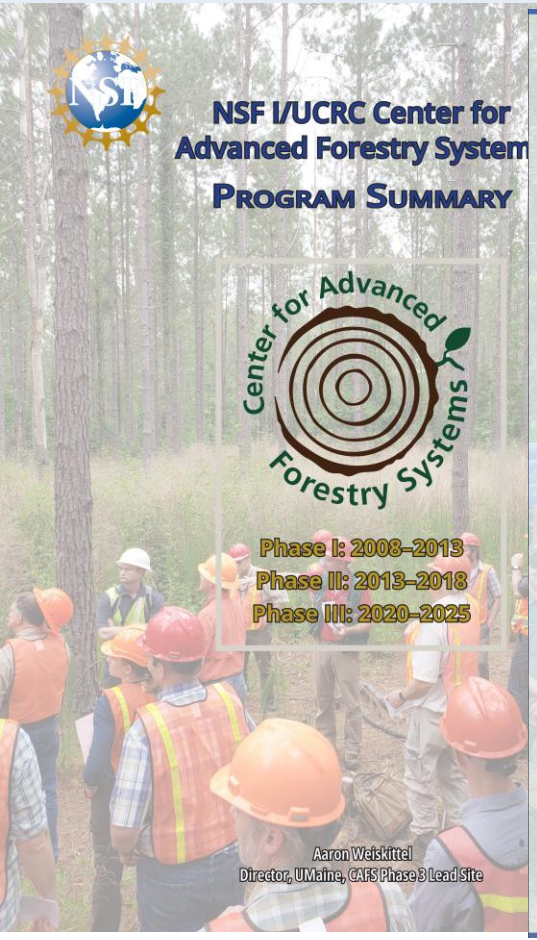
The Future of

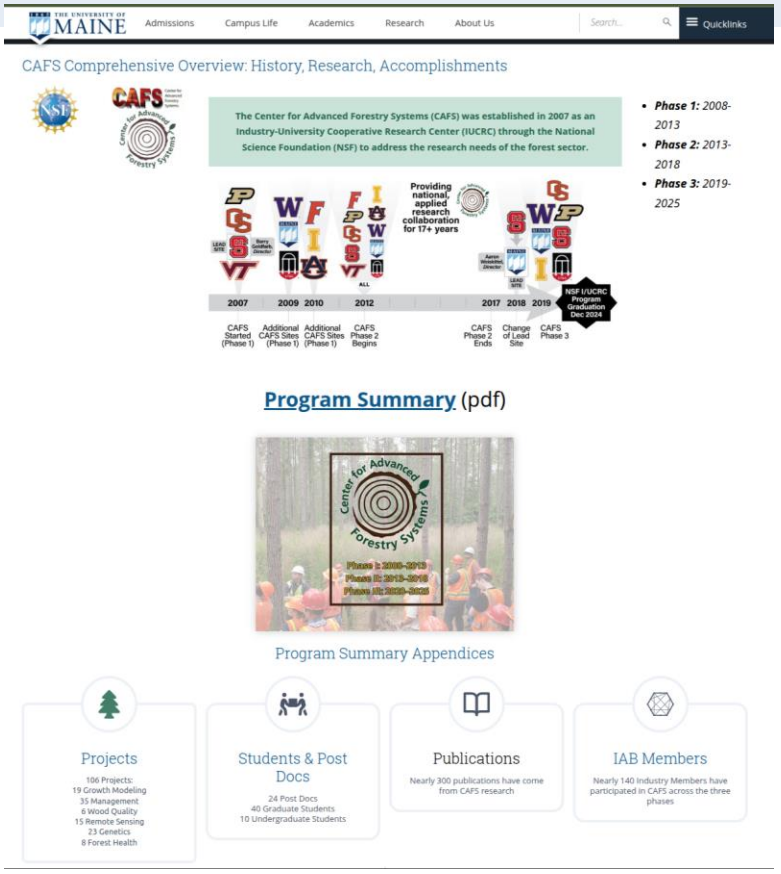
NSF's Center for Advanced Forest Systems (CAFS)?

Aaron Weiskittel,
Director

1865 THE UNIVERSITY OF MAINE

Summative Report





https://crsf.umaine.edu/forest-research/cafs/program-summary/

National Relevancy of Forest Centric R&D and Need for a National Consortium

Center for Advanced Forestry Systems | NSF | IUCRC

Current State of R&D

10/17 FINAL REPORT

The Blue Ribbon Commission on Forest and Forest Products Research & Development in the 21st Century

Forest Science, 2022, **68**, 226–236
https://doi.org/10.1093/forsci/fxac004
Advance access publication 30 March 2022
Research Article

OXFORD SAF

Social Sciences

Change in Doctoral Dissertation Topics in Forest Resources from US Universities Over Four Decades

Robert G. Wagner[1,*], **Kristen M. Bellisario**[2], **and Ningning N. Kong**[2]

[1]Department of Forestry and Natural Resources, Purdue University, 715 W State Street, West Lafayette, Indiana 47907, USA.
[2]Libraries and School of Information Studies, Purdue University, 715 W State Street, West Lafayette, Indiana 47907, USA.
*Corresponding author email: rgwagner@purdue.edu

Abstract

Changes in forest resources expertise from 1978 to 2017 as measured by annual number of doctoral dissertations published on twenty topics, were examined. Using the ProQuest Dissertations and Theses Global database, titles and abstracts from 11,536 dissertations produced by fifty-six universities in the United States were selected. Automated content analysis and latent Dirichlet allocation were used to identify the optimal number of topic groupings among 2,782 dissertations that met selection criteria. Substantial differences were found in the pattern of publication among the twenty topics over time. The number of dissertations related to forest growth and silviculture, tree seedling propagation, physiology, and regeneration, and forest soil nutrients, ecology, and management declined over the past two decades. Dissertations related to forest wildlife management, including terrestrial wildlife ecology and management; wildlife food and nutrition; and fish ecology and management also declined during the same period. The number of dissertations in the fields of forest policy, politics, and social science; forest modeling, biometrics, and statistics; wood science; forest vegetation ecology; and avian ecology increased during the four decades. Dissertations published in the fields of forest economics, and forest entomology and pathology, remained relatively stable.

Study Implications: We found decreasing production of doctoral dissertations focused on applied forest and wildlife management topics in recent decades. Declining doctoral-level expertise in applied fields after the early 2000s suggest that there may be reduced capacity to address practical problems facing both forest and wildlife managers. This decline also suggests that finding university instructors qualified to teach more applied forest and wildlife courses may have been more difficult over the past decade and possibly into the future. Our analysis indicated that the increased number of dissertations in adjacent sciences supporting forest resources has substantially increased capacity in these areas.

