Program & Abstracts
23rd Biennial Southern Silvicultural Research Conference

Greenville, SC
March 18–20, 2025

Conference Chairs

Geoff Wang & Brian Oswald

Hosted by

Clemson University

Supported by

USDA Forest Service, Southern Research Station

Preface

The 23rd Biennial Southern Silvicultural Research Conference (BSSRC) is being held March 18–20, 2025 at the Hyatt Regency in Greenville, South Carolina. This conference is the latest in a series of meetings designed to provide a forum for the exchange of research information among silviculturists, researchers, and managers. Presentations will emphasize research in hardwood and pine silviculture, fire, carbon, stand development, forest measurements and modeling, and many other fields in forest ecology and management. In addition to an opening morning plenary session, seven sessions including 81 oral and 37 poster presentations will be offered on March 18 and 19 (pages 4–14). An online General Technical Report (e-GTR-SRS) will be compiled for publication by the Southern Research Station to document the proceedings. A *Forest Science* special edition publication option will be offered for complete manuscripts.

A field tour will be offered on Thursday, March 20 (page 11). We will tour DuPont State Recreational Forest in western North Carolina and visit sites showcasing active silviculture within a forest that receives more than 1 million visitors per year.

As part of their registration, attendees will be provided breakfasts, refreshments for morning and afternoon breaks, a reception concurrent with the poster session (March 18 only), and a dinner and evening social (March 19 only) on March 18 and 19. Because we will be near the restaurants of downtown Greenville (including the one at the Hyatt Regency), a longer block of time will be provided to attendees and lunch will be on your own both days. During the poster session on Tuesday evening in Regency AB, a reception with heavy hors d'oeuvres and drinks provided will be held from 6:00 to 8:00 p.m. A social at Hyatt Regency C will be held from 7:00 to 10:00 p.m. on Wednesday evening with buffet dinner and drinks provided. Thursday field tour attendees will be offered breakfast and lunch, and transportation to the field sites will be provided.

Finally, we are grateful to Ms. Sandi Priddy for their diligence in handling the fiscal responsibilities of the meeting and for helping with the registration process. We would like to recognize the following for their support: Jeremy Stovall for the BSSRC website, Helen Mohr for organizing the field tour, and Clemson graduate students Trisha Markus, Ryan Bohannon, Htet Naing, Armin Weise, and Ruth Cumberland for their logistical support. In addition, we would like to recognize the 23rd BSSRC's steering committee for devoting numerous hours to reviewing abstracts, establishing the program for oral and poster presentations, developing field tours and presentations, and making all the other necessary arrangements to ensure a successful conference. Steering committee members include:

Respectfully, Geoff Wang, Professor, Clemson University, and Brian Oswald, Professor, SFASU
23rd BSSRC co-chairs

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23rd Biennial Southern Silvicultural Research Conference

Conference Venue: Hyatt Regency Greenville

220 North Main Street, Greenville, SC 29601

Monday, March 17, 2025

5:00 – 9:00 pm **Registration — Meeting Planning Office**
5:00 – 9:00 pm **Poster set-up — Regency AB**

23rd Biennial Southern Silvicultural Research Conference Program

Tuesday, March 18, 2025

7:00 – 8:00 am **Continental Breakfast – Outside Ballroom**

8:00 am – 8:00 pm **Poster Visitation – Regency AB**

Welcome Session — Regency C

8:00 – 9:30 am **Welcome and Plenary Session speakers:**

Geoff Wang, Co-chair, 23rd Biennial Southern Silvicultural Research Conference
Bob Jones, Executive VP and Provost, Clemson University (CU)
Tom Patton, Deputy State Forester, SC Forestry Commission
Kyle Barrett, Interim Chair, Dept. Forestry and Environmental Conservation, CU
Brian Oswald, Co-chair, 23rd Biennial Southern Silvicultural Research Conference

9:30 – 10:00 am **Break – Outside Ballroom**

Concurrent Session 1 — Regency C

Management 1: Waqar Shafqat (moderator)

10:00 – 10:30 am* Status and ecological impacts of draft animal logging in the southeastern United States. L. Hales, J. Hart

10:30 – 11:00 am* Do successional dynamics of deadwood indicate a need for silvicultural intervention within National Parks of the National Capital Region? D. Maslyukova, T.A. Coates, W.M. Ford, V.R. Emrick

11:00 – 11:30 am* Building Climate-Sensitive Individual Tree Mortality Models for Softwoods/Hardwoods in Mississippi State Forests. S. Baskarla

11:30 – 1:30 pm **Lunch on your own**

Management 2: Waqar Shafqat (moderator)

1:30 – 2:00 pm Positive Biodiversity-Productivity Relationship in Populus at Southeastern USA. W. Shafqat, H. Renninger, C. Siegert, A. Himes, A. Drager

2:00 – 2:30 pm Log landings are for the bees: a case study in the coproduction of actionable science to benefit native pollinators. L.S. Pile Knapp (withdrawal)

2:30 – 3:00 pm Evaluation of biological invasion in forested coastal wetlands: High impact invaders as legacies of Hurricane Katrina. M. Bataineh, D. Saenz, C. Schalk, L.S. Pile Knapp, J. Fraser, M. Sieja (withdrawal)

3:00 – 3:30 pm **Break – Outside Ballroom**

Concurrent Session 2 — Regency DE

Longleaf Pine 1: Steve Jack (moderator)

10:00 – 10:30 am* Estimating the effect of silvicultural practices and environmental co-variables on plantation longleaf pine productivity in the southeastern United States. O. Reed, H. Tripp, B. Bullock, S. Kinane, B. DaSilva, D. Dickens, D. Clabo, S.-I. Yang, D. Zhao

10:30 – 11:00 am* Structure and Spatial Patterns of Longleaf Pine Woodlands in the Fall Line Hills. D. Phillips, L. Hales, J. Hart

11:00 – 11:30 am* Longleaf pine aboveground production after Hurricane Helene and pine straw raking treatments on the Lower Coastal Plain in south Georgia. N. Shephard, S. Kinane, D. Clabo, D. Markewitz

11:30 – 1:30 pm Lunch on your own

Longleaf Pine 2: Steve Jack (moderator)

1:30 – 2:00 pm* Site Index and Growth Efficiency of Longleaf Pine Planted on Marginal Agricultural Lands. J.T. Pegues, A.D. Polinko, J. Puhlick, K. Poudel

2:00 – 2:30 pm The Role of Genetic Variation in Early Height Growth of Longleaf Pine Seedlings. K.D. Shoemaker, D.P. Jackson, J.P. Adams

2:30 – 3:00 pm Modeling Regional Forest Site Productivity Accounting Spatial Structure in Climatic and Edaphic Variables. M.R. Subedi, A.A. Baeza-Castro, P. Dwivedi, B. Costanzo, J.A. Martin

3:00 – 3:30 pm **Break – Outside Ballroom**

Longleaf Pine 3: Rebecca Kidd (moderator)

3:30 – 4:00 pm Restoring longleaf pine woodlands on tallow invaded Flatwoods: Mastication, prescribed burning, and herbicide effects on ground vegetation. M. Bataineh, V. McDaniel, E. Baka, V. Manrique, J. Vogt

Shortleaf Pine: Rebecca Kidd (moderator)

4:00 – 4:30 pm Shortleaf pine-hardwood mixture development through ten years in the eastern Highland Rim of Tennessee. D. Clabo, P. Khanal, K. Hoyt, M. Schubert, H. Garner, S. Peairs

4:30 – 5:00 pm Pinus echinata resprouting and growth dynamics in a frequent fire regime: a preliminary analysis. E.M. Wachter, M. Varner, T. Shearman

5:00 – 5:30 pm Survival and sprouting of shortleaf pine seedlings growing individually or in clusters following prescribed burning in Southern MO. H. Fillingim, B. Knapp

Concurrent Session 3 — Crepe Myrtle

Hardwood 1: Rabia Amen (moderator)

10:00 – 10:30 am* Promoting resilient regeneration in coastal forests: herbivore impacts and growth potential of planted oak and pine seedlings. R. Bohannon, L.S. Pile Knapp, G.G. Wang

10:30 – 11:00 am* Effects of Crop Tree Release on Understory Vegetation and Selected Trees in Virginia's Appalachian Mountains. A.W. Holloway, J. Seiler, D. Carter, W.M. Ford, J. Gagnon, J. Peterson

11:00 – 11:30 am* The Relationship between Soil Properties and Oak Regeneration in Eastern Kentucky. K.L. Shrout, L.A. Vickers, C.A. Cotton, J.M Lhotka

11:30 – 1:30 pm Lunch on your own

Hardwood 2: Rebecca Kidd (moderator)

1:30 – 2:00 pm Single-cohort Mixed Species Deciduous Stands Exhibiting Multi-cohort Attributes in Mature Forests. W.K. Clatterbuck

2:00 – 2:30 pm Understory plant community response to midstory hardwood removal vs. retention in longleaf pine sandhills. K. Quigley, D. Schnake, J. Forrester

2:30 – 3:00 pm Harnessing hardwood sprouts to establish pine-hardwood mixtures. A. Polinko, J. Willis, M. Blazier, A. DeStefano

3:00 – 3:30 pm **Break – Outside Ballroom**

Hardwood 3: Rabia Amen (moderator)

3:30 – 4:00 pm Survival and Growth of Planted Shade-Intolerant Seedlings in Silvicultural Canopy Gaps. D.J. Twedt

4:00 – 4:30 pm Seedling survival and growth of four forest tree species: the role of resource gradients in bottomland hardwood forests. Z. Cheng, O.O. Ajala, J. Stovall, K.R. Kidd, B.P. Oswald, Y. Weng

4:30 – 5:00 pm Potential Oak Regeneration in Oak Woodlands on the Daniel Boone National Forest, KY. C.J. Schweitzer, J. Royse (withdrawal)

5:00 – 5:30 pm Effects of visual grading on northern red oak (*Quercus rubra*) 17 years after planting in a shelterwood stand in the Cumberland Mountains of Tennessee. S.L. Clark, S. Schlarbaum (withdrawal)

5:30 – 6:00 pm Response of Planted Hardwoods to Mulch Treatments: Mimicking Soil Moisture and Fertility Gradients. B.M. Rau, H.K. Davis, J. Garabedian (withdrawal)

Concurrent Session 4 — Regency FG

Biomass/Physiology: Brian Oswald (moderator)

10:00 – 10:30 am* Interspecific competition affects biomass partitioning in young longleaf pine. B.D. Doughty, A. Polinko, C. Siegert, H. Renninger

10:30 – 11:00 am* Salinity tolerance of the three primary pines of the southeastern United States. J. Leopard, A. Sharma

11:00 – 11:30 am* Predicting Above-Ground Biomass of Forest in South Carolina: Integrating Remote Sensing, Machine Learning, and Interpolation Techniques. S. Sharma, P. Khanal, N. Timilsina

11:30 – 1:00 pm **Lunch on your own**

Concurrent Session 4 — Regency FG

Carbon/Climate/Soil: Courtney Siegert (moderator)

1:30 – 2:00 pm Enhancing Carbon Sequestration and Reforestation Foci at select U.S. Marine Corps installations in the Southeastern, U.S. N.R. Beane (withdrawal)

2:00 – 2:30 pm Species Level Differences in Decomposition Rates and Carbon Sequestration Potential of Trees in the Southeast U.S. R. Amen, C. Siegert, J. Granger, D. Williams, E. White

2:30 – 3:00 pm Climate and soil interact to affect pine root system architecture. M.A. Sayer, K. Wharton, W. Johnson, J. Hwang, R. Olatinwo (withdrawal)

3:00 – 3:30 pm **Break – Outside Ballroom**

Intermediate Treatment & Competition Control: Stephen Kinane (moderator)

3:30 – 4:00 pm Evaluating Site Preparation Applications Using Vastlan, Vista XRT, Garlon XRT, Accord XRTII, Glufosinate Ammonium, and Chopper GEN2. A.B. Self, J.E. Ezell, A.W. Ezell

4:00 – 4:30 pm A Comparison of Glufosinate Products for Control of Natural Pines. J.E. Ezell, A.B. Self, A.W. Ezell

4:30 – 5:00 pm Impact of Herbicide Application Timing on the Growth and Survival of Sweetgum x Formosan Gum Hybrid. K. Furukawa, A. De Stefano, J.P. Adams, M. A. Blazier

5:00 – 5:30 pm Using Imazapyr, Glyphosate, and Glufosinate for Control of Understory Hardwoods in Pine Plantations. A.W. Ezell1, J.E. Ezell, A.B. Self

Poster Session and Reception — Regency AB

6:00 – 8:00 pm **Poster Session and Reception: complementry hors d'oeuvres and cash bar**

23rd Biennial Southern Silvicultural Research Conference Program

Wednesday, March 19, 2025

7:00 – 8:00 am **Continental Breakfast – Outside Ballroom**

8:00 am – 4:00 pm **Poster Visitation – Regency AB**

Concurrent Session 5 — Regency DE

Loblolly Pine 1: Jason Vogel (moderator)

8:00 – 8:30 am* Crown dynamics of loblolly pine under 12 years of simulated drought stress. L. Paulus, B. Bullock, S. Kinane, T. Queiroz

8:30 – 9:00 am* Impact of Thinning Regimes on Growth and Economic Returns of Improved Loblolly Pine Genotypes in the Coastal Plain of Southeast US. C.E. Ogbuka, P. Saud, S.G. Chhetri, M. Yanez, M. Blazier

9:00 – 9:30 am* Evaluating Financial Trade-offs in Silvicultural Treatments for Pine Tip Moth and Needle Diseases. D.E. Quintero, B.K. da Silva, S.M. Kinane, K. Gandhi, C. Villari, E. McCarty

9:30 – 10:00 am **Break – Outside Ballroom**

Loblolly Pine 2: Gordon Holley (moderator)

10:00 – 10:30 am* Impact of Planting Density and Management Intensity on Size-Class Distribution of Loblolly Pine in Southeast United State. S.M. Adedapo, B. Bullock, S.-I. Yang, S. Kinane

10:30 – 11:00 am Evaluating live crown length and its impact on growth in response to juvenile fertilization of loblolly pine. C.M. Beasley, T. Albaugh, D. Carter, R. Cook, O. Campoe, R. Rubilar

11:00 – 11:30 am* Evaluating Environmental Influences of Growth Responses to Thinning in Loblolly Pine Plantations: Implications for Forest Management in the Southern United States. M.M. Pinyan, S.M. Kinane

11:30 – 1:30 pm **Lunch on your own**

Loblolly Pine 3: Wayne Clatterbuck (moderator)

1:30 – 2:00 pm Using leaf spectroscopy to assess whole-plant hydraulic conductance in loblolly pine. B.T. Wolfe, J. Kankam

2:00 – 2:30 pm Leaf area index changes in first- and second-thinned loblolly pine plantations. S.M. Kinane, B.P. Bullock, S.-I. Yang, T. Queiroz

2:30 – 3:00 pm Size heterogeneity and its impact on growth in managed loblolly pine plantations in east Texas. Y. Weng, J. Gorgan

3:00 - 3:30 pm **Break – Outside Ballroom**

3:30 – 4:00 pm Carryover effects and the sustainability of intensive loblolly pine (*Pinus taeda*) management through mid-rotation. J.G. Vogel, E.J. Jokela, T.A. Martin

Concurrent Session 5 — Regency DE

4:00 – 4:30 pm Genotype and silvicultural intensity affect loblolly and slash pine maximum size-density relationships. A. Polinko, T. Martin, G.P., J. Vogel

4:30 – 5:00 pm Using UAV remote sensing to estimate loblolly field biomass and volume. J. Kim, S.C. Popescu, J. Grogan, D. Kulhavy, I.-K. Hung, Y. Zhang

Concurrent Session 6 — Crepe Myrtle

Climate/Soil Carbon: Courtney Siegert (moderator)

8:00 – 8:30 am* A Meta-analysis of Afforestation Impacts on Soil Greenhouse Gas Emissions. J. Liang, C. Siegert, A. Himes

8:30 – 9:00 am* Characterizing aboveground forest carbon for mixed-species forests in the national parks and national forests in the southern Appalachian region. T. Skiba, S.-I. Yang, T.J. Brandeis

9:00 – 9:30 am* Geographic variations in stem taper of loblolly pine in the southern United States. N. Qadir, K.P. Poudel

9:30 – 10:00 am Break – Outside Ballroom

Growth & Yield 1: Tom Dean (moderator)

10:00 – 10:30 am* Enhanced Biomass Estimation at Smaller Domains: Conventional vs. Modern Small Area Estimation Techniques. P. Dhungana

10:30 – 11:00 am* Comparing the impacts of planting density and thinning on individual tree survival trajectories using survival analysis. D.M. Senevirathne, S.-I. Yang, D. Zhao, B. Bullock, S.M. Kinane

11:00 – 11:30 am* Examining a modeling strategy to select the optimal mixed model for characterizing height-diameter relationships. S. Wagle, S.-I. Yang, T. Brandeis, B. Bullock

11:30 – 1:30 pm Lunch on your own

Growth & Yield 2: Tom Dean (moderator)

1:30 – 2:00 pm* Assessing Spatial Variation in Forest Productivity Across the Southeastern USA Using a Climate-Based Productivity Index: Implications for Southern Silviculture. D. Ugaldes, M.M. Pinyan, S.M. Kinane

2:00 – 2:30 pm* Fuel structure and forest management affects deadwood volume estimation using terrestrial laser scanning in Appalachian Mountain forests. J.A. DeFeo, G. Coleman, A. Coates, D. Carter, M. Ford, T. Keyser

2:30 – 3:00 pm Invasive species may threaten forest ecosystem integrity with climate change. J. Wang, A. Coates, J.P. Schmit, A.J. Brolis, M. Ford

3:00 – 3:30 pm Break – Outside Ballroom

Growth & Yield 3: Jason Grogan (moderator)

3:30 – 4:00 pm Validating a Shortleaf Pine Plantation Growth and Yield Model System for the Western Half of the Southeastern United States. C. VanderSchaaf

4:00 – 4:30 pm Predicting Stand Basal Area Growth of Loblolly Pine Plantations. Q. Cao

Concurrent Session 7 — Regency FG

Fire 1: Rebbeca Kidd (moderator)

8:00 – 8:30 am*	Stand composition affects soil chemistry in frequently-burned Coastal Plain pine forests of Virginia. J.A. DeFeo, A. Coates, N. Flanders
8:30 – 9:00 am*	Interaction of woodland fire management and the spread of the invasive Chinese silvergrass (*Miscanthus sinensis*). A. Weise, D. Hagan
9:00 – 9:30 am*	Wildland fuel loading estimates along a gradient of forest cover types and landscape factors for two National Parks, Rock Creek Park and Harper's Ferry National Park. S. Wolsiffer, A. Coates, M. Ford, V. Emrick
9:30 – 10:00 am	**Break – Outside Ballroom**

Fire 2: Rebbeca Kidd (moderator)

10:00 – 10:30 am*	An assessment of potential volume and value losses for commercial hardwood species up to six years following one or two prescribed fires on the Monongahela National Forest, WV. C. Coleman, A. Coates, C. Sharpe, D. Carter, M. Thomas-Van Gundy
10:30 – 11:00 am	Exposure to shade stress modifies fire tolerance among southeastern U.S. tree species. J. Willis, A. Sharma, T. Shearman, M. Varner, J. McKeithen
11:00 – 11:30 am	Fire-induced cladaptosis in southern pines: fire effects on surviving trees. T. Shearman, M. Varner, J. Willis, E. Wachter
11:30 – 1:30 pm	**Lunch on your own**

Climate-smart Forestry 1: Ben Knapp (moderator)

1:30 – 2:00 pm	Climate-Smart Forestry: Sustainable Forest Management in the Era of Climate Change and AI. G. Wang
2:00 – 2:30 pm	Approaches for adapting longleaf pine ecosystems to climate change. J. Puhlick.
2:30 – 3:00 pm	Balancing Forest management objectives: effects of stand density on carbon dynamics. B. Knapp, S. Anderson, J. Kabrick
3:00 – 3:30 pm	**Break – Outside Ballroom**

Climate-smart Forestry 2: Ben Knapp (moderator)

3:30 – 4:00 pm	Artificial Intelligence for Climate Smart Forestry: A Forward Looking Vision. F. Luo
4:00 – 4:30 pm	Hurricane risk and ecology: Understanding climate resilience in longleaf pine woodlands. J. Cannon, N. Zampieri
4:30 – 5:00 pm	A Guide for Advancing Climate-Smart Forestry in Longleaf Pine Ecosystems. L. Lord, T. O'Halloran, L. Clay, C. DeGarady
5:00 – 5:30 pm	Applications of terrestrial LiDAR in forest inventory and management planning. J. Fraser, L. Pile Knapp, K. Floress, A. Thompson (withdrawal)

Wednesday Evening Social — Regency C

7:00 – 10:00 pm **Dinner and Social**

23rd Biennial Southern Silvicultural Research Conference Program

Field Tour
Thursday, March 20, 2025

7:00 – 8:00 am **Continental Breakfast – Outside Ballroom**

8:30 am **Depart Hyatt Regency**

5:00 pm **Return to Hyatt Regency**

Field Tour Description:

We will tour DuPont State Recreational Forest managed by the NC Forest Service. We will visit sites showcasing active silviculture within a forest that receives more than 1 million visitors per year. Transportation and lunch will be provided.

