Carbon Dynamics of the Forest Sector

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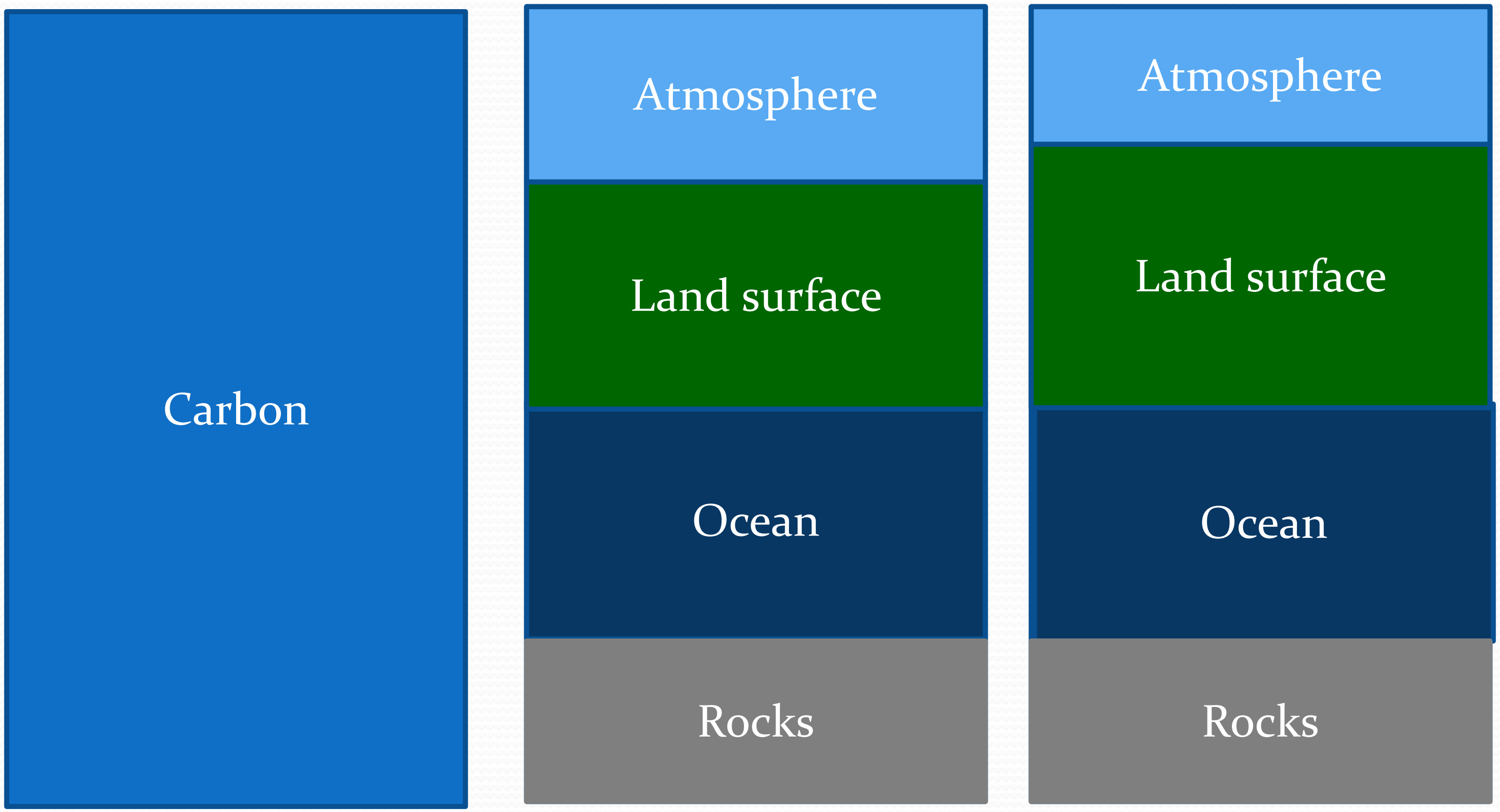
Main points

- The basic ecosystem science behind carbon dynamics in forests is relatively straightforward (really!)
- This science doesn't seem to be applied routinely in the policy arena
- This mismatch is undermining the potential of the forest sector in helping to mitigate greenhouse gases in the atmosphere

