Plantation Management Research Cooperative
*Warnell School of Forestry & Natural Resources*
UNIVERSITY OF GEORGIA

# Fact Sheet
# Plantation Management Research Cooperative (PMRC)
2025/2026

## Mission

Create value for its members by improving knowledge about forest plantations under different silvicultural management regimes, and by developing growth and yield systems and decision support tools that result in improved valuation of the plantation resource in a sustainable manner.

## About us

In collaboration with four faculty members, six staff, and more than ten graduate students from Warnell, the team is dedicated to improving southern pine plantation performance. The team manages over 140 field trial plots and has developed decision-making tools based on more than 50 years of research. With partnerships involving 32 companies and study sites across ten U.S. states, we focus on enhancing silviculture, management, and the valuation of plantation resources.

***@PMRC Team – 2024/2025***

## Approach

- Partnership between forest investors/management/service providers and the University of Georgia's Warnell School of Forestry and Natural Resources.
    - PMRC members contribute annual dues and guide PMRC direction via participation on an Advisory Committee. Research plots are located on members' lands.
    - Warnell provides excellent faculty and staff support to direct and coordinate PMRC activities.

- South's most comprehensive series of designed research field trials to quantify the impact of silvicultural management activities and inform growth and yield decision support systems.
    - Allows evaluation of forest management regimes with objectives ranging from biomass to sawtimber production. Field trials are located from Virginia to Texas to Florida.
    - Singularly strong field trial program in planting density, vegetation control treatments, thinning intensity, treatment combinations and silvicultural regimes for both loblolly and slash pine.
    - South-wide field trials on pine plantation performance of thinned stands with fertilization and competition control combinations.

- Field testing emphasis is on true region-wide analysis to ensure widest applicability of resulting management tools and decision support systems.

- The PMRC field crew performs 100% of the field-related work, relieving member companies of these responsibilities (and associated costs), while also promoting greater quality and uniformity in maintenance and measurements.

## Products

- Growth and yield systems for loblolly and slash pine plantations
    - Whole-stand models including prediction and projection equations for dominant height, mortality, and basal area. Most PMRC models also include stand table prediction and projection equations, along with yield prediction equations (volumetric and tonnage-based) including breakdown functions for estimating product class distributions.

- Stand response estimates for a comprehensive set of silvicultural treatments
    - Both height and basal area response models for common silvicultural treatments
    - Stocking control via planting density and thinning, mechanical and chemical site prep, tillage, herbaceous weed control, woody release, and fertilization, culture x genetic improvement

- Technology transfer integrating soils, silviculture, and growth and yield modeling
    - Reports, meetings, workshops, online decision support tools

- Loblolly, slash, and longleaf pine taper equations

- Comprehensive databases for loblolly and slash pine growing in the southeast US

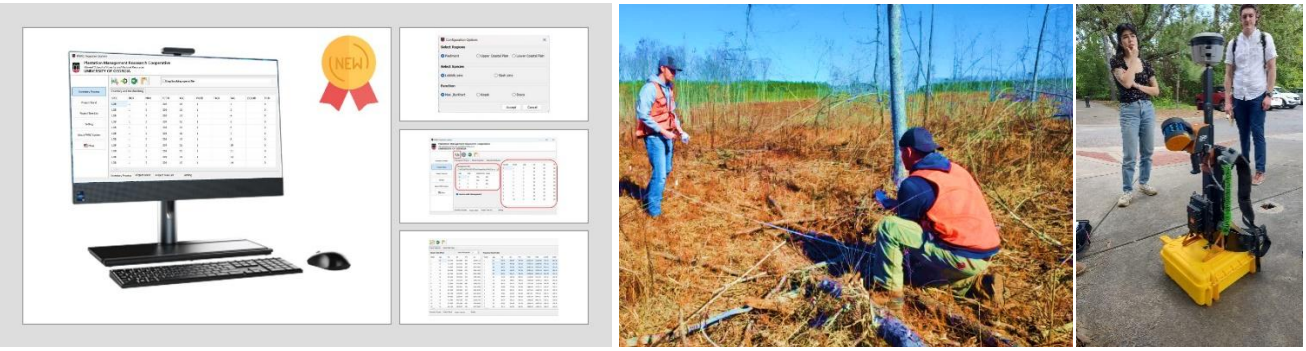


**Figure 2 -** Deployment of the new PMRC batch process G&Y model system | Maintain and implement experimental trials | Incorporate new tools

## Priorities

- Improve response models for mid-rotation treatments including thinning, release, and fertilization so they accurately reflect responses for a range of site and forest stand conditions.

