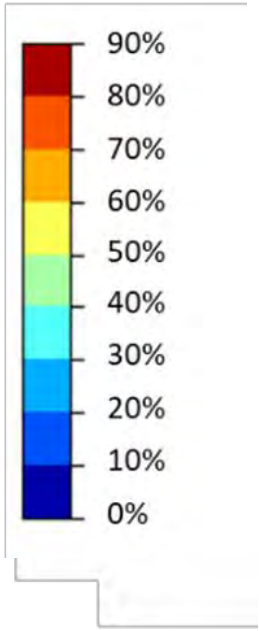
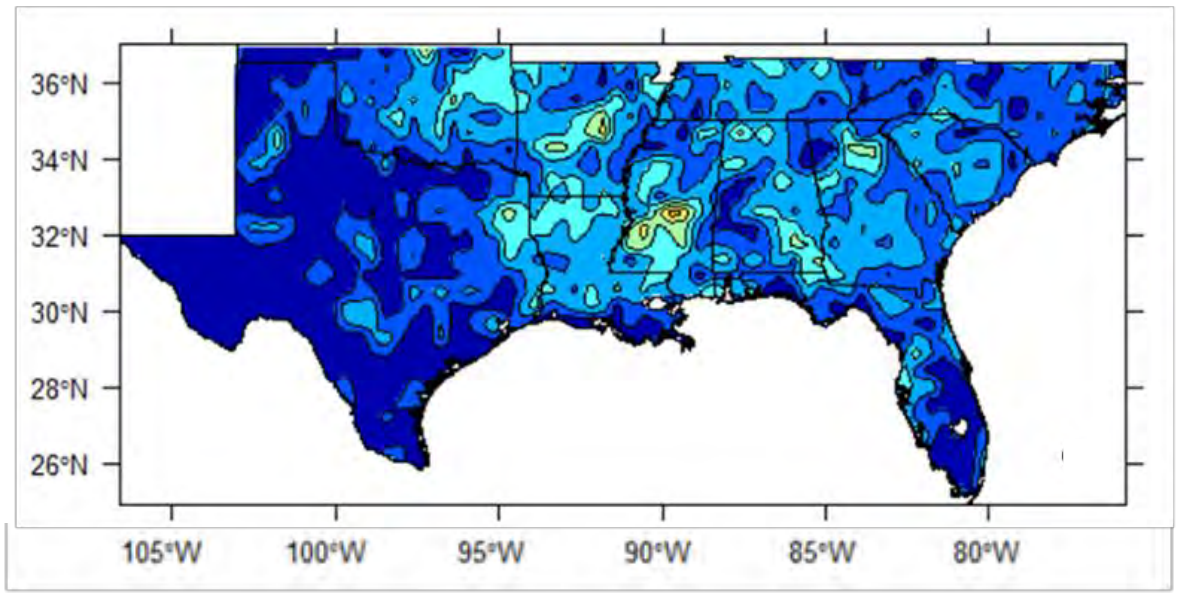