Basic Principles

Conservation of mass law

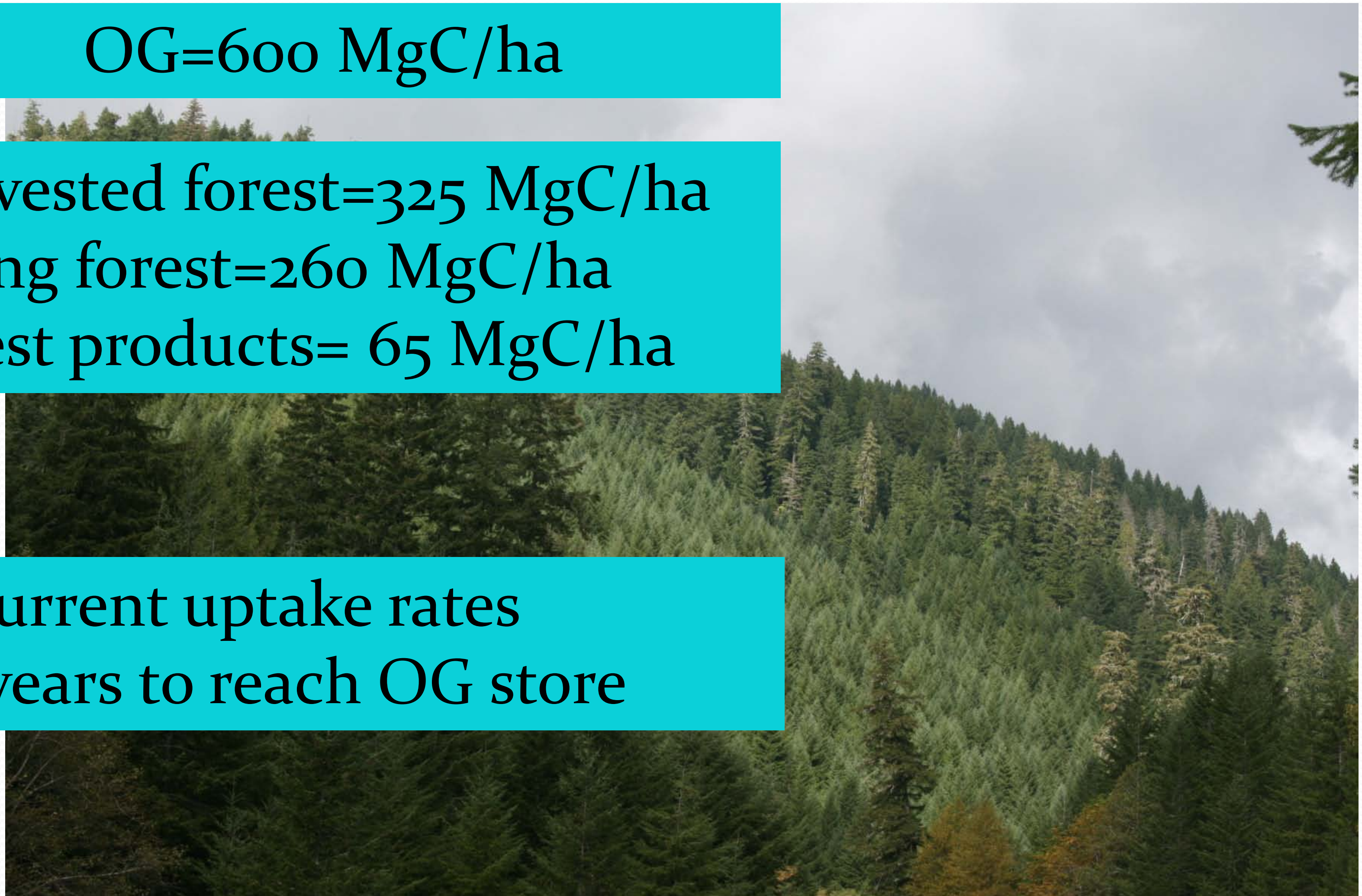


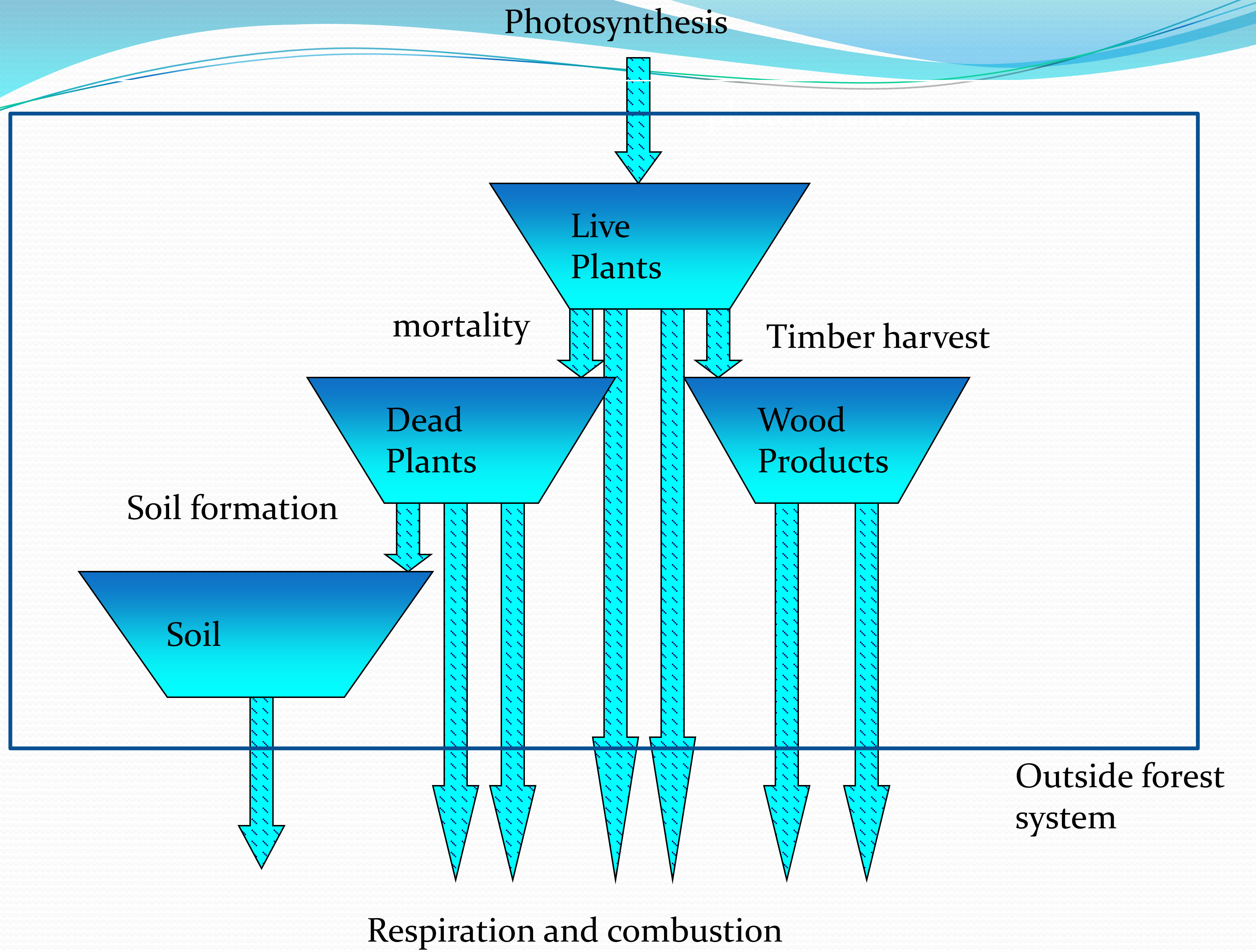
Which forest stores more carbon?

OG=600 MgC/ha

Harvested forest=325 MgC/ha
Young forest=260 MgC/ha
Forest products= 65 MgC/ha

At current uptake rates
130 years to reach OG store




Photosynthesis
Live
Plants
mortality
Timber harvest
Dead
Plants
Wood
Products
Soil formation
Soil
Outside forest
system
Respiration and combustion


00:00.0
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
DR
Experiment
Leak Size:
Total Leak A
Input Flow:
Half-time to
Leakiness =
Steady-state
Time to 95%
steady-state:
00:01

