Assessing landscape-scale, climate-smart forest management strategies: Is it possible?

Aaron Weiskittel, Erin Simons-Legaard, Adam Daigneault and Ivan Fernandez

Center for Research on

Sustainable Forests, University of Maine

MAINE

Center for Research on Sustainable Forests

Forest Climate Change Initiative

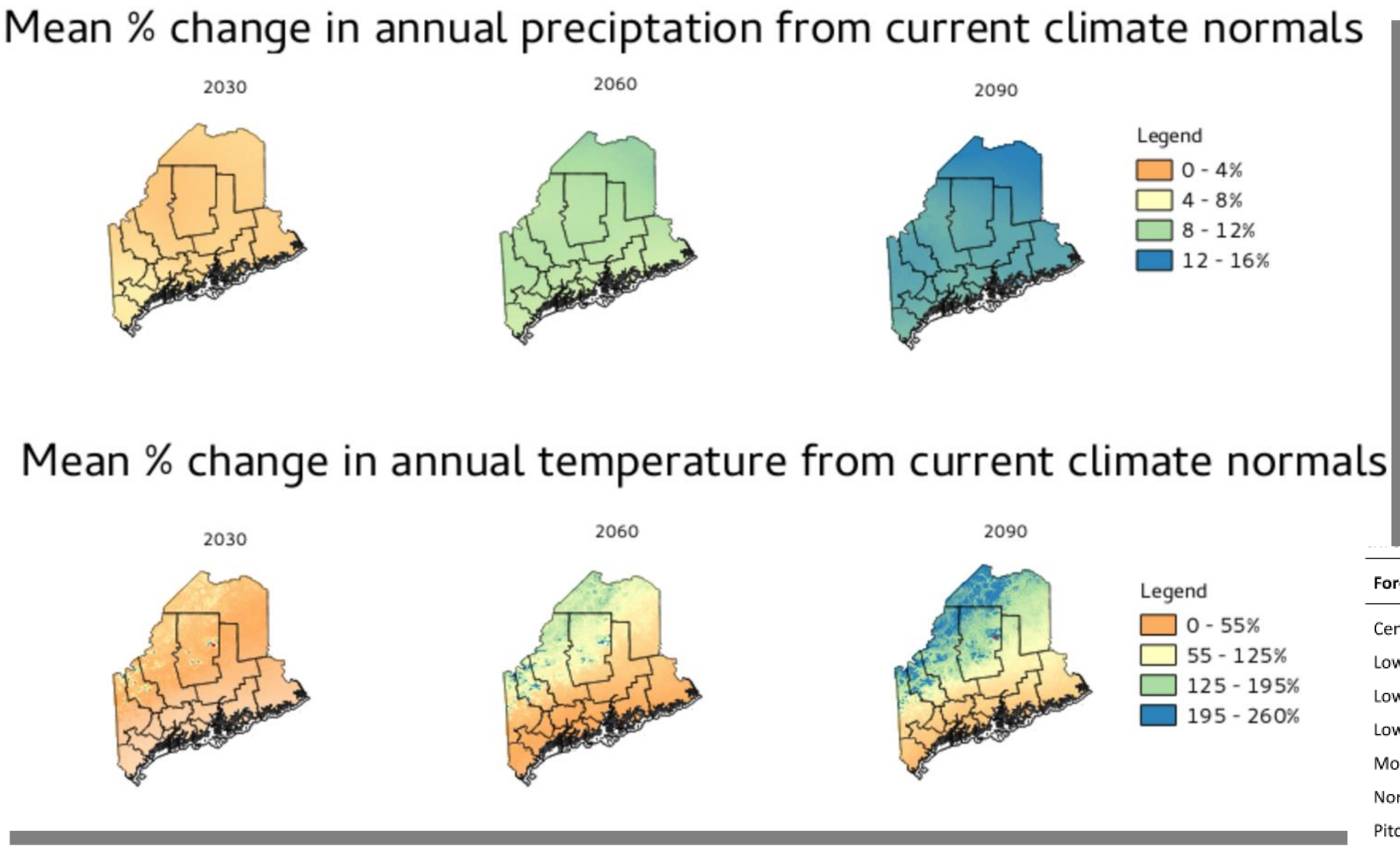
Maine Natural Climate Solutions Initiative

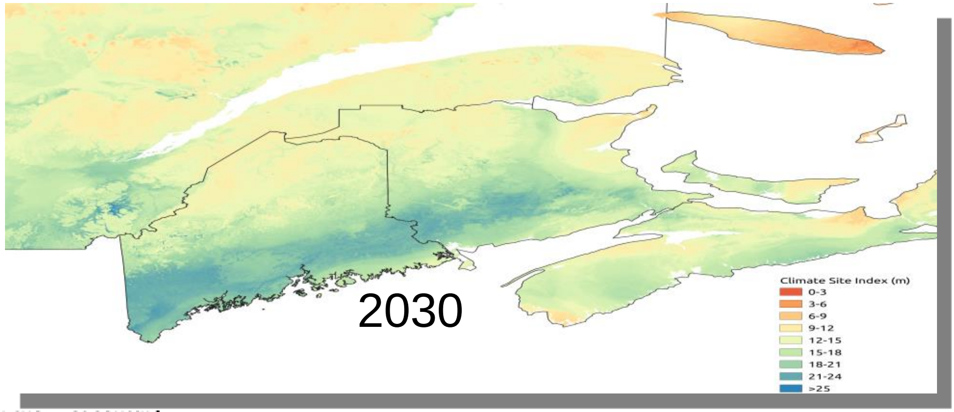
Photo credit: umaine.edu

Natural Climate Solutions

Climate smart or natural climate solutions for forests have been proposed but rarely assessed for feasibility at large scales

Overview



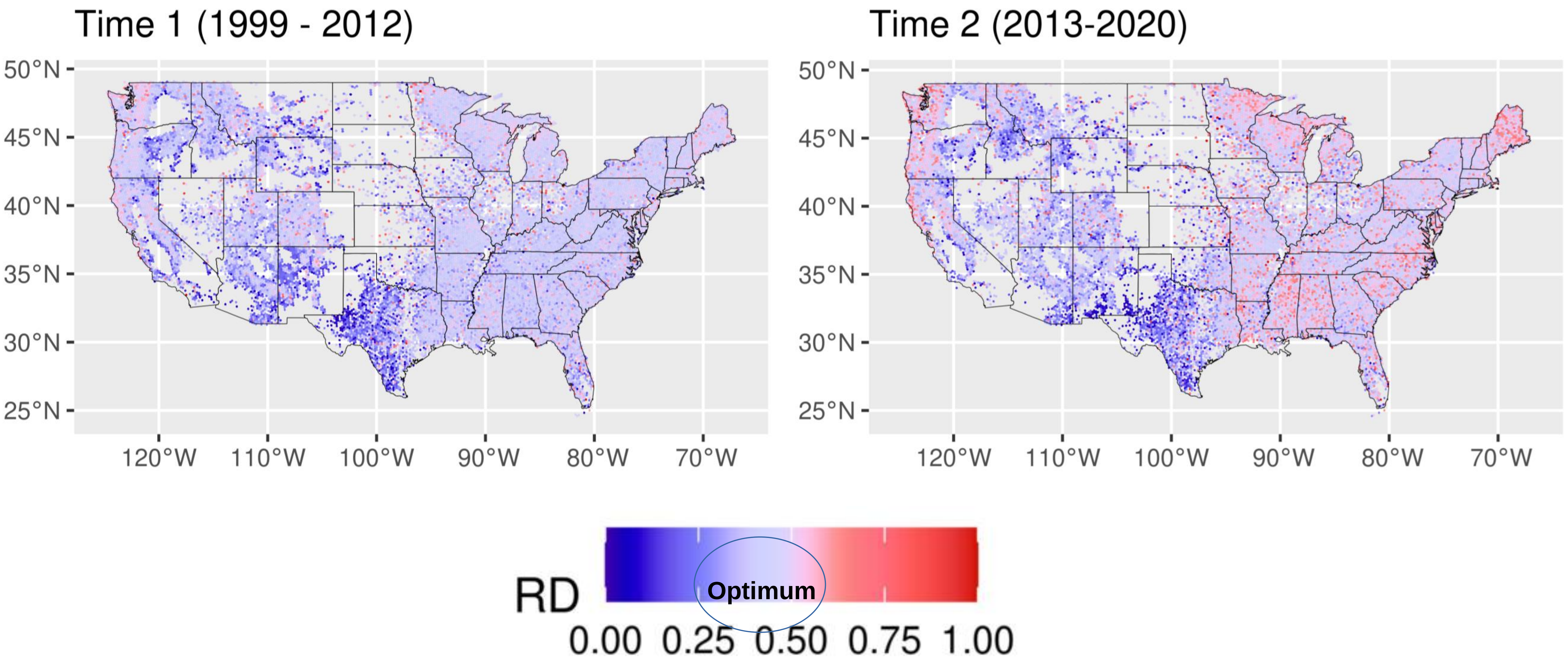


Forest system	Potential impacts	Adaptive capacity	Vulnerability	Evidence	Agreement
Central hardwood-pine	Neutral-Positive	Moderate-High	Low	Medium	Medium-High
Low-elevation spruce-fir	Neutral-Negative	Moderate	Moderate-High	Medium	Medium
Lowland and riparian hardwood	Positive and Negative	Moderate-High	Moderate	Limited	Limited
Lowland mixed conifer	Neutral-Negative	Low-Moderate	Moderate-High	Limited-Medium	Medium
Montane spruce-fir	Neutral-Negative	Moderate	Moderate-High	Medium	Medium
Northern hardwood	Positive and Negative	Moderate-High	Low-Moderate	Medium	Medium
Pitch pine-scrub oak	Neutral-Positive	Moderate	Low	Medium	Medium
Transition hardwood	Positive and Negative	Moderate-High	Low-Moderate	Medium	Medium-High

Janowiak et al. (2018)

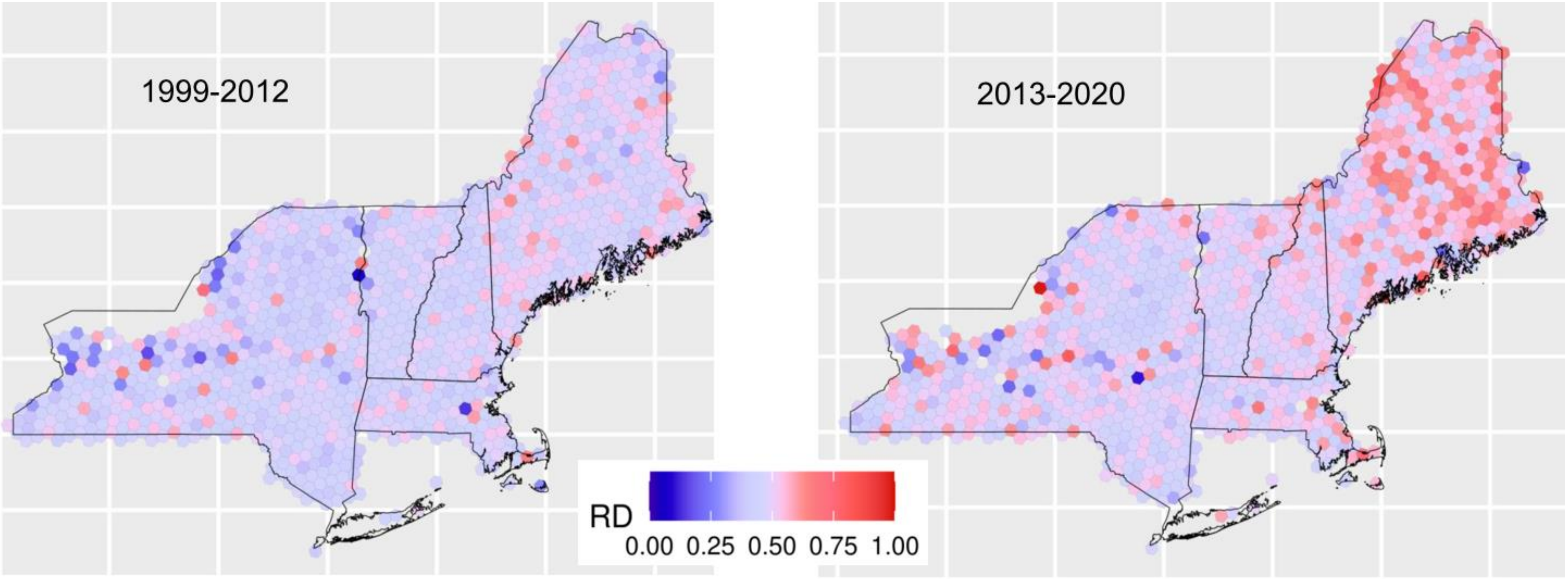
Climate is expected to be warmer and wetter with implications for both forest productivity and composition

Relative density trends in the US



CW Woodall, AR Weiskittel (2021). Relative density of United States forests has shifted to higher levels over last two decades with important implications for future dynamics. Scientific reports 11 (1), pp. 1-12.

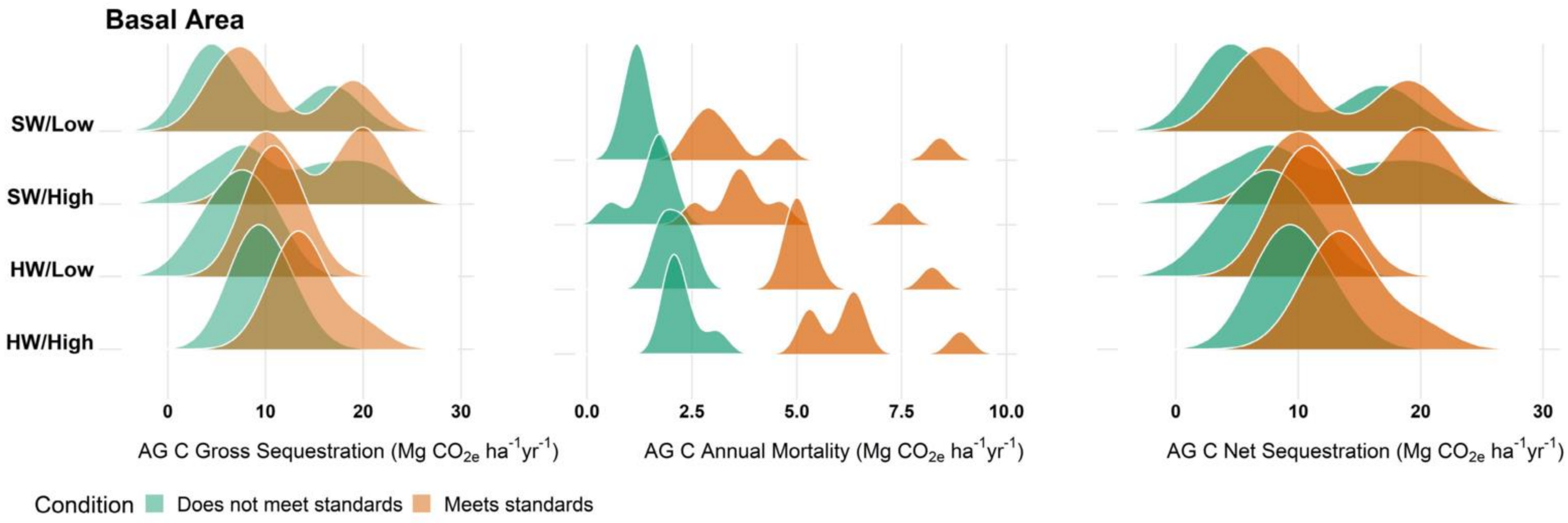
Relative density trends in New England



23% of Maine's forests are now outside the target 'medium' RD zone, up from 2% in 1999-2012

Carbon conundrums: Do United States' current carbon market baselines represent an undesirable ecological threshold?

Anthony W. D'Amato[1] | Christopher W. Woodall[2] | Aaron R. Weiskittel[3] | Caitlin E. Littlefield[1,4] | Lara T. Murray[5]



Current baselines based on basal area result in increased annual mortality and similar net sequestration rates as forests that do not meet the standard

STRATEGY E

Protect Maine's Environment and Working Lands and Waters: Promote Natural Climate Solutions and Increase Carbon Sequestration

Climate change and development are harming Maine's natural and working lands and waters, which are key to the state achieving its carbon neutrality commitment by 2045. Protecting natural and working lands from development maintains their potential to draw back carbon from the atmosphere, as well as provide important co-benefits. Maine's coastal and marine areas also store carbon, while supporting our fishing, aquaculture, and tourism industries.

1 Protect Natural and Working Lands and Waters

- Increase by 2030 the total acreage of conserved lands in the state to 30% through voluntary, focused purchases of land and working forest or farm conservation easements.
  - Additional targets should be identified in 2021, in partnership with stakeholders, to develop specific sub-goals for these conserved lands for Maine's forest cover, agriculture lands, and coastal areas.
- Focus conservation on high biodiversity areas to support land and water connectivity and ecosystem health.
- Revise scoring criteria for state conservation funding to incorporate climate mitigation and resiliency goals.
- Develop policies by 2022 to ensure renewable energy project siting is streamlined and transparent while seeking to minimize impacts on natural and working lands and engaging key stakeholders.

2 Develop New Incentives to Increase Carbon Storage

- DEP will conduct a comprehensive, statewide inventory of carbon stocks on land and in coastal areas (including blue carbon) by 2023 to provide baseline estimates for state carbon sequestration, allowing monitoring of sequestration over time to meet the state's carbon neutrality goal.
- Establish by 2021 a stakeholder process to develop a voluntary, incentive-based forest carbon program (practice and/or inventory based) for woodland owners of 10 to 10,000 acres and forest practitioners.
- Engage in regional discussions to consider multistate carbon programs that could support Maine's working lands and natural-resource industries, and state carbon-neutrality goals.

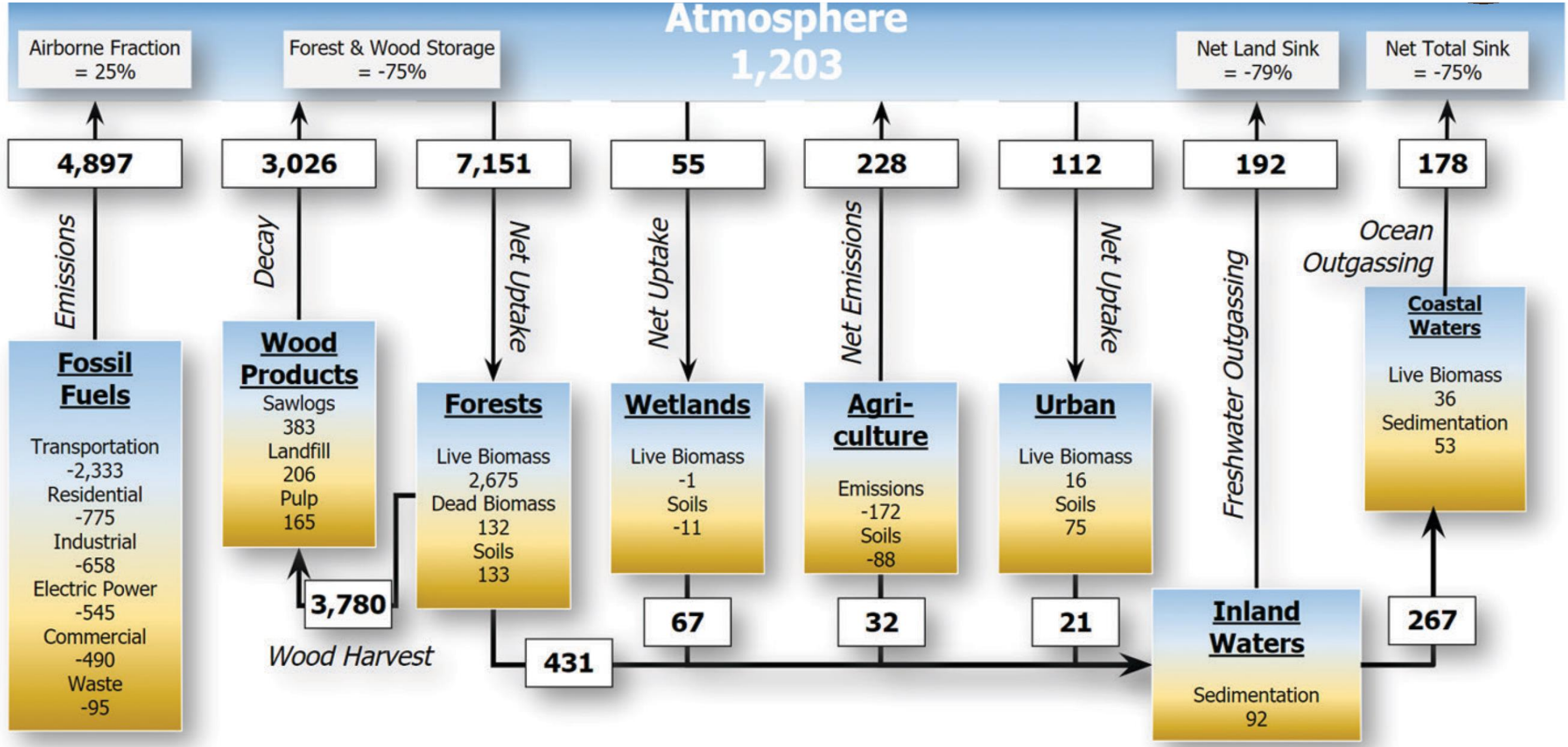
3 Expand Outreach to Offer Information and Technical Assistance

- Increase technical service provider capacity by 2024 to deliver data, expert guidance, and support for climate solutions to communities, farmers, loggers, and foresters at the Department of Agriculture, Conservation and Forestry, Maine Forest Service, Department of Inland Fisheries and Wildlife, the Department of Marine Resources, and the University of Maine.
- Launch the Coastal and Marine Information Exchange by 2024.