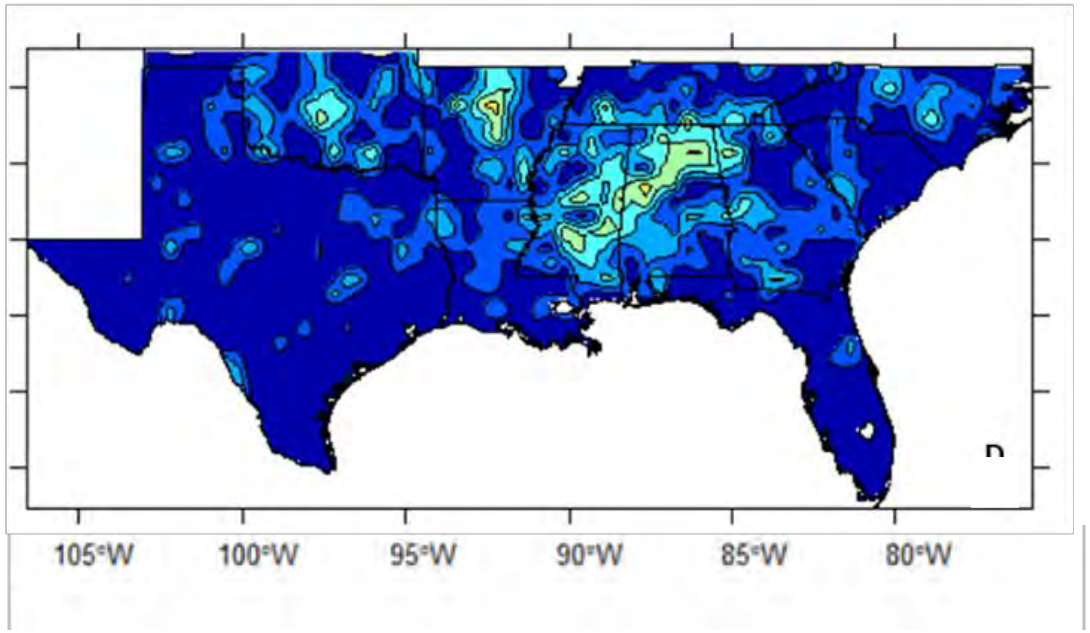


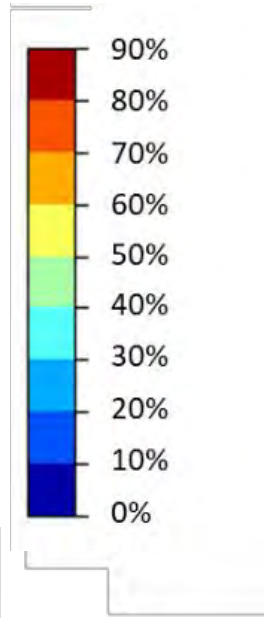
20-year probability

Uprooting



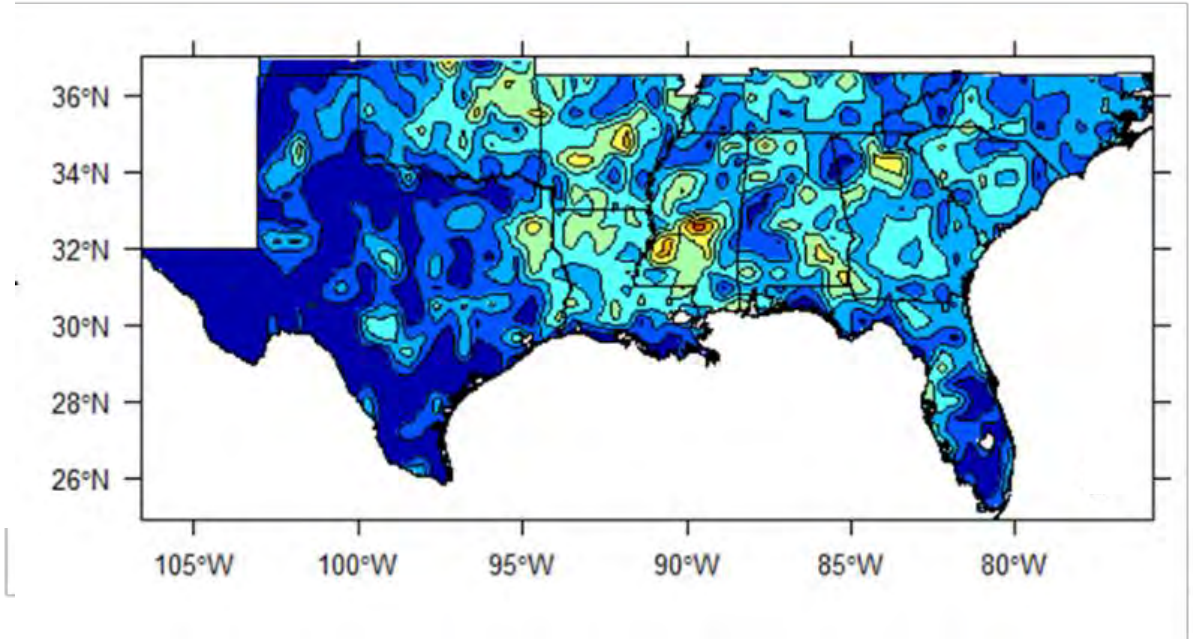
Trunk Breakage



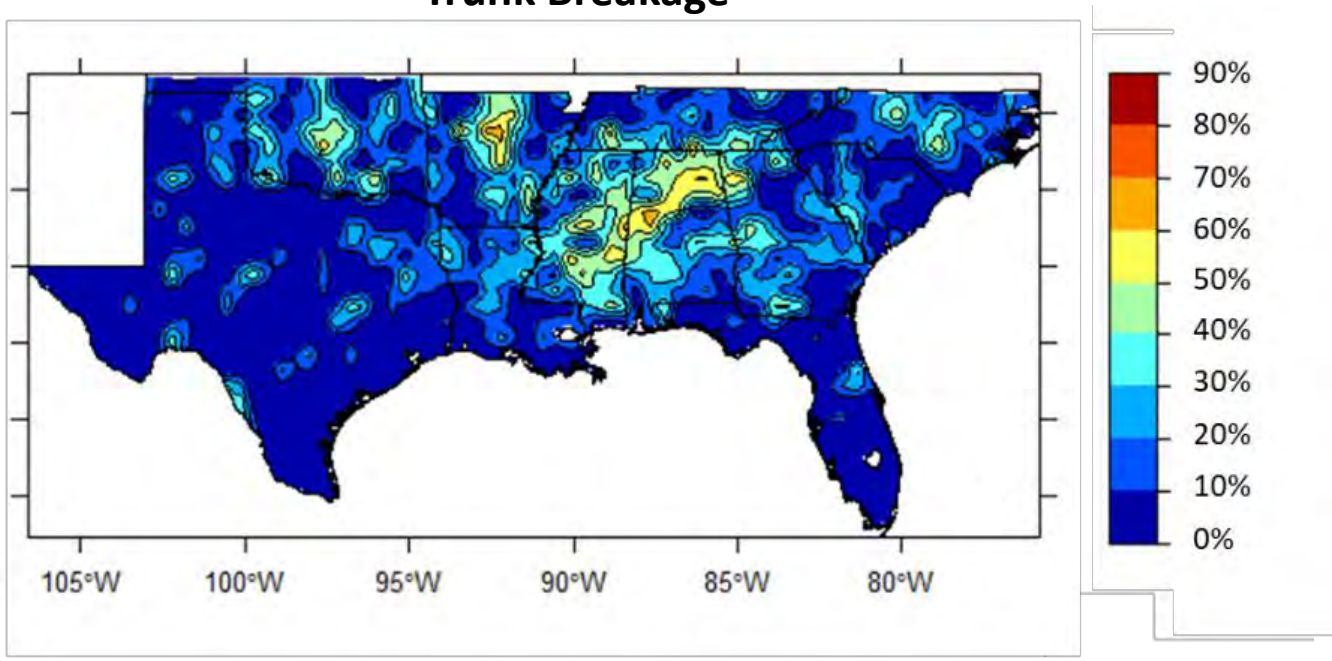


30-year probability

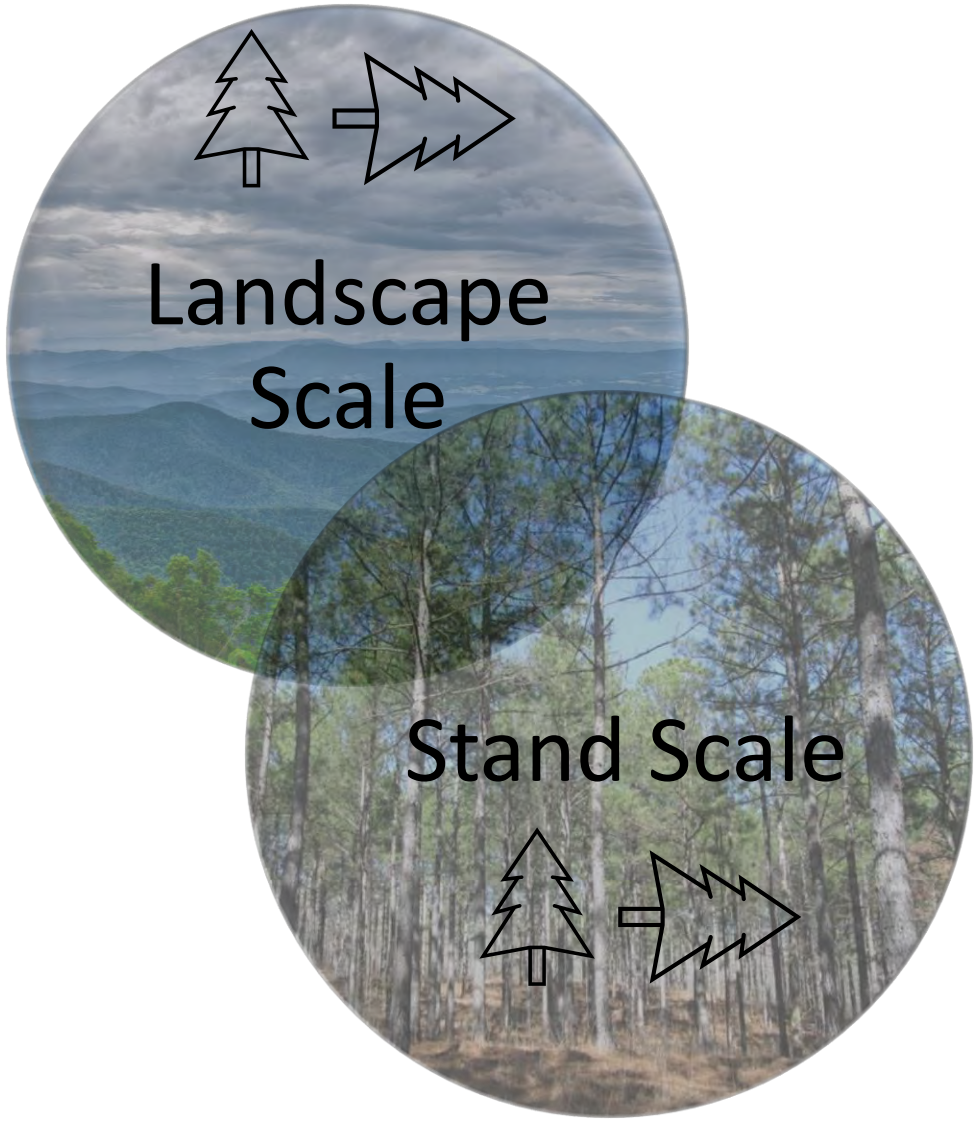
Uprooting



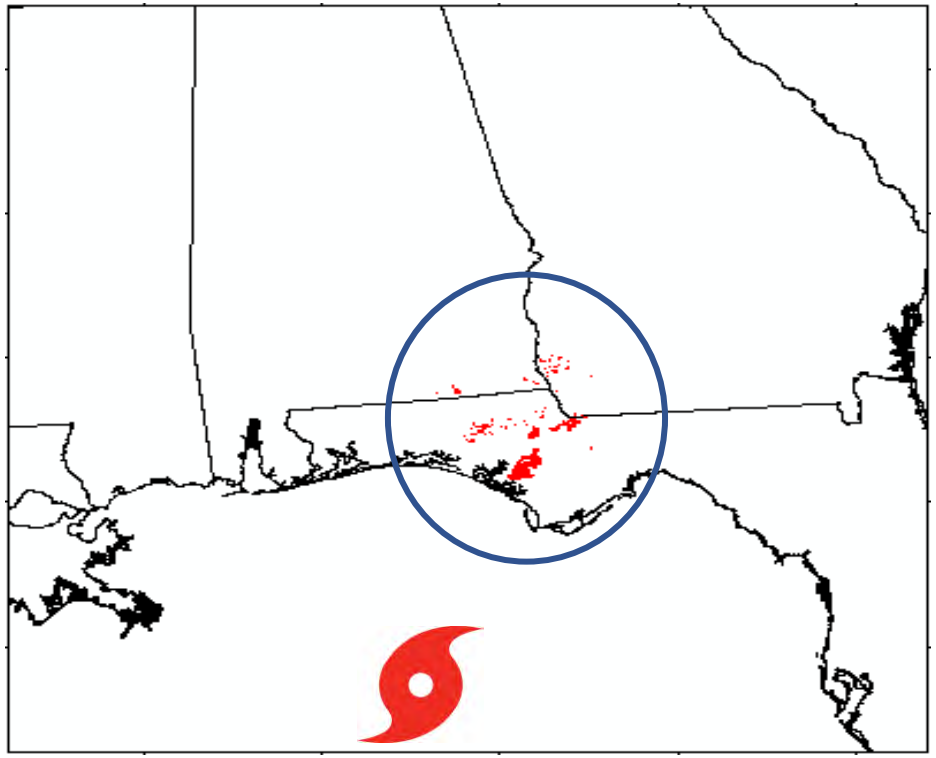
Trunk Breakage