Keywords: graduate education and research, land-grant universities, McIntire-Stennis, automated content analysis, latent Dirichlet allocation

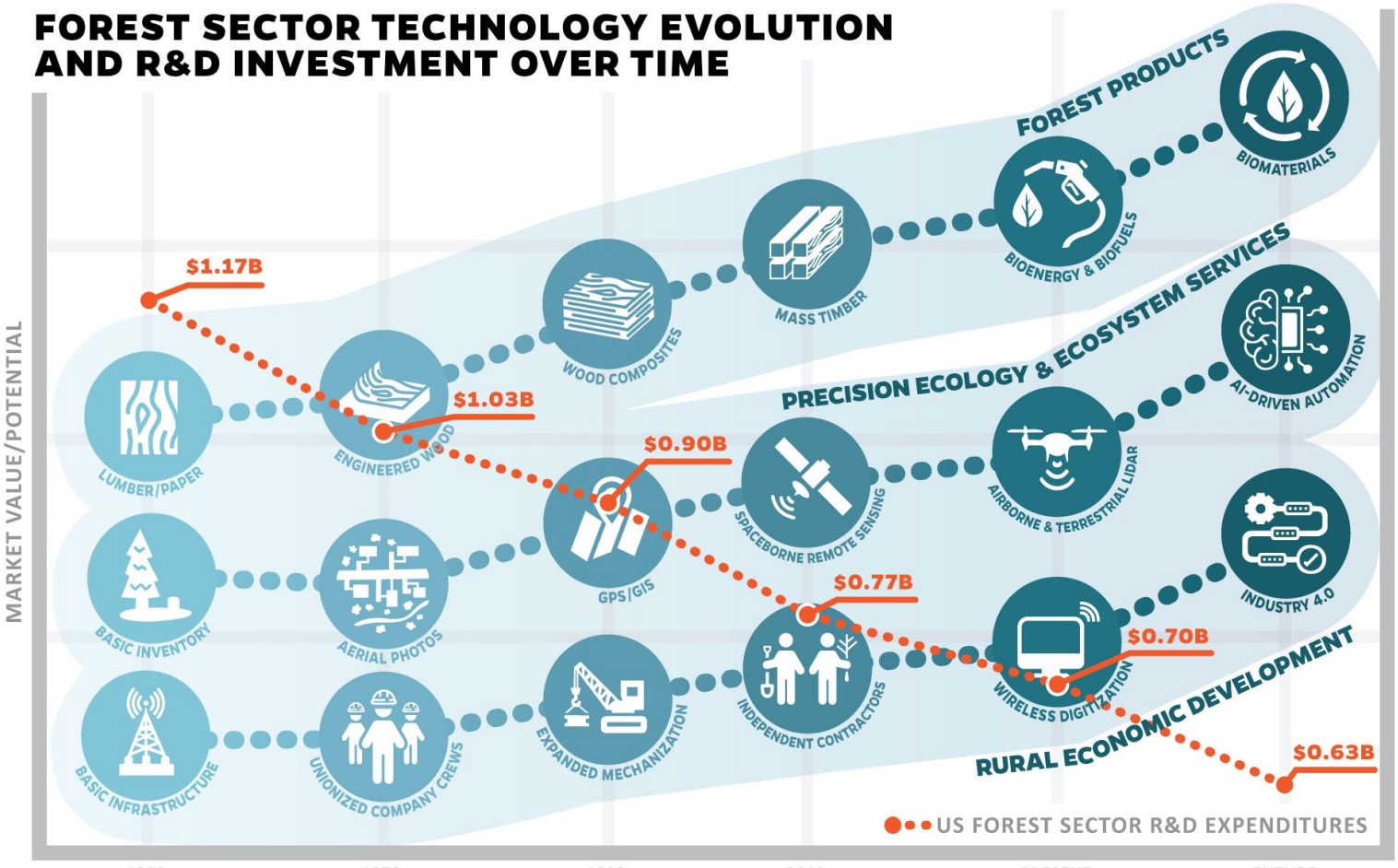
Forest resources research and development (R&D) capacity in the US has eroded significantly over the past several decades (US Endowment for Forestry and Communities 2017, McGinley et al. 2019). This reduction in capacity has been occurring across federal, university and industry organizations. For example, USDA Forest Service staffing in fields essential for wood products innovation is only 25% of the level that it was three decades ago (US Endowment for Forestry and Communities 2017). Staffing also has been reduced by 40% in fields critical for protecting forest health (e.g., entomology and pathology).

McGinley et al. (2019) assessed changes in the nation's forest research capacity since it was last reported by the National Research Council (National Research Council 2002). They found that both the numbers of scientists and total funding available for forest resources R&D has declined substantially since 2002. The total number of university forestry professors and Forest Service scientists has declined approximately 15% since 2002, and research programs supported by forest industry have declined significantly more. As a result, there are fewer experts in the fields of forest management, forest protection, and forest products employed by forest resources organizations than a few decades ago. This reduction has occurred during a period when the risks and opportunities for forests in the US have never been greater, and thus potentially threatens long-term stewardship of the nation's forests and global competitiveness of the US forest products sector.