- Enhance state of the art loblolly and slash pine growth and yield systems.

    - Use new data and approaches to improve base growth models, refine response models, and evaluate value of additional predictive variables (location, climate, soils, leaf area, etc.).

- Refine understanding of the effects of genetics, soils, physiology and silviculture on pine plantation growth and yield and value.

- Evaluate ways to incorporate new, remotely sensed data including easily accessible, satellite imagery and both aerial and terrestrial LiDAR measurements into future growth and yield systems.

- Develop growth and yield systems that accurately portray performance of advanced pine genotypes.

- Identify new approaches to enhance forest inventory quality and efficiency including the use of remotely sensed data.

- Improve predictions of biomass and carbon production and yields associated with southern pine plantations.

- Develop collaborative relationships with other institutions and researchers and grant funding to advance PMRC research objectives and increase the scope and efficiency of PMRC research.

## Flagship Research Trials

- **Mid-rotation Treatment Study (MRT)**

    - Objective: Develop thinning and mid-rotation treatment response models for first- and second-thinned loblolly and slash pine plantations across the southeast US.
    - Established: 2010 - 2018
    - Design: 48 loblolly pine installations (24 first- and 24 second-thin) across the Lower Coastal Plain and Piedmont/Upper Coastal Plain of the southeastern USA along with 12 first-thin, slash pine installations. Each installation contains five plots including a control plot, thin-only plot, thin and fertilize plot, thin and herbicide plot, and thin + fertilize + herbicide plot. Installations were thinned to one of three basal areas: 50, 70, or 90 sq ft. Installations receive full remeasurements every three years.

- **Coastal Plain and South Atlantic Gulf Slope Culture Density Studies (CPCD/SAGSCD)**

    - Objective: Evaluate the effects of intensive (multiple fertilizations, complete competition control) vs. high intensity operational management (fewer fertilizations, one year of banded weed control) on loblolly and slash pine plantations. The interaction of the intensity of the culture with planting density is also being studied.
    - Established: 1996 – 1997 (CPCD) and 1998 – 1999 (SAGSCD)
    - Design: There are 16 loblolly pine installations across the Lower Coastal Plain of Florida, Georgia, and South Carolina (CPCD), and 24 across the Piedmont/Upper Coastal Plain of Alabama, Georgia, and South Carolina (SAGSCD). Each installation has six intensive and six operational treatment plots, planted at one of six densities: 300, 600, 900, 1200, 1500, and 1800 trees per acre (TPA). A slash pine component is included at nine CPCD installations, with three intensive and three operational plots planted at 300, 900, and 1500 TPA. Installations are fully remeasured every three years, with diameter-only measurements in non-full measurement years.

- **Western Gulf Culture Density Study (WGCD)**

    - Objective: Evaluate the effects of intensive vs. operational management and to develop region specific silvicultural response models for loblolly pine plantations in the Western Gulf region of the southeast US. The interaction of the intensity of the culture, planting density, and thinning is also being studied.
    - Established: 2000 - 2003
    - Design: 18 loblolly pine installations established across Arkansas, Louisiana, Mississippi, and Texas. Each installation consists eight intensive and eight operational treatment plots planted at 200 (1 plot), 450 (2 plots), 700 (3 plots), 950 (1 plot), and 1200 (1 plot) trees per acre (TPA) for a total of 16 plots per installation. Additionally, one of the 450 TPA plots was thinned to 200 TPA, and two of the 700 TPA plots were thinned – one to 200 TPA and the other to 450 TPA. Installations receive full remeasurements every other year.

