Forest Management in Space and Time

When it Matters and When it Doesn't

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National Institute of Food and Agriculture

Working Definition

Forest management is the control and manipulation of forest ecosystems by humans to achieve a desired set of environmental services.

Forest Management Across Scales

Large: Managing Patterns of Forest Distribution

- Forest Conservation and Planning, REDD+

Small: Managing forest attributes, products, services

- Forestry & Silviculture

Climate Change Mitigation

Forest Management Across Scales

Large: Managing Patterns of Forest Distribution

- Forest Conservation and Planning, REDD+
- LULCC

Small: Managing forest attributes, products, services

- Forestry & Silviculture
- Wood Harvest

Climate Change Mitigation

- SSP-RCP Scenarios

Problem solved? What are we missing?

What We Did

We looked at two aspects of ***spatial and temporal heterogeneity of wood harvest*** *not currently represented within the CLM.*

Two Models Assumption Experiments

Harvesting wood everywhere (diffuse harvest)

vs.

Protecting some forest from harvest

Harvesting forests a little each year

vs.

Harvesting in clear-cut rotations

These two assumption have very different effects.

Forest Management in Space

- *The CLM harvests all forest in a grid cell*

Reality:

- Not all forest is harvested
- Protected Areas
  - National Parks
  - Conservation and Wilderness Areas
  - Economically marginal forest

- Is the CLM sensitive to protecting some areas of forest from harvest?

Management in Space: Design

Standard CLM Grid Cell

Diffuse Harvest

All Forest in Grid Cell Partially Harvested

e.g. 100g C / m^2 / yr

Management in Space: Design

Standard CLM Grid Cell

Diffuse Harvest

All Forest in Grid Cell Partially Harvested

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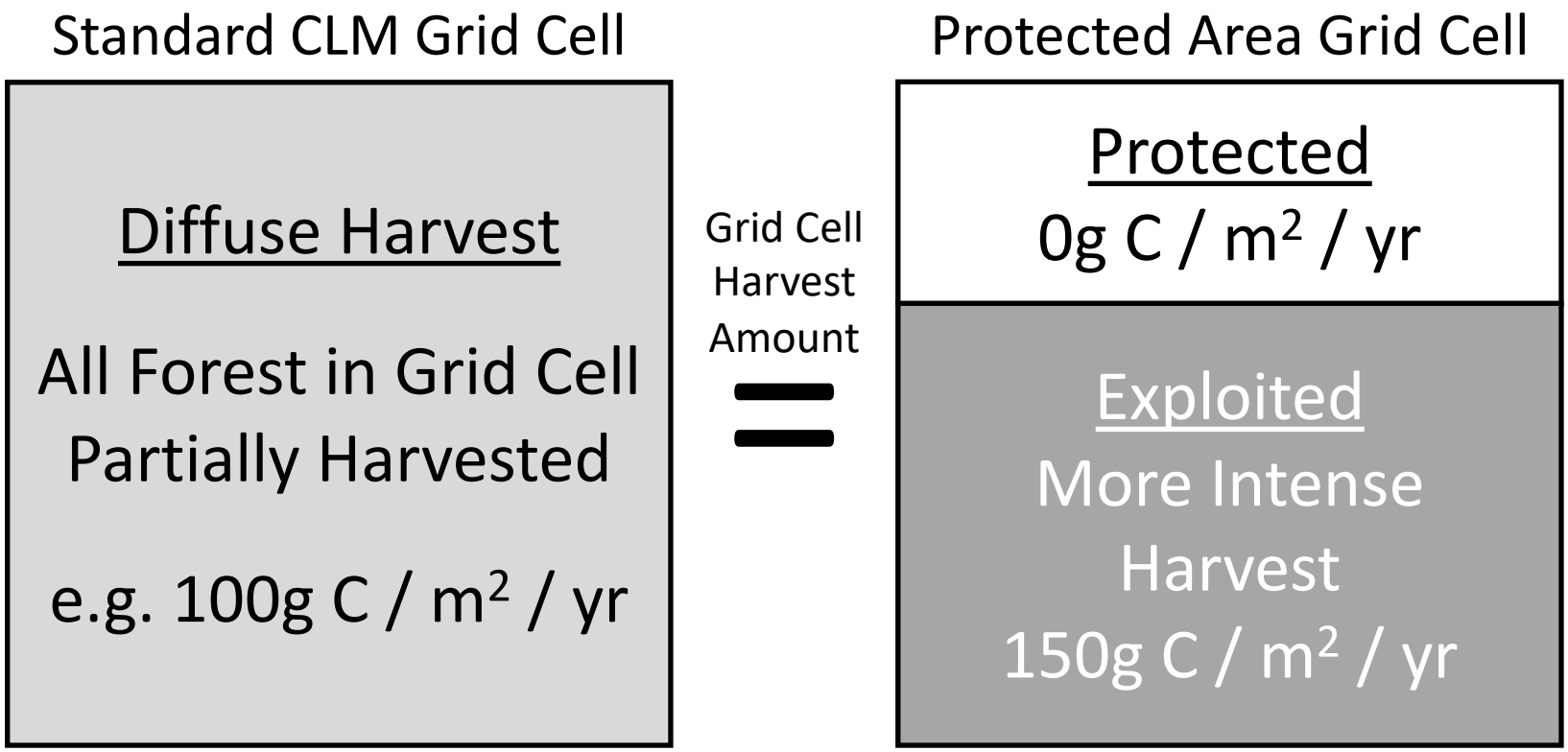
Protected Area Grid Cell

