

# Future of NSF's Center for Advanced Forest Systems (CAFS)?

Aaron Weiskittel  
Director



# U.S. Forest and Forest Products R&D Capacity:

## Results from 2020-21 Stakeholder Summit

### Project Coordinator

Emily S. Huff, Ph.D.  
Michigan State University

### Project Directors

Robert G. Wagner, Ph.D.  
Purdue University

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UC-Berkeley

Michael Goergen,  
US Endowment for Forestry and Communities

### Steering Committee

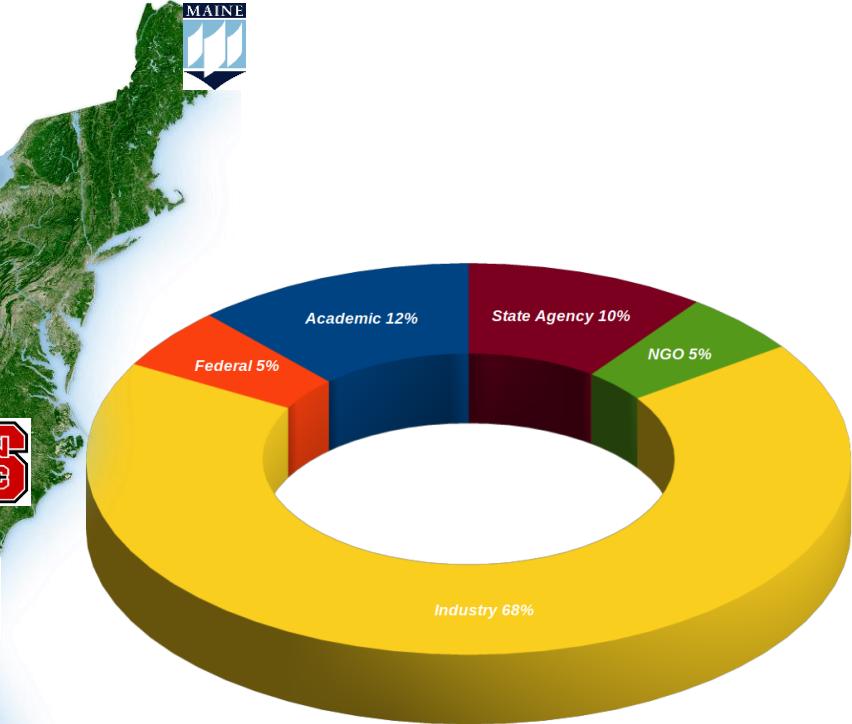
Susan McCord, NCASI  
David Tenny, NAFO  
Tom Martin, AFF  
Justin Morrill, AWC  
Alexander Friend, USFS

	R&D Producers		R&D Consumers		R&D Producers and Consumers				
Research Priority	Academic	USFS Station Directors	USFS National Forest System	Family Forest Owners	Private Large Forest Owners / Managers	NGOs	State Foresters	Industry	
#1	Carbon and Climate	Fire	Fire	Forest health	Forest Productivity	Carbon and Climate	Mass Timber	Markets for forest products	
#2	Forest Health	Water	Water	Carbon and Climate	Carbon and Climate	Fire	Carbon and Climate	Social License to Operate	
#3	Fire	Markets for Forest Products	Carbon and Climate	Water	Markets for Forest Products	Social License to Operate	Markets for Forest Products	Wood Energy	

National Institute of Food and Agriculture Project #IND00136672G

**NAFO has helped to assess current forest sector R&D capacity and set national priorities with strong alignment on certain topics**

# Center for Advanced Forestry Systems (CAFS)



A national industry-university collaborative research center involving  
7 universities and over 50 members