4 Enhance Monitoring and Data Collection to Guide Decisions

- Establish a "coordinating hub" with state and non-state partners for key climate-change research and monitoring work to facilitate statewide collaboration by 2024.

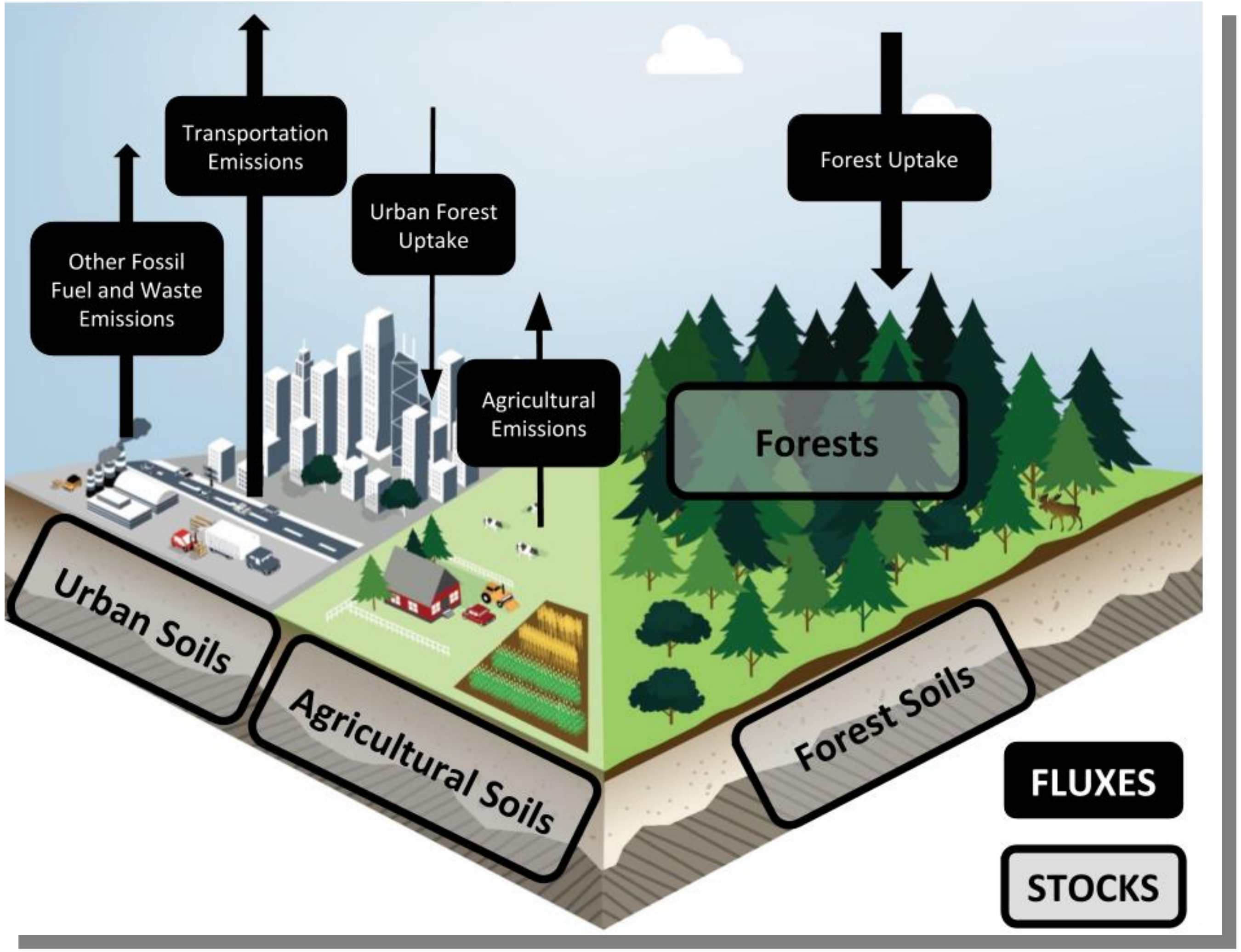
Maine's First Statewide Carbon Budget



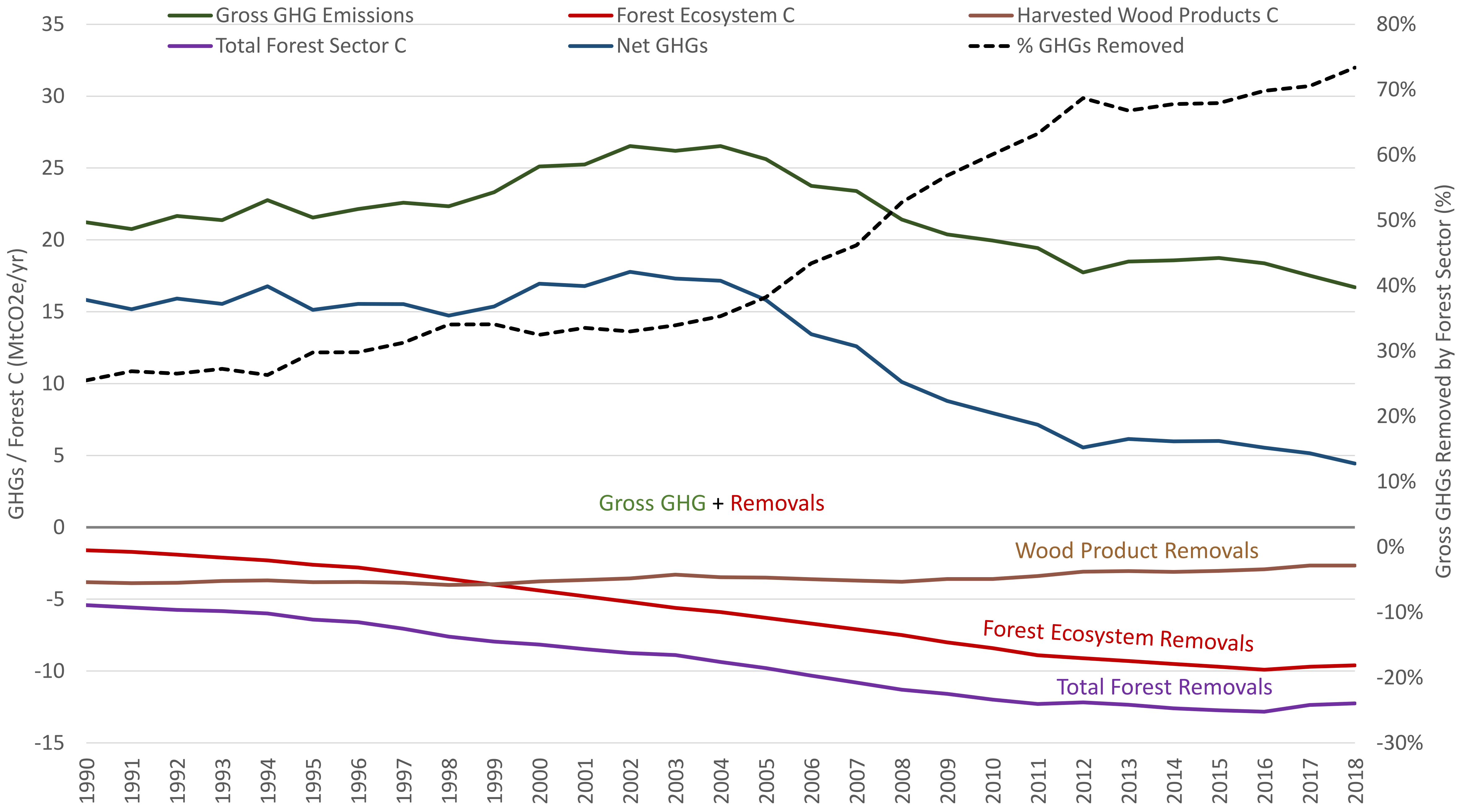
https://crsf.umaine.edu/forest-climate-change-initiative/carbon-budget/

Maine’s Managed Forest Captures Carbon

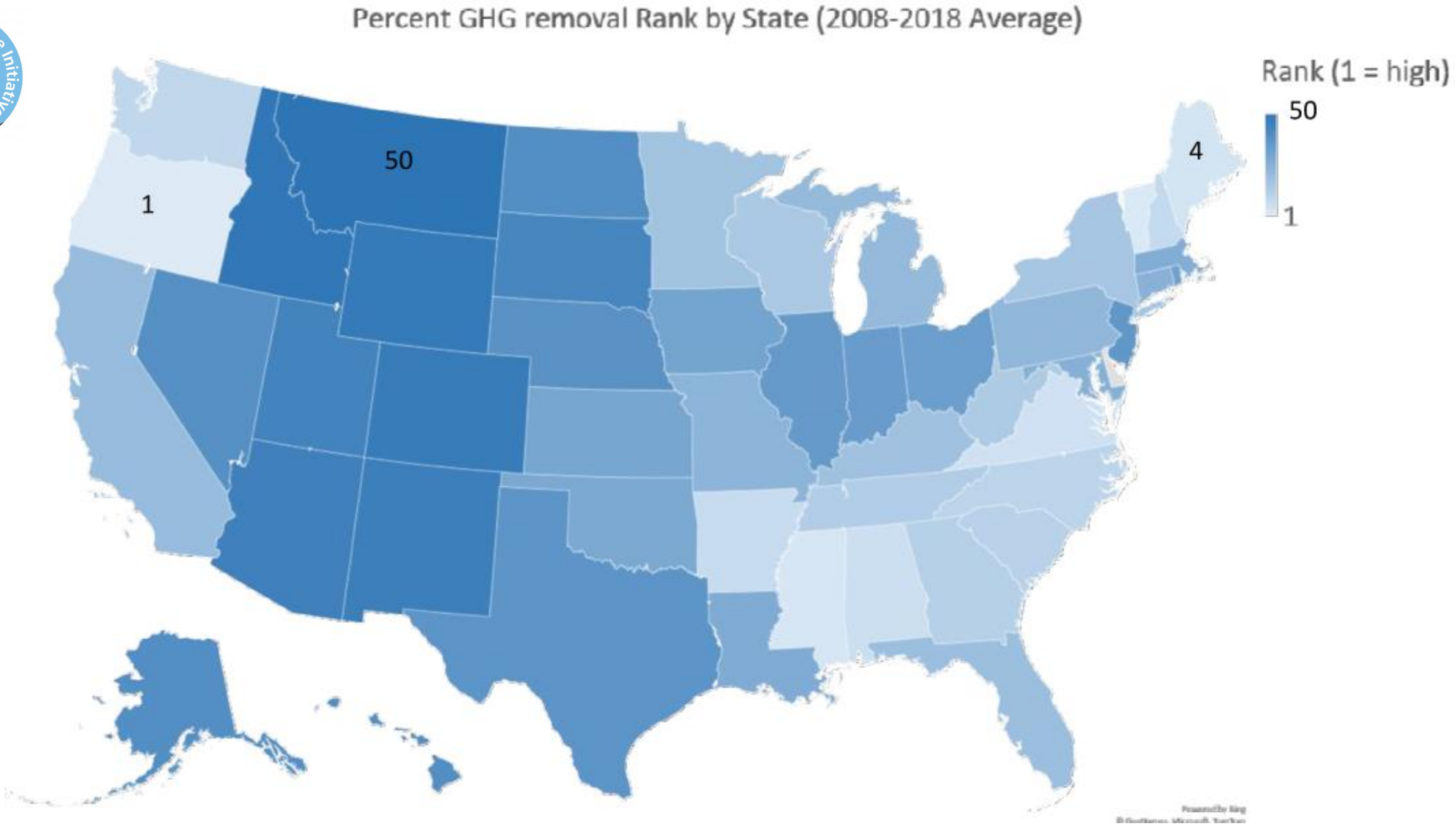
Carbon Pool	% of State’s Annual Fossil Fuel Emission
Forest carbon stocks + annual growth	60%
Forest products	15%
Total forestry sector	75%
Net Land Sink	78%



https://crsf.umaine.edu/forest-climate-change-initiative/carbon-budget/

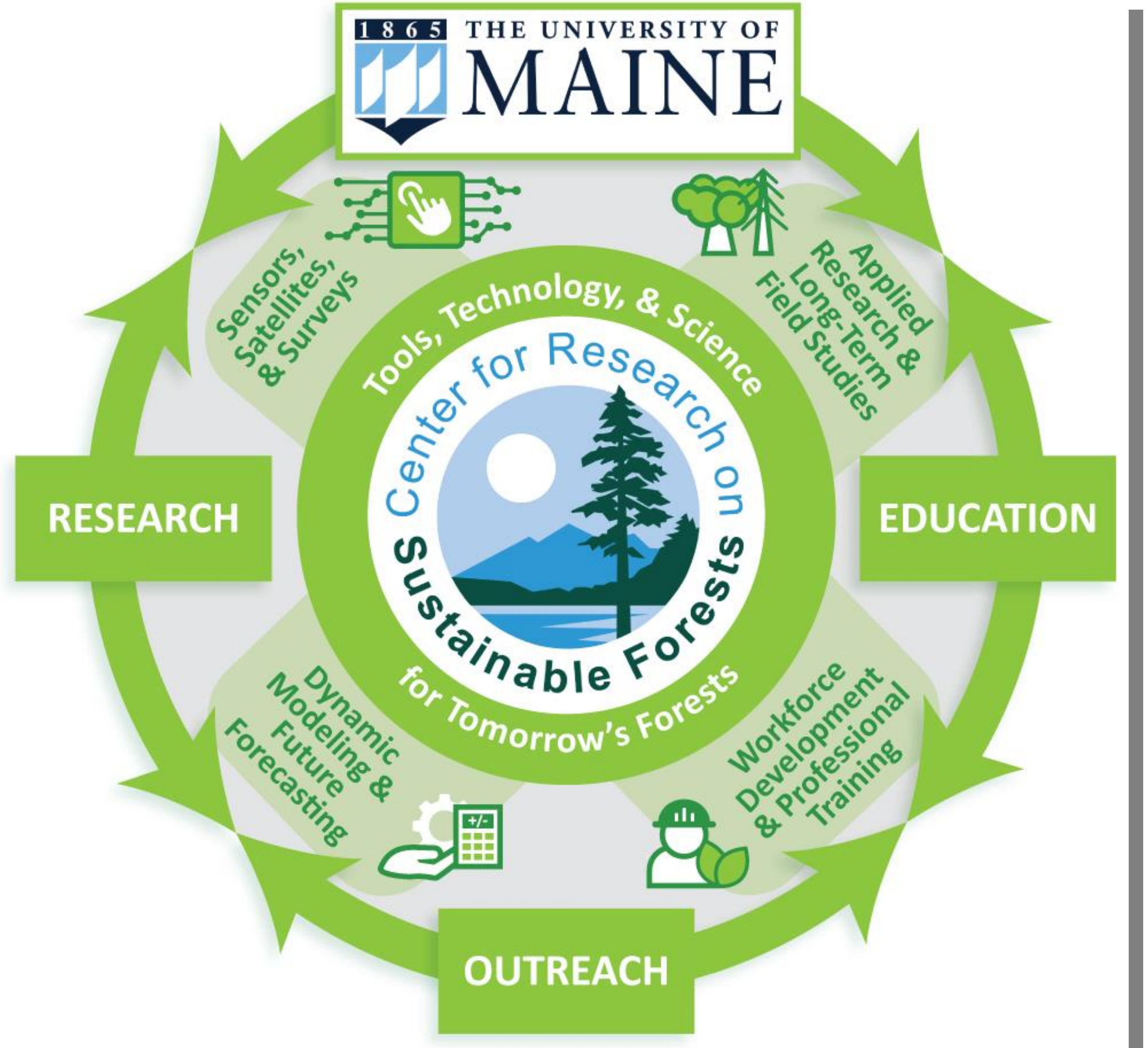


% GHG removal has increased over time yet primarily driven by forest condition and composition



Maine is in the top 5 in the US for % GHG removal by forests

Center for Research on Sustainable Forests' Natural Climate Solutions Initiative

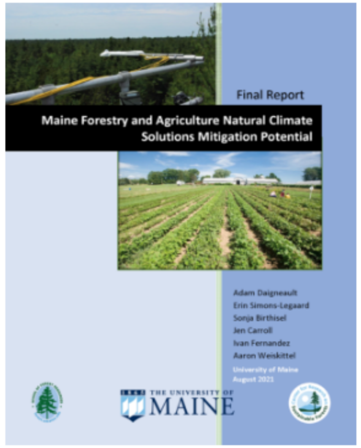


Natural Climate Solutions (NCS) Initiative

The FCCI Natural Climate Solutions (NCS) Initiative was formed to evaluate the potential of alternative NCS to decrease greenhouse gas (GHG) emissions through management in forestry and agriculture. Alternatives include reforestation, planting of fast-growing tree species, and extended rotations in forests as well as no-till cultivation, cover cropping, and capturing methane from manure on farms. In particular, researchers are assessing land management strategies for Maine's farms and working forests that will optimize future carbon sequestration rates and how the price of carbon influences the outcome.

The recently released Final Report highlights the cost and effectiveness of various NCS approaches compared to standard business-as-usual practices.