Organizer: Helen Mohr (Forester; Director, Consortium of Appalachian Fire Managers and Scientists)

Tour Assistants: Trisha Markus, Ryan Bohannon, Armin Weise, Ruth Cumberland, Htet Naing (Graduate Students, Clemson University)

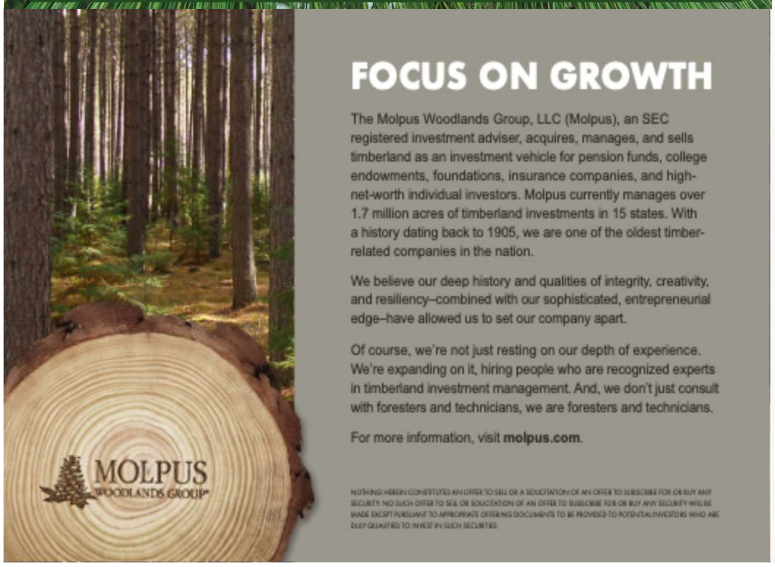
23rd BSSRC Poster Session and Reception
Tuesday, March 18, 2025

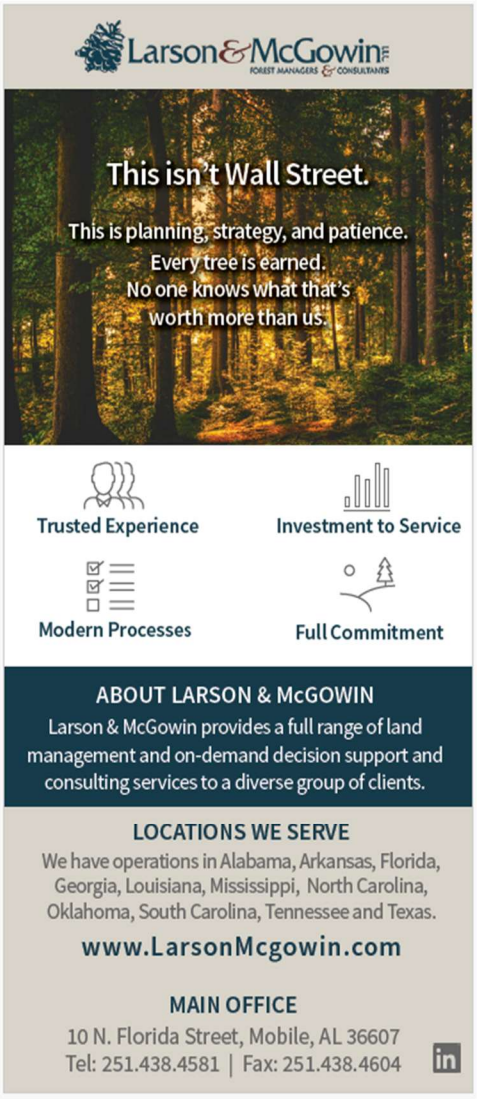
Poster #	Lead presenter	Poster Title
1	Kyungrok Hwang*	Influence of Structural, Species, and Functional Diversity on Post-Damaged Tree Growth in Forests in United States
2	Fernanda Leite Cunha*	Life Cycle Assessment of Paper Products from *Eucalyptus* and *Pinus* Forests in Brazil
3	Htet Lin Naing*	Probing fire adaptation through flammability characteristics during the younger phases of longleaf pine and loblolly pine along the Coastal Plain of South Carolina, U.S.A.
4	Ruth Cumberland*	Patterns of Overstory Mortality & Recruitment Eight Years After a Wildfire in the Southern Appalachians
5	Rabina Phuyal*	Variation in the growth response and survival of longleaf pine (*Pinus palustris* Mill.) families from contrasting provenances established in a drought-prone site
6	Tej Raj Oli*	Comparison of Diameter and Height Growth among Four Genetically Improved Loblolly Pine Genotypes
7	Lorelei Wigginton*	Suppression and Release of White Oak (*Quercus alba*) During Canopy Recruitment in Upland Hardwood Stands
8	Lucy McGuire*	Structural and Compositional Effects of Fire in Long-Unburned Oak-Pine Mixedwoods in Tennessee
9	Emily Gustafson*	Spatial Measures of Species Composition in a Multi-Aged Hardwood Stand
10	Connor Crouch	Post oak decline: investigating the extent, impacts, and causes of an emerging forest health threat (withdrawal)
11	Lauren Pile Knapp	Tornado Impacts on the Structure and Composition of an Upland Oak Forest in Southern Indiana (withdrawal)
12	Morgan Silanskis*	Documenting 60 years of structural and compositional change in an oak-hickory forest in southern Illinois
13	Zachary Hackworth	Barricading the Buffet: Does Slash Discourage Herbivory Damage to Underplanted Oaks?
14	Zachary Hackworth	gapdesignR: A Decision-Support Tool for Gap-based Harvest Planning

** denotes student presenter*

15	Jiaxin Wang	SapFlower: An automated tool for sap flow data preprocessing, gap filling, and analysis using deep learning
16	Daniel Markewitz	White Oak and Tulip Poplar Plantings in the Piedmont of Georgia: Year 3 Survival and Vigor
17	Henry McNab	Twenty-two years of coarse woody debris decomposition in microburst gaps in an Appalachian upland oak forest
18	Curtis VanderSchaaf	Reforestation Tax Incentive Impacts On Financial Returns Of Loblolly Pine Plantations For Material Participant Business Landowners In Mississippi
19	John Jacobson*	Quantifying The Effects of Prescribed Fire on Loblolly Pine Growth: A Dendrochronological Analysis
20	Dawson Garrett*	Climate Variability and Water Availability in Loblolly Pine Plantations: A 44-Year Study in the US Transition Zone
21	Luke Ferguson*	Generalized aboveground biomass equation for *Populus deltoides*
22	Jaden King*	Foliar response of loblolly pine (*Pinus taeda* L.) to different infection levels of brown spot needle blight (*Lecanosticta acicola*)
23	Gracey Goldsby*	Using Dendrochronology to Evaluate the Impacts of Brown Spot Needle Blight
24	Caroline Crews*	Restoration of an Old Field Shortleaf Pine-Oak-Hickory Woodland Following Six Decades of Fire Exclusion
25	Trisha Markus*	Invasive Plants and the Forests They Invade: Use of FIA data & Bayesian inferential statistics
26	Katharine Gilbert*	Duff removal as a pre-fire treatment in the restoration of long-unburned mixed pine woodlands: preliminary results
27	Max Arnold*	Bark hygroscopicity as a function of morphology and subsequent impacts on stemflow volume in a mixed hardwood stand; an analysis of 6 different southeastern tree species
28	Kern Freesland*	The Effects of Longleaf Pine Restoration on Breeding Bird Communities of William B. Bankhead National Forest
29	Anthony Umeojiakor*	Preliminary Study of Soil Carbon and Nitrogen Storage at On-going Silvicultural Treatments in Upland Oak Regeneration of Hardwood Forest of Northern Mississippi

30	Sabina Sigdel*	Assessing the Status and Distribution of Yaupon within Pre-Thinned Loblolly Pine Plantations in East Texas
31	Morné le Roux*	The effects of repeated canopy scorch on the growth, wind resistance, and resilience of longleaf pine (*Pinus palustris*) in southeastern pine savannas
32	Kylie Birchfield*	Evaluating family-level response to heat and drought stress in longleaf pine
33	Emmaline Clark*	Quantifying Streamside Management Zone Breakthroughs for Tethered and Conventional Harvesting Sites in West Virginia
34	Zhongqian Cheng	The influence of mulching and overstory species composition on understory plant diversity in East Texas pine woodlands
35	Seth Bigelow	Canopy cover and acidic soil improve performance of wiregrass plugs in loblolly-shortleaf pine woodland
36	Daniel Grebner*	Evaluating Drought Resistance of Loblolly, Longleaf and Sonderegger Pine Hybrid Seedlings
37	Dennis Richardson*	50-years of structural change in managed bottomland hardwood forests of the Lower Mississippi Alluvial Valley





** denotes student presenter*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ALL PRESENTATION ABSTRACTS

*** Adedapo, S.M., B. Bullock, S.-I. Yang, and S. Kinane**

Impact of Planting Density and Management Intensity on Size-Class Distribution of Loblolly Pine in Southeast United States. (ORAL)

An accurate understanding of the response of loblolly pine to different stand densities and management intensities is important to ensure the sustainable supply of wood to the wood-based industry. Studies have shown that higher planting densities and management intensity tend to affect stand development. Therefore, this study analyzed the effect of planting densities and management intensities on size class distribution and stand development in the lower coastal plain of South Carolina, Georgia and Florida. Data for this study was obtained from the Plantation Management Research Cooperative (PMRC) coastal plain culture/ density study where a total of 17 installations were established in the lower coastal plain. Analysis was carried out on installations with a planting density of 300, 600, 900, 1200, 1500, and 1800 TPA. The study analyzed the influence of planting densities and different management intensities (i.e., operational and intensive management) on size class distribution across the different installations. Results obtained from this study would help landowners understand the dynamics of different silvicultural practices and how it affects stand development over time.

Amen, R., C. Siegert, J. Granger, D. Williams, and E. White

Species Level Differences in Decomposition Rates and Carbon Sequestration Potential of Trees in the Southeast U.S. (ORAL)

Forests can play a significant role in mitigating climate change by storing carbon in living biomass. Standing dead trees and coarse woody debris are large carbon pools, representing ~8% of terrestrial carbon found in forest ecosystems. The longevity of this carbon stored in dead wood varies across ecosystems as a function of climate, decomposers communities, woody chemical composition and wood density. However, the knowledge regarding species-specific wood decomposition rates is still limited. The main goal of this study was to quantify the carbon sequestration potential and decomposition rates in the southeastern US. We established a common garden experiment using eight common tree species (Eastern redcedar, hickory, loblolly pine, Osage orange, red maple, red oak, Sweetgum, and white oak) that was replicated across three forests in central Mississippi. We measured changes in wood mass, carbon, and nitrogen at intervals of 0, 6, 12, 18, and 24 months. Fourier transform infrared (FTIR) analysis was used to detect chemical differences in wood that influence decomposition. After 24 months, Osage orange (OS) decomposed the slowest, with 89±1.02% mass remaining, while Sweetgum (SG) had the fastest decomposition with 31±2.28% mass remaining followed by red maple (RM) (39±2.66%). OS also exhibited the greatest long-term storage of carbon with an overall initial storage of 46±0.67% (0 month) and at 24 months it was still 50.96±0.56%, while in SG initial C% (0 months) was 47.22±0.18% and decreased to 45.3±1.03% by 24th month. Loblolly Pine (LOB) had the highest initial carbon composition (51.53±0.76%), however, LOB sustained the lowest nitrogen composition of all species through month 24 with 0.18±0.01%. FTIR results are pending. Overall, OS exhibited the maximum resistance to decomposition with minimal mass loss consequently contributing to prolonged carbon storage. Results of this study demonstrate the species-specific controls on dead wood decomposition in southeastern forests. Acknowledging the important role of forest composition in carbon sequestration can be used to develop forest management plans that enhance outcomes of natural climate solutions.

*** Arnold, M., C. Siegert, A. Polinko, A. Dowtin, and H. Blakely**

Bark hygroscopicity as a function of morphology and subsequent impacts on stemflow volume in a mixed hardwood stand; an analysis of 6 different southeastern tree species. (POSTER)

Stemflow, the movement of water down the branches and stem of vegetative structures, plays a small but critical role in forest hydrologic nutrient cycling, and is strongly linked to bark morphology. Specifically, bark hygroscopicity, which is a measure of bark's ability to absorb and exchange water with the environment, leads to measurable trunk swelling and decreased stemflow in comparison to less hygroscopic species. These bark traits have direct implications to the partitioning of water and nutrient resources to the forest floor. To more thoroughly understand species-level differences on these properties and the subsequent role of species diversity on forest hydrology, we established a field study to investigate bark-water at a high temporal resolution. We outfitted five replicates of six species (white oak, southern red oak, loblolly pine, shortleaf pine, mockernut hickory, and sweetgum) with stemflow collars and two dendrometers to partition changes in bark thickness due to precipitation and diurnal growth. This poster will represent the preliminary findings of this study, which began in October 2024. Quantifying stemflow and its relationship with bark morphology will be useful in predicting soil moisture and nutrient conditions, allowing for more precise estimates of forest hydrologic nutrient cycling.

*** Baskarla, S.**

Building Climate-Sensitive Individual Tree Mortality Models for Softwoods/Hardwoods in Mississippi State Forests. (ORAL)

Tree mortality is one of the crucial aspects of growth and yield estimation; compared to other individual tree distance-independent models, it is the least understood component. Tree mortality is affected by several direct factors, such as climate change intensity, temperature, precipitation, and humidity. Therefore, it is essential to consider climate variation when evaluating the impact of tree mortality on forest carbon productivity. The data used in this study originate from the U.S. Forest Service, Forest Inventory and Analysis (FIA) program, which consists of detailed records of individual trees in various forest plots and subplots; individual trees are modeled for survival/mortality using logistic regression. The dependent variable in this model is mortality, while tree-level independent variables are height, DBH, age, and species. Other independent variables at stand level, topography, and climate include basal area, site slope, aspect, mean temperature, precipitation, elevation, and vapor pressure deficit. This research aims to develop an individual tree mortality model incorporating climate factors such as temperature, precipitation, humidity, and other climatic factors for softwood and hardwood forest types. Building a new climate-sensitive survival/mortality model helps estimate future forest growth under different climatic conditions. The overall outcome helps understand and manage forest ecosystems by estimating future growth under different climatic conditions.

Bataineh, M., D. Saenz, C. Schalk, L. Pile Knapp, J. Fraser, and M. Sieja

Evaluation of biological invasion in forested coastal wetlands: High impact invaders as legacies of Hurricane Katrina. (ORAL)

Hurricanes affect coastal wetlands in a variety of ways including storm surge inundation, wind effects, and increased soil salinity. Such disturbance events have direct and long-lasting effects on biodiversity patterns and invasibility (i.e., vulnerability determining attributes of recipient communities) of these systems. With emphasis on invasive plant species presence and

abundance, we report on current structural and compositional conditions of an impounded wetland, Little Pine Island of Bayou Sauvage Urban National Wildlife Refuge, collected as baseline data within the course of an ongoing restoration project.

Bataineh, M., V. McDaniel, E. Baka, V. Manrique, and J.T. Vogt

Restoring longleaf pine woodlands on tallow invaded Flatwoods: Mastication, prescribed burning, and herbicide effects on ground vegetation. (ORAL)

Fire dependent ecosystems such as coastal prairies, marshes, upland forests, and flatwoods support diverse plant communities and organisms. Principal among those, are the longleaf pine (*Pinus palustris*) woodlands and savannas that historically dominated the southern plains. Owing to longleaf pine reduced historical extent and abundance, restoration efforts aim to reestablish longleaf pine through planting and reintroduction of fire. Non-native, invasive species like Chinese tallow (*Triadica sebifera*) can hinder restoration efforts. Tallow is prevalent in flatwoods and prairie grasslands of the Gulf Coast with associated negative effects on native biodiversity, fire regimes, nutrient cycling, and wildlife habitat. To restore longleaf pine in tallow invaded flatwoods, a long-term restoration project was initiated in fall of 2021 on Marsh Bayou Wildlife Management Area, near Oakdale Louisiana. We used a combination of mastication followed by burning and herbicide to remove loblolly pine and tallow, prepare the site for longleaf pine planting, and restore the native ground flora. Here we report on the successional dynamics of ground vegetation associated with restored and unrestored areas with emphasis on tallow presence and abundance in treated units.

Beane, N.R.

Enhancing Carbon Sequestration and Reforestation Foci at select U.S. Marine Corps installations in the Southeastern U.S. (ORAL)

The Department of Defense (DoD) Climate Adaptation Plan requires that installations integrate climate change considerations into all operational, planning, business, and resource allocation decisions. Carbon storage and sequestration is an ecosystem function that helps to regulate the climate and provides ecosystem services that benefit society. As a result, activities that preserve or enhance carbon retention on the landscape align with efforts to use natural infrastructure to increase resiliency as outlined in the Climate Adaptation Plan. Forests and wetlands store a disproportionately large volume of carbon on the landscape, sequestering carbon at higher rates than many other habitats. Management activities can impact the ability of ecosystems to store carbon, such as improving conditions for forest growth and restoring degraded wetlands. The U.S. Army Engineer Research and Development Center, Environmental Laboratory (ERDC-EL) is evaluating and prioritizing carbon storage and sequestration opportunities at USMC installations across the continental U.S. and will highlight results from this research with examples from the southeast U.S. The goal of this research effort is to quantify soil carbon storage and sequestration priorities across dominant forest and wetland habitats, at select USMC installations. Additionally, efforts to identify and quantify reforestation opportunities while ensuring mission sustainment will be presented.

Beasley, C.M., T. Albaugh, D. Carter, R. Cook, O. Campoe, and R. Rubilar

Evaluating live crown length and its impact on growth in response to juvenile fertilization of loblolly pine. (ORAL)

Live crown length and growth of loblolly pine (*Pinus taeda* L.) were evaluated in stands receiving four fertilization rates at ages 3 to 6 and varying planting densities across 11 locations in the southeastern United States. Fertilization treatments included a single application of nitrogen (N) at 0 (control), 120, 180, or 240 pounds per acre (lb acre-1). Phosphorous (P) was applied at 10% the rate of N. Four-year volume growth increased with increasing initial live crown length across all fertilization rates. The 240 N rate resulted in the greatest volume increases. Greater live crown length changes resulted in greater volume change, but the 240 N rate had the smallest increase in volume per foot increase in live crown length change. Stand density impacts on plot-level live crown length post-fertilization did not differ by fertilization rate. For each additional planted tree, live crown length decreased by 0.01 feet. Live crown length, live crown length change, and growth efficiency significantly differed by fertilization rate. Live crown length change was significantly greater in the control and 120 N rate (6.73 and 6.81 ft, respectively) compared to the 180 and 240 N rates (6.34 and 6.15 ft, respectively). Live crown length had similar results. Growth efficiency was 22% greater in the 240 N rate compared to the control.

Bigelow, S.W., and E. Lundstrom

Canopy cover and acidic soil improve performance of wiregrass plugs in loblolly-shortleaf pine woodland. (POSTER)

Wiregrass (*Aristida beyrichiana*) is a prized component of pine savanna groundcover for its burning properties. We assessed factors influencing growth and survival of wiregrass plugs 17 years after dense planting in old-field vegetation on clay loams in northeast Florida. We tested the hypotheses that survival of plugs is related to tree canopy cover, slope, aspect, soil bulk density and pH. We also tested the hypotheses that growth is related to density of surrounding ground cover, basal area of nearby trees, species composition of neighboring groundcover plants, and soil pH. Biomass of wiregrass clumps varied from 6 to 273 grams; clumps were a minor component of the fuel bed despite having been planted at 2.7 m-2 and burned biennially. Survival was positively correlated with tree canopy cover and negatively correlated with soil pH. Survival was uncorrelated with slope, aspect, or soil bulk density. Growth was negatively correlated with soil pH; predicted wiregrass biomass decreased by 100 g across the pH range from 5 to 6.5 ($p = 0.06$). Growth was uncorrelated with other factors. Establishment of wiregrass in quantities sufficient to influence fire regimes is a challenging restoration problem. Planting wiregrass plugs on fertile soils in the absence of chemical competition control will be most successful if restricted to shady and/or acidic microhabitats.

* Birchfield, K., G. Aturu, A. Polinko, and E. Galeano

Evaluating family-level response to heat and drought stress in longleaf pine. (POSTER)

Longleaf pine (*Pinus palustris*) is an ecologically important pine species in the southeastern US. Longleaf pine is valued for its adaptation to fire, high-quality wood, and capacity to tolerate droughty site conditions. There is increasing interest in targeting genetic improvement to optimize restoration across longleaf pine's native range. While field studies have demonstrated that longleaf pine can tolerate drought and warm temperatures, the provenance specific variation in these traits remains unknown. For this research, we evaluated heat and drought resistance of five provenances of longleaf pine. We established a randomized complete block design with treatments of heat, drought, heat and drought and an untreated control across seeds collected in five provenances (Mississippi, Texas, Florida, Alabama, and Louisiana). Seeds were kept in cold storage until stratified at 1□ C for 14 days and then sown in Fall 2024. Seeds will be allowed to germinate and establish over a period of four months before treatments are

implemented in a greenhouse. We will present preliminary growth results and discuss management implications.

*** Bohannon, G.R., L.S. Pile Knapp, and G.G. Wang**

Promoting resilient regeneration in coastal forests: herbivore impacts and growth potential of planted oak and pine seedlings. (ORAL)

Coastal forests of the southern United States are shaped by an intensifying and interacting suite of disturbances, including hurricanes, sea level rise, saltwater intrusion, and invasive plants and pests. On Parris Island, South Carolina, forests are impacted by hurricane damage and salinity. Regeneration and recruitment of native trees are inhibited by the invasive tree Chinese tallow (*Triadica sebifera*) and heavy browsing by white-tailed deer (*Odocoileus virginianus*). Silvicultural strategies, including enrichment planting and assisted migration, can enhance the resilience and adaptive capacity of forests to these stressors by promoting climate-resilient tree regeneration. In this context, this research aims to develop successful regeneration approaches for establishing seedlings of disturbance-adapted species. Plots in hurricane-impacted stands were masticated to remove tallow and planted with three seedling species: live oak (*Quercus virginiana*), cherrybark oak (*Quercus pagoda*), and south Florida slash pine (*Pinus elliottii* var. *densa*). Initial basal diameter and height of all 1,536 seedlings were measured at the time of planting. Cherrybark oaks had significantly larger basal diameters than live oaks, indicating greater potential for future growth and competitive ability. In the spring following planting, evidence of deer browse on oak seedlings was recorded, and tree shelters were installed on half of the oaks to mitigate browse impacts. Deer browse was significantly higher on cherrybark oak than live oak. This likely reflects differences in size and vigor between species, with deer selecting larger, more vigorous, and more conspicuous seedlings. Ongoing research will continue to examine seedling survival, growth, and herbivore impacts over time based on species, initial seedling size, and silvicultural treatments to inform best practices for resilience-focused tree planting, including species and stock type selection and the effectiveness of browse mitigation treatments.

Cannon, J.B., and N.E. Zampieri

Hurricane risk and ecology: Understanding climate resilience in longleaf pine woodlands. (ORAL)

Longleaf pine ecosystems once spanned the southeastern US where they regularly experience severe winds from tropical cyclones. Severe storms such as 2018 Hurricane Michael can impact a substantial portion of extant longleaf pine, offsetting restoration efforts and threatening persistence of the ecosystem. Enhancing resilience of longleaf pine woodlands in hurricane-prone regions will require understanding the risk posed by hurricanes and their ecological effects. Here we review recent research on the hurricane ecology of longleaf pine and discuss factors for increasing hurricane resistance in the ecosystem. Hurricanes are commonplace in the southeastern US, and tropical storm level winds have a return interval of approximately 6 years throughout the range of longleaf pine. Given the high frequency of hurricanes, longleaf pine may have adaptations to severe winds. Recent work has confirmed high wind resistance in longleaf pines and explored traits related to canopy architecture associated with windfirmness. Recently tropical cyclones were implicated in the masting behavior of the species, stimulating synchronous reproduction of the species over large areas. Thus, hurricanes may have unexplored ecological effects on the structure and function of longleaf pine ecosystems. Despite the long association with tropical storms, severe hurricanes pose challenges for the management and restoration of longleaf pine woodlands. Proactive strategies for managing wind resistance in longleaf pine forests considers soils, landscape position, stand structure, and management regime. Pre-emptive planning of salvage logging operations, benefits, and risks can

reduce amplifying ecological damage from severe events. More research on how hurricanes shape longleaf pine forests historically and currently can provide guidance on sustaining the ecosystem in future climates with increasingly severe hurricanes.

Cao, Q.V.

Predicting Stand Basal Area Growth of Loblolly Pine Plantations. (ORAL)

Compatible growth and yield models are those where yield can be derived through mathematical integration of the growth model. In contrast, annual growth models provide more flexibility by predicting annual growth directly. This study evaluates these two different types of growth models for their ability to predict future stand basal area. Additionally, it investigates whether stand basal area (B) should be predicted directly or indirectly through modeling quadratic mean diameter (Dq). The data used in this study are from the Southwide Seed Source Study. Four methods will be assessed: the Compatible-B, Compatible-Dq, Annual-B, and Annual-Dq methods. Evaluation will be based on the Mean Difference, Mean Absolute Difference, and Fit Index, computed from the predicted values of stand basal area.