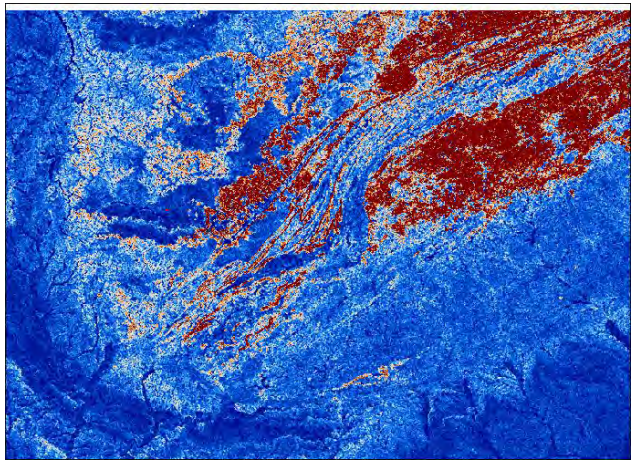


Modeling Wind Disturbance in Forest Habitats: Multiple scales of investigation

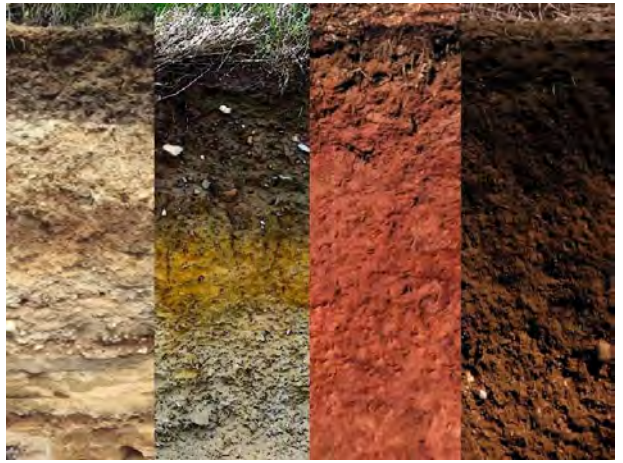


Collected data from over 900 commercial stands affected by hurricane Michael in 2018, in FL, GA, AL.





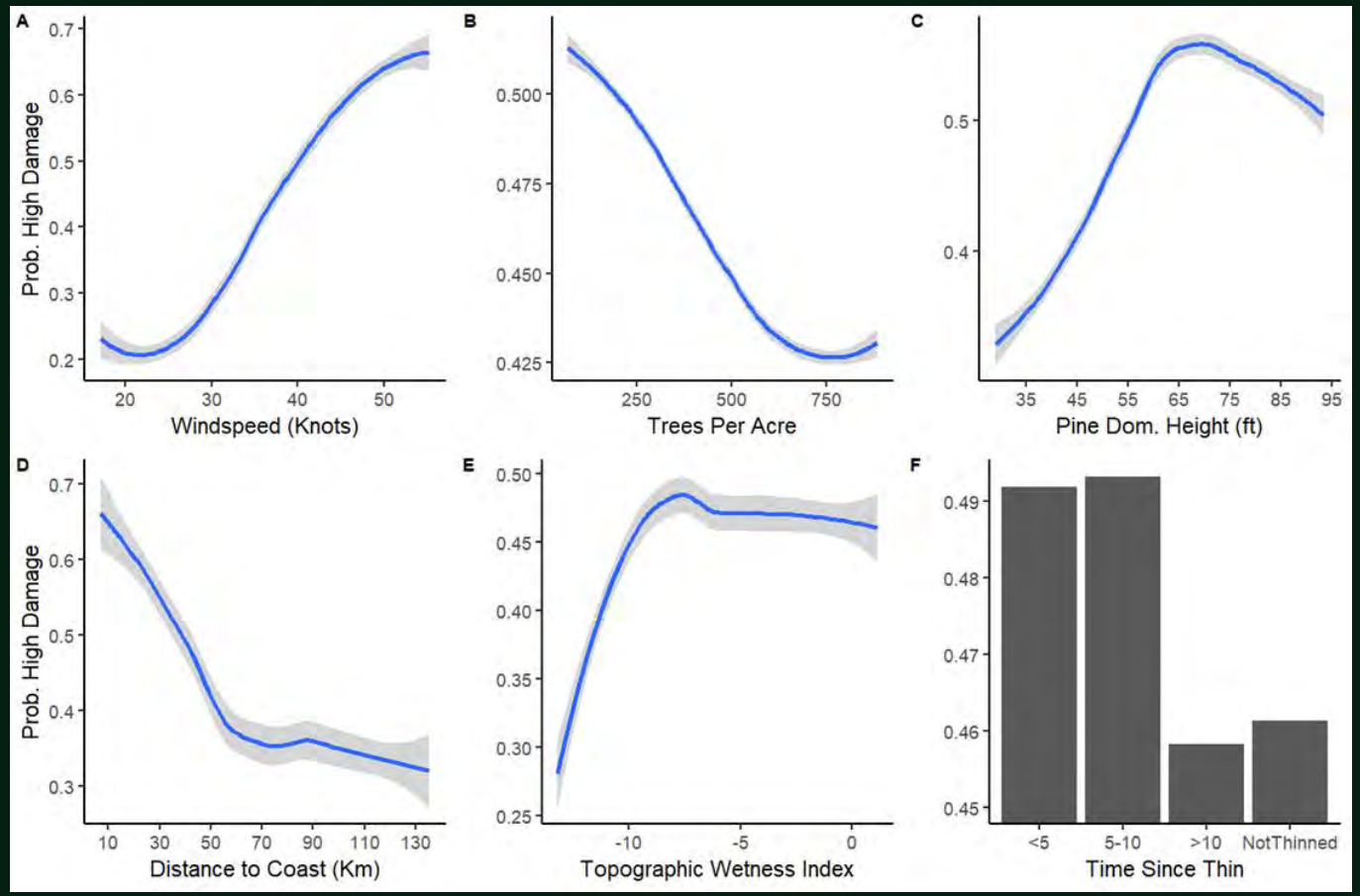
Terrain: Elevation, Slope, Aspect, Terrain Ruggedness Index, etc..