Protected

Unharvested

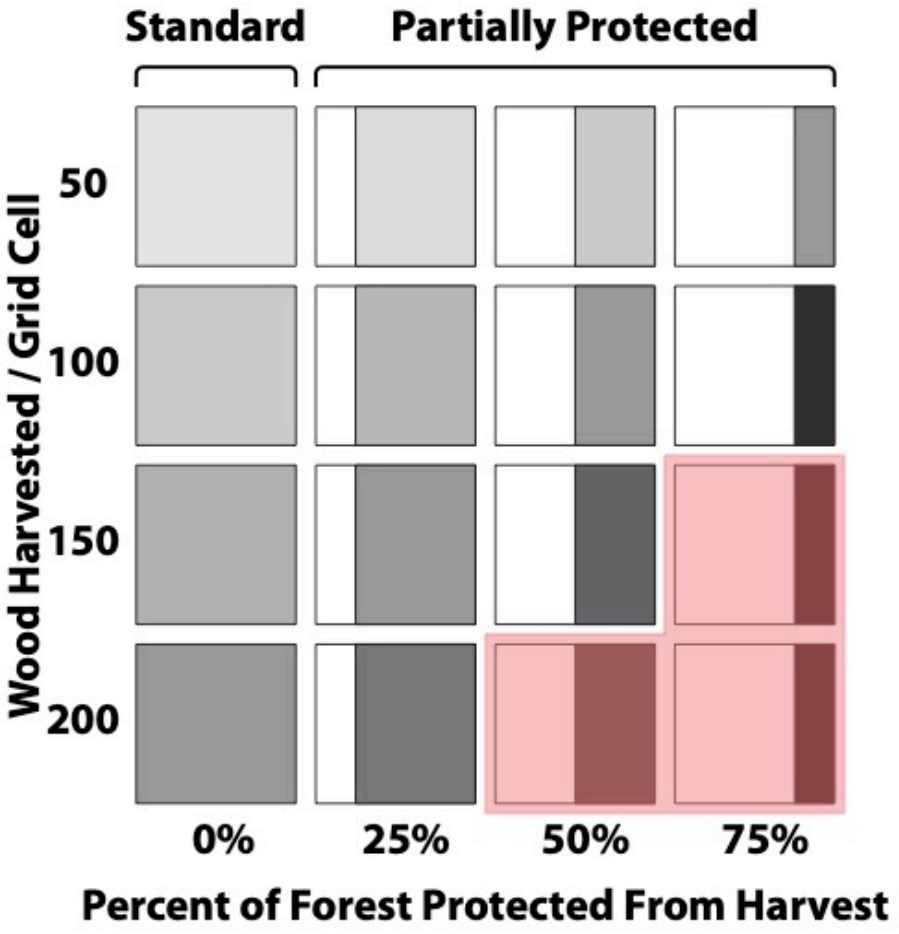
Management in Space: Design



Management in Space: Design

Protected Area Grid Cell

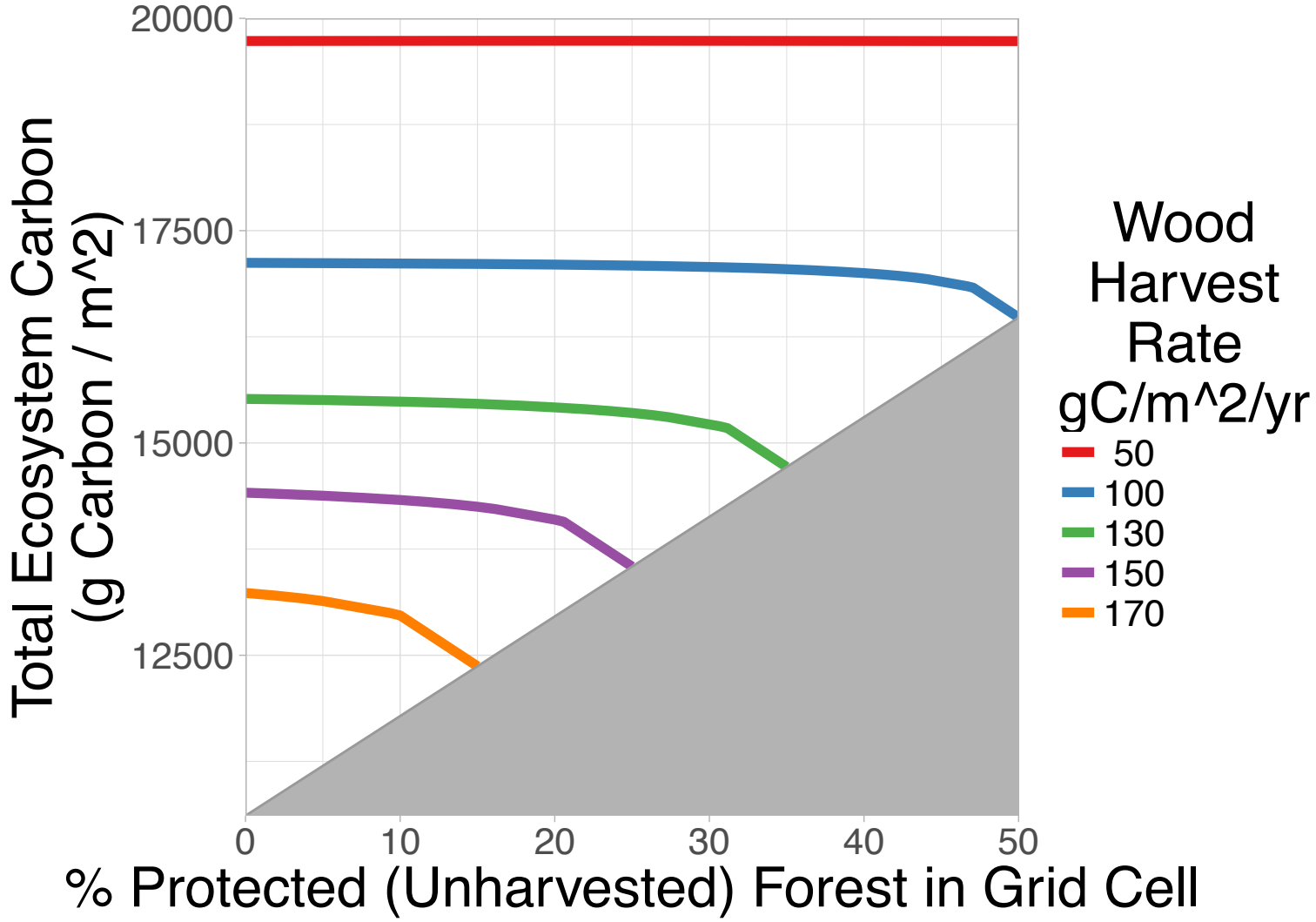
Protected
0g C / m^2 / yr
Exploited More Intense Harvest 150g C / m^2 / yr