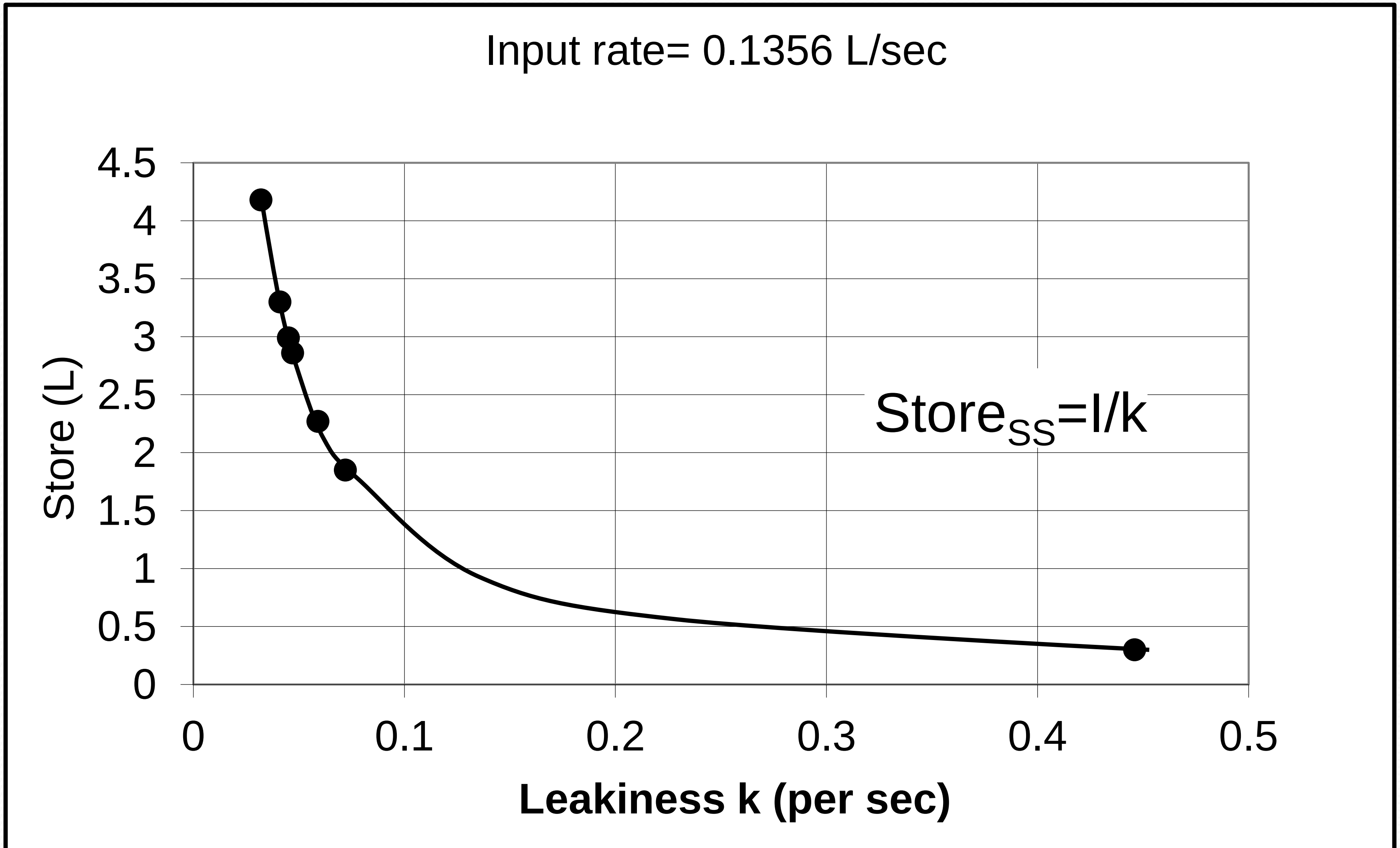
5
Medium
leaks

5
Large
leaks

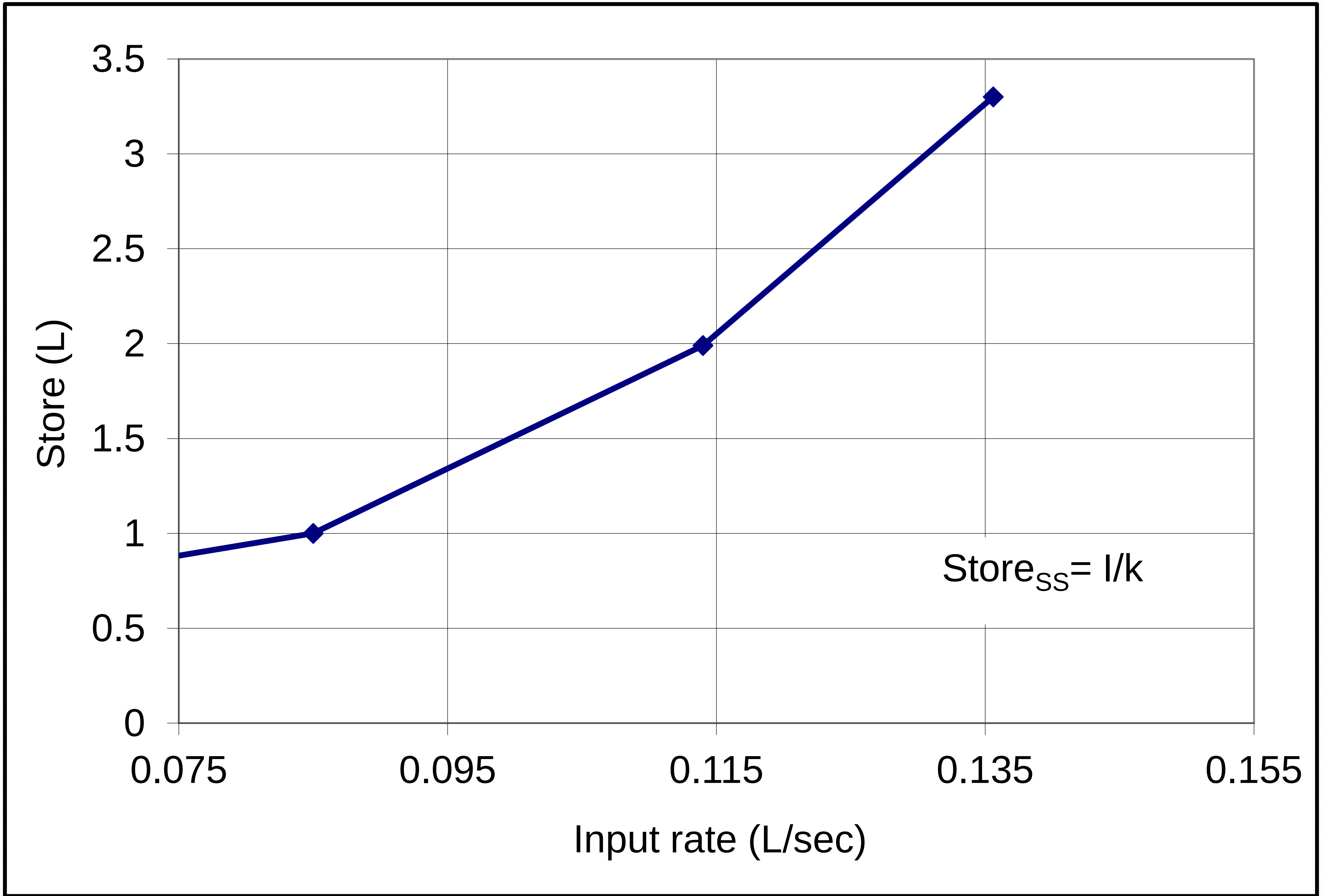
7
Small
leaks

2
Large
leaks

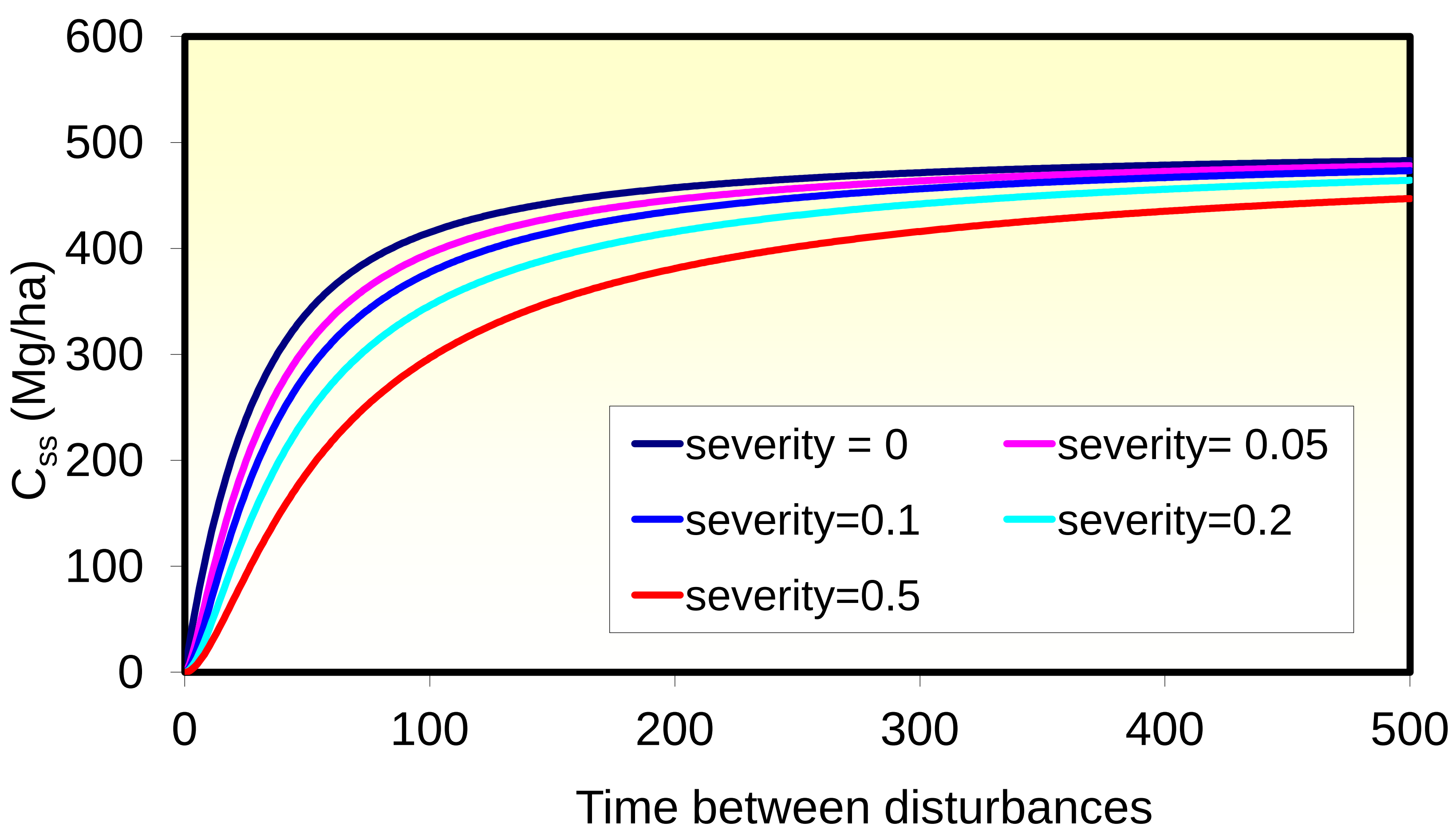
As the leakiness increases, the amount stores decreases (hyperbolically)



As the input increases, the amount stored increases (linearly)