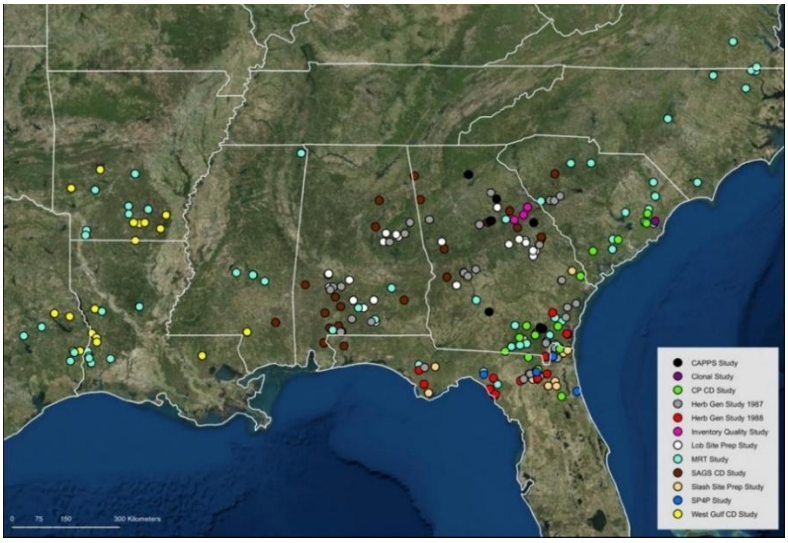


**Figure 4** - Geographic distribution of PMRC research trials. Data collected from all appropriate studies is used in PMRC modeling efforts.

## Future Research Trials and Areas of Interest (in addition to current projects)

- The PMRC is currently installing two new region-wide research trails.

**Silviculture x Genetics Research Trial**

- Enhancing forest productivity by optimizing management regimes for genetically improved southern pines: Two large research sites were installed in 2023/2024 and 2024/2025, with another planned for 2025/2026. The initial target is a total of 20 installations.
    - Quantify growth gains from genetically improved materials and intensive silviculture

**Operational Growth + Yield Validation Plot**

- A permanent sampling plot design to improve and validate current G&Y models
    - Operational validation plots are located throughout the southeastern U.S. on industry land. A total of 39 plots have already been established, with a target of 399.

- The PMRC is also becoming heavily involved in research related to the use of remotely sensed data including satellite imagery and both terrestrial and aerial based LiDAR data. These data are used to

estimate important stand characteristics such as leaf-area index and standing volume and are also being used to develop taper and other biomass equations.

## Active Research Trials (2025)

1. Coastal Plain Culture Density Study (CPCD)
2. Consortium for Accelerated Pine Production Studies (CAPPS2)
3. Guyton Enhanced Genetics Trial
4. Mid-rotation Treatment Study (MRT)
5. PineMap – Tier III site
6. South Atlantic Gulf Slope Culture Density Study (SAGSCD)
7. Silviculture and Herbicide Cooperative SP4P Study
8. Western Gulf Culture Density Study (WGCD)
9. Silviculture x Genetics Research Trial (SxG) – currently installing
10. Operational Growth + Yield Validation Plots (OVP) – currently installing

## Agenda 2025

*Jan. 9-10 th, 2025*

### Contact Winter Meeting

The meeting provides an opportunity for PMRC members to connect, ask questions, share experiences, and participate in a field tour.

*April 8-9th, 2025*

### Strategic Planning Meeting

The team engaged in brainstorming to identify priority goals, objectives, and approaches, fostering an open discussion of ideas that culminated in a group summary of key priorities.

*Save the date!*

PMRC 50 years
*A half-century Celebration of Research!*
1975-2025

July 16, 17, 18th, 2025
Athens, GA

### Annual Advisory Meeting

The annual meeting serves as a gathering to present key research findings on forest plantations across the Southeastern U.S., fostering knowledge exchange and discussion among stakeholders.

## Recent Publications (2021 – 2025) *


Zhao, D., B. Bullock, M. Wang, E. Dickens. 2024. Whole-tree green density equations for loblolly and slash pine Trees. Forest Science, 4, 271-282.

Zhao, D., E.D. Dickens, D. Clabo, D. Markewitz, B.P. Bullock, D.C. Pederson. 2024. Soil-based assessment of site productivity for southern pine plantations in the coastal plain of the southern US: (I) loblolly pine. Forest Ecology and Management 565, 122054.

Dickens, E.D., D. Zhao, D. Clabo, D. Markewitz, B.P. Bullock, D.C. Pederson. 2024. Soil-based assessment of site productivity for southern pine plantations in the coastal plain of the southern US: (II) slash pine. Forest Ecology and Management 566, 122093.

Young, J. B., Bullock, B. P., & Montes, C. R. (2024). Assessing Mid-rotation Loblolly Pine and Competing Vegetation Responses to Post-thin Fertilization and Herbicide Application in the Southeastern United States. Journal of Forestry, 122(1), 54-69.

Zhao, D., B.P. Bullock, M. Wang. 2023. Long-term dynamics of aboveground carbon stocks in managed loblolly pine plantations in the southeast United States. Forest Ecology and Management 546, 121384.