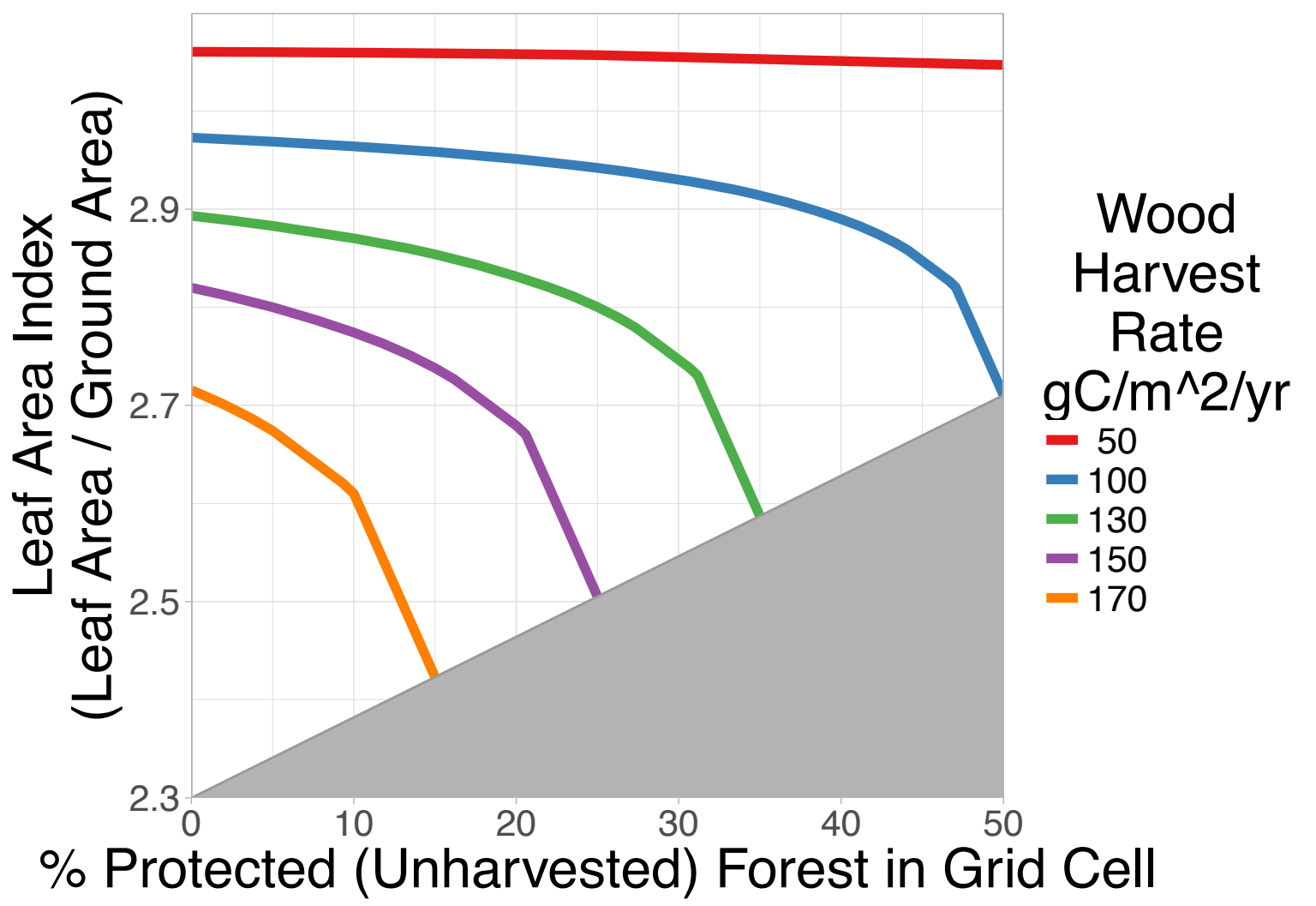
Management in Space: Details

- Single point in coastal plan of North Carolina
- Fixed 1850 land cover
- Constant climate x 400 years
- Constant harvest at multiple intensities
- Harvested and unharvested fractions simulated separately and combined, i.e. separate columns
- Aggregate effects presented
- Equilibrium (last 20 years) used for analysis

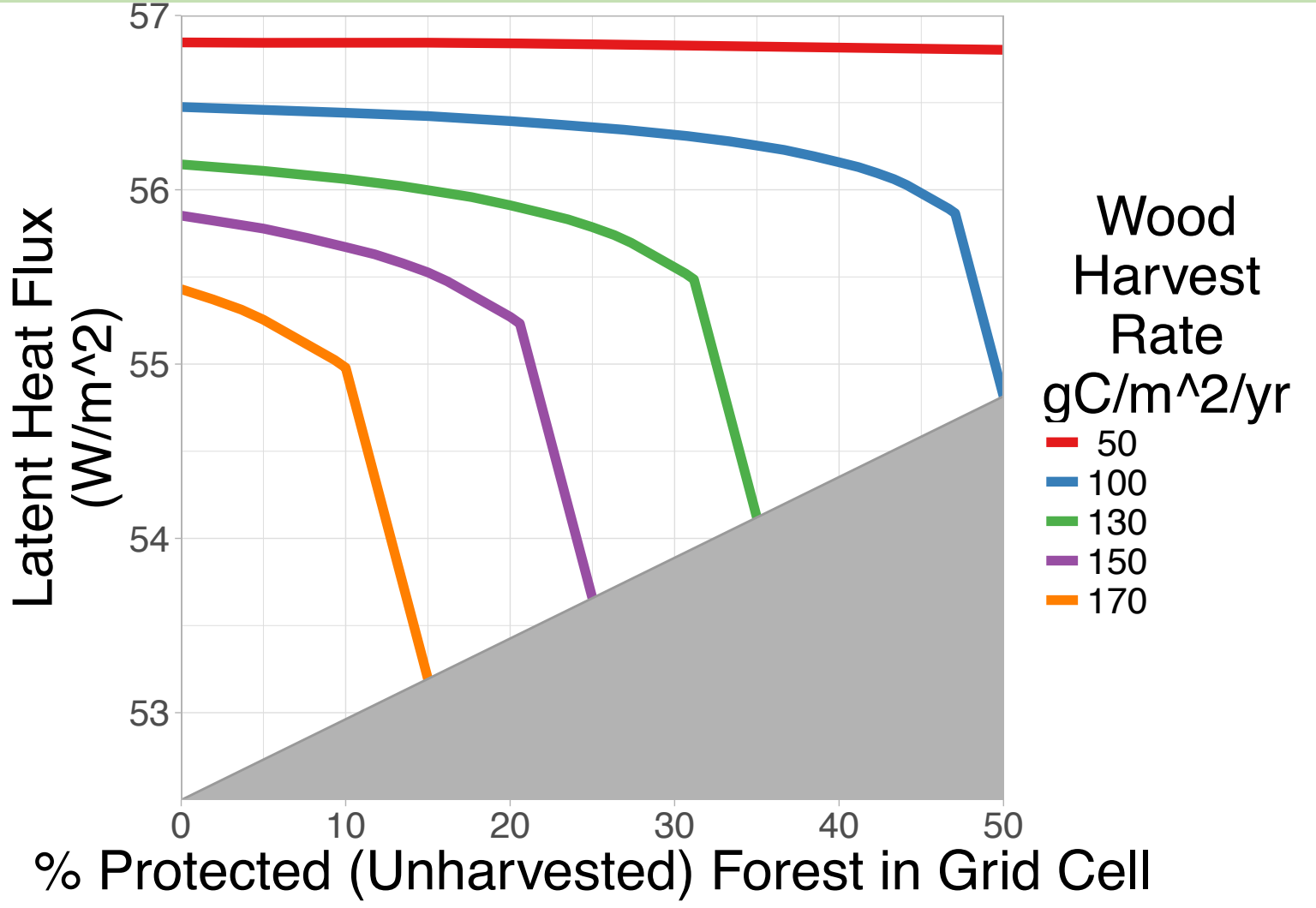
Ecosystem Carbon Changes are Small



Leaf Area Index Changes More



Shift from Latent to Sensible Heat



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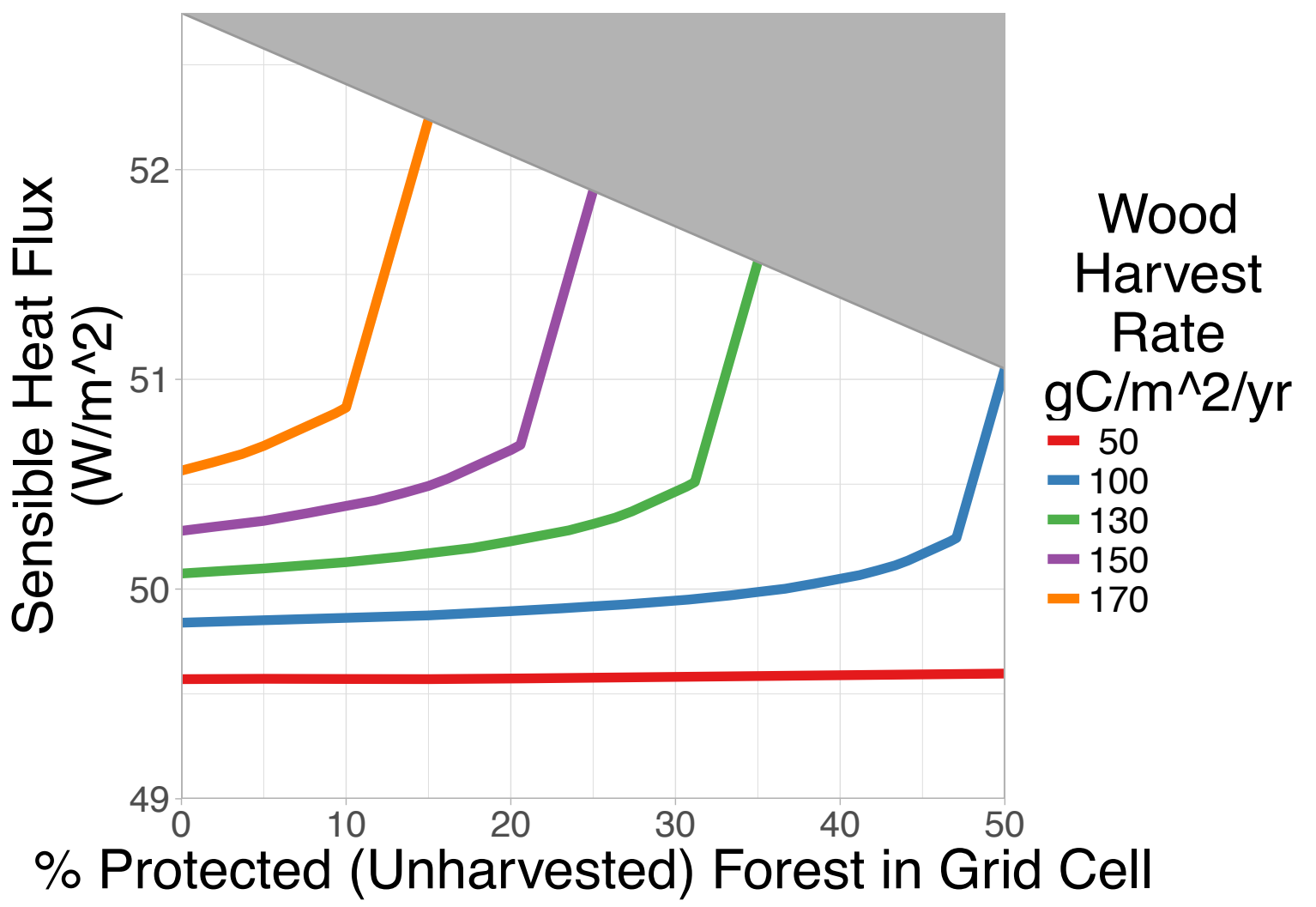