Cheng, Z., O.O. Ajala, J. Stovall, K.R. Kidd, B.P. Oswald, and Y. Weng

Seedling survival and growth of four forest tree species: the role of resource gradients in bottomland hardwood forests. (ORAL)

The survival and growth of bottomland hardwood tree species in floodplain ecosystems are largely driven by species-specific microenvironmental conditions. To assess the performance of native tree species under occasional flooding, we planted seedlings of four native species—baldcypress (*Taxodium distichum*), loblolly pine (*Pinus taeda*), water oak (*Quercus nigra*), and water tupelo (*Nyssa aquatica*)—across the Green Bayou Wetland Mitigation Bank (GBWMB) in Harris County, TX, in 2019. Seedling survival and height were repeatedly monitored over 30 months following planting. The effects of soil texture, water table depth, soil pH, litter layer mass, light availability (both direct and diffuse), and leaf area index (LAI) on seedling survival and height were analyzed using Cox proportional hazards analysis and generalized linear mixed models, respectively. Baldcypress exhibited the highest survival rate 30 months after planting (41.2 ± 2.7%, mean ± standard error, the same below). Water tupelo (64.4 ± 10.2 cm) and baldcypress (60.6 ± 1.5 cm) reached the greatest final heights compared to loblolly pine (36.5 ± 2.4 cm). Loblolly pine (13.1 ± 3.5 cm) and water tupelo (21.3 ± 11.3 cm) showed significant height increases 30 months after planting. Baldcypress survival enhanced with higher sand proportion (r=- 0.412), higher soil pH (r= -0.304), higher diffuse (r= -0.395) and direct (r= -0.406) light proportion, and higher LAI (r= -0.402). Water oak survival benefited from decreased direct light proportion (r= 0.358). Water tupelo survival improved with decreased sand proportion (r= 0.408), lower soil pH (r= 0.367), lower direct light (r= 0.627), and decreased LAI (r= 0.311). Diffuse and direct light availability, along with LAI, were key factors influencing height growth, though AIC-based model selection did not reveal statistically significant relationships with monthly seedling height increments. In conclusion, soil texture and pH were the most influential abiotic factors affecting seedling survival, while canopy light availability was critical for height growth across species. These findings provide guidance for species selection in flood-prone areas, helping to mitigate flood-related risks based on site-specific resource gradients.

Cheng, Z., J.L. Figliozzi, K.R. Kidd, B.P. Oswald, J.P. Stovall, and J.L. Willis

The influence of mulching and overstory species composition on understory plant diversity in East Texas pine woodlands. (POSTER)

Pine woodlands provide a multitude of ecosystem services and values including wildlife habitat, carbon storage, timber, protection of soils, and hydrological benefits. Associated plant communities and the biodiversity represent one highly-valued resource that is often a desired outcome of woodland restoration. Common management practices used to restore and maintain pine woodland conditions include prescribed burning and mechanical (e.g., mulching) and chemical (i.e., herbicide) treatments. Many programs aimed at restoration and management of woodlands emphasize species-specific woodlands implying that overstory composition is a key driver in achieving desired outcomes. Therefore, this study examined whether overstory species composition and implementation of mulching in combination with frequent prescribed fire influenced understory plant communities in woodland settings. Twelve pine woodlands (four per overstory species class: pure shortleaf pine, pure loblolly pine, mixed) were identified in the Davy Crockett National Forest in East Texas. Overstory (DBH ≥10.2 cm), midstory (DBH 2.5 to 10.2 cm), seedlings (DBH <2.5 cm), and ground cover (grasses, forbs, vines, shrubs) were inventoried in three plots randomly located in previously mulched (mulch + burn) and un-mulched (burn only) areas within each stand. Our findings revealed that diversity in understory plant communities was greater in the mulch + burn than in the burn only treatment. Overall, overstory species composition did not appear to have an influence, indicating that overstory density and general canopy structure are likely more important to achieving desired outcomes. This study provides an improved understanding of the effects of treatments used in pine woodland restoration and maintenance on highly-valued plant communities.

Clabo, D., P. Khanal, K. Hoyt, M. Schubert, H. Garner, and S. Peairs

Shortleaf pine-hardwood mixture development through ten years in the eastern Highland Rim of Tennessee. (ORAL)

Pine-hardwood management is gaining interest in the southeastern United States where landowner objectives/attitudes, site conditions, timber and carbon markets, and logging workforce factors may provide rationale for intentional management of these forest types. Few studies in the region have documented long-term stand development patterns for pine-hardwood mixtures with planted shortleaf pine and naturally regenerated hardwood component. The objectives of this study were to 1) report on age ten-year survival and growth of planted shortleaf pine following four site preparation and early release treatments, and 2) assess natural regeneration composition and growth after ten years. A study area was established near Estill Springs, Tennessee at the University of Tennessee's Highland Rim Forest. Prior to study installation. Fell-and-burn site preparation was completed on all experimental units and served as the control treatment. During early April 2014, 1-0 stock bareroot shortleaf pine seedlings were hand planted at either 12 x 12 or 18 x 18 ft spacing. At the end of the first growing season, an herbicide woody release treatment, prescribed fire (burn), or a combination release treatment were randomly assigned to experimental units resulting in four treatments. Shortleaf pine survival, diameter and height growth were assessed after the tenth growing season. Natural regeneration species composition, stem counts and heights were assessed during the same inventory. Results indicated a significant treatment x spacing interaction for survival ($p=0.01$) with significantly better shortleaf pine survival in the 12 x 12 ft spacing for the two treatments that included herbicide woody release. Average height growth was significantly ($p=0.01$) greater in the combination release treatment (26.7 ft) compared to the control (22.2 ft)

and burn release (22.2 ft) treatments. Diameter growth did not differ by treatment. Natural regeneration stem densities per acre did not vary by treatment or planting spacing. Invasive woody species including Chinese privet and Callery pear were more common than any other species group but were significantly shorter on average than native woody species ($p<0.001$). Oak spp. and wilding pines (Virginia pine and loblolly pine) averaged 184 to 934 and 175 to 837 stems per acre, respectively and were the tallest ($p<0.001$) naturally regenerating species groups on average across treatments (14.2 and 17.7 ft, respectively). Treatments that included herbicide release resulted in greater shortleaf pine survival and height growth. Oak spp. and wilding pine were present in dominant crown classes in these stands after ten years, but additional management will be needed to suppress Chinese privet and Callery pear as these stands continue to develop.

*** Clark, E., M. Aust, S. Barrett, M. Berry, and A. Coates**

Quantifying Streamside Management Zone Breakthroughs for Tethered and Conventional Harvesting Sites in West Virginia. (POSTER)

Ground-based harvesting systems in the mountains of the Eastern United States generally consist of manual chainsaw felling. Although the use of chainsaws may improve accessibility on steeper slopes, fellers may face numerous safety hazards in manual operations. Soil rutting and compaction are also concerns related to ground-based operations. Bladed skid trails are commonly used to overcome terrain issues in the mountains, but this method may induce negative impacts when best management practices (BMPs) are not followed. BMP implementation most often includes the use of streamside management zones (SMZs) that typically restrict harvesting activities within specific distances of streamsides. Tethered logging is another technique used on steeper terrain and has the potential to improve worker safety and lessen environmental impact while increasing high-value timber accessibility on steep slopes. However, largely due to equipment costs and implementation complexity, tethered logging is not commonly employed on the East Coast. In this presentation, we will compare the quantity of SMZ breakthroughs per acre of harvest between bladed skid trail, tethered-felling, and tethered felling-skidding operations on 9 sites on Weyerhaeuser property in West Virginia. We will also discuss the trends in identified causes of each breakthrough between treatments, and discuss potential solutions for breakthroughs on these sites. Understanding the potential differences of environmental impact between ground-based and tethered systems will be helpful for harvesters as tethered systems expand to the Eastern United States.

Clark, S.L., and S. Schlarbaum

Effects of visual grading on northern red oak (*Quercus rubra*) 17 years after planting in a shelterwood stand in the Cumberland Mountains of Tennessee. (ORAL)

Oaks (*Quercus*) are difficult to sustain in many stands across the eastern United States because natural processes are failing to establish advance reproduction. A study was implemented in the Cumberland Mountains of east Tennessee to examine how seedling quality, assessed visually by commercial nursery workers, influence post-planting survival, growth, and competitive ability in a commercial shelterwood. The stand was harvested in 2007, leaving approximately 55 ft2 per acre. Half of the seedlings were “Nursery-run” seedlings, representing a 10 percent increase in nursery seedling size over all seedlings in the nursery bed. Half of the seedlings were “Premium” grade, representing the largest 30 percent of seedlings lifted. Survival was not different between nursery-run and premium grade seedlings and averaged 45 percent after 17 years. Premium seedlings were larger in height, ground-line diameter (GLD), and were more free-to-grow than

nursery-run seedlings at the time of planting and these differences increased slightly over time. Results indicate that a relatively practical, efficient, and commercially scalable practice, like visual grading, can improve artificial regeneration outcomes and reduce time and resources needed to keep seedlings in competitive positions.

Clatterbuck, W.K.

Single-cohort Mixed Species Deciduous Stands Exhibiting Multi-cohort Attributes in Mature Forests. (ORAL)

Growth and development patterns in four stands in east Tennessee and western North Carolina with seemingly multi-cohort structure were investigated. These second-growth natural stands are on mesic sites undisturbed since the 1930s with ages greater than 100 years. The stands have multiple canopy layers, are composed of more than 25 woody, deciduous species, and have diameter arrays approximating negative exponential distributions. The stands are less than 20 hectares, government-owned and located in secluded areas, primarily gorges and coves that escaped weather events that could influence stand development. Although these stands have a range of diameters that is similar to multi-cohort diameter distributions and have other multi-cohort attributes, the stands actually are stratified, single-cohort or even-aged, species mixtures. Different species of similar ages have different growth rates resulting in the wide range of diameters. Intensive management with frequent disturbances could create true multi-cohort stands in these multi-species deciduous forests. However, stratified single-cohort stands with multi-cohort parameters occur naturally in these landscapes without disturbance and may substitute for multi-cohort stands with many of the same attributes.

*** Coleman, C.S., T.A. Coates, C.M. Sharpe, D.R. Carter, and M.A. Thomas-Van Gundy**

An assessment of potential volume and value losses for commercial hardwood species up to six years following one or two prescribed fires on the Monongahela National Forest, WV. (ORAL)

Studies of prescribed fire effects on hardwood stem quality (determined by tree grades and wounds) in the midwestern and eastern US have produced mixed results based upon numerous factors, including the tree species of interest, number of fires implemented, intensity and severity of ignitions, and time since fire when stems were evaluated. For these reasons, we designed research to investigate the effects of one or two prescribed fires conducted since 2012 on stem quality for four commercially valuable hardwood species (*Acer rubrum, Quercus alba, Quercus montana*, and *Quercus rubra*) on the Monongahela National Forest, WV, USA. Trees were visited twice: a. one to three years after the last prescribed fire occurred (2021) and b. three years after the initial inventory (2024). During our first inventory period in 2021, a higher probability of encountering wounded stems, total and by wound type (catface, oval, seam, bark slough), was found in burned locations (37.6%) than adjacent, unburned locations (8.7%). All species except *Q. alba* possessed more wounds in burned locations than unburned locations. However, no trees within the burned locations contained wounds or defects that reduced tree grades. Median tree grades for each species did not differ between the burned and unburned locations. Only 1.9% and 6.2% of the stems in the unburned and burned locations, respectively, had wounds associated with potential volume and value losses, and each of the potential losses accounted for less than 3% of the first 4.9 m log. Based upon our preliminary analyses, it does not appear that the tree grades, volume losses, or value losses changed significantly from 2021 to 2024. Based upon this information, procurement foresters, fire practitioners, and mill

managers should feel more confident that the use of low to mixed intensity and severity prescribed fires will not adversely impact stem quality in the central Appalachian Mountains.

*** Crews, C.D., T.M. Shearman, J.M. Varner, and K.M. Robertson**

Restoration of an Old Field Shortleaf Pine-Oak-Hickory Woodland Following Six Decades of Fire Exclusion. (POSTER)

Open savanna and woodland ecosystems dominated by southern yellow pines (*Pinus* species) and pyrophytic oaks (*Quercus* species) were once prevalent in the southeastern U.S. These open forests depend on frequent surface fires to maintain their open structure and diverse understory vegetation. However, fire suppression has led to their decline, resulting in closed-canopy forests with diminished diversity. Restoration efforts following prolonged fire exclusion aim to reestablish the rich ground layer diversity, open canopy, and frequent fire regime that characterize these ecosystems. Understory regeneration during restoration may be hindered by factors such as light availability, fire intensity, competition from resprouting hardwoods, forest floor litter depth, and seed or propagule limitation. Common restoration approaches used to manage these dynamics include reintroducing prescribed fire, thinning the canopy, controlling midstory hardwoods, and planting native seeds, yet research on the effectiveness of these strategies in restoring the herbaceous layer remains limited, particularly in shortleaf pine (*Pinus echinata*) woodlands. Our study will take place in a long-term experimental fire exclusion plot at Tall Timbers Research Station in the Red Hills region of northern Florida known as "NB66." This site, a former shortleaf pine-oak-hickory woodland, was last burned in the winter of 1966-1967. Previous research has documented substantial vegetation change at NB66 in the absence of fire, including forest densification, mesophytic hardwood encroachment, and declines in herbaceous plant cover and richness. Our study will take advantage of long-term vegetation monitoring plots at NB66 to monitor woody and herbaceous response to prescribed fire reintroduction, canopy thinning, and other management treatments during the initial phases of woodland restoration. Using a split-plot experimental design, we will assess the efficacy of restoration treatments in recovering a diverse understory of grasses and forbs and evaluate potential limiting factors to restoration. This poster will highlight the current condition of NB66 and the proposed restoration treatments, experimental design, and expected outcomes. Ultimately, we aim to provide actionable insights that land managers can use to restore biodiversity and ecological resilience in long-unburned, remnant shortleaf pine woodlands.

Crouch, C., K. Costanza, R. Doerhoff, and J. Fraser

Post oak decline: investigating the extent, impacts, and causes of an emerging forest health threat. (POSTER)

In 2021, forest health specialists in Missouri began observing a novel decline of post oak (*Quercus stellata*), characterized by severe epicormic sprouting and dieback. Incidence and severity have increased in recent years, with accelerated dieback and mortality in Missouri and reports of post oak decline in other states, such as Arkansas. The extent, impacts, and cause(s) of post oak decline are unknown, representing an urgent research need given the importance of post oak in the western portion of its range. Our study is the first to address this emerging threat. We hypothesize that post oak decline is driven by interactions between climate change, a new or previously innocuous pathogen, and possibly site or stand characteristics. For example, preliminary foliar samples collected from symptomatic post oaks in summer 2024 tested positive for *Tubakia* spp., some of which were infected by *Tubakia iowensis*, the causal agent of bur oak blight. This represents a host change and significant southward migration for *T.*

iowensis, which has not previously been reported affecting post oak or occurring in the Ozark Highlands. Our poster will detail symptoms of post oak decline, encouraging viewers to be on the lookout for and report detections of decline. We will also provide an overview of the approaches we are using to investigate the extent and etiology of post oak decline, including a severity rating system, diagnostic disease testing, dendrochronological methods, terrestrial LiDAR, and aerial imagery. Finally, we will provide results from a pilot study demonstrating the relationship between post oak decline and individual tree health. Our goal is to assist land managers in developing silvicultural options to address post oak decline.

*** Cumberland, R., and D. Hagan**

Patterns of Overstory Mortality & Recruitment Eight Years After a Wildfire in the Southern Appalachians. (POSTER)

Permanent monitoring plots were established to examine mortality of canopy trees in burned and unburned forested watersheds following the >2016 Rock Mountain Wildfire. Data have been collected nearly every year since 2017. Additional data were collected in 2024 to assess tree regeneration and overstory recruitment patterns. These regeneration patterns assess small sapling and large sapling recruitment through the lens of mesophication, as well as ericaceous shrub cover and presence 8 years post-wildfire. Preliminary results suggest mesophytic overstory trees experience significant delayed mortality in burned plots, and regeneration of mesophytic species and drier and fire-adapted species are regenerating into small sapling and large sapling stages. These data suggest a forthcoming shift in overstory composition. Ericaceous shrub cover has been significantly reduced in burned areas compared to unburned areas.

*** Cunha, F.L., O.C. Campoe, J. Baker, and R. Cook**

Life Cycle Assessment of Paper Products from *Eucalyptus* and *Pinus* Forests in Brazil. (POSTER)

Brazilian plantations, mainly *Pinus* and *Eucalyptus*, sequester up to 1.79 Gt CO_2 annually and store carbon (C) in harvested wood products, highlighting their potential in C credit projects despite quantification challenges (IBÁ, 2023; Johnston & Radeloff, 2019).This study aims to analyze C fluxes from wood products derived from *Pinus* and *Eucalyptus* plantations in southern Brazil, assessing their contribution to atmospheric C removal and evaluating their climate benefits. We use data from *Eucalyptus* and *Pinus* plantations managed by Klabin in southern Brazil. For this study, we adapted the Wood Inventory, Storage, and Emissions (LobWISE) (Puls et al., 2024) to the Brazilian forest sector. The framework produces 120 years of outputs following the initial harvest. Our analysis includes data on C emissions from methane and fossil fuel use in harvesting and industrial processes, as well as C stocks in landfills and in pulp and paper products in use. The model applies elements from a life cycle assessment (LCA) to create a framework in Microsoft Excel that tracks wood product C through five stages: (1) harvesting, (2) milling, (3) post-mill manufacturing, construction, and use, (4) recycling, downcycling, and landfilling, and (5) emissions. We used as input in the model 14 million tons of wood and 400,000 tons of recycled corrugated paper, corresponding to 2023 production. We estimate that HWPs from *Pinus* and *Eucalyptus* store 3.1 MtC in the year they enter the market (year 0), 1.8 MtC after 10 years, and 1.4 MtC after 120 years, both in use and in landfills (Figure 1). The net carbon balance (carbon in use minus C emissions) was 1.5 MtC, 0.78 MtC, and 0.68 MtC, respectively. C stored in paper and pulp products remains in use for up to 29 years, after which it transitions to landfills. Maximum C emission occurs in the first year with 1.65 MtC due to accounting for fossil fuel emission and impaired over time. Despite C losses over time, primarily through landfill emissions, HWPs, along with standing forest biomass, represent a valuable

resource for climate mitigation projects. HWPs have been recognized as part of greenhouse gas (GHG) reduction strategies at COP17 (Puls et al., 2024) and by the U.S. Environmental Protection Agency (EPA, 2021). This is particularly relevant in Brazil, where the high productivity of *Eucalyptus* and *Pinus* plantations positions the country as a key player in global C mitigation efforts. Klabin's pulp and paper products store significant amounts of C, making them potential contributors to the company C accounting in GHG reporting, as well as in sustainability and marketing strategies. To maximize the C storage potential of HWPs, especially in high-productivity regions like Brazil, it is essential to improve our understanding of the cumulative effects of annual harvests on the net C balance and integrate this data with the biomass stock of planted forests.

*** DeFeo, J.A., G. Coleman, A. Coates, D.R. Carter, W.M. Ford, and T. Keyser**

Fuel structure and forest management affects deadwood volume estimation using terrestrial laser scanning in Appalachian Mountain forests. (ORAL)

Prescribed fire has been proposed as a restoration tool for central Appalachian Mountain forests, especially in systems where changes in fire regime have contributed to mesophication and the replacement of fire-adapted pine-oak stands with fire-intolerant species. Conventional field-based methods for assessing fuel structure and predicting prescribed fire behavior are typically time-consuming and vulnerable to observer error. Procedures to detect and approximate coarse woody fuel volume from terrestrial laser scanning (TLS) data have been developed, but their efficacy in topographically and structurally diverse pine-hardwood systems is not yet clear. To assess the applicability of TLS for fuel estimation in the central Appalachians, we present results from a comparison of field-based fuel data to TLS metrics across a gradient of structural diversity. Our findings support our hypotheses that 1) TLS-based fuels assessment methodology is most appropriate in stands with reduced understory and topographic complexity and, 2) TLS can effectively model large coarse woody fuels (diameter > 7.6 cm), but is less effective for litter and fine fuels. By decreasing the time and effort required to collect high-precision fuel and forest structure data, TLS data products have strong potential to help plan fire prescriptions more closely aligned with management objectives.

*** DeFeo, J.A., A. Coates, and N. Flanders**

Stand composition affects soil chemistry in frequently-burned Coastal Plain pine forests of Virginia. (ORAL)

The southeastern US also hosts a large portion of the nation’s domestic timber resource, earning the frequent descriptor of “America’s wood basket.” Much of this timber is harvested from plantations of loblolly pine (*Pinus taeda* L.), a southern yellow pine species chosen for its strong form and fast growth rate. However, young loblolly pine stands are vulnerable to damage during wildfires, which are anticipated to increase in frequency and severity in the Southeast over the coming decades. One recommendation aimed at promoting landscape-scale ecosystem resilience is to manage for a variety of pine species, including those with greater fire tolerance, such as longleaf pine (*P. palustris* Mill.) and pond pine (*P. serotina* Michx.). For example, adaptations like rapid bark development are believed to improve fire tolerance of *P. palustris* compared to other pine species. Management practices associated with yellow pine silviculture impact forest soils in myriad ways. The effects of prescribed burning on soil chemistry and fertility in this region have been evaluated previously, but specific results depend on many factors, including management history (e.g. fire regime), stand composition and structure, and soil type. Prior research has highlighted how even slight variations in species composition may

correspond to fluctuations in nutrient cycling, as differing species exhibit different rooting depths and uptake patterns. In this presentation, we will discuss soil chemistry of four stands which differ by fire history (frequently-burned vs. fire-suppressed) and species composition (dominated by *P. taeda, P. palustris, P. serotina*, or mixed pine-hardwood). Our results suggest that stand composition does play a significant role in mediating soil chemistry, especially the relative abundance of carbon and nitrogen.

*** Dhungana, P.**

Enhanced Biomass Estimation at Smaller Domains: Conventional vs. Modern Small Area Estimation Techniques. (ORAL)

National inventories often lack accuracy in estimating forest attributes at smaller geographic domains due to insufficient sample sizes. As interest in small-scale estimates grows, small area estimation (SAE) techniques have become crucial. This ongoing project aims to compare conventional SAE methods with state-of-the-art approaches for estimating aboveground tree biomass. The study focuses on four states representing different FIA units: Mississippi, Minnesota, Colorado, and Oregon. Data sources include FIA EVALIDator biomass data, remote sensing information from Landsat, climatic variables, and GEDI L3 canopy height metrics. These data are processed using Google Earth Engine and Excel. For conventional SAE, we implement standard, measurement error, and spatial Fay-Herriot models using R packages "emdi" and "saeME". Unit-level SAE is performed using the "sae" package, with estimates aggregated to the county level. A machine learning approach employs mixed effects random forest models (MERF), with GEDI L4B gridded biomass density as the response variable and various environmental predictors. Analysis is conducted individually for each state and the combined dataset. R packages such as "nlme", "ranger", and "MixRF" are used for analysis, with "ggplot2" for visualization. Remote sensing data processing involves both Google Earth Engine and ArcGIS Pro. Preliminary results are promising, indicating potential improvements in biomass estimation accuracy using advanced SAE techniques. The project aims to provide insights into model assumptions, evaluate the benefits of MERF in reducing bias, and offer practical recommendations for effective SAE methods at smaller geographic scales.