Soils: specific soil type, textures, horizons, drainage class, etc.

Stand characteristics and management history: tree height, spacing, basal area, thinning history, herbicide or fertilizer treatment history, etc.

Lower Density and Taller Sands Most Vulnerable to Damage Losses

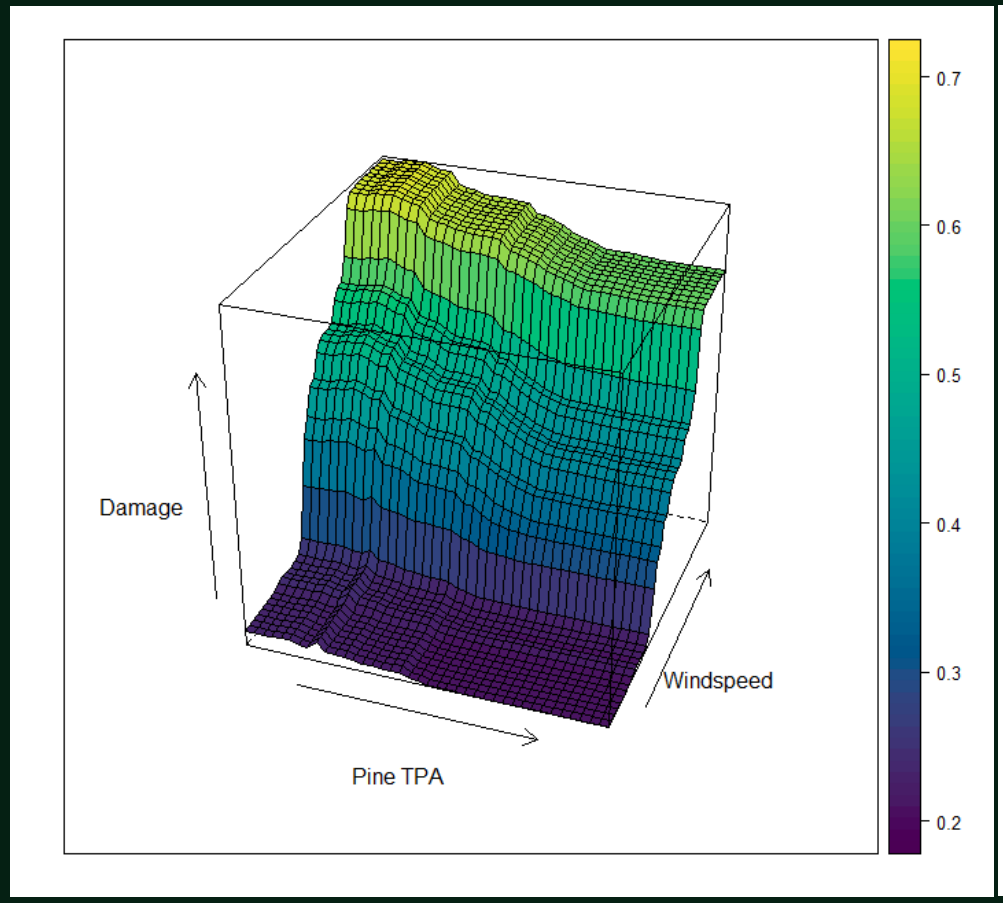


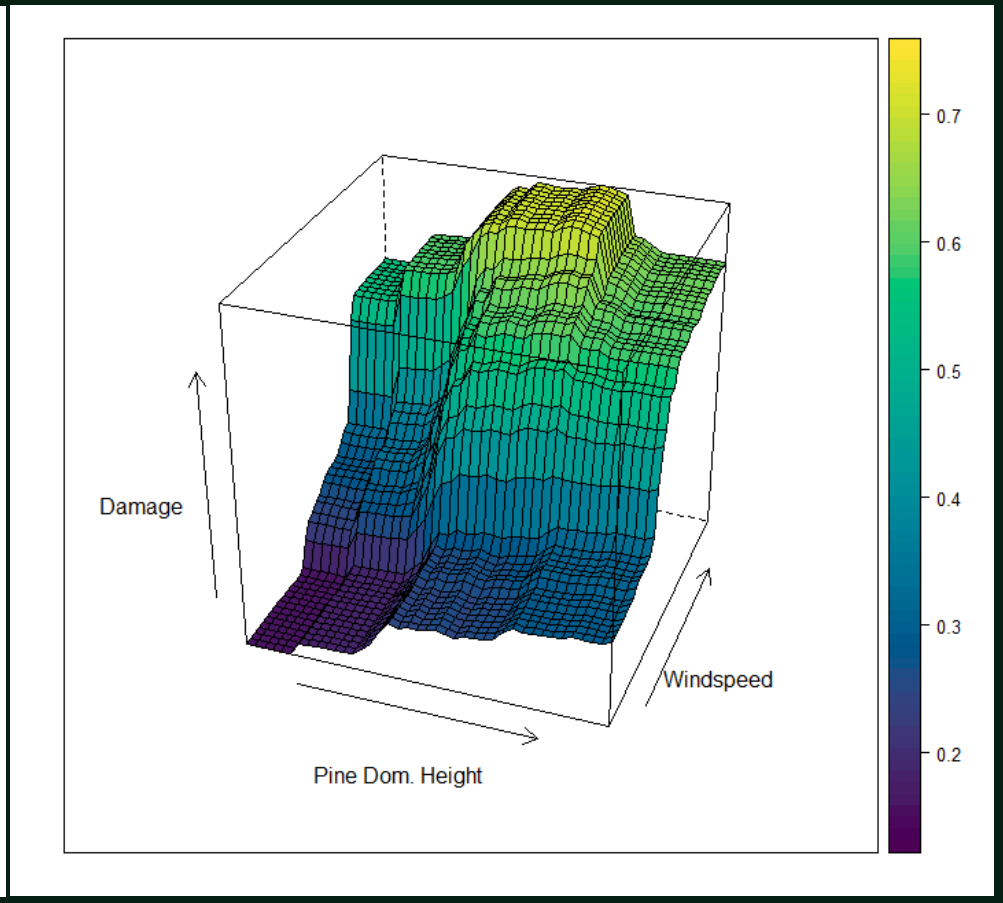
Most Important Predictors of Damage (i.e. Lost Volume per Acre):

