CAFS Continuing Project

Density Management Strategies for Enhancing Carbon Sequestration in U.S. Working Forests

CAFS.23.100

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Density management will continue to be a method to achieve goals for a variety of objectives

PCT/CT are useful to have in our toolbox

Commodity production, Crop tree release, C sequestration, Stand composition, Forest health, Wildlife habitat, Aesthetics, Structure, etc.

Justification

Little is known about the causal factors of the magnitude and duration of response

f (tree size, light, water, nutrient availability, competition)

How much? What is the threshold?

Justification

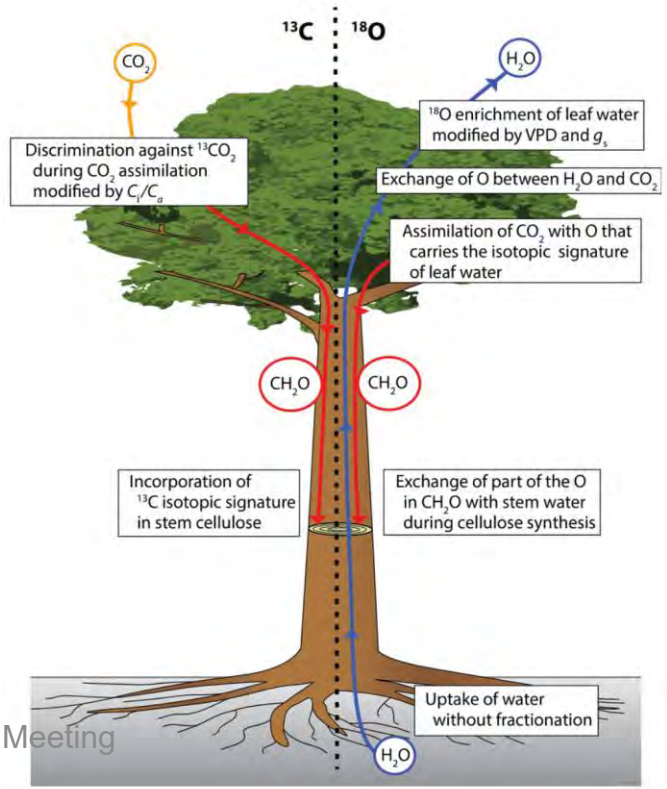
Tree-ring isotopes* and Site Water Availability (light and water)

Novel tools of quantifying potential water use efficiency and a *promising solution* to site-specific density management regimes

*Atoms that do not decay, C^{13} and O^{18}

If resources are not limiting, trees are "picky" and don't utilize the heavier isotopes of C and O

van der Sleen et al. (2017).



As resources become limiting, trees will "use what is available"

If light limited, drop in ^{13}C, if water limited, drop in ^{18}O

This is recorded in the tree ring tissue each growing season

Site water availability, leaf area, and productivity

Continued success in application of SWA estimators (WD/WDI)

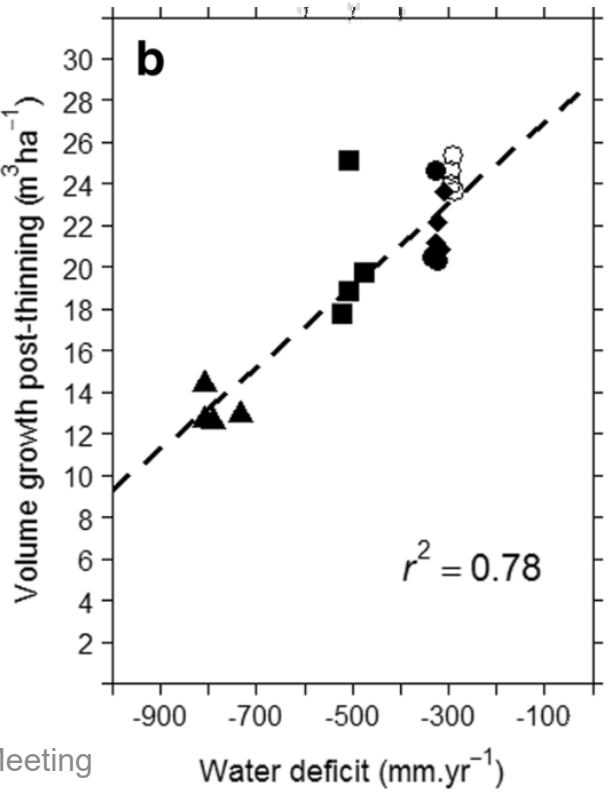
Predicting thinning response in Radiata pine in Chile
(Ojeda et al. 2018)