*** Doughty, B.D., A. Polinko, C. Siegert, and H. Renninger**

Interspecific competition affects biomass partitioning in young longleaf pine. (ORAL)

The removal of fire from southeastern forests and a landowner preference for loblolly pine (*P. taeda* L.) and slash pine (*P. elliottii* Engelm.) has resulted in a major decrease of the range of longleaf pine (*Pinus palustris* Mill.). Of the southern pines, longleaf pine is the most sensitive to competition due to the grass stage. Though longleaf pine has been widely studied, the mechanisms that drive growth and allocation during and after the grass stage remain limited. This study aimed to understand how competition impacts early establishment dynamics of longleaf pine, including overall biomass, biomass allocation, and nutrient uptake. The study area was located in Clarke County, Mississippi, on soils that consisted of a mix of fine sands and sandy clays. A total of four fertilizer treatments were applied in a randomized complete block design to a previously clear-cut stand. The site was chemically site prepped prior to seedling establishment but natural regeneration of adjacent loblolly pine has been extensive. We measured root collar diameter (RCD), survival, and height growth of each planted longleaf pine seedling, then randomly selected an individual from three height quantiles for each plot to be further evaluated. Once selected, 250th acre fixed-area plots were installed to measure tree and non-tree competition, soil chemistry and soil texture. Seedlings were then clipped for foliar

analysis and excavated to measure biomass. Results suggest that there is a significant decrease in overall biomass with increasing competition from loblolly pine and grass. We will present and discuss additional results regarding the relationship between biomass allocation and soil chemistry, soil texture and aboveground competition. Understanding establishment dynamics may help to re-establish longleaf pine within its native range and increase ecological biodiversity across the southeastern U.S.

Ezell, A.W., J.E. Ezell, and A.B. Self

Using Imazapyr, Glyphosate, and Glufosinate for Control of Understory Hardwoods in Pine Plantations. (ORAL)

Mid-rotation brush control (MRBC) in loblolly pine plantations using foliar applications of herbicides became an option with the label approval of imazapyr for such use. Use of MRBC applications has increased and interest has grown in the potential incorporation of other materials for cost-effective applications. Glyphosate has been an option if applications could be completed without spraying foliage of the crop pines. Given the current concerns related to using glyphosate, an evaluation involving glufosinate was undertaken. A total of 15 treatments involving imazapyr, glyphosate and glufosinate applied alone and in mixtures were installed in a pine plantation in Oktibbeha County, MS. An untreated check was also included in the treatments. Each treatment was replicated three times. Total spray volume was 30 gallons per acre (gpa) in an effort to simulate MRBC ground applications. A total of 14 hardwood species and natural loblolly pine occupied the understory with an average of 4000-5000 stems per acre. Woody stems in the plots were recorded by species and height class prior to treatment application. Plots were evaluated at 14, 28, 56, 90, and 120 days after treatment (DAT) with final evaluation at 1 year after treatment (YAT). Treatments with imazapyr applied alone or in mixtures provided the best control of hardwoods. Complete details of materials, application and results will be presented. Data will be presented that indicates a reduction in hardwood control could possibly be due to the rapid brownout in some treatments containing glufosinate.

Ezell, J.E., A.B. Self, and A.W. Ezell

A Comparison of Glufosinate Products for Control of Natural Pines. (ORAL)

Controlling natural pines in site preparation continues to be a challenge across the South. For many years, land managers relied on glyphosate to provide this control, but recent concerns have resulted in a reduced use of glyphosate in forestry operations. Glufosinate has been identified as a material which could prove cost-effective in control of natural pines. In this study, five different glufosinate products were compared for control of natural loblolly pine. These products were applied alone and in mixtures with other herbicides. A total of 13 treatments, including an untreated check, were utilized in the study with three replications of each treatment. The study site in Oktibbeha County, MS had pine density ranging from 1740 to 20,790 stems per acre with most plots containing 5600-6500 stems per acre. Treatments were applied September 13, 2022, and plots were evaluated at 14, 28, and 56 days after treatment (DAT) with final evaluation at 1 year after treatment (YAT). Pines exhibited significant brownout by 14DAT in glufosinate plots. At 1YAT, all glufosinate products provided excellent control of the natural pines. Complete details of materials, application and results will be presented.

* Ferguson, L.A., and K.P. Poudel

Generalized aboveground biomass equation for *Populus deltoides*. (POSTER)

Alternative and environmentally friendly sources of energy are becoming increasingly important to mitigate the adverse effects of climate change exacerbated by fossil fuel extraction and use. One such alternative is the use of short rotation woody crops (SRWCs) for woody biomass for energy generation. Not only do SRWCs produce clean alternative sources of energy, but such plantations can also mitigate atmospheric carbon through carbon sequestration. Eastern cottonwood (*Populus deltoides* Bartr. ex Marsh) is one such SRWC that has garnered a lot of attention and has been extensively studied. Eastern cottonwood has short rotation periods, and it can coppice regenerate, cutting down on potential replanting costs. For large-scale bioenergy production using SRWCs, it is important that tools are produced that allow for accurate estimation of aboveground biomass and therefore, prediction of yields. While aboveground biomass equations have been developed for eastern cottonwood, most of them are localized and can only be applied to eastern cottonwoods that are grown in the location where the equation was developed. To this end, this study aimed at developing a generalized aboveground biomass equation for eastern cottonwood that can be used across multiple regions. A modified meta-analysis was used by compiling existing aboveground biomass equations for eastern cottonwood from multiple studies to generate aboveground biomass pseudodata and finally, deriving a final biomass equation by fitting models to the pseudodata using regression analysis. The models were then evaluated using criteria such as bias and root mean square error. New models will simplify the process of producing accurate estimates of aboveground biomass for eastern cottonwood and expand the pool of SRWC aboveground biomass equations.

Fillingim, H., and B. Knapp

Survival and sprouting of shortleaf pine seedlings growing individually or in clusters following prescribed burning in Southern MO. (ORAL)

Shortleaf pine was once prevalent across the southeastern United States, and there is interest in its restoration throughout its former range for its ecological and economical importance. Prescribed fire is a tool often used in shortleaf pine management. Shortleaf pine is well adapted to fire, having both thick bark, which protects larger trees from fire, and the ability to resprout following top-kill, which allows seedlings to persist in frequent low-intensity fire regimes. This study examines the role of seedling size in survival and sprouting following prescribed burning in a mixed pine oak forest in southern Missouri, and also compares the survival and sprouting dynamics between seedlings growing in dense natural clusters to those growing individually. Results demonstrate that the ability of shortleaf pine seedlings to survive fire and resist top-kill increase with seedling size, and also indicate that seedlings growing in clusters are more susceptible to top-kill than similarly sized seedlings growing individually. The work also explores possible explanations for the increased likelihood of top-kill for seedlings in clusters, as well as possible implications for stand dynamics and interspecific v. intraspecific competition among seedlings.

Fillingim, H., A. Gaskins, and C. Trettin

Watershed Response to Silvicultural Prescriptions for Longleaf Pine Restoration in the southern Atlantic Coastal Plain. (ORAL)

Throughout the southeastern U.S., there is interest in restoring longleaf pine (*Pinus palustris*) ecosystems, both for their unique habitats and their high water-use efficiency, which makes them more resilient to likely droughts in the changing climate. At the Santee Experimental Forest in SC, a new experiment offers the ability to compare two important ecosystem services, water management and carbon storage, between longleaf pine restoration and a naturally

regenerating old growth forest using a paired watershed approach. The paired watershed approach is widely used to compare hydrological responses to larger-scale land management and includes two neighboring watersheds, one treatment and one reference, that are compared prior to and following treatment. In this case, the reference watershed is a 160 ha old growth mixed hardwood pine forest naturally regenerating after damage caused by Hurricane Hugo, and the treatment watershed is a 155 ha former loblolly pine plantation undergoing conversion to longleaf pine. Both watersheds have been monitored as part of ongoing paired watershed research since the late 1960s. Hydrological variables compared between the watersheds include stream flow, water quality, water table depth, and soil moisture. Additionally, forest inventory plots allow for comparisons of biomass across watersheds, leaf area index is measured monthly in both watersheds, and soil samples to a depth of 1 m were taken prior to conversion and will be repeated throughout the restoration process. Three silvicultural prescriptions were developed based on stakeholder input to convert the stands in the treatment watershed from loblolly pine to longleaf pine. These treatments were designed to be both operationally practical and consistent with multiple management objectives common in both public and private lands. They include a "regeneration" treatment similar to a clear-cut with reserves, a group selection treatment, and a thinning treatment. The harvesting was conducted in 2020-2021 under the agency's Good Neighbor Authority in collaboration with the South Carolina Forestry Commission; herbicide site-preparation was conducted on the regeneration treatment and prescribed fire was used pre- and post-harvest across the treatment watershed. Longleaf pine seedlings were planted in the regeneration and group opening treatments in March 2023, and a subset of these seedlings will be monitored throughout the study. All three silvicultural treatments resulted in a reduction in stand density, while remaining trees increased in both diameter and height. A prescribed fire in February 2024 provided the opportunity to evaluate seedling survival across treatments.

Fraser, J., L. Pile Knapp, K. Floress, and A. Thompson

Applications of terrestrial LiDAR in forest inventory and management planning. (ORAL)

Emerging technologies provide new opportunities for collecting forest biometric attributes and interactive resources for planning. LiDAR (Light Detection and Ranging) scanners can collect high-resolution three-dimensional characteristics of vegetation structure that can be used to estimate structural characteristics at the stand, plot, tree, or component level. This presentation will demonstrate methods for incorporating terrestrial LiDAR scan data in forest inventory and planning applications related to initiating a climate smart research project. Coupled with pre-treatment plot inventory data we used LiDAR data to build statistical models using vertical structure metrics to predict plot-level basal area, density, and quadratic mean diameter. We used LiDAR point clouds to generate tree-level stem maps, DBH estimates, and height. To facilitate the collaborative planning of climate adaptation management strategies we will demonstrate the use of stand-level LiDAR data as a digital twin to test the effects of proposed treatments on structural characteristics and provide inputs for visualization scenes.

*** Freesland, W.K., Y. Wang, and A. Cantrell**

The Effects of Longleaf Pine Restoration on Breeding Bird Communities of William B. Bankhead National Forest. (POSTER)

The longleaf pine community has faced significant declines since the beginning of European settlement, which has implications for the avian communities within. A lack of proper management and alterations to longleaf pine forests are leading causes of their decline. William

B. Bankhead National Forest (BNF), located in north Alabama, is restoring longleaf pine by replanting longleaf pines followed by burn rotations to ensure no hardwood encroachment. An understanding of how avian communities are affected by longleaf pine restoration is a critical factor in assessing the success and benefits of longleaf pine restoration. We established line transects within 16 longleaf pine stands delineated by four restoration timelines (Control, Early, Late, and Mature) in the southern portion of William B. Bankhead National Forest, AL. During 2023, we measured the breeding season abundance and diversity of the avian communities within all 16 stands. We used one-way ANOVA tests followed by post-hoc Tukey tests to compare abundance and diversity between communities and between restoration timelines. The abundance was significantly higher in the mature and early stands compared to the control stands ($F = 6.408$, $P = 0.001$). Species diversity was significantly higher in the mature, early, and late stands compared to the control stands ($F = 6.300$, $P = 0.001$). We used Morisita's similarity index to compare the differences in species between each restoration timeline. The control stands had the least similarity between the early, late, and mature stands, with 39.9%, 62.7%, and 48.1% similarity, respectively. The early stands are more similar to the mature stands than the late stands, with 92.6% and 89.8% similarity, respectively. The highest similarity is between the late and mature stands at 98% similarity. Avian abundance and diversity are showing positive responses to longleaf pine restoration, which suggests that the longleaf pine restoration benefits the avian communities.

Furukawa, K., A. De Stefano, J.P. Adams, and M.A. Blazier

Impact of Herbicide Application Timing on the Growth and Survival of Sweetgum x Formosan Gum Hybrids. (ORAL)

Short Rotation Woody Crop (SRWC) forestry is a system involving the intensive management of plantation trees for pulpwood production. Growth rates can be maximized through fertilization, herbicide application, and utilization of genetically improved or hybrid varieties of fast-growing hardwood species. Sweetgum (*Liquidambar styraciflua*) x Formosan gum (*L. formosana*) hybrids are of interest in the Western Gulf region of the United States for hardwood feedstock due to their productivity on a wide range of site types. However, hybrids break dormancy earlier than native sweetgum and applying sulfometuron methyl herbicides on active hardwoods can slow growth or induce mortality. Our goal was to explore the impact of herbicide timing on the growth and survival of sweetgum hybrids, as well as the effectiveness of timing on controlling herbaceous competition. Sweetgum plantations consisting of five hybrid genotypes were established in October 2015 at the Louisiana State University Agricultural Center's Hill Farm Research Station and Louisiana Technical University South Campus. Oust XP® herbicide was applied based on three distinct phases of bud development: during dormancy (early treatment), bud swell prior to breaking dormancy (recommended), and after breaking dormancy (late). Sites were sampled throughout the first two growing seasons. Overall seedling survival exceeded 80% and trees at LA Tech outgrew those at the Hill Farm regardless of genotype and herbicide treatment. Growth metrics varied across treatment, location, and genotype, but the tallest overall trees received herbicide at the recommended timing. Trees receiving the recommended and early herbicide treatments were also generally the largest at ground-line diameter after two growing seasons. Herbaceous competition varied across the two sites, but reached similar height and groundcover by the middle of the growing season in all treatments. Our findings suggest that herbicide application accelerates the early growth of hybrid sweetgum in northern Louisiana, although a single application is not sufficient to control vegetative competition throughout the growing season.

*** Garrett, D., J. Yang, L. Zhai, R. Holeman, and C. Zou**

Climate Variability and Water Availability in Loblolly Pine Plantations: A 44-Year Study in the US Transition Zone. (POSTER)

The westernmost distribution of loblolly pine (*Pinus taeda*) in the eastern USA extends to eastern Texas and southeastern Oklahoma, an ecosystem transition zone characterized by significant climate variability. The evolution of the climate over the past half-century and its impact on water availability remain largely unknown. To address this, we collected and analyzed runoff data from an experimental loblolly pine plantation catchment near the Ouachita Mountains, located along the Oklahoma-Arkansas border, covering the period from 1979 to 2023. We estimated potential evapotranspiration (PET) using the Penman-Monteith method, and the actual evapotranspiration (AET) was derived based on the Budyko framework. We analyzed annual variations of runoff and peak runoff events. Our results indicate that the study catchment is water-limited, with an Evaporative Index (EI) of 0.574 and Dryness Index (DI) of 0.999, positioning it below the theoretical Budyko curve. Linear regression analysis revealed increasing trends in annual PET ($p = 0.1$) and annual AET ($p = 0.06$), both significant at the 10% level. However, preliminary linear regression did not detect significant trends in either annual runoff or peak flow during the study period. We are continuing to employ different analytical approaches and assess various time periods to better understand the complex interplay between climate variables and runoff regime, with the goal of informing sustainable forest management and water resource planning for this region.

*** Gilbert, K., T. Shearman, S. Bigelow, and J. Willis**

Duff removal as a pre-fire treatment in the restoration of long-unburned mixed pine woodlands: preliminary results. (POSTER)

Fire suppression in longleaf ecosystems has resulted in the accumulation of a thick duff layer around the base of large pines. This complicates the reintroduction of fire to longleaf ecosystems as duff smoldering can continue for extended periods after a burn, causing tree mortality in large diameter trees. The current standard to limit tree mortality is reintroducing a lower intensity fire after heavy rain. Duff reduction as a pre-fire treatment has been demonstrated in ponderosa pine ecosystems, but limited research has been conducted in longleaf ecosystems. Here, we report preliminary results from duff reduction treatments in a long-unburned longleaf pine system in Autauga County, AL. We compared three treatments: control, standard, and duff reduction prior to reintroducing fire in January 2025. To assess the initial response to treatments, we installed point dendrometers, which measure fine scale diameter growth, in each treatment. Additionally, we measured fire behavior, duff consumption, and looked at changes in understory cover. Evaluating the efficiency and effectiveness of these treatments will help land managers reduce the time needed to restore fire dependent ecosystems.

*** Goldsby, G.R., J. King, and L.G. Eckhardt**

Using Dendrochronology to Evaluate the Impacts of Brown Spot Needle Blight. (POSTER)

Lecanosticta acicola is the causal agent of brown spot needle blight (BSNB), a fungus impacting the foliage of 53 *Pinus* species. BSNB infection severity ranges between species, causing minimal symptoms to rapid defoliation. Specifically in loblolly pine, BSNB has been causing severe symptoms within the past 10 years, ranging from browning of needles, premature needle shed, stunted growth, and tree mortality. A dendrochronology approach can be used to understand

the relationship between loblolly pine growth over time and BSNB severity. Data was collected from a 9.5 acre 26-year-old loblolly pine plantation located in Cullman, AL. Within this plot, visible symptoms of BSNB were first noticed in 2017. To capture growth change, we took year-to-year growth measurements of 312 trees, measuring 7 years before symptoms were noticed (2010-2017) and 7 years after symptoms were noticed (2017-2023). Year to year measurements were measured using a digital microscope software (AmScope). Disease rating was measured by classifying each tree into 5 categories, with 1 being minimal symptoms and 5 being almost all needles symptomatic. Our results show that most trees in the stand had a disease rating of 2 or 3, so our results were not significant ($p<0.05$) when comparing growth to disease level. For all trees regardless of disease rating, total tree growth of 7 years before (2010-2017) noticeable symptoms in 2017 were 8.18 mm (+/-0.43 ; +/- 95% CI) higher than growth rates in the 7 years after (2017-2023) disease was noticeable ($p<0.0005$).

*** Grebner, D., A. Pecarovich, B. Doughty, A. Polinko, and J. Willis**

Evaluating Drought Resistance of Loblolly, Longleaf and Sonderegger Pine Hybrid Seedlings. (POSTER)

Sonderegger pine, a naturally occurring hybrid of longleaf pine (*Pinus palustris*) and loblolly pine (*Pinus taeda*), remains largely understudied, especially in terms of its functional traits. While growth patterns and crown morphology of Sonderegger pine have been previously documented, questions remain about the inheritance of the drought tolerance characteristic of longleaf pine, which generally persists in drier sites compared to loblolly pine. To explore this, we evaluated the drought response of Sonderegger pine, longleaf pine, and loblolly pine under controlled drought treatments designed to evaluate resistance, resilience, and heritability of functional traits. Specifically, seedlings were subjected to two drought regimens: (1) extreme drought and (2) prolonged drought with supplemental moisture. During the 25-day extreme drought phase, seedlings received no water and were weighed every 3–4 days. Following the first 25-day period, all seedlings were watered and one third of seedlings were returned to a normal watering regime. During the following 25-day phase, drought-treated seedlings received supplemental moisture only when soil moisture dropped to 2%. In the final 25-day period, transpiration rates were estimated by recording pot weights every 2 days relative to a well-watered control. We also measured survival and photosynthesis following each month of drought treatment as well as seedling survival rates to determine the overall impact of each drought treatment on each species. This study will further our understanding of Sonderegger pine.

*** Gustafson, E.E., D.L. Phillips, and J.L. Hart**

Spatial Measures of Species Composition in a Multi-Aged Hardwood Stand. (POSTER)

Multi-aged stands are increasingly desired for their ecological functions and resistance and resiliency to stresses and perturbations. Understanding intra-stand spatial patterns of species composition and stand structure and how those patterns change over time can help in the development of silvicultural systems implemented to create desired stand conditions. In 2015, we established a 1-ha permanent plot to quantify stand structure and composition of a multi-aged hardwood stand, in the Alabama Fall Line Hills. Tree density was 504 stems·ha−1 and total basal area was 26.6 m2·ha−1. The dominant species initially recorded within the plot were *Quercus alba, Liriodendron tulipifera, Carya tomentosa, Carya glabra*, and *Fraxinus pennsylvanica*. Our objective was to quantify the intra-stand spatial patterns of hardwood species over two time periods of measurement. Dominant species were analyzed using

univariate point pattern analysis and neighborhood indices. Preliminary analyses indicated *Carya glabra* had the highest mean stand dominance value at 0.818. Point pattern analysis indicated significant clustering of *Liriodendron tulipifera* within eight meters and random spatial distribution across other dominant species. The study area will be remeasured to observe canopy disturbances and structural changes within the stand within a ten-year interval. These preliminary data will be compared to current stand conditions to draw larger connections in intra-stand structural changes over an extended study period.

Hackworth, Z.J., and L.A. Vickers

Barricading the Buffet: Does Slash Discourage Herbivory Damage to Underplanted Oaks? (POSTER)

Herbivory damage from white-tailed deer (*Odocoileus virginianus* Zimmermann) and other mammalian herbivores presents challenges to forest regeneration practices in many regions across the USA. In regions with high densities of white-tailed deer, artificial regeneration of hardwoods may experience high failure rates without herbivory exclusion measures. Although fencing, tree protectors, and other exclusion practices can be implemented successfully, exclusion requires an added financial investment, which often renders artificial regeneration under exclusion measures operationally infeasible at larger scales. In cut-to-length timber harvest operations, desired products are extracted from felled trees, while the unmarketable wood (slash) remains at the stump. Since slash prevalence presents a physical barrier to ease of travel, we established a study to evaluate the exclusionary effects of logging slash to promote establishment of underplanted northern red oak (*Quercus rubra* L.) and white oak (*Quercus alba* L.). The study was conducted in a recent watershed-scale ash (*Fraxinus* sp.) salvage harvest in west-central Kentucky. In early 2024, we selected 60 slash piles of varying perceived exclusion efficacy and planted a cluster of 5 seedlings (1-0 bareroot) of one species within the slash pile. Adjacent to the slash pile in a more open area, a second cluster of 5 seedlings was planted to create a paired experimental design. At one month after planting, 70% of white oaks and 62% of red oaks in open plots were damaged by deer browse, while 43% of white oaks and 30% of red oaks planted in slash piles were browsed – an overall 40% reduction in expected herbivory. Preliminary analyses suggest that operationally created slash piles may afford seedlings a level of exclusion from deer. Further evaluation of slash pile characteristics in context of deer exclusion will improve our understanding of the mechanisms reducing herbivory damage. Patterns in herbivory damage, height growth, and survival of planted seedlings during the first growing season will be presented.

Hackworth, Z.J., and J.M. Lhotka

gapdesignR: A Decision-Support Tool for Gap-based Harvest Planning. (POSTER)

Post-disturbance within-stand regeneration patterns are driven by myriad microenvironmental factors, including light transmittance, moisture availability, and competition dynamics. In gap harvest systems (and near the boundaries of large harvest areas), the distribution of solar irradiance within the gap and adjacent forest edge is heterogeneous. The spatial distribution of light reaching the forest floor depends on gap design parameters (gap shape and size), adjacent forest structure (forest height, composition, canopy depth, plant area index), topographic variables (aspect, slope), and geographic area (latitude). However, harvest planners sometimes rely on oversimplified “rules of thumb” (e.g., gap diameter should be twice the adjacent forest height) when designing gap harvests, despite a growing body of evidence emphasizing the need for tools that support planning at finer scales. gapdesignR is a software package developed in

the R programming language that simulates light dynamics in user-defined gap harvest systems. Based on proven reverse ray-tracing principles and three-dimensional planar geometry, the tool allows users to visualize spatially and temporally explicit light transmittance patterns in one or more parameterized elliptical gaps across the full growing season or on individual days and times. The ability to evaluate light transmittance patterns in landscapes containing multiple gaps makes gapdesignR a unique and useful tool for practical harvest planning applications. Preliminary validation indicates moderately high correlations (r = 0.6 – 0.8) between model-simulated light transmittances and heights of yellow-poplar (*Liriodendron tulipifera* L.) reproduction within 60-m (diameter) gap harvests in intermediate-quality Kentucky forests at 8 years following harvest. These results suggest that the model may be used successfully as an a priori planning tool to predict localized regeneration patterns. Further applications of the model and results from additional validation analyses will be presented.

