NSF IUCRC Center for Advanced Forestry Systems

2025 Phase III Final Year Report

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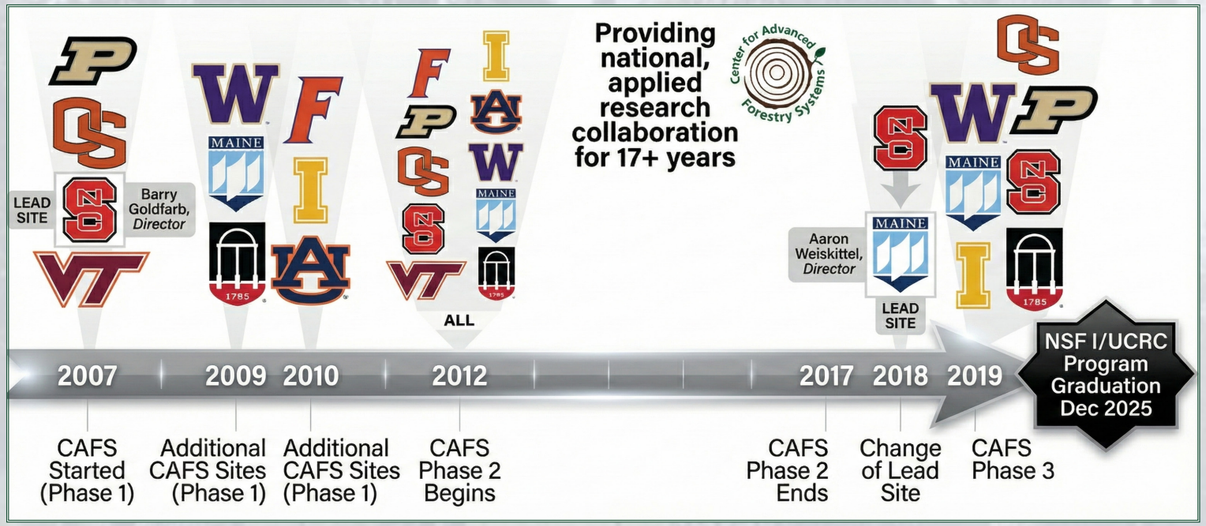
Vision

To actively support the US forest industry by solving problems with targeted, applied, and collaborative research coordinated across multiple universities.

Mission

Optimize genetic and cultural systems to produce high-quality raw forest materials for new and existing products by conducting collaborative research that transcends traditional species and disciplinary boundaries.

Please visit the CAFS webpage for access to annual reports, meeting web pages, and the latest updates.
crsf.umaine.edu/forest-research/cafs



CAFS Site Participation Over the Years

EXECUTIVE SUMMARY

The **Center for Advanced Forestry Systems (CAFS)** completed its fifteenth year of operation and successfully graduated from the National Science Foundation Industry-University Cooperative Research Center (IUCRC) program in December 2025. As strong engagement continued among industry members and university partners, the past year proved a pivotal time for the organization to transition from NSF funding to a self-sustaining model (i.e., Phase IV) while maintaining its mission to optimize genetic and cultural systems for producing high-quality forest outcomes through collaborative, multi-disciplinary research.

Key Highlights

- 27 active research projects addressing national and regional forestry challenges
- 70% of projects are multi-site collaborations spanning eight university partners
- $15 million+ in cumulative NSF funding received since CAFS inception in 2010
- Successful Phase III completion with robust engagement from industry and academic partners
- Transition to Phase IV with seed funding of $100,000 from committed university and IAB members

Core Objectives

CAFS operates as a national research organization with six primary objectives:

1. Serve as a national organization for research and development relevant to the forest industry.
2. Coordinate and perform national research activities across multiple sites aligned with forest industry needs.
3. Document and communicate key research outcomes to commited university and IAB partners.
4. Provide long-term strategic vision for forest industry research needs.
5. Convene leading scientists from academia and industry prepared to address emerging forestry challenges.
6. Create national networking opportunities connecting universities and the forest industry.

CAFS Industry Advisory Board (IAB) meetings, both in-person and virtually, have been an integral part of the program since its inception. Site directors, industry representatives, and researchers who attend the in-person IAB and field tours have the opportunity to develop strong connections, augment research possibilities, and visit seminal work at new and existing field sites.

IAB field tour attendees at Waikokoa Dry Forest Preserve , June 2025, on the big island of Hawaii.

DIRECTOR'S LETTER

Dear CAFS Members, Partners, and Collaborators,

It is my pleasure to present the 2025 Annual Report of the Center for Advanced Forestry Systems (CAFS). This year marks a pivotal transition as CAFS moves from its foundation under the National Science Foundation (NSF) Industry-University Cooperative Research Center program to a sustainable, member-driven research consortium. This milestone underscores the continued strength of our partnerships and our shared commitment to advancing forest science and innovation.

Over the past 15 years, CAFS has leveraged more than $15 million in NSF investment to deliver research outcomes now embedded in forest management systems across the country. Our network of seven universities, more than 150 alumni, and numerous industry partners continues to translate science into actionable solutions. In 2025, CAFS supported 27 active research projects—70% involving multi-site collaboration—along with new initiatives in climate-adaptive silviculture and small-area estimation. Our member meetings, held in-person in Hawaii and virtually in December, demonstrated the strength and viability of a member-driven model.

CAFS will now enter into a new era, one defined by independence, collaboration, and strategic focus. With declining federal research budgets, including significant reductions projected for the USDA Forest Service, the role of CAFS as a cohesive, cross-regional research network has never been more essential. As we transition to Phase IV, CAFS is evolving toward a project-based funding structure that links resources directly to demonstrable outcomes. Universities have already pledged over $100,000 in new seed funding, and 95% of surveyed members support continued participation. Our 2026 priorities include:

- Implementing a tiered membership structure that aligns with partner engagement;
- Pursuing complementary federal, state, and private funding opportunities;
- Expanding direct industry partnerships and cultivating an endowment for long-term stability; and
- Enhancing collaboration with organizations such as PSAE, NCASI, and regional forest cooperatives.

CAFS' success depends on sustained commitment from its members and partners. Together, we possess the expertise, infrastructure, and collaborative spirit necessary to ensure forestry research remains strong in the face of evolving global challenges. I encourage all partners to reaffirm their engagement, identify shared research priorities, and help expand the reach and influence of CAFS across the forestry sector.

With gratitude for your continued support, I look forward to shaping this next chapter of CAFS' growth and impact together.

Sincerely,

Aaron Weiskittel

Dr. Aaron Weiskittel

Director, Center for Advanced Forestry Systems
Director, University of Maine Center for Research on Sustainable Forests

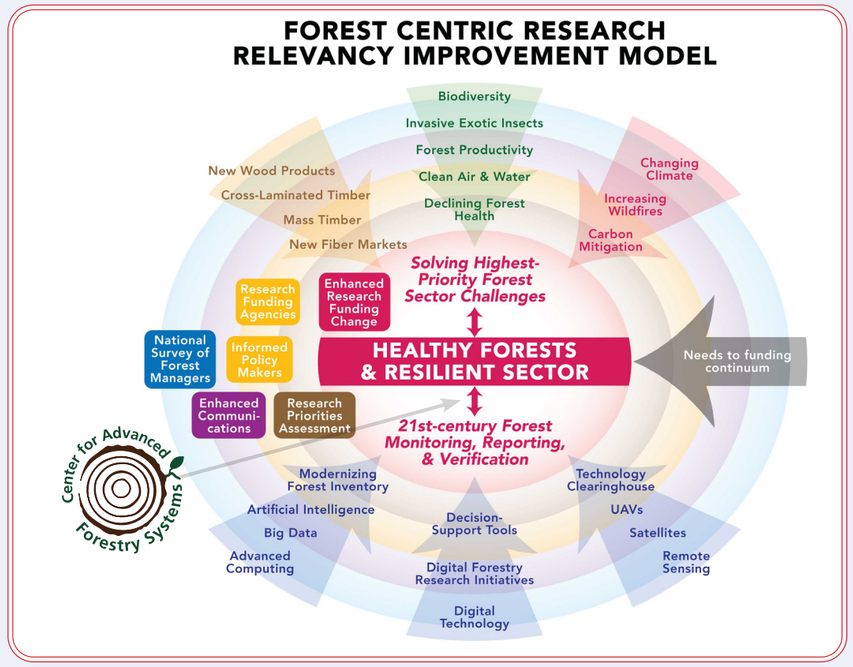


Figure 1. *CAFS structure unifying regional cooperatives and leveraging resources.*

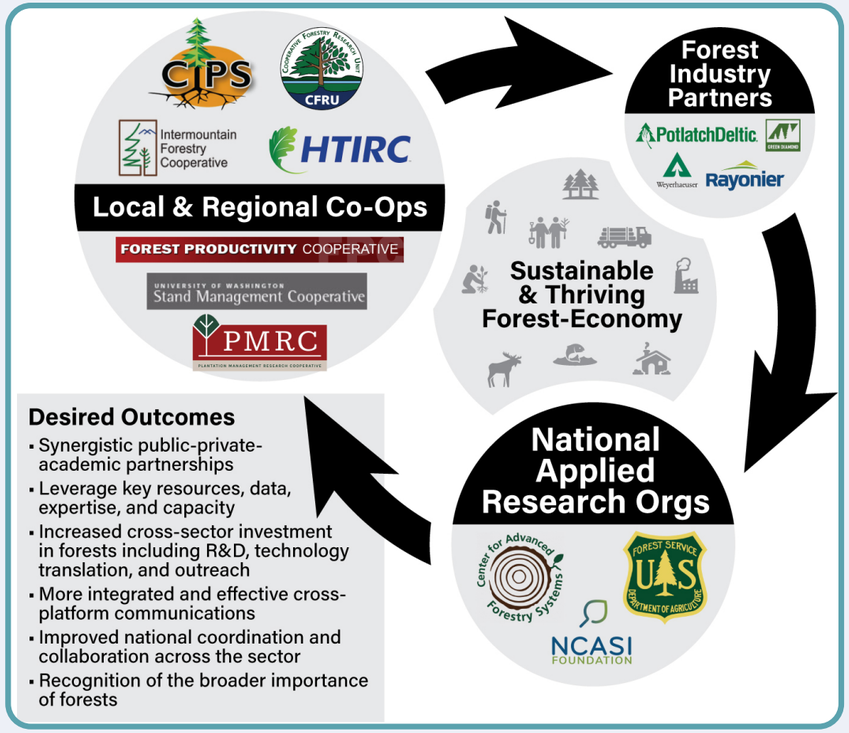


Figure 2. *Future vision and relevance for a national R&D consortium that builds on CAFS' past history and current momentum.*