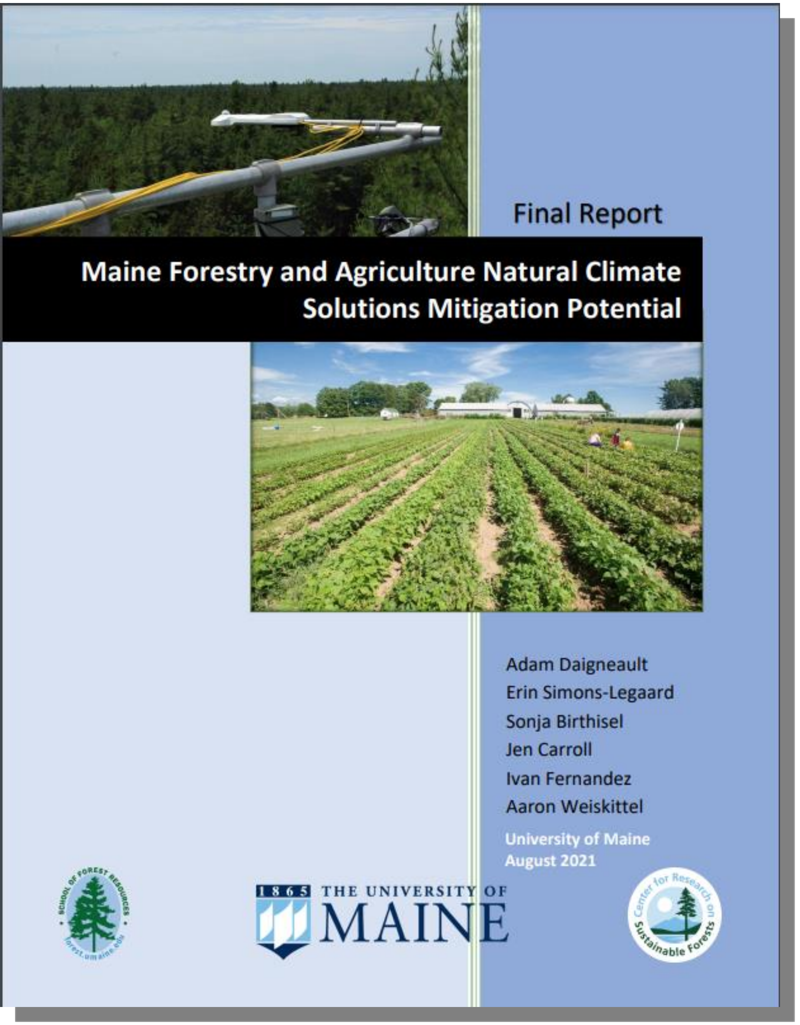
The Maine NCS Initiative project seeks to:
(1) assess current practices to determine the degree to which foresters and farmers are using NCS;
(2) determine the most cost-effective NCS for Maine;
(3) understand key barriers to adopting NCS; and
(4) generate information about which practices can be implemented on a broader scale.

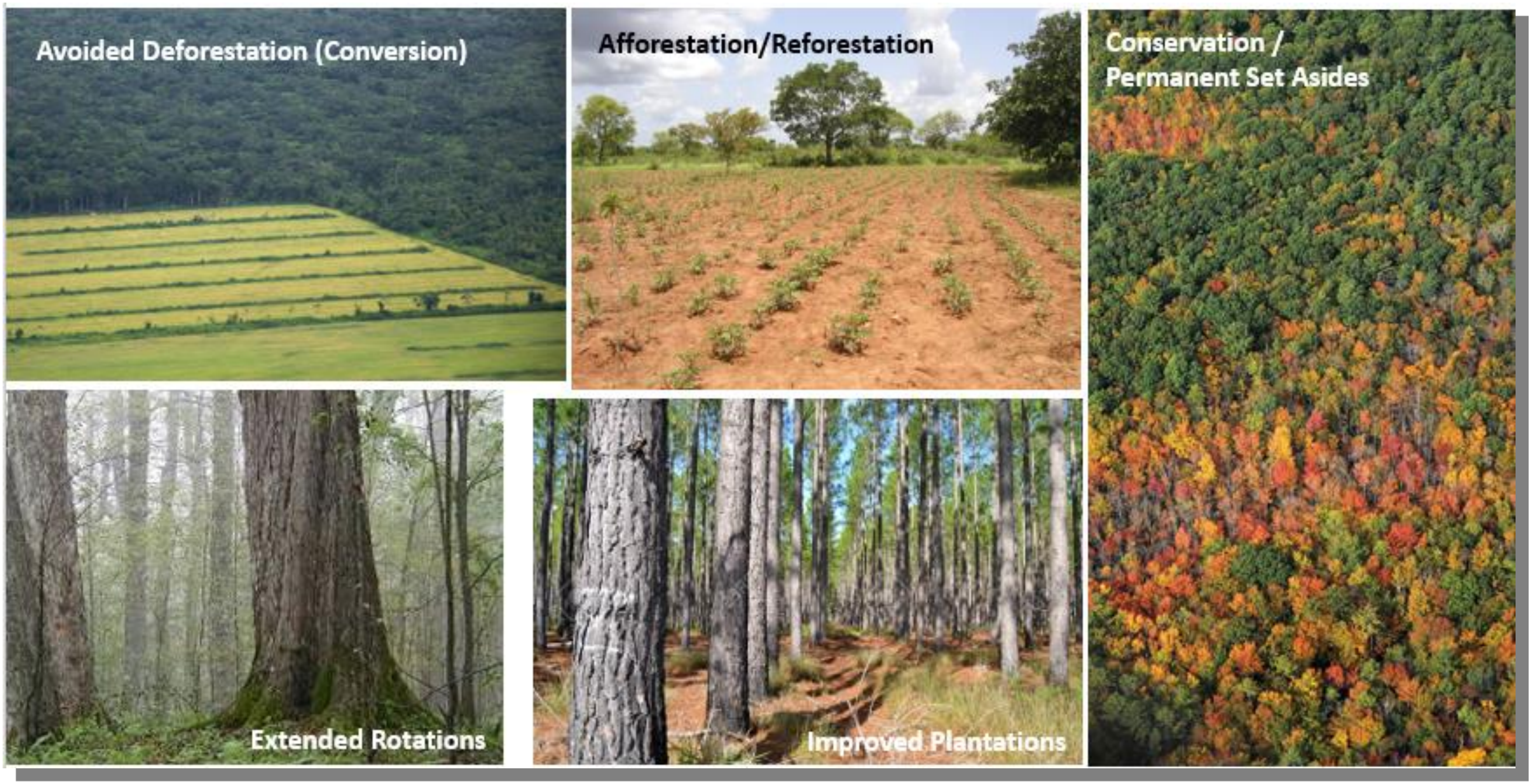


Download Report PDF

Stakeholder-engaged research and implementation effort

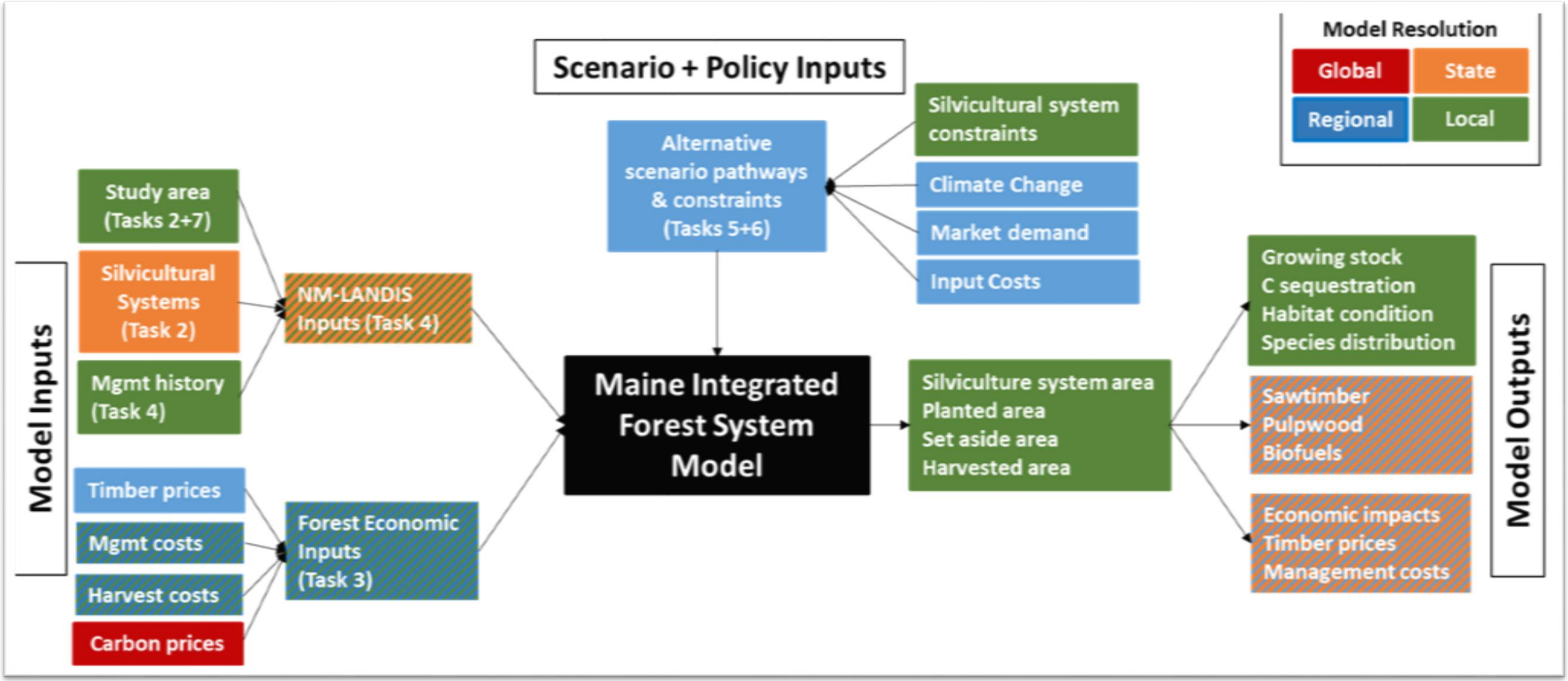
Center for Research on Sustainable Forests' Natural Climate Solutions Initiative

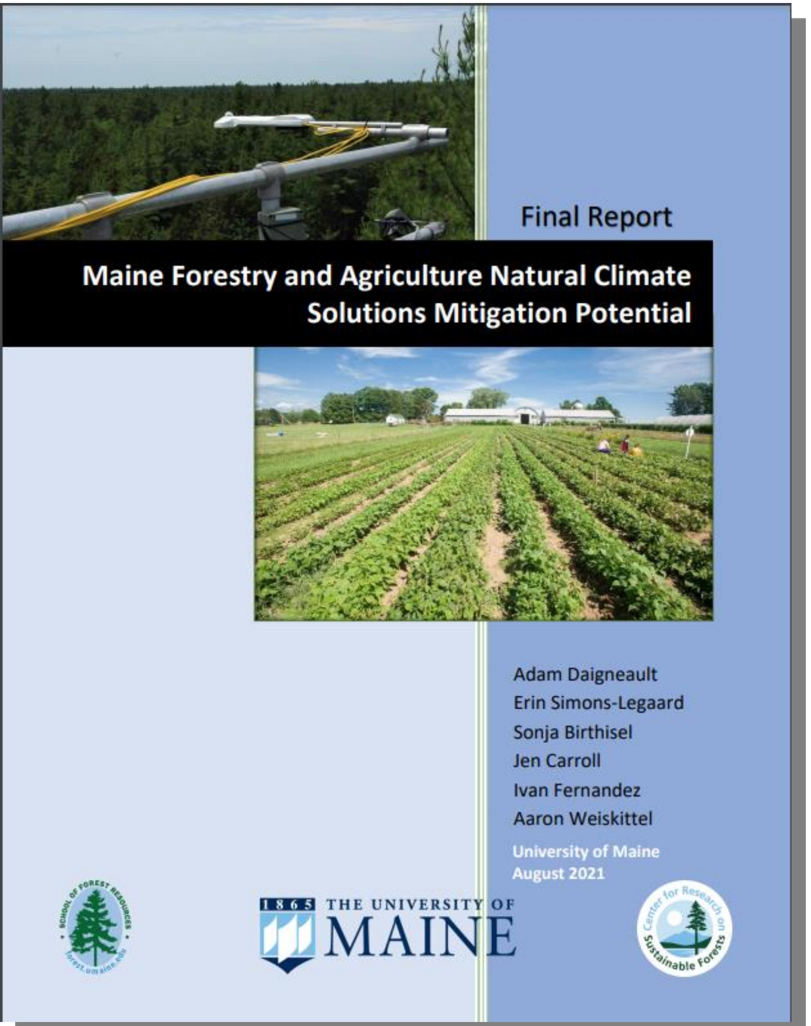




https://crsf.umaine.edu/forest-climate-change-initiative/ncs/

Integrated and linked biophysical & economic modeling framework





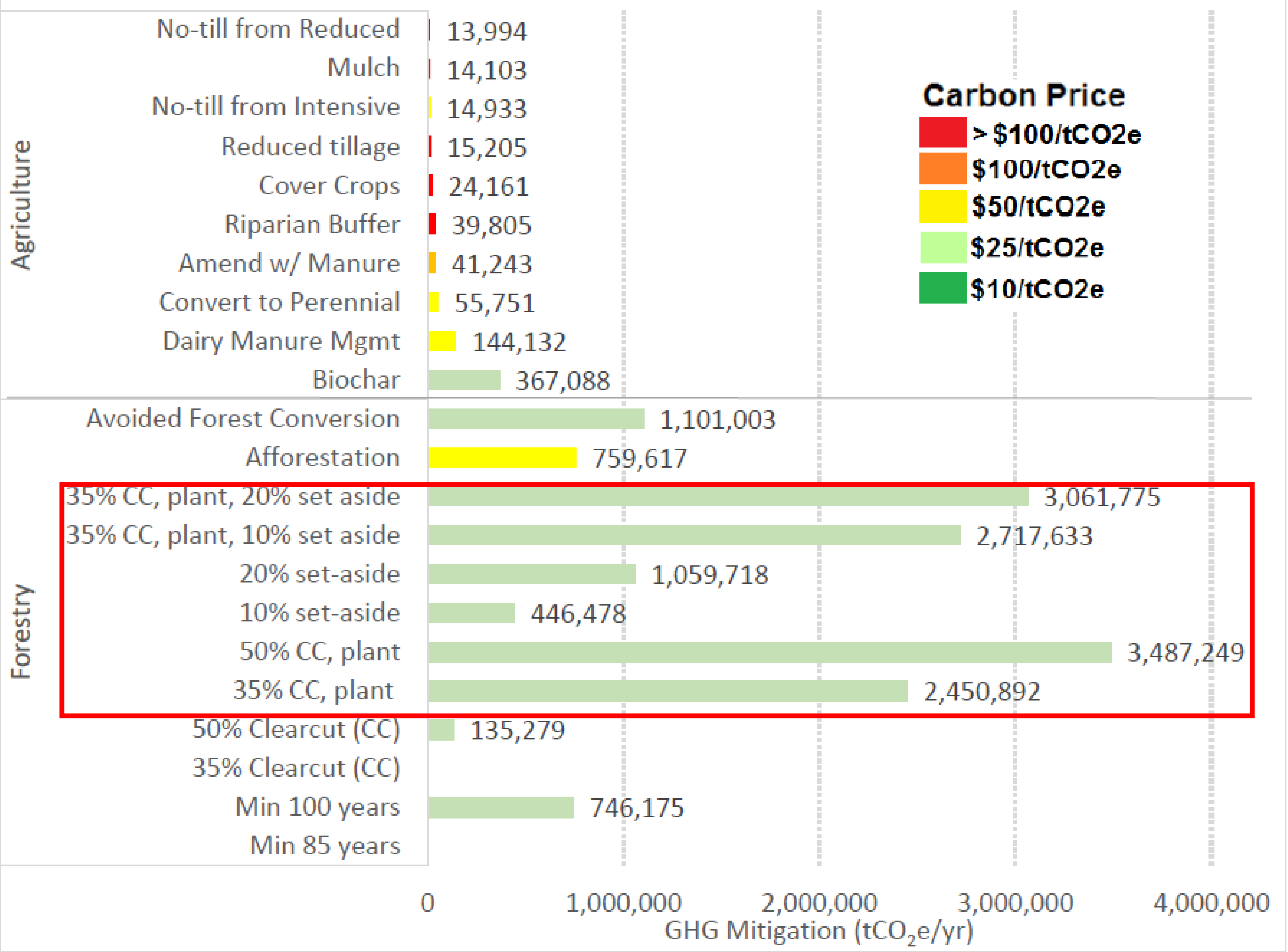


Figure 1. Summary of Maine NCS mitigation potential (tCO_2e/yr) and break-even carbon price ($\$/tCO_2e$).

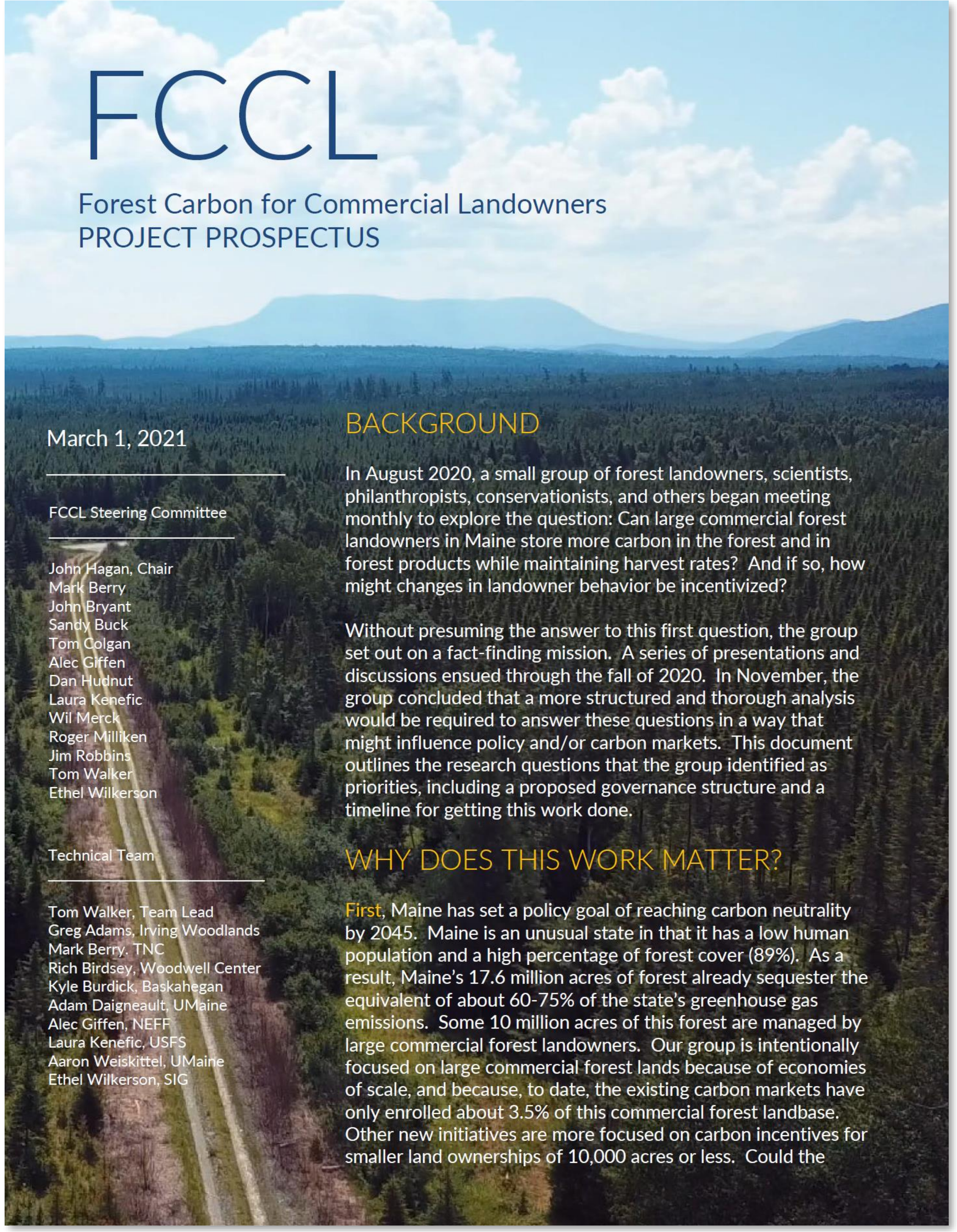
Mixture of forest management approaches achieved highest mitigation potential with modest carbon prices

Coming in December 2022

Forest Carbon for Commercial Landowners Project (FCCL)

“Can Northern Maine’s Commercial Forests Store More Carbon Without Reducing Harvests?”