*** Hales, L., and J. Hart**

Status and ecological impacts of draft animal logging in the southeastern United States. (ORAL)

With parcelization and ecological objectives reshaping forest ownership and management in the southeastern United States, the need for low-impact, small-parcel-optimized forestry is growing. Many small forest landowners could benefit from some degree of timber harvesting and forest management to provide sustainable income and maximize the aesthetic, wildlife, or recreational value of their forested land. However, it is not economically feasible for conventional mechanized logging operations, which have high start-up and operational costs, to make the small-volume timber harvests included in such forest management plans. Draft animal logging may have the potential to effectively fill this niche, but a more robust understanding of the status and ecological impacts of the practice is necessary before it can be advocated for or incorporated into management plans. This research seeks to contribute to that understanding by 1) indexing and surveying the current network of draft animal logging practitioners in the southeastern United States and 2) conducting a modern case study of the ecological impacts of a draft animal logged timber harvest in the Southeast. No animal logger surveys have been conducted in the U.S. before or since a 2001 study examined the status of the practice in Alabama. This research thus provides novel information on the demographics of draft animal loggers, their locations, what equipment they use, what kind of harvests they do, and the general trajectory of the practice. Further, the impacts of this logging system on soils and residual trees have not been quantified in the U.S. since the adoption of modern draft animal logging methods. This research thus provides crucial decision-making information to foresters, landowners, and other natural resource managers, helping them evaluate the potential of draft animal logging to meet their needs. This research sheds light on a poorly understood forest management option that has noteworthy potential.

*** Holloway, A.W., J. Seiler, D. Carter, W.M. Ford, J. Gagnon, and J. Peterson**

Effects of Crop Tree Release on Understory Vegetation and Selected Trees in Virginia's Appalachian Mountains. (ORAL)

Crop tree release (CTR) is an intermediate silvicultural treatment that can be used by woodland owners to achieve multiple management goals. Our study addresses a knowledge gap regarding the understory response to CTR in the Appalachian Mountains of southwest Virginia. An increase in understory species composition and abundance is expected, as CTR increases the availability of light and nutrients to the understory. Increased understory growth and abundance

can improve habitat for some wildlife species. However, the longevity and composition of this increase in understory vegetation is unknown. We sampled locations on the George Washington and Jefferson National Forests that had received CTR treatments over the past ten years. Understory data were collected within one-meter square sampling areas near released and non-released trees to determine woody plant species abundance and composition. Crown widths of crop trees were measured in two perpendicular directions, and epicormic branching was ranked. Understory vegetation was dominated by five species: teaberry (*Gaultheria procumbens*), greenbrier spp. (*Smilax* spp.), red maple (*Acer rubrum*), eastern white pine (*Pinus strobus*), and blueberry spp. (*Vaccinium* spp.). We found that at two, three, five, seven, and ten-years post release there was a significant percentage increase in the amount of understory stems surrounding released trees compared to non-released trees. We also found that the crown of released trees was significantly wider than that of non-released trees and that epicormic branching did not differ between released and non-released trees.

*** Hwang, K., and L. Zhai**

Influence of Structural, Species, and Functional Diversity on Post-Damaged Tree Growth in Forests in United States. (POSTER)

Tree damage is a common consequence of natural disturbances, such as hurricanes and ice storms, resulting in significant reductions in tree growth and forest productivity. Thinning enhances forest recovery and resilience following natural disturbances by reducing competition, which accelerates regrowth and stabilizes ecosystem functions. Biodiversity plays a critical role in enhancing resilience to such disturbances by promoting tree growth recovery and maintaining ecosystem stability. However, there is a limited understanding of how biodiversity – specifically, structural, species, and functional diversity — interacts with the severity of tree damage to influence recovery, and how this knowledge can be utilized to optimize thinning regimes. To address this gap, we analyzed data from the USDA Forest Service Forest Inventory and Analysis (FIA) database, covering the contiguous United States from 2000 to 2017. We specifically analyzed trees that experienced crown and stem damage and quantified the extent of damage for each individual tree. Additionally, we examined both abiotic and biotic stand attributes that influence forest productivity, using annual biomass increment as the response variable. Our findings highlight the potential of using biodiversity to enhance forest resilience and recovery following disturbances. These insights will inform how biodiversity influences the growth of damaged trees and how its interaction with stand density impacts overall growth, promoting the development of optimized thinning practices that focus on empowering biodiversity, rather than merely thinning intensity, to sustain long-term productivity and ecological health in post-disturbance forest management.

*** Jacobson, J.C., A. Polinko, and A. Schulz**

Quantifying The Effects of Prescribed Fire on Loblolly Pine Growth: A Dendrochronological Analysis. (POSTER)

In recent decades, prescribed fire use in southeastern pine plantation management has grown more widespread, though the effects of prescribed fire on loblolly pine growth remain uncertain. While previous research has suggested that prescribed fire enhances growth in fire-adapted species, such as longleaf pine (*Pinus palustris*) and ponderosa pine (*P. ponderosa*), this study examines the growth response of loblolly pine (*P. taeda*) by analyzing basal area increment pre- and post-prescribed fire application. While there are no conclusive results regarding the impact of prescribed fire on loblolly pine, some literature suggests that herbicide

application in mid-rotation loblolly pine stands can result in increased increment growth. Three stands near Starkville, MS were selected to test the effect of prescribed fire on loblolly pine increment, and to compare the change in growth rate of burned stands relative to stands treated with herbicide. Selected stands were primarily made up of loblolly pine (≥ 90% basal area dominated) with a documented burn history. Each stand was thinned to the same residual basal area, then treated with prescribed fire only, herbicide and prescribed fire, or received no treatment. At least six co-dominant or dominant pine trees were haphazardly selected from each stand. Increment cores were taken from the north and east sides of each plot center tree. These cores were then dried, mounted, scanned, and dated using standard dendrochronological methods. Dating was performed with CooRecorder imaging software, and cross-dating was conducted using the dplR package in R. The relationship between annual and interannual growth variation was assessed with a linear mixed-effects model. Growth rates were then compared across different treatment types. To estimate the impact of prescribed fire on increment growth, the natural growth rate from the control stand was subtracted from the growth rate of the burned stands. To quantify the effect of herbicide, the growth rate of the stand treated with prescribed fire was subtracted from that of the stand treated with both herbicide and fire. Preliminary results will be discussed. Results from this study will help inform management practices aimed to promote loblolly pine growth and vigor in the southeastern United States.

Kim, J., S.C. Popescu, J. Grogan, D. Kulhavy, I.-K. Hung, and Y. Zhang

Using UAV remote sensing to estimate loblolly field biomass and volume. (ORAL)

In forest management, gathering information on stand characteristics typically involves field surveys that require individual tree measurements, which are often costly and labor-intensive. This study aims to estimate tree biomass and volume of loblolly pines using variables derived from UAV imagery. Conducted in various loblolly pine plantation stands in east Texas, the study included sites with different tree densities and age groups to explore how tree density and stand development stage affect this relationship between field data and the UAV-derived variables differently. Once the relationship between field data and remote sensing data is established, it can be applied to new UAV images of a different site to estimate tree biomass and volume without the need for field surveys. This approach will allow for more frequent, cost-effective tree monitoring and enable timely management decisions.

Kinane, S.M., B.P. Bullock, S.-I. Yang, and T. Queiroz

Leaf area index changes in first- and second-thinned loblolly pine plantations. (ORAL)

Leaf area index is a useful biophysical parameter forest managers can utilize to understand productive potential of a site and its ability to capture energy. In this study, we look at the long-term leaf area index dynamics across the southeastern United States using the Plantation Management Research Cooperative's Mid-Rotation Treatment study. Our investigation focusses on how leaf area index changes in response to first-and second-thinning and their interaction with other mid-rotation treatments. Characterizing the response of leaf area in a stand and coupling it with growth responses to stand-level attributes will help forest managers use remotely sensed information to infer stand dynamics after mid-rotation treatments for more informed decision making.

*** King, J., J. Cale, T. Shearman, J. Fan, and L.G. Eckhardt**

Foliar response of loblolly pine (*Pinus taeda* L.) to different infections levels of brown spot needle blight (*Lecanosticta acicola*). (POSTER)

Loblolly pine (*Pinus taeda* L.) plays a crucial role in the economy of the southeastern United States and is the most prevalent tree in Alabama. However, loblolly pine populations are threatened by rapid defoliation caused by the pathogen *Lecanosticta acicola*, the causal agent of brown spot needle blight. Thirteen forest health plots were established in loblolly pine plantations across Northern and Southern Alabama. Samples were collected in August 2024 to assess tree foliar nutrient levels in relation to disease. The nutrient levels evaluated included phosphorus (P), nitrogen (N), potassium (K), magnesium (Mg), calcium (Ca), sulfur (S), sodium (Na), boron (B), zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), and aluminum (Al). The severity of disease in each tree sample was assessed as a percentage of infected foliage, categorized into five groups: Group 1 represented 1-20% of leaves affected, while Group 5 indicated 81-99% of leaves diseased. The initial findings indicate that trees with a higher disease rating have lower levels of sodium, manganese, and aluminum and have a higher rating of iron in both the north and south plots. Soil data was taken in May 2024 and will be analyzed in addition to the foliage nutrients to understand the nutrients available to the tree compared to the nutrients in the foliage. The disease-tree relationships identified from this project will be utilized to create best management practices for areas impacted by needle blight. These guidelines will inform future research, especially in regions with limited knowledge about the effects of pests and pathogens related to loblolly pine in the southeastern United States.

Knapp, B.O., S. Anderson, and J.M. Kabrick

Balancing forest management objectives: effects of stand density on carbon dynamics. (ORAL)

Temperate forests play an important role in the sequestration and storage of carbon. Forest management can influence carbon dynamics and has recently been discussed as a natural climate solution. We used data from two long-term thinning studies in Missouri, one from shortleaf pine (*Pinus echinata*) stands and the other from upland oak (*Quercus* spp.) stands, to evaluate effects of stand density management on carbon sequestration and storage and volume production over approximately 50 years. In both forest types, total live aboveground carbon storage in trees reached around 100 Mg/ha in unthinned stands. While thinning reduced stand-level carbon storage in live aboveground trees, it increased individual tree size and volume production. Stand-level, annualized carbon sequestration was greatest when thinning treatments were used but maintained fully stocked conditions (i.e., not overstocked and not understocked) in the pine stands. Consequently, the gross amount of carbon accumulated in tree growth (including residuals on the site and those removed through mortality or harvest) was greatest for stands maintained at fully stocked conditions throughout stand development. These results demonstrate that stand density management can yield complementary benefits in carbon accumulation and volume production, highlighting the positive role active management can play in enhancing forests as a natural climate solution.

* le Roux, M., T. Shearman, and J. Cannon

The effects of repeated canopy scorch on the growth, wind resistance, and resilience of longleaf pine (*Pinus palustris*) in southeastern pine savannas. (POSTER)

Longleaf pine savannas in the southeastern United States experience recurring disturbances in the form of prescribed fire, tropical storms, and hurricanes. Fire typically occurs more frequently than major wind events, making it likely that these ecosystems experience multiple fires

between significant tropical storms and hurricanes. Understanding these interactions is essential to our understanding of how these ecosystems function, particularly in the context of a changing climate that may alter the frequency and intensity of both fire and wind disturbances. Previous studies of wind and fire disturbance interactions have focused on potential amplifying effects of wind disturbances on subsequent fire severity. However, fewer studies have examined fire and wind disturbance interactions from the perspective of how preceding frequent fire can affect tree mortality from subsequent wind disturbances. Our study aims to address this gap in knowledge by assessing interactive effects of multiple prescribed fires over a 29-year period and tree mortality from Hurricane Michael. This poster will discuss preliminary results from analysis of hurricane mortality data already collected within areas identified as having experienced repeated scorch.

*** Leopard, J., and A. Sharma**

Salinity tolerance of the three primary pines of the southeastern United States. (ORAL)

Increasing salinity in coastal forest ecosystems due to saltwater intrusion and rising sea levels is accelerating tree mortality and diminishing growth. We examined morphological and physiological responses of three southern pines (longleaf, loblolly, and slash) in greenhouse conditions to salt concentrations ranging from 0 to 3.5% (up to 35,000 ppm). Six-month-old and 18-month-old seedlings were exposed to salt treatments for 24 hours in a replicated randomized block design, facilitating robust comparisons across species and ages. One month after treatment, survival rates at the highest salinity level were 100%, 61%, and 92% for longleaf, loblolly, and slash pines, respectively, with survival increasing as salinity decreased across species. Chlorophyll fluorescence measurements revealed intensified salt stress with rising concentrations, with loblolly pines the most affected. Surprisingly, younger seedlings showed greater tolerance. Data collection will continue for three additional months post-treatment, providing deeper insights into the prolonged impacts of salinity on these species. Findings could inform strategies for enhancing coastal forest resilience under future climate scenarios.

*** Liang, J., C. Siegert, and A. Himes**

A Meta-analysis of Afforestation Impacts on Soil Greenhouse Gas Emissions. (ORAL)

Afforestation is promoted as a natural climate solution and a key strategy for mitigating climate change. Afforestation projects usually focus on above-ground carbon sequestration, but soils also play an important dual role as sources and sinks for greenhouse gases (GHG), particularly carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), which have high global warming potentials. Therefore, understanding the effects of tree planting on soil GHG flux is crucial for leveraging afforestation projects to combat global warming. In this research, we conducted a global meta-analysis of 158 studies to assess the effects of tree planting on GHG emissions across prior land use and identify key variables driving emissions. Our findings indicate that tree planting significantly reduced CO2 emissions in prior grasslands and deforested areas. CH4 emissions generally decreased across most previous land uses, except grasslands, while soil N2O flux did not respond to afforestation across most land use types. Soil GHG emissions also varied with the type of planted forest. Hardwood tree planting significantly reduced CH4 emissions, while no clear trend was observed for N2O emissions in either softwood or hardwood plantings. Additionally, tree planting density did not impact soil GHG flux. Moreover, our review demonstrated that GHG responses to tree planting varied significantly over afforestation time and were influenced by various environmental factors. CO2 emissions were positively correlated

with soil organic carbon (SOC), mean annual precipitation (MAP), C: N ratio (C: N), and soil temperature (SoilT). The response of soil N2O flux increased with soil NO3- and microbial biomass nitrogen (MicroN) and decreased with SOC and SoilM. Furthermore, the effect size of soil microbial biomass carbon (MicroC) and SOC was positively correlated with CH4 emissions. These findings provide evidence that afforestation projects can be optimized by considering factors such as tree species, site conditions, and environmental variables to maximize GHG mitigation benefits. They can inform management decisions by guiding the selection of planting sites and forest types that are most effective in reducing soil GHG emissions over time, enhancing the role of large-scale tree planting as a natural solution to climate change.

Lord, L.J., T. O'Halloran, L. Clay, and C. DeGarady

A Guide for Advancing Climate-Smart Forestry in Longleaf Pine Ecosystems. (ORAL)

Climate-smart forestry represents an extension of sustainable forestry, emphasizing the adaptation potential of longleaf pine forests to the effects of climate change, simultaneously leveraging their potential to mitigate its impacts and provide benefits to communities, landowners, and the environment. The southeast experiences continuing challenges including wildfires, floods, and windstorms, and the resilience of longleaf pine is evident as they are insect and disease-resistant, fire-adapted, and drought-resistant. Landowners who implement climate-smart forestry initiatives will likely further increase the resilience of their forests against these challenges. Additionally, forest management decisions have impacts beyond individual land boundaries, and maintaining healthy forests can improve wildlife habitat, provide cleaner air and water, maintain and support water supplies, and mitigate the effects of a changing climate. This presentation will provide an overview of climate-smart forestry within the context of longleaf forests, drawing upon current research and practical insights, and introduce a new climate-smart guide tailored specifically for longleaf pine forest management — the first of its kind. As forest landowners and managers, it is important to know the best options for land management practices that will meet your objectives, reduce risk, and contribute positive outcomes to mitigate the current climate and biodiversity challenges facing the world. The guide described a variety of forest management practices, helping landowners to optimize the benefits of their longleaf pine forests.

Luo, F.

Artificial Intelligence for Climate Smart Forestry: A Forward Looking Vision. (ORAL)

Forests and forest ecosystems are vital to our social, economic, and environmental well-being. However, climate change and climate-driven disturbances (CDDs) are undermining the health and resilience of forests worldwide and pose significant uncertainty to sustainable forest management. Climate-smart forestry (CSF) remains a grand challenge in practice due to our limited knowledge of how forests respond to climate change and our abilities to collect related information to empower decision making. Rapid advances in artificial intelligence (AI) can offer a timely opportunity to address the challenges in CSF. We argue that the AI-enabled, next-generation CSF can be achievable through synergistically coordinated and transdisciplinary efforts that develop and advance foundational and use-inspired AI technologies that can lead to building next-generation forest decision support systems.

Markewitz, D., D. Clabo, E. Jones, T. Showunmi, and I. Vahle

White Oak and Tulip Poplar Plantings in the Piedmont of Georgia: Year 3 Survival and Vigor. (POSTER)

White oak (*Quercus alba*) native range covers ~104 million acres in central and eastern US forestlands. White oak is a foundational species that supports high animal biodiversity due to mast production, and is an important timber species used for furniture, crossties, pallets, flooring, cabinetry, and wine and spirits barrels. The last value occurs due to the use of white oak barrels (produced in the cooperage process) for aging wine and spirits. Demand for barrels (produced in the cooperage process) derived from stave logs has improved hardwood timber markets in the white oak range as demand for barrel aged spirits has increased. This demand has raised concern about future white oak timber supplies. Refinement of white oak artificial regeneration management practices will be important to maintain white oak timber supplies in the future. In the Piedmont region, there have been few studies that have examined long-term development of planted hardwoods for commercially and ecologically valuable species such as white oak. We have initiated an experiment with white oaks being planted on their own or in mixed species plantings with yellow-poplar (*Liriodendron tulipifera*). Third year survival rates of oak in oak only plots was ~75%, poplar in poplar only plots ~49%, oak and poplar in mixed oak-poplar plots ~77 and ~60%, respectively.

*** Markus, T., C. Oswalt, L. Pile Knapp, and G.G. Wang**

Invasive Plants and the Forests They Invade: Use of FIA data & Bayesian inferential statistics. (POSTER)

Invasive plants are a widespread national issue for natural resource managers and landowners because of their ability to outcompete native plants further impacting forest health, successional processes, and overstory regeneration. The USDA Forest Service Forest Inventory and Analysis (FIA) Program monitors for invasive plants along with the extensive forest attributes (e.g., slope, elevation, distance from roads, and forest type), making it invaluable to determine the variables that may determine a forest's susceptibility for plant invasion. We identified the top ten most frequently occurring invasive plants with the greatest abundance in FIA plots from the 2015 – 2019 cycle for the southern region. We assessed the forest attributes and compared the invaded and uninvaded FIA plots using a Bayesian analysis. This information will be informative to land managers, landowners, and policy makers to determine the invasive plants that have the greatest potential to invade their forests.

*** Maslyukova, D., T.A. Coates, W.M. Ford, and V.R. Emrick**

Do successional dynamics of deadwood indicate a need for silvicultural intervention within National Parks of the National Capital Region? (ORAL)

Dead organic material, defined here as the sum of litter (Oi Horizon), duff (Oe+Oa Horizons), and deadwood (both downed woody material and standing and dead stems, or snags), is a significant component of terrestrial forest ecosystems. The amount and structure of dead organic material may influence potential wildfire hazard by altering the amount of fuel available to burn and by creating fuel structures that increase fire intensity and spread. Dead organic material is also critical to carbon storage and nutrient cycling and may vary based upon the size classes of individual pieces of downed woody material. Lastly, deadwood structural variability has been found to positively affect species richness in bees, salamanders, birds, and small mammals, such as shrews and woodland mice. However, in the mid-Atlantic region, few tools are available to rapidly approximate dead organic material of long unmanaged second growth forests to help inform future management decisions. Management agencies within this region, such as the National Park Service (NPS), may benefit from a greater understanding of the potential factors that influence dead organic material accumulation, retention, and

decomposition. Therefore, a project was funded by NPS to investigate the dynamics and factors that may influence the presence and potential management of dead organic material across the National Capital Region. During two summer field seasons, May through August of 2023 and 2024, an inventory of dead organic material was conducted using planar intercepts nested within fixed area plots along the gradient of forest cover types, aspect, elevation, and soil orders found within 1. Prince William Forest Park (PRWI) in Triangle, Virginia, 2. Catoctin Mountain Park (CATO) in Thurmont, Maryland, and 3. Manassas Battlefield Park (MANA) in Manassas, Virginia. In this presentation we will share how forest cover type, elevation, aspect, and soil order related to snag basal area and dead organic material masses across PRWI, MANA, and CATO. Information obtained from this study may be benefit managers and practitioners as they consider how these factors may uniquely influence the successional development of dead organic material in different locations.

*** McGuire, L.T., and J.L. Hart**

Structural and Compositional Effects of Fire in Long-Unburned Oak-Pine Mixedwoods in Tennessee. (POSTER)

Reintroducing fire to oak-pine (*Quercus-Pinus*) mixedwoods is critical to restore and maintain their composition, structure, and function. Fire alone is insufficient to restore long-unburned oak-pine mixedwoods that have an abundance of subcanopy mesophytes. Nonetheless, understanding the effects of fire reintroduction in these mixedwoods is necessary to inform further silvicultural treatments. Savage Gulf State Park in Tennessee contains complex stage oak-pine mixedwoods that have excellent potential for transition to woodland structure. In these oak-shortleaf pine (*Pinus echinata* Mill.) stands, we have established four one-hectare plots to monitor the effects of a prescribed fire program implemented by the Tennessee Department of Conservation in 2020. Here, we quantified differences in structure and composition between burned and unburned stands following two prescribed fires to elucidate the effects of reintroducing fire to long-unburned mixedwoods. Tree density, basal area, and sapling density have been calculated for two twice-burned hectares and two unburned hectares. As expected, tree density and basal area were consistent between burned and unburned hectares, with basal area ranging from 31.8 to 35.1 m2 ha-1. At the sapling level, unburned hectares had sapling densities of 2,362 and 3,156 stems/ha and burned hectares had sapling densities of 482 and 1,749 stems/ha. Differences in sapling density within the burned hectares were driven largely by red maple (*Acer rubrum*) sprouting post-fire. These data support the insufficiency of fire alone to restore oak-pine mixedwoods and provide a baseline for continued monitoring of effects of consecutive burning treatments and of the thinning treatment planned for fall of 2024.

