

Carbon Dynamics of the Forest Sector

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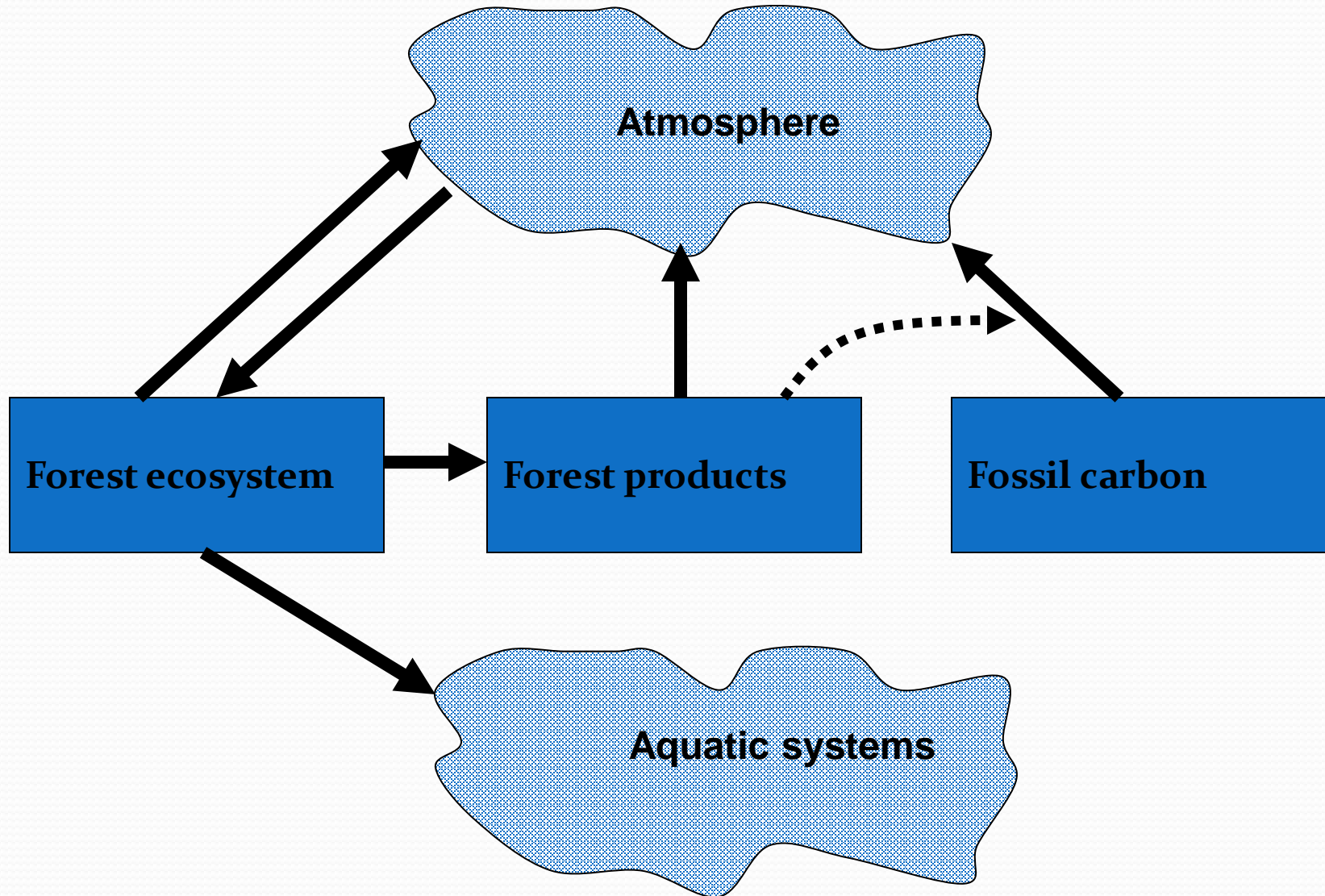
Main points

- The basic ecosystem science behind carbon dynamics in forests is relatively straightforward (really!)
- This science doesn't seem to be applied very 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