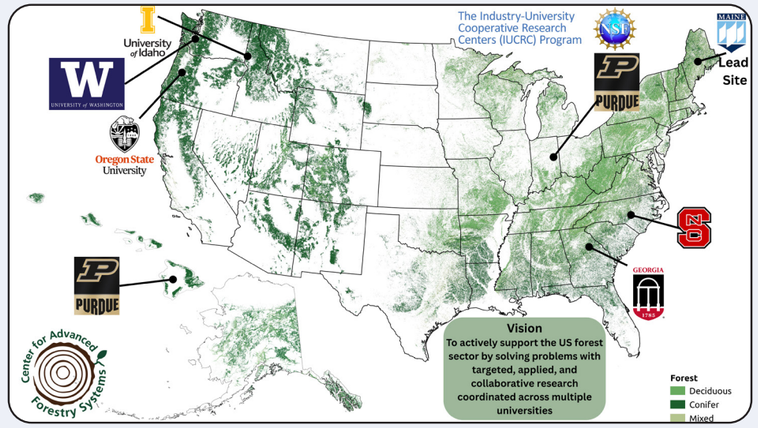
LEADERSHIP STRUCTURE

CAFS Phase III-IV Director

Dr. Aaron Weiskittel, University of Maine

Lead Site

University of Maine, Center for Research on Sustainable Forests (CRSF)



Phase III Member Universities & Site Directors

North Carolina State University,
Dr. Rachel Cook

Oregon State University,
Dr. Carlos Gonzalez & Dr. Temesgen Hailemariam

Purdue University,
Dr. Douglass Jacobs

University of Georgia,
Dr. Bronson Bullock & Dr. Joseph Dahlen

University of Idaho,
Dr. Mark Kimsey & Dr. Andrew Nelson

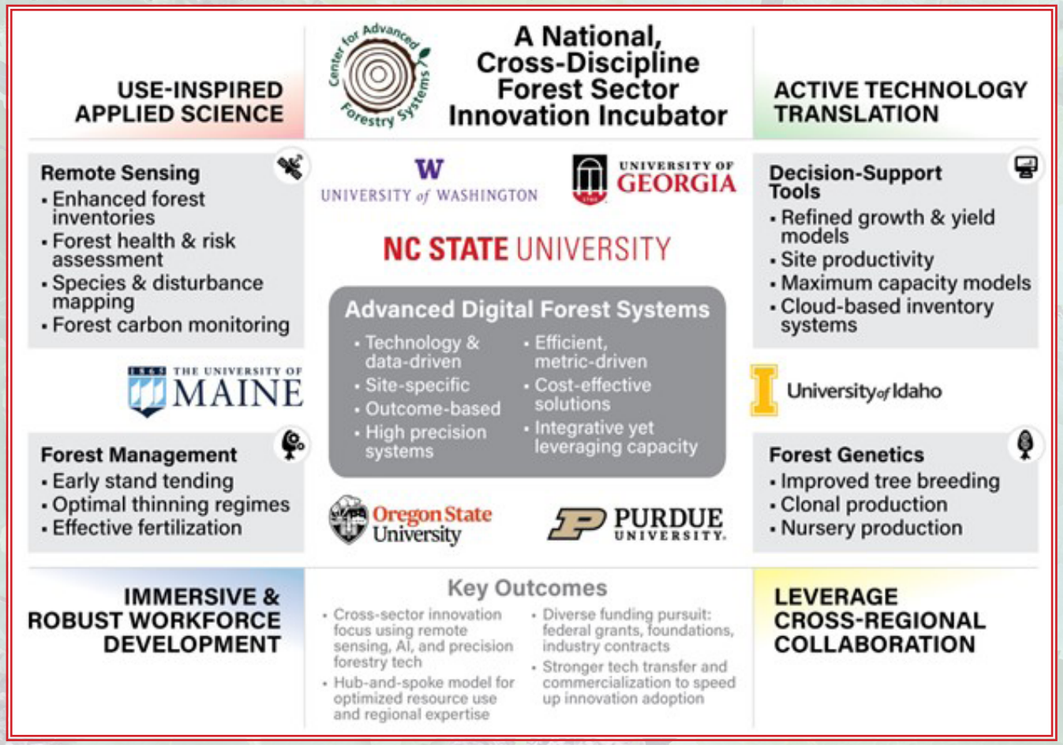
University of Maine,
Dr. Aaron Weiskittel

University of Washington,
Dr. Eric Turnblom

Table 1. Primary Expertise by CAFS Phase III Sites

Site	Forest Type	Genetics	Biotech	Soils	Eco-Physiology	Growth & Yield	Wood Quality	Remote Sensing
NC State University	Southern Pine; Eucalyptus	✓	✓	✓	✓	✓		✓
Oregon State University	Douglas-fir; Eucalyptus	✓	✓		✓	✓	✓	
Purdue University	Upland Hardwoods	✓	✓	✓	✓	✓		✓
University of Georgia	Southern Pine				✓	✓	✓	
University of Maine	Mixed Forest			✓	✓	✓	✓	✓
University of Washington	Douglas-Fir			✓		✓	✓	✓
University of Idaho	Mixed Conifer	✓	✓	✓	✓			✓

Figure 3. *Synergistic linkage of institutional capacity and expertise across the individual CAFS Sites.*



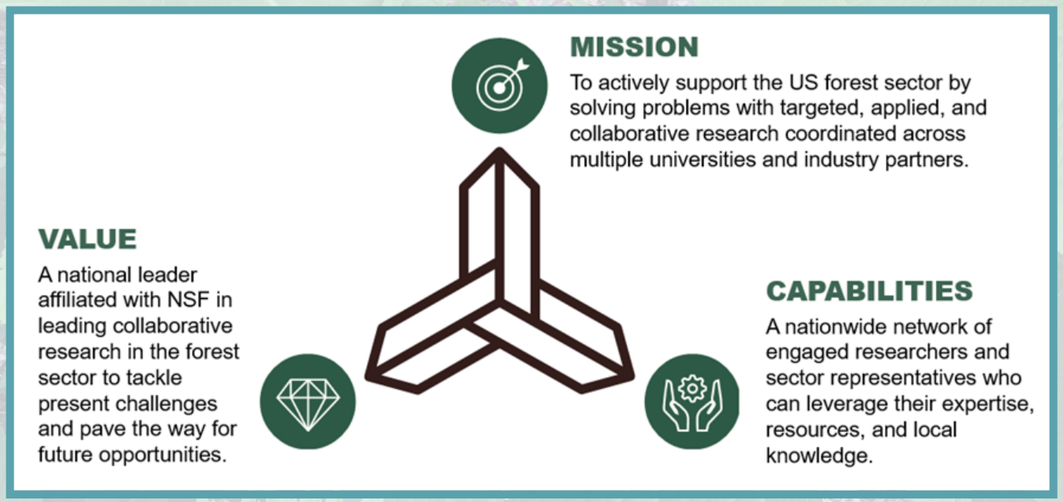


Figure 4. *CAFS unique value proposition that links its vision, mission, and unique capabilities.*

Phase III Research Outcomes and Impacts

CAFS Research has Generated Substantial Scientific and Practical Outputs

Decision Support Tools and Maps

» SPOT (Site Productivity Optimization for Trees) v3.1 soil mapping system for southeastern forests
» Statewide species and forest type maps at 10-meter resolution for Maine with plans for Idaho and Oregon
» Web-based fertilization suitability maps for Douglas-fir management
» Interactive mapping platforms (CAFS IMP) for data visualization and member access
» SDImax models for regional forest carrying capacity assessment

Scientific Publications

» Over 15 peer-reviewed papers published from Phase III research
» Multiple manuscripts in preparation from ongoing studies
» Research presented at major conferences (Ecological Society of America, SOMENS/NEMO, GIS conferences)

Table 2. Summary of Key Accomplishments and Outcomes, CAFS Phase III

Metric	Phase III
University Sites	
Number of Active Sites	7
Research Activity	
Number of Center Projects	32
Multi-Site Projects	23
Publications	
Number of Presentations Made	345
Faculty & Student Publications Based on Center Research	154
Publications Co-authored with Industry Members	24
Total by Phase:	523
IUCRC Graduate Degrees Awarded	
Bachelors	25
Masters	41
Doctorates	20
Total by Phase:	86
IUCRC Alumni Career Outcomes	
IUCRC Graduates Hired by I/URC Members (nonspecific)	37
IUCRC Graduates Hired by Government Members	3
IUCRC Graduates Hired by Non-Member Industry Firms	2
IUCRC Graduates Taking Faculty Positions	8
IUCRC Graduates Continuing Education/Advanced Degree	10

Industry Implementation

» Technology transfer from CAFS scientists to member personnel enhances understanding and implementation of new technologies
» Industrial members benefit from broader knowledge of technological capabilities
» Research outcomes translated into practical management guidelines

Cumulative Impact

✦ Since its inception in 2010, CAFS has:
✦ Received over $15 million in direct NSF funding
✦ Supported research across eight major universities
✦ Trained approximately 25 PhDs, 74 Masters students, and 57+ undergraduates (SMC alone)
✦ Developed collaborative networks spanning North America and internationally
✦ Established multi-site research databases enabling continental-scale investigations
✦ Advanced digital transformation of the forestry sector through remote sensing, AI, and decision-support tools

2025 Research Portfolio

CAFS is centered around forest science academic institutions across the US and the unique expertise that each bring to the collective effort. CAFS research leverages these collaborative synergies and remains need- and member-driven as guided by its Industrial Advisory Board (IAB), who are instrumental in identifying key research priorities. CAFS maintains a robust portfolio of 27 IAB-approved projects addressing critical forestry challenges across multiple regions and forest types.