A study led by Tom Walker and Adam Daigneault (UMaine)



FCCL

Forest Carbon for Commercial Landowners
PROJECT PROSPECTUS

March 1, 2021

FCCL Steering Committee

John Hagan, Chair
Mark Berry
John Bryant
Sandy Buck
Tom Colgan
Alec Giffen
Dan Hudnut
Laura Kenefic
Wil Merck
Roger Milliken
Jim Robbins
Tom Walker
Ethel Wilkerson

Technical Team

Tom Walker, Team Lead
Greg Adams, Irving Woodlands
Mark Berry, TNC
Rich Birdsey, Woodwell Center
Kyle Burdick, Baskahegan
Adam Daigneault, UMaine
Alec Giffen, NEFF
Laura Kenefic, USFS
Aaron Weiskittel, UMaine
Ethel Wilkerson, SIG

BACKGROUND

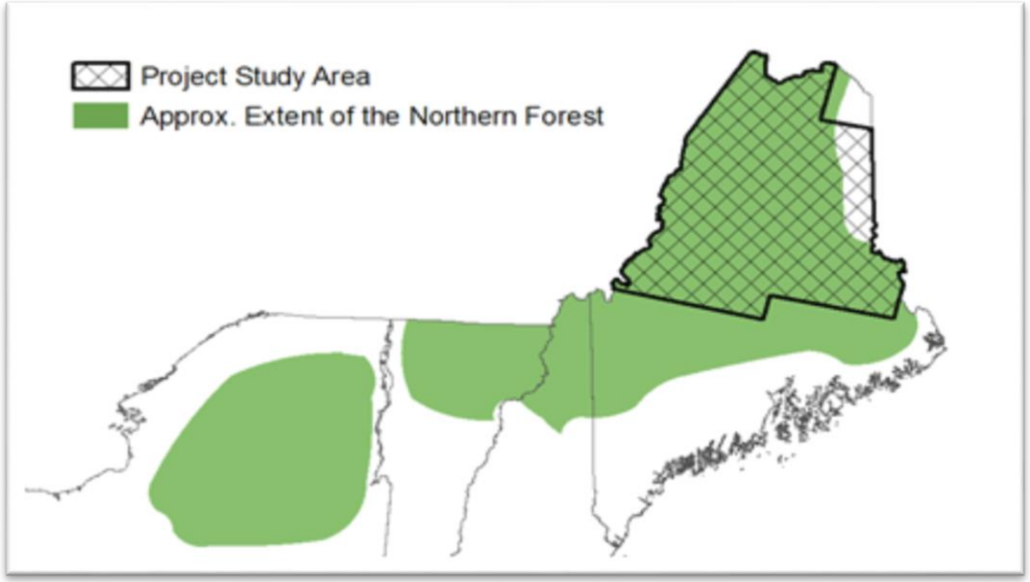
In August 2020, a small group of forest landowners, scientists, philanthropists, conservationists, and others began meeting monthly to explore the question: Can large commercial forest landowners in Maine store more carbon in the forest and in forest products while maintaining harvest rates? And if so, how might changes in landowner behavior be incentivized?

Without presuming the answer to this first question, the group set out on a fact-finding mission. A series of presentations and discussions ensued through the fall of 2020. In November, the group concluded that a more structured and thorough analysis would be required to answer these questions in a way that might influence policy and/or carbon markets. This document outlines the research questions that the group identified as priorities, including a proposed governance structure and a timeline for getting this work done.

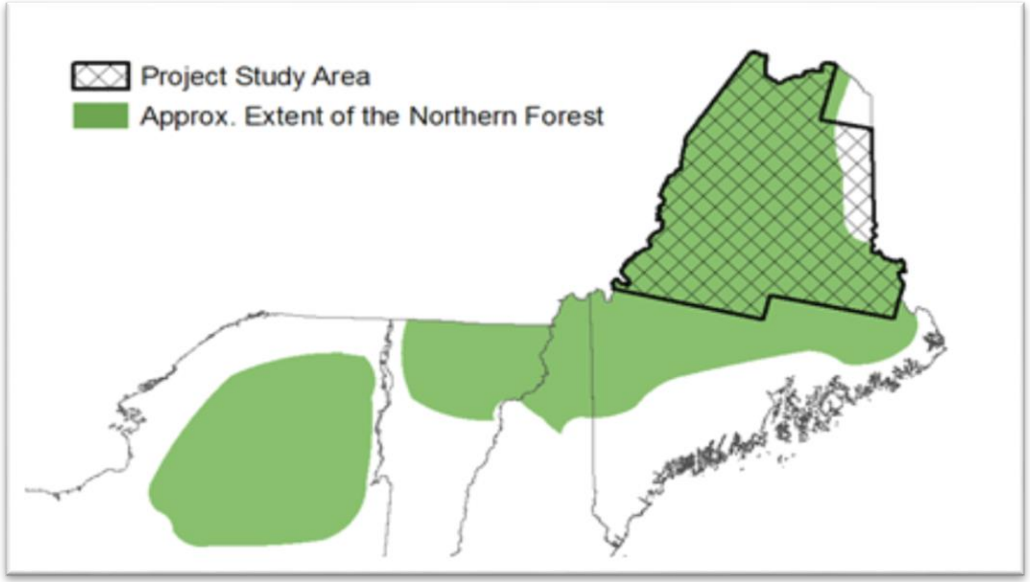
WHY DOES THIS WORK MATTER?

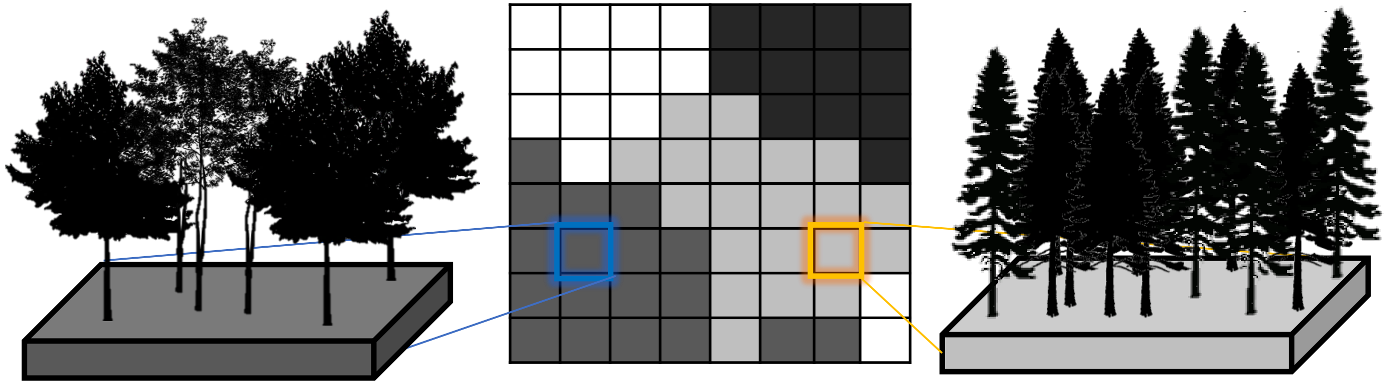
First, Maine has set a policy goal of reaching carbon neutrality by 2045. Maine is an unusual state in that it has a low human population and a high percentage of forest cover (89%). As a result, Maine’s 17.6 million acres of forest already sequester the equivalent of about 60-75% of the state’s greenhouse gas emissions. Some 10 million acres of this forest are managed by large commercial forest landowners. Our group is intentionally focused on large commercial forest lands because of economies of scale, and because, to date, the existing carbon markets have only enrolled about 3.5% of this commercial forest landbase. Other new initiatives are more focused on carbon incentives for smaller land ownerships of 10,000 acres or less. Could the

LANDIS-II forest landscape model



LANDIS-II forest landscape model



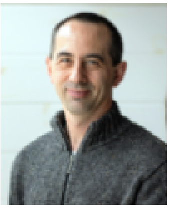


Figurative example of the cell-based system used by LANDIS-II.
Stands are formed by groups of like cells.

Intelligent GeoSolutions Research Team

Kasey Legaard
Remote Sensing
kasey.legaard@maine.edu

Erin Simons-Legaard
Landscape Ecology
erin.simons@maine.edu
SFR Faculty webpage



Aaron Weiskittel
Forest Biometrics
aaron.weiskittel@maine.edu
SFR Faculty webpage

IGS Resources

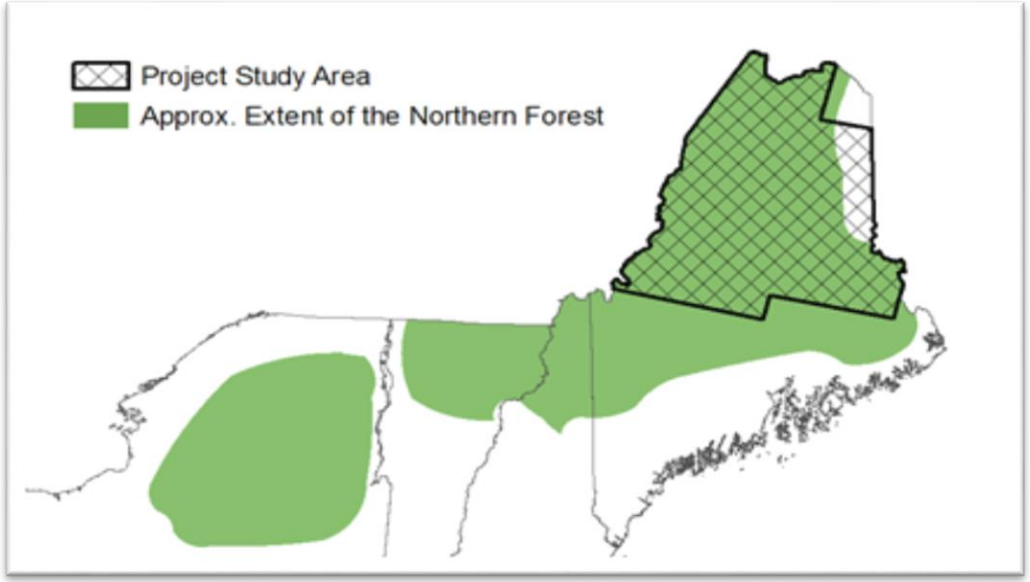
Northeast Forest Information Source

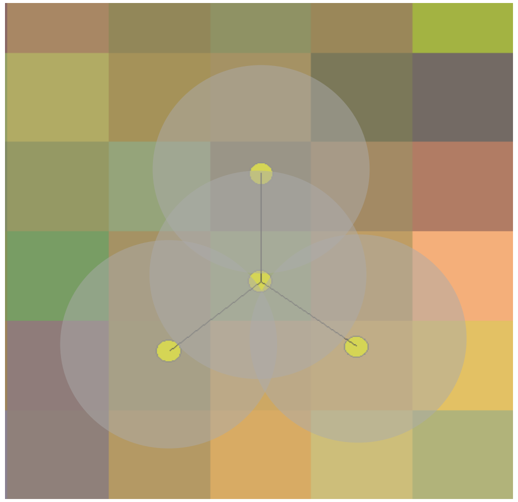
Intelligent GeoSolutions Overview: Presentation at land cover mapping workshop, August 14, 2019.

Mapping Maine's Land Cover: A New Approach. Position paper on the how a next-generation land cover mapping project for the state of Maine be approached as a partnership between state and federal agencies, the University of Maine, and other private stakeholder organizations.

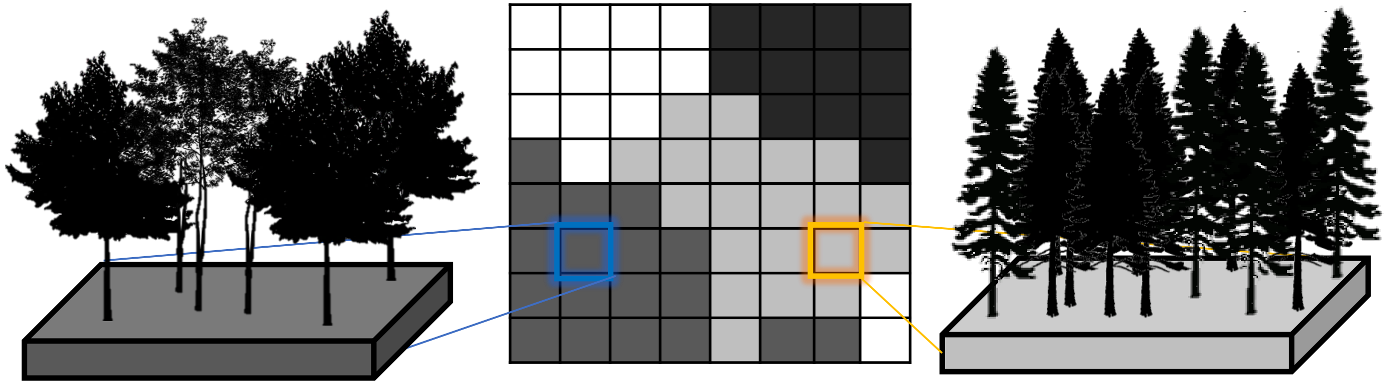
TOP

Model initialization

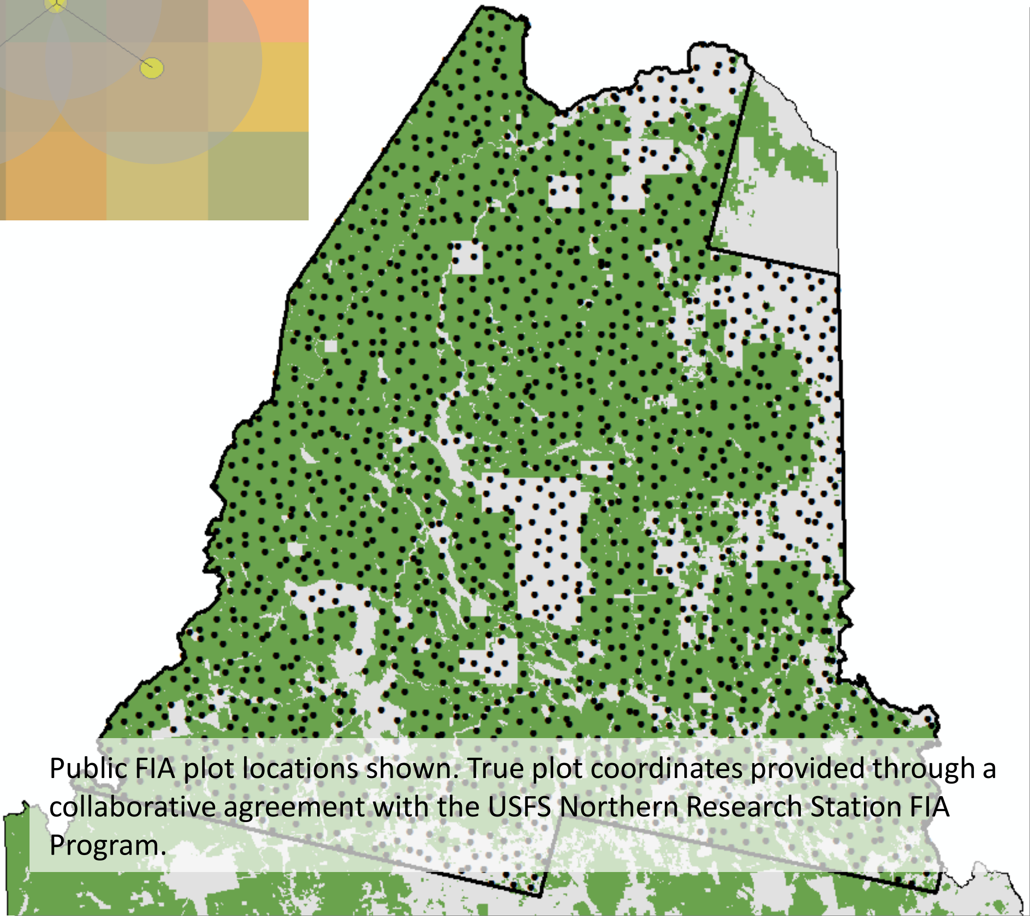




FIA plot (+ location error), superimposed over 30 m pixels:

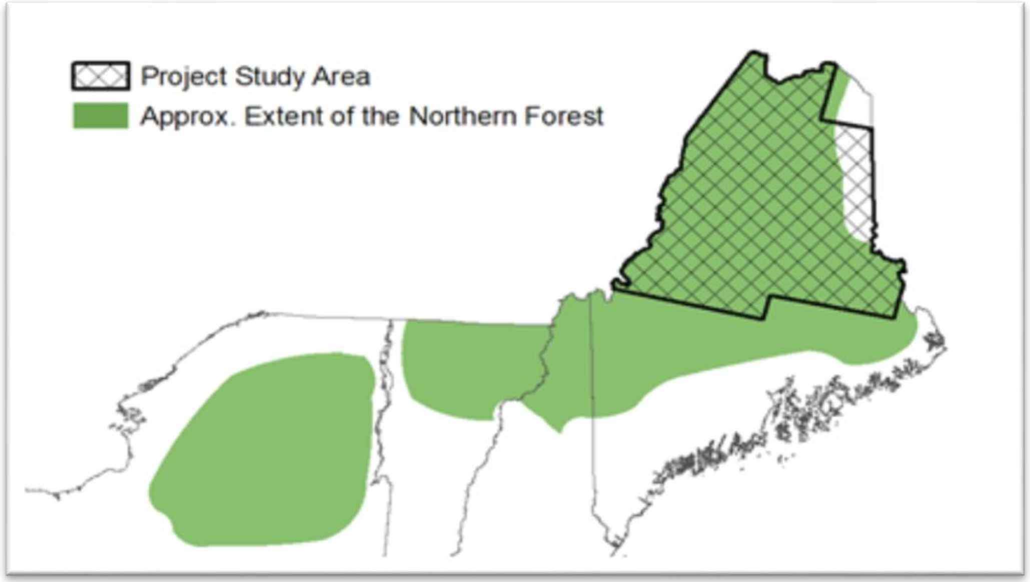


Figurative example of the cell-based system used by LANDIS-II. Stands are formed by groups of like cells.



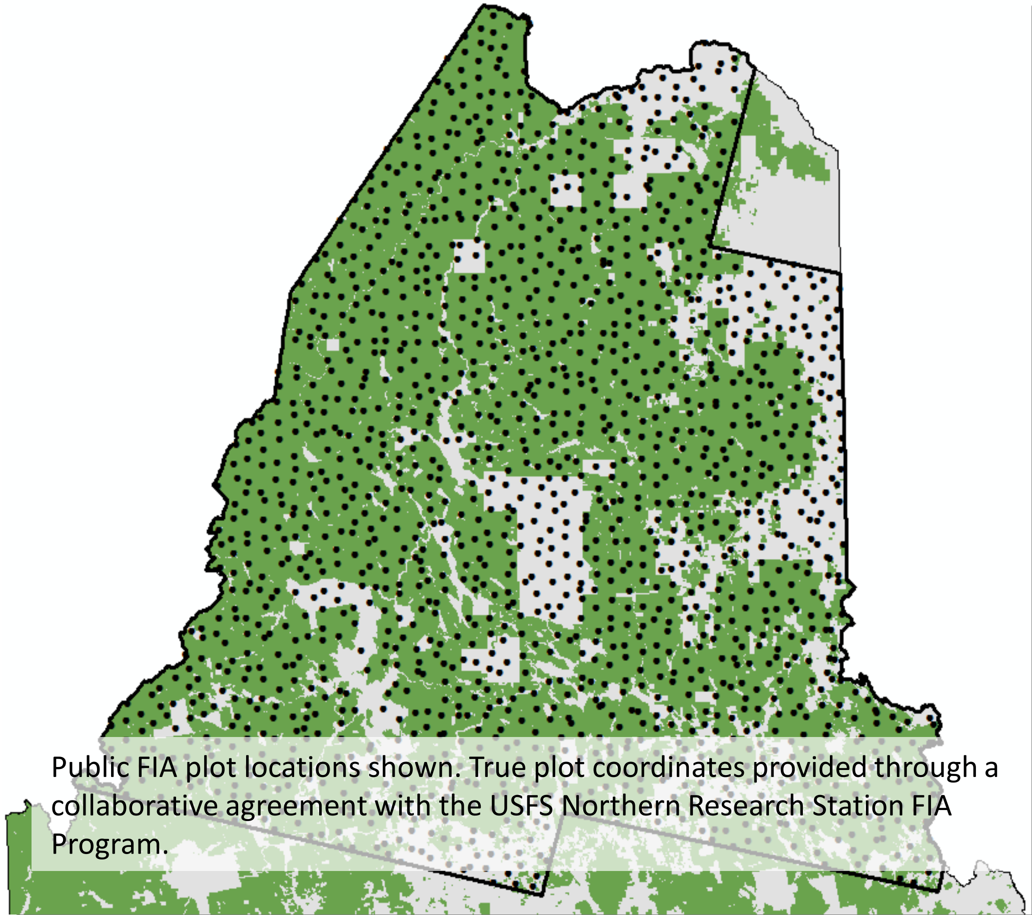
Public FIA plot locations shown. True plot coordinates provided through a collaborative agreement with the USFS Northern Research Station FIA Program.