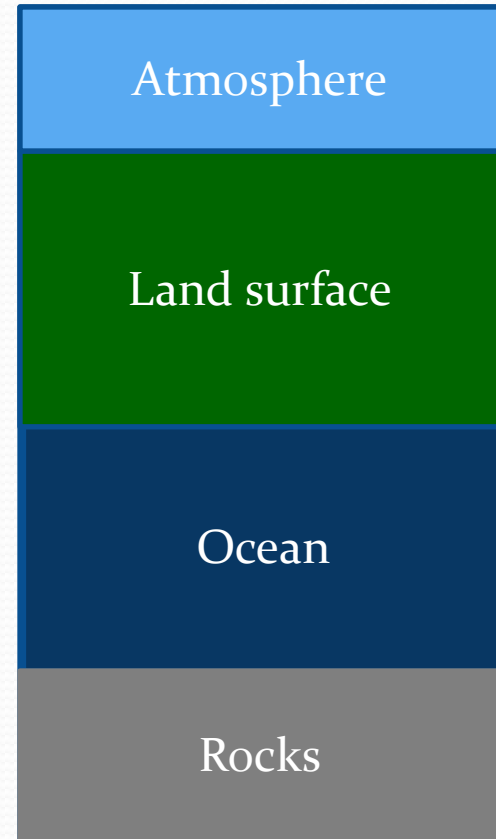
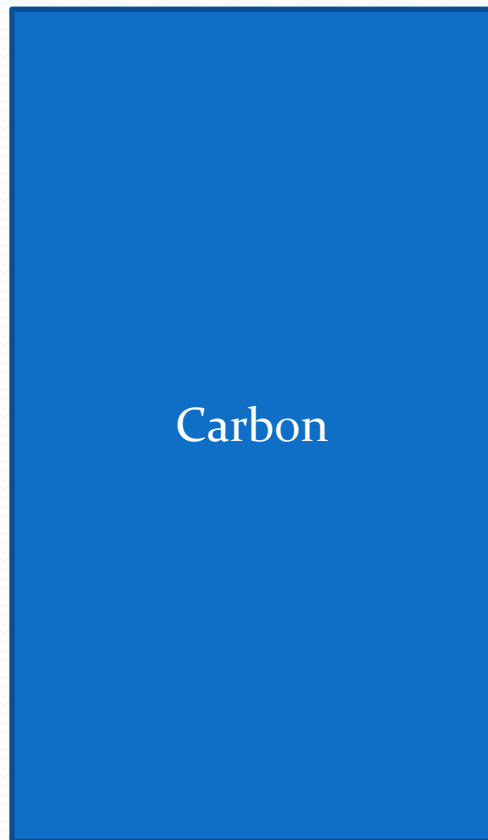
The forest sector



Conservation of mass law

before

after



Which forest stores more carbon?