Forest Management in Time

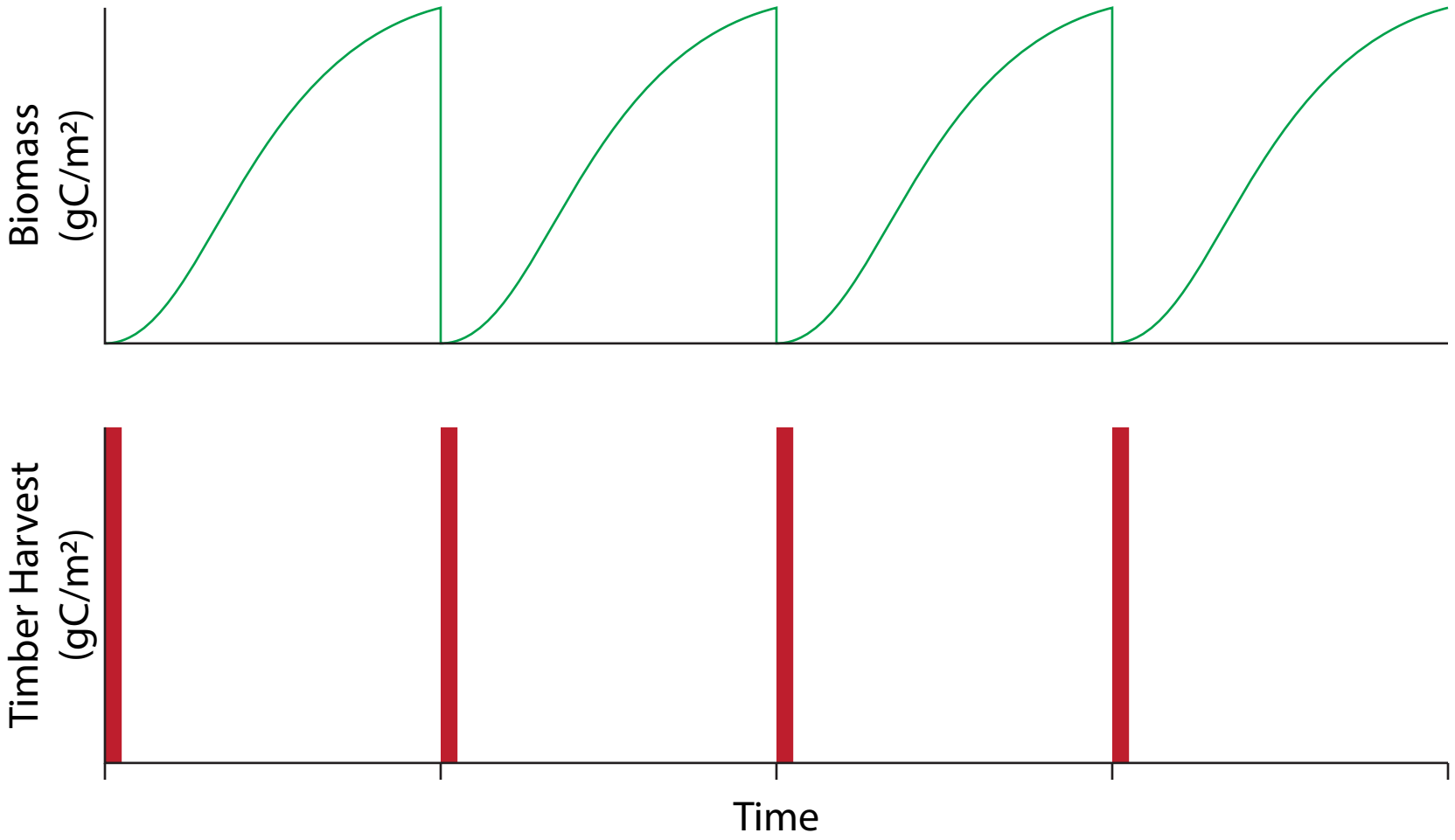
- *The CLM harvests forest a little each year*

Reality:

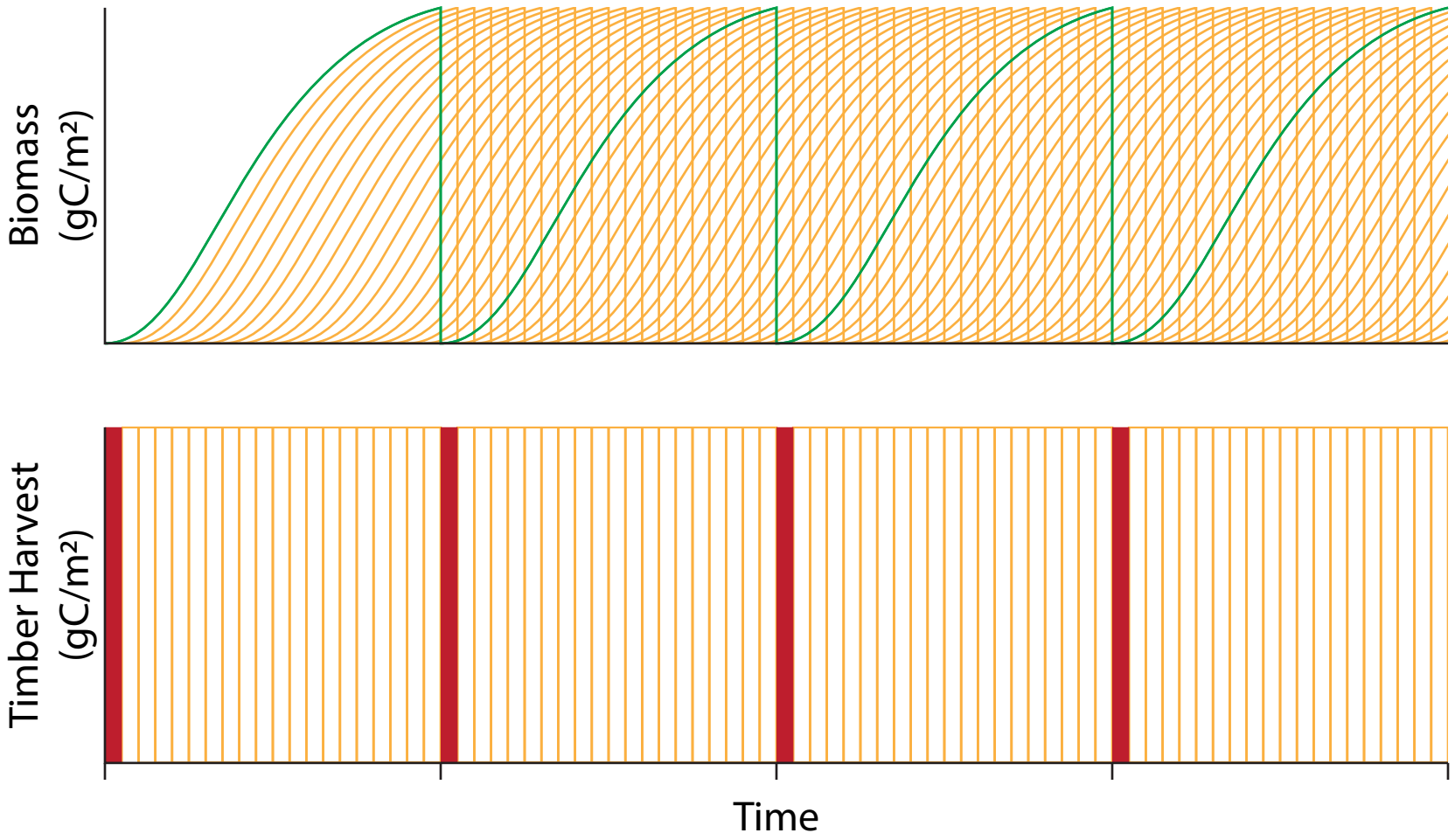
- Forest is harvest heterogenous in time
  - Patches on landscape
  - Clear-cutting is common
  - Harvest rotations

- Do harvest rotations change forest carbon stocks and climate feedbacks in the CLM?

Harvest Rotation at *One Point*



Harvest Rotation on the *Landscape*



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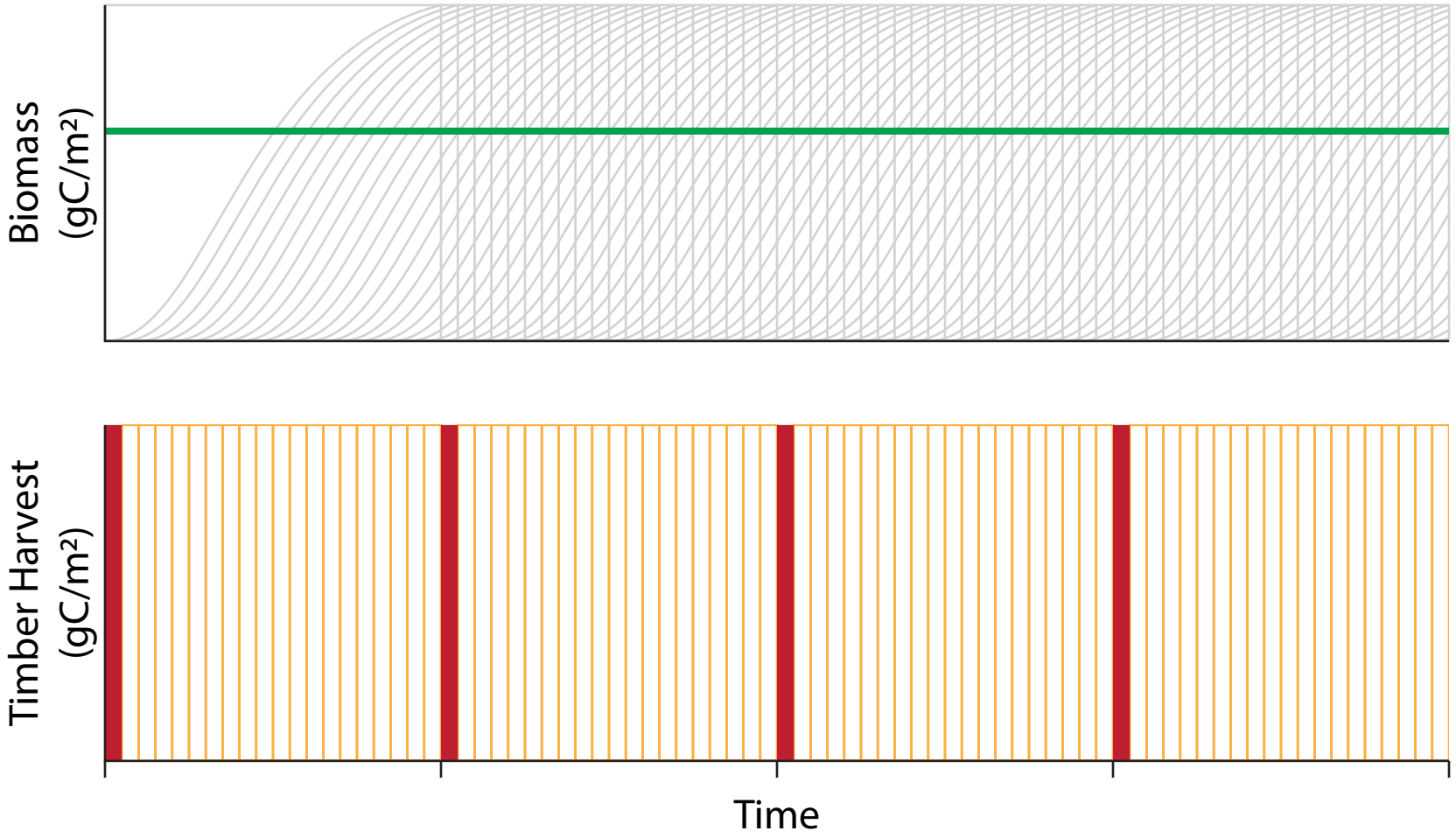
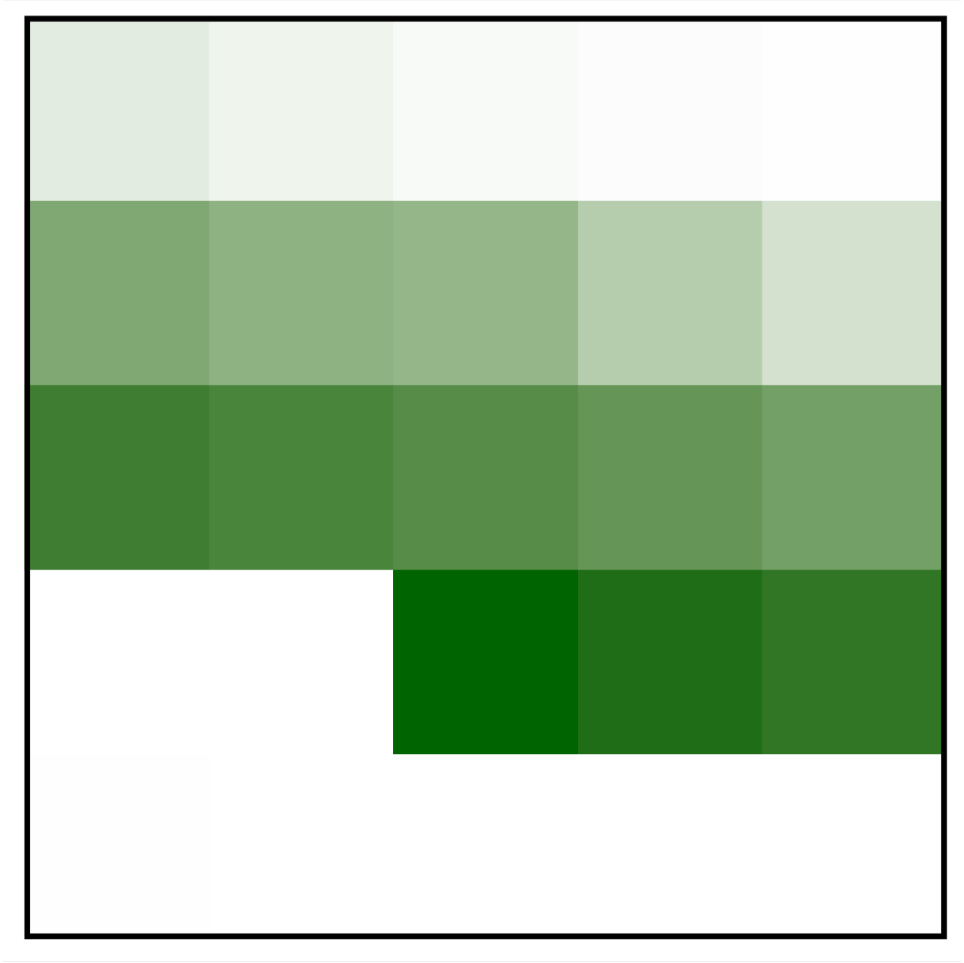