Model initialization



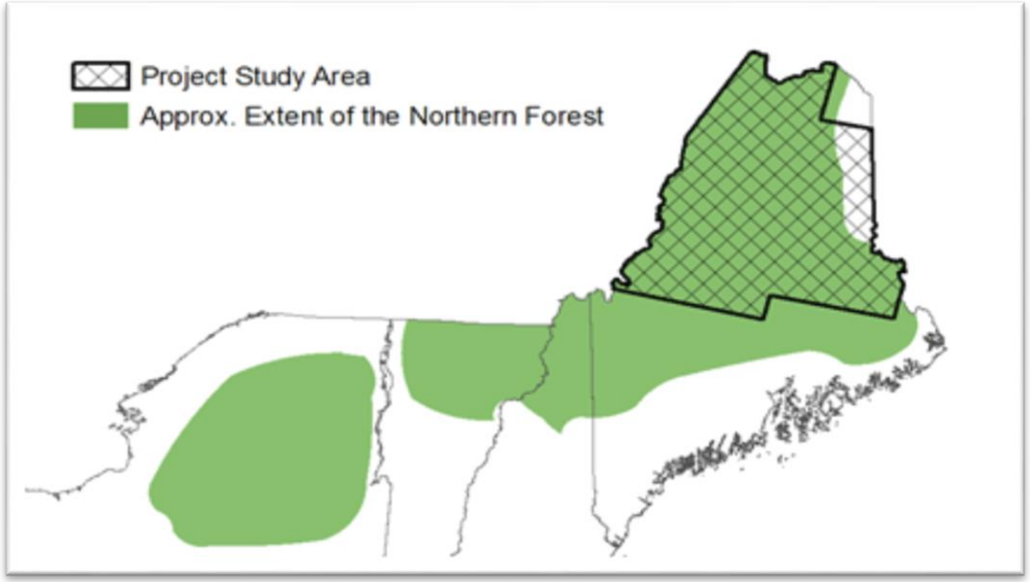
Species with relative abundance > 10% biomass:

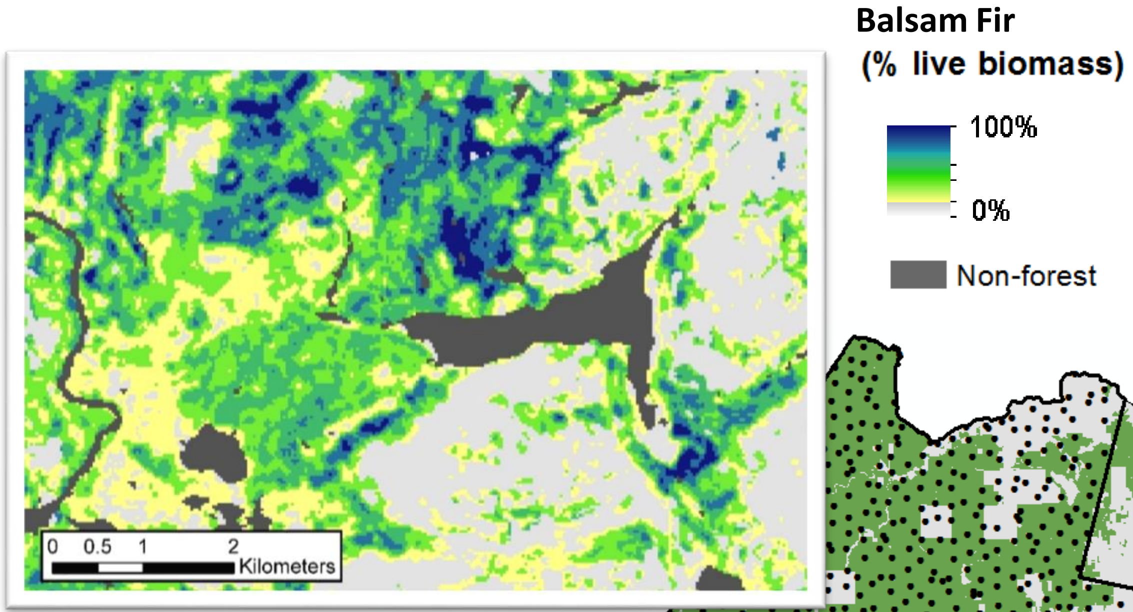
- Balsam fir
- Red, white, black spruce
- E. White pine
- N. White cedar
- Sugar and Red maple
- E. Hemlock
- American beech
- Yellow birch
- Paper birch
- White ash

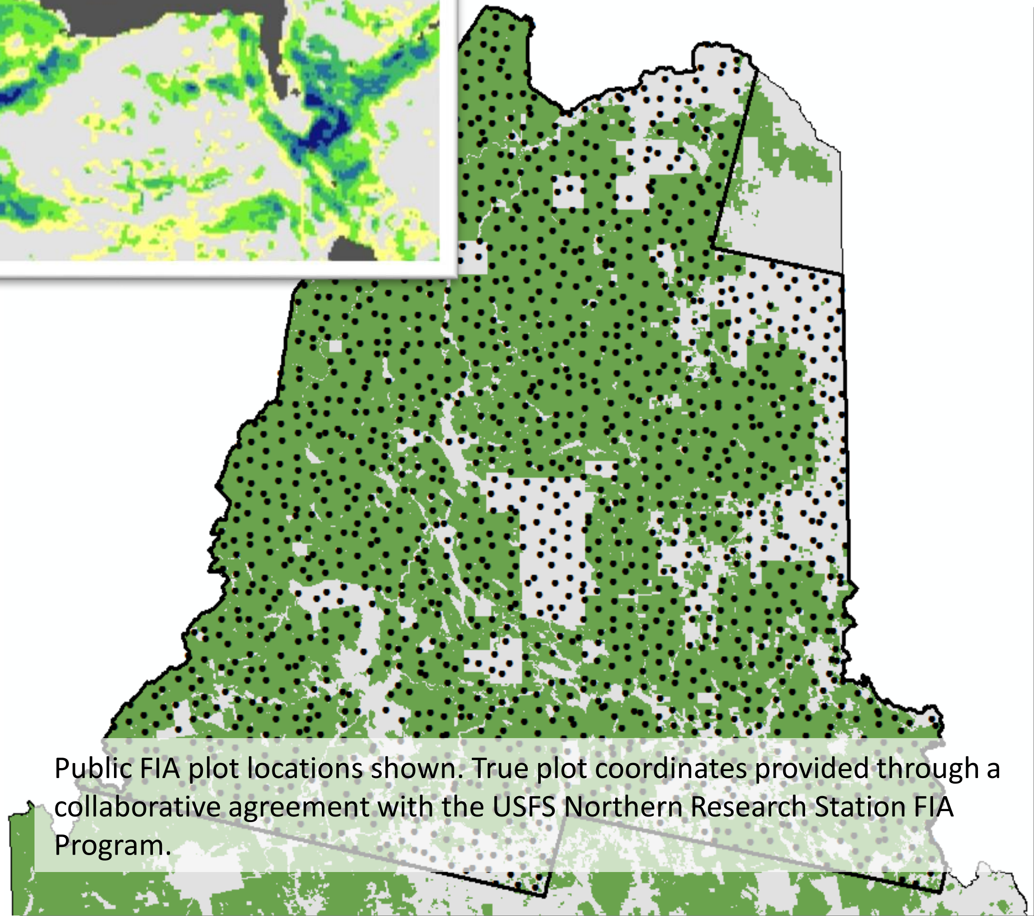


Public FIA plot locations shown. True plot coordinates provided through a collaborative agreement with the USFS Northern Research Station FIA Program.

Model initialization





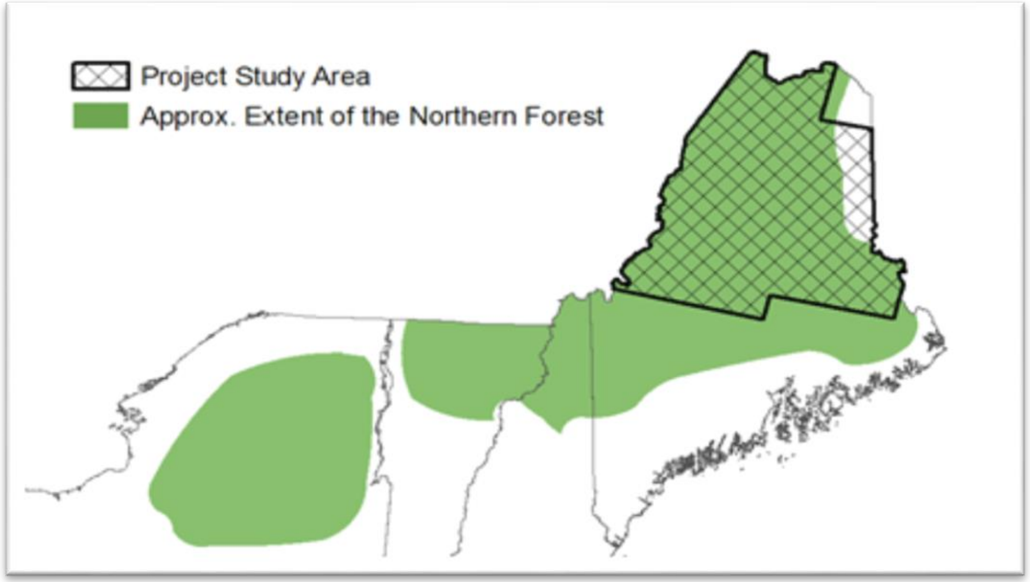


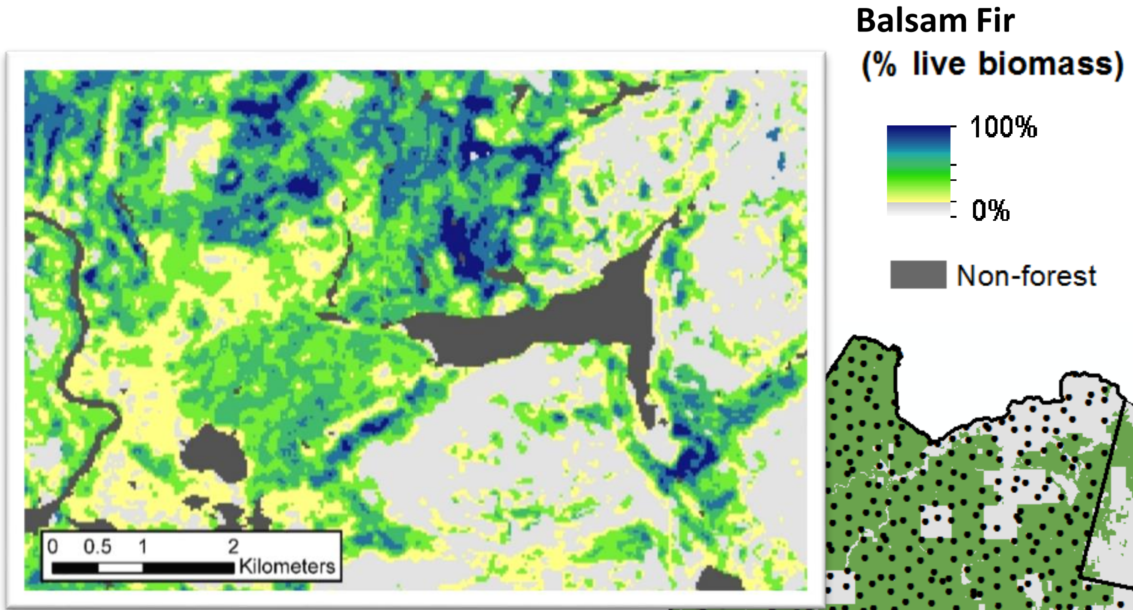
Public FIA plot locations shown. True plot coordinates provided through a collaborative agreement with the USFS Northern Research Station FIA Program.

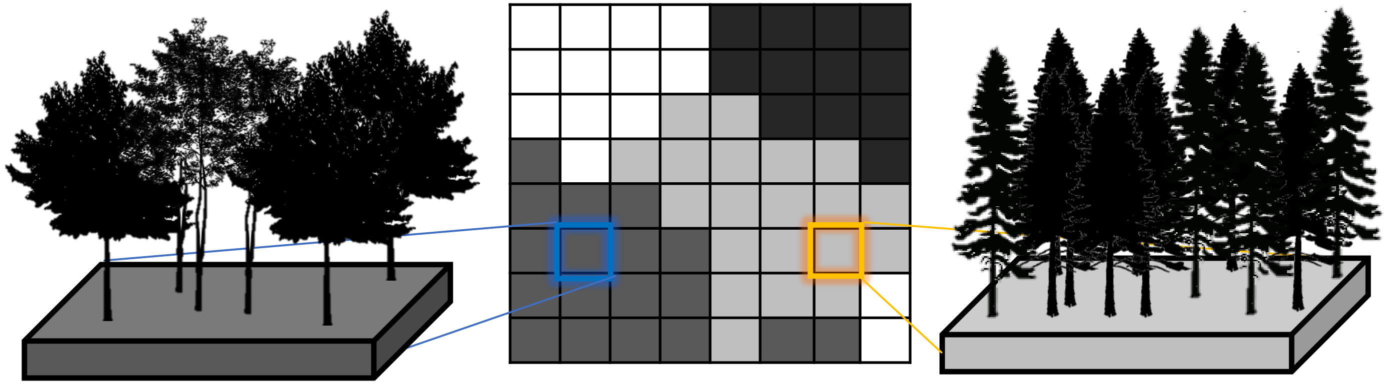
Species with relative abundance > 10% biomass:

- Balsam fir
- Red, white, black spruce
- E. White pine
- N. White cedar
- Sugar and Red maple
- E. Hemlock
- American beech
- Yellow birch
- Paper birch
- White ash

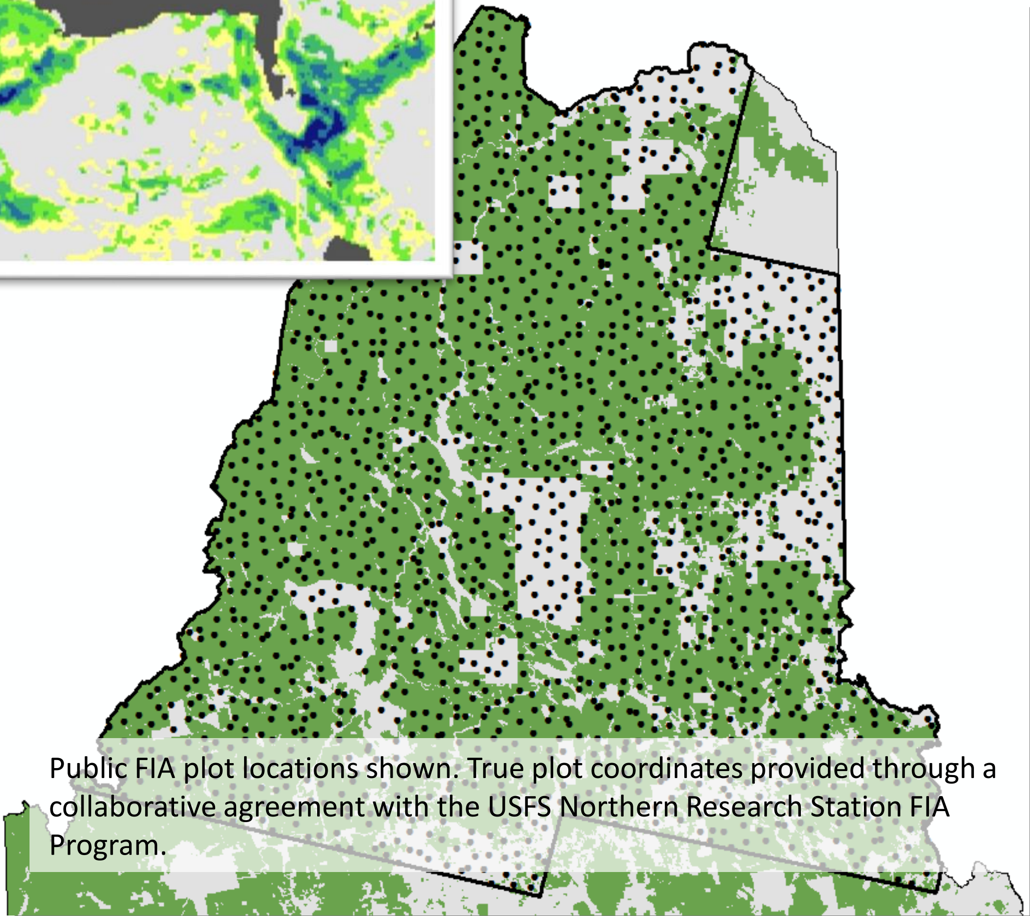
Model initialization







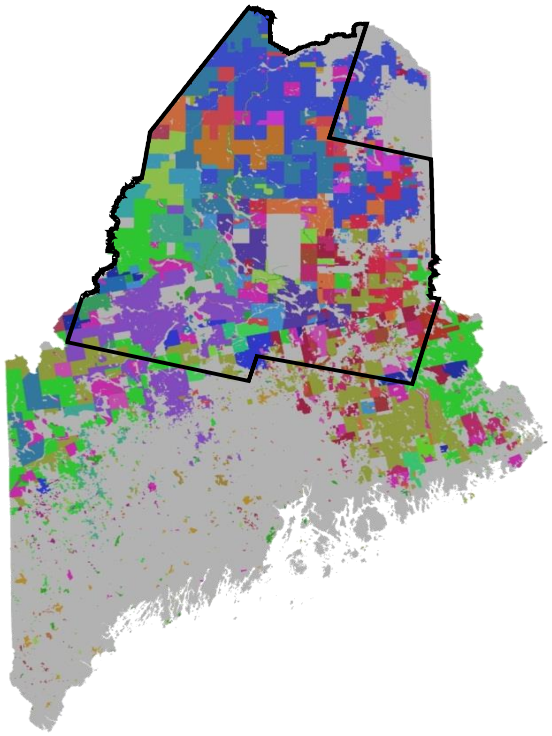
Figurative example of the cell-based system used by LANDIS-II.
Stands are formed by groups of like cells.