FOREST PRODUCTIVITY AND SILVICULTURE

- Stand and tree responses to late-rotation fertilization (UW): Estimating regional nitrogen fertilization response across Pacific Northwest regions
- Regional variation in site productivity (NCSU/UGA/UM): Developing consistent metrics of potential site productivity across diverse regions
- Regional variation in site carrying capacity (UI/UM/NCSU): Standardized maximum carrying capacity modeling for multiple commercial species
- Variation in productivity, wood quality, and soil carbon (OSU): Evaluating nine conifer species across climate gradients in the Pacific Northwest
- Physiologic response to commercial fertilization programs (UW): Long-term Douglas-fir response to nitrogen fertilization under varying climate conditions
- Stand response to thinning (UW/UM/UGA): Enhancing response prediction through improved modeling of yield impacts

FOREST HEALTH AND RESILIENCE

- Site-stand dynamics and pine beetle mortality (UI): Developing models sensitive to western pine beetle outbreak stressors in ponderosa pine ecosystems
- Resilience of soil organic matter to harvesting (OSU): Understanding soil carbon dynamics following extreme disturbances
- Enhancing resistance to fungal pathogens (UI): Using endophytic treatments to improve seedling survival against devastating pathogens
- Drought conditioning of commercial tree seedlings (UI/Purdue/OSU/NMU): Testing drought preconditioning protocols to reduce reforestation costs

FOREST GENETICS AND TREE IMPROVEMENT

- Crown morphological traits in Douglas-fir and loblolly pine (OSU/NCSU/VT): Using laser scanning to identify heritable traits associated with enhanced tree growth
- Silvicultural treatment effects on Douglas-fir stem form (OSU/UW/UI): Developing taper equations accounting for treatment-induced stem form changes
- Genetic variation in wood properties of loblolly pine (UGA): Analyzing wood quality characteristics across different genetic families

CARBON AND ECOSYSTEM SERVICES

- Quantifying carbon sequestration in loblolly pine (UGA): Understanding carbon content as a function of silvicultural treatment
- Density management strategies for carbon sequestration (UM/UW/NCSU/UI/UGA): Synthesizing silvicultural treatment effects on terrestrial carbon sequestration
- Throughfall reduction impacts on loblolly pine (UGA): Evaluating climate change impacts on productivity under reduced moisture conditions

REMOTE SENSING AND DIGITAL FORESTRY

- Multi-regional machine learning for tree species mapping (UM): Developing algorithms to map tree species distribution and abundance at 10-meter resolution
- Leaf area index estimates for mid-rotation treatments (NCSU/UI/UM/UGA): Predicting plantation canopy leaf-area index using satellite data
- Using hyperspectral imaging to evaluate forest health (Purdue/UM/UGA): Rapid assessment of tree biochemical and physiological status
- CAFS Interactive Mapping Platform (CAFS IMP) (NCSU): User-friendly geospatial platform for data visualization and collaboration

FOREST INVENTORY AND GROWTH MODELING

- Robust small-area estimation strategies (UI): Developing machine learning frameworks for accurate stand-level diameter distributions
- Small area estimation with 3D-NAIP and Sentinel data (OSU): Multivariate prediction of key forest attributes
- Sampling design and small area estimation (OSU/UM/NCSU/VT): Optimizing stand-level forest inventory estimation
- Integrating SAE with forest inventory and growth projection (UGA/VT): Improving stand-level inventory systems for southern pine plantations
- Quantifying silvicultural treatment effects on lumber quality (UGA): Assessing lumber quantity and quality impacts from thinning regimes

WORKFORCE DEVELOPMENT

- University of Maine START Program (UM): Supporting students at UM and University of Maine at Fort Kent in forest research
- NSF supplemental funding initiatives (UM, NCSU, UI): INTERN and START programs developing future forestry professionals

June 2025 In-Person IAB Meeting

The CAFS In-Person IAB Meeting held June 10-12, 2025, marked a critical juncture for the organization as it transitions to Phase IV. The meeting convened approximately 50 industry members and researchers across three days of scientific presentations, field tours, and strategic discussions.

KEY THEME: SUSTAINABILITY AND TRANSFORMATION

Director Aaron Weiskittel opened the meeting framing CAFS at a critical moment. With the end of 15 years of continuous NSF funding and a projected collapse in federal forestry R&D (Forest Service R&D budget potentially reaching zero in fiscal year 2026), CAFS must define a new, sustainable path forward while maintaining its position as a premier forestry research collaborative.

UNIVERSITY SITE UPDATES

CAFS lead site Director Aaron Weiskittel also serves as director to UMaine's Center for Research on Sustainable Forests (CRSF), home to its Cooperative Forestry Research Unit (CFRU). Now in its 49th year, CFRU operates on an industry member-driven model with diverse research covering silviculture, productivity, remote sensing, forest health, and carbon. It is currently managing its largest and most diverse research portfolio since 2008, including long-term monitoring of a major spruce budworm outbreak, a 20-year commercial thinning research network, and the Maine Adaptive Silviculture Network (MASN) across 12 sites. Director Weiskittel is co-leading a $160 million NSF Regional Innovation Engine proposal on digital forestry and the integration of a forest-based economy driven by science and technology, with award status expected in early 2026. CRSF is also home to a variety of multi-institutional research projects, including the USDA PERSEUS project, and the Intelligent GeoSolutions Initiative and Mane Forest Management Lab.

The Forest Productivity Cooperative (FPC), with a 55-year history and international partnerships, conducts site-specific resource management research on loblolly pine and eucalyptus. Recent advances include high-resolution drone LiDAR capabilities and development of the SPOT (Site Productivity Optimization for Trees) soil mapping system. Over the years, CAFS and the FPC have provided support and forest research opportunities for more than a dozen graduate students. Looking forward, strategic priorities at NCSU include nutrition and site-specific resource supply, vegetation control v. fertilization trials, and remote sensing focused on competing vegetation and stand inventories.

Research at the University of Georgia focuses on growth modeling and wood quality analysis, responding to market shifts from pulpwood to sawtimber production. The university is undergoing major faculty hiring to achieve American Association of Universities (AAU) status, strengthening forestry research capabilities in forest biomaterials and precision forestry.

The University of Idaho's Inland Northwest program addresses complex interactions among water, nutrients, geology, and aspect. UI has managed 14 CAFS projects involving nearly 20 graduate students and 30 external collaborators. Major projects include white pine genomics, blister rust resistance, larch and cedar nutrient dynamics, and forest carrying capacity mapping across the U.S. It is home to the newly established Forest Innovations Institute to advance contemporary and emerging technologies and information systems. CAFS synergies and collaborations provided a strong launching pad for the Institute.

The Hardwood Tree Improvement and Regeneration Center (HTRC) at Purdue is a collaborative partnership with USFS and focused on the advancement hardwood research, development, and technology transfer in the Central Hardwood Forest Region. The Institute for Digital Forestry focuses on automated measurement and precision management.

Established in 2007, the Center for Intensive Planted-forest Silviculture (CIPS) at Oregon State University produces decision support tools for Douglas-fir and western hemlock across 7.3 million acres of intensively managed timberlands. Collaborative research with multiple cooperatives includes long-term soil moisture, stand biomass, and nutrient monitoring; genetic environment and early silviculture interactions; and the development of decision support systems for stand management.

The Stand Management Cooperative (SMC) at the University of Washington were established to help the forest industry achieve more efficient utilization of productivity of forest land. Their goals include designing and establishing field research installations to inform growth models and decision-support tools for the Pacific Northwest. The UW SMC has trained 25 PhDs, 74 MS students, and 57 undergraduates in forestry research.

June 2025 IAB Meeting
Industry Engagement,Future Directions, & Strategic Priorities

Phase IV Vision

As CAFS enters Phase IV, the organization faces both opportunities and challenges in sustaining its mission without NSF funding. The emerging consensus supports Option B/C approaches: establishing sustainable funding through tiered membership contributions while positioning CAFS as an umbrella organization capable of launching large-scale initiatives aligned with critical industry and ecosystem challenges.

Strategic Research Priorities

Based on the Phase IV priority survey and IAB discussions, future CAFS research will focus on the following areas.