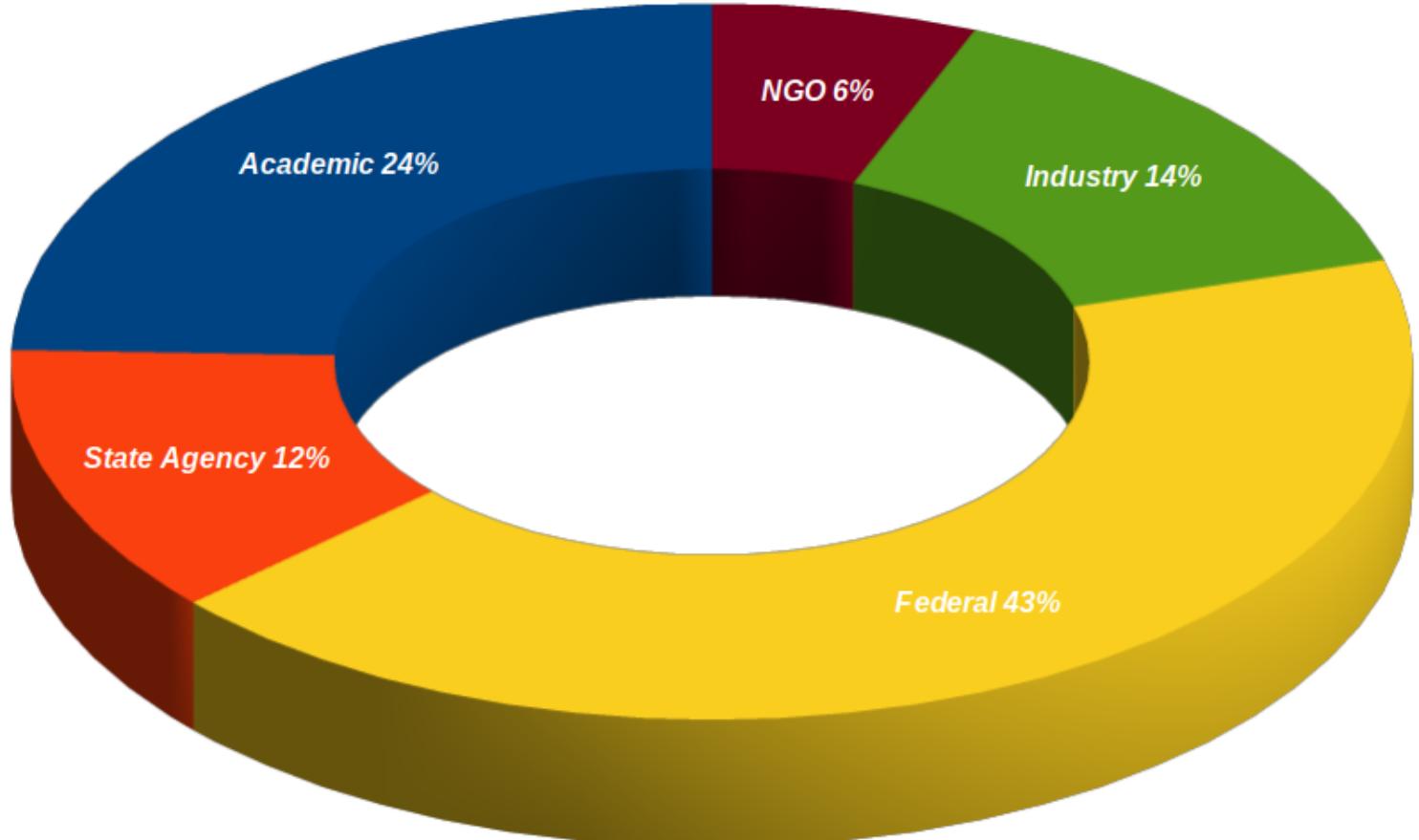
# Partnership for Small Area Estimation (PSAE)

Executive Committee (5)

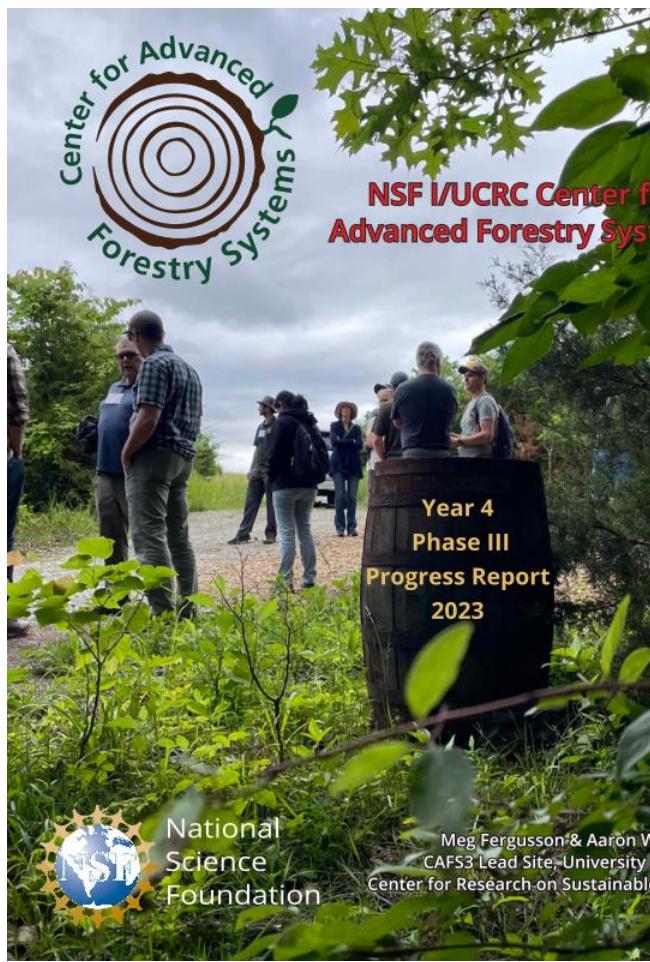
Users (21)

Development (6)

Science (18)



Broad consortium of ~50 individuals across 25 unique organizations





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



**Mission**  
To 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.

**Objectives**

Serve as national organization for R&D relevant to the forest industry

Coordinate and perform national research activities across multiple sites that align with the prioritized needs of forest industry

Document and communicate key research outcomes to relevant stakeholders

Provide a long-term strategic vision for research needs of forest industry

Convene leading scientists from academia and industry who are prepared to address new/unforeseen challenges to the forest industry, such as changing markets

Create national networking opportunities for universities and forest industry



THE UNIVERSITY OF  
**MAINE**  
Center for Research on Sustainable Forests

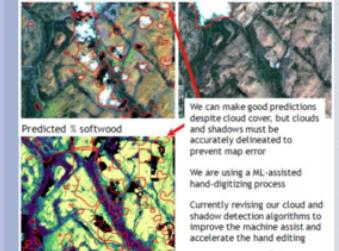
The University of Maine became the lead site for CAFS in 2016. The CAFS program is led by Dr. Aaron Weiskittel, Director of UMaine's Center for Research on Sustainable Forests.