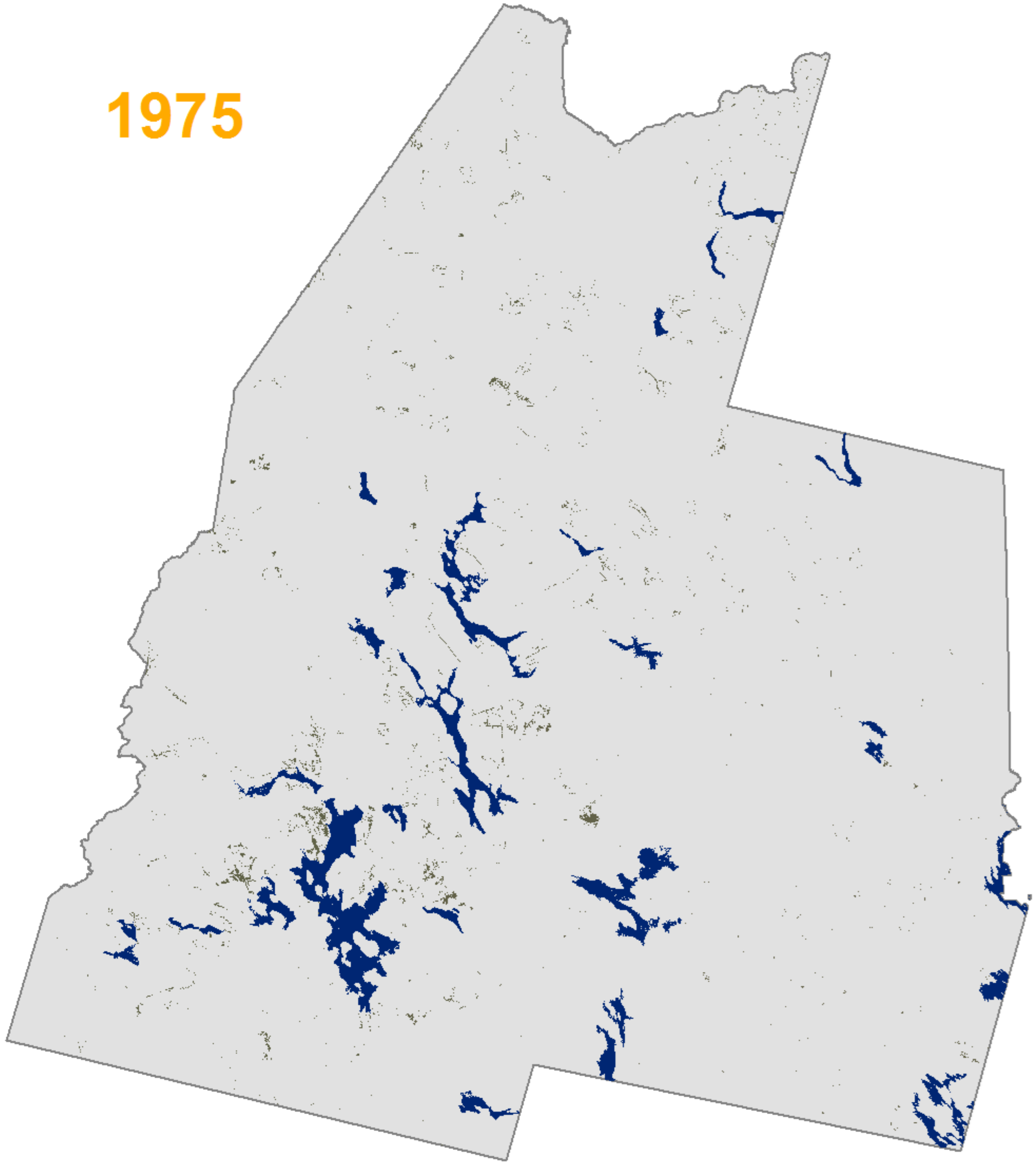


Public FIA plot locations shown. True plot coordinates provided through a collaborative agreement with the USFS Northern Research Station FIA Program.