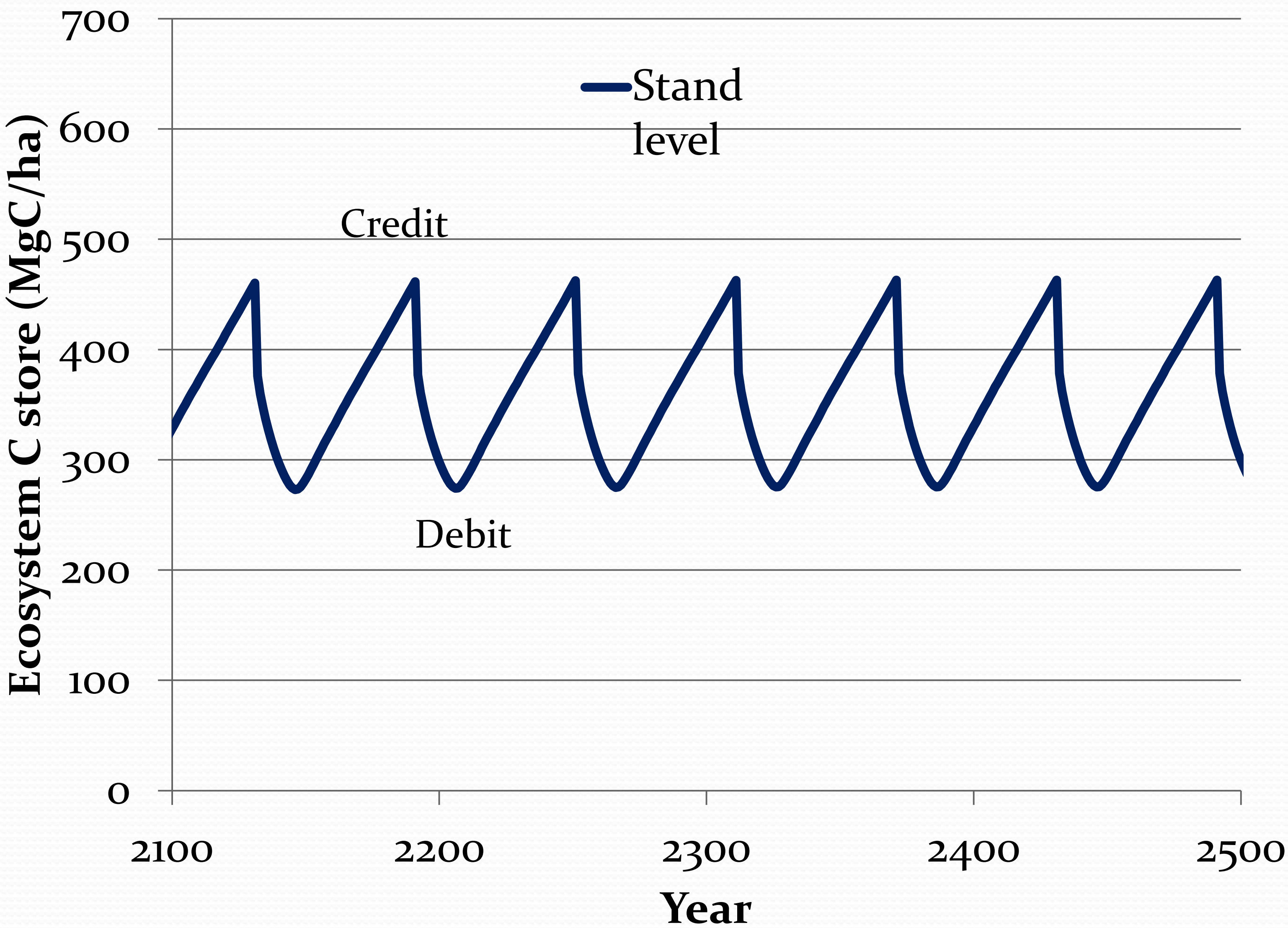


The fewer and smaller the holes the more stored

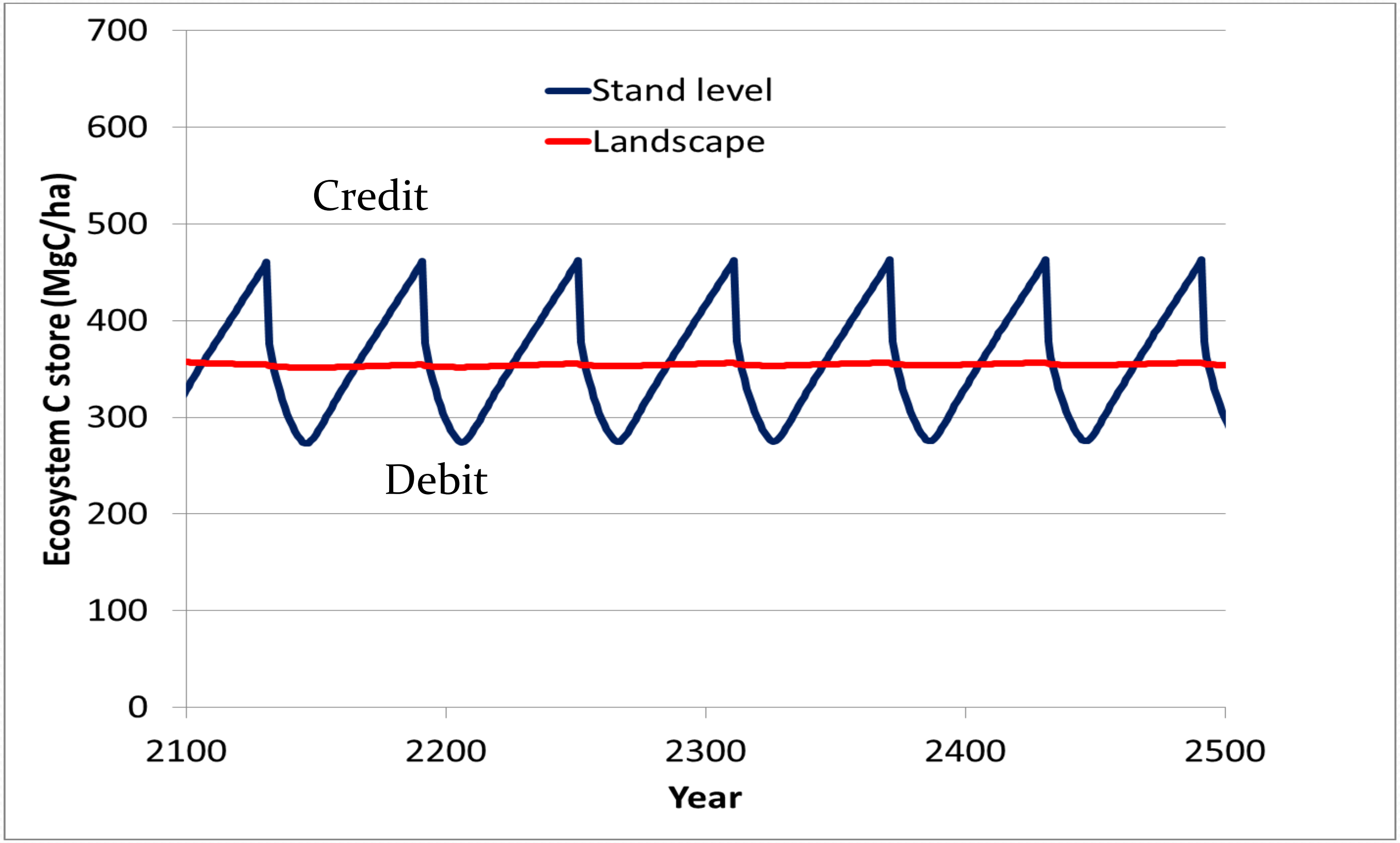


Full input (NPP) returns in 25 years

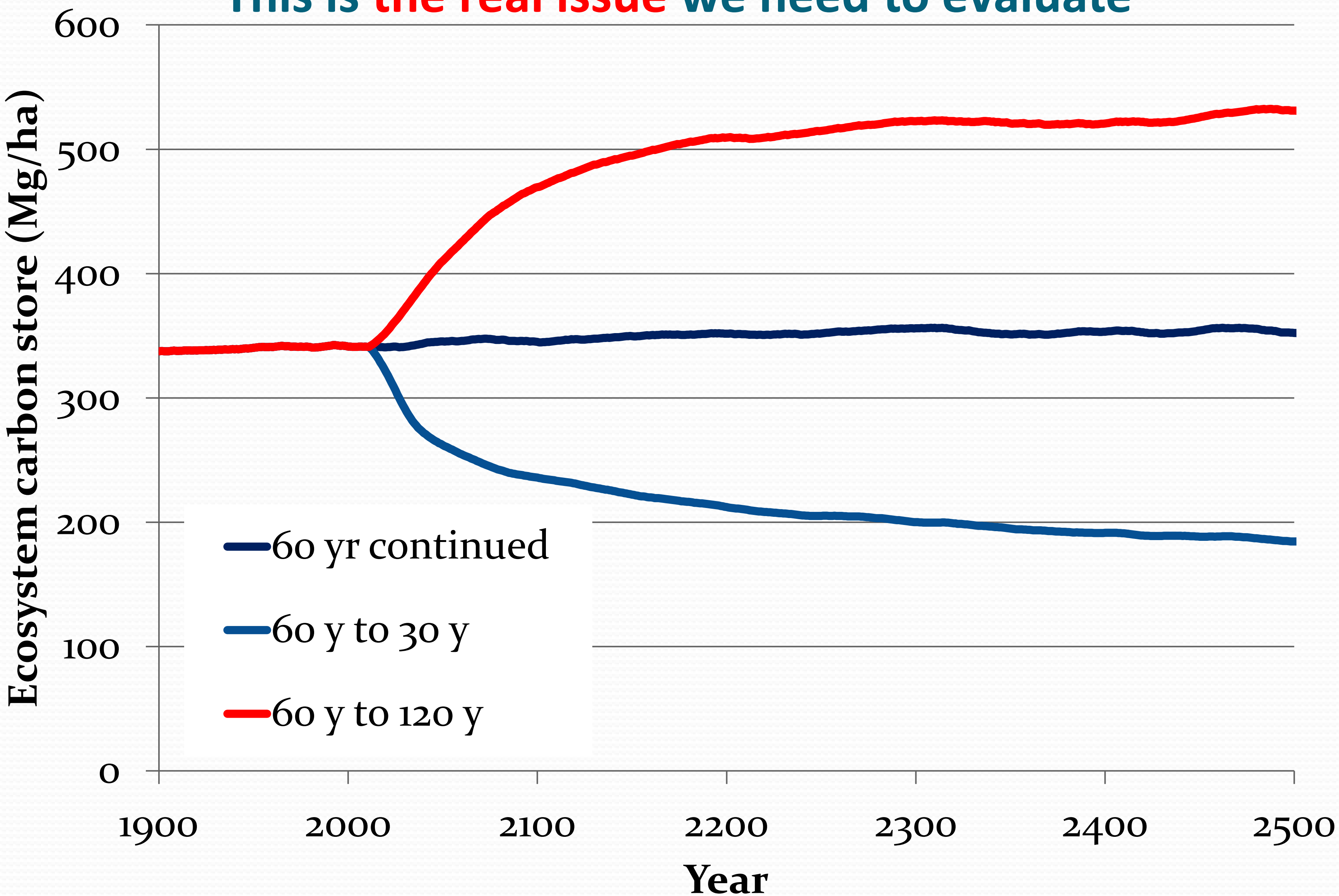
Can a steady-state have a carbon debt or credit?



Can a steady-state have a carbon debt or credit? Not really, as it makes no sense



Going from one steady-state to another can create either a carbon debt or credit!
This is the real issue we need to evaluate



An example of dubious carbon science:

Thinning adds more carbon to forests than not thinning

Forest Thinning

- Increases the health and growth of trees
- Faster growing trees means more carbon can be stored
- Before After
- **1 < 1.1**

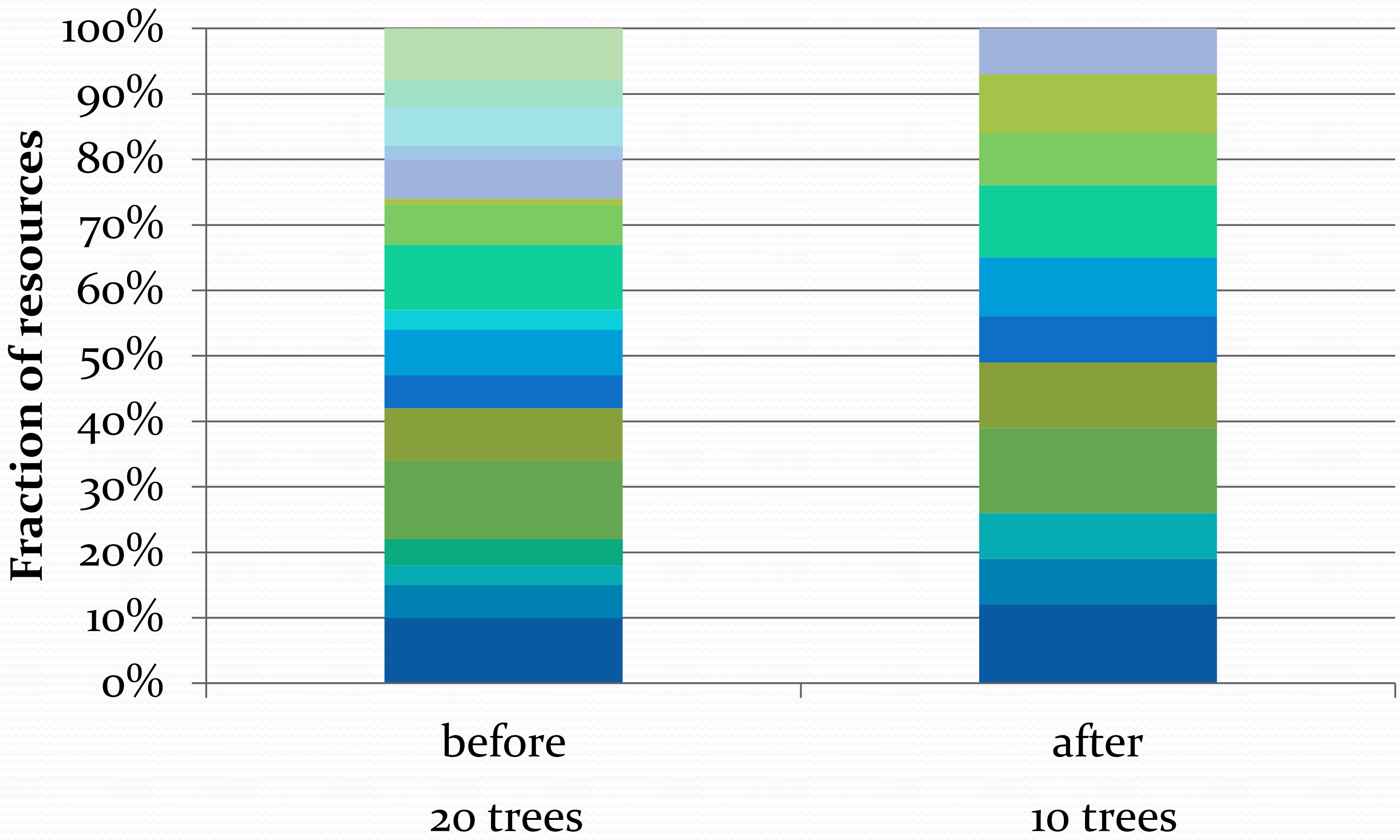
Wait a minute!