Dominant height and leaf area in loblolly pine in the SE
(Koirala et al. 2021; Kinane et al. 2022)

Diameter increment in white spruce in Maine
(Premer, unpublished)

Total volume of Eucalyptus in Brazil
(Scolforo et al. 2019)

A continuous composite variable that is compatible across regions



Project Objectives

1. Quantify **causal mechanisms** of stem growth response (or lack of) to variations in thinning **intensity**, **timing**, and **site variables** through sampling and analysis of tree ring **stable isotopes** ($\delta^{13}C$ and $\delta^{18}O$) with regional long-term datasets

2. Link remote sensing composite **estimates of productivity**, (e.g., cumulative monthly timesteps of water availability) with thresholds of **thinning response** across the hydrologic gradient of sites and patterns in stable isotopes

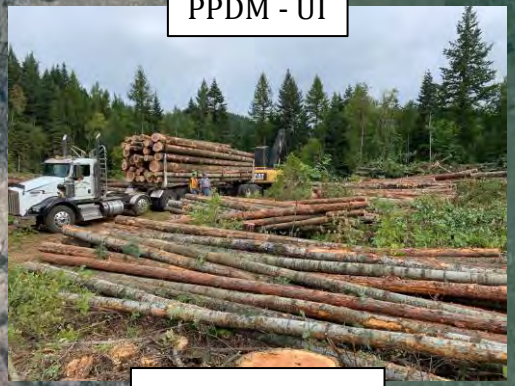
3. Develop cross-regional silvicultural **thinning guidelines** and **geospatial tools** to aid decision support in commercial forest operations.

Each working forest region has an intact experimental thinning network

Type I - UW

Douglas fir

PPDM - UI



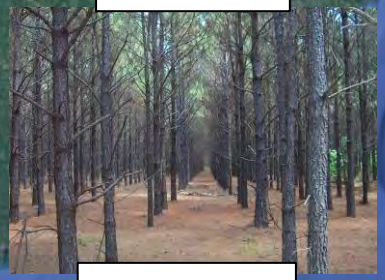
Ponderosa pine

CTRN - UMaine

Red spruce

RW-19 – NCSU and VPI

C x D - UGA



Loblolly pine

Project approach – three pronged

Tree physiologic processes

Tree-ring isotopes

Stand dynamics

Competitive metrics
stem maps

Remote sensing data, soil samples

Site productivity and hydrologic flux

Project approach – three pronged

Tree physiologic processes

Tree-ring isotopes

2023-2024 6 CTRN (UM)

- 1 Thinned Plot and 1 Control Plot per installation
  - Core 20* trees per installation, 1 per diameter distribution quintile
  - RS, 10 at each plot (control/treatment)
  - Core samples will be processed pre-harvest, and 5-10-15-20 years post treatment (5 samples per tree, if possible)
  - Lab processing at UMaine and Columbia University

2024 6 SMC Type I (UW), 6 RW-19 (NCSU)

- 1 Thinned Plot and 1 Control Plot per installation
  - Core 20 trees per installation, 1 per diameter distribution quintile

2025 6 C x D (UGA), 6 PPDM (UI)

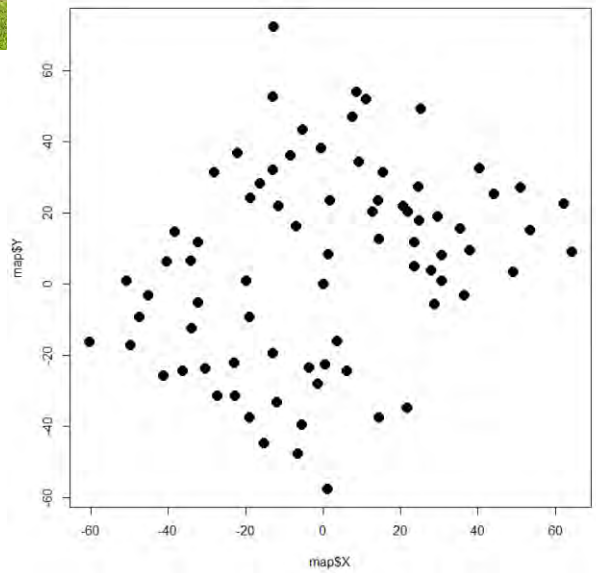
- 1 Thinned Plot and 1 Control Plot per installation
  - Core 20 trees per installation, 1 per diameter distribution quintile