Disturbance history

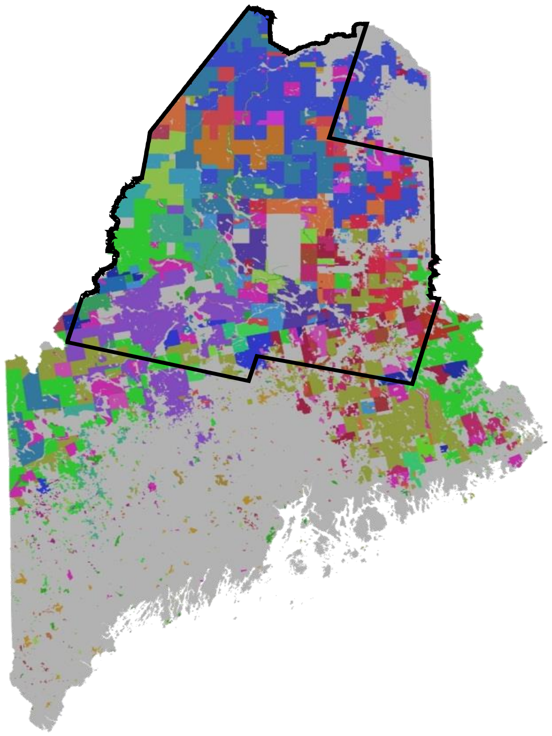
across a diverse ownership

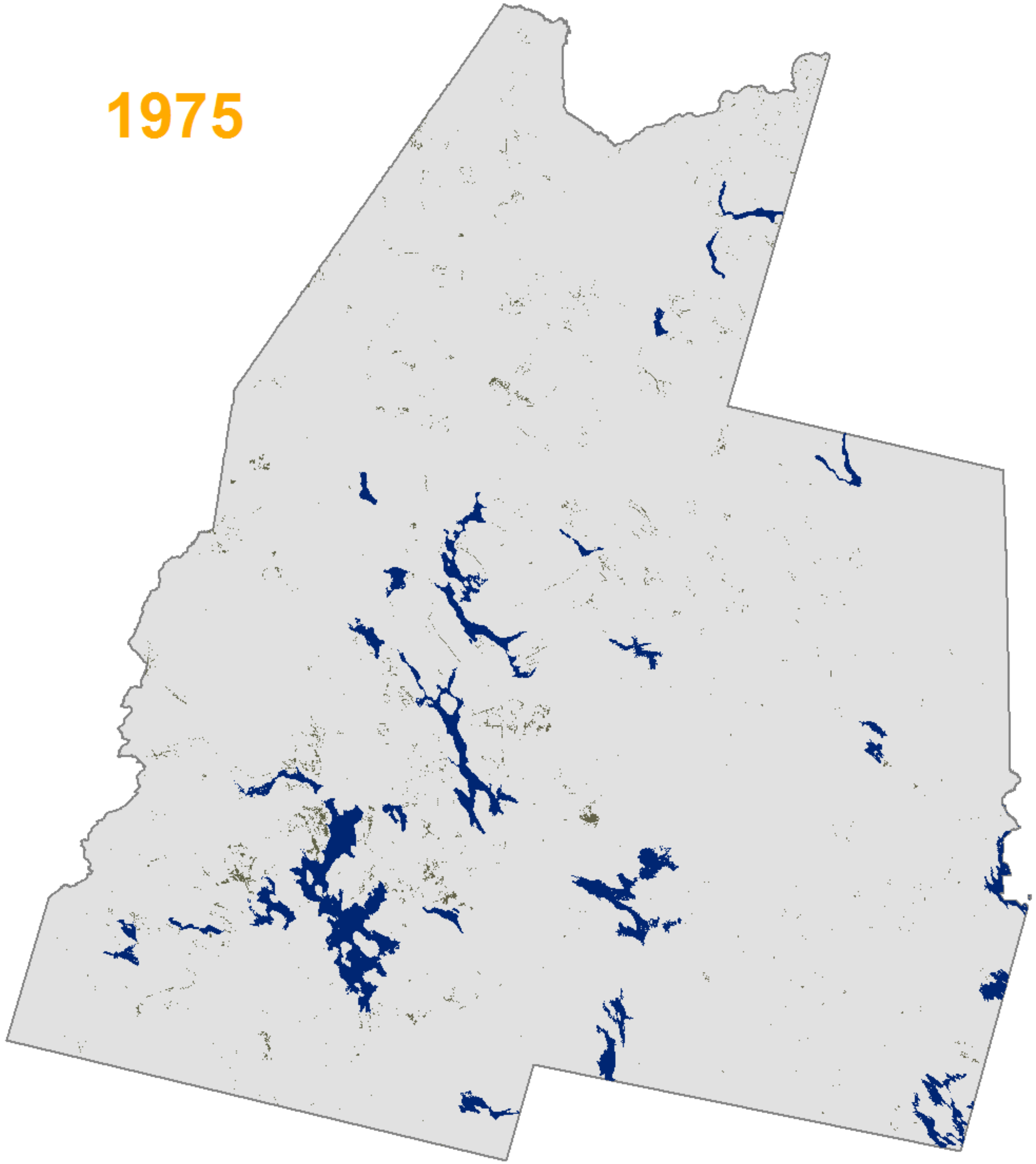




Disturbance history

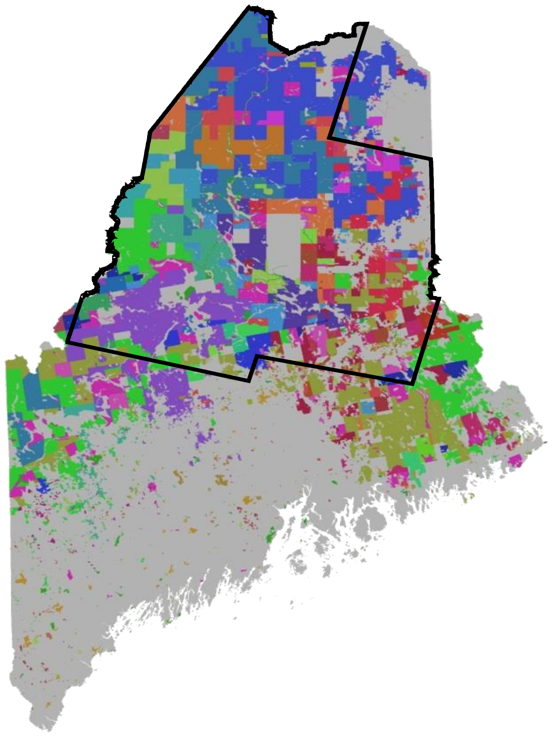
across a diverse ownership



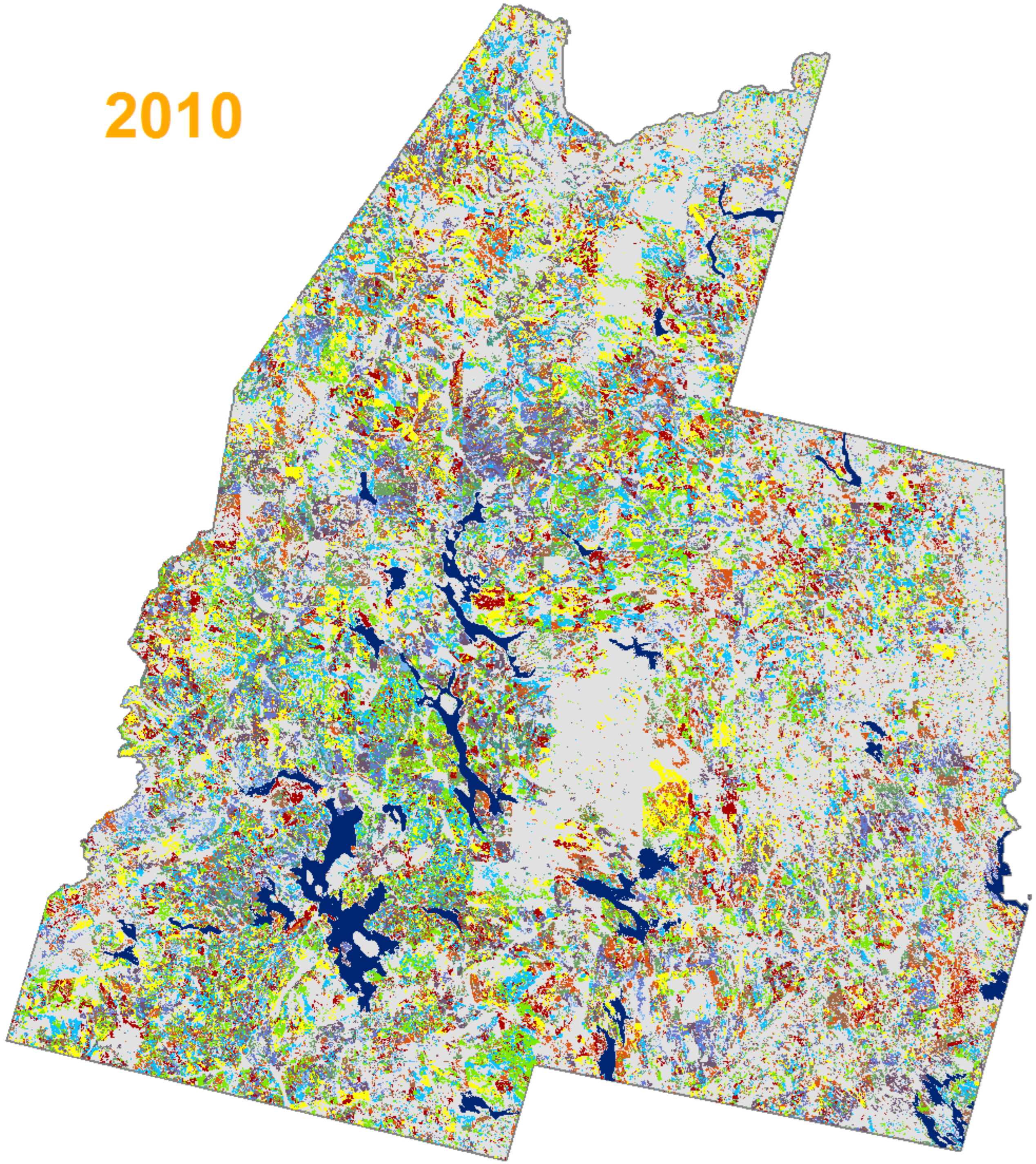


Disturbance history

across a diverse ownership

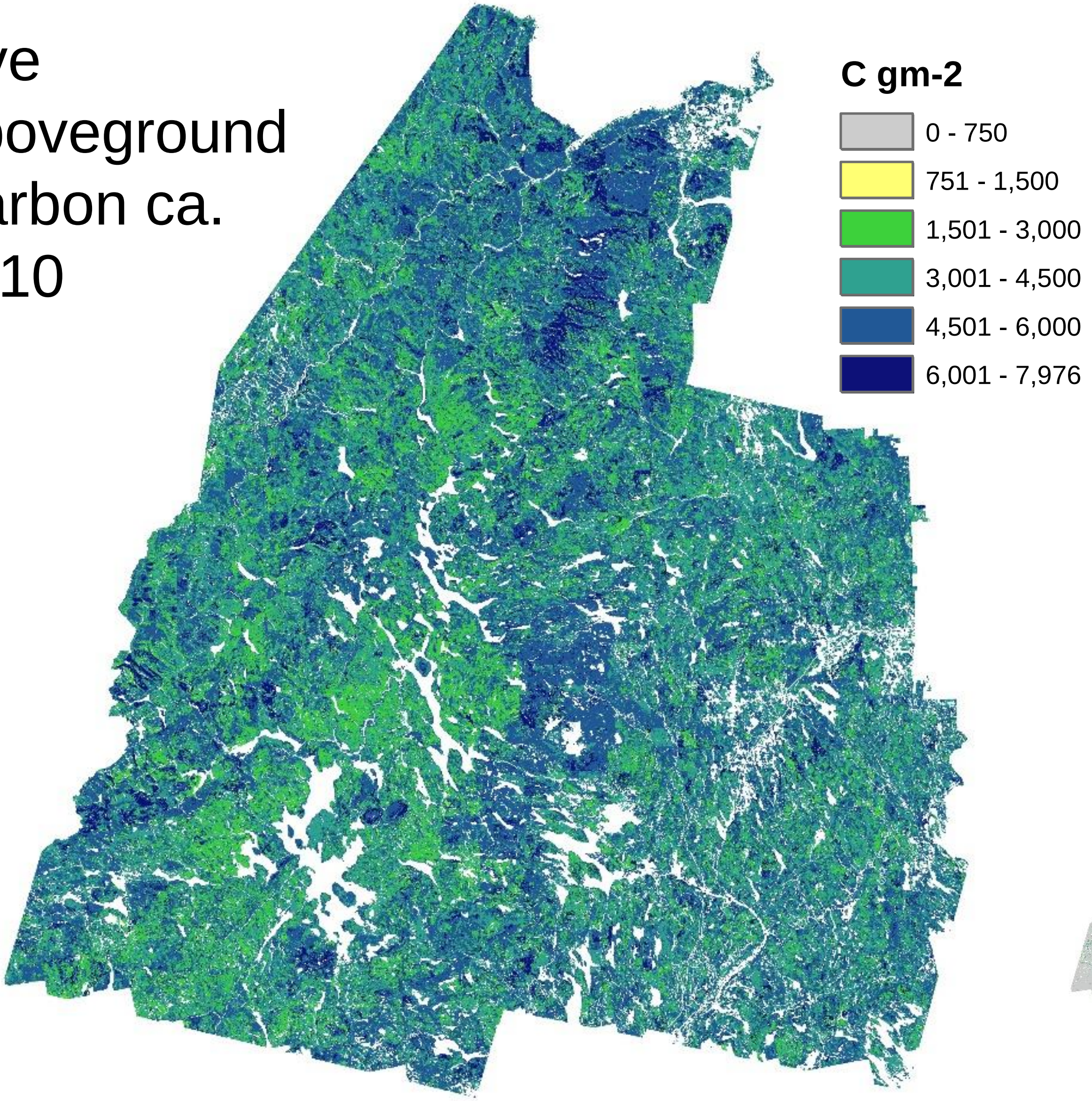


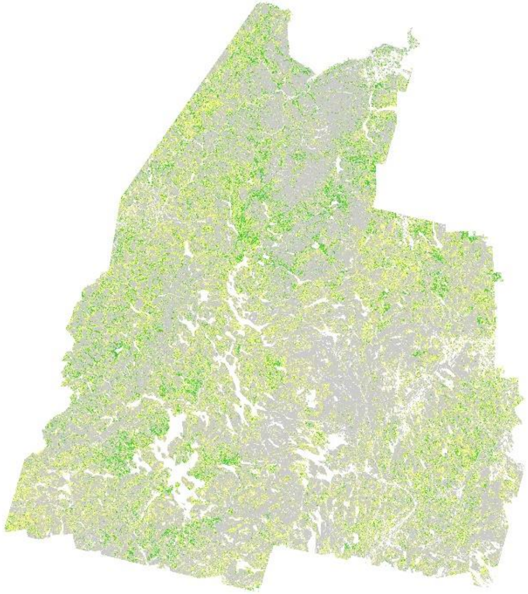
2010



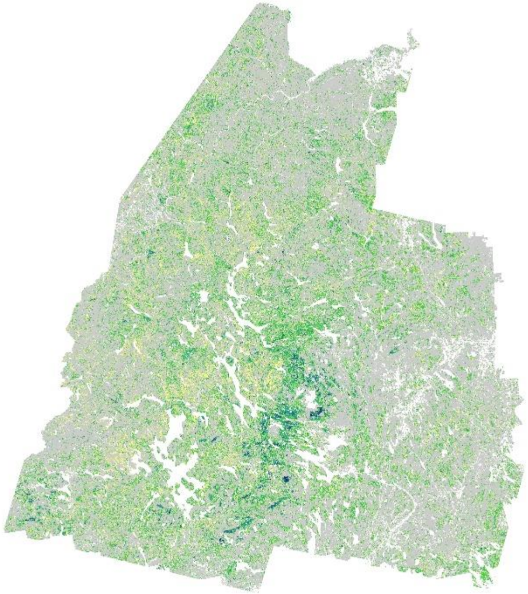
Initial Carbon Density

Live Aboveground Carbon ca. 2010

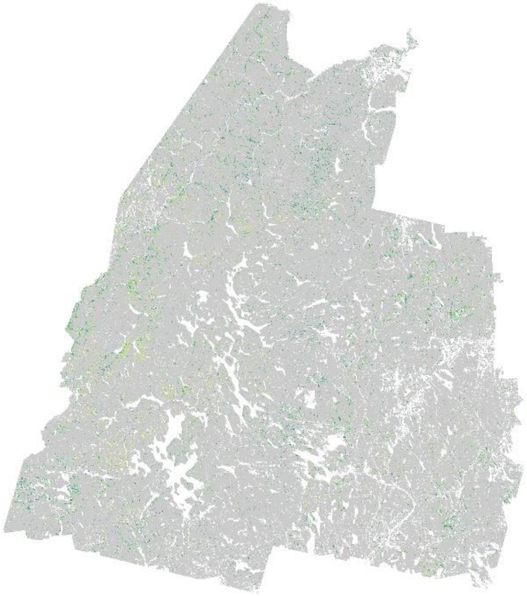




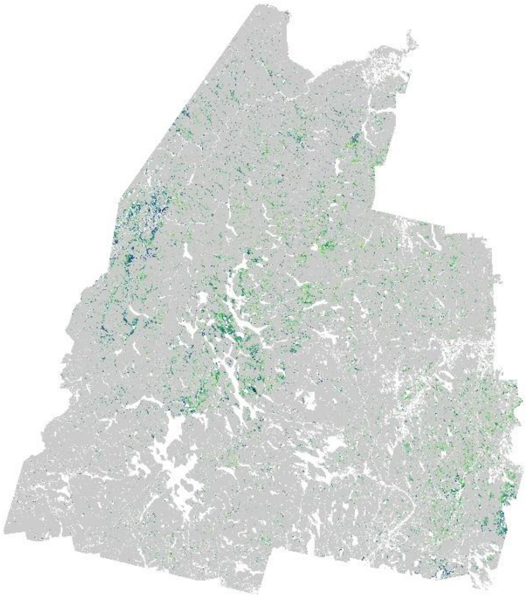
Balsam fir



Red spruce



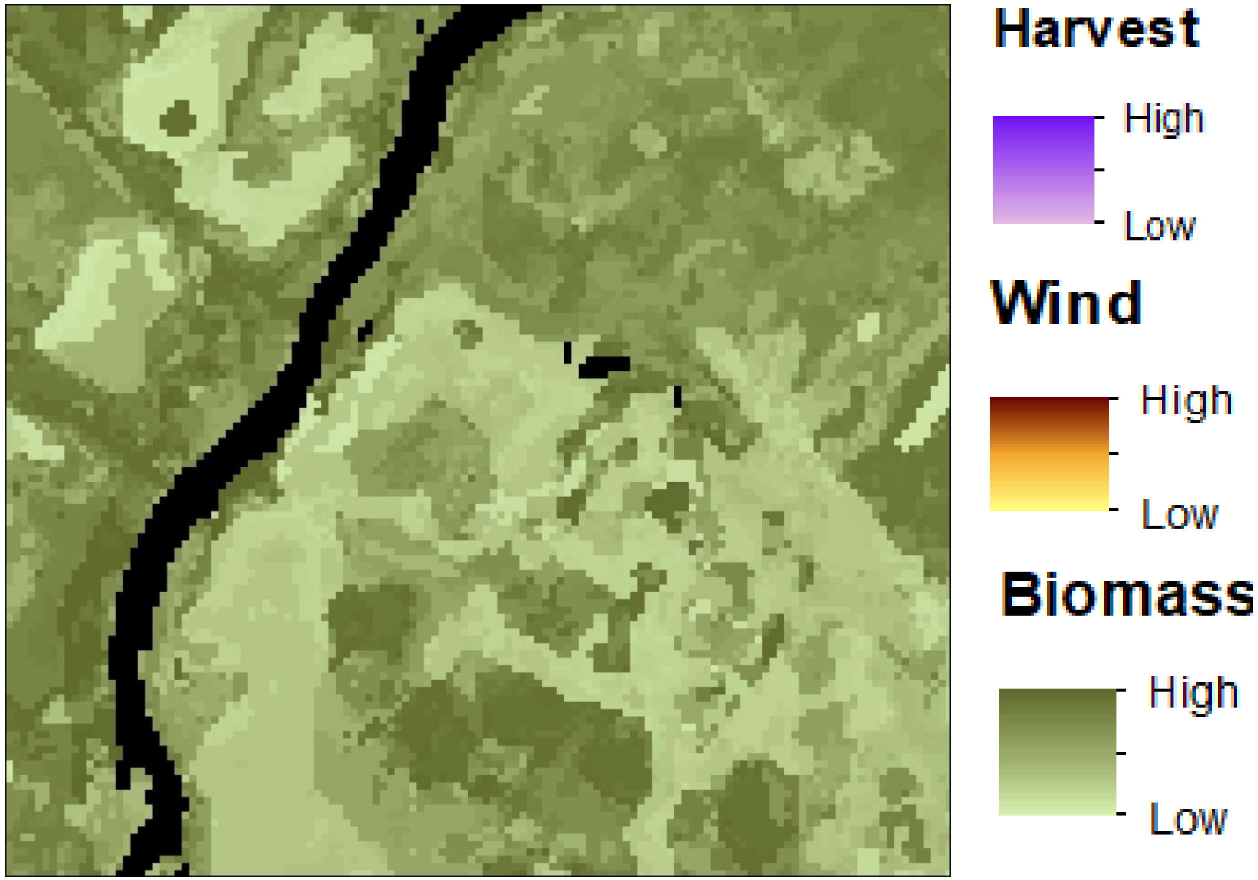
White spruce



Black spruce

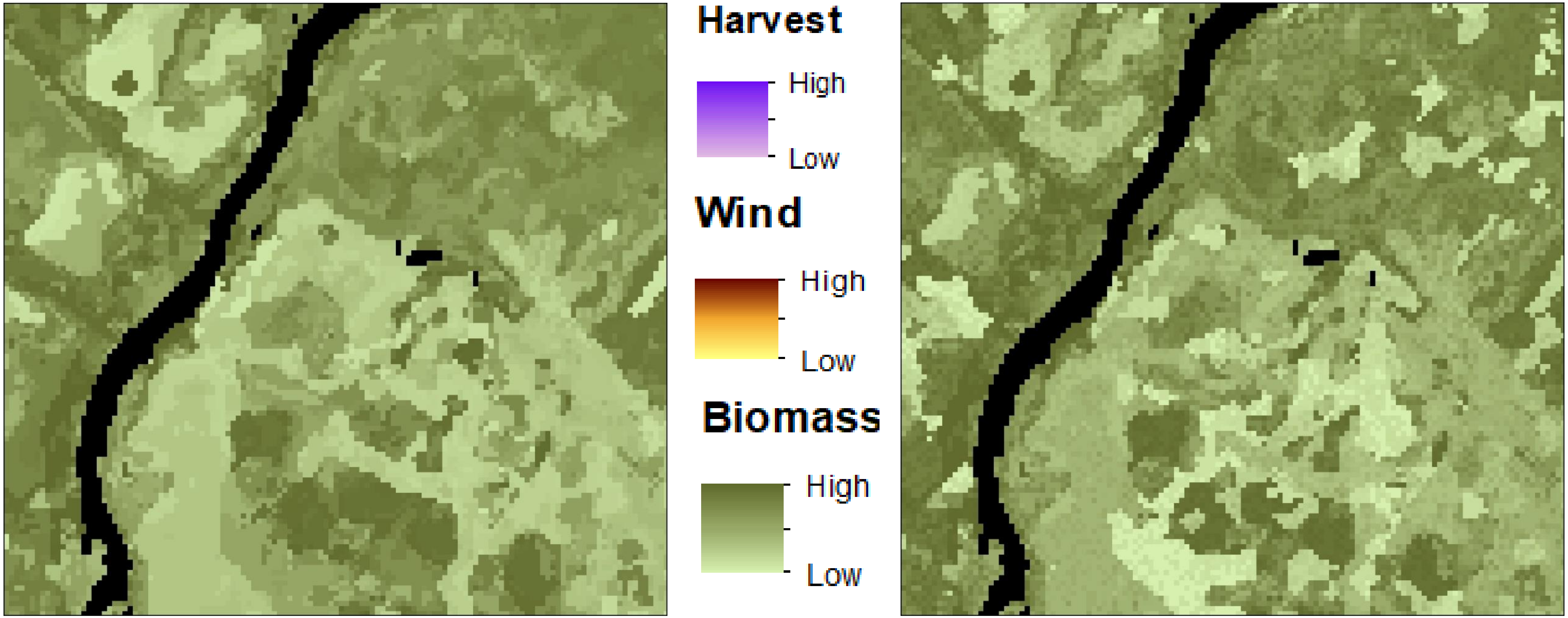
Landscape simulation

of current disturbance regime



Landscape simulation

of current disturbance regime

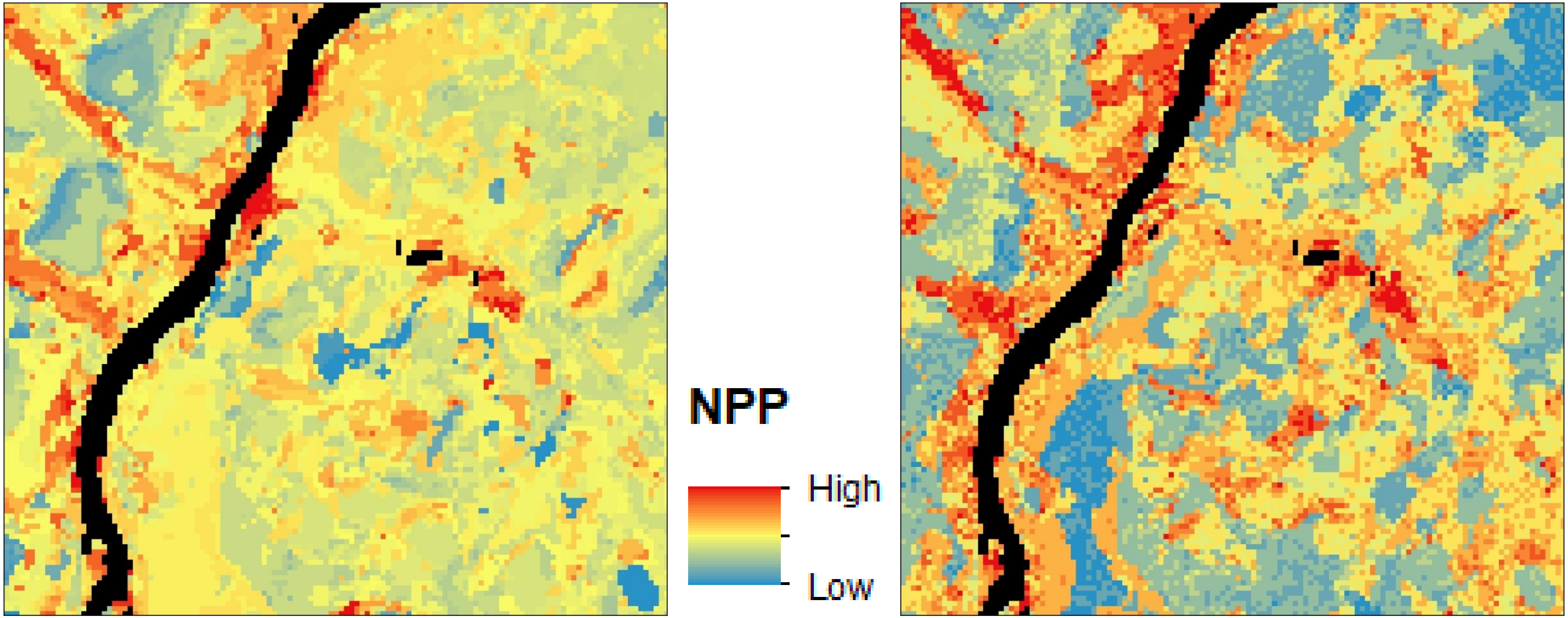


2010

2020

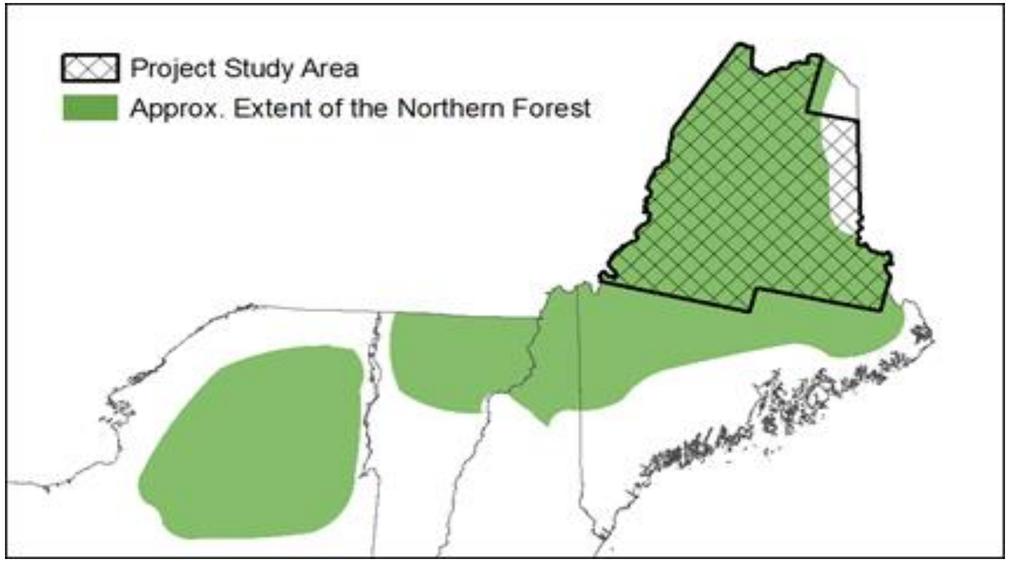
Landscape simulation

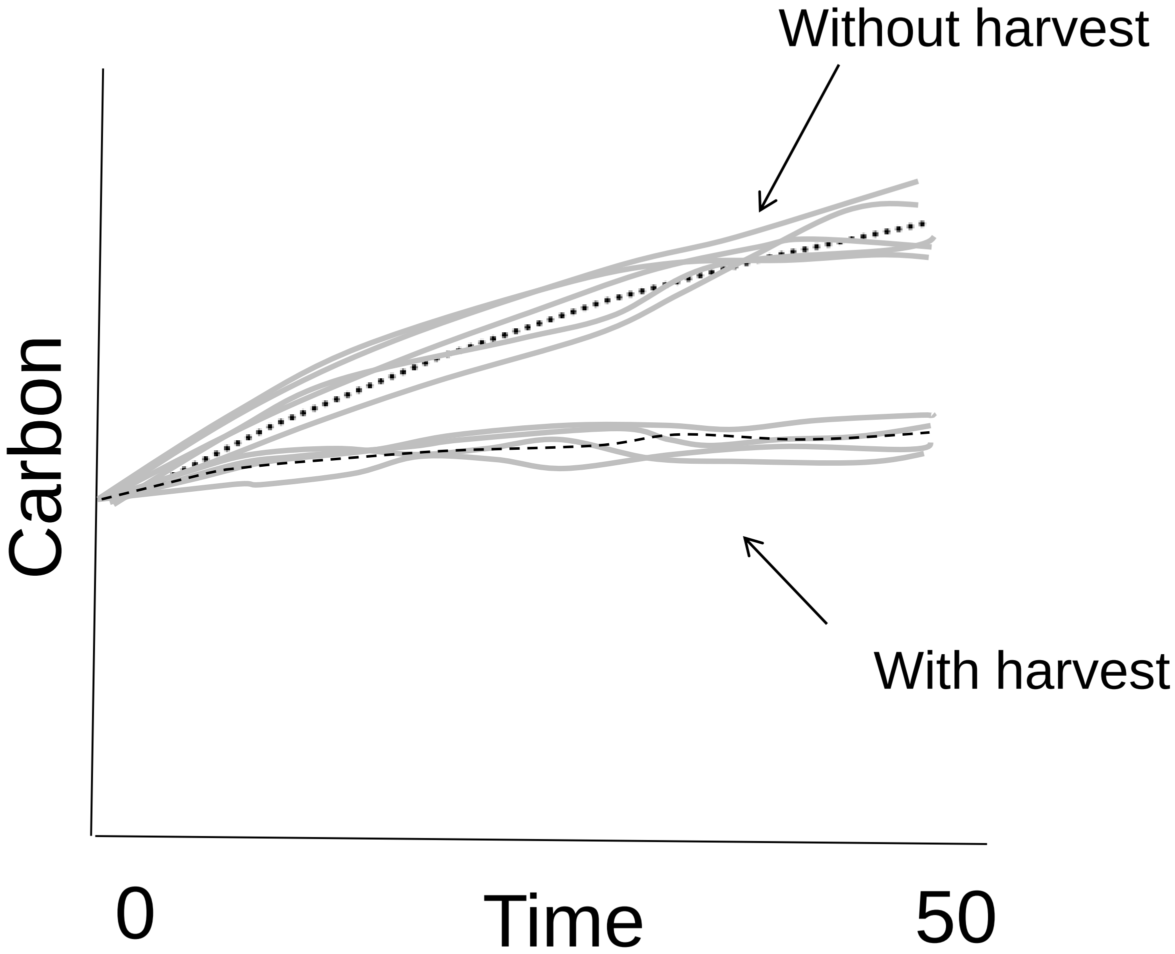
of current disturbance regime



Large area application

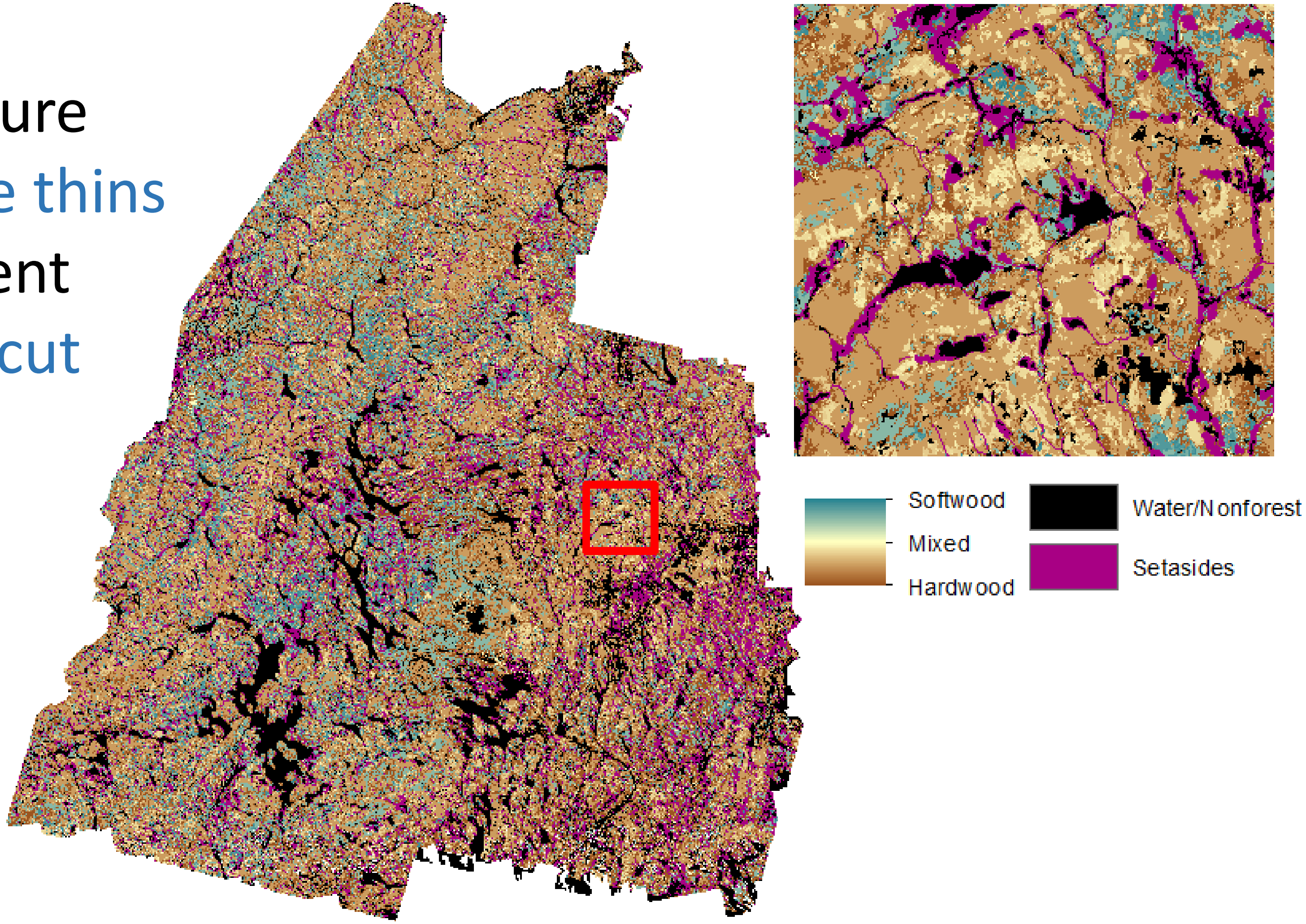
assuming recent climate and harvesting trends