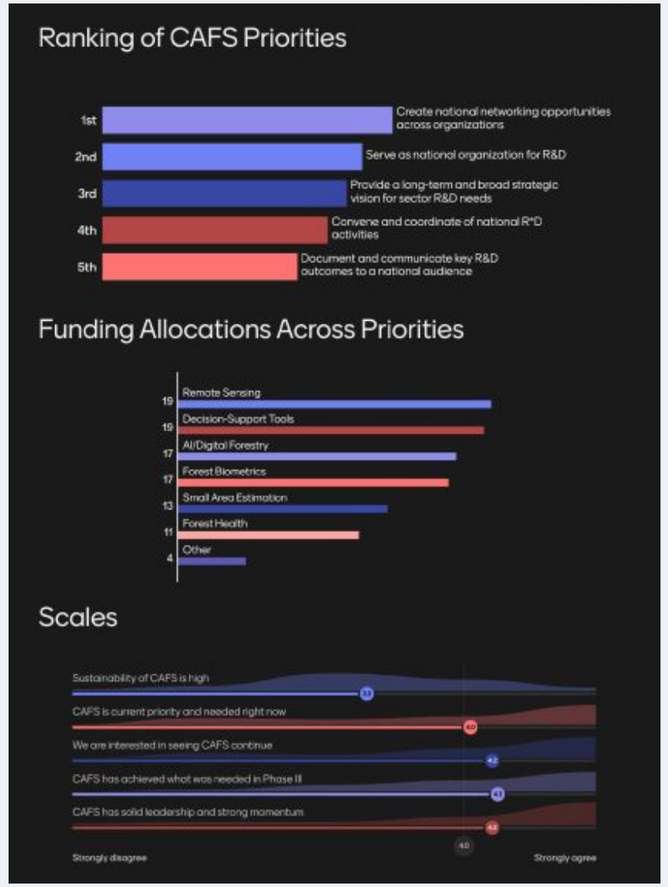
1. Digital Forestry and Advanced Technology Integration
   - Continued development of AI and machine learning applications for forest monitoring and management
   - Remote sensing technologies for precision forestry and inventory
   - Decision-support systems incorporating climate data and scenario analysis
   - UAV and LiDAR applications for operational forestry
2. Climate-Adaptive Forest Management
   - Species selection and assisted migration under changing climate
   - Density management for climate resilience
   - Drought conditioning and seedling performance
   - Forest health under novel stress combinations
3. Forest Carbon and Ecosystem Services
   - Carbon sequestration quantification and accounting
   - Forest management scenarios for climate mitigation
   - Ecosystem service valuation and trade-off analysis
   - Integration of carbon and timber production objectives
4. Forestry in Emerging Regions
   - Hardwood genetics and silviculture
   - Hawaiian forestry development
   - Tropical and subtropical forest research
   - Restoration and conservation-oriented forestry

5. Forest Industry Adaptation
   - Wood quality and value-over-volume strategies
   - New product markets and emerging technologies
   - Supply chain optimization
   - Digital communication of research outcomes

Funding Strategy

CAFS will pursue multiple funding mechanisms for Phase IV sustainability:

1. Tiered membership model with universities, industry partners, and affiliates contributing annual fees
2. Federal grant programs (NSF, USDA, EPA) supporting specific research initiatives
3. Industry partnerships for direct project funding
4. Endowment development for long-term institutional support
5. Synergistic partnerships with complementary research organizations (PSAE, NCASI, regional cooperatives)



June 2025 Field Tour
Tropical Hardwood Tree Improvement & Regeneration Center

FIELD TOUR: HAWAII FORESTRY RESEARCH

Beginning in ~1200 AD and accelerating with Western contact, native ecosystems in Hawai'i were replaced by agriculture, ranching, and urbanization. These influences resulted in more than half of the native ecosystems converting to non-native vegetation. Large-scale restoration began in 1970s and 1980s, with efforts to restore upland grasses to native *Acacia koa*. The Tropical Hardwood Tree Improvement and Regeneration Center (HTIRC) was formed in 2010 to advance the science and application of tree improvement, management, and protection to improve tropical hardwood forests, with emphasis on the Hawaiian Islands. Research aims are to increase *koa* productivity through improvement and resistance to abiotic and biotic stressors while developing propagation technologies and hardwood forest regeneration.

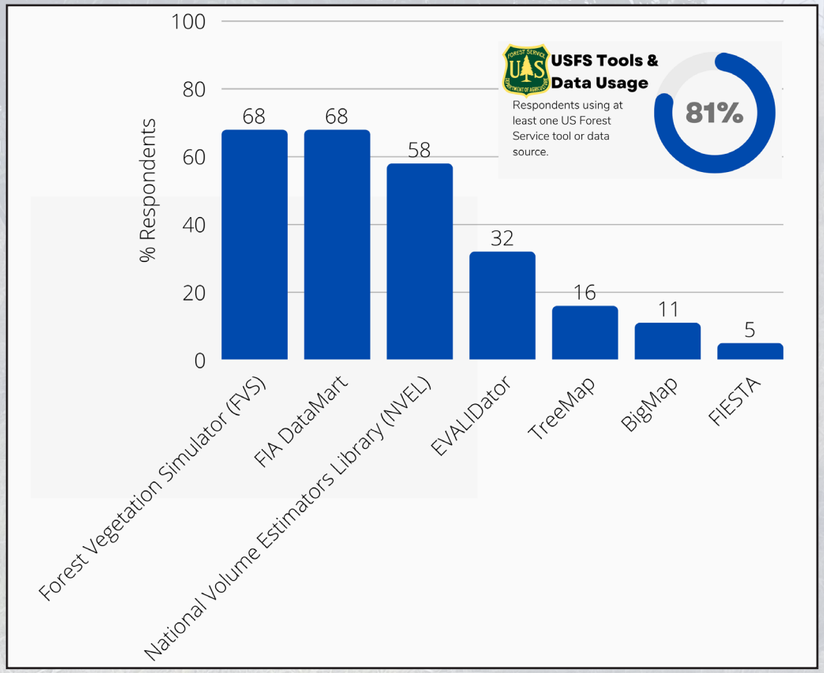
Meeting attendees visited the Siglo Forest at Kapoaula (a 565-acre *koa* reforestation project) and the Waikoloa Dry Forest Preserve, where ancient wiliwili trees (*Erythrina sandwicensis*) persist in some of the roughest and driest (average annual rainfall of 12 inches) ecosystems in Hawai'i. Field tour participants observed mixed native species plantings, soil preparation research, and disease-resistant seed orchards. The tour highlighted that Hawaiian forestry is far behind mainland standards, lacking reliable growth models, site indexes, and disease knowledge—presenting a frontier for CAFS collaborative research.

December 2025 IAB Meeting
Virtual Meeting and Phase IV Transition

The December IAB meeting had two clear objectives. ***First,*** comprehensive project updates of ongoing research on forest inventory methods, remote sensing technologies, and genetic studies, with several presentations showcasing progress in data collection, modeling, and analysis (see following section for detailed project progress reports). ***Second,*** the December 2025 virtual IAB meeting marked the official beginning of CAFS Phase IV, and included the presentation of new research proposals along with strategic planning for the organization's future.

PHASE IV TRANSITION OVERVIEW

After acknowledging CAFS' successful completion of Phase III under NSF-requirements, Director Weiskittel turned the discussion to the framework for Phase IV operations. With NSF funding concluded, three university partners (Purdue, Idaho, and Maine) and four IAB members have committed $130,000 in seed funding for new collaborative projects. This represents a shift to a project-based national consortium model, positioning CAFS to support high-visibility collaborative research through member contributions.



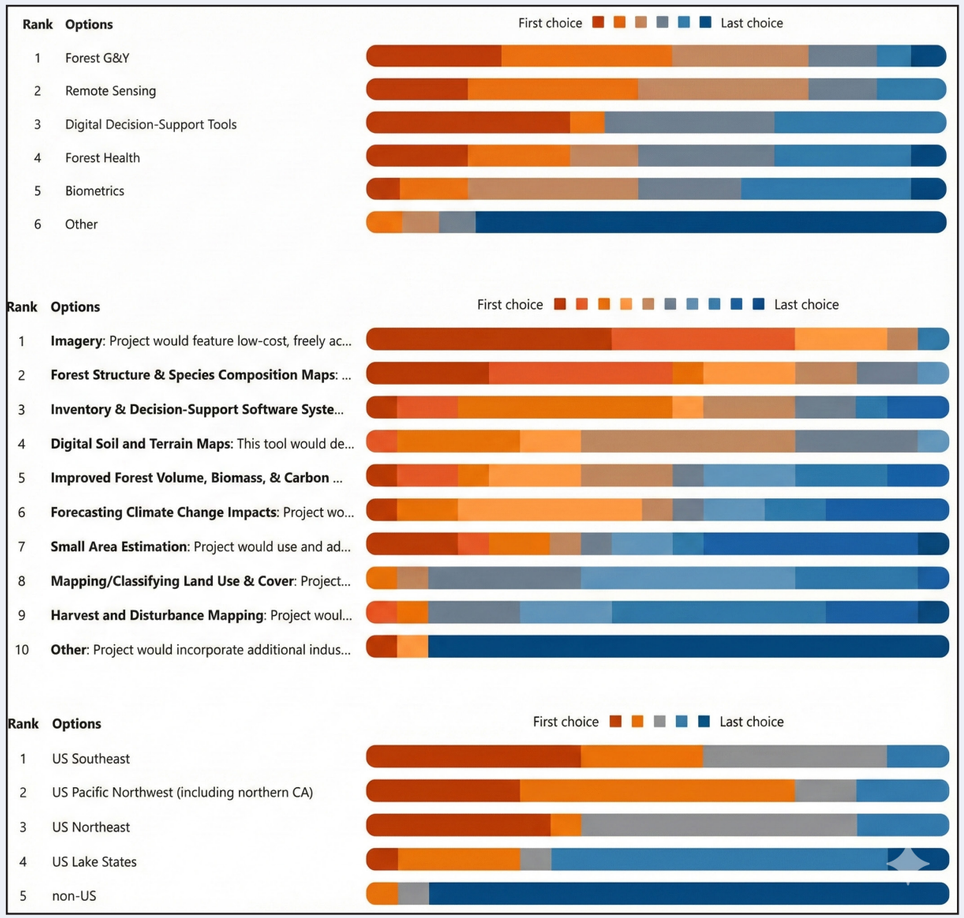
Member-reported reliance on US Forest Service data and tools. Phase IV considerations address concerns about future accessibility for these data.

Over the course of the year, considerable time was put into working out the best funding strategy for Phase IV. The emerging consensus favors first establishing a tiered contribution model with universities, industry, and affiliates paying annual fees, with a goal of evolving into a broader national organization capable of launching multiple large-scale initiatives (e.g., Digital Forestry, Forest Carbon Modeling).