McNab, W.H., and E.C. Berg

Twenty-two years of coarse woody debris decomposition in microburst gaps in an Appalachian upland oak forest. (POSTER)

The long term rate of decay of coarse woody debris (CWD, diameter >7.62 cm) has not been quantified in natural canopy gaps in the southern Appalachian Mountains. We relocated permanent line intercept transects established in four large canopy gaps (0.09 - 0.30 ha) created by Hurricane Opal (October 1995) in oak (*Quercus*) dominated stands on relatively dry sites that had been established for a study of regeneration following natural disturbance. Our objective was to estimate change in mass of tagged CWD and compare fractions remaining with published decay models. From 8 to 13 permanent line transects were established in each gap to estimate

mass of a total of 112 pieces of CWD ranging in diameter from 7.62 to 45.7 cm. Mass of CWD averaged 6.9 Mg/ha (range 3.6 - 9.9 Mg/ha) soon after gap formation and averaged 2.3 Mg/ha (1.5 - 3.6 Mg/ha) after 22 yr. The fraction of CWD remaining after decomposition averaged 0.26 (0.09 - 0.41). Pieces of CWD <15 cm diameter were typically completely decomposed and not detectable. Decay of individual pieces of CWD varied widely and proceeded at a faster rate when in ground contact. Decomposition of CWD was similar for scarlet oak (*Q. coccinea*) and white oak (*Q. alba*). The mean annual linear rate of mass decomposition was 2.6%. We applied published hardwood CWD decay models and found our inventoried amounts exceeded predicted quantities.

*** Naing, H.L., and G.G. Wang**

Probing fire adaptation through flammability characteristics during the younger phases of longleaf pine and loblolly pine along the Coastal Plain of South Carolina, U.S.A. (POSTER)

Longleaf pine (*Pinus palustris*) has a great reputation for its fire resistance ability under the frequent surface fire regime, and it was distributed approximately 37 million hectares before European settlers' arrival to North America. Due to the various forms of mismanagement made by the European settlers, especially the alteration of the fire regime through intensive fire suppression, this species was replaced by other fire-intolerant species such as loblolly pine (*Pinus taeda*). Given the different fire resistance abilities between the two species, there is a substantial need to scientifically understand the phenomena behind the reason why the longleaf pine can survive much better under the frequent surface fire regime, in contrast with its counterpart, loblolly pine. To this end, the live foliar moisture content (LFMC) of both species was sampled across different growing stages of life because it is a flammability fuel characteristic. Varying life stages of longleaf and loblolly pine were collected across four sites and analyzed for LFMC (N=390). Inter-specifically, longleaf pine needles were found to generally have a relatively higher LFMC (mean 167.38 ± 3.05) than that of loblolly pine (mean 142.14 ± 3). Intra-specifically, variations among different life stages of each species were also witnessed. The LFMC of the height growth stage of longleaf pine was found to be significantly higher than the grass, sapling, and adult stages of the same species. However, the trend is reversed for the loblolly pine in which the adult stage's LFMC is higher than its juvenile stages. Therefore, the former has higher water content in the pine needles during the younger lifeforms, which makes it unique and able to survive under the frequent surface fire regime, whereas the latter can survive only when it can successfully pass the earlier stages of life and reach to the fire-free height (adult stage).

*** Ogbuka, C.E., P. Saud, S.G. Chhetri, M. Yanez, and M. Blazier**

Impact of Thinning Regimes on Growth and Economic Returns of Improved Loblolly Pine Genotypes in the Coastal Plain of Southeast US. (ORAL)

Improved varieties of loblolly pine (*Pinus taeda*), one of the most valuable species in the southern US, have been employed in plantation establishments over time. As the demand for sustainable wood production increases, it is necessary to assess the impact of silvicultural practices on the growth dynamics of these improved genotypes. Thinning, a fundamental silvicultural practice in loblolly pine management for timber production, reduces competition and thus influences the growth and productivity of forest stands. By simulating multiple thinning regimes, this study aims to evaluate the volume yield and economic performance of five improved loblolly pine genotypes (three open-pollinated and two varietals) across a 20-acre site in the southern US. Since 2006, data from 54 plots comprising multiple replicates of the

genotypes planted in blocks, have been collected from northern Louisiana. The Forest Vegetation Simulator (FVS) will be used to model and project future growth trajectories, detailing how different thinning regimes impact the volume yield over time. Individual tree variables, total height, diameter at breast height (dbh) and crown ratio for each genotype, will be input into FVS for analysis. Diameter and height modifiers will be adjusted within FVS to reflect the enhanced performance of each improved genotype compared to unimproved loblolly models typically used in FVS. Volume estimates, specifically the merchantable board foot volume under the different thinning scenarios, will be used to estimate the soil expectation value (SEV) over time, providing insight into the economic viability of improved stands of loblolly pine. We anticipate that the improved genotypes will exhibit higher yields under the optimal thinning regime compared to unthinned stands. The SEV calculations will highlight the economic advantage of thinning for long-term timber production under optimal thinning regimes. This study will give insight into how improved genetics combined with optimized silvicultural management strategies, specifically thinning, can maximize both timber yield and economic returns, thereby informing effective management practices. The findings will help inform landowners and forest managers about genotype selection and management practices that enhance productivity and profitability while maintaining sustainable forestry practices.

*** Oli, T.R., P. Saud, M. Blazier, and M. Yanez**

Comparison of Diameter and Height Growth among Four Genetically Improved Loblolly Pine Genotypes. (POSTER)

Determining the relationship of diameter at breast height (DBH) and tree height with age is crucial for estimating the productivity at both tree and stand level, but also to identify the most productive genotypes. These relationships tend to be complex when comparing the performance of individuals having different genetic background (e.g., families versus clonal varieties), which is still poorly understood in Loblolly pine (*Pinus taeda* L.). This study aims to compare the growth dynamics of a 20-year-old plantation of four genetically improved loblolly pine genotypes (Open pollinated families 7-56 and 8-103, and MeadWestvaco clonal varieties 9 and 93) planted at the Hill Farm Research Station in north central Louisiana. Tree DBH and tree height were measured periodically between 2005- 2024. Preliminary findings indicate that at age 20 years, clone 93 exhibited the highest tree height (78.07 ft.), while genotype 7-56 had the highest DBH (9.81 inches). The genotype 8-103 had inferior performance in both variables (Height of 67.73 ft. and DBH of 9.39 inches). Further analysis will compare the growth dynamics of DBH and tree height with age genotypes using the best-fit sigmoid growth models, such as Chapman-Richards function and Korf function. These models are expected to help predict growth estimate and trend of DBH and height over age for different genotypes. The findings of this study will be helpful to landowners to compare the growth characteristics of these loblolly pine genotypes, aiding them in planning effective forest management strategies.

*** Paulus, L., B. Bullock, S. Kinane, and T. Queiroz**

Crown dynamics of loblolly pine under 12 years of simulated drought stress (ORAL)

PINEMAP was designed to improve our understanding of how southern pines will respond to future climatic conditions. The study consisted of three tiers of increasingly intensive measurements, where at Tier III sites, throughfall exclusion (reduced throughfall simulating future drought conditions) and fertilization were manipulated. The treatments imposed are 1) control, 2) one-time fertilization, 3) 30% throughfall exclusion, and 4) one-time fertilization and 30% throughfall exclusion. Four Tier III sites were established across the natural range of loblolly

pine. The Tier III site in the Georgia Piedmont has been continuously maintained by the Plantation Management Research Cooperative (PMRC) at the University of Georgia since PINEMAP's end in 2015. The continued collection of tree-level measurements at this site where throughfall exclusion has been imposed allows for further analysis of loblolly pine under 12 years of simulated drought stress. Recent research has shown a significant effect of treatment on DBH, basal area, total stem volume, and total stem green weight 12 years post-treatment installation. Differences in crown dynamics, including live crown length and crown ratio, between treatments will be presented (work on-going).

*** Pegues, J.T., A.D. Polinko, J. Puhlick, and K. Poudel**

Site Index and Growth Efficiency of Longleaf Pine Planted on Marginal Agricultural Lands. (ORAL)

Efforts to restore longleaf pine (*Pinus palustris*) over the last three decades resulted in a significant increase of planted longleaf pine on marginal agricultural lands. While the re-establishment of longleaf pine across the Southeast has largely been a success, tools to quantify and project growth of planted stands remain limited, particularly compared to other Southern pines with a longer history of management in planted stands. To address this concern, we developed models of site index and tree-level growth efficiency for longleaf pine planted on marginal agricultural lands in southwest Georgia. We conducted stem analysis on cross sections cut every meter along the bole of 36 longleaf pine trees to develop site index models for twelve stands with presumed differences in productivity. We evaluated the model fit of different functions used to derive site index equations for southern pines. We also collected all branches and needles from a subset of trees (n = 12) to determine total branch biomass and projected leaf area. For each tree, growth efficiency was then quantified as the ratio of stemwood volume increment to projected leaf area. Total branch biomass and a competition index were considered for inclusion in the model of growth efficiency, along with management unit and stand within management unit as random effects. The two management units, which each included two stands, reflected differences in timing of the first commercial thinning. Ultimately, this study will provide longleaf pine landowners with quantitative information on the potential production of their investment in longleaf pine restoration.

*** Phillips, D., L. Hales, and J. Hart**

Structure and Spatial Patterns of Longleaf Pine Woodlands in the Fall Line Hills. (ORAL)

Traditional measures of forest structure are useful but fail to incorporate spatial patterns. Implementation of traditional forest structure measures into tree marking guidelines can result in structurally homogeneous stands or fail to accurately guide stands toward desired future conditions. Despite uniform management by USDA Forest Service personnel, some longleaf pine stands on the Oakmulgee Ranger District (ORD) of the Talladega National Forest, Alabama exhibit variability in spatial patterns and structural characteristics. To capture the range of stand structure and spatial patterns within stands that exhibited desired future conditions, we sampled five, 1-ha plots in reference longleaf pine woodlands. Within each 1-ha plot, we recorded location, species, height, and dbh of all trees, pine saplings, and oak saplings. We then quantified structure using traditional and spatially-explicit measures. Specifically, we used global point pattern analysis (g(r) function) to test for spatial clustering or dispersion of trees and saplings both separately and in relation to each other. We also quantified the number of individual stems, and the size and number of groups of stems following a fixed- and variable-radius individuals, clumps, and openings method. To quantify neighborhood patterns of spatial

structure, we used the mingling index (species interspersion), uniform angle index (spatial distribution), and dominance index (diameter comparisons). Structural and spatially-explicit data from multiple longleaf pine woodland stands in the ORD will provide a more complete range of spatial patterns and structure of longleaf pine woodlands in the Fall Line Hills, and perhaps indicate underlying causes for observed differences. Forest managers can then adapt management actions and develop tree marking guidelines to account for previously unobserved structural and spatial differences and their drivers.

*** Phuyal, R., M. Yanez, and M. Blazier**

Variation in the growth response and survival of longleaf pine (*Pinus palustris* Mill.) families from contrasting provenances established in a drought-prone site. (POSTER)

Longleaf pine (*Pinus palustris* Mill.) is a prominent and ecologically important forest species in the southeastern United States. Currently, the species is present in less than 5% of its historical distribution range, mainly due to extensive deforestation, habitat fragmentation, and genetic erosion. Although the species has adaptive attributes that make it more resilient to the climate change scenario compared to other pine species, there is still not a clear understanding of the resilience of different populations (i.e., provenances) across its geographical distribution, and how this knowledge could be used to guide the genetic improvement and restoration efforts of the species. This study aims to assess the variation in growth and survival of longleaf pine families from different provenances established in a drought-prone site in north central Louisiana. The study was established in 2016 at the Hill Farm Experimental Station of Louisiana State University, Homer, LA. The experiment corresponds to a randomized complete block design that includes 18 longleaf pine families (16 OP and 2 CMP families) from 4 provenances. The result of this study will present the variation of stem growth, live crown and size, and survival at both provenance and family levels. This study could provide insights that can be helpful for the species tree improvement and ecological restoration, such as the selection of better seed sources, and the potential of using provenance inter-crossing to increase climatic resilience.

Pile Knapp, L.S.

Log landings are for the bees: a case study in the coproduction of actionable science to benefit native pollinators. (ORAL)

Active forest management is anticipated to favor early successional and open forest wildlife including native pollinators, especially in aging, homogeneous forested landscapes. However, the heavily impacted areas from timber harvest (e.g., log landings, skid trails, and forest roads) are slow to recover and typically result in an indelible visual impact resulting from forest operations. Further, scientific evidence suggests that many pollinating species, including native bees, are declining in range and abundance and that habitat loss is likely the most significant driver. Log landings that serve as semi-natural habitats may boost the abundance, diversity, and floral continuity of food and nesting resources for native bees. Staff from National Forests (i.e., Hoosier, Mark Twain, and Shawnee) in the midwestern US wanted to 'do something better' than typical log landing closeout procedures by providing ephemeral, rapidly establishing pollinator habitat. Scientists and managers came together to develop a project to reduce compaction, improve soil conditions, and establish floral resources across the growing season. During this presentation, we will discuss the coproduction process that grew this management need into a large-scale research project with unforeseen interest. We will highlight the treatments and the outcomes – for soils, plants, and native bees. Further, we will discuss ideas for developing

protocols for establishing pollinator habitat on log landings on your Forest. With increases in the pace and scale of active forest management, log landings resulting from timber harvest and scaled across the landscape offer the opportunity to promote and sustain a diversity of native pollinators.

Pile Knapp, L.S., and J. Fraser

Tornado Impacts on the Structure and Composition of an Upland Oak Forest in Southern Indiana. (POSTER)

The central states have the most tornadic activity of any region of the US, except Florida. The severity and frequency of extreme weather is anticipated to increase with climate change. In August 2023, an F2 tornado impacted the Paoli Experimental Forest located on the Hoosier National Forest in southern Indiana. Prior to the severe wind disturbance, this forest was characterized as a dry-mesic upland oak forest, with a developed midstory of sugar maple, and minimal oak reproduction. In the winter following the storm, a damage assessment was conducted over 70 forest inventory plots to determine damage category (bent bole, uprooted, snapped bole, crown loss, or no damage) by tree species and DBH. We also assessed fuel loads. Across the plots, 47% of trees sustained crown loss, 35% had no damage, 10% had their bole snapped, 5% had a bent bole, and 2% were uprooted. Of the trees that experienced crown loss, 91% lost less than 50% of their crown. In this forest, oaks and hickories were half as abundant as maples, were larger in height and diameter, and were the canopy dominants. However, oaks sustained the greatest amount of crown loss and hickories snapped more often than other species. Although many maples sustained damage from the tornado, their lower canopy status and abundance may quickly respond to the gaps formed by the loss of the overstory oaks and hickories. Continued monitoring will provide examples of the resulting effects of overstory oak-hickory loss on regeneration and recruitment dynamics following severe wind disturbance.

*** Pinyan, M.M., D. Ugaldes, and S.M. Kinane**

Assessing Spatial Variation in Forest Productivity Across the Southeastern USA Using a Climate-Based Productivity Index: Implications for Southern Silviculture. (ORAL)

Physiographic regions have traditionally been used to parameterize growth and yield models to capture regional differences in the behavior of forest stand dynamics. Often, these predetermined physiographic regions oversimplify the annual growth trends due to variations in covariates for similarly classified areas. Data from a long-term study was used to investigate growth trends across a large spatial range, initial planting densities, and silviculture intensity. This study examines the potential productivity of the southeastern United States by analyzing the influence of regional climatic factors on forest growth. Utilizing historical climate data and in situ observations of stand growth, we examine key variables such as temperature, precipitation, and solar radiation to assess their impact on dominant height dynamics. Through a combination of statistical modeling, spatial clustering, and geographic information system (GIS) techniques, we identify regions with different forest productivity potential and explore the interplay between climatic conditions and silviculture practices. This research underscores the importance of adapting silvicultural strategies to optimize productivity in a changing climate.

*** Pinyan, M.M., and S.M. Kinane**

Evaluating Environmental Influences of Growth Responses to Thinning in Loblolly Pine Plantations: Implications for Forest Management in the Southern United States. (ORAL)

Thinning is a common management tool to modify density in loblolly pine plantations across the southeastern United States. In addition to the biological benefits of reducing competition among crop trees, the economic benefits are leveraged to support mid-rotation and final harvest decisions. To inform forest managers, accurate projections of post-thinned stand level growth responses are required to plan the timing and intensity of thinning treatments. In this

study, we evaluated the effect of environmental variables on the growth response of stands to thinning treatments. Leveraging the Plantation Management Research Cooperative's Mid-Rotation Treatment study, growth responses from long-term thinning and mid-rotation treatment plots established across the southeastern United States were analyzed to understand stand-level dynamics and the impact of environmental covariates on reducing model uncertainty.

Polinko, A., T. Martin, G. Peter, and J. Vogel

Genotype and silvicultural intensity affect loblolly and slash pine maximum size-density relationships. (ORAL)

Understanding stand dynamics in intensively managed plantations is critical for optimizing stand- and forest-level management decisions. Central to this optimization is the relationship between the maximum size and density of trees within a stand. While maximum size-density relationships in loblolly pine (*Pinus taeda*) have been extensively studied, comparatively less information is available for slash pine (*Pinus elliotii*). Additionally, regardless of species, investigations into the effects of varying silvicultural intensity have historically been limited to retrospective studies. This study examines the role of silviculture and genetic improvement on maximum size-density relationships in intensively managed loblolly and slash pine. Specifically, we explore the following questions: 1) Does silvicultural intensity influence maximum size-density relationships during stand development? 2) What role do genetics play in determining maximum size-density relationships? 3) How do elite loblolly pine genotypes interact with silvicultural intensity? To accomplish these objectives, we examined maximum size-density relationships in an experimental trial located in Georgia and Florida. Each trial was replicated on two sites and included treatments of two densities (540 and 1200 trees per acre), two levels of silvicultural intensity (low and high) across 5 elite genotypes of both loblolly and slash pine. We demonstrate that both silvicultural intensity and genetics interact with the site to influence maximum size-density relationships. We will discuss the results and important management implications for production forests.

Polinko, A., J. Willis, M. Blazier, and A. DeStefano

Harnessing hardwood sprouts to establish pine-hardwood mixtures. (ORAL)

Establishing mixed species plantations has the potential to increase stand-level resistance and resilience to disturbance which is often suggested as the primary benefit of mixed-species management. However, increasing lack of small diameter timber markets combined with a potential for decreased establishment costs may also increase the attractiveness of mixed-species plantings. Many pine-hardwood mixtures across the southeast result from natural regeneration following the abandonment of old fields while few examples exist of planted mixtures. Here, we explored the potential for creating pine-hardwood mixtures by planting loblolly and shortleaf pine among hardwood sprouts. The site was located near Homer, LA on fine silt-textured soils. Shortleaf pine and two levels of improved loblolly pine were established alongside separate treatments of herbaceous weed control, imazapyr or an untreaded control. 3-year Results demonstrated adequate survival across all treatments and that herbicide treatments effectively shifted species composition. However, increased hardwood competition may mute productivity that is generally associated with genetic improvement. These strategies may offer novel solutions to landowners seeking to diversify their management while adding additional economic and ecological benefits.

Poudel, K.P., and N. Qadir

Geographic variations in stem taper of loblolly pine in the southern United States. (ORAL)

Taper equations are useful to forest managers as they allow the prediction of diameter at any height or height to any diameter along the stem and facilitate the estimation of total or merchantable volume. These equations are typically species-specific and fitted with data from a small geographic area. Even when the models are developed with regional datasets, differences in tree shape across geographic regions have not been thoroughly evaluated. This study aimed to assess the differences in stem taper and volume of the most commercially important tree species – loblolly pine (*Pinus taeda*) across different geographic regions. Results showed considerable differences in the estimated taper and volume across regions. Mean absolute error (MAE) and root mean square error (RMSE) for total volume were up to 74.9% and 112.9%, respectively when a model fitted to one region is applied to the other compared with MAE and RMSE of 8.5% and 12.4%, respectively when the model is applied to the same region. This suggests that to accurately estimate the upper stem diameter and volume of different sections, forest managers should consider the location of model-fitting data when selecting the taper model for their tree stands. Potential factors leading to these differences will be discussed.

Puhlick, J.

Approaches for adapting longleaf pine ecosystems to climate change. (ORAL)

The Adaptive Silviculture for Climate Change (ASCC) is a network of replicated research sites for testing climate change treatments across a gradient of adaptive approaches: resistance, resilience, and transition. The Jones Center at Ichauway, in southwestern Georgia, is one of fourteen core research sites across the USA and Canada. At Ichauway, adaptation approaches were implemented in mature uneven-aged longleaf pine-oak stands, dominated by longleaf pine. The planning and design process involved formulating desired future conditions, objectives, and silvicultural prescriptions. Treatments were conducted in early 2018, followed by Hurricane Michael in October 2018. Live trees, dead wood, groundcover, and soil are monitored on permanent plots within stands to evaluate the relative success of the adaptation approaches over time. Our site features some of the up-front risks of transition approaches, such as partial stand disturbance, and resulting concerns about fuel discontinuity and regeneration failures. However, the risk and costs associated with transition approaches are expected to decrease under future change. After six growing seasons, stocking of planted turkey oaks in the transition stands ranged from 31 to 95%. Planting of turkey oaks was an Assisted Population Expansion strategy to promote climate adapted species. Since 2018, the use of prescribed fire and follow-up herbicide treatment of mesic oaks was done across adaptation approaches. Additionally, variable density thinning conducted to increase heterogeneity in horizontal and vertical structure in our resilience stands. Overall, the study site features lessons learned from and challenges to adapting longleaf pine ecosystems to anticipated climate change.

Quigley, K., D. Schnake, and J. Forrester

Understory plant community response to midstory hardwood removal vs. retention in longleaf pine sandhills. (ORAL)

Although hardwood trees are commonly removed to aid in longleaf pine restoration on xeric sites, recent studies show conflicting evidence for a facilitative vs. competitive effect of hardwoods on longleaf seedling establishment warranting further research on how vegetation dynamics are impacted by hardwood retention vs. removal. To better understand how midstory

retention influences ground layer vegetation in a North Carolina sandhills ecosystem, we compared plant community composition of sites where midstory hardwoods were either removed via a chemical cut-stump treatment or retained. Our randomized complete block design included 13 study blocks (0.17 ha) spanning a gradient of overstory tree basal area (6 – 25 m2). Each block contained 3 replicate plots for each of the two treatments (hardwood removal vs. retention), and species identity and cover class, plus litter cover and bare ground, were recorded in two 1-m2 quadrats at each plot (n = 156 quads surveyed). We observed 34 species overall, and although species richness declined along a gradient of increasing tree basal area, it did not differ between retention treatments. Percent cover of the most common species, wiregrass (*Aristida stricta*), was similar between treatments and showed little variation along the basal area gradient. Ordination revealed that plant community composition of 18 common understory species (i.e. those present in > 5 % of plots) was very similar between the midstory retention vs. removal treatments. 5 of the 18 common species were associated with midstory removal plots, whereas turkey oak (*Q. laevis*) seedlings were more common in the retention plots. Although subtle, the observed differences in understory communities may become exaggerated over longer periods of time or in the presence of fire.

*** Quintero, D.E., B.K. da Silva, S.M. Kinane, K. Gandhi, C. Villari, and E. McCarty**

Evaluating Financial Trade-offs in Silvicultural Treatments for Pine Tip Moth and Needle Diseases. (ORAL)

Pine tip moth (*Rhyaciona frustrana*) and needle diseases pose significant threats to the profitability of southern pine plantations, particularly in fast-growing species like Loblolly pine. These pests and diseases lead to reduced tree growth, timber deformities, and substantial losses in yield, ultimately impacting the financial returns of forest investments. The pine tip moth affects young pine trees by damaging their shoots, while needle diseases result in defoliation, causing a continued decline in growth rates. Both issues can be aggravated by certain silvicultural practices, as they may unintentionally create conditions that favor infestations. Depending on how they are managed, these infestations can significantly impact timber production and value over time. To mitigate the economic impacts, a range of effective treatments is used, including systemic insecticides for pine tip moths and fungicides for needle diseases. This study utilizes a cash flow model to evaluate the financial implications of pine tip moth and needle disease in pine plantations across the Southeastern United States, estimating changes in timber volume and growth under multiple treatment scenarios. By comparing Land Expectation Value (LEV) for untreated stands versus those receiving chemical treatments, the study assesses the economic viability of pest and disease management strategies. In addition, a sensitivity analysis explores how fluctuations in treatment costs, timber prices, environmental conditions, and other variables influence profitability.