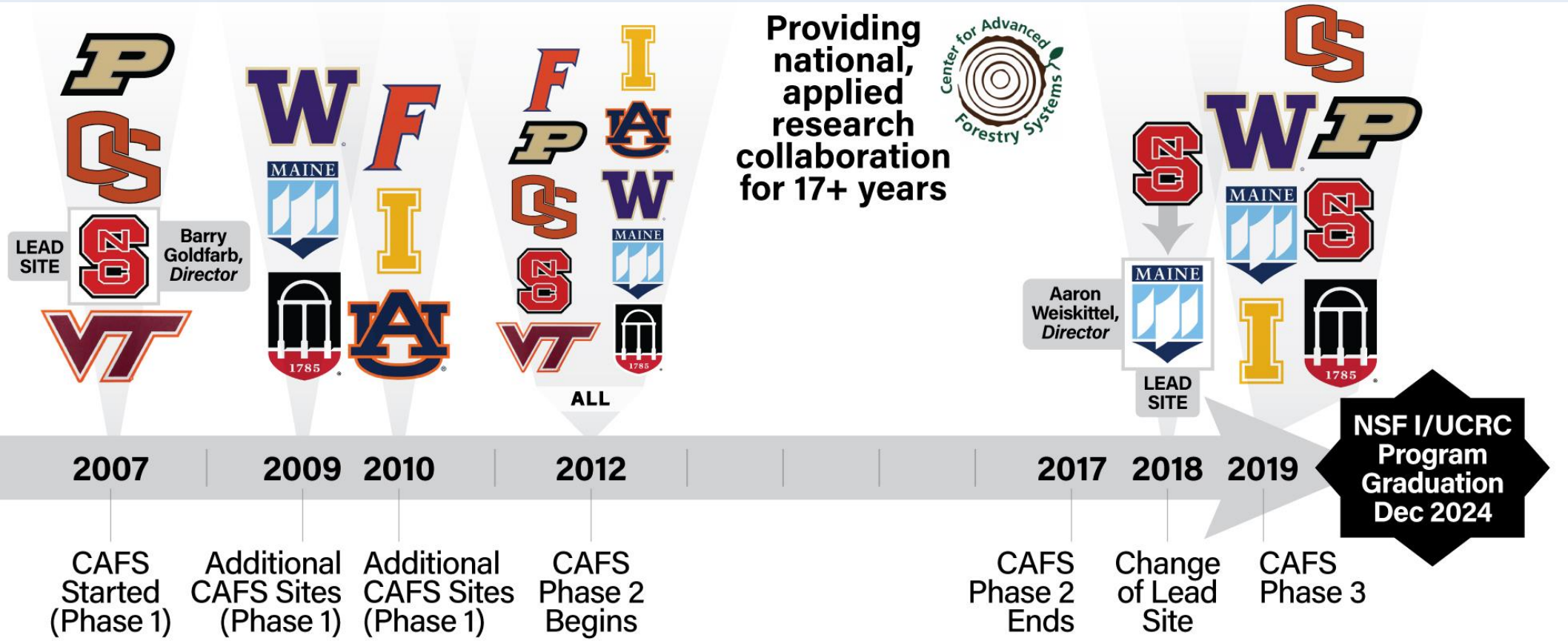
We were curious whether production of expertise in forest resources also was changing while this reduction in national R&D capacity was occurring. In addition to overall capacity, changes in subject matter expertise can affect the kind of capacity that is available to address problems that forest resource managers face across the nation and world. At the very least, it can influence the relative contribution that US-trained forest scientists can make in helping address these problems.

The objective of this study was to quantify changes in the production of forest resources expertise in the US during previous decades as measured by changes in number of forest-resources-related doctoral dissertations from university programs. Change in doctoral dissertations was selected as a key metric because it is the highest level of forest resources expertise produced in the country. The subject matter expertise developed by doctoral students also determines much of the national capacity to (1) lead future government, university, and industry research efforts to address current and future

Received: August 11, 2021. Accepted: January 28, 2022

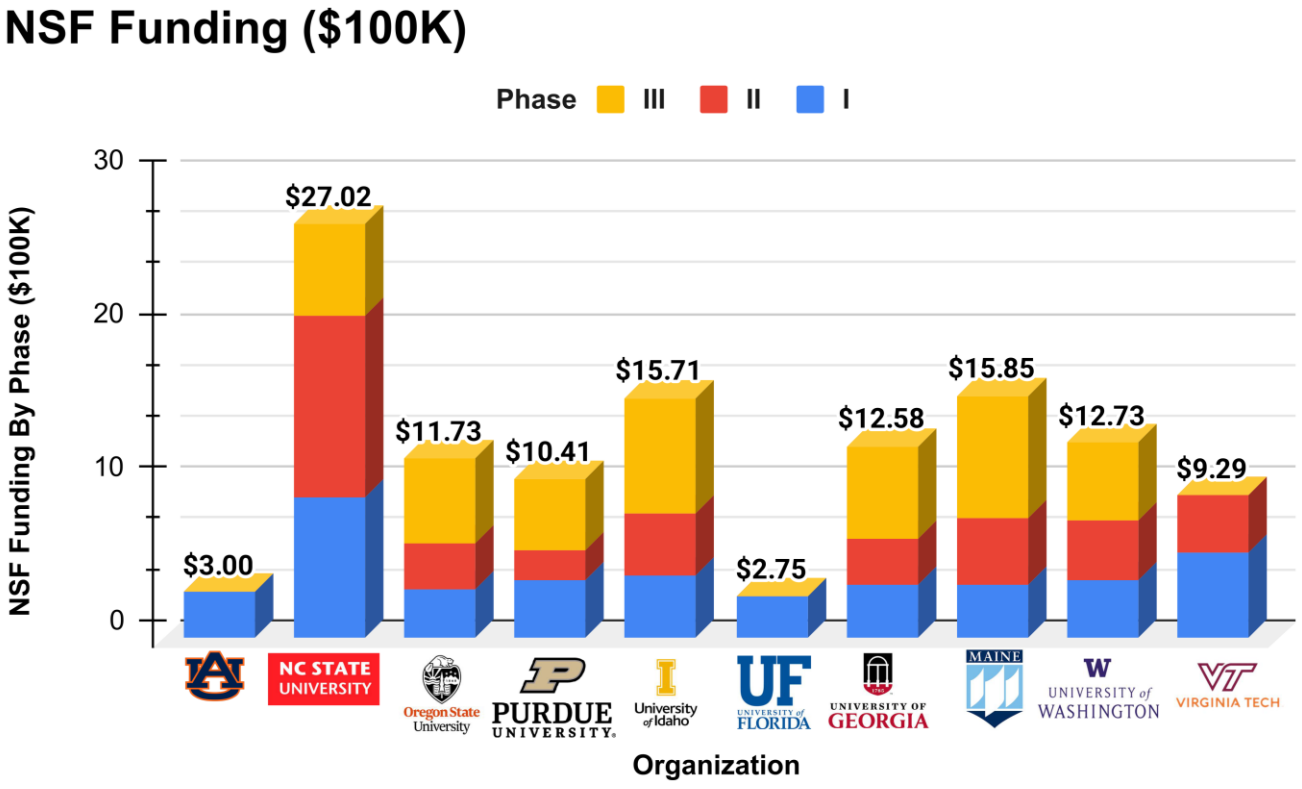


CAFS TIMELINE



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

NSF Center Funding



NSF has provided over $12M in funding that has benefitted multiple universities over the years