- Aren't there fewer trees after thinning?
- Before After
- $1 < 1.1$ incomplete comparison
- $1 \times 100 \approx 1.1 \times 90$ complete comparison
- To store more total growth must increase, not stay the same

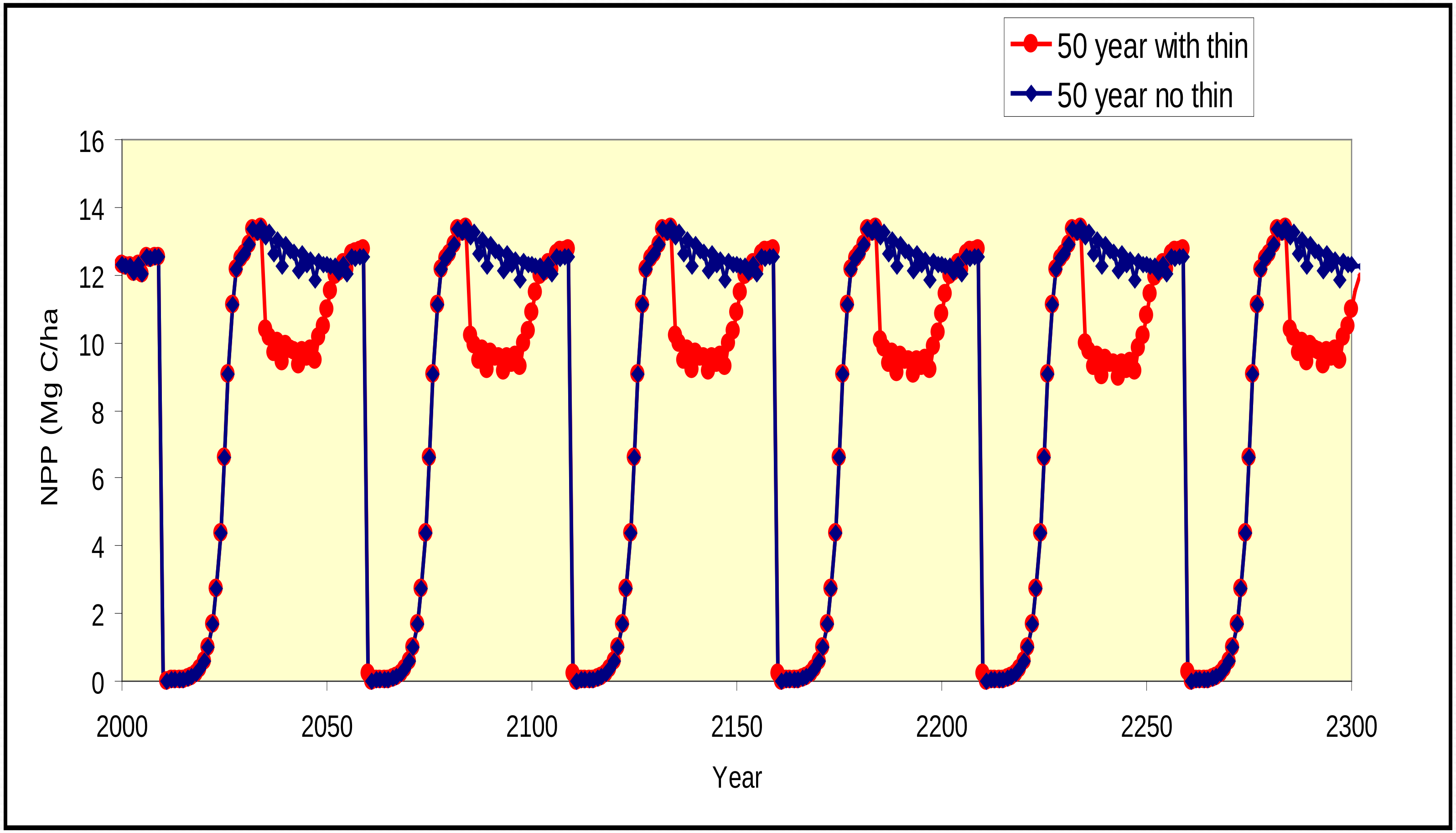
For total growth to increase the following must be true

- The recovery of tree production after thinning must be instantaneous (BUT IT IS NOT)
- Thinning must increase the total amount of resources available to trees so that total production of thinned trees can increase (HOW?)

Thinning redistributes the same resources among few individuals



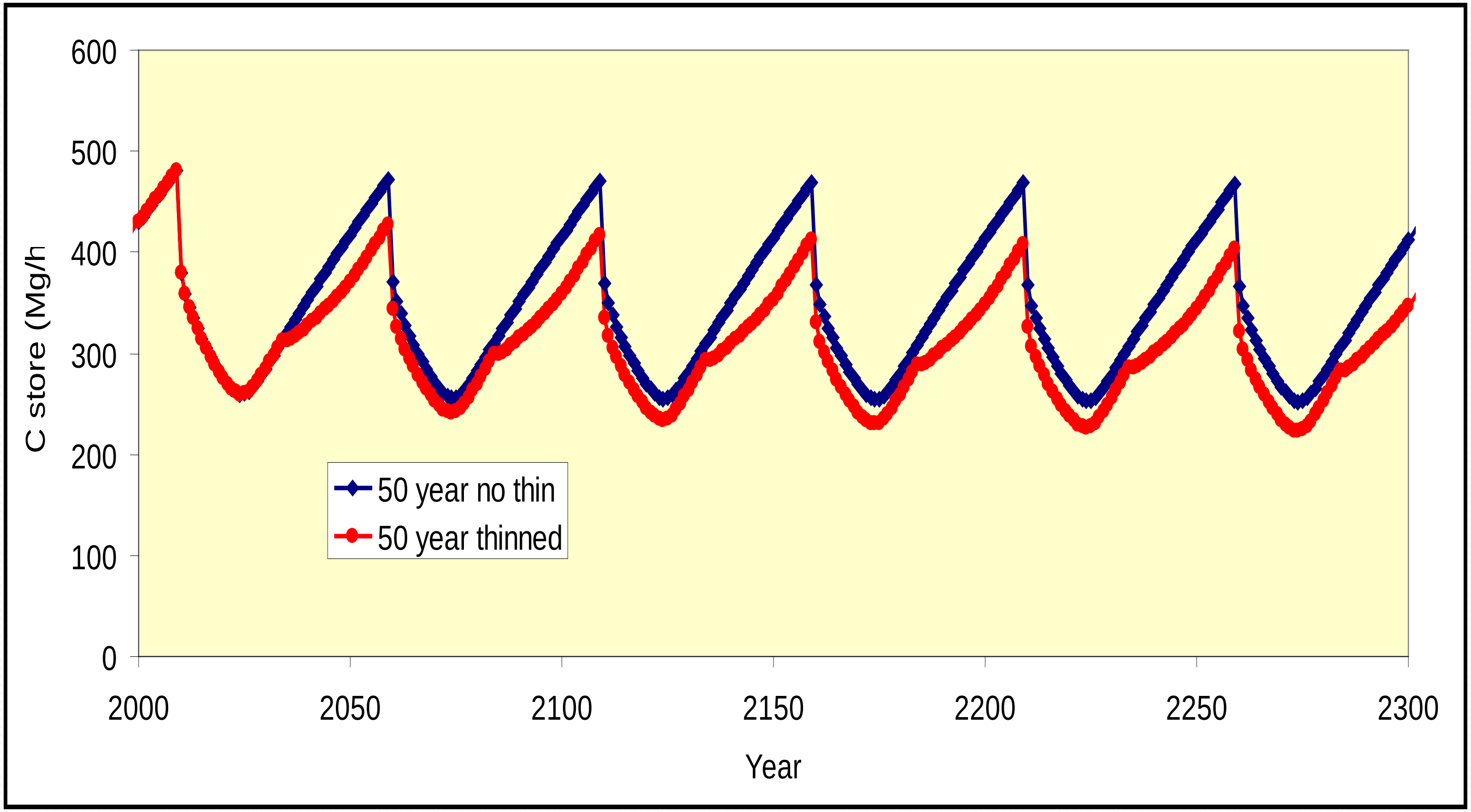
Thinning does not increase the input to the forest!