[crsf.umaine.edu/forest-research/cafs](https://crsf.umaine.edu/forest-research/cafs)

## Project Highlights

**Multi-Regional Evaluation of New Machine Learning Algorithms for Mapping Tree Species Distribution and Abundance**  
Kasey Legard, Aaron Weiskittel, Ken Bundy, Erin Simons-Legard (UM)

For the past several decades, machine learning (ML) algorithms have been adopted and refined to improve forest map accuracy. However, several decades of data and algorithm development in satellite remote sensing have not yielded robust solutions for eliminating systematic map error. This research specifically targets this problem 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).



**Annual Progress**  
**Species & Forest Type Mapping**

- ❖ Species and forest type mapping workflows tested and finalized across approx. 5 million acres.
- ❖ Currently processing data for statewide coverage.
- ❖ Plan to integrate with NOAA C-CAP data this winter, and deliver final land cover products in spring 2024.

**State of Maine Biomass Mapping**

- ❖ Preliminary aboveground live biomass from NAIP point cloud metrics and Sentinel-2 bands, northwest Maine

**Processing 2021 NAIP point cloud statewide, at 10-meter resolution, using software developed in-house**

**Future Plans**

- ❖ Expand processing to test sites in the NW, SE, and Upper Midwest.
- ❖ Working to establish pilot studies with both public and private organizations within Maine to evaluate species predictions and derivative forest type or composition maps.
- ❖ Complete statewide processing in parallel with modeling.

**Member Company Benefits**

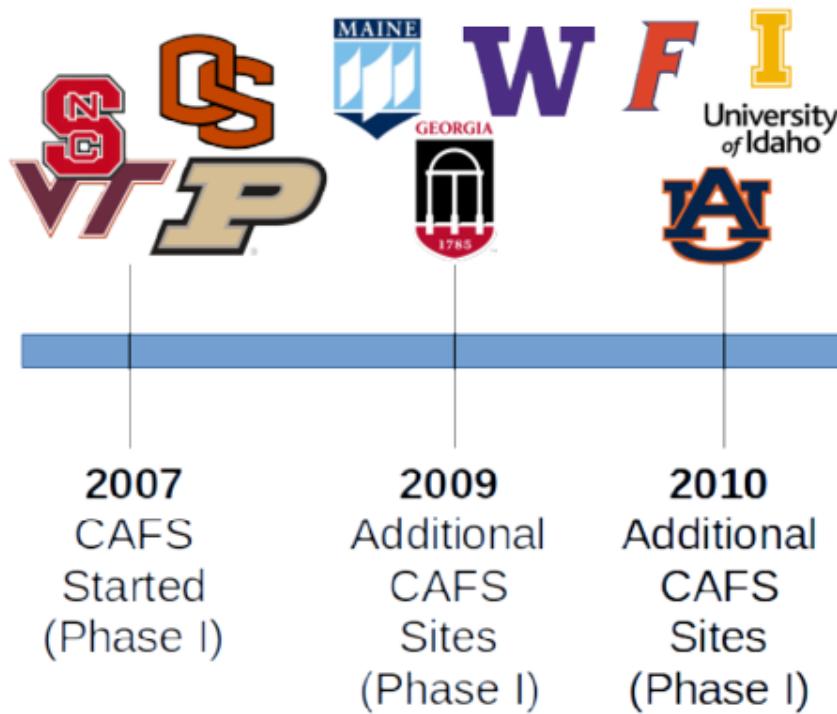
- ❖ Continued development and proof of concept of low-cost forest mapping methods using multi-objective ML and automated geospatial processing.

2023 CAFS Phase 3 Progress Report

# CAFS facilitates and support sector relevant applied R&D

(<https://crsf.umaine.edu/forest-research/cafs/>)