*** Reed, O., H. Tripp, B. Bullock, S. Kinane, B. DaSilva, D. Dickens, D. Clabo, S.-I. Yang, D. Zhao**

Estimating the effect of silvicultural practices and environmental co-variables on plantation longleaf pine productivity in the southeastern United States. (ORAL)

The forest industry in the southeastern United States favors the *Pinus* genus due to its fast growth rates and ability to be transformed into a variety of products from dimensional lumber to pulp and pellets. Historically, longleaf pine (*Pinus palustris*) was the dominant pine species of the southeastern United States, extending from Virginia to Texas, and was an influential component of the early South's economy. Unfortunately, longleaf pine today represents a marginal fraction (approximately 3%) of land compared to its native range. Over the past few

decades, interest in longleaf pine restoration has grown significantly, driven by a combination of ecological, economic, and policy-related factors. Pine straw revenue, a greater density wood for high-end timber products, fire resistance, long-term carbon storage, and ecological management objectives are some of the many reasons behind this recent growth in desirability. A major concern currently hindering the restoration and establishment of longleaf pine is the scarcity of region-wide and applicable longleaf pine productivity information for planted stands which reflects silvicultural decisions and site metrics at the establishment phase. This information gap is critical for silvicultural decision-making and policy formulation, especially as it pertains to landowner incentives and risk management. Using data from permanent sample remeasurement plots established in longleaf pine plantations across the Southeast, we have analyzed the relationship of productivity (dominant height, basal area, volume, tonnage), mortality, and overall establishment success with environmental co-variables and silvicultural practices including soil horizon information, drainage class, macronutrient availability, topography, planting density, herbaceous competition, and pine-straw raking. These relationships influence management decisions, policy considerations, and provide landowners with information they must consider when establishing a longleaf pine plantation. Furthermore, this research provides guidance on optimal planting density, potential response to competition, and growth and yield on varying CRIFF soil groups commonly associated with longleaf pine. Ultimately, this work supports the restoration of longleaf pine by filling in the silvicultural gaps of knowledge, mitigates establishment risks, and promotes the alignment of restoration efforts with policy incentives to ensure the long-term sustainability and resilience of longleaf pine in the southeastern United States.

*** Richardson, D., B. Lockhart, and A. Polinko**

50-years of structural change in managed bottomland hardwood forests of the Lower Mississippi Alluvial Valley. (POSTER)

Bottomland hardwood forests historically dominated the Mississippi Alluvial Valley as well as the surrounding minor bottoms. However, land type conversion to agriculture has resulted in a major reduction in bottomland hardwood forests across this landscape. In addition to range wide decreases, changes in disturbance regimes have resulted in shifts in species composition. For example, there has been a considerable reduction in the recruitment of overstory red oak species into the overstory. This study will evaluate the stand structural and changes in species composition associated with disturbance regime and silvicultural practices in bottomland hardwood forests. Specifically, we will use a 50-year permanent inventory dataset to 1) evaluate changes in stand structure and species composition across a range of sites in the lower Mississippi alluvial valley and 2) evaluate changes in individual tree and stand level growth through time. We will present results and discuss management implications for this unique forest type.

Sayer, M.A., K. Wharton, W. Johnson, J. Hwang, and R. Olatinwo

Climate and soil interact to affect pine root system architecture. (ORAL)

Establishment success and acceptable growth during early stand development require essential soil resources. Root system expansion is key to a continuous supply of these resources from the time of planting to stand maturity. Interaction between climatic and edaphic factors at the planting location has the potential to obstruct normal root system development. As carbon demand for tree growth increases over time, chronic soil resource limitations may intensify causing a significant negative effect on available carbon for growth, maintenance, and defense.

A study was established in a 7-year-old loblolly pine plantation in Vernon Parish, LA that exhibited high variation in stemwood growth. The site is dominated by Eastwood very fine sandy loam (very slowly permeable, very high runoff rate, shallow argillic horizon (Bt)). Seedlings were planted in January 2018 during a 3-month window of normal rainfall that followed four months of drought and preceded 5 months of drought. From across the range of tree vigor in the plantation, 20 trees were destructively harvested in August 2024. Early analyses indicated maximum rooting depth was a function of root plug length and depth increment of the Bt horizon. When microsite conditions caused the root plug end to extend into the Bt horizon, maximum rooting depth decreased significantly by Bt horizon depth increment and sand-to-silt ratio. With further analysis of root system architecture and soil properties, planting scenarios that maximize rooting depth and root system expansion will be discussed.

Schweitzer, C.J., and J. Royse

Potential Oak Regeneration in Oak Woodlands on the Daniel Boone National Forest, KY. (ORAL)

Silviculture used to create oak woodlands relies on intermediate stand prescriptions that often include stem density reduction maintained by prescribed fire. The goal is to create vertical structure that has a dominant oak canopy, a little to sparse midstory layer, and an understory with an increased herbaceous component. However, in eastern upland hardwood forests, creating oak woodlands with this method will result in an understory dominated by sprouts from woody species, including oaks. As part of a larger study aimed at increasing forest health and resiliency, we created oak woodlands on the Daniel Boone National Forest in Kentucky. Six stands, averaging 30 to 50 acres, were thinned once to a residual basal area between 60-70 square feet per acre, and then burned 3 times over 12 years. Prior to burning but after thinning, the density of understory oaks that were 1-to-3 feet tall increased; red maple that was greater than 4.5 feet also increased in number. Because oak woodland habitat structure is ephemeral, we considered management options of woodlands in an adaptive sequence toward regeneration or continuation of habitat with oak reproduction and stand structure changes.

Self, A.B., J.E. Ezell, and A. Ezell

Evaluating Site Preparation Applications Using Vastlan, Vista XRT, Garlon XRT, Accord XRTII, Glufosinate Ammonium, and Chopper GEN2. (ORAL)

Site preparation continues to be the major use of herbicides for forestry applications in the South. Imazapyr and glyphosate have been the dominant materials in this work for years, but recent concerns have stimulated the need to evaluate other materials. A total of seven treatments were evaluated in this study which involved five different herbicides and an untreated check. Each treatment was replicated three times. Treatments were applied September 20, 2022 using a total spray volume of 15 gallons per acre (gpa). The study site was in a cutover in Winston County, MS which had 15 hardwood species and natural loblolly pine present. Woody stems in the plots were recorded by species and height class prior to treatment application. Plots were evaluated at 4, 8, and 12 weeks after treatment (WAT) and again at 1 year after treatment (YAT). Control varied among the herbicide treatments with only one treatment achieving marginally acceptable control of the natural pines on the site. Hardwood control varied significantly among the treatments. Complete details of materials, application, and results will be presented.

*** Senevirathne, D.M., S.-I. Yang, D. Zhao, B. Bullock, and S.M. Kinane**

Comparing the impacts of planting density and thinning on individual tree survival trajectories using survival analysis. (ORAL)

Accurately quantifying the probability of tree survival is critical for predicting forest growth and yield. In this study, we compared the impacts of planting density and thinning on individual tree survival trajectories using random survival forests for loblolly pine (*Pinus taeda*) and slash pine (*Pinus elliottii*). Both species are economically and ecologically important in the southeastern US. Various tree- and stand-level variables were selected in model building. Tree data used in this work were collected from the culture-density trials established and maintained by the Plantation Management Research Cooperative at the University of Georgia. The model was able to capture the variation of tree survival curves across different initial planting densities and thinning treatments. The findings of this study offer a valuable quantitative tool for forest managers to analyze tree mortality.

Shafqat, W., H. Renninger, C. Siegert, A. Himes, and A. Drager

Positive Biodiversity-Productivity Relationship in *Populus* at Southeastern USA. (ORAL)

Poplar forest silviculture that emphasizes biodiversity through mixed-species plantations can significantly enhance bioenergy production by improving ecosystem resilience and resource efficiency. This approach not only increases biomass yields but also contributes to sustainable forest management and carbon sequestration. The biodiversity-productivity relationship is foundational to our understanding of the global extinction crisis and its impacts on ecosystem functioning. The goals of this study were to test the relative impact of taxonomical diversity and functional diversity on the productivity of trees using short rotation *Populus* spp. and their hybrids as a model system. We established monocultures and mixed clonal plantings of six *Populus* clones across three taxa (*P. deltoides* D×D, hybrids of *P. deltoides* × *P. maximowiczii* D×M, and hybrids of *P. deltoides* × *P. trichocarpa* D×T). These clones were planted in three blocks per two sites with 24 plots per block to test the impacts of taxonomic and functional diversity (we chose two clones per taxa, one with low photosynthetic nitrogen use efficiency (PNUE) and one with high PNUE). Here we report after two years that above ground biomass of mixed clone plantings compared to the weighted average of their constituent monocultures. We found that, on average, functionally diverse two-clone mixtures with differing PNUE over yielded by producing more above ground biomass than either of their constituent monocultures, while taxonomically diverse, but functionally similar, three-clone mixtures under yielded, producing less above ground biomass than the average of their constituent monocultures. Above ground biomass in planting mixtures with all six clones was not significantly different from the average biomass of all monocultures. Our results suggest that, with careful implementation, increasing functional diversity managed ecosystems, like *Populus* biomass plantations, may be a viable strategy for increasing production.

*** Sharma, S., P. Khanal, and N. Timilsina**

Predicting Above-Ground Biomass of Forest in South Carolina: Integrating Remote Sensing, Machine Learning, and Interpolation Techniques. (ORAL)

This study evaluates the effectiveness of a Random Forest model for predicting above-ground biomass in South Carolina (SC), utilizing diverse remote sensing and climatic data sources. SC, with its humid subtropical climate and varied geography, including the Atlantic coastal plain, Piedmont, and Blue Ridge Mountains, poses unique challenges for biomass estimation. We

integrated global biomass datasets for 2010, MODIS vegetation indices (NDVI and EVI), Leaf Area Index (LAI) from MOD15A2H, and climate data from TerraClimate. The model was trained using 2010 data and applied to 2022 datasets to assess biomass changes. To validate the model, plot-level biomass estimates from the 2023 FIA data were interpolated using Inverse Distance Weighting (IDW). Performance evaluation showed a strong positive correlation between predicted and observed biomass, with a correlation coefficient of 0.77 and an R^2 value of 0.62, indicating that the model explains 62% of the variability in biomass. Comparison with IDW-interpolated biomass data resulted in a correlation coefficient of 0.64, confirming the model's validity. Although the Random Forest model demonstrated reliable predictions, the study suggests potential improvements by incorporating additional data sources and advanced modeling techniques. The findings emphasize the value of integrating remote sensing data, machine learning, and interpolation methods to enhance biomass estimation accuracy. This research provides crucial insights into biomass distribution in SC and establishes a basis for future studies on forest monitoring and carbon accounting, highlighting the importance of combining various data sources for comprehensive environmental analysis.

Shearman, T.M., J.M. Varner, J. Willis, and E. Wachter

Fire-induced cladaptosis in southern pines: fire effects on surviving trees. (ORAL)

The effects of fire are generally broken into two categories, first- and second-order effects. First-order effects occur during or shortly after fire and include direct effects such as immediate tree mortality, fuel consumption, smoke production, and soil heating. Second-order effects are indirect effects that can occur years after the fire, including delayed tree mortality usually through secondary mechanisms such as bark beetle attack or drought. However, in surface fire regimes, many trees survive fire events despite injuries. Here, we discuss potential fire effects on surviving trees. In the southeastern USA, prescribed fire is a management tool used to achieve various objectives such as controlling hardwood encroachment, reducing fuel loads, and maintaining animal habitat. Southern pines in these frequent fire systems often survive multiple fire injuries, such as canopy scorch. Decision support tools to estimate fire effects, such as the First Order Fire Effects Model (FOFEM) generally overpredict mortality in these systems. We surveyed tree injury from seven prescribed fires in southeast US. Fires ranged in intensity, producing varying levels of scorch injuries. Approximately 1634 individual trees (*Pinus palustris, P. taeda,* and *P. echinata*) were mapped, and total height, diameter, and crown height were measured. Total crown volume scorched was visually estimated shortly after each fire for each tree. Average crown scorch of trees larger than 20 cm diameter ranged from 19.5 – 80% across fires. A total of 1490 surviving trees were remeasured each year after fire. Crown scorch resulted in a lifting of the average canopy height that increased with increasing average scorch ($R2 = 0.66$, $P = 0.02$). We discuss the implications of fire-induced cladaptosis (self-pruning) on surviving trees in prescribed fires, including the potential to mitigate the effects of future disturbances. In these systems of frequent fire, we stress the need to understand the effects of multiple recurring injuries and the possibility of interacting disturbance effects.

* Shephard, N., S. Kinane, D. Clabo, and D. Markewitz

Longleaf pine aboveground production after Hurricane Helene and pine straw raking treatments on the Lower Coastal Plain in south Georgia. (ORAL)

Pine straw is a valuable non-timber commodity to south Georgia and was valued at USD $127 in 2022. Beyond economic evaluation, the preferred species for pine straw, longleaf pine, has also recently been touted for its resilience to wind events. However, intensive pine straw-oriented

silvicultural regimes could increase longleaf pine's risk to wind extreme wind events, like hurricanes. Our south Georgia-based study offers a unique stand-level perspective to understand if and how pine straw raking intensity could potentially interplay with hurricane wind damage. The study, installed in 2023, was recently hit by Hurricane Helene on September 23, 2024, with damage from the storm was recorded at all four of the study sites. The original experimental design was a randomized, incomplete block design with a factorial combination of temporal raking (1-year, 3-year) and raking type (no rake, pitchfork, yardrake, mechanical) regimes. In total, there were 84, 0.1 acre plots, evenly distributed between two cutover and two oldfield sites. As of Fall 2024, predominant production trends were between oldfield and cutover sites, rather than raking treatments. For instance, 2024 standing basal area was 98.87 ft2 ac-1 and 70.63 ft2 ac-1 for oldfield and cutover sites, and 2023 leaf area indexmax (LAI) was 3.0 and 2.6, with no apparent trends due to raking treatments. To quantify wind damage from the hurricane, in Winter 2024/Spring 2025 the study sites will be surveyed for mortality and injury type, along with, but not limited to diameter, height, and LAI. Hopefully, results from the hurricane impact survey could uncover if high intensity raking treatments could lead to higher mortality rates or tree injury. As in, if pine straw raking lowers longleaf pine's ability to withstand high winds. Additionally, hurricane damage assessment will help uncover if stand nutrient availability, related to oldfield and cutover land use, significantly alter a stands susceptibility to wind. We hypothesize that (1) Intensive raking correlated with higher tree mortality; (2) cutover sites experienced greater mortality than cutover sites; and (3) Stands with greater pre-storm LAI will show greater LAI recovery post-storm. Data collected and anticipated results will help inform land managers and landowners if pine straw raking can alter a stands ability to withstand hurricane wind damage and if so, what are the most effective pine straw raking regimes to mitigate wind damage.

Shoemaker, K.D., D.P. Jackson, and J.P. Adams

The Role of Genetic Variation in Early Height Growth of Longleaf Pine Seedlings. (ORAL)

Sonderegger pine (*Pinus palustris* Mill. x *Pinus taeda* L.) seedlings commonly occur in longleaf pine seedlots grown in southern forest tree seedling nurseries. Because landowner objectives often include planting pure longleaf pine, nursery workers cull Sonderegger pine seedlings from longleaf pine nursery stock before being shipped to landowners for outplanting. For decades, the initiation of height growth (12 to 15 cm) in longleaf pine seedlots has been used to indicate that hybridization with loblolly pine has occurred. However, recent studies have shown that pure longleaf pine seedlings can exhibit up to 10 cm of stem elongation, causing them to be misidentified and culled as Sonderegger pine. The cause of early height growth in these seedlings is currently unknown, and genetic and environmental interactions influencing stem development in Sonderegger pine seedlings is not well documented. To better understand how genetic variation influences longleaf and Sonderegger pine seedling development, stem length, hypocotyl length, and root-collar diameter (RCD) will be compared among one-year-old container-grown longleaf and Sonderegger pine seedlings collected from two Texas and Louisiana seed sources (four total sources). The main objectives of this study are to (1) determine if stem height and/or hypocotyl length is significantly different among longleaf and Sonderegger pine genotypes and (2) examine correlations between longleaf and Sonderegger pine seedlings collected from the same geographic sources. Understanding the role of genetic variation in longleaf pine seedling development may help refine Sonderegger pine culling standards and improve longleaf pine seed efficiency, thereby enhancing longleaf pine restoration across the southern region.

*** Shrout, K.L., L.A. Vickers, C.A. Cotton, and J.M. Lhotka**

The Relationship between Soil Properties and Oak Regeneration in Eastern Kentucky. (ORAL)

Oaks (*Quercus* spp.) are a keystone tree species in Kentucky, both ecologically and economically. However, that dominant status is at risk due to persistent and well-documented regeneration struggles in the absence of active management targeted at perpetuating oak into the next generation of forests. Oak regeneration struggles typically vary in degree with soil and site characteristics, and the risk to oak regeneration is especially high on productive sites where oak is often overtaken by fast-growing competitor species. This project aims to examine the utility of soil physical and chemical properties towards modeling the abundance of oak regeneration in Eastern Kentucky, using both fine-scale and broad-scale data. Fine-scale models will be developed using soil and vegetation data collected within the study area, an approximately 120-acre watershed located in Improvement Hollow in Robinson Forest, Breathitt County, KY. Broad-scale models will be developed using soil and vegetation data from national databases such as the Forest Inventory Analysis (FIA) database and the Soil Survey Geographic (SSURGO) database. This presentation will highlight the prominent soil and forest characteristics of the study site and the nature of their relationships. As a result of this research, our understanding of the relationships between soil properties and oak regeneration will improve and, in turn, so will the precision in which we can identify areas that may benefit from silvicultural intervention to foster oak regeneration.

*** Sigdel, S., J. Stovall, Y. Weng, and K.R. Kidd**

Assessing the Status and Distribution of Yaupon within Pre-Thinned Loblolly Pine Plantations in East Texas. (POSTER)

Yaupon (*Ilex vomitoria*) grows frequently in moist hardwood and pine forest of the Western Gulf Coastal Plain of east-central Texas. This native evergreen shrub or small tree often competes with planted loblolly pines for essential resources such as sunlight, water, and nutrients. The study area is of planted loblolly pine with average of 425 trees per acre (TPA), 153.4 square feet of basal area per acre (BAPA), and a quadratic mean diameter (QMD) of 8.12 inches. of 425 trees per acre (TPA), 153.4 square feet of basal area per acre (BAPA), and a quadratic mean diameter (QMD) of 8.12 inches. A field survey was conducted across 20 split plots containing 40 nested plots, each of 11.8 ft radius to assess the average height and density of yaupon. The results showed an average height of 8.5ft with standard error of 0.66 and an average density of 1,748 yaupon per acre with standard error of 224. These findings highlight the status of yaupon before thinning in mid-rotation pine plantations and provide a baseline to evaluate the effects of future management practices, such as thinning and herbicide treatments.

*** Silanskis, M.E., J. Fraser, L. Pile Knapp, and B. Knapp**

Documenting 60 years of structural and compositional change in an oak-hickory forest in southern Illinois. (POSTER)

Established in 1942, the Kaskaskia Experimental Forest is a designated research area within the Shawnee National Forest in southern Illinois. The predominant forest types are oak-hickory and mixed-hardwood. With an area of 466 ha, it includes 40 research compartments of uneven age and even age stands. Previous research studied the long-term impacts of commercial management practices on species composition through a full forest inventory. The compartments were subject to clear-cut and group selection cutting treatments from the 1940's-1960's. Additional factors included a long or short rotation lengths, long or short cycle

lengths, and management that was either intensive, meaning to improve stand conditions for increased growth, or extensive, meaning that no operation was done unless it would pay for itself through the products of the cut. Planting of shortleaf pine and eastern redcedar was also done with the objective of producing a 50/50 mixed forest. This research was halted in the 1960's. In 2023 and 2024, an updated inventory of the oak-hickory compartments was conducted. Randomized sampling plots were established within each compartment. Overstory data, including species and diameter at breast height (DBH; cm), were collected on trees with a DBH>10 cm in a 16-m radius from the plot center. The data will be used to document the changes that have occurred in the composition and structure of the experimental forest since 1960. Analysis shows that there has been an increase in basal area per hectare across all compartments and oak-hickory remained the dominant forest type. Shortleaf pine successfully established in three of the six planted compartments, predominantly in the even-aged clear cut treatment, which may be due to the treatment eliminating the overstory competition. Eastern redcedar did not establish most likely due to its inability to withstand competition and the lack of management leading to overcrowding in the overstory. Scarlet oak no longer appeared in the species composition apart from compartments 39 and 14, which could be due to misidentification in the field, or increased leaf litter and overstory cover, both being inconducive to regeneration. From the results, the best silvicultural approaches to forest management objectives over long time periods can be determined. The ongoing research can be utilized to guide the active management of forests through climate change and other challenges that may arise for landowners.

*** Skiba, T., S.-I. Yang, and T.J. Brandeis**

Characterizing aboveground forest carbon for mixed-species forests in the national parks and national forests in the southern Appalachian region. (ORAL)

As vital components of the global carbon cycle, forest ecosystems play an important role in sustainable forest management. The national parks and national forests in the southern Appalachian region conserve critical and unique forest ecosystems in North America. In this collaborative project, we will develop a statistical methodology to quantify aboveground live forest carbon in the parks and national forests. Specifically, a mixed-effects modeling approach will be implemented to provide forest-type-specific predictions of this forest carbon pool. Forest and site variables (e.g., environmental conditions, biodiversity indices) will be included in model building. Long-term, forest inventory data collected by the USDA Forest Service, Forest Inventory and Analysis (FIA) program will be used. The results of the proposed research will provide quantitative methods for monitoring aboveground live forest carbon of the mixed-species forests, which can then be expanded to other regions in the country. Data collected from the FIA program will be used in analyses. Permanent plots were installed throughout the natural growing range of the mixed-species forests in the national parks and national forests. Most of the plots fall within forest types dominated by hardwood species such as oaks, hickories, and maples. Some plots in the high elevation mountains are defined by the prevalence of coniferous species such as pines and spruces. Forest (e.g., species composition, species richness, basal area) and site variables (e.g., elevation, slope, aspect) collected from the FIA plots will be included in model building. A mixed-effects modeling approach will be implemented to provide forest-type specific estimates of aboveground live forest carbon. Lasso regression or similar variable selection procedure will be used to determine the key variables in quantifying this forest carbon pool. The results will provide additional information of the status of aboveground live forest carbon stocking in the Southern Appalachian Mountains.