	Thinned	Not thinned	
NPP	7.93	8.83	11% less

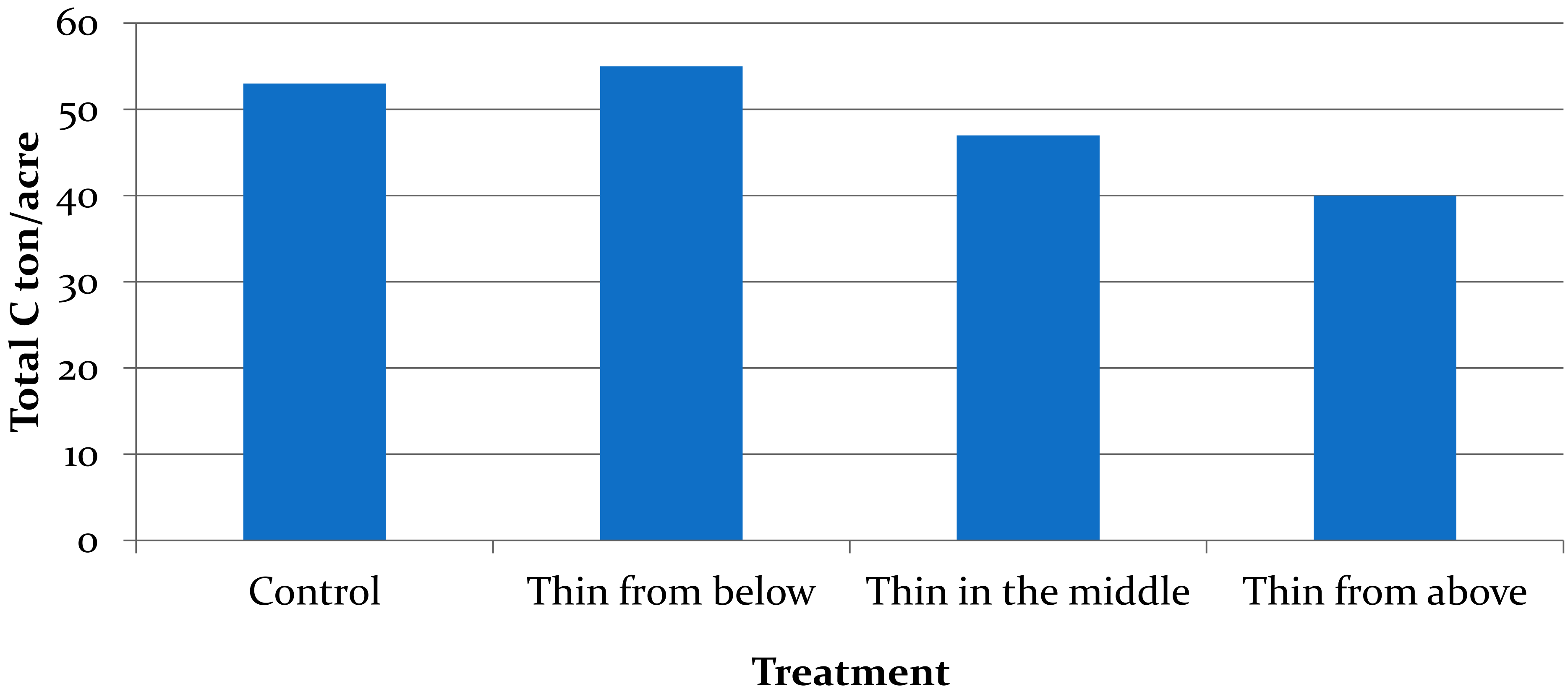
Mg C/ha/y

Thinning decreases forest carbon stores



	Thinned	Not thinned	
Store	298	341	13% less

Mg C/ha

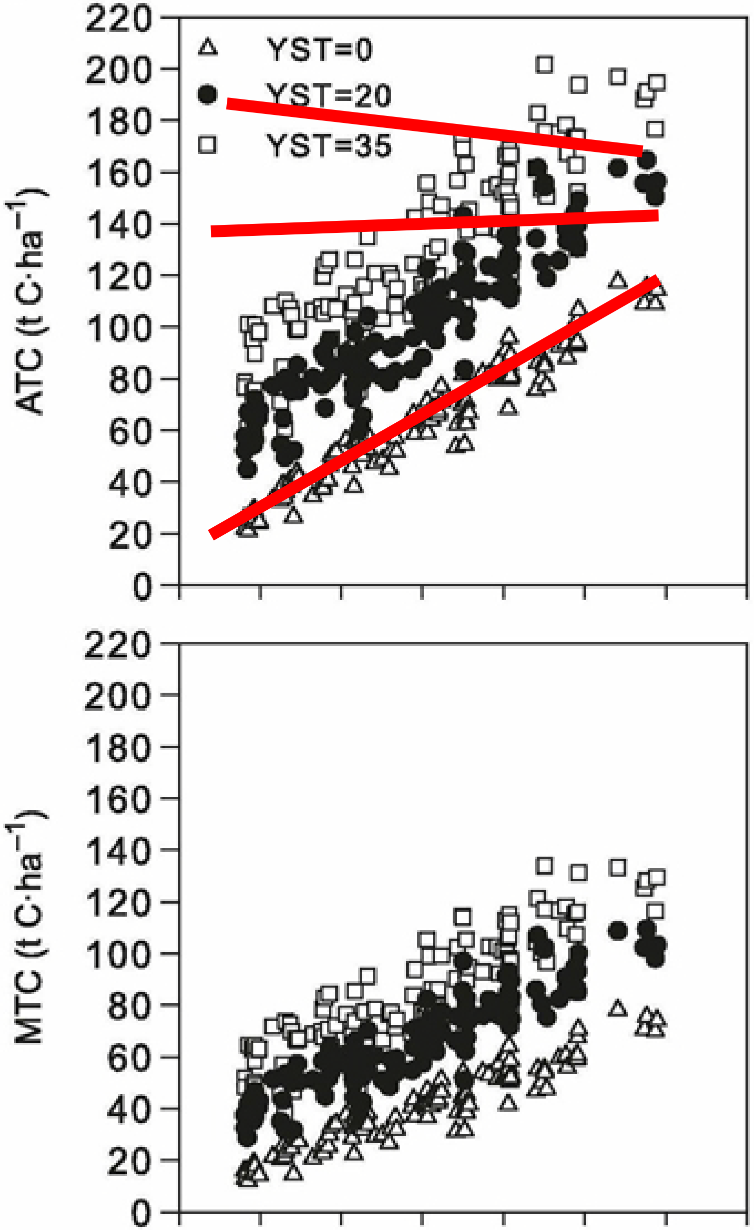


The larger the trees removed, the less the carbon forest sector stores

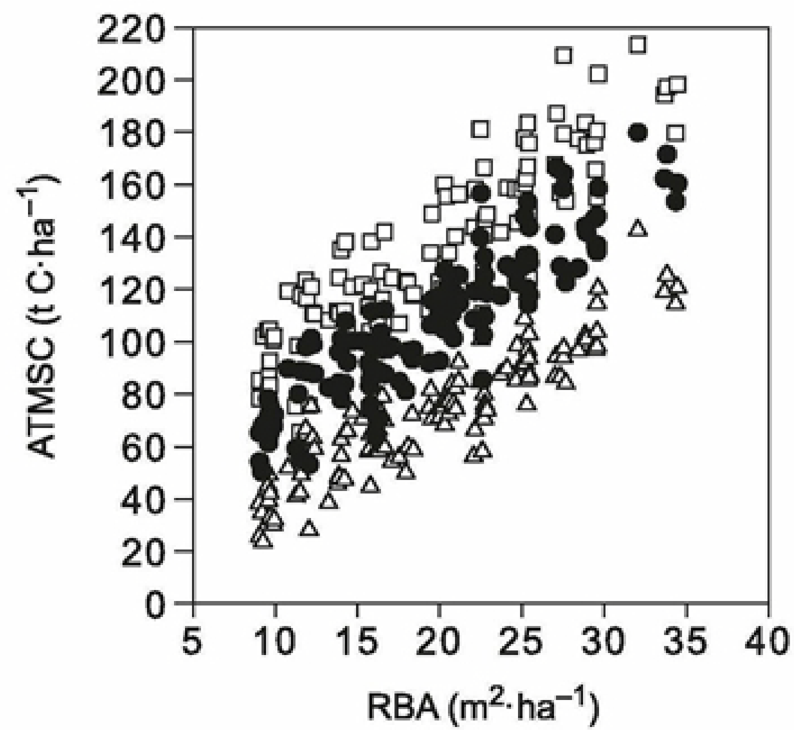
Larger leaks means less carbon stored in the forest sector

Hoover and Stout 2007 Journal of Forestry Black cherry/sugar maple

Fig. 1. Observed C storage in the ATC, MTC, and ATMSC biomass pools over 0, 20, and 35 years since thinning (YST) (0 = 1966).