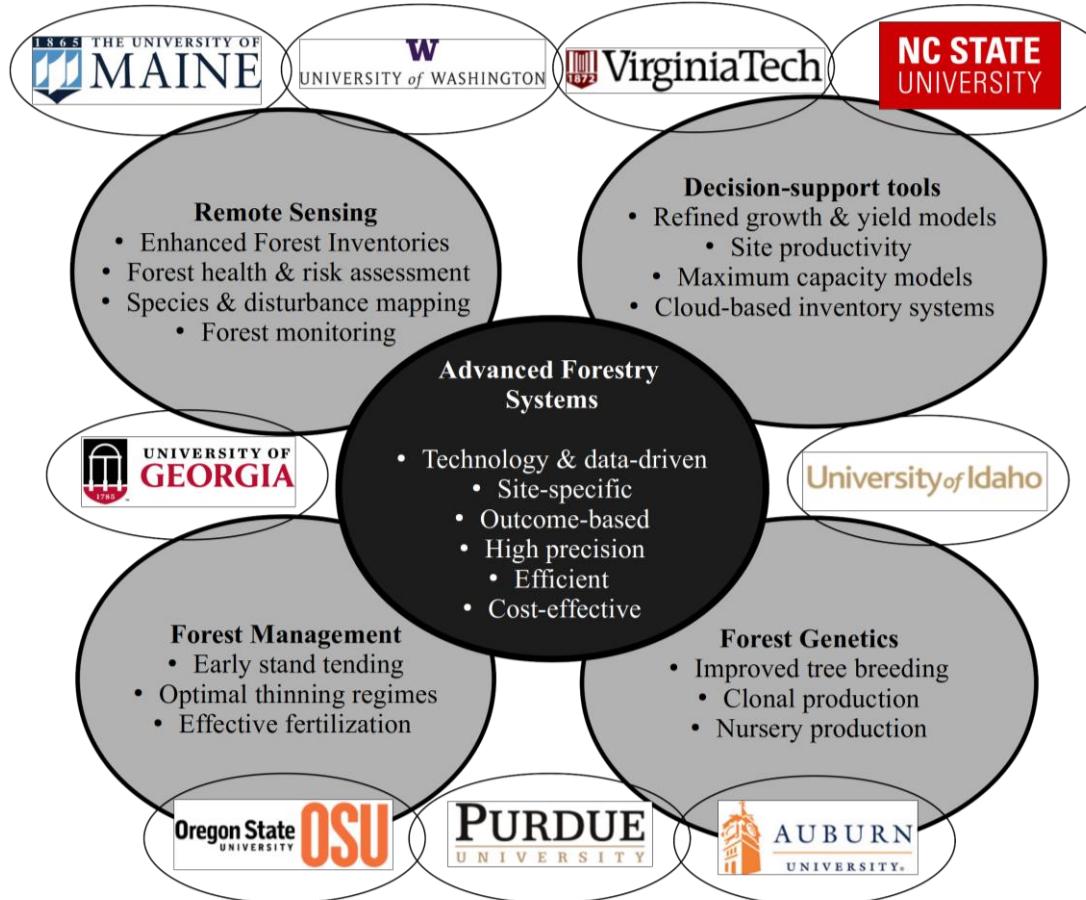
# CAFS Timeline



Grad-  
uation  
Dec  
2024

Long history of a successful national public-private-academic partnership

# Leveraging Institutional Strengths & Partners

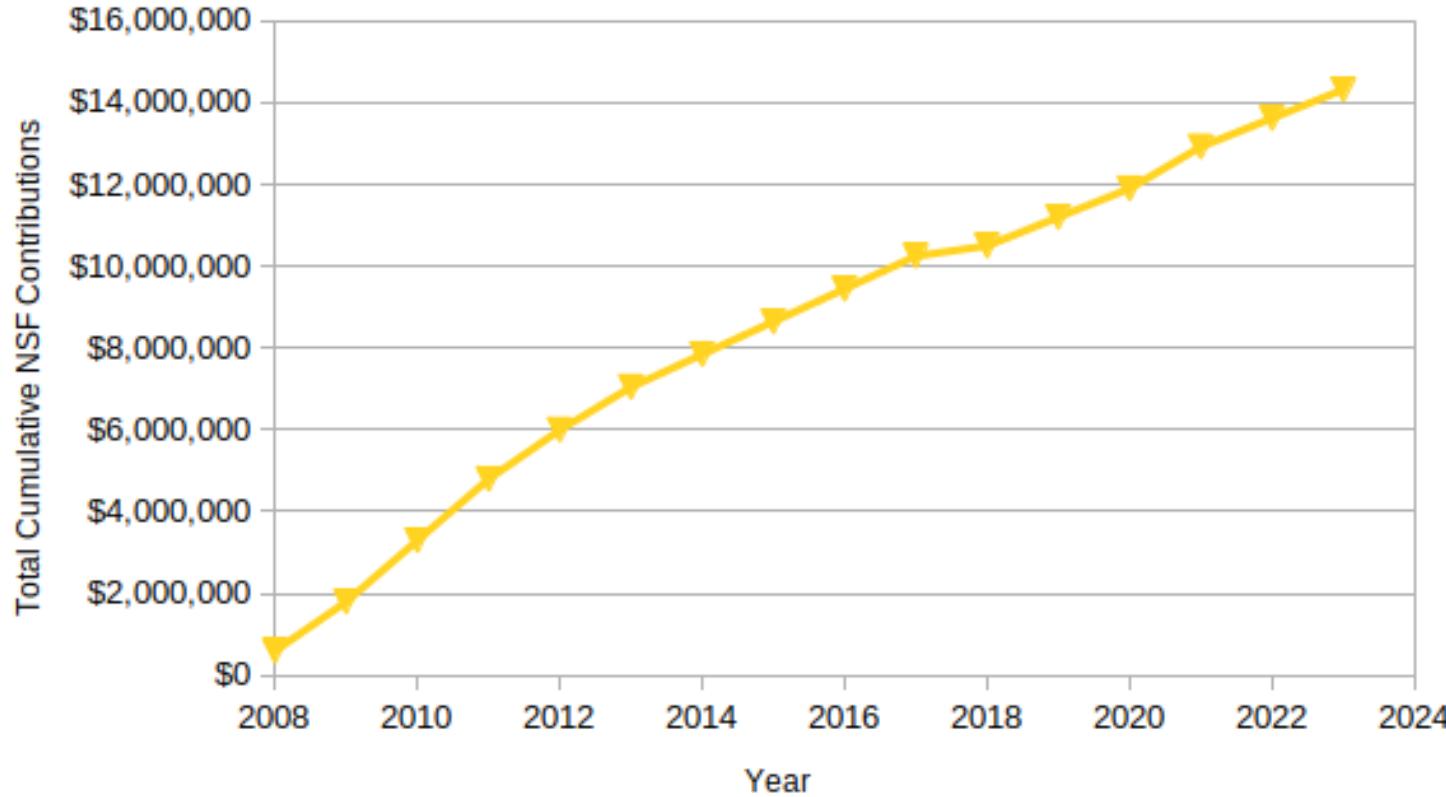


**CAFS strategically aligns the primary forest sector