Management in Time: Design



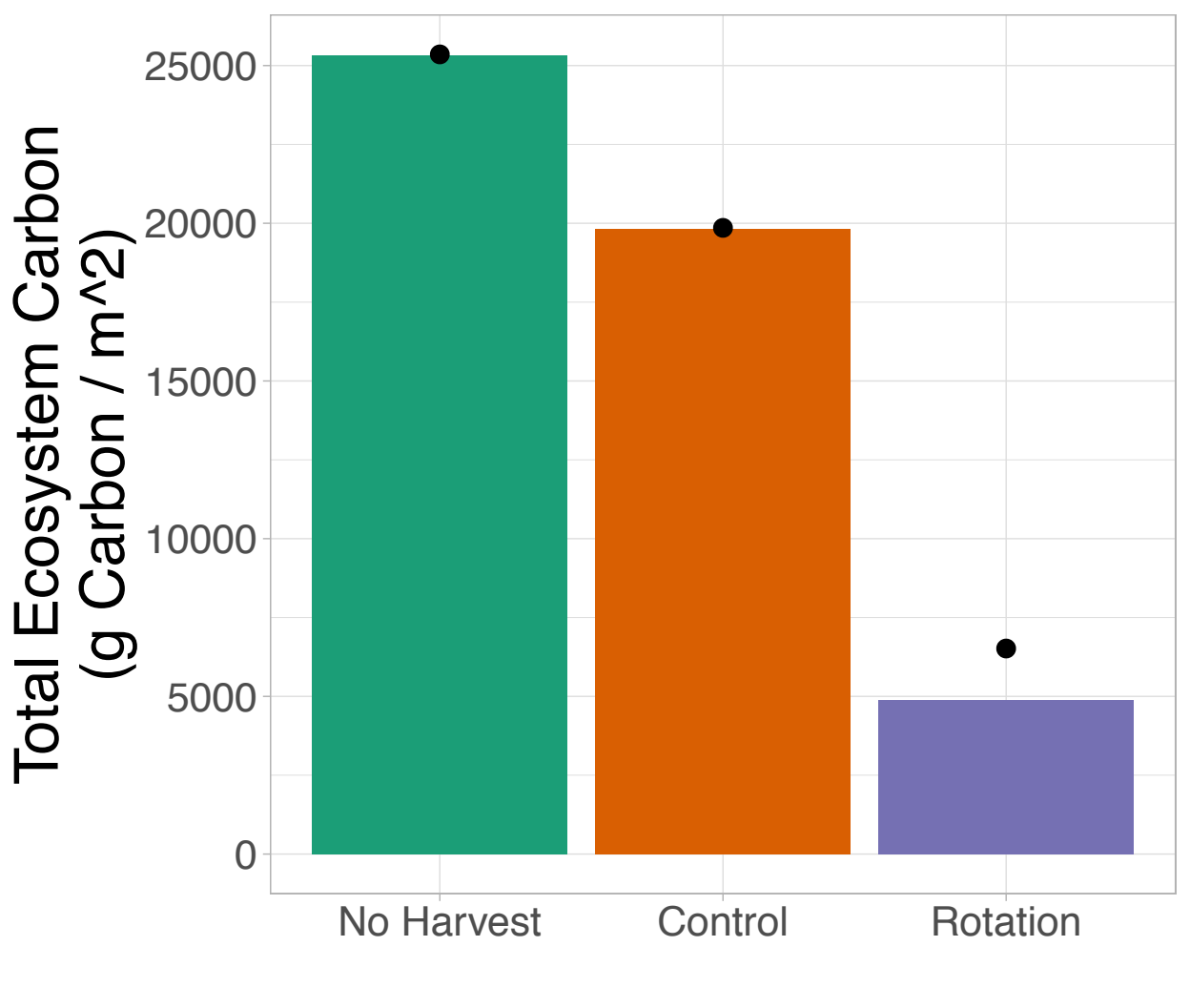
Management in Time: Details

- Single point in coastal plan of North Carolina
- Fixed 100% needle leaf evergreen tree cover
- Constant climate x 500 years