Keyser 2010
Canadian Journal of Forest Research
Yellow poplar



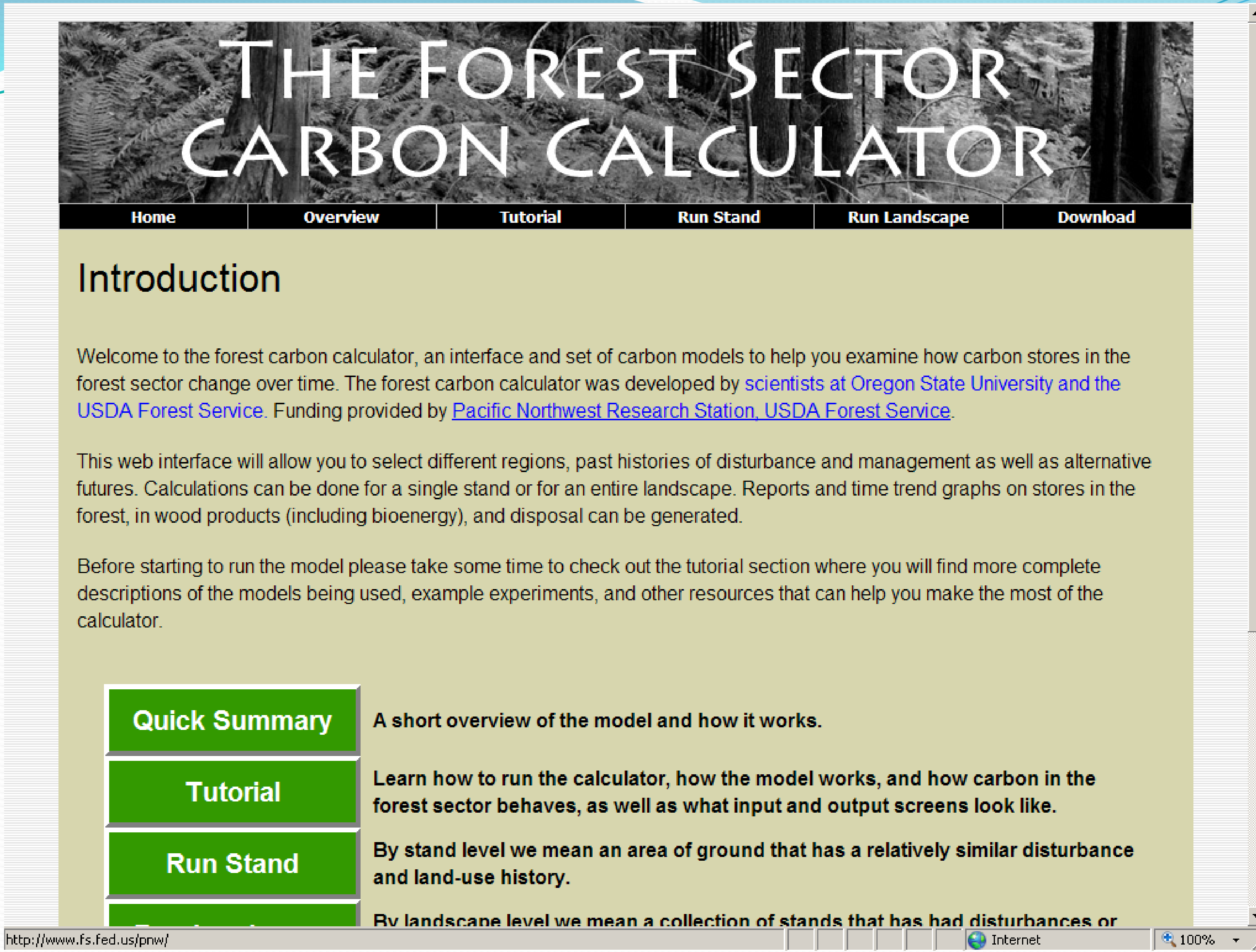
Other issues needing to be addressed ASAP

- Failure to observe conservation of mass
- Exclusion of pools, processes, or key factors
- Irrelevant processes (hiding real relationship)
- Failing to give initial conditions or BAU
- Improper or inconsistent scaling in space & time
- Instantaneous uptake/release versus long-term stores
- Inconsistent frameworks
- Logical incongruities

Conclusions

- To be credible carbon policy must be based on science (real world) otherwise it will not deliver the desired goal

- There are many objectives of forest management
- Some will have carbon costs
- If these costs are not recognized then policies to counter or reduce these costs can not be developed



THE FOREST SECTOR CARBON CALCULATOR

Home | Overview | Tutorial | Run Stand | Run Landscape | Download

Introduction

Welcome to the forest carbon calculator, an interface and set of carbon models to help you examine how carbon stores in the forest sector change over time. The forest carbon calculator was developed by scientists at Oregon State University and the USDA Forest Service. Funding provided by Pacific Northwest Research Station, USDA Forest Service.

This web interface will allow you to select different regions, past histories of disturbance and management as well as alternative futures. Calculations can be done for a single stand or for an entire landscape. Reports and time trend graphs on stores in the forest, in wood products (including bioenergy), and disposal can be generated.

Before starting to run the model please take some time to check out the tutorial section where you will find more complete descriptions of the models being used, example experiments, and other resources that can help you make the most of the calculator.

Quick Summary	**A short overview of the model and how it works.**
Tutorial	**Learn how to run the calculator, how the model works, and how carbon in the forest sector behaves, as well as what input and output screens look like.**
Run Stand	**By stand level we mean an area of ground that has a relatively similar disturbance and land-use history.**
	By landscape level we mean a collection of stands that has had disturbances or

http://www.fs.fed.us/pnw/ Internet 100%

http://landcarb.forestry.oregonstate.edu/

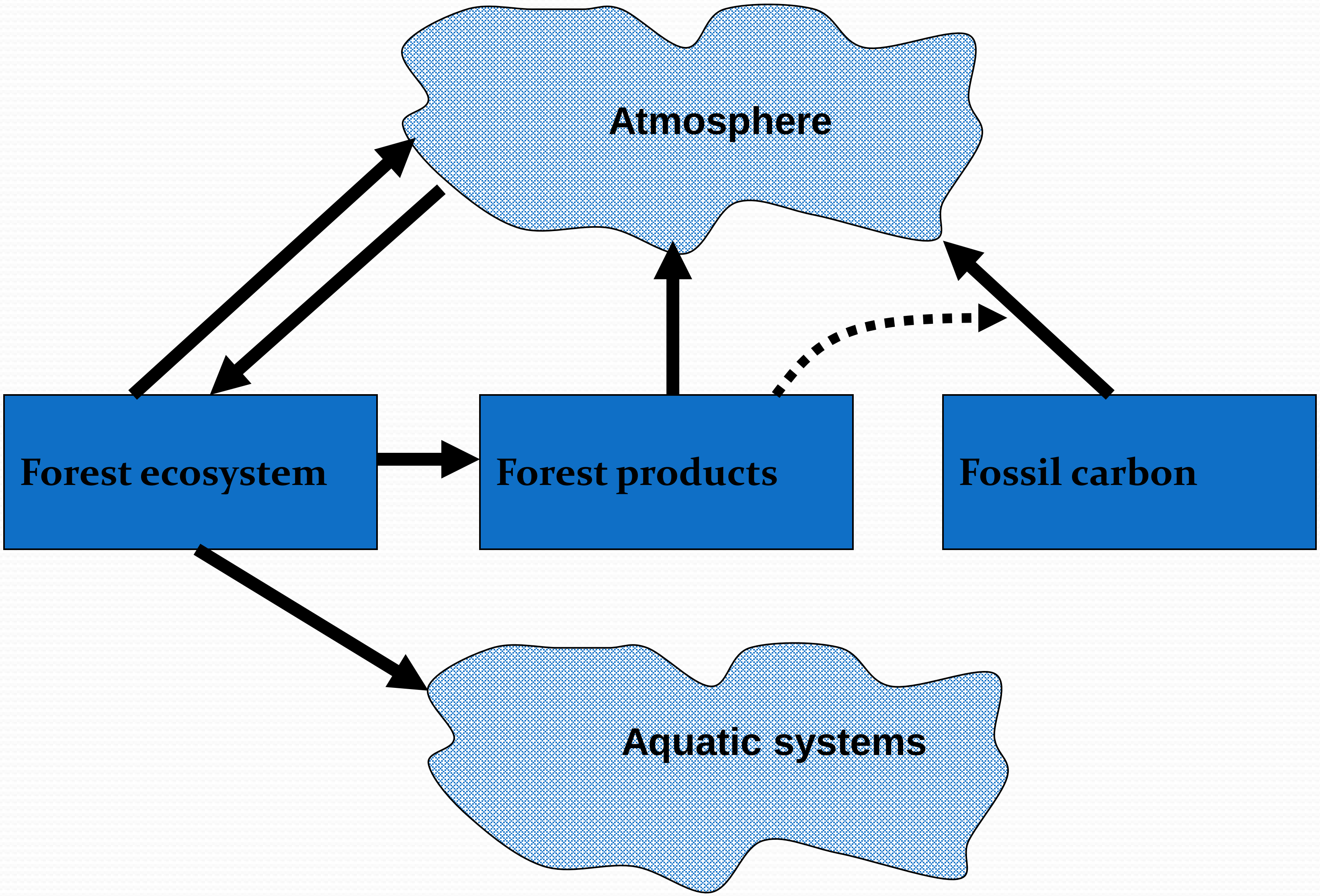
Thanks!!