relevant universities in the US on topics of high relevance**

# NSF Support



IUCRC



**CAFS has received over \$15M in NSF funding since its inception through direct and supplemental contributions**

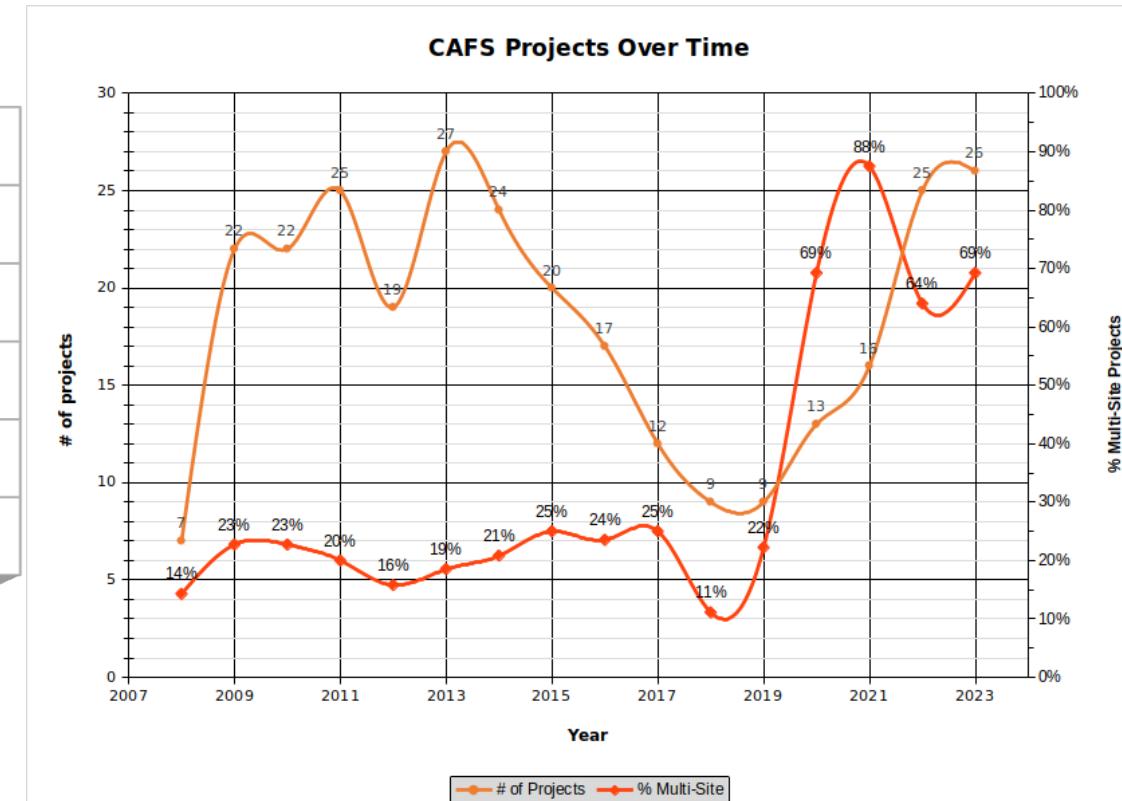
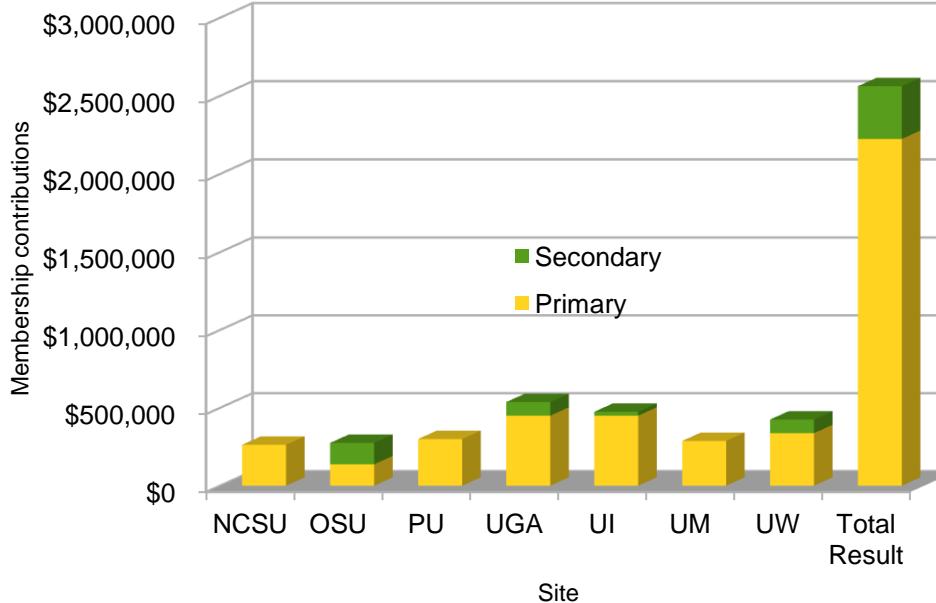
## Phase 3 Technology Roadmap