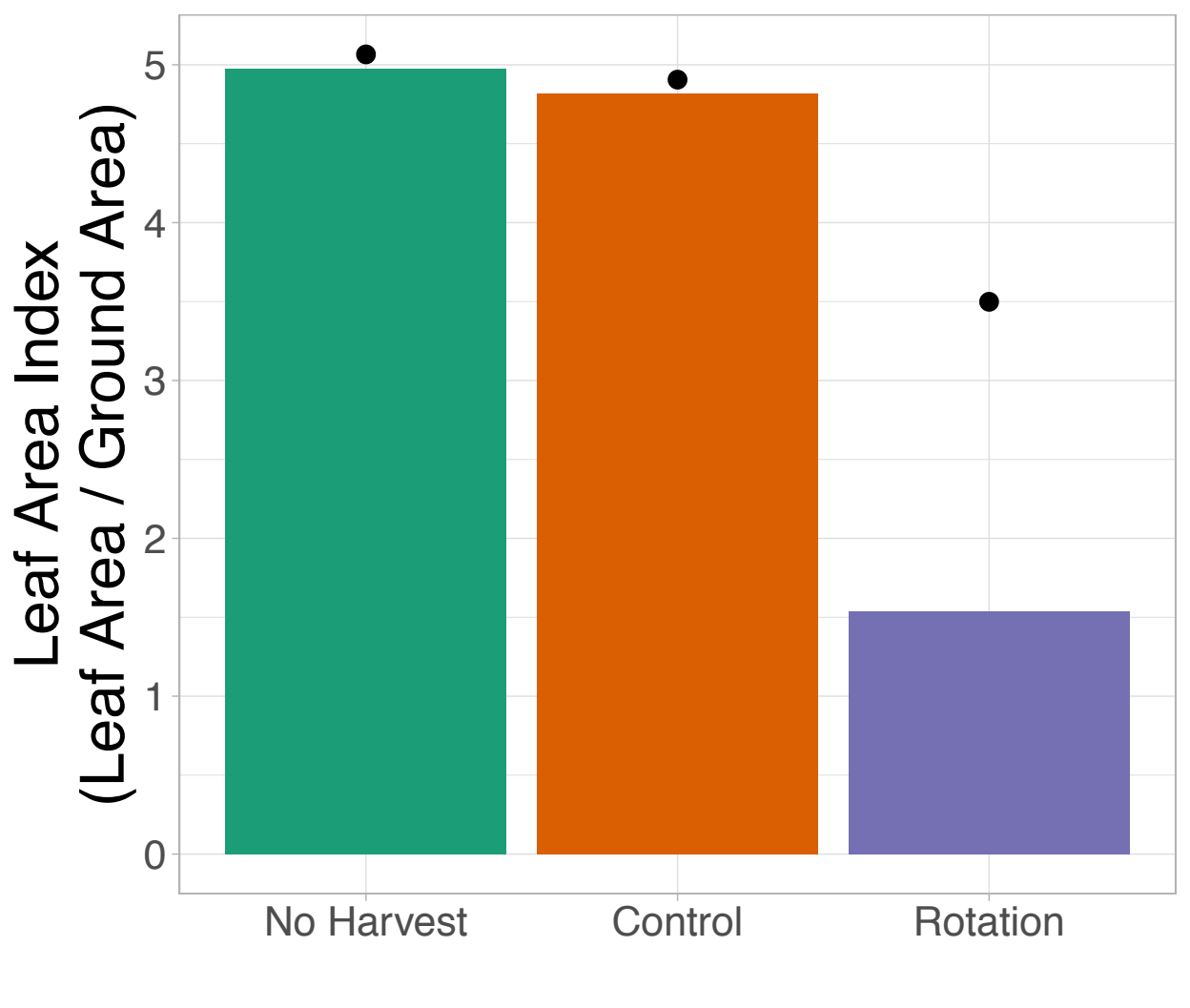
1. No Harvest Control
2. Harvest Rotation: Average of 25 x 25 year clear-cut simulations (3 line Source Mod)
3. Matched Control: grid cell harvested at average of rotation simulations

- **Equivalent harvest between conditions**
- Equilibrium (last 25 years) used for analysis