NEW PROJECTS FOR PHASE IV

IAB members were invited to provide feedback on the proposals (survey results below) and to prioritize funding. This feedback was used by the IAB Executive Committee to recommend funding for seven projects that will begin in 2026:

1. Enhancing GY model accuracy and transferability through open data (PI Temesgen Hailemariam, OSU)
2. Multi-temporal point-cloud periodic height growth determination: Relevance to site index estimation (PI Mark Kimsey, UI)
3. Expanding digital soil maps for working forests of the US (PI Mike Premer, UM)
4. Robust small area estimation from machine learning models (PI Kasey Legaard, UM)
5. MicroFVS Web API: Scalable and reproducible growth-and-yield (PI David Diaz, Vibrant Planet)
6. Utilizing stable isotopes to refine density management regimes of US working forests (PI Lila Beck, UM)
7. Potential for spectral-based data to assess disease incidence and severity (PI Douglass Jacobs, PU)



Project Updates

CAFS Project 19.75 (Final Report)
Assessing & Mapping Regional Variation in Site Productivity
Rachel Cook (NCSU), Cristian Montes (Rayonier), Aaron Weiskittel (UM), Jeff Hatten (OSU), Mark Coleman (UI), Doug Jacobs (Purdue), Mark Kimsey (UI), Doug Maguire (OSU), Kim Littke (UW)

Background and Objectives

One of the primary determinants of optimal management practices is the potential site productivity, which influences the growth and development of forests. This project features cross-site collaboration and sharing of remotely sensed and empirical field data for spatial modeling of potential site productivity. The objective is to develop a consistent and biologically-meaningful metric of potential site productivity that can be related to a combination of environmental and edaphic factors and mapped across the various regions.

Experiment Design

- Site Productivity Optimization of Trees: SPOT
- Collected USGS data across southeast US for large-scale site index mapping
- Develop web-based interface

Methodology

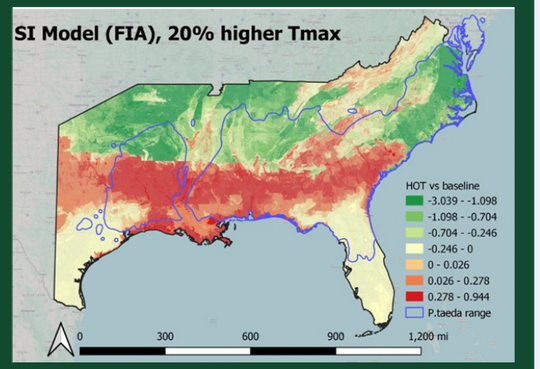
- Look for “gaps” in actual v. potential productivity
- Incorporate satellite/drone LAI to refine predictions/productivity modeling
- Continent-scale C budget under varying scenarios

Annual Progress

- USGS data collected across southeastern US for large-scale site index mapping.
- Map base and potential site productivity.
- Built web-based interface.
- In progress: Incorporating LAI into productivity modeling.

Impact

Optimize inputs to reduce risk and improve ROI: baste & potential site index; soils & geology to predict site limitations, canopy & understory AI; site specific response models.



Predicted SI across Loblolly range

Project Updates

CAFS Project 19.76 (Final Report)
Assessing & Mapping Regional Variation in Site Carrying Capacity Across the Primary Forest Types in the US

Mark Kimsey (UI), Aaron Weiskittel (UM), Rachel Cook (NCSU), Cristian Montes (Rayonier), Doug Mainwaring (OSU), Eric Turnblom (UW)

Background and Objectives

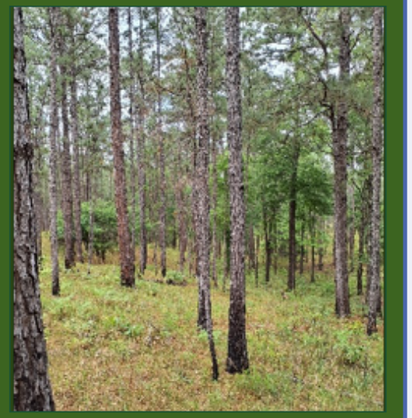
Maximum site carrying capacity determines the number of individuals of a certain size per unit of area that a defined stand can support and maintain. The objectives of this research project are to 1) synthesize a nationwide forest measurements database from publicly available data and from CAFS members, 2) standardize maximum carrying capacity modeling, and 3) create efficiencies for multiregional forest management organizations via species-site spatial models of SDImax for commercial species.

Experiment Design

- Datasets: 543,249 inventory plot records supplied by CAFS members and the USFS FIA program, spatially associated with >200 physiographic variables
- Analysis: Robust machine learning models applied across major US regions to relate key forest growth factors to maximum carrying capacity

Outcomes

- Standardized methods across regions
- Site-Species driven analytics
- SDI max models are available in Jupyter Notebook Python code, toolbox for ESRI's ArcGIS Pro platform, and web deployment script (Java/Python/Flask)
- Robust machine learning models
- Flexible models for assessing projected climate impacts on forest carrying capacity
- Deployed for operational use across the US
- Expansion underway to incorporate beetle impacts on pine mortality



Impact

This project has contributed to a consistent methodology for identifying and managing forest density across multi-regional land holdings allowing for species and silvicultural treatment optimization. Tailored SDImax estimates by unique ownership Stand ID, allowing for: Identification of target species for thinning and retention; target densities reflective of site resources and management objectives; determine effects of species conversion on site carrying capacity and its effects on long-term growth and yield ; improved growth and yield estimates in Forest Vegetation Simulator through use of Keyword SDIMAX; and identify effects of projected climate shifts on forest carrying capacity.

Project Updates

CAFS Project 20.79 (Final Report)
Multi-Regional Evaluation of New Machine Learning Algorithms for Mapping Tree Species Distribution and Abundance

Kasey Legaard, Aaron Weiskittel, Ken Bundy, Erin Simons-Legaard (UMaine)

Background and Objectives

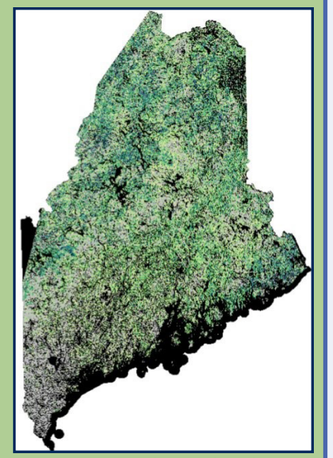
This research specifically targets the problem of eliminating systematic map error using a ML method that is capable of minimizing both total and systematic error in satellite-derived maps. This mapping approach combines the strength of Support Vector Machines (SVMs) to model complex, nonlinear relationships based on limited training data, a common condition in forestry applications, with the adaptability of a multi-objective Genetic Algorithm (GA).

Experiment Design

- Statewide image processing (300+ Sentinel-2 images)
- Species and forest types mapping across northern Maine; followed by the remainder of the state
- Improve the effective resolution of species maps by modifying the production code
- Integrate newly developed forest maps with spruce budworm monitoring data to test for associations between forest conditions and population trend
- Develop and test a prototype cloud-hosted geospatial database application to enable borderless, un-tiled raster data processing for large forest mapping project

Annual Progress

- Statewide at 10-meter resolution from multi-temporal Sentinel-2 and FIA.
- Modeled using multi-objective ML to reduce the effects of regression dilution or attenuation bias caused by mismatches between FIA plots and satellite image pixels.
- 16 species and species groups combined to map 15 forest type classes.
- Currently working on integration of 10-meter species and 1-meter NOAA land cover to derive 5-meter land cover and forest type



2021 species relative abundance: Balsam fir

Impact

This project has continued the development and proof of concept of low-cost forest mapping methods, improving the accuracy and efficiency of forest mapping.

Project Updates

CAFS Project 20.84 (Final Report)

Stand and Tree Responses to Late-Rotation Fertilization

Eric Turnblom, Kim Littke, Jason Cross, Mason Patterson, and Rob Harrison (UW)

The study is designed to estimate a regional nitrogen fertilization response (RRE) for Douglas-fir on late-rotation stands from paired-plots in randomly located late-rotation stands within four distinct regions of Washington and Oregon and two regions in British Columbia. This study will provide a much-needed examination of the economics involved with late-rotation fertilization.

Major Findings

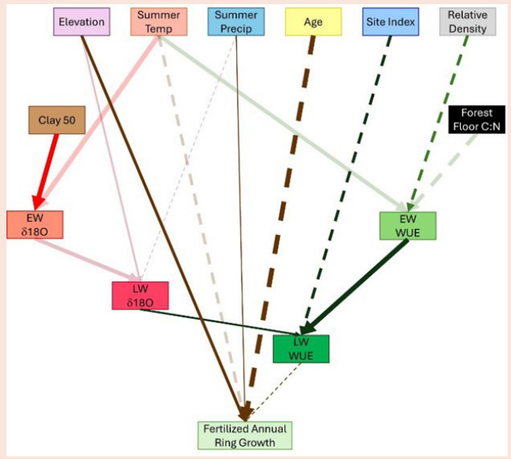
- Structural equation models explain the effects of climate, soil, and site variables on ring growth using §18O and WUE.
- Negative relationship between summer temps and stomatal conductance: Little effect of fertilization on stomatal conductance; Responding stands increase photosynthesis after fertilization especially at low summer temps and low site productivities.
- Ring area growth greatest at lower summer temps, younger ages, and greater stomatal conductance; Greater fertilizer ring growth response at younger ages, higher elevations, and lower summer temps.
- Models suggest that increasing temperatures due to climate change will result in lower ring growth due to decreases in stomatal conductance. Fertilization could yield increased growth with rising temps in responding stands.
- Three peer-reviewed publications that reflect each project objective.

Recommendations

- Expect negative impacts of increasing summer temperatures on ring growth due to lower stomatal conductance.
- Focus fertilization on stands most likely to respond (higher elevations, colder temperatures, and lower site index) due to N limitations.

Impact

- ✦ Improved fertilization and silviculture recommendations for Douglas-fir plantations based on physiologic variables
- ✦ Inclusion of response data into growth models.
- ✦ Recommendations for fertilization under future climate scenarios.



Model: solid line, positive relationship; dotted line, negative relationship. Arrows indicate predictors of the dependent variable. Arrow width indicates relative strength of each variable.