Ramirez, L., C.R. Montes and B.P. Bullock. 2023. Modeling slash pine mortality rates incorporating responses to silvicultural treatments and fusiform rust infection rates. *Forest Ecology and Management* 532: 9 p.

Zhao, D., Bullock, B. P., & Wang, M. (2023). Long-term dynamics of aboveground carbon stocks in managed loblolly pine plantations in the southeast United States. Forest Ecology and Management, 546, 121384.

Shalizi, M. N., Walker, T. D., Heine, A. J., Payn, K. G., Isik, F., Bullock, B. P., & McKeand, S. E. (2023). Performance Based on Measurements from Individual-Tree Progeny Tests Strongly Predicts Early Stand Yield in Loblolly Pine. FOREST SCIENCE, 12 pages.

Peay, W., Bullock, B., & Montes, C. (2023). A maximum entropy approach to defining geographic bounds on growth and yield model usage. Frontiers in Forests and Global Change, 15 pages.

Restrepo, H.I., C.R. Montes, B.P. Bullock and B. Mei. 2022. The effect of climate variability factors on potential net primary productivity uncertainty: An analysis with a stochastic spatial 3-PG model. *Agricultural and Forest Meteorology.* 315: 16 p.

Zhao, Dehai, B.P. Bullock, C.R. Montes and M. Wang. 2022. Production, tree size inequality and growth dominance in loblolly pine plantations under different silvicultural management regimes. *Forest Ecology and Management.* 526: 13 p.

Ramirez, Laura, C.R. Montes, and B.P. Bullock. 2022. Long-term effect of bedding and vegetation control on dominant height of slash pine plantations in the southeastern United States. *Forest Ecology and Management.* 522: 11 p.

Wang, Mingliang, C.R. Montes, B.P. Bullock and D. Zhao. 2022. An inverse growth curve representation of the Clutter-Jones stand survival model. *Forest Science.* 68: 239 – 245.

Zhao, D., C.R. Montes, B.P. Bullock, M. Wang, W.D. Greene and B. Borders. 2022. Effects of intensive fertilization, complete competition control and site quality on aboveground net primary production (ANPP) dynamics of loblolly pine plantations. *Forest Ecology and Management.* 506: 10 p.

Kinane, S.M., C.R. Montes, T.J. Albaugh and D.R. Mishra. 2021. A model to estimate leaf area index in loblolly pine plantations using Landsat 5 and 7 images. *Remote Sensing*. 13-1140: 16 p.

Kinane, S.M., C.R. Montes, and B.P. Bullock. 2021. A non-parametric framework to estimate fertilization response in loblolly pine plantations using environmental covariates. *Forestry*. 10 p.


*These represent only a small sample of the most recent publications from PMRC-sponsored work. Much more is available online on the PMRC members-only website.

## Membership

- Entities that own or control forest land, provide forestry management and consulting services, utilize forest products, have pine plantation allied businesses, or interest in the U.S. South plantation resource should consider membership.

- 2025 membership consists of 16 full members, four supporting members, six allied members and six contributing members.

- Membership – The PMRC has a total of 32 forest industry members!
    - *Full Members*: American Forest Management, Campbell Global, Domain Timber Advisors, Forest Investment Associates, Four Rivers Land & Timber, Green Diamond Management Company, Manulife Investment Management, Molpus Woodlands Group, PotlatchDeltic Forest Holdings, Rayonier, Resource Management Service, Timberland Investment Resources, TTG Forestry Services, TVF Services, The Westervelt Company, and Weyerhaeuser
    - *Supporting Members*: American Forest Foundation, F&W Forestry Services, Nuveen Natural Capital, and Roseburg Forest Products
    - *Allied Members*: ArborGen, Funga, GAIA AI, International Forest Company, NCASI, NCX
    - *Contributing Members:* AgVictus Capital Management, Beasley Timber Management, ForesTech International, International Woodland Company, The Rohatyn Group, and Varn Wood Products

- 2025 full membership dues of $29,000/year leverages about $45 for every $1 dedicated to core PMRC efforts. Dues are reduced for organizations based on the scale of operations and type of operations.

- Membership represents over 23.5 million acres of plantations in the U.S. South.

## Contacts

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PMRC
PLANTATION MANAGEMENT RESEARCH COOPERATIVE

## Website

https://pmrc.uga.edu
(There is also a members-only website available with more detailed information)