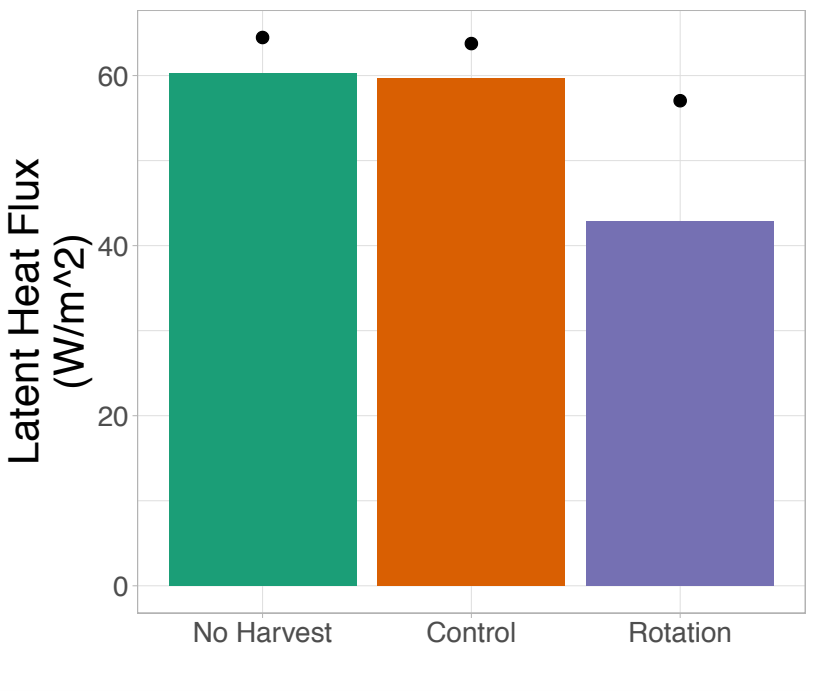
Large Changes in Ecosystem Carbon

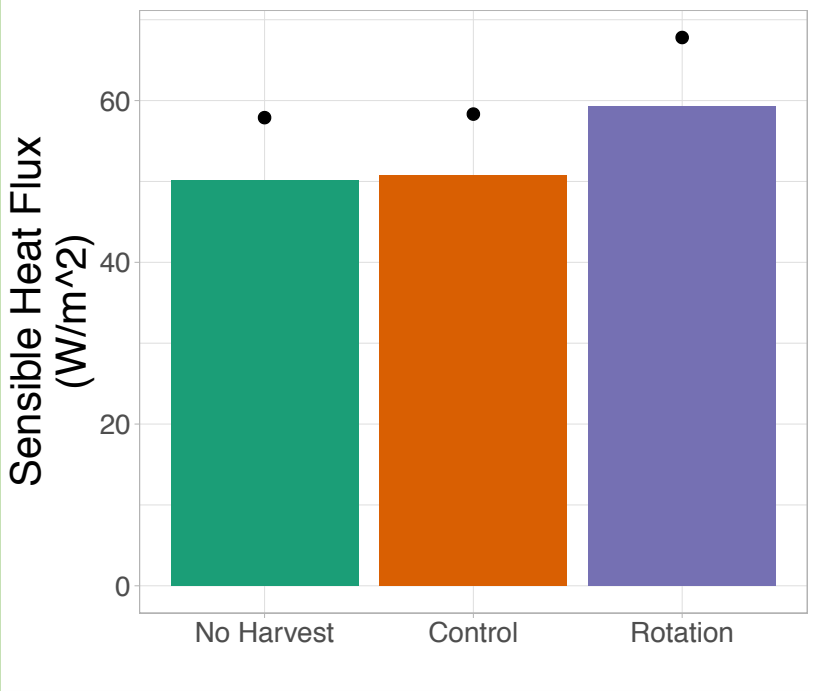


Average Canopy Structure Changes

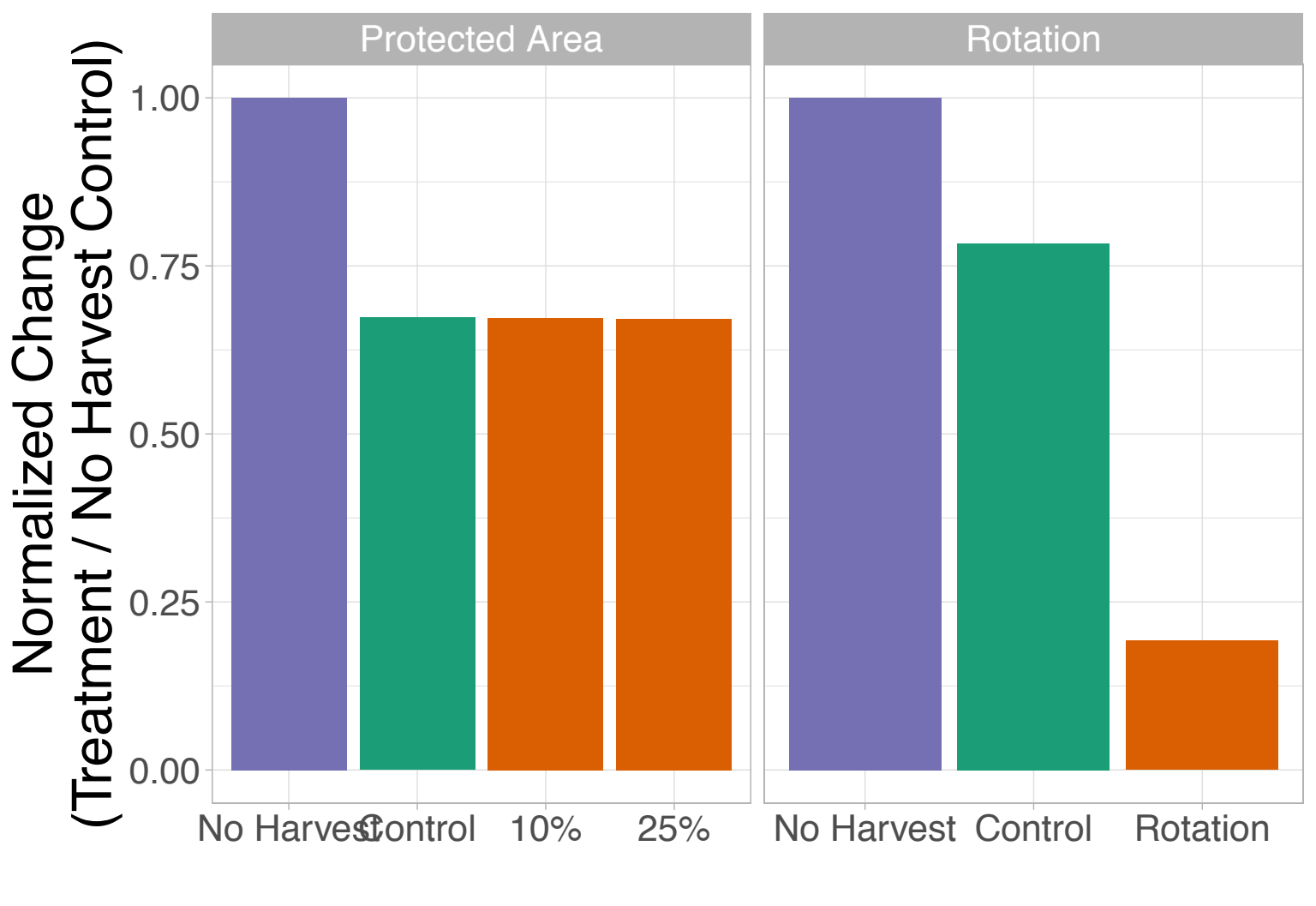


Shift from Latent to Sensible Heat

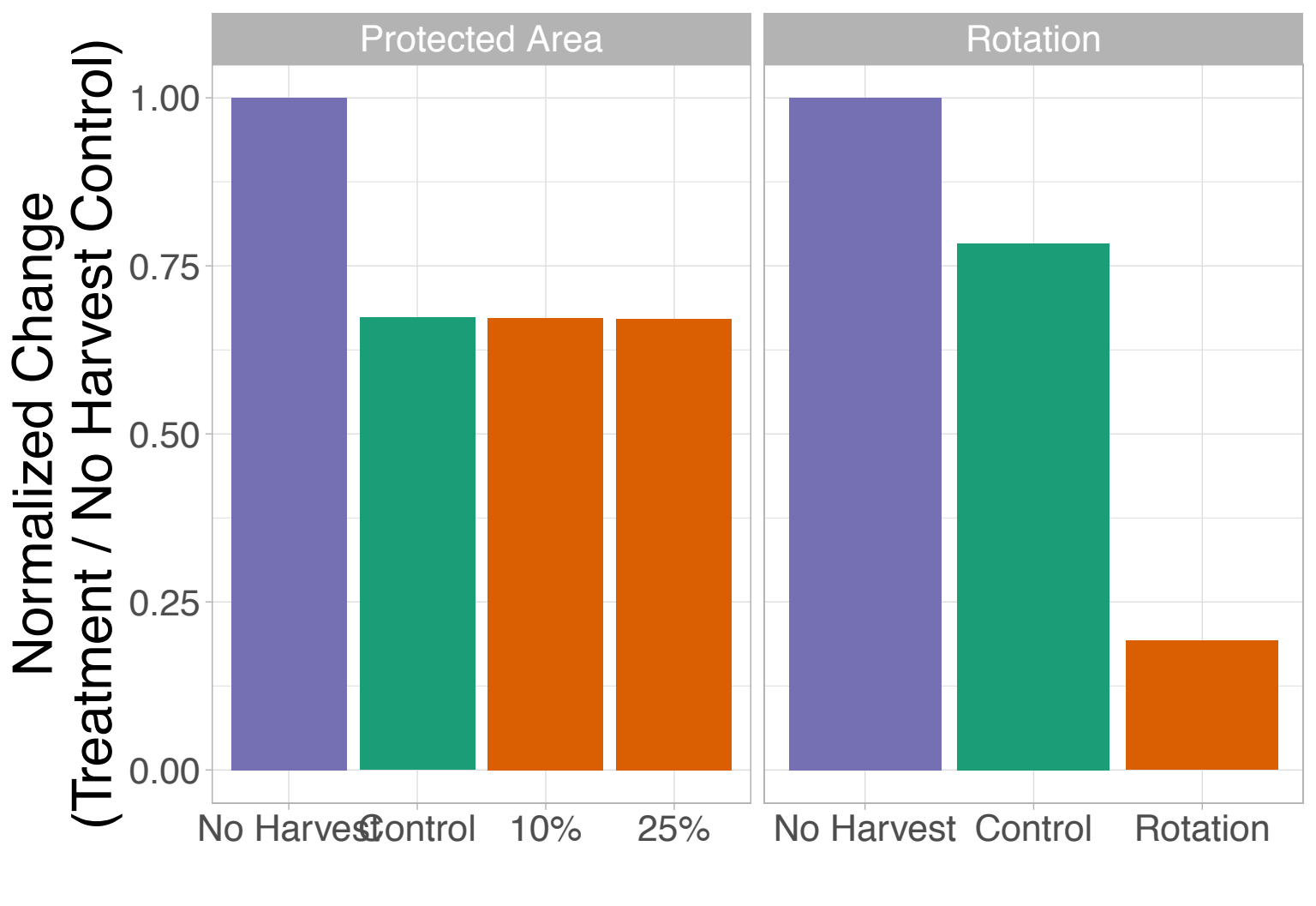




How do Responses Compare?



Fair Comparison?



Summary

The CLM is moderately sensitive to Protected Area Assumption

- Causes changes in carbon and biophysics
- *But* effects were small at realistic protected area %

Temporal Dynamics are Important

- Harvesting wood in clear-cut rotations caused notable changes in carbon stocks and surface energy fluxes.

Implications and Next steps

Standard CLM handles protected area reasonably.

Rotations may really matter. More research!

- What should we do?
- ”Easy” Experiments:
  - Additional locations,
  - Different rotation lengths
- Long-term Solutions:
  - Probably not changing standard CLM
  - Maybe FATES

    Issue: Columns issues, logging module, …

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