	2019	2020	2021	2022	2023	Outcomes
All CAFS Sites						IAB Meetings, evaluation, undergraduate education, publications, attendance at national meetings, securing of additional research support
<b>Theme 1: Forest Modeling &amp; Decision-Support Tools</b> Primary IAB Partners: American Forest Management, Green Diamond, Campbell Global Project 1: Assessing and mapping regional variation in potential site productivity Lead Partners: NCsu, UI, UGA, UW, PU Project 2: Assessing and mapping regional variation in site carrying capacity Lead Partners: UI, UM, OSU, VT, UGA, UW Project 3: Evaluation and refinement of regional GY models Partners: UM, VT, UGA, OSU, PU						Better understand how potential site productivity differs across the key forest regions in the US, the most influential factors, and produce high-resolution maps for IAB members to aid planning
						Derive consistent estimates of maximum stand density index, evaluate most influential factors, and provide high-resolution maps to aid management
						Using the outcomes from Projects 1 and 2, evaluate regional growth and yield behavior and refine as possible
<b>Theme 2: Effective Use of Remote Sensing Technologies</b> Primary IAB Partners: JD Irving, Rayonier, Weyerhaeuser Project 4: Mapping species composition and past disturbance using optical sensors Partners: UI, UM, UGA Project 5: Improving efficiency and accuracy of Enhanced Forest Inventories derived from LiDAR Partners: UW, OSU, UGA, UM Project 6: Using hyperspectral imaging to evaluate forest health risk Partners: VT, NCsu, OSU, UM						Evaluate and leverage emerging remote sensing technologies to improve planning
						Optimal sensors like Landsat and Sentinel-2 offer the ability to annual map species composition and past disturbance, but have yet to be tests across the US
						LiDAR is becoming increasingly used to produce Enhanced Forest Inventories, but uncertainties on ground data, necessary metrics, and modeling method remain.
						Forest health risks are extensive and difficult to detect. Hyperspectral imaging from terrestrial and/or airborne sensors can help detection and quantification
<b>Theme 3: Improved Silvicultural Practices</b> Primary IAB Partners: Hancock Forest Management, International Forest Company, Molpus Timberlands Management Project 7: Quantifying long-term gains using advanced genetics Lead Partners: PU, UGA, OSU, NCsu Project 8: Modeling forest response to early stand treatments Lead Partners: UW, UI, NCsu, VT Project 9: Identifying type and level of response to forest fertilization Lead Partners: UW, UI, NCsu, PU						Forest managers have a variety of silvicultural regimes to select from, but it is often unclear on selecting the best practices for each site
						Tree genetics has seen significant advances in recent years due to better breeding practices and cloning, but a synthesis of the long-term potential effects of these practices across multiple species has yet to be presented
						Vegetation management is critical to successful rotations, but its prediction is complicated by a variety of factors such as the type and extent of competing vegetation. Leveraging long-term datasets, the outcomes of contrasting treatments would be assessed and modeled.
						Forest fertilization is a widely used silvicultural practice that is difficult to predict. Using long-term and newly available data, methods to improve predictions of forest responsiveness would be evaluated.
<b>Project-wide activities informed by Research Plan</b>	Incorporation of advanced and emerging technologies Delivery of multi-platform, decision-support tools Harmonization, and synthesis of available regional datasets to generalize trends Multi-disciplinary, knowledge to action, and stakeholder-drive framework					

Lead Site	PI	Project/Title	Status 2023
UW	Turnblom et al.	16.69 Stand and tree responses to late rotation fertilization	Continuing
UI*	Kimsey et al.	19.75 Assessing & mapping regional variation in site carrying capacity across the primary forest types in the US	Continuing
NCsu/UGA*	Cook et al.	19.76 Assessing & mapping regional variation in site productivity across the primary forest types in the US	Continuing
UI*	Nelson/Jacobs/Gonzalez	20.78 Intraspecific hydraulic responses of commercial tree seedlings to nursery drought conditioning	Continuing
UM	Legaard/ Weiskittel	20.79 Multi-regional evaluation of new machine learning algorithms for mapping tree species distribution and abundance	Continuing
PU*	Couture/Jacobs	20.80 Using hyperspectral imaging to evaluate forest health risk	Continuing
OSU*	Hatten	20.81 Resilience of soil organic matter to harvesting: A global study of long-term soil productivity experiments	Continuing
UW*	Turnblom and Cross	20.82 Stand response to thinning: Enhancing response prediction through modeling	Continuing
UW	Cross and Turnblom	20.83 Using predictive analytics to decompose site index	Ending
UW	Littke	20.84 Physiologic response to commercial fertilization programs in Pacific Northwest forest plantations	Continuing
OSU*	Gonzalez	21.85 Variation in productivity, wood quality and soil carbon of nine conifer species across a gradient in water deficit	Continuing
NCsu*	Trlica	21.87 Linking leaf area index and remote sensing across different forest types	Continuing
UGA*	Dahlen et al.	21.88 Quantifying silvicultural treatment effect on lumber quantity and quality in loblolly pine	Continuing
UGA	Dahlen et al.	21.89 Quantifying carbon sequestration as a function of silvicultural treatment in loblolly pine	Continuing
NCsu*	Cook et al.	21.91 NCsu START: NCsu, Montgomery Community College, Wayne Community College	Continuing
UM*	Weiskittel et al.	21.92 UMaine START: UM & UMaine at Fort Kent	Continuing
UI	Coleman	22.95 UI INTERN: Improving tree seedling survival with defense-enhancing endophytes	Ending
NCsu	Pala	22.98 CAFS Interactive Mapping Platform (CAFsimp)	Continuing
UGA*	Bullock et al.	22.99 Effects of dominant tree height definition on loblolly pine growth & yield model outputs	Continuing
UM*	Premer et al.	23.100 Use of carbon isotopes for assessing site-specific response to thinning	New
UI	Kimsey et al.	23.101 Site-stand dynamics & pine beetle mortality in Ponderosa pine ecosystems	New
UI	Nelson et al.	23.102 Enhancing resistance to fungal pathogens in commercial tree seedlings	New
OSU*	Mainwaring	23.103 Determination of crown morphological traits using laser scanning in Douglas-fir and loblolly pine genetics trials	New
OSU*	Hailemariam et al.	23.104 Interplay between sampling design and small area estimation to improve forestland inventory	New