- Windspeed
- Density (Trees Per Acre)
- Dominant Height
- Distance to Coast
- Soil Wetness
- Time Since Last Thin

Fortuin, C., C.R. Montes, J.T. Voght, K.J.K. Gandhi (2023). Stand and tree characteristics influence damage severity after a catastrophic hurricane disturbance. *Forest Ecology and Management*

Lower density stands are more vulnerable at all windspeeds
Tree height between 15-23m (50-75 ft) experience increased damage at the highest windspeeds





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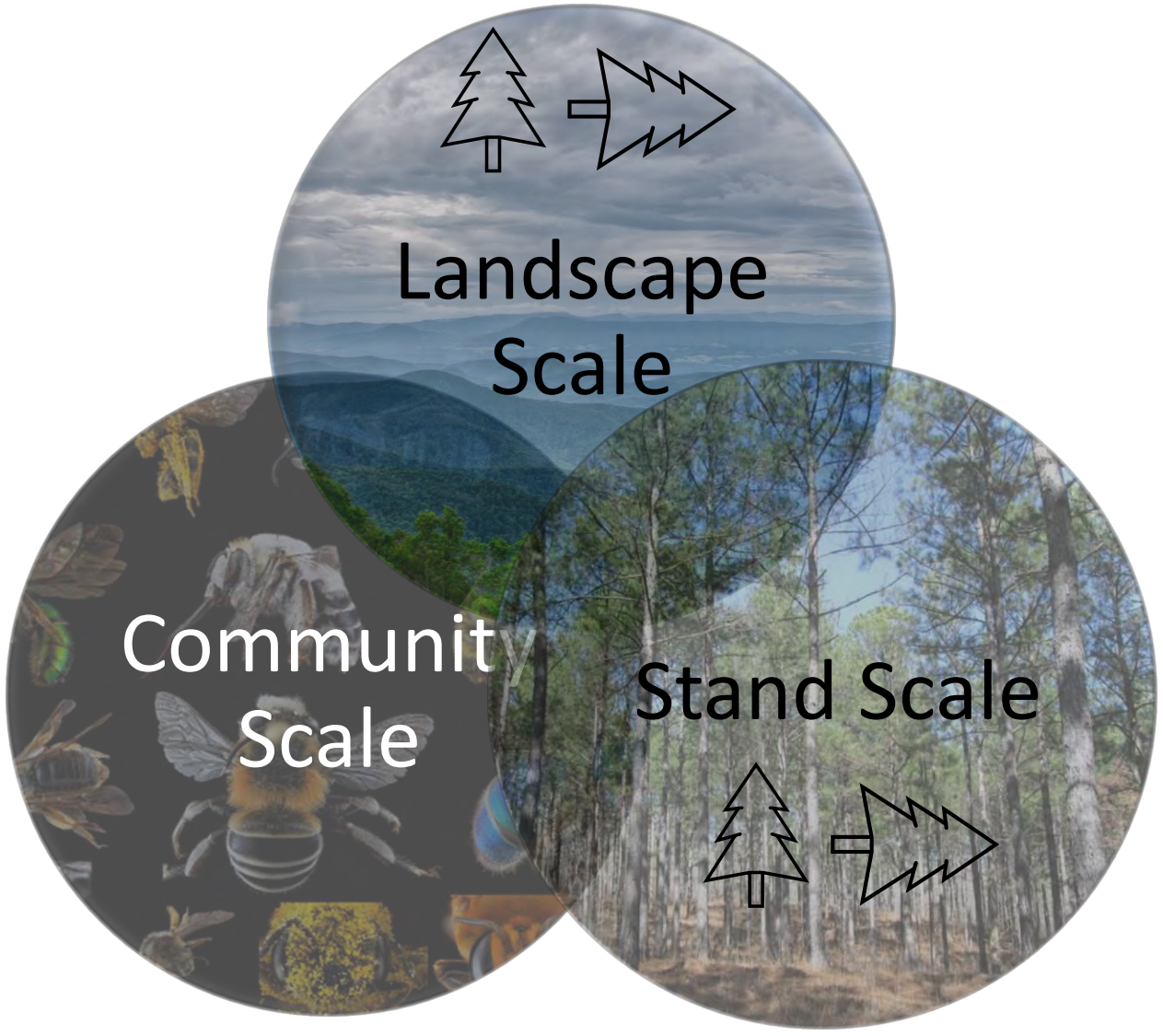
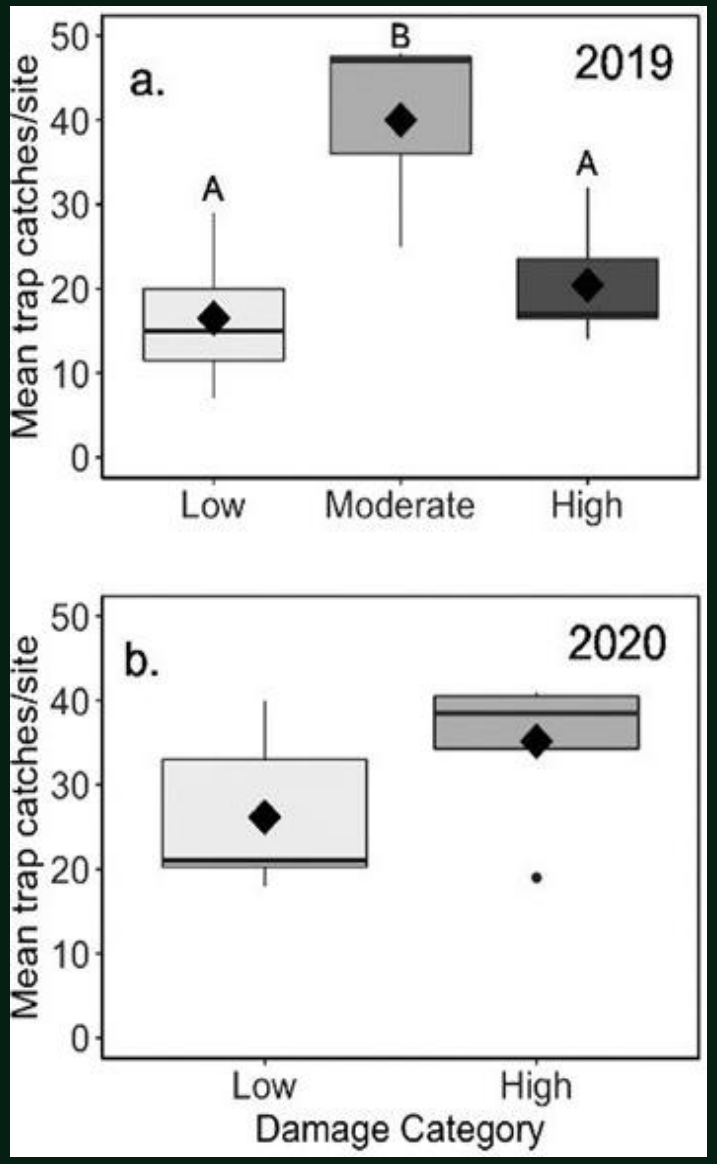


Compared Beetle Populations Among Three Damage Categories

- 5 stands/treatment (N = 15)
- Sampled for:
  - Woodboring Beetles
  - Bark Beetles
  - Root-Feeding Weevils