OG=600 MgC/ha

Harvested forest=325 MgC/ha

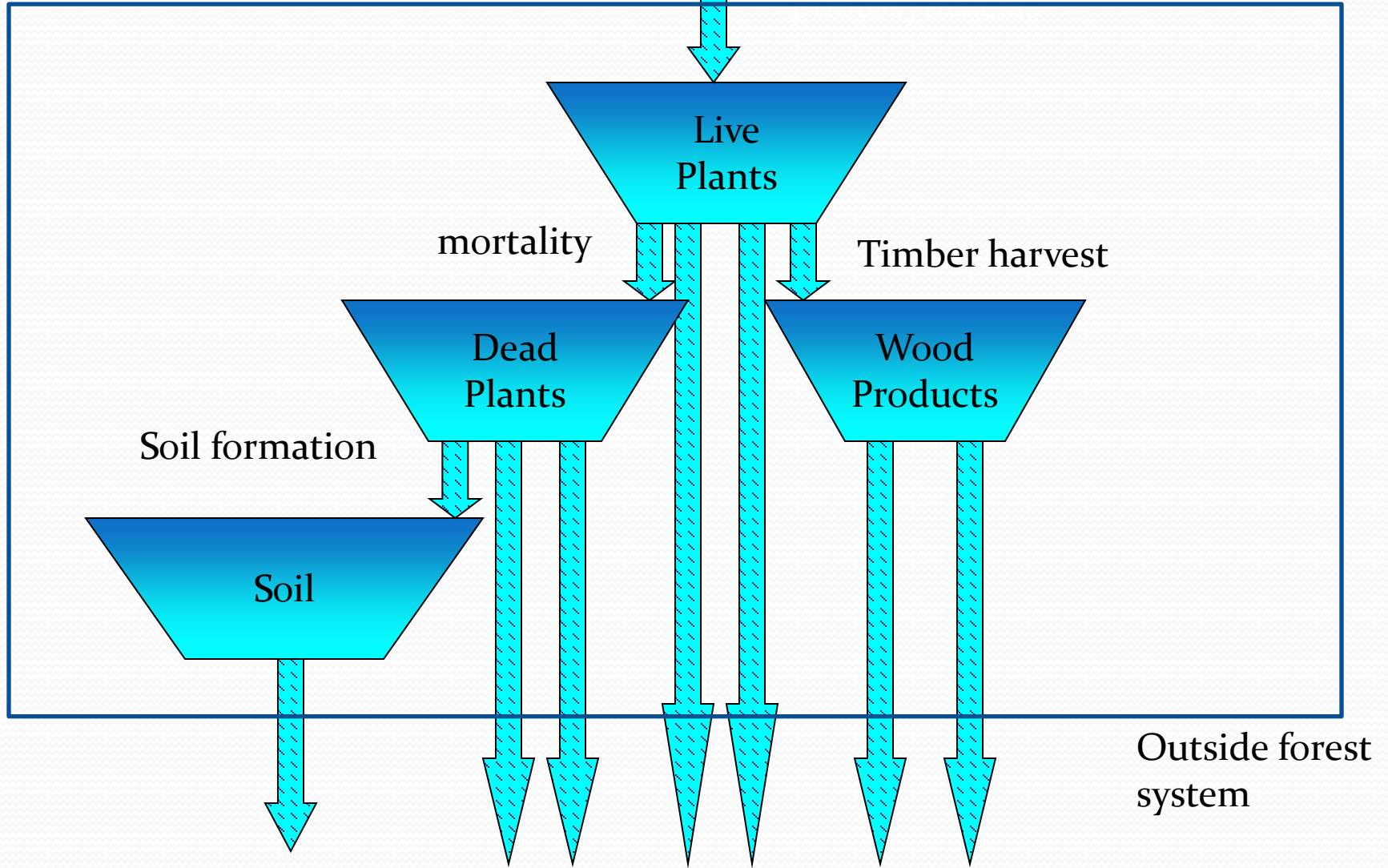
Young forest=260 MgC/ha

Forest products= 65 MgC/ha

At current uptake rates
130 years to reach OG store



Photosynthesis



Respiration and combustion



**5
Medium
leaks**



**5
Large
leaks**



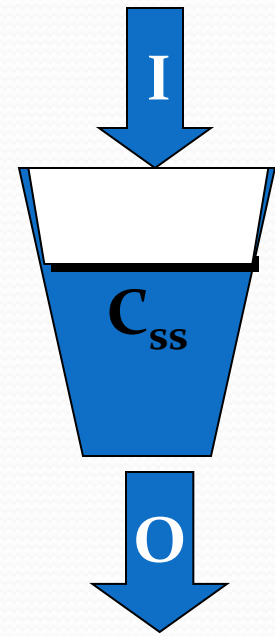
**7
Small
leaks**



**2
Large