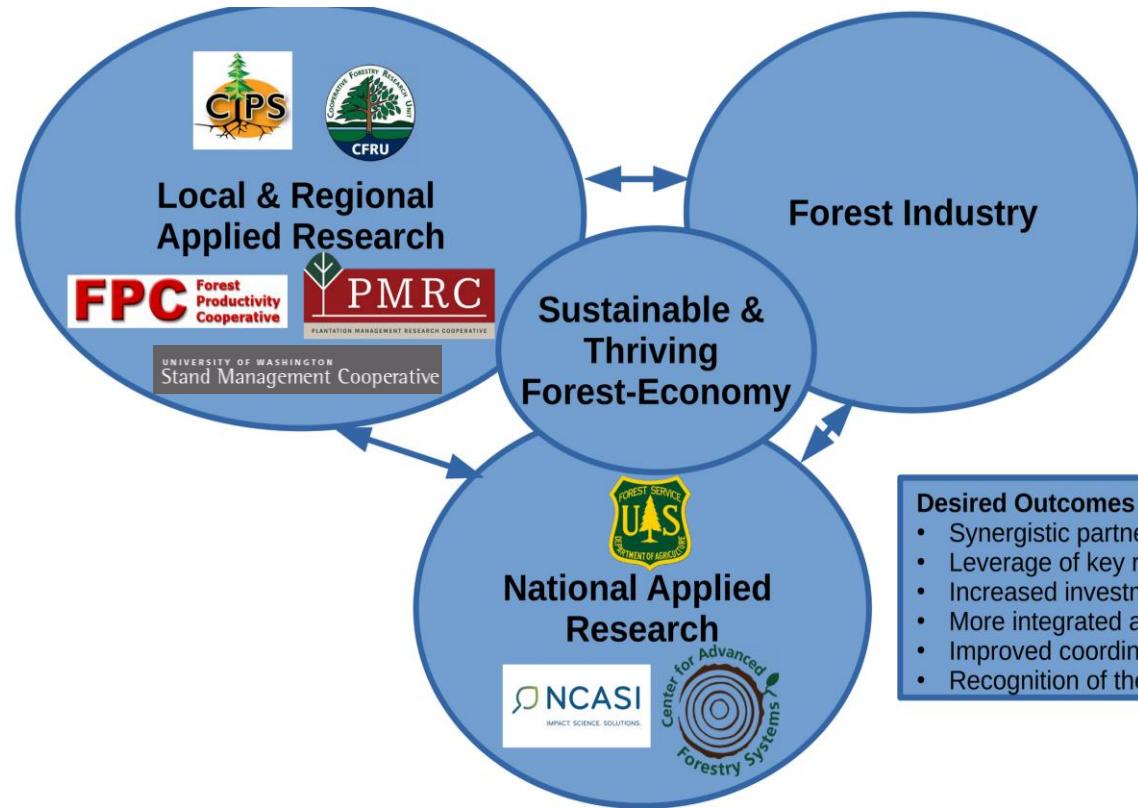
**National R&D consortium with priorities and projects driven by the support and needs of membership**

# Center Funding & Projects



Funding and membership remain stable, while projects have continued to increase and are now 70% multi-site