CAFS MEMBERSHIP

Center for Advanced Forestry Systems | NSF | IUCRC

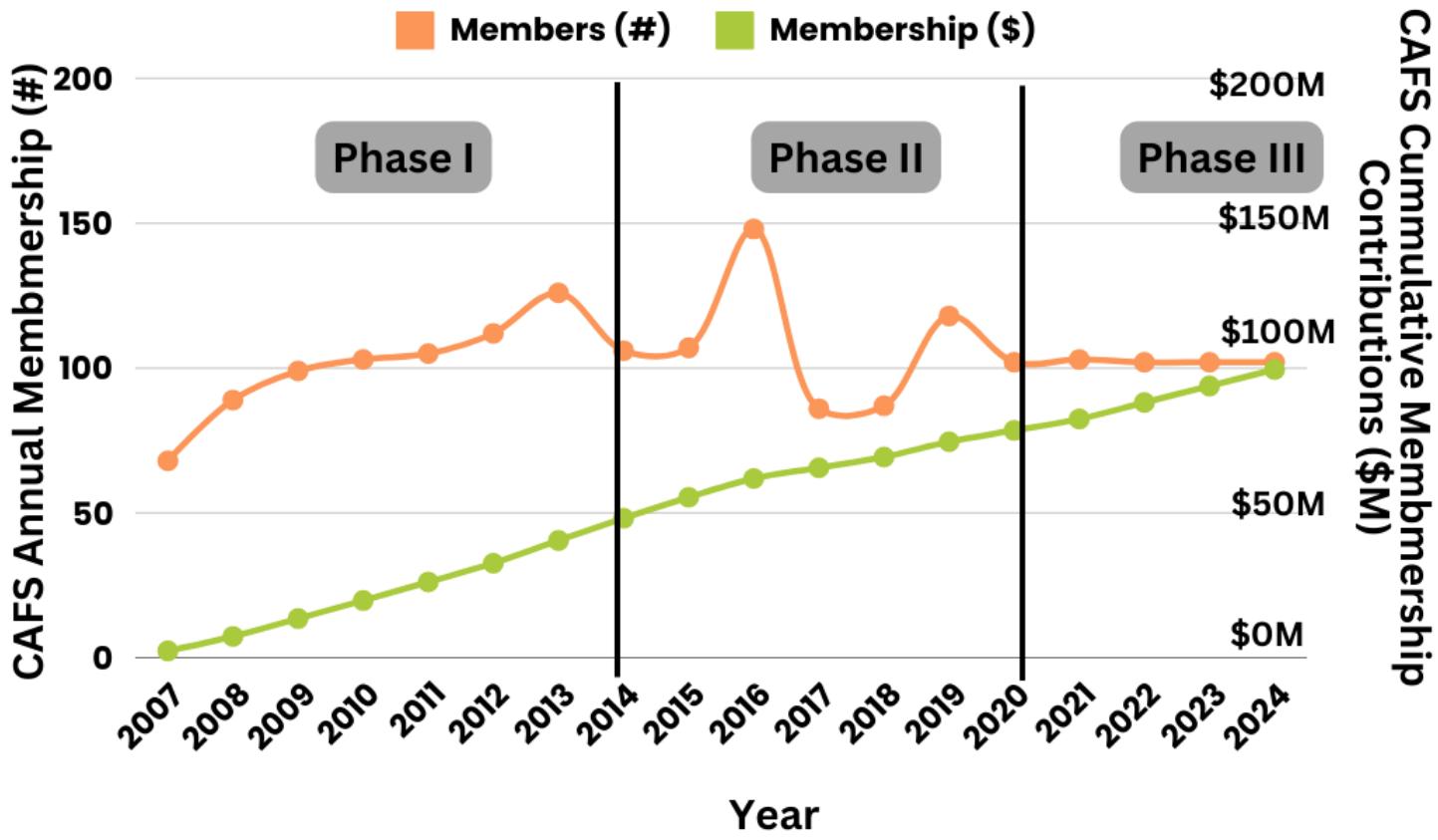
Weyerhaeuser

Hancock Natural Resource Group®
A Manulife Investment Management Company

PotlatchDeltic

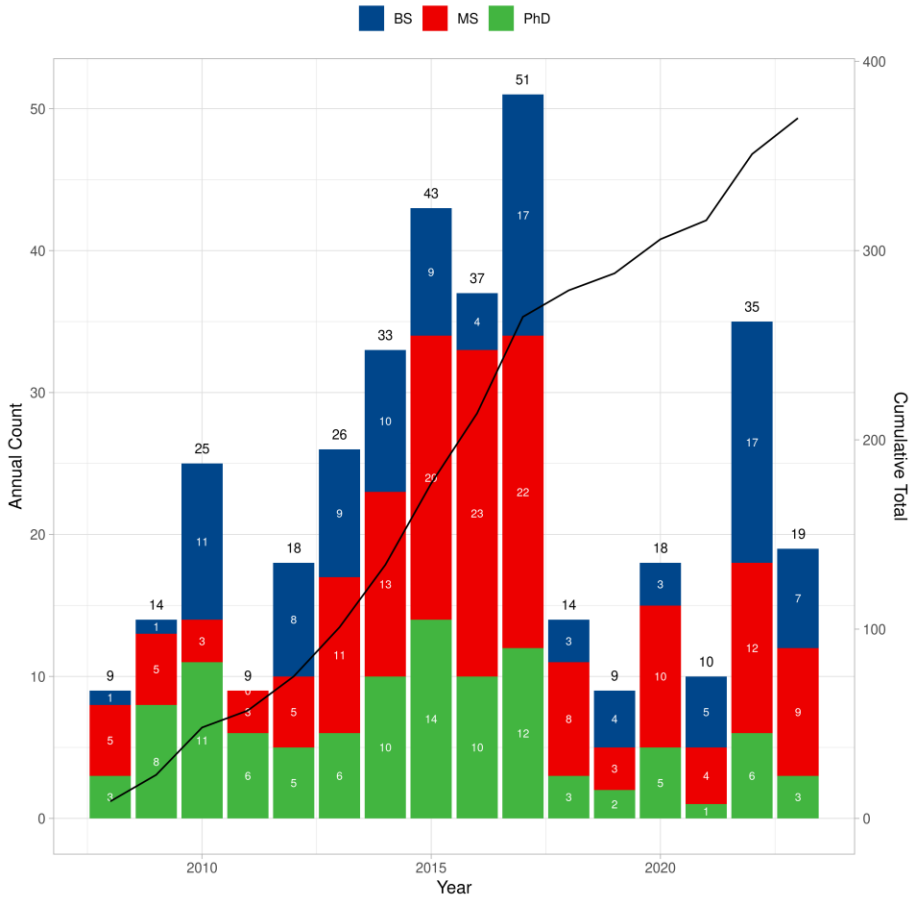
Rayonier
More than trees

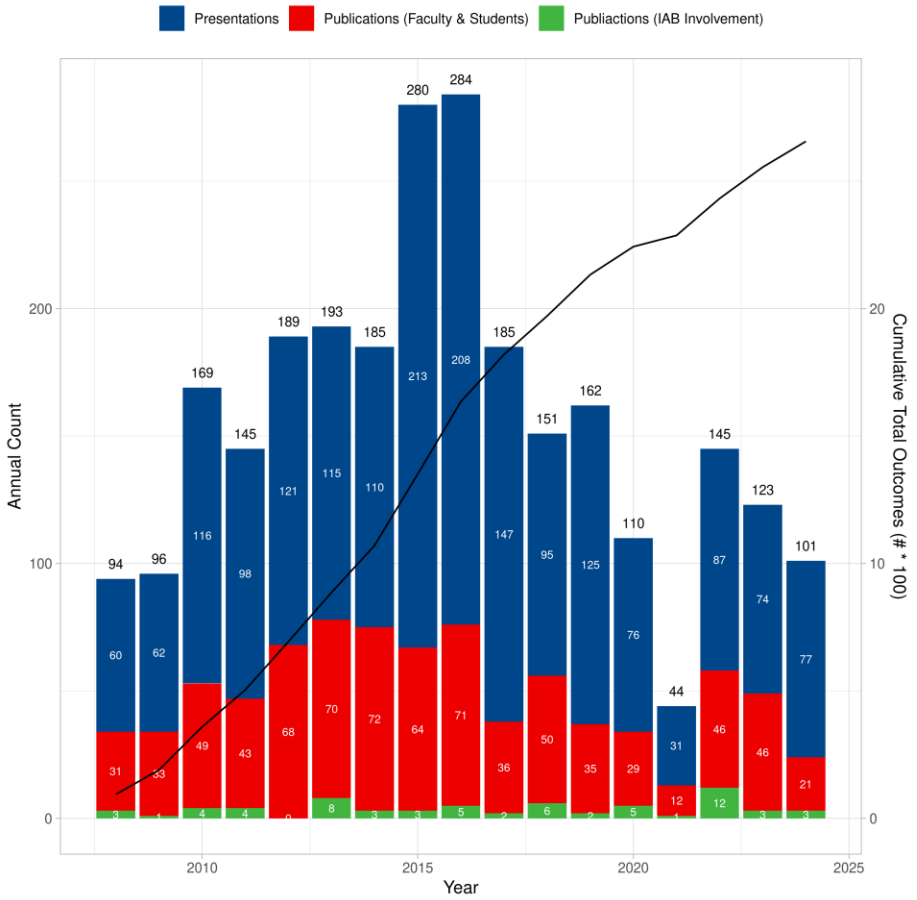
CampbellGlobal
FOREST & NATURAL RESOURCE INVESTMENTS