Forest management practices for carbon sequestration

Landowner's forest resource management practices for improving carbon accumulation are categorized as follows (US EPA, 2010):

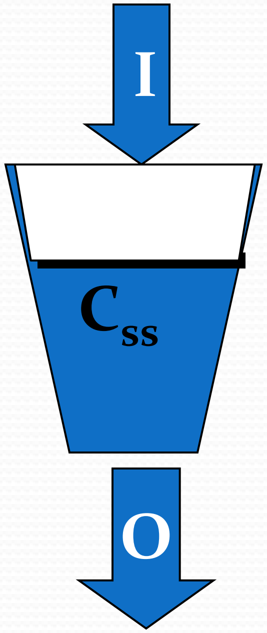
i)Forest conservation: called avoided deforestation or forest preservation, means not clearing a forest,
ii)Afforestation/Reforestation, and
iii)Intermediate forest management, called improved forest management or active forest management, means changing management approaches so that standing volume in the forest is increased. Practices such as **forest thinning can both reduce fire risk and stimulate growth that, over time, increases carbon storage**.
iv)Biomass energy – Using fuel from wood and biomass in place of fossil fuel.
v)Carbon storage in forest products and substitution: Storing carbon in long-lived forest products (such as lumber) and substituting forest products for products (such as steel and concrete) whose manufacture releases much more CO2 than does the processing of wood.

The forest sector



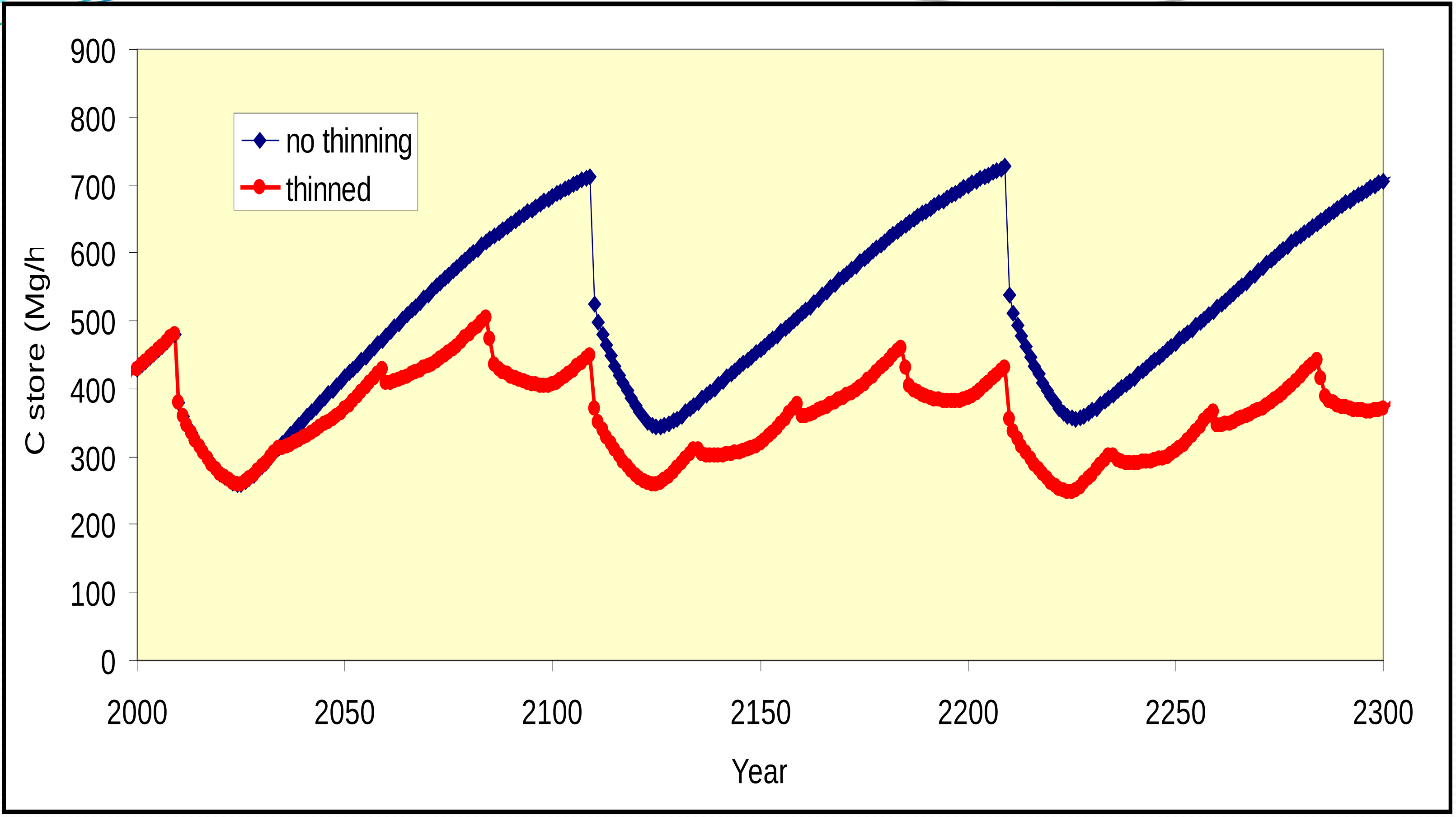
The Math of Leaky Buckets

$$C_{ss}=I/k$$



I is the input rate

k is the proportional loss rate



	Thinned	Not thinned	
Store	346	530	35% less

Mg C/ha

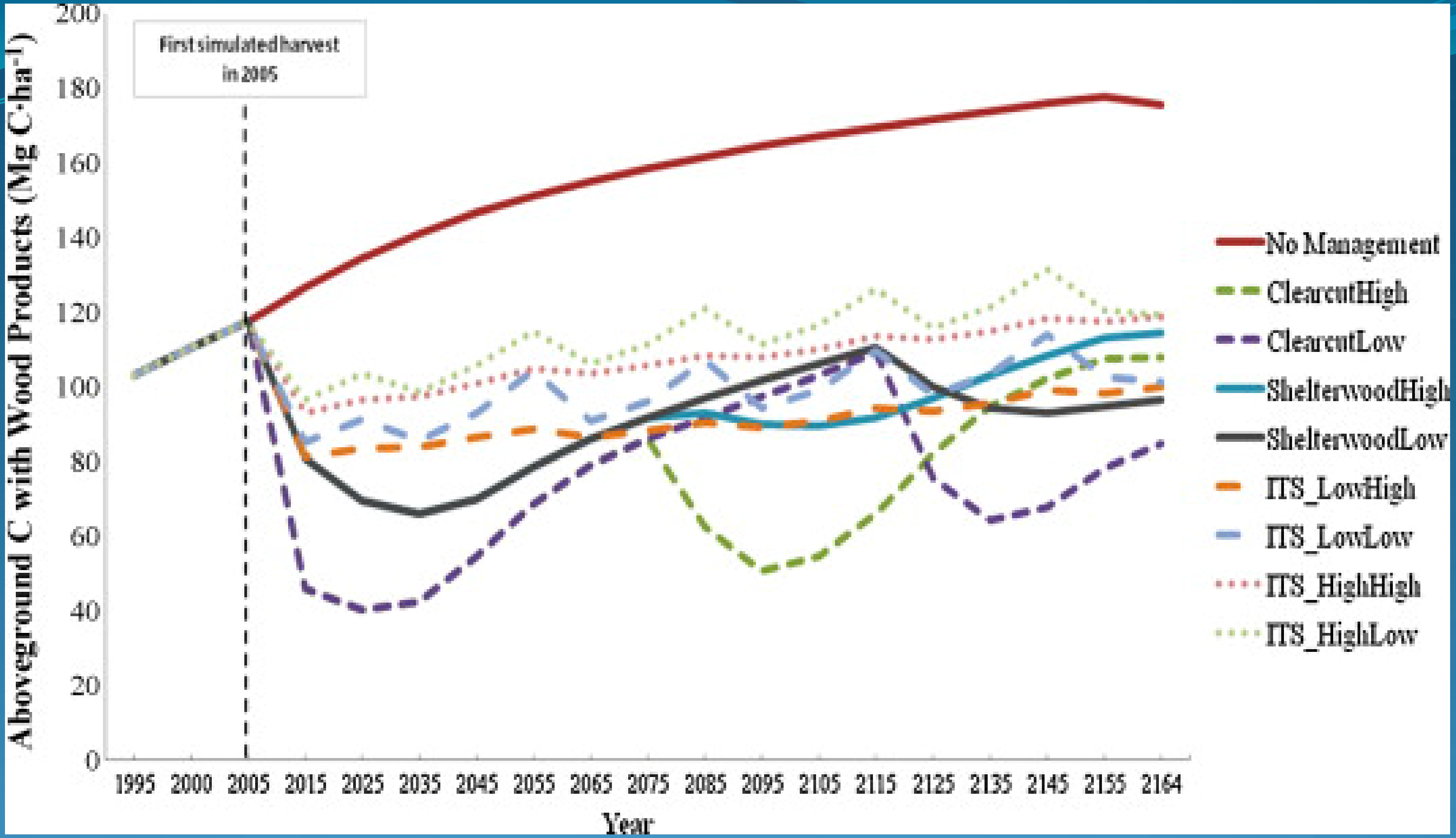


Fig. 2.
Simulation output time series for the 9 different management scenarios (values represent 10 year mean of 32 stands C storage in aboveground live/dead biomass and wood products). Ten year means of C sequestration were used to create chronosequences to illustrate the temporal dynamics for each management scenario, however these values were not used in the overall statistical analyses and are presented here for illustrative purposes. Average forest growth was estimated for 1995 using 20 year mean predicted growth rates of all stands. Chronosequences starts from the estimated mean averages in 1995, all harvest cycles began at 2005 (noted with vertical dotted line). For management scenario descriptions refer to Table 2 and Table 3.

Nunnery and Keeton 2010 Forest Ecology and Management