Seth Spinner (bark beetles and weevils)
& Chelsea Miller (woodboring beetles)

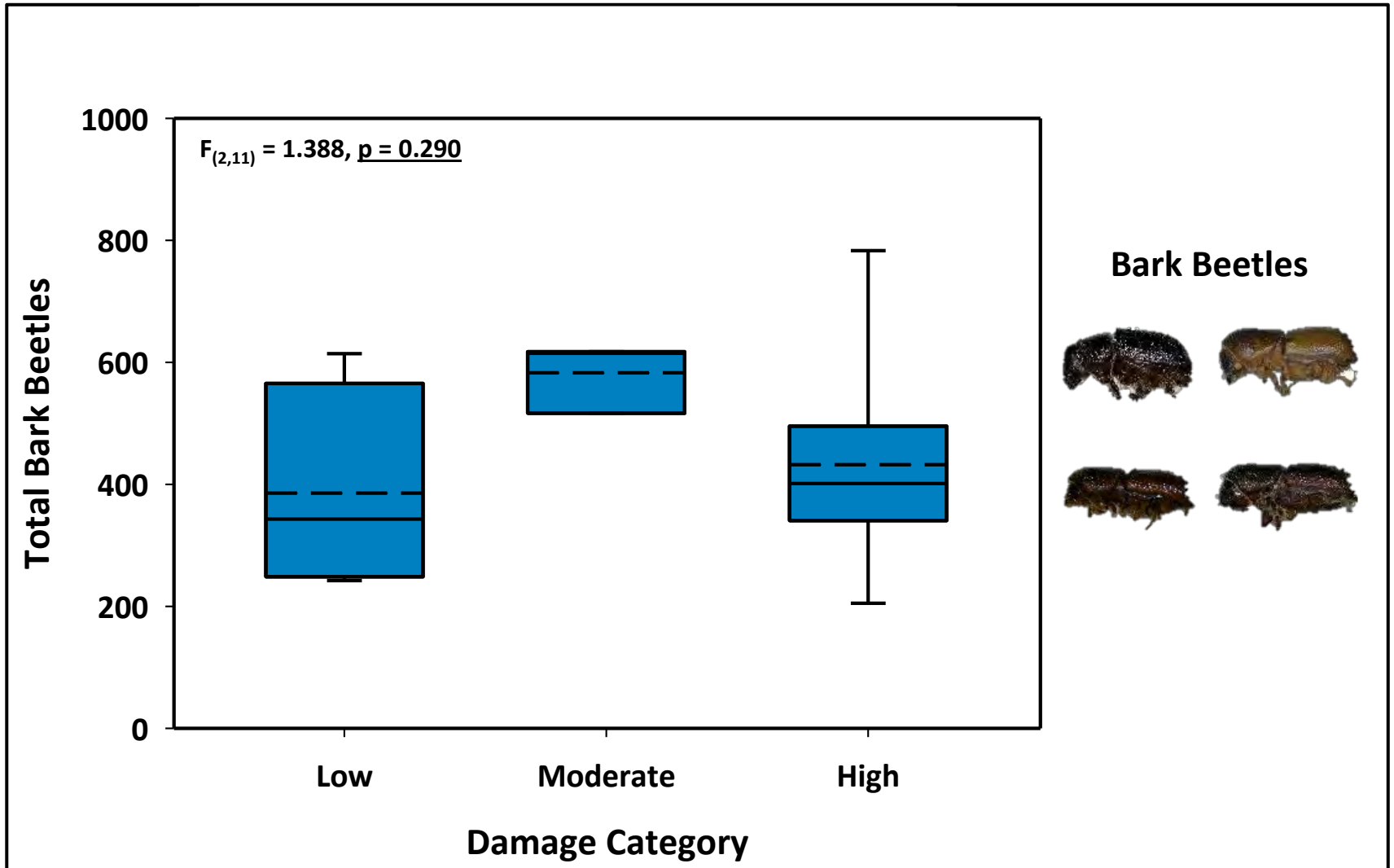
Higher numbers of total woodborers in moderate and highly damaged stands



Number of beetles = 3,800
Number of species = 32

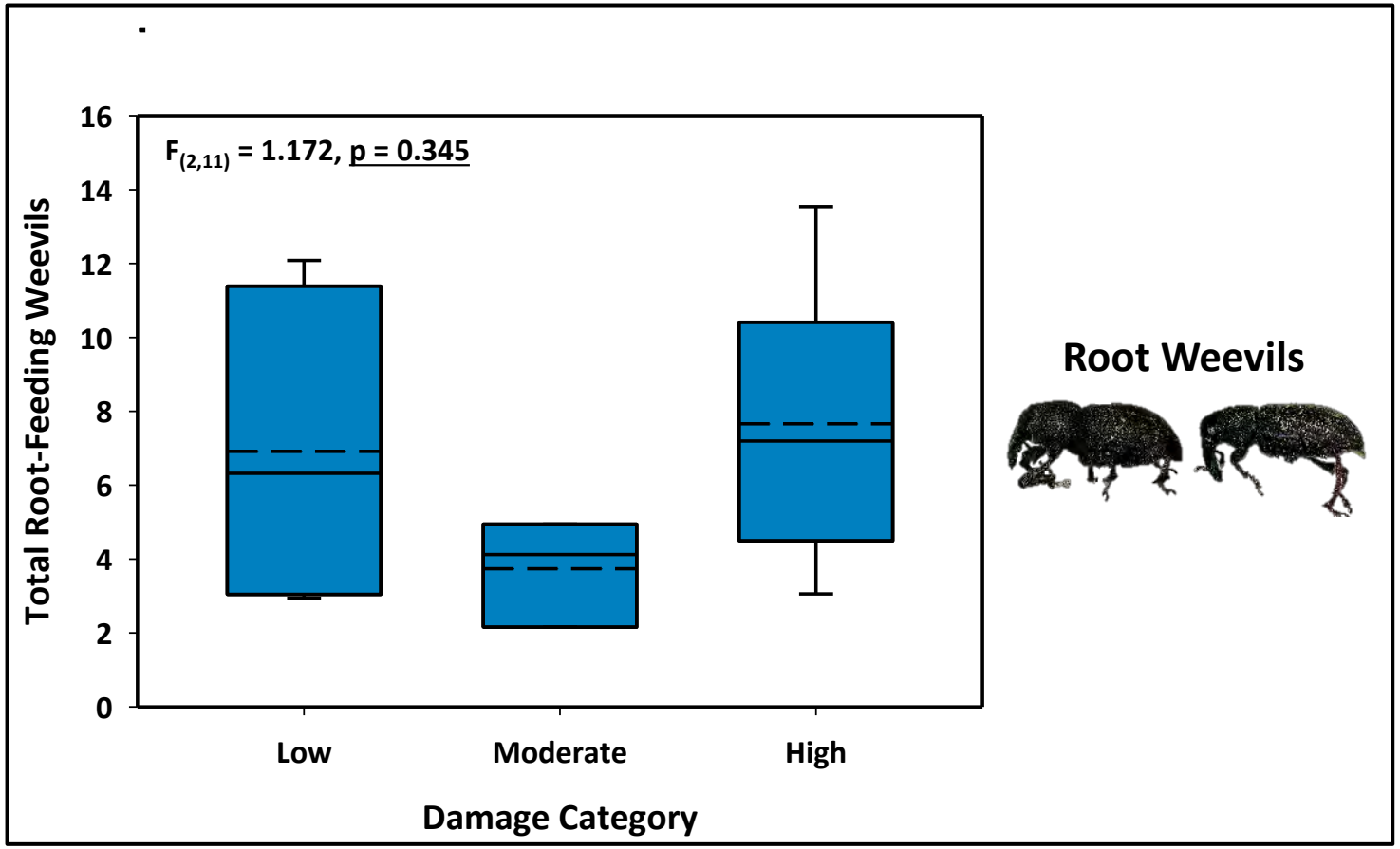
Miller et al. (2023) Woodboring Beetle (Buprestidae, Cerambycidae) Responses to Hurricane Michael in Variously Damaged Southeastern US Pine Plantations. *Forest Science*.