Project Updates

CAFS Project 21.85 (Final Report)

Variation in Productivity, Wood Quality and Soil Carbon of Nine Conifer Species Across a Gradient in Water Deficit

Carlos Gonzalez (OSU), Kim Littke (UW), Jeff Hatten (OSU), Doug Mainwaring (OSU), Maxwell Wightman (OSU), Aaron Weiskittel (UM), Emily Von Blon (OSU)

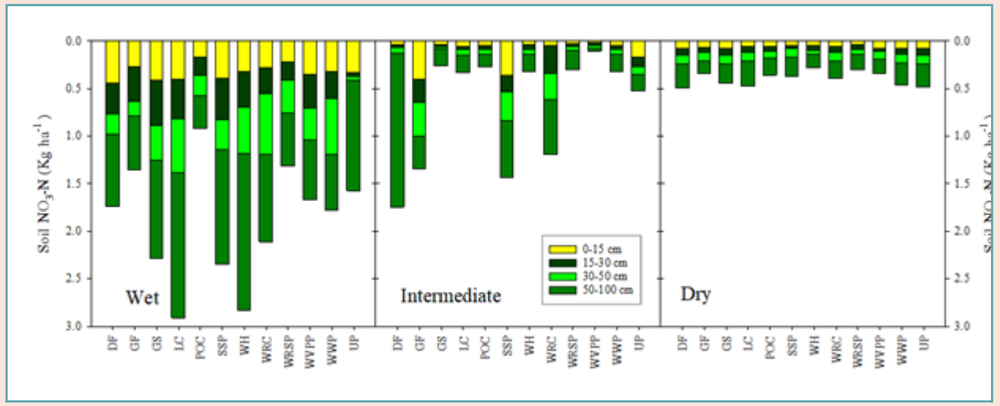
Climate change is expected to increase average temperatures and shift precipitation regimes, contributing to more severe and widespread disturbances. Higher evapotranspiration demands and the potential increase in water deficit can be detrimental to the growth and survival of tree species in the PNW. Understanding how commercially and ecologically valuable species are sensitive to climate can help to guide species selection and management decisions to enhance stand resistance and resilience to projected climate changes.

Annual Progress

- Additional soil sampling and monthly growing season diameter growth phenology.
- Updated climate-growth relationships using new data.

Impact

- ✦ Better understanding of the sensitivity of commercially and ecologically valuable species in the PNW in terms of productivity and wood properties to water deficit and climate variability.
- ✦ Inform where proactive management is required across species ranges and prioritize the management of potentially vulnerable forests under climate change.
- ✦ Improved understanding of where species are predicted to expand their range and inform assisted migration efforts.



Separation of soil organic matter at different layers, showing big differences across the sites.

Project Updates

CAFS Project 21.87 (Final Report)

Leaf Area Index Estimates to Inform Midrotation Treatments

Rachel L. Cook (NCSU), Aaron Weiskittel (UM), Mark Kimsey (UI), Alicia Peduzzi (UGA)

This project seeks to expand the capability and accessibility of our ongoing modeling work in predicting timber plantation canopy leaf-area index (LAI) using freely available global-coverage satellite data. Leveraging the work completed to date, we seek funding to 1) expand the species range covered by the model, 2) develop a user friendly interface so the results can be accessed and used by the non-specialist, 3) build capacity to predict and map deciduous understory presence, and finally 4) to build a national-scale site potential productivity baseline map for future silvicultural response modeling.

Annual Progress

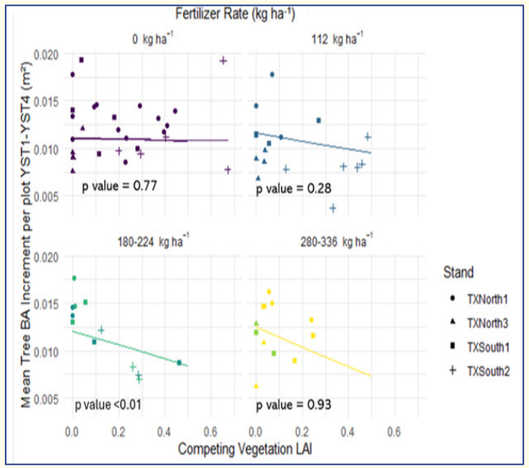
- Continuing to collect data (diameter, height, height to live crown, understory metrics) in the field.
- New LiDAR acquisition planned for late 2025/early 2026.

Future Plans

- Ongoing LAI and Deciduous Understory model improvements.
- Completion of Evergreen understory model in collaboration with Manulife.
- Integration of this work with soils and Site Index modeling.

Impact

- Accessibility to LAI canopy layers: Determination of when/where LAI-based, variable rate fertilizer application can be beneficial
- Operational scale results from mid-rotation fertilization vs herbicide across soils and geology.
- With time, ability to assess return on investment for rates of fertilization and/or herbicide.
- Combined with soils map and Site Index models, ability to estimate fertilizer response based on present canopy/understory conditions.



Project Updates

CAFS Project 21.89 (Final Report)

Quantifying Carbon Sequestration as a Function of Silvicultural Treatment in Loblolly Pine

Joe Dahlen (UGA), Nawa Raj Pokhrel (UGA), Tilak Neupane (UGA), Tom Eberhardt (USFS)

Information is limited on the carbon sequestered as a function of silvicultural treatment. Trees from the Intensively Managed Plantation thinning trial will be sampled from 5 of the study sites. Wood properties relevant to carbon include specific gravity, extractives, cellulose, lignin, and carbon percentage. The stem volume will be measured, and disks collected at multiple height levels. The amount of carbon sequestered from each tree will be measured annually from the disks such that the total carbon found in the main bole can be quantified annually.

Approximately 2,000 pith-to-bark samples have been scanned on the hyperspectral system. A subset of the samples were selected for extractives, lignin content, cellulose content, and carbon content.

Major Findings

- Cellulose and lignin vary radially from pith to bark and longitudinally from stump to tip.
- In extractive free wood, calculated carbon content is relatively stable from pith to bark, shows very little variation with height, and measured carbon content is relatively consistent
- Regional stand samples (N=45) used for calculating carbon across the region (Southeastern US). Compared coastal v. inland regions.

Impact

- Information on carbon stored as a function of silvicultural treatment in loblolly pine.
- Provide preliminary results on the use of a rapid field tool to estimate carbon stored at a stand level when combined with biometric information.

Coastal Group (Conventional vs Intensive)

Tissue	Property	Conventional	Intensive
		Mean	Mean
Tree	Age (years)	22.9	23.0
	DBH (cm)	22.9a	26.8b
	Height (m)	19.8a	21.0b
Wood	Specific gravity	0.464a	0.499b

Inland Group (Conventional vs Intensive)

Tissue	Property	Conventional	Intensive
		Mean	Mean
Tree	Age (years)	23.1	24.2
	DBH (cm)	23.4a	27.9b
	Height (m)	18.1a	21.4b
Wood	Specific gravity	0.437a	0.447b

For Wood SG, p-value = 0.0497

Comparison of carbon % conventional versus intensive management in coastal and inland areas.

Project Updates

CAFS Project 21.92 (Final Report)
START: University of Maine & University of Maine at Fort Kent

Aaron Weiskittel and Nicole Rogers (UM)
Ned Rubert-Nason, Neil Thompson, Libin T. Louis (University of Maine Fort Kent)

Partnership with University of Maine Fort Kent's 2-year technical college to support a two-year project working toward a better understanding of commercial tree responses to stress. Working with faculty from UM and UMFK, internships will encompass lab sampling and field work, including using hyperspectral imaging to assess tree health, determining the effects of microclimate on forest health and regeneration, and estimation of wood moisture content. CAFS funded three student interns, and indirectly supported 10+ undergraduates since 2021. CAFS also sponsored travel by 2 UMFK faculty to attend the 2023 conference in Louisville, KY.

Experiences

- Geospatial analysis (w/ QGIS, ENVI)
- UAV and ground-based remote sensing
- Tree mensuration (morphology, health class, etc)
- Specimen collection, transport & storage
- Soil chemical & physical analysis
- Phytochemical analysis (e.g., tannins, terpenoids)
- Physiological measurements (w/ LiCOR-6800 analyzer)
- Climate monitoring equipment operation
- Data curation and analysis (e.g., Google sheets, Access)

Impact

✦ 11 synergistic projects (+4 from 2024)

✦ Data collection & curation: Increase availability and accessibility of data to inform decisions

✦ Collaboration with Purdue's PERSEUS project

✦ Workforce preparation: Collaboration and leadership skills; logistics + field work; critical thinking; experience with tools, technologies & procedures; networking

✦ Remote sensing tools and skills to rapidly identify changes in tree health

Project Updates

Project 23.100 (Final Report)
Use of Carbon Isotopes for Assessing Tree Response to Thinning

Mike Premer (UMaine), Rachel Cook (NCSU),
Mark Kimsey (UI), Bronson Bullock (UGA), Lila Beck (UMaine)

The role of forest ecosystems as a natural climate solution, specifically C sequestration and storage, has been widely recognized across the forested regions of North America. This project aims to quantify causal mechanisms of stem growth response (or lack of) to variations in thinning intensity, timing, and site variables through analysis of tree ring stable isotopes (δ13C and δ18O) in red spruce across a long-term thinning network in Maine and across other regions.

Annual Progress

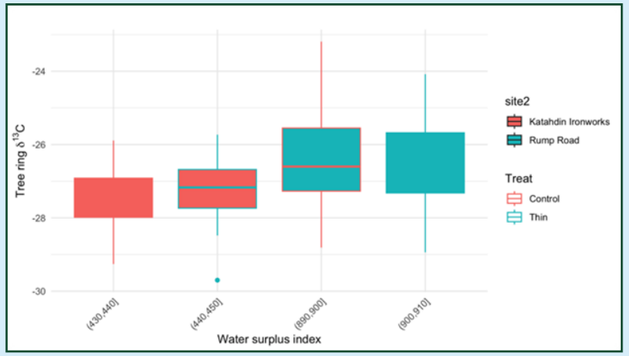
- Using a three-pronged approach: Tree physiologic processes-stand dynamics-site productivity and hydrologic flux.
- Initial round of sampling in Maine complete: 6 Maine sites sampled (1 to be re-sampled). 5 isotope samples sent to Columbia University for processing.
- PDP plots cored; RW-19 plots to be cored in upcoming year.