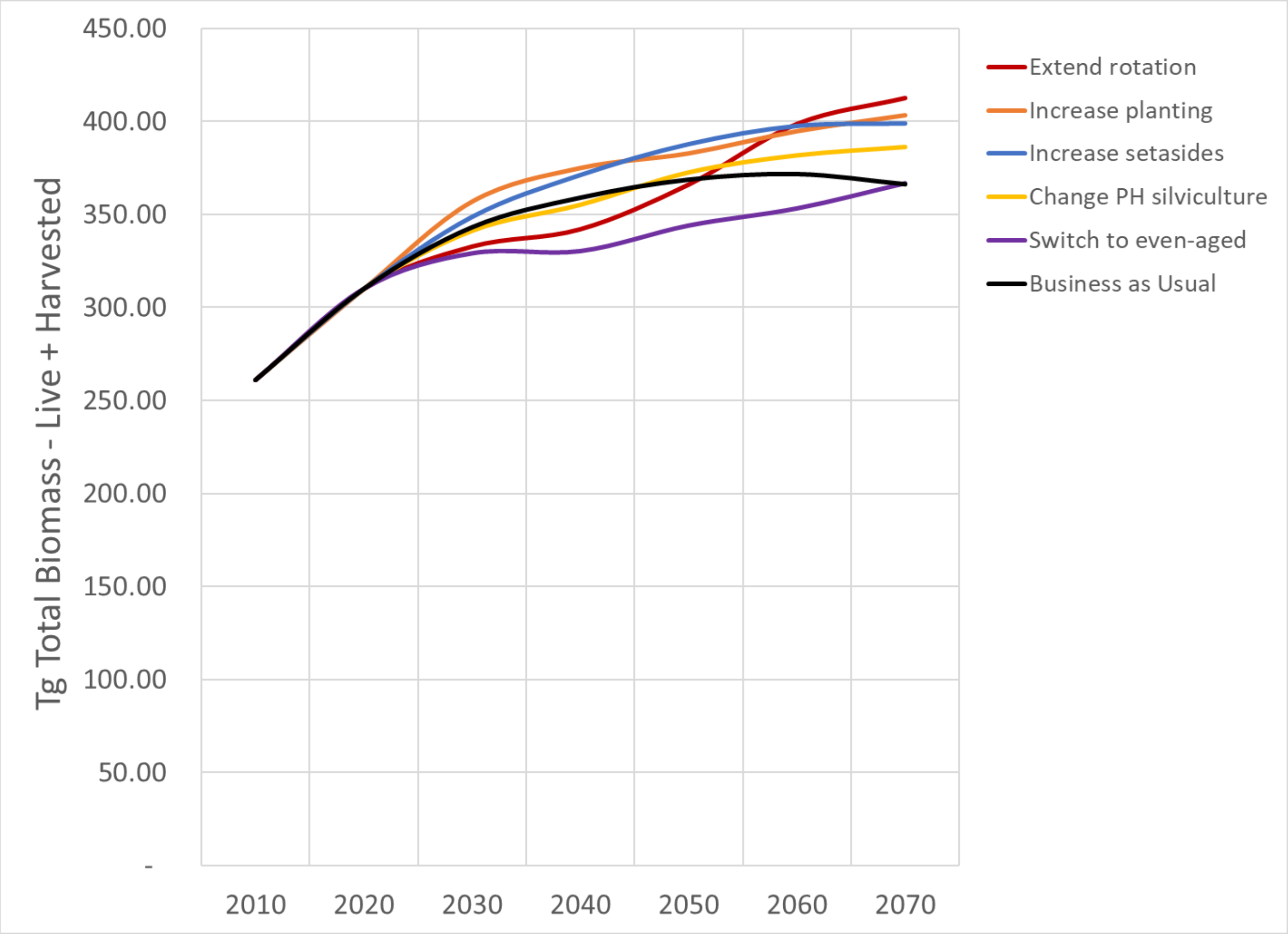
Climate-smart adaptation strategies

- Extend rotation
    - from 50 to 100 years
- Change partial harvest silviculture
    - to repeat light/moderate thins
- Increase even-aged management
    - percent harvest by clearcut
- Increase plantations
    - plant spruce in clearcuts
- Increase setasides
    - to 20% of the landbase



Climate-smart adaptation strategies

- Extend rotation
- Change partial harvest silviculture
- Increase even-aged management
- Increase plantations
- Increase setasides



Climate-smart adaptation strategies

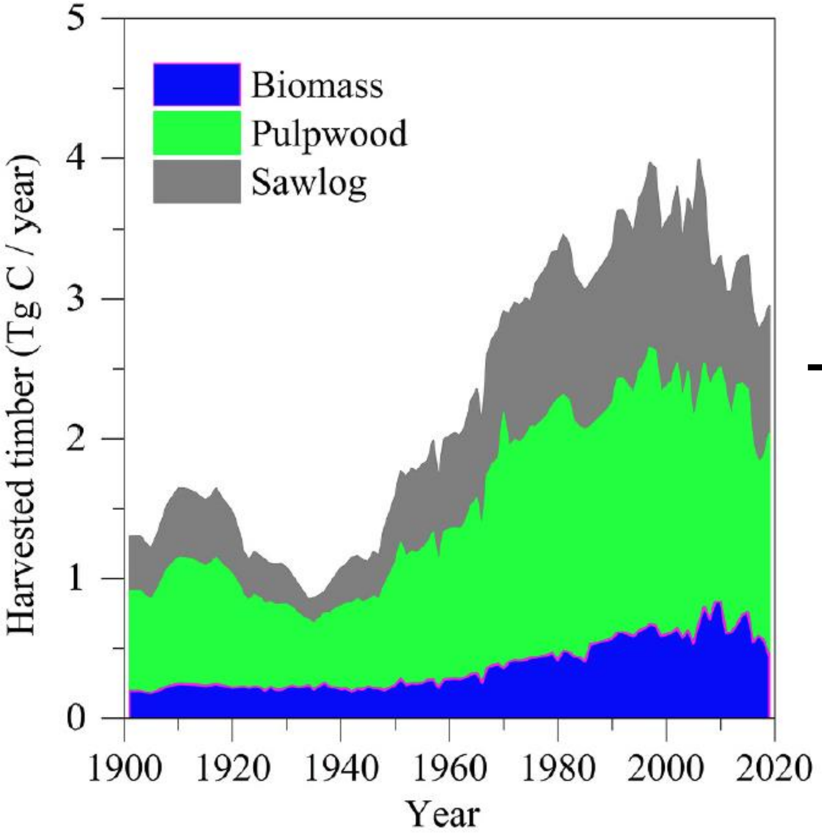
Tradeoffs
ca. 2070
Relative to BAU

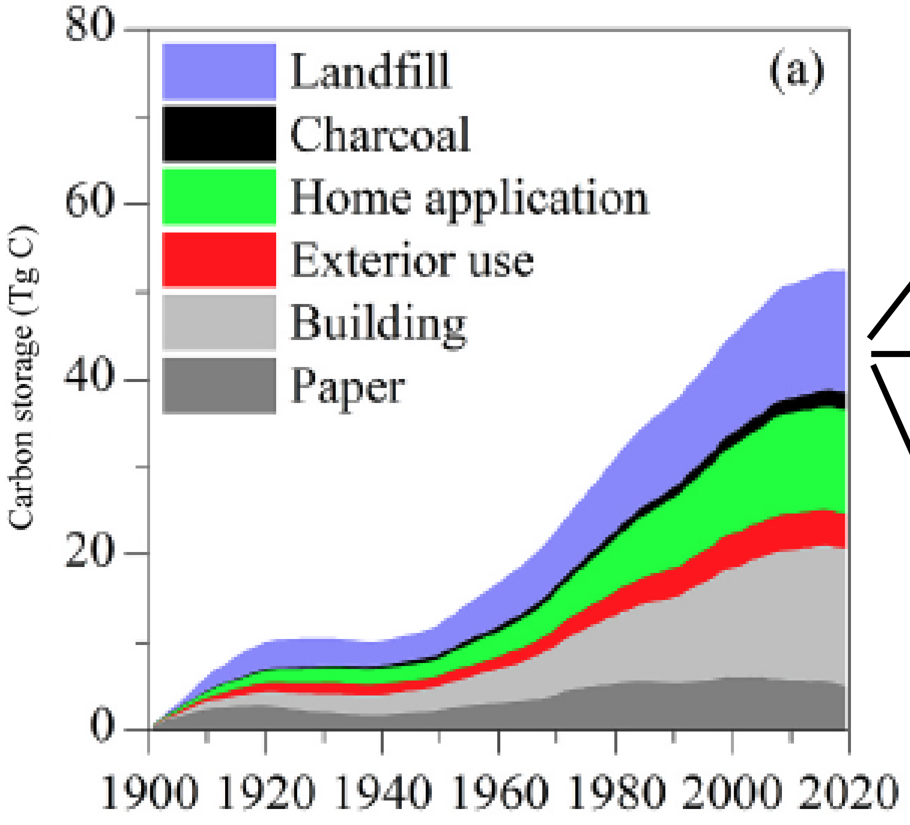
Reduction

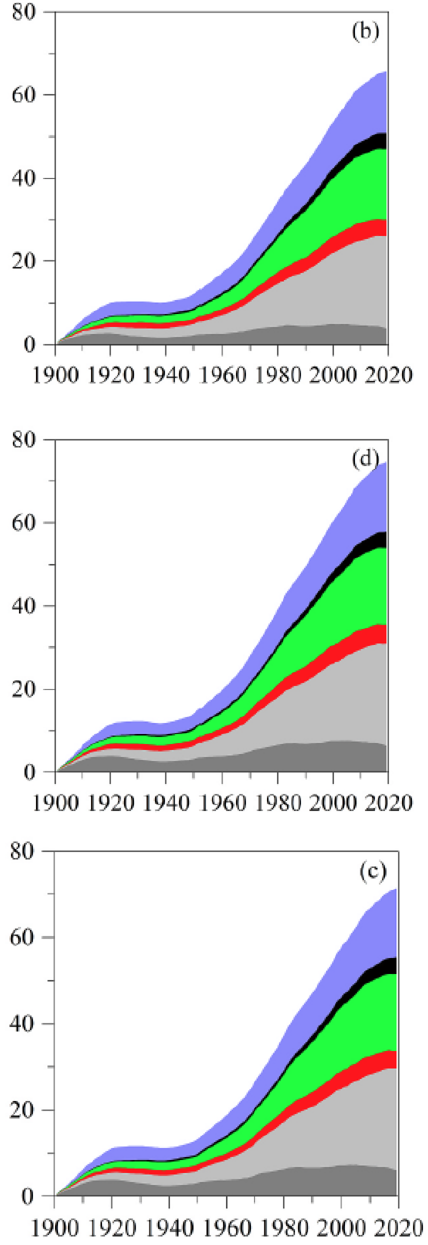
Increase

Scenario	Total harvest	Late-Successional Forest		Lynx habitat	Marten habitat
		Spruce-Fir	N. Hardwood		
Extend rotation	-2%	1%	1%	8%	-4%
Change PH silviculture	-7%	5%	80%	-94%	13%
Increase even-aged management	-5%	-61%	-12%	>100%	-38%
Increase plantations	+18%	-60%	-7%	>100%	-53%
Increase setasides	-18%	2%	9%	-26%	2%

End product effects on carbon



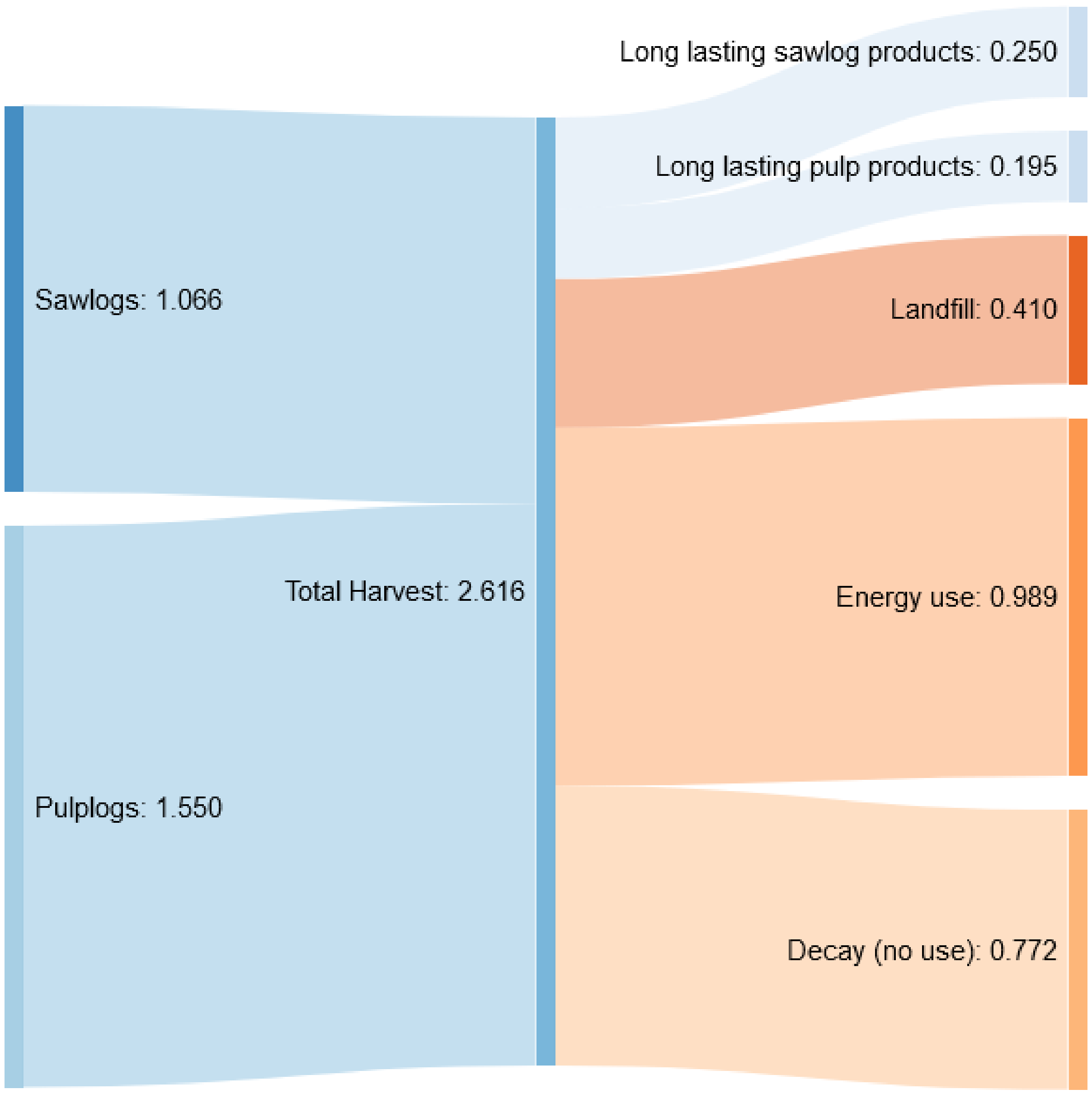




Li et al. 2022. Technological advancement expands carbon storage in harvested woods products in Maine, USA. Biomass and Bioenergy 161:106457

Current challenges

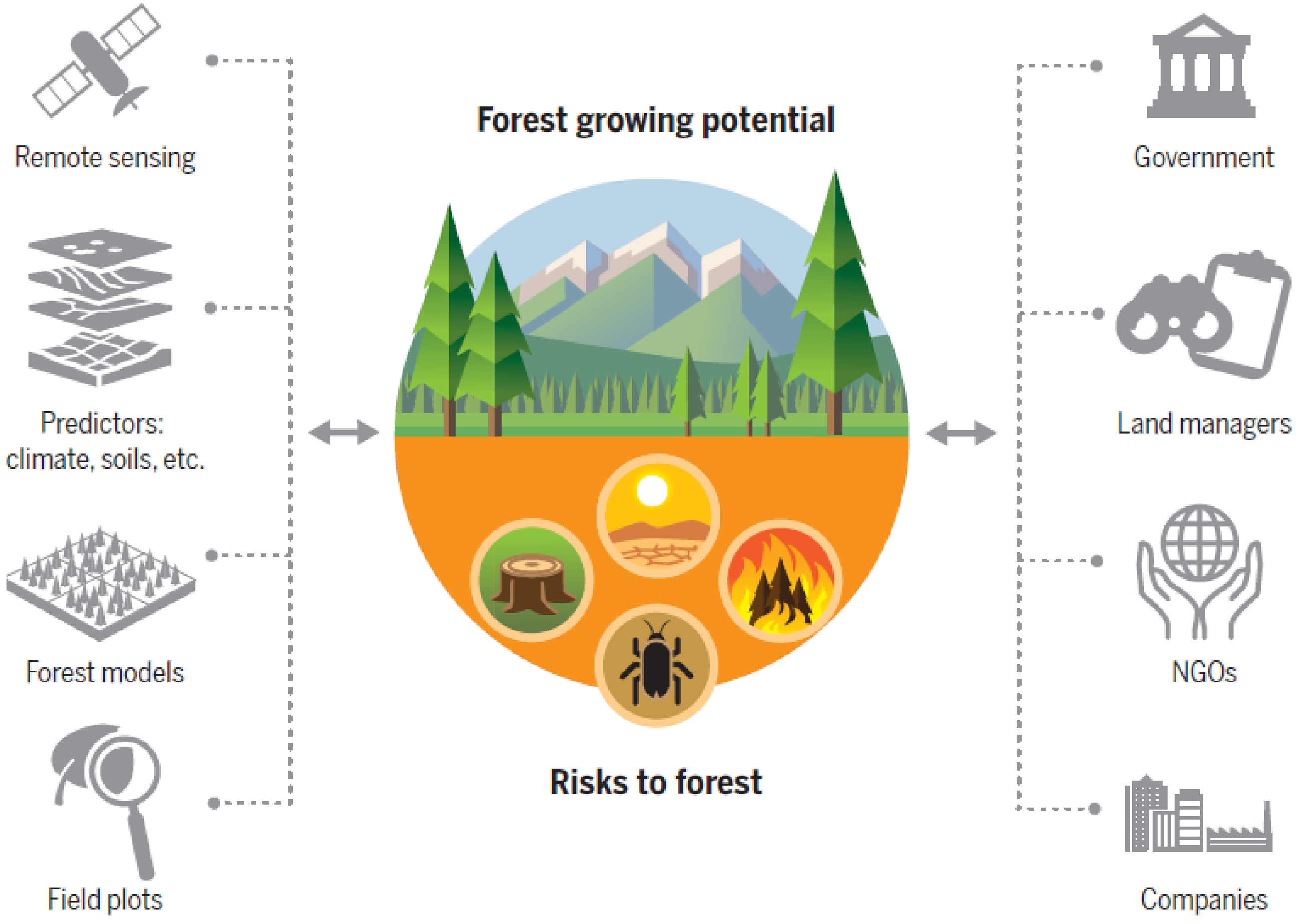
- Intra- and inter-model uncertainty
- Interactive effects of climate change
- Availability of robust economic data and pricing forecasts
- Changing policy and potential market demands
- Technological advances in harvesting & transport



Maine 100-yr HWP C Flow (MtC)

Summary

- Tradeoffs associated with different climate-smart management strategies
- Mixture of management methods (intensive, extensive, conservation) is most effect in complex landscapes
- Incentives (policy/financial) may be necessary for implementation



Anderegg et al (2020)

Acknowledgments

- Data
  - US Forest Service
  - Maine Forest Service
  - NASA
- Funding
  - National Science Foundation
  - NCASI
  - Forest Carbon for Commercial Landowners
  - Cooperative Forestry Research Unit
  - NASA
  - The Nature Conservancy

Questions?

Aaron Weiskittel
aaron.weiskittel@maine.edu

Erin Simons-Legaard
erin.simons@maine.edu