No differences in numbers of major bark beetle species in three damage levels



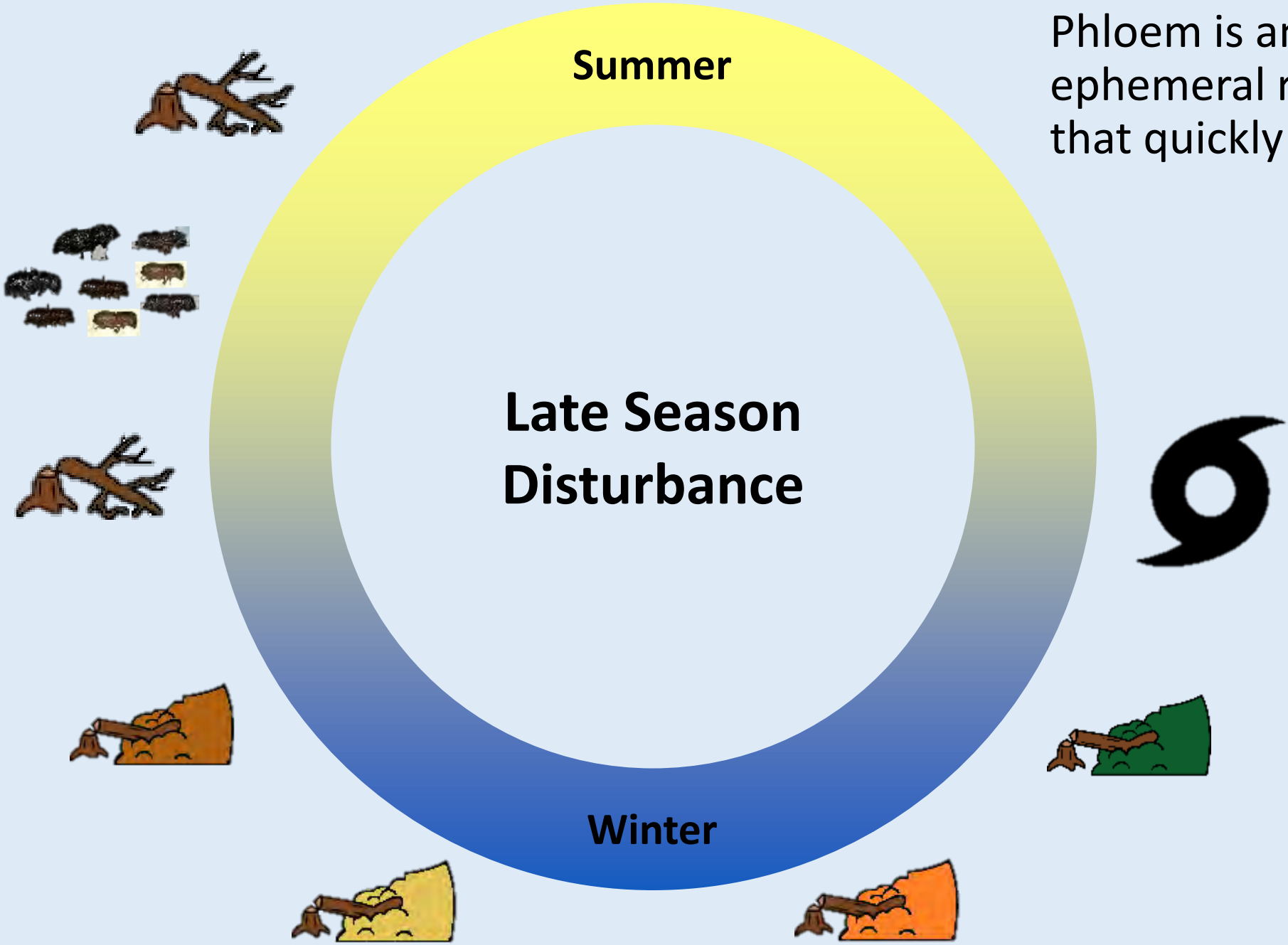
Seth Spinner, UGA
MS Thesis, 2022

No differences in numbers of major root weevil species in three damage levels

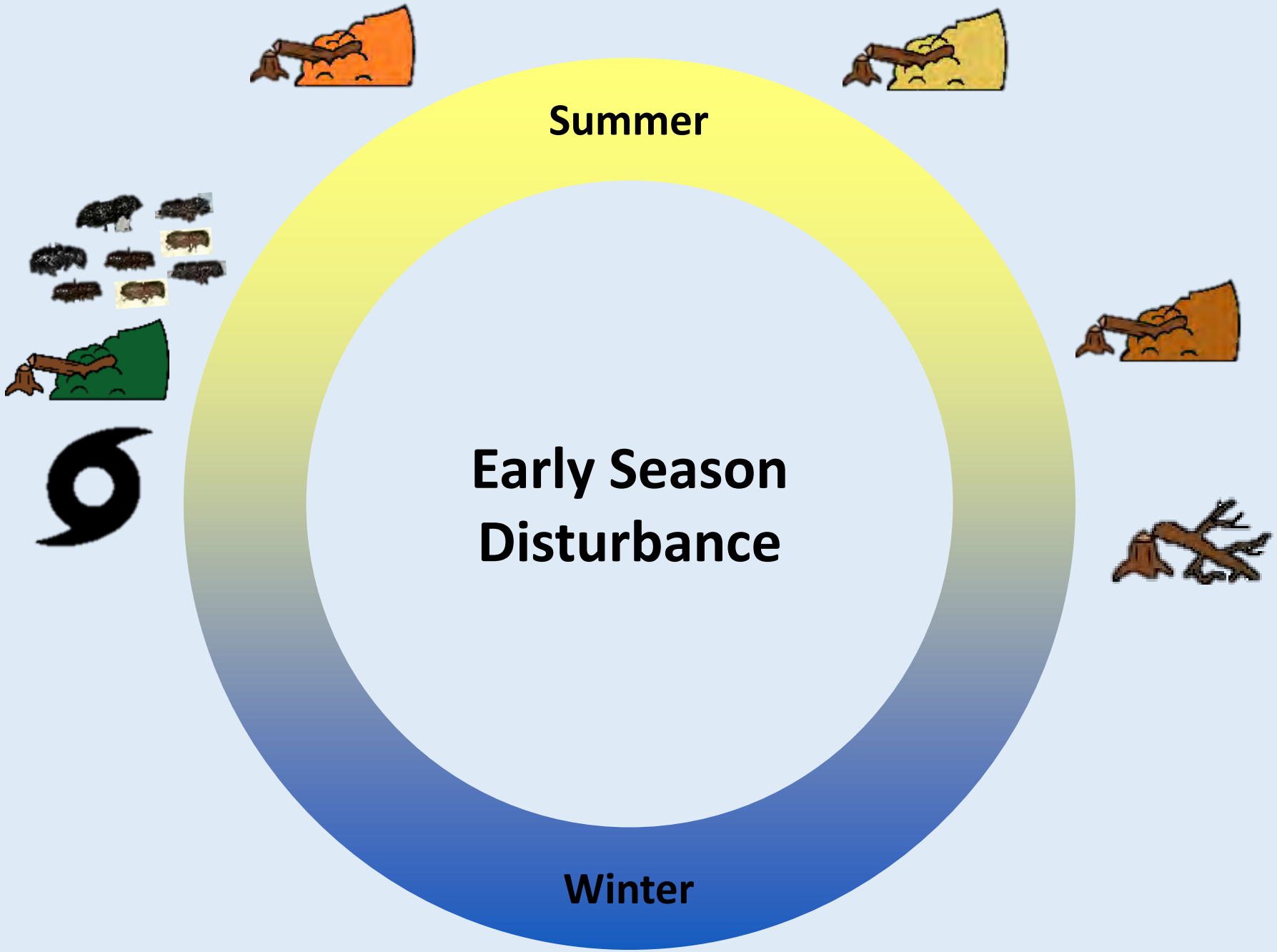


Root Weevils

Seth Spinner, UGA
MS Thesis, 2022

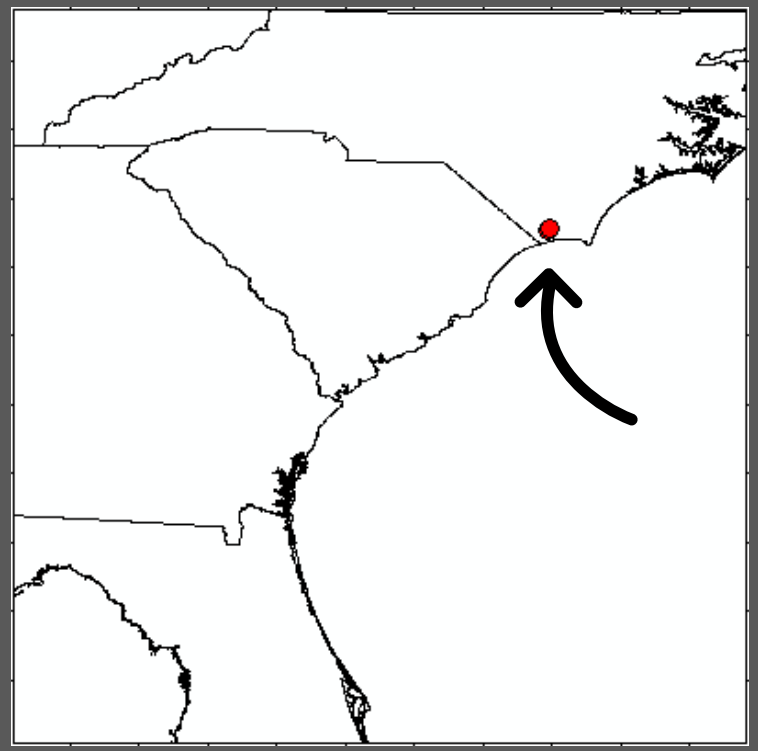


Phloem is an ephemeral resource that quickly degrades


Summer
Early Season
Disturbance
Winter