Consistent support and direct financial contributions of CAFS membership

Center Outcomes

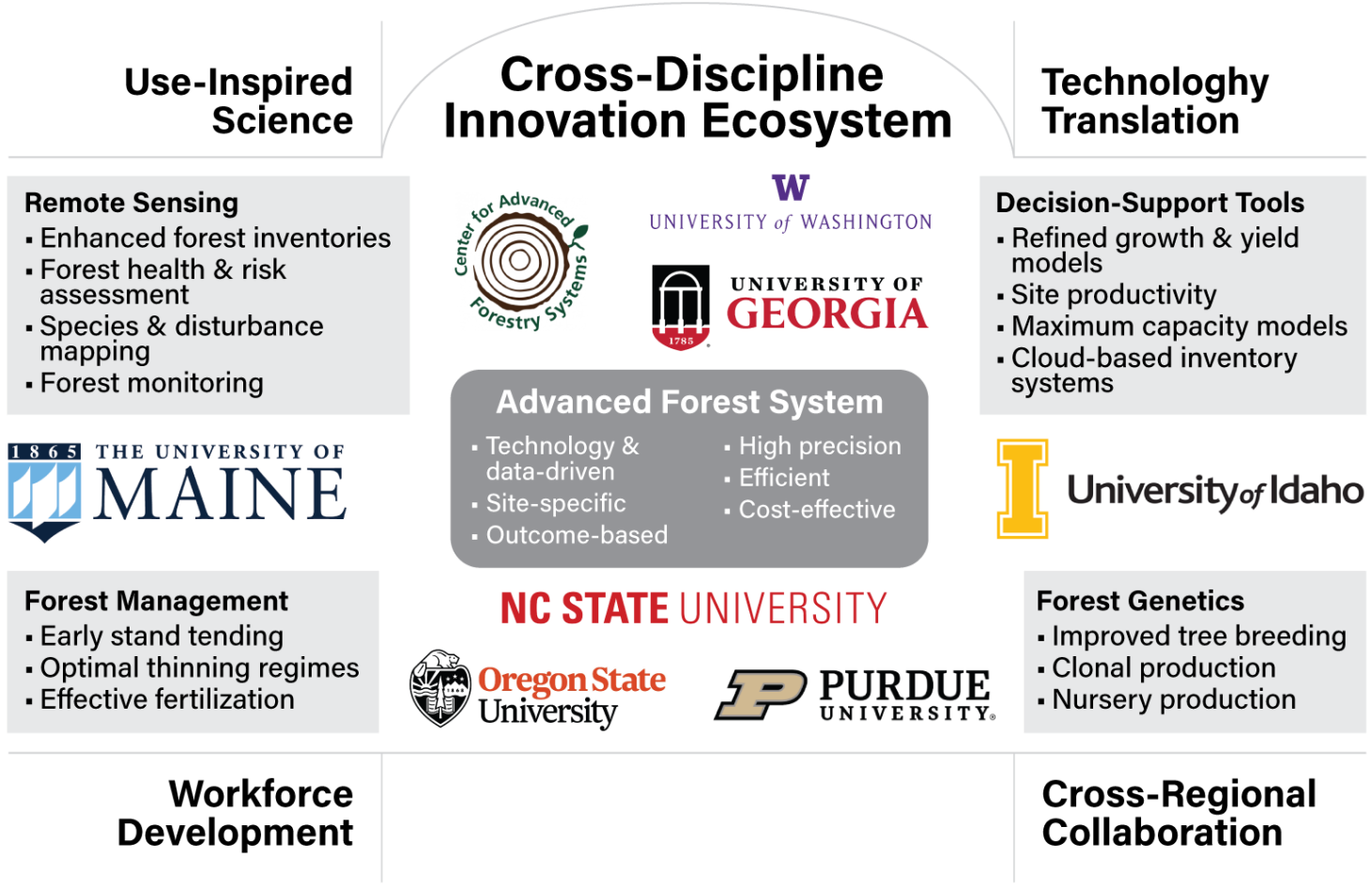




Trained several students and produced numerous scientific outcomes

Innovation Ecosystem

CAFS leverages the strengths & expertise of its university partners



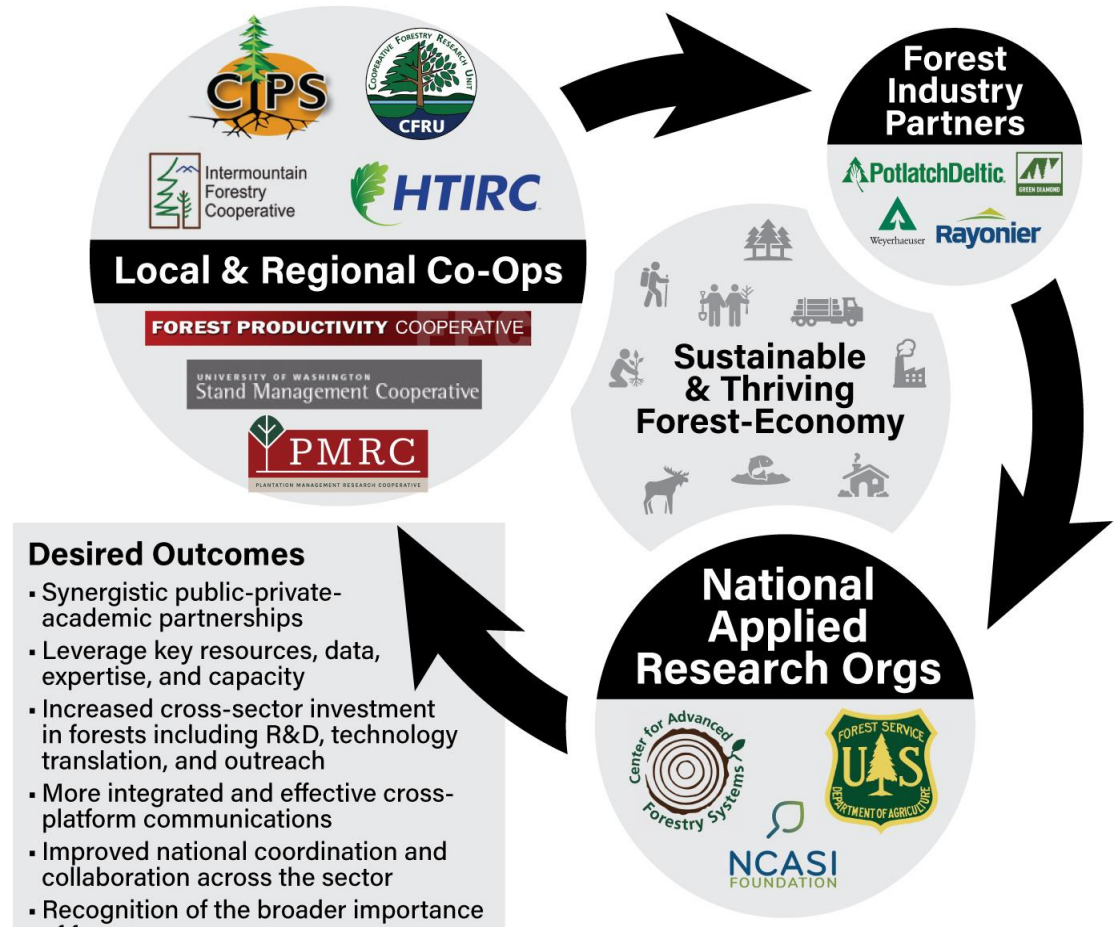
Technology Roadmap

	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Outcomes
Theme 1: Forest Modeling & Decision-Support Tools **Primary IAB Partners: American Forest Management, Green Diamond, and Campbell Global**						**Provide IAB members with improved tools that allow better and more precise forest management and planning**
Project 1: Assessing and mapping regional variation in potential site productivity Lead Partners: NCSU, UI, UGA, UW, 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
Project 2: Assessing and mapping regional variation in site carrying capacity Lead Partners: UI, UM, OSU, VT, UGA, UW	■	■	■			Derive consistent estimates of maximum stand density index, evaluate most influential factors, and provide high-resolution maps to aid management
Project 3: Evaluation and refinement of regional GY models Partners: UM, VT, UGA, OSU, PU			■	■	■	Using the outcomes from Projects 1 and 2, evaluate regional growth and yield behavior and refine as possible
Theme 2: Effective Use of Remote Sensing Technologies **Primary IAB Partners: JD Irving, Rayonier, and Weyerhaeuser**						**Evaluate and leverage emerging remote sensing technologies to improve planning**