Subedi, M.R., A.A. Baeza-Castro, P. Dwivedi, B. Costanzo, and J.A. Martin

Modeling Regional Forest Site Productivity Accounting Spatial Structure in Climatic and Edaphic Variables. (ORAL)

With increasing interest in sustaining productivity amid changing climate, disturbance regimes, and management practices, an accurate forest productivity estimate is important to develop sustainable management regimes. Our goal was to estimate and map the potential productivity of co-occurring tree species. We used forest inventory and analysis (FIA) data and climatic and edaphic variables to model the composite site index (CSI) as a proxy of potential forest productivity. Initially, we identified the site index model for selected species: slash pine (*Pinus elliottii*), longleaf pine (*Pinus palustris*), loblolly pine (*Pinus taeda*), and yellow poplar (*Liriodendron tulipifera*). We then standardized species-specific site index (SI) values to generate composite site index (CSI) values. Finally, we used a random forest (RF) machine learning algorithm (ML) to predict CSI values based on climatic and edaphic factors while addressing spatial dependencies in the data set. The RF model explained 81% of the variation (R2adj = 0.81), with a mean bias of 0.11 m and a mean absolute error (MAE) of 3.37 m. The accuracy of modeling and mapping forest productivity using CSI depends on the quality and spatial distribution of national forest inventory data at the species level and climatic information. We recommend modeling forest productivity that accounts for spatial structure in the data to reduce overinflation of overall accuracy.

Twedt, D.J.

Survival and Growth of Planted Shade-Intolerant Seedlings in Silvicultural Canopy Gaps. (ORAL)

Management of bottomland hardwood forests to enhance wildlife habitat in the Lower Mississippi Valley often prescribes creation of canopy gaps. Regeneration of canopy trees within these canopy gaps is likely limited by availability of sunlight, as dictated by gap size, but competition with understory vegetation may also constrain regeneration. To examine the influence of understory vegetation on tree regeneration, I reduced competition by clipping vegetation and providing supplemental fertilization. I assessed survival and heights of planted shade-intolerant canopy tree seedlings for circa 6 years within canopy gaps ranging from 121 to 3359 m2 expanded gap area that were created by silvicultural treatments on 4 bottomland forest stands. Survival varied markedly among planted species. Species that had moderate survival probabilities (~0.5) were negatively affected by understory vegetation competition whereas I did not detect any influence of competition for species with high (>0.95) survival or low (<0.12) survival probabilities. In contrast to survival, heights of planted seedlings were not positively influenced by either understory vegetation removal or by supplemental fertilization. For most species, both survival and seedling heights were greater within larger (>400 m2) gaps. Although I found survival of planted seedlings was enhanced by reducing competition with understory vegetation, depending on the species planted, the surviving seedlings in gaps without competition control would likely fill the canopy gap – assuming sufficient availability of sunlight within the gap.

*** Umeojiakor, A.O., K.G. Ibeh, J.J. Granger, A. Himes, and C.M. Siegert**

Preliminary Study of Soil Carbon and Nitrogen Storage at On-going Silvicultural Treatments in Upland Oak Regeneration of Hardwood Forest of Northern Mississippi. (POSTER)

Upland Hardwood Forests are highly valued for provision of ecosystem services and economic importance. However, these forests are often subjected to natural and human-related disturbances like fire, silvicultural practices, harvesting, etc. which affect the amount and rate of changes in carbon and nitrogen storage. A better understanding of how carbon and nitrogen sequestration will change because of silvicultural treatments must be acquired to be able to select the most appropriate management strategies for increasing carbon and nitrogen as well as enhance upland oak regeneration. Therefore, the study provides a preliminary study of soil carbon and nitrogen storage at on-going silvicultural treatment for upland oak regeneration in Hardwood Forest. This study was conducted at Spirit Hill Farm in Tate County, MS on 234 hectares of hardwood or mixed hardwood forest which were randomly assigned to three silvicultural treatments (T1, T2, T3): T1 – hack and squirt + overstory removal to residual basal area of 11m2/ha, T2 – hack and squirt + overstory removal to residual basal area of 7m2/ha, and T3 – no treatment (control). Each treatment area was approximately 5 – 10 hectares and was replicated four times. Overstory, midstory and regeneration plots were surveyed, and soil sample collected at each survey point prior to treatment implementations. Species composition will be calculated as proportion of total tree species. Analysis is ongoing and results are pending. Data will be analyze using R statistics. Preliminary results are expected to provide baseline information on the status of total soil carbon and nitrogen in the established plots. After the implementation of treatment, further soil samples data collection will be done to compare the implications of total soil carbon and nitrogen on oak regeneration. The study will contribute to understanding soil carbon and nitrogen storage and potentially improve decision support tools for managing soil at the Southern range of the Central Hardwoods Region.

VanderSchaaf, C.L., and Y. Li

Reforestation Tax Incentive Impacts On Financial Returns Of Loblolly Pine Plantations For Material Participant Business Landowners In Mississippi. (POSTER)

Tax related issues are an important consideration that are often not addressed in forest financial assessments, or directly addressed at least. Many financial assessments can be defined as "before-tax." Rates of return from forest plantation investments depend on survival and growth rates, as well as costs and revenues associated with various practices, but also tax related issues. Forest landowners within Mississippi have the potential to reduce reforestation cost burdens through two important tax-related opportunities. The first being the Federal reforestation deduction and amortization provisions and the second being the state-based reforestation tax credit. Due to poor stumpage prices, particularly pulpwood, plus increasing reforestation costs largely due to inflation and increases in fuel costs, for many landowners returns on investment will be marginal without some type of assistance. In a previous paper, we examined the impacts of these two income tax reduction opportunities on unthinned loblolly pine financial returns when a landowner was classified as an Investor. Here, we present results for the same analysis but when the landowner is classified as a Material Participant Business. Similarly, three planting densities (454, 519, and 605 seedlings per acre) were examined for a site index 65 feet site (base age 25), a final harvest clearcut was conducted at age 26, and the landowner is assumed to be within the 22% Federal income tax bracket.

VanderSchaaf, C.L.

Validating A Shortleaf Pine Plantation Growth And Yield Model System For The Western Half Of The Southeastern United States. (ORAL)

A system of growth and yield equations for shortleaf pine (*Pinus echinata*) plantations using data from across the western half of the southeastern United States was validated using updated measurements from plots in north Mississippi (old-field) and independent data from Oklahoma (cutover). Data used in model fitting were obtained from Arkansas, Mississippi, Oklahoma, and Tennessee (n = 168 plot measurements). Planting densities ranged from 194 to 1,742 seedlings per acre, and measurement ages ranged from 1 to 30 years. The majority of the measurement ages were ≤16 years of age (n = 152). A mix of cutover and old-field sites were modeled. Validation data had planting densities of 544 and 622 seedlings per acre and measurement ages ranged from 4 to 20 years. Predictions of dominant height, trees per acre, basal area per acre, and total volume per acre were obtained directly. Quadratic mean diameter was mathematically derived from the number of trees and basal area per acre estimates. Predictions from this new model system were compared with predictions from the USDA Forest Service Forest Vegetation Simulator (FVS) and with a model system produced by Smalley and Bailey (1974).

Vogel, J.G., E.J. Jokela, and T.A. Martin

Carryover effects and the sustainability of intensive loblolly pine (*Pinus taeda*) management through mid-rotation. (ORAL)

The intensive management of loblolly pine can dramatically increase productivity. However, it is unclear if past management affects current rotation productivity, or if repeating practices across rotations influences subsequent growth. The Intensive Management Practices Assessment Center (IMPAC) experiment in north central Florida was planted in 1983 with loblolly pine and slash pine (*Pinus elliottii*) and had an untreated control (C) and treatments of complete and sustained weed control (W), fertilization with all micro- and macronutrients (F), and a combined treatment (FW) applied at levels expected to maximize tree productivity on a sandy Spodosol (Pomona series). After IMPAC's harvest, a second rotation experiment was established in 2010 with the loblolly pine plots receiving the same silvicultural treatments as the first rotation ("active" treatments), while the slash pine plots were replanted with loblolly pine and left untreated to assess carryover (C-) effects (CC, CF, CW, CFW). The active treatments required thinning at ages 6 and 13 (F, FW) and 7 (W) years old with a thinning trigger of ~55-65% relative density. At age 14, mean tree diameter at breast height (DBH) for the C, F, FW, and W treatments were 5.8, 8.9, 9.8 and 7.6 inches, respectively, and 25%, 23%, 30%, and 12% greater than in the first rotation. In the carryover treatments, the DBH of the CF (7.2 inches) and CFW (6.9 inches) were significantly greater than the CC (6.0 inches) and CW (6.5 inches) treatments, indicating a significant carryover effect of fertilizer. These results suggest that repeated silvicultural applications are sustainable, and that legacy fertilizer improves next rotation growth through mid-rotation.

Wachter, E.M., M. Varner, and T. Shearman

***Pinus echinata* resprouting and growth dynamics in a frequent fire regime: a preliminary analysis. (ORAL)**

Tree regeneration is a major determinant of its resilience in frequently burned forests and woodlands. Recurrent fire selects for an array of traits that enable survival and persistence. One common response to fire-induced top-kill among woody plants is resprouting from the root collar. This response is prevalent in angiosperms but less common in gymnosperms, particularly pines (*Pinus* spp.) where only 15 of the 118 species are capable of resprouting. Shortleaf pine (*P. echinata*) is one of the few pines in North America with this adaptation. Resprouting gives *P.*

echinata a competitive advantage over other pines that cannot resprout and co-occurring angiosperms that are not as tolerant of fire. To quantify post-fire regeneration dynamics in shortleaf pine, we followed the fate of 225 individuals throughout two successive prescribed fires, two years apart, by measuring the number of resprouting stems per individual, resprout height and diameter growth rates, and seedling mortality. Following both prescribed fires, we found prolific resprouting that slowly diminished over time. While initial resprouting was higher following the first prescribed fire (mean = 22.3 versus 18.8 sprouts per individual), resprouts were retained longer following the second prescribed fire, after three months, (mean = 19.7 versus 20.4). After the second fire, 3% of seedlings were killed outright, however 13% were able to survive without sprouting. The prolific resprouting of shortleaf pine underscores its evolutionary relationship with frequent fire, emphasizing the integral role of prescribed fire in its management. Because a seedling's recovery from topkill is dependent on its ability to resprout, understanding the resprouting dynamics and functionality of *P. echinata* is important to promote regeneration in future woodlands.

*** Wagle, S., S.-I. Yang, T. Brandeis, and B. Bullock**

Examining a modeling strategy to select the optimal mixed model for characterizing height-diameter relationships. (ORAL)

Accurately characterizing height-diameter (H-D) relationships is crucial for making proper management decisions and predicting forest growth and yield. Mixed modeling techniques have proven useful in forestry, as they allow for the integration of pooled information. In this study, we proposed a methodology to identify the optimal mixed model. Specifically, a total of 25 parametric H-D models published in the literature were selected as model candidates. Based on the form of the best candidate, all possible combinations of mixed models were explored to determine the optimal mixed model. Two case studies were used to demonstrate the proposed methodology: (1) loblolly pine data collected from culture-density trials established and maintained by the Plantation Management Research Cooperative (PMRC) at the University of Georgia, and (2) subtropical tree data collected from long-term permanent plots in Puerto Rico and the U.S. Virgin Islands, queried from the USDA Forest Service's Forest Inventory and Analysis database. Preliminary results revealed that the optimal model selected can provide reliable predictions of total tree heights, which varied across different management treatments and forest types. The findings of this work will enhance existing modeling approaches for characterizing height-diameter relationships.

Wang, G.

Climate-Smart Forestry: Sustainable Forest Management in the Era of Climate Change and AI. (ORAL)

Forests provide a range of vital ecosystem services, including serving as a carbon sink to mitigate climate change. However, contemporary, human-caused global warming and its derived extreme climate events and other disturbances have presented unprecedented challenges to global forest ecosystems, threatening their sustainability and resilience. To address these challenges, climate-smart forestry (CSF) has emerged as an innovative solution to ensure climate change adaptation to sustain forest productivity and ecosystem services while optimizing climate change mitigation. Coinciding with the emergence of CSF, artificial intelligence (AI) has progressed significantly in solving real-world data problems in virtually all areas of application domains. As a result, forestry is also undergoing a digital transformation towards a "smart" forestry, which has also been integrated into CSF. This paper reviewed recent developments in

forestry, particularly how forestry is evolving in response to a changing and uncertain climate in the future. A new definition of climate-smart forestry is proposed, and its contents are discussed

Wang, J., A. Coates, J.P. Schmit, A.J. Brolis, and M. Ford

Invasive species may threaten forest ecosystem integrity with climate change. (ORAL)

Mapping and predicting invasive species distribution is crucial for biodiversity conservation, ecological management, and informed decision-making. Invasive plants, such as Japanese honeysuckle (*Lonicera japonica* Thunb.), have raised increasing concerns due to their spread and negative impacts on local ecosystem integrity. In this study, we integrated Forest Inventory and Analysis (FIA) and National Capital Region Network (NCRN) inventory and monitoring data to estimate the status of dominant invasive plant species in the National Capital Region (NCR) and U.S. forests, and to predict their future distribution under different Shared Socioeconomic Pathways (SSPs). We also explored the impacts of invasive plants on native keystone species, such as white oak (*Quercus alba*), including their distribution, diversity, and ecosystem integrity. Using historical bioclimate data, soil properties, and elevation as predictors, we trained multiple models—including Maximum Entropy (MaxEnt), Gaussian Process, Random Forest, and ensemble models—to predict the probability of invasive species presence across the NCR and U.S. mainland. For model training, we used NCR presence data and combined NCR and FIA data to derive presence and absence datasets, allowing us to assess how the inclusion of absence data affected model performance. Model evaluation using multiple indices showed an AUC range of 0.75-0.93 for most models. Our results indicate that Japanese honeysuckle is the most abundant invasive plant in the NCR, while Russian knapweed (*Acroptilon repens* (L.) DC.) dominates at the U.S. scale. Future climate change scenarios, especially SSP585, significantly increase the spread of these invasive species across both regions. The presence of invasive species has notably reduced native keystone species abundance, diversity, and forest ecosystem integrity. These findings highlight the need to consider invasive species management and climate adaptation strategies to best preserve ecological balance, safeguard native biodiversity, and support sustainable forest management.

Wang, J., and H.J. Renninger

SapFlower: An automated tool for sap flow data preprocessing, gap filling, and analysis using deep learning. (POSTER)

Sap flow, the movement of water through a plant's vascular system, is a critical process for understanding plant transpiration and overall water use, which are essential components of ecosystem water cycles. It is typically measured using various methods, including thermal dissipation probes (TDP), heat pulse velocity (HPV), and heat field deformation (HFD). While these methods vary in complexity and accuracy, TDP is one of the most widely used due to its ease of installation and continuous data collection capability. However, sap flow data often suffers from noise, outliers, and gaps due to sensor failures or environmental factors, which makes the data difficult to analyze without extensive manual intervention. The lack of standardized, automated tools for data preprocessing, cleaning, and gap-filling has been a significant challenge for researchers, particularly in large-scale or long-term ecological studies. Manual methods are prone to errors and inconsistencies, limiting the reliability and reproducibility of the results. Therefore, there is a need for a solution that can automate the entire process while leveraging advanced machine learning techniques for accurate data handling. To address these challenges, we developed SapFlower, a novel software application that automates the preprocessing, model training, gap-filling, and analysis of sap flow data.

SapFlower integrates machine learning models, including random forest and deep learning models such as LSTM and BiLSTM, to accurately predict and fill missing data points based on environmental variables. This tool simplifies the data processing workflow, improving the accuracy and efficiency of sap flow analysis, and making it accessible to researchers across disciplines, regardless of their programming expertise. Source code and standalone application have been made available on GitHub (https://github.com/JiaxinWang123/SapFlower) and Zenodo (https://doi.org/10.5281/zenodo.13665919).

* Weise, A., and D. Hagan

Interaction of woodland fire management and the spread of the invasive Chinese silvergrass (*Miscanthus sinensis*). (ORAL)

Highly flammable non-native grasses threaten the stability of natural communities across North America including cheatgrass (*Bromus tectorum*) in the west and cogon grass (*Imperata cylindrica*) in the south. Another species, Chinese silvergrass (*Miscanthus sinensis*), is becoming more abundant in some regions, with emerging evidence that it similarly increases the frequency, intensity, and severity of wildfires. *Miscanthus* has seen increasing interest for development as a biomass crop after years of interest as an ornamental planting. In its native range of east Asia, *Miscanthus* is known to dominate sites heavily disturbed by landslides or severe erosion and is known to be associated with clearcutting, agricultural abandonment, and burning. Repeated fires result in a feedback loop that inhibits the establishment of woody vegetation, thus further promoting *Miscanthus* establishment and spread. The recognition of the invasive potential of *Miscanthus* has catalyzed a broader discussion on how the grass is invading natural communities throughout the eastern United States. In the Southern Appalachians, for example, areas heavily invaded by *Miscanthus* tend to burn more easily, frequently, and intensely than those that are not. If *Miscanthus* spreads into Southern Appalachian forests and woodlands, this fire feedback will make it more challenging to use fire as a restoration tool. As desired open woodland structural characteristics coincide with high-light conditions favored by *Miscanthus*, reductions in overstory basal area might further facilitate *Miscanthus* spread. Without appropriate management, successes from years of woodland restoration by fire may thus be put in jeopardy. We hereby present preliminary results on the patterns of *Miscanthus* spread in woodlands managed with prescribed fire.

Weng, Y., and J. Grogan

Size heterogeneity and its impact on growth in managed loblolly pine plantations in east Texas. (ORAL)

Current management of loblolly pine plantations is intensive, focusing primarily on growth and yield outcomes. However, aspects such as the stand structure of these plantations, specifically size heterogeneity, have received less attention. Size heterogeneity of a stand often include tree size inequality and growth dominance. The East Texas Pine Plantation Research Project (ETPPRP), a long-term, regional co-op project in the western Gulf, installed permanent plots in intensively managed loblolly pine plantations. Tree diameter at breast height (DBH) and height in these plots are repeatedly measured every third year. Gini index, an indicator of tree size equality, and growth dominance, an indicator of tree competition, of DBH and height were calculated. Temporal trends of these metrics in relation to stand development and their associations with periodic annual growth at both tree and stand levels will be explored. The implications of these findings for effective loblolly pine plantation management will be discussed.

*** Wigginton, L., L.A. Vickers, and J.M. Lhotka**

Suppression and Release of White Oak (*Quercus alba*) During Canopy Recruitment in Upland Hardwood Stands. (POSTER)

White oak (*Quercus alba*) has been ubiquitous in US forests since the Holocene era. Since the 20th century, however, steep declines in the rates of oak canopy recruitment have raised concern over the long-term sustainability of the current oak population. White oak is reported to be more tolerant of shade than other upland oaks, making it plausible that white oaks can withstand more and longer periods of suppression during their ascent to the canopy than conventionally thought for other upland oak species. Our project aims to examine the frequency and extent of suppression events experienced by mature white oaks in contemporary stands, including the length of suppression period experienced and the life stage in which it occurred, using increment cores and destructive samples. This poster will highlight preliminary results including common dendrochronological patterns found among previously suppressed oak trees and their response to that suppression. The continuation of this study will yield results that improve our understanding of the regeneration ecology of white oak and inform practices toward a more effective management strategy for this important species.

Willis, J.L., A. Sharma, T.M. Shearman, M.J. Varner, and J. McKeithen

Exposure to shade stress modifies fire tolerance among southeastern U.S. tree species. (ORAL)

Fire tolerance is the foremost trait used to predict fire effects in frequently burned ecosystems. However, focusing on fire tolerance alone does not account for other cooccurring forms of stress that could modify species tolerance and produce non-additive responses to burning. Shade is an increasingly important form of stress on the contemporary landscape, as many woodlands have transitioned into closed canopy forests following fire exclusion. To investigate the interaction of fire and shade, we established an experiment examining seedling mortality and recovery of six subtropical tree species from surface fire applied under four levels of shade (unshaded, 60%, 70%, 85%) in northwest Florida, USA. Across shade levels, mockernut hickory maintained the highest pre-fire non-structural carbohydrates (NSC) (15%) and experienced the lowest post fire mortality (9 to19%); while loblolly pine maintained the lowest pre-fire NSC (2%) and had the highest mortality (88 to 96%). Longleaf and shortleaf pine mortality consistently increased with shade and was best predicted by shade intensity and crown scorch. All living hardwood seedlings survived through sprouting. In contrast, longleaf and shortleaf pine survived by resisting top-kill and sprouting, with sprouting becoming dominant under increasing shade. Post-fire NSC recovery of northern red oak and mockernut hickory increased with shade intensity and significantly exceeded that of unburned seedlings under 70% and 85% shade, respectively. In contrast, shortleaf pine NSC recovery declined steadily with shade and was significantly lower than unburned seedlings under 70% shade. Collectively, these results demonstrate that shade can modify fire tolerance and alter recruitment dynamics.

Wolfe, B.T., and J. Kankam

Using leaf spectroscopy to assess whole-plant hydraulic conductance in loblolly pine. (ORAL)

Trees must transport water from soil to leaves to sustain the transpiration stream. The hydraulic efficiency of this water transport can be described as whole-plant hydraulic conductance (kplant), which is the water flux rate through the plant per leaf area per pressure difference between the soil and leaf. In theory, trees with higher kplant can sustain higher growth rates, making kplant a potentially useful phenotypic trait for improving growth performance. However,

kplant is tedious to measure, requiring destructive sampling and specialized instruments. Leaf spectroscopy uses light reflectance from the leaf surface to infer physical and chemical traits. It has been used to assess a wide range of plant traits, but to our knowledge it has not been used to assess kplant. At a field site in Louisiana, we measured kplant in 105 loblolly pine saplings directly with a combination of leaf water potential and gas exchange measurements. Concurrently, we measured leaf reflectance on each sapling and used partial least squares regression to test whether reflectance spectra could accurately predict kplant. A fully spectra-based approach could not predict measured kplant well (predicted vs measured kplant R2 = 0.12). However, an approach using a combination of gas exchange and reflectance spectra predicted kplant with reasonable precision (R2 = 0.64). These results suggest that leaf spectroscopy may be a useful tool for assessing kplant. Further developing these methods may enable rapid assessment of whole-plant hydraulic traits and facilitate tree improvement programs.

*** Wolsiffer, S., T.A. Coates, W.M. Ford, and V.R. Emrick**

Wildland fuel loading estimates along a gradient of forest cover types and landscape factors for two National Parks, Rock Creek Park and Harper's Ferry National Park. (ORAL)

Wildland fuel loading estimates are utilized by natural resource managers today for a variety of reasons, including but not limited to the approximation of fire behavior and potential fire effects. While standing and dead trees, downed woody material, litter (Oi Horizon), and duff (Oe+Oa Horizons) may contribute to fuel loading, they also play a crucial role in overall ecosystem health. Downed woody material contributes to carbon storage and nutrient cycling, and provides an important source of habitat heterogeneity for multiple insect, reptile, amphibian, and small mammalian species. Within the National Park Service, many managers of parks with high visitation rates have been asked if forests within their parks are in decline, or are at risk of decline, due to the number of standing and dead trees and the amount of downed and dead material on the forest floor. They have also vocalized concern regarding potential wildfire hazard in these forests. To address this concern at Rock Creek Park (located near Washington D.C.) and Harper's Ferry National Park, standing and dead trees, downed woody material, litter, and duff were inventoried May-August 2024. At each inventory location, aspect, elevation, forest cover type, slope percent, slope position, and soil order were recorded. In this presentation, we will discuss how these factors influence the current status of standing and dead trees and fuels in these parks. Knowledge from these analyses may guide land managers at these parks, and other parks within the National Capital Region of the National Park Service, as they prioritize and allocate resources for long-term management.