Invertebrate community response to wind damage

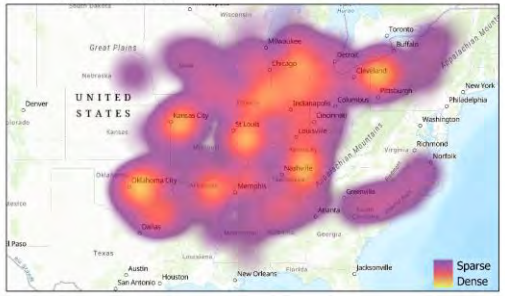
- Tracking beetle, bee and plant communities in recent tornado tracks
- Managed coastal plain forests in NC



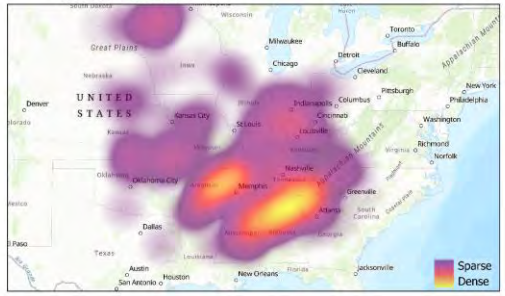
Current Projects

Tornado Outbreaks

1950-1989

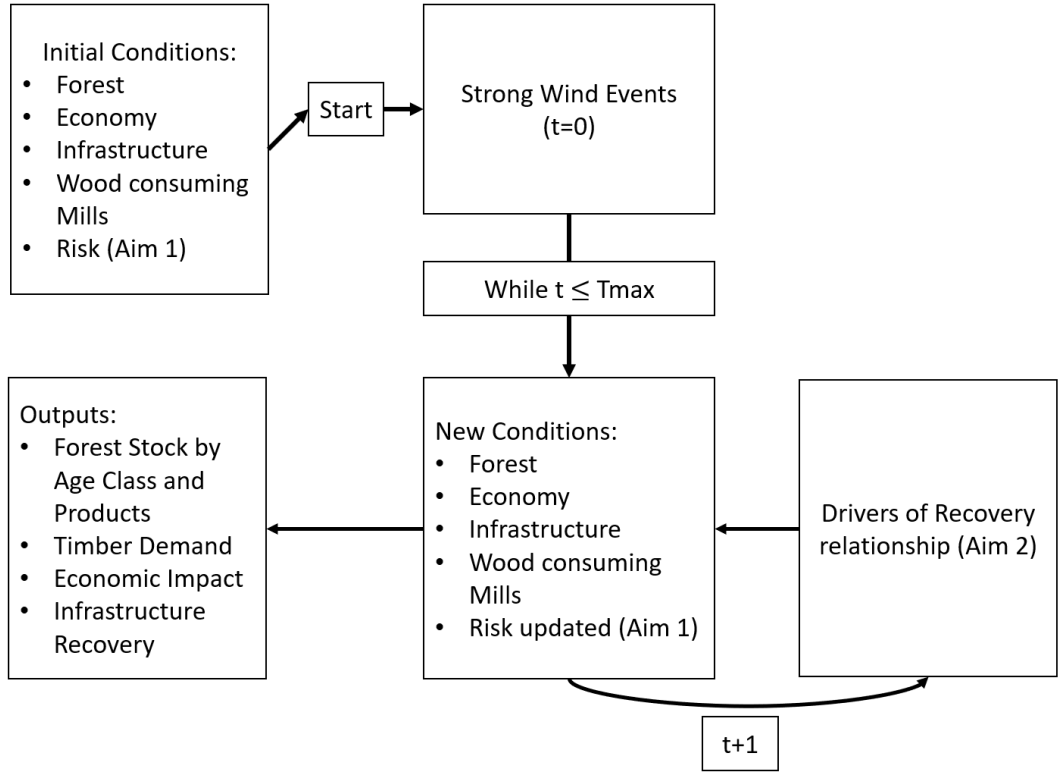


1990-2022



Graphic credit: Bruno Kanieski da Silva, UGA

Agent-Based Model



Thank You!

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