Project 4: Mapping species composition and past disturbance using optical sensors Partners: UI, UM, UGA	■	■	■			Optimal sensors like Landsat and Sentinnel-2 offer the ability to annual map species composition and past disturbance, but have yet to be tests across the US
Project 5: Improving efficiency and accuracy of Enhanced Forest Inventories derived from LiDAR Partners: UW, OSU, UGA, UM	■	■	■	■	■	LiDAR is becoming increasingly used to produce Enhanced Forest Inventories, but uncertainties on ground data, necessary metrics, and modeling method remain.
Project 6: Using hyperspectral imaging to evaluate forest health risk Partners: VT, NCSU, OSU, UM			■	■	■	Forest health risks are extensive and difficult to detect. Hyperspectral imaging from terrestrial and/or airborne sensors can help detection and quantification
Theme 3: Improved Silvicultural Practices **Primary IAB Partners: Hancock Forest Management, International Forest Company, and Molpus Timberlands**						**Forest managers have a variety of silvicultural regimes to select from, but it is often unclear on selecting the best practices for each site**
Project 7: Quantifying long-term gains using advanced genetics Lead Partners: PU, UGA, OSU, NCSU	■	■				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
Project 8: Modeling forest response to early stand treatments Lead Partners: UI, UW, NCSU, VT	■	■	■	■	■	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.
Project 9: Identifying type and level of response to forest fertilization Lead Partners: UW, UI, NCSU, PU			■	■	■	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.