Project approach – three pronged

Stand dynamics

Integrate records from long-term databases

- Stand structure
- Competitive metrics
  (spatially explicit tree neighborhoods)



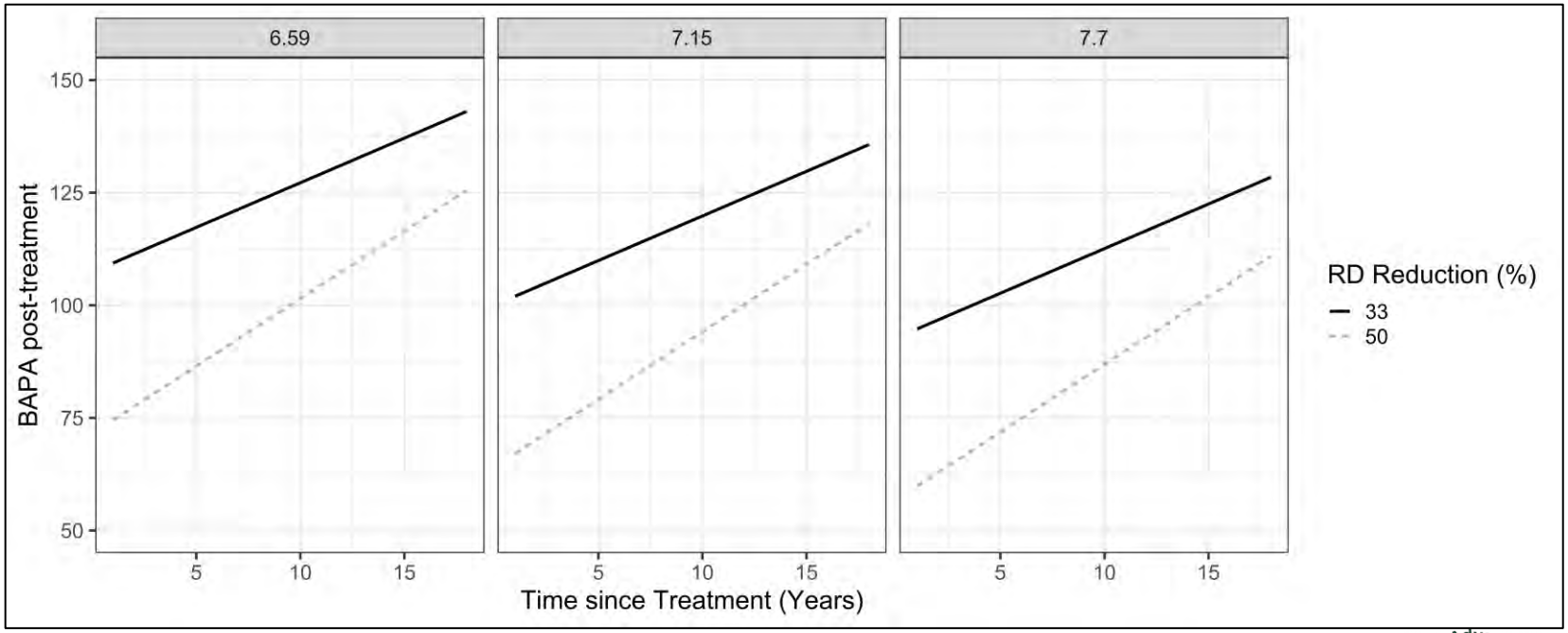
Preliminary Findings

Preliminary Findings

Thinning response greater on sites with less water surplus

By 15 years, 10-12 ft^2 difference in basal area between ”dry” and “wet” sites

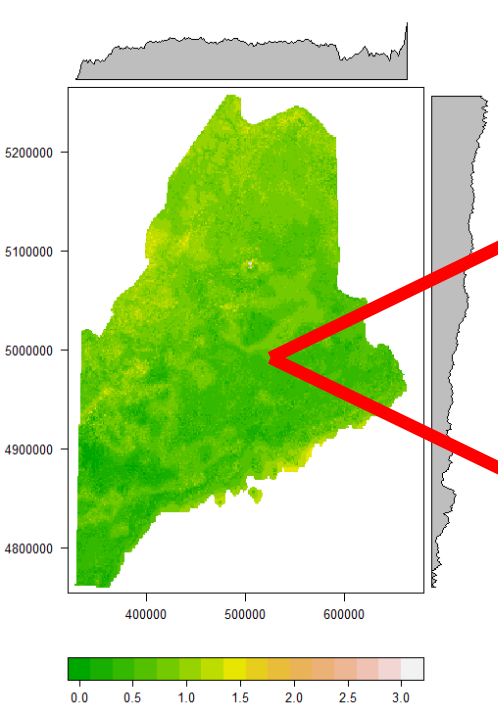
Everywhere in Maine is wet.

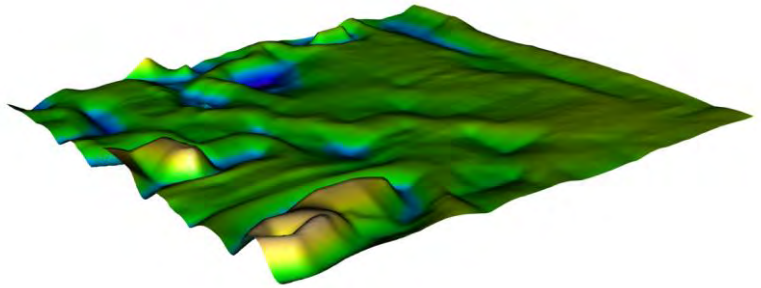


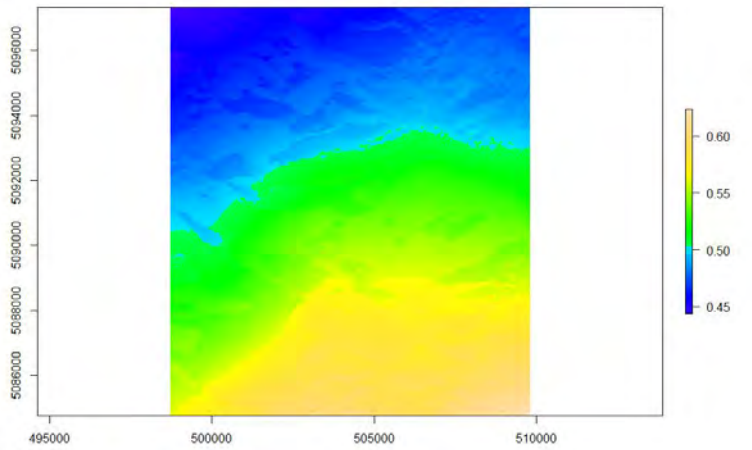
Deliverables

Integration of processes across the tree, stand, and site scales

…C based forest management - *when does tree slow down pulling C from atmosphere*?







$\Delta^{13}C = f$ (Species, $\sum WDI_{t2\text{-}t1}$, Competition, DBH, Age)

Company Benefits

Silvicultural guidelines and geospatial tools of treatment priority and response

Towards site-specific silviculture – "*should I open the stand up a bit more?...*"

Leveraging long-term, cooperative dataset with emerging technologies

Quantifying C sequestration and tools for C based management

The approach can be extended to a variety of applications

Next Steps

5 of 6 CTRN sites have been sampled

Isotope cores are being processed–samples to be sent to Columbia University

Analysis to be completed this fall

Increment borers sent to UW

Summary

- Density management will continue to be a useful tool in our toolbox – but more research is needed to optimize treatments
- Using new technology while leveraging long-term datasets to develop site-specific thinning regimes has tremendous value
- C based forest management
- This approach can be extended to other areas of future research

  (M/CSP, nutrition, tree improvement, species migration)

Thank you. Questions/Comments/Criticisms?

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