# Future of Forestry R&D?



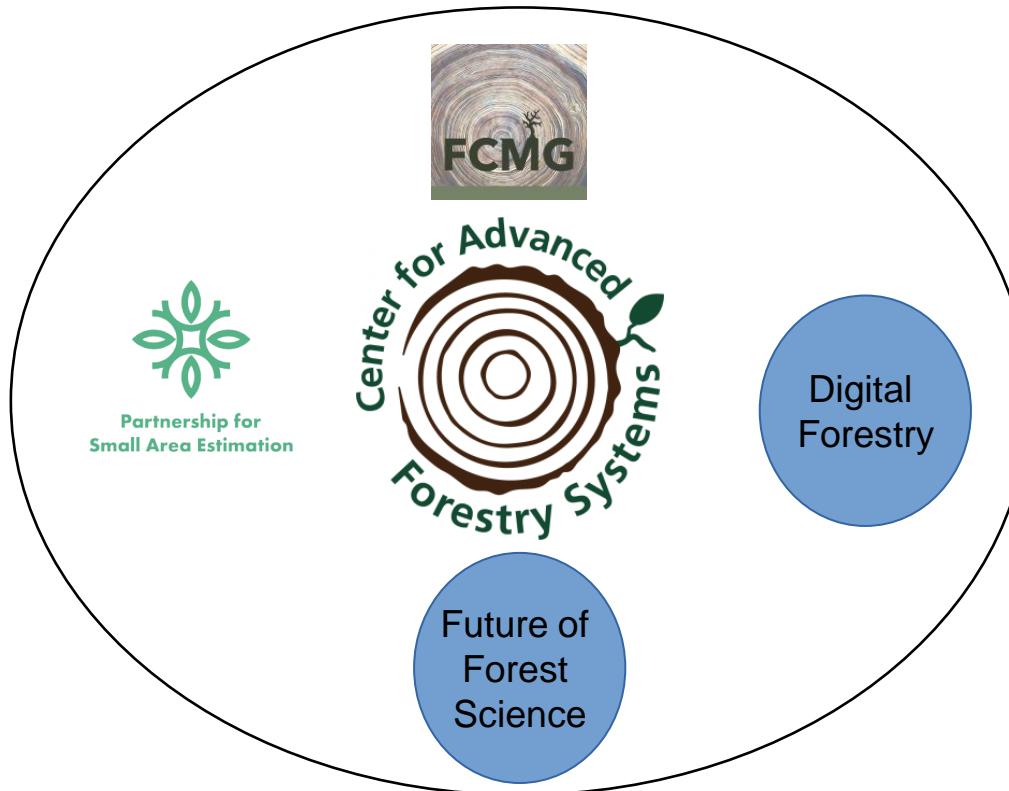
## Desired Outcomes

- Synergistic partnerships
- Leverage of key resources and expertise
- Increased investment in forests including R&D
- More integrated and effective messaging
- Improved coordination across the sector
- Recognition of the broader importance of forests



**A national public-private-academic R&D consortium is needed, which CAFS fulfills**

# Potential National R&D Partnerships?



**CAFS could serve as an umbrella organization to provide R&D support of ongoing and future national research initiatives driven by members**



# CAFS Future Options

Option	Details
A	Wrap-up and close-out CAFS
B	Seek \$15k/yr from participating sites and invite other sites to join
C	Option B + Federal funding
D	Request actual membership contributions directly for CAFS
E	Re-direct regional co-op contributions for CAFS
F	?

**Evaluating various options for long-term sustainability with strong support for Option C**

# USFS FIA Blue Ribbon Panel

- Bill introduced to form a Blue Ribbon Panel for FIA in fall of 2022

- Panel should:
  - -Assess modernization of the program
  - -Evaluation of SAE and remote sensing integration
  - -Consider public-private-academic partnership
- CAFS could address many of these recommendations
  - -Serve as the primary public-private-academic partnership
  - -Platform for assessing and prioritizing research
  - -Support research on SAE and remote sensing

118TH CONGRESS  
1ST SESSION

**S.**

To require the Secretary of Agriculture to convene a blue ribbon panel to review the forest inventory and analysis program of the Forest Service, and for other purposes.

IN THE SENATE OF THE UNITED STATES

Mr. KING introduced the following bill; which was read twice and referred to the Committee on \_\_\_\_\_

## **A BILL**

To require the Secretary of Agriculture to convene a blue ribbon panel to review the forest inventory and analysis program of the Forest Service, and for other purposes.

1       *Be it enacted by the Senate and House of Representa-*

2       *tives of the United States of America in Congress assembled,*

3       **SECTION 1. FOREST INVENTORY AND ANALYSIS PROGRAM**

4                   **BLUE RIBBON PANEL.**

5       Section 3 of the Forest and Rangeland Renewable

6       Resources Research Act of 1978 (16 U.S.C. 1642) is

7       amended by adding at the end the following:

8        “(f) FOREST INVENTORY AND ANALYSIS PROGRAM

9        **BLUE RIBBON PANEL.—**

# Draft FY24 Senate Appropriations

*Research Funding Priorities.*—For the following research initiatives, funding for geographically-based items is in addition to funds otherwise provided to individual research stations and therefore is not to be factored into base allocations.—\$6,000,000 to support the Northeastern States Research Cooperative, a collaboration among universities in Maine, New Hampshire, New York, and Vermont, sponsoring research to sustain the health of northern forest ecosystems and communities, develop new forest products and improve forest biodiversity management, including to establish a Digital Forestry Systems Research Consortium to advance data-driven, AI-supported forest management systems that increase both the provision of ecosystem services and operational efficiency. None of these funds shall be factored into the base allocation of the Northern Research Station. Further, funding should be expeditiously distributed in a manner consistent with fiscal year 2022 and prior.

- \$2,000,000 for research on forest-based cellulose nanomaterials, including material forms, manufacturing processes, and technology transfer.
- \$2,000,000 to support new and existing academic partnerships to further explore the use of available technologies like remote sensing and methodologies such as small area estimation to further refine county and State biomass estimates as outlined in Sec. 8632 of the Agriculture Improvement Act of 2018 (Public Law 115–334).

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# CAFS Path Forward

1. Secure USFS R&D as a CAFS member (✓)
2. Secure CAFS relevant Federal appropriations (✓)
3. Enact FIA Blue Ribbon Panel that highlights the need and importance of CAFS
4. CAFS receive USFS Federal funding via NCASI Foundation
5. Continue to grow CAFS to beyond USFS

# Summary

- CAFS has been a net benefit for all and addresses the need for a national consortium
  - Provided direct funding
  - Built a strong collaboration network
  - Leveraged research investments
- CAFS officially graduates from NSF at the end of Phase III (12/24)
- Be highly difficult to recreate CAFS from scratch or do another NSF IUCRC



# Questions/Comments?



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<https://crsf.umaine.edu/forest-research/caf/>