leaks**

The Math of Leaky Buckets

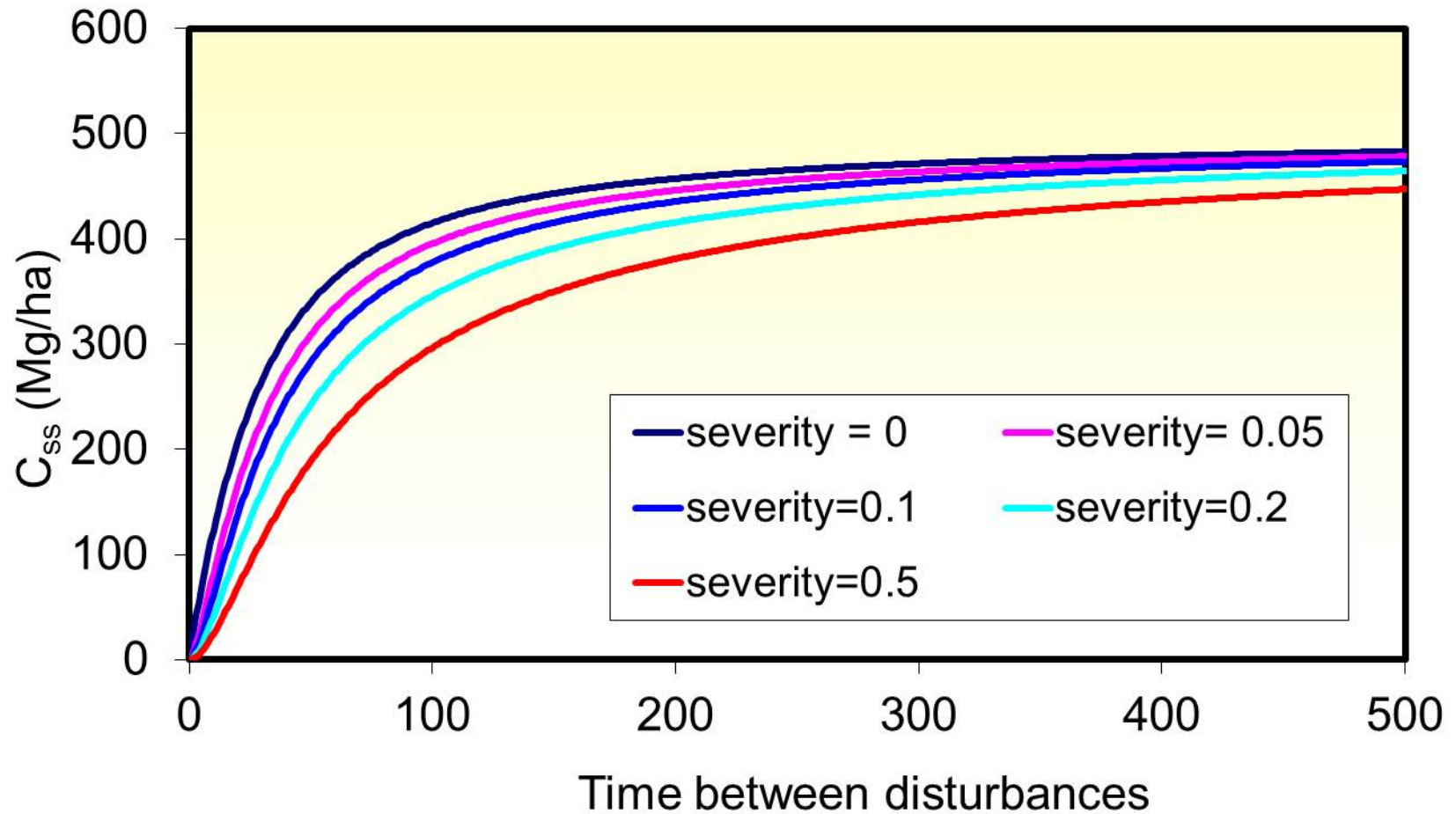
$$C_{ss} = I/k$$



I is the input rate

k is the proportional loss rate

The fewer and smaller the holes the more stored



Full input (NPP) returns in 25 years



Which is more relevant?

The average rate of uptake
(sequestration)

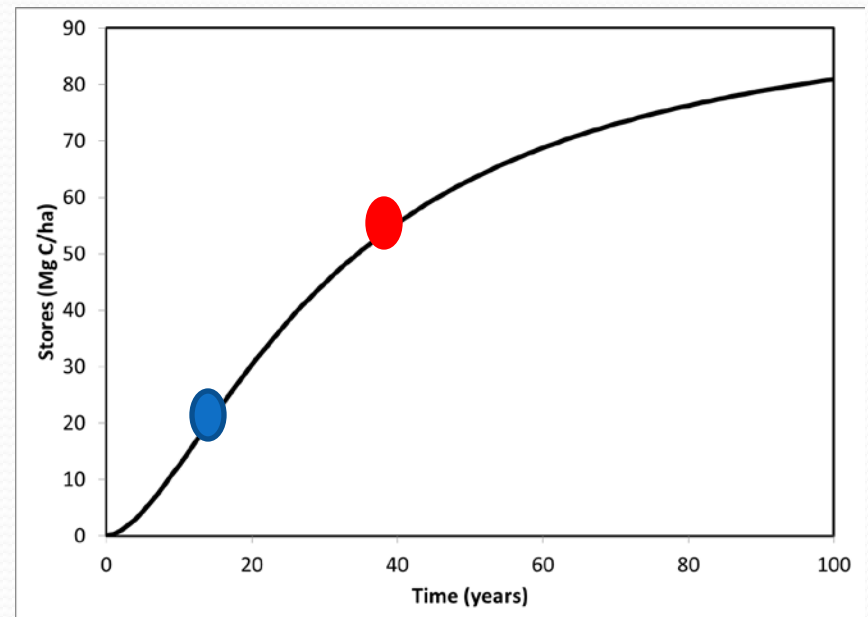