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: NSCU, 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

Roadmap drove the Phase III research project portifolio

Future of Forestry R&D



Desired Outcomes

- Synergistic public-private-academic partnerships
- Leverage key resources, data, expertise, and capacity
- Increased cross-sector investment in forests including R&D, technology translation, and outreach
- More integrated and effective cross-platform communications
- Improved national coordination and collaboration 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

Partnership for Small Area Estimation

Center for Advanced Forestry Systems

Digital Forestry

Future of Forest Science

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

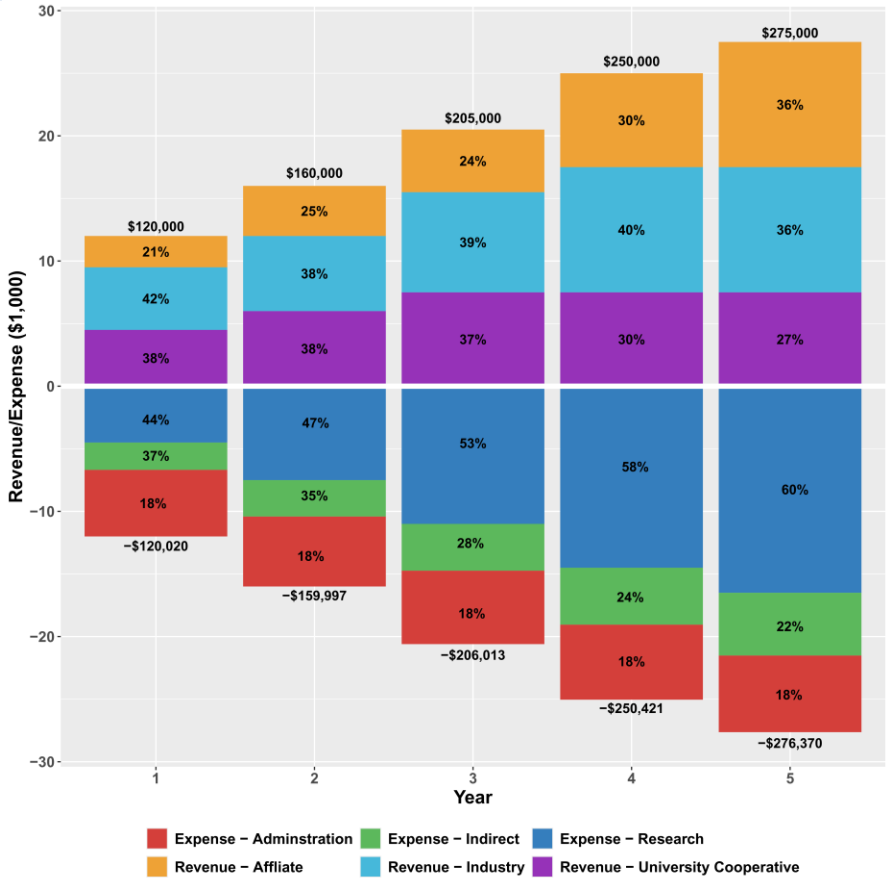
CAFS Future Options

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

Option	Details
A	Wrap-up and close-out CAFS
B	Seek $10-15k/yr from participating sites, IAB members 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	?

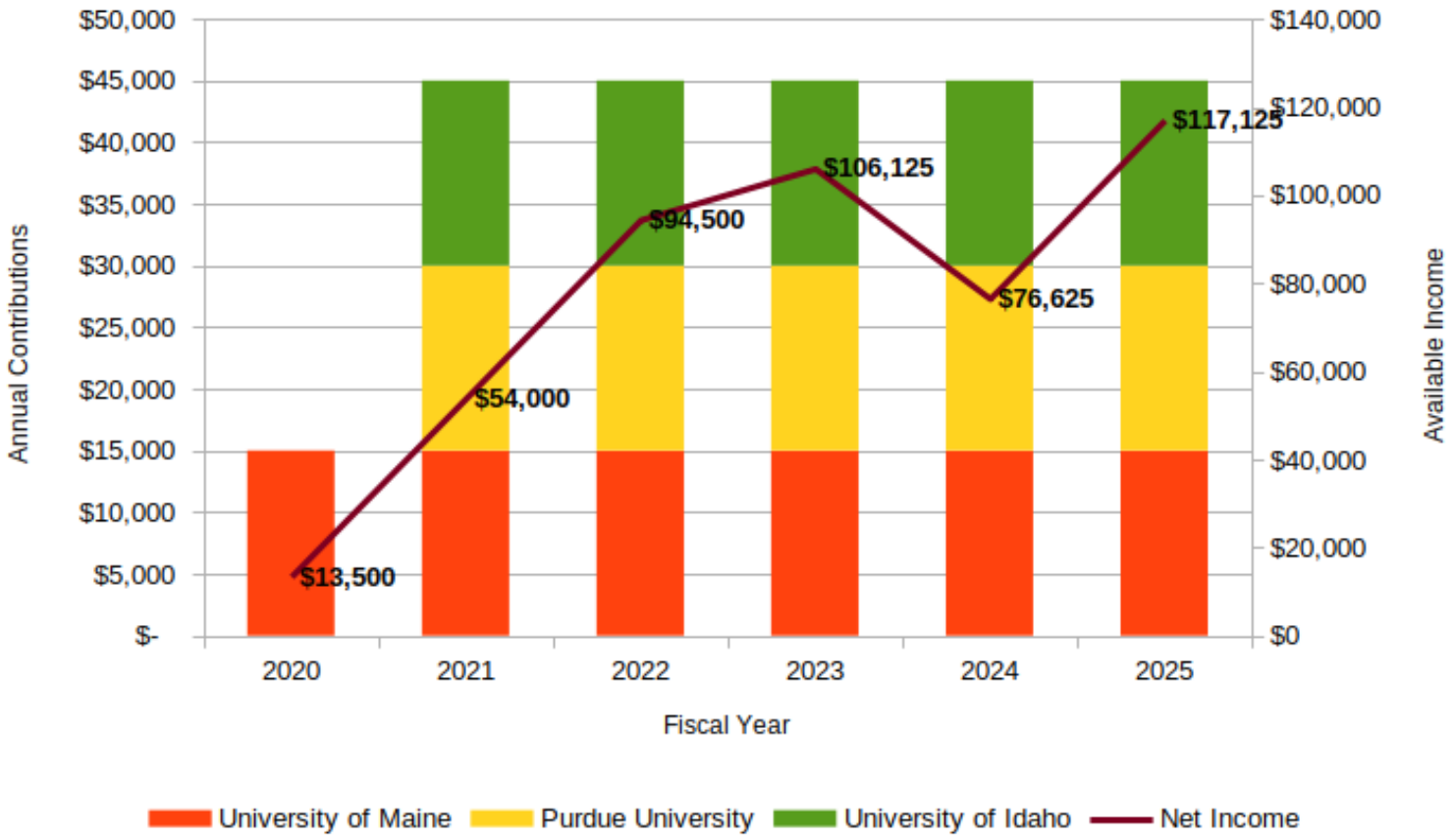
CAFS Future Options

Membership	Annual Contribution	Benefits
University Cooperative	$15,000	Participation in CAFS and eligibility to receive funding
IAB Organization	$10,000	Voting rights on projects and governance; Priority access to research
Affiliate	$5,000	Participation in CAFS and collaboration on projects