Future Plans

- ✦ Finalize processing of CTRN cores.
- ✦ Generate competition indices for focal trees with local stem maps and reconstruct tree diameter for each measurement period for CTRN.
- ✦ Test the effect of tree size, stand conditions, neighborhood competition, and SWA on BAI and C13 for CTRN.

Impact

- ✦ Insight to the limiting factors of site carrying capacity (e.g., Stand Density Index) and thinning response, leading to refined site-specific density guidelines, silvicultural planning, and forest C sequestration.
- ✦ Silvicultural guidelines and geospatial tools of treatment priority and response.



Preliminary Results: At Rump Road, trees appear to experience "thinning shock" where newly exposed shade leaves close stomata.

Project Updates

CAFS Project 23.101 (Continuing)

Site-Stand Dynamics and Pine Beetle Mortality in Ponderosa Pine Ecosystems

Mark Kimsey Jr., Haley Anderson (UI)

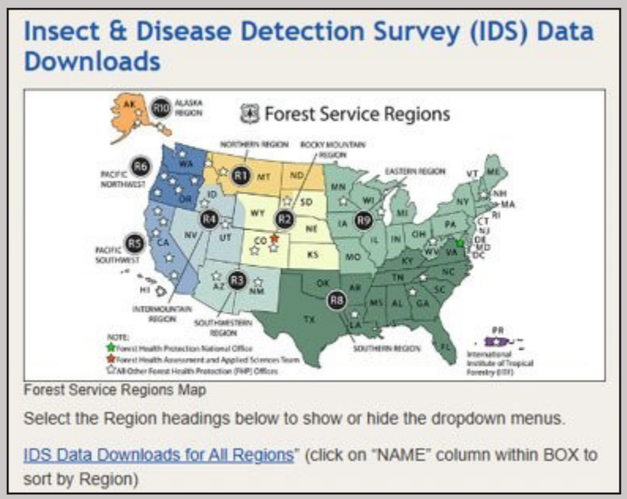
The goal of this project is to develop a companion ponderosa pine SDImax model that is sensitive to stressors that precipitate pine beetle (WPB, MPB) mortality outbreaks. These stressors may or may not coincide with traditional density management thresholds that are associated with density dependent related mortality. It is critical to develop a more granular understanding of which site and stand variable combinations contribute to pine beetle outbreaks across spatial and temporal scales.

Annual Progress

- Data processing underway: downloading climate lag data; merging stand, site, and beetle data.
- Thesis chapter 1 complete and submitted for publication.

Future Plans

- Identify variables of particular interest with preliminary data manipulation/analysis in R.
- Complete nonparametric analysis of variables to develop susceptibility model for bark beetle severity and adapt base SDImax model to bark beetle susceptibility.
- Integrate predicted climate data for integration into model.
- Analyze data and develop model for future predicted climate.
- Develop web app for models.



Forest Service Regions Map

Impact

- Potential time and cost savings by reducing large-scale mortality from pine beetle epidemics, and more resilient forest stands.
- Density threshold modifiers for existing SDImax models that incorporate pine beetle epidemic risk factors.
- Spatially and temporally explicit models that identify at risk pine ecosystems will enable targeted and timely treatment prescriptions for creating resilient forests.

Project Updates

CAFS Project 23.104 (Continuing)

The Interplay Between Sampling Design and Small Area Estimation to Improve Forestland Inventory

Temesgen Hailemariam (OSU), Aaron Weiskittel and Mike Premer (UM), Rachel Cook (NCSU), Phil Radtke and Corey Green (VT)

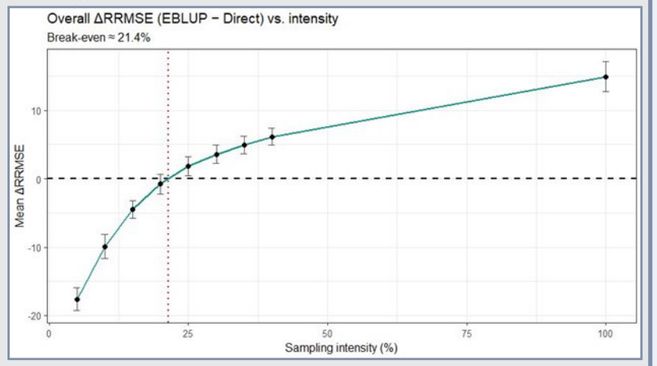
One of the challenges often faced in forestland inventory/valuation is estimating gross and net merchantable volume for smaller areas of interest consisting of delineated stands within a larger forested population or ownership. This project has three sets of objectives: (1) examine variable selection methods for developing small-area estimation models that link inventory plots and remotely sensed data for timberland inventory; (2) examine the performance of selected sampling designs and sample sizes for applying SAE models. In that, we seek to examine the use of small-area estimators to either reduce sample size when precision is given or improve precision when the sample size is fixed; and (3) allocate sample size to subpopulation, including optimal allocation of samples in small domains.

Annual Progress

- Prepared "cruise + covariate" stand-level dataset.
- Variable selection to fit Fay-Herriot on stand data.
- Implemented two-stage sampling strategies + simulations.

Future Plans

- Protocols for linking remote-sensing and ground data to improve small-area timber inventory estimates.
- Quantify uncertainty of SAE predictions under different sampling intensities.
- Summary report for member companies.



Relative Performance of EBLUP and Direct Estimators Across Sampling Intensity

Impact

- Better understanding of linking data and sources.
- Optimized sampling reduces the number of expensive ground plots while maintaining accuracy.
- Efficiency gained by incorporating SAE models into operational forest inventory in plantations.

Project Updates

CAFS Project 24.105 (Continuing)

Robust Small-Area Estimation (SAE) Strategies for Developing Accurate Stand-level Diameter Distributions

Jaslam Poolakkal (UI), Mark Kimsey (UI), David Affleck (UMontana), Paul Parker (UC-Santa Cruz), Nathaniel Naumann (PotlatchDeltic Corp.)

Forest decisions—like harvest planning, habitat protection, and carbon accounting—require highly localized data (e.g., tree sizes, species mix, biomass). However, traditional methods fail to produce precise estimates of diameter distributions at the stand level due to small or unbalanced samples sizes and complex stand structures. SAE enables reliable estimation in small domains where traditional approaches lack precision. SAE effectively "borrows strength" from auxiliary data (e.g., LiDAR, NAIP, Sentinel-2) to improve predictions even when sample sizes are small. This project advances SAE through robust model-based techniques integrated with machine learning.

Annual Progress

- Engaged with industry partners, public land managers, and research networks to compile forest inventory data across the Pacific Northwest and Southeast U.S.
- Leveraging publicly available datasets and initiating procurement of 3D NAIP products via project collaborations.
- Initial Implementation Areas (Idaho): St. Joe National Forest, Moscow Mountain.
- LiDAR Preprocessing Workflow.

Colorized 3D NAIP Point Cloud (GSD: 30 cm, Frame Sensor).

Findings

- Most influential predictors across methods: Cruise Design, Canopy Height Metrics, Soil and Drought Variables repeatedly significant and strong in effect size.
- Residuals & Diagnostics: Good fit, but residual skewness/kurtosis and some non-normal random effects suggest opportunities for improvement.

Impact

- Ability to estimate stand characteristics in areas with limited or no sample data. This method enhances precision and reduces bias.
- Statistically sound approach to estimating forest metrics, ensuring reliable results even where direct survey data is scarce.
- Characterization of the diameter distribution of forest stands managed for timber production provides accurate estimates of existing wood volume by diameter class and area unit, providing the basis for determining the stand's ecological and economic value, its structure, potential for ecosystem services, and appropriate management practices.

Project Updates

CAFS Project 24.106 (Continuing)

Integrating SAE Methods with Stand-level Forest Inventory and Growth Projection for Southern Pine Plantations

Sheng-I Yang (UGA), Phil Radtke (VT), Bronson Bullock (UGA), Corey Green (VT), Qianqian Cao (VT), Chad Lincoln (FIA), Nate Herring (AFM), Scott Hillard (AFM)

This project aims to evaluate the applications of unit-level SAE techniques in improving the stand-level inventory and model projection systems for southern pine plantations. Phase I will detail information for the targeted populations under different forest conditions at a specific point in time. In Phase II, the applicability of using past inventories and/or historical remote sensing data as auxiliary information will be used to update the estimates of variable of interest at time II.

Annual Progress

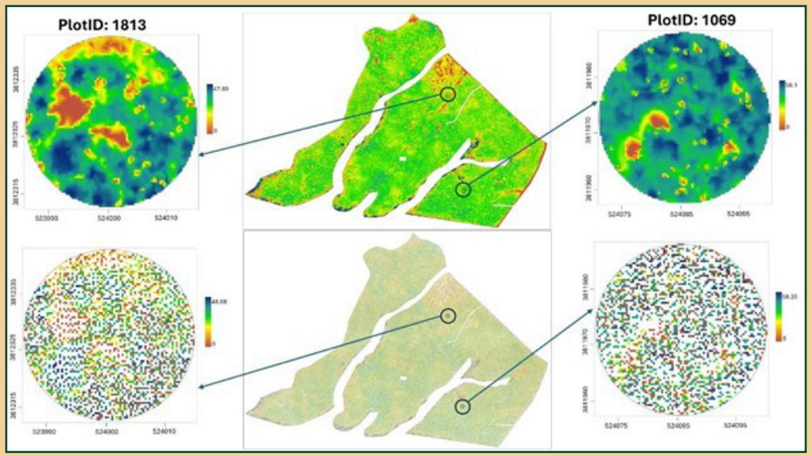
- Ground inventory data and LiDAR data acquisition.
- Applying unit-level SAE models and examining sampling strategies.
- Examining the impacts of canopy height models (CHMs) on SAE model accuracy.

Future Plans

- Request additional data from other industry partners.
- Expand to additional regions.
- Recruit additional students for the project.

Impact

- Useful documents and toolboxes for member companies when selecting proper methods for calibrating FVS.



A total 324 methods to generate CHM based on ground classification, digital terrain model, height normalization and canopy height model.

Project Updates

CAFS Project 24.107 (Continuing)

Using Small Area Estimation and 3D-NAIP/Sentinel-Derived Variables for Multivariate Prediction of Stand Attributes

Sukhyun Joo (OSU), Temesgen Hailemariam (OSU), Bryce Frank (USDA FIA)

When estimating at fine spatial resolution, such as geographic units, industrial land ownerships, or county levels, the accuracy of FIA data decreases due to increased sampling errors caused by limited sample sizes. Small area estimation (SAE) techniques have been proven effective in forest inventories for generating reliable estimates in areas with limited data (i.e., small areas). The primary objective of this research is to provide current stand- and tree-level attributes across various spatial resolutions (e.g., state, county, specific stand, management unit, pixel). The aim is to create detailed multivariate models integrating FIA, 3D-NAIP, and Sentinel data with climate and non-FIA private industry data (cruise/stand exam data) to estimate detailed forest attributes

Annual Progress

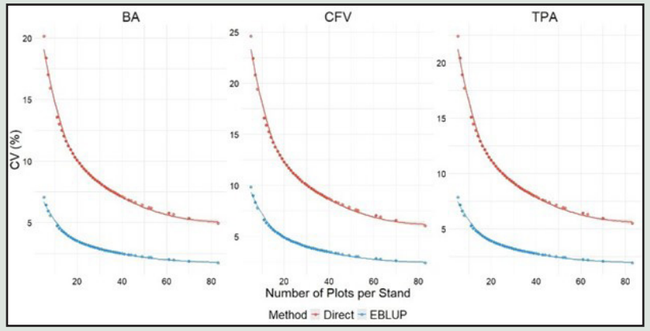
- Secured unfuzzed FIA plot coordinates for Oregon, Washington, Alabama, and Georgia.
- Compiled FIA and private industry inventory datasets.
- Developed univariate prediction models for basal area (BA), trees per acre (TPA), and volume (VOL) using FIA data.
- Completed independent validation of BA, TPA, and VOL models using industry data (Western WA counties).
- Established baseline model performance to guide future multivariate and SAE model development.

Findings

- SAE provides substantial improvement over direct estimation 25-40% reduction in RMSE.
- 3D-NAIP height metrics and Sentinel-2 spectral indices proved successful auxiliary predictors in the SAE model.

Impact

- Improved data for decision-making in forest management, carbon accounting, and wildfire risk assessment.
- SAE approaches that integrate ground-based samples with remote sensing technologies for more precise predictions.



Project Updates

CAFS Project 24.108 (Final Report)

The Effect of Silvicultural Treatment on Douglas-fir Stem Form

Doug Mainwaring (OSU), Sukhyun Joo (OSU), Eric Turnblom (UW), Mark Kimsey (UI), Carlos Gonzalez (OSU), Jason Cross (UI), Kim Littke (UW), Temesgen Hailemariam (OSU)

Volume estimates of projected tree lists are based on existing taper equations which do not currently account for any changes in stem form that may result from silvicultural treatments. Proper assessment of the short- or long-term volume or financial yield of such treatments require that any benefits derived from associated changes in stem form be accounted for. Taper measurements of rotation-aged trees from thinned stands and mid-rotation-aged trees from stands representing contrasts in early vegetation control, pre-commercial thinning, or genetic selection were used to test for silvicultural effects on stem form using a combination of felled tree, climbed tree, and SLAM LiDAR measurements.

Annual Progress

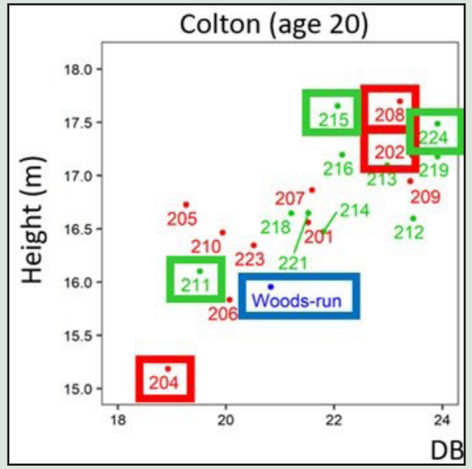
- Opportunistic sampling when weather and scanner availability intersected.
- 32 trees were scanned twice.

Findings

- Thinning was not significant in the prediction of upper stem diameter.
- Intensive vegetation treatment was not a significant factor for mid-rotation stem form.
- Largest quartile trees had a smaller upper stem diameter, all else being equal. No significant treatment difference between trees of other quartiles.
- Despite the larger overall size of genetically elite trees relative to woods run, the largest elite trees had significantly smaller upper stem diameter, all else being equal.
- Select genetics was a significant factor for mid-rotation stem form if dataset only included most productive high gain families; insignificant if all families were included.

Impact

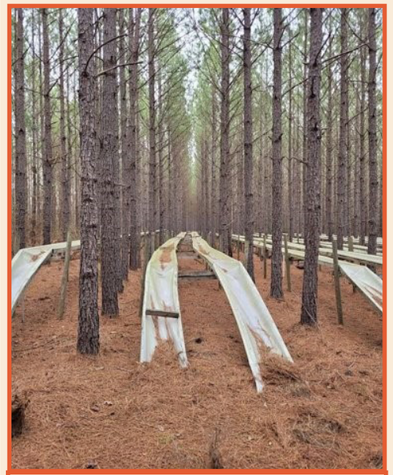
- Improved volume/yield estimates within treated stands, and additional information on mid-rotation-aged stands to improve the timing of potential mid-rotation thinning treatments
- Improved assessment of financial benefit of genetics at mid-rotation.
- Incorporation of results into regional growth models.



24.109 (Final Report)
Throughfall Reduction Impacts on Loblolly Pine Plantations Pre- and Post-Thinning

Bronson Bullock (UGA), Joe Dahlen (UGA), Stephen Kinane (UGA), Sheng-I Yang (UGA), Tom Eberhardt (USFS Forest Products Laboratory)

Changes in precipitation are widely documented as a result of a changing climate. This project will examine the possible impacts of future climate change on the growth and resulting yield of loblolly pine via simulating reduced rainfall using throughfall exclusion troughs to carry a portion of the water off of each plot into a buffer area. How loblolly pine will respond under reduced moisture conditions when there is a mid-rotation thinning treatment applied will be evaluated. The resulting impacts on wood quality and related wood properties will be analyzed using disks sampled destructively from trees on the treatment plots during the thinning operations.



PINEMAP GA Tier III site, age 18. Photo by UGA MS student Lainey Paulus.

Annual Progress

- Leveraged the PINEMAP installation in the Georgia Piedmont.
- Tier III experimental sites established in 2011 with current thinning design being developed in coordination with Weyerhaeuser.
- Model different thinning scenarios to look at outcome prior to operational thinning on the research plots.

Findings

- Significant reduction in DBH, no significant reduction in height although there is a slight trend for reduced height in R treatment
- Understanding the impact of reduced throughfall on loblolly pine growth as a proxy for potential future climate variability: May reduce growth, comparable to control, but fertilization helps mitigate this effect.
- Thinning would allow more resources to residual crop trees and opening the canopy, potentially reducing the effect of throughfall exclusion.

Impact

- Support for two MS students.
- This work provides insight into the impacts of reduced moisture in loblolly pine plantations both pre- and post-thinning.

CAFS 25.110 (Final Report)
Silviculture by Genetics Loblolly Pine Research Trial

Bronson Bullock, Túlio Queiroz, Stephen Kinane, Sheng-I Yang, Dehai Zhao
University of Georgia

This project establishes a region-wide research trial to evaluate growth, yield, and product quality of improved pine genotypes. The results will inform potential modifications to growth and yield models based on observed relationships and it will suggest how and where modifications may eventually be made to the growth and yield model systems.

Annual Progress

- Planting setup: 64 trees per plot/8x8 tree grid
- 9-12 families/3 planting densities
- 3 replications/81 plots per installation
- 3 buffer trees/rows around each planting density

Findings

- Site assessment and maintenance ongoing, new data sets expected by 2035.

Impact

- A new set of adaptive growth and yield models built from early-age data, capable of predicting stand performance across different TIP PRS scores to guide timely, data-driven management decisions.
- Integrated predictive tools that combine genetic information and environmental variables to optimize rotation length, thinning schedules, and long-term yield forecasting.
- Decision-support outputs—including stand-level productivity estimates, risk assessments, and management recommendations.

The Center for Advanced Forestry Systems has successfully completed Phase III of NSF IUCRC support while establishing a strong foundation for Phase IV sustainability. With 27 active research projects, strong university and industry engagement, and a track record of impactful science, CAFS is well-positioned to continue its mission of advancing forest management through collaborative research.

The organization's transition from NSF funding to a self-sustaining model represents a natural evolution reflecting CAFS' maturation and the robust demand for its research outputs. The strong IAB support (95% of members support continued sustainability), committed university partners, and emerging industry interest in collaborative research all indicate confidence in CAFS' future.

As the forestry sector faces unprecedented challenges—including climate change, forest health threats, market disruption, and technological transformation—the collaborative, multi-institutional research network that CAFS provides becomes increasingly valuable. By maintaining focus on applied research addressing industry-identified priorities while remaining adaptable to emerging needs, CAFS will continue to serve as the premier forestry research organization in North America.

CAFS graduated as a NSF IUCRC in 2025.

The University of Maine served as the lead site for CAFS Phase III under the direction of Dr. Aaron Weiskittel, NSF Award # 1915078. Phase III materials, including members, annual reports, and IAB meeting pages, are available via the CAFS webpage:

crsf.umaine.edu/forest-research/cafs