Opportunity to start small and build capacity over time

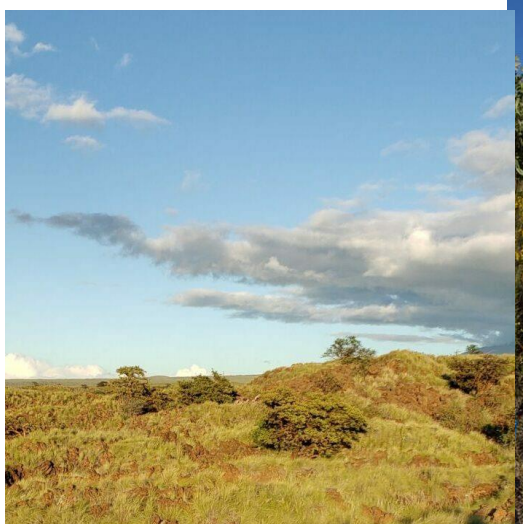
Available Budget

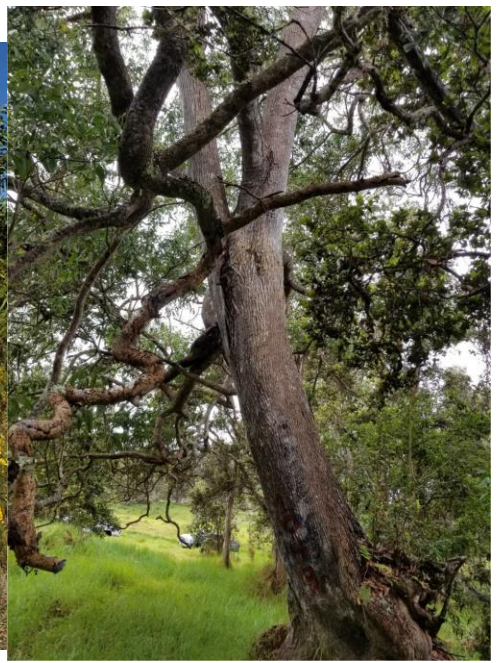


Due to contribution by a few CAFS Sites, there's $115k in available funding after providing 20% direct cost-share to several PSAE proposal

June 2025 CAFS IAB Meeting

Thanks to the Doug Jacobs and Tropical Hardwood Tree Improvement Research Cooperative!!!





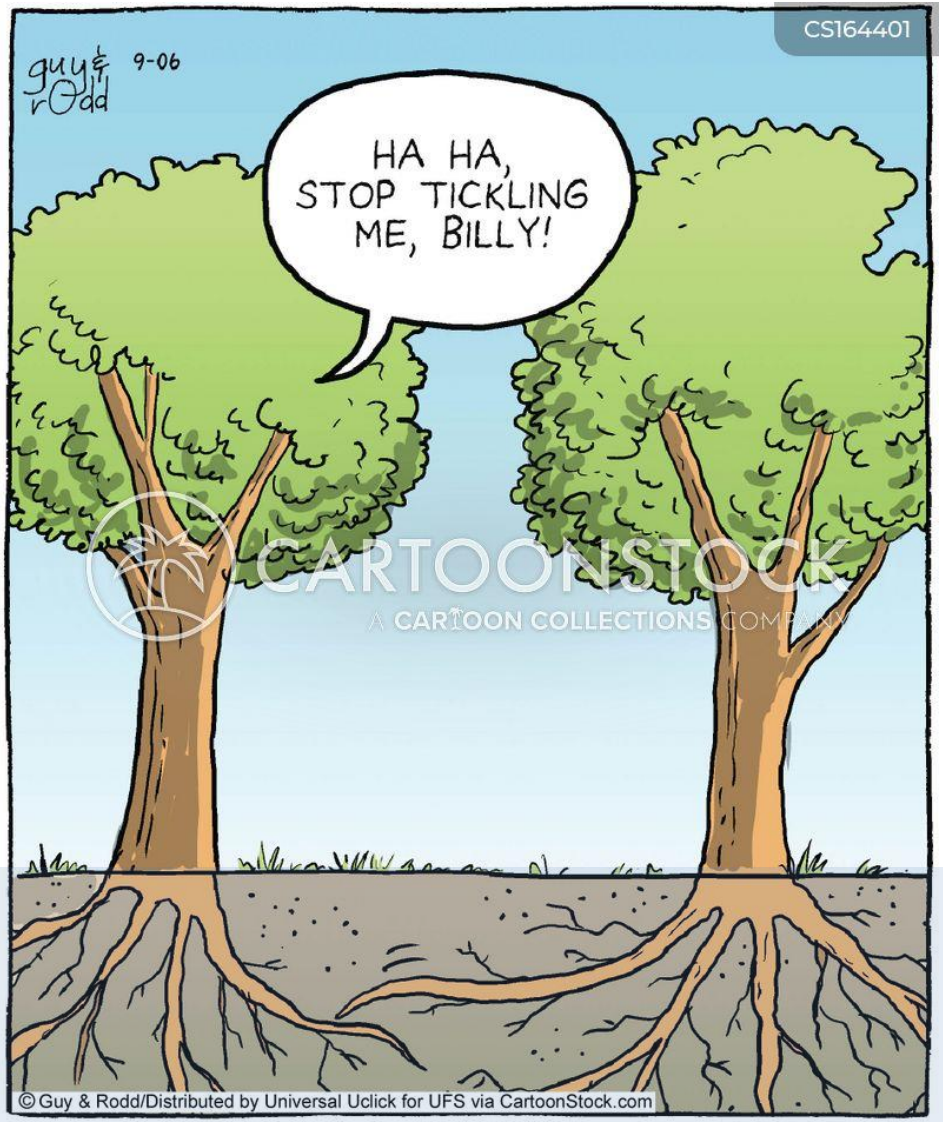
Summary

- 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 has officially graduated from NSF as of December 2024
- Highly difficult to recreate CAFS from scratch or do another NSF IUCRC

Questions & Comments

aaron.weiskittel@maine.edu
207-581-2857

https://crsf.umaine.edu/forest-research/cafs/



Center for Advanced Forestry Systems

NSF | IUCRC

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

J. Keith Gilless, Ph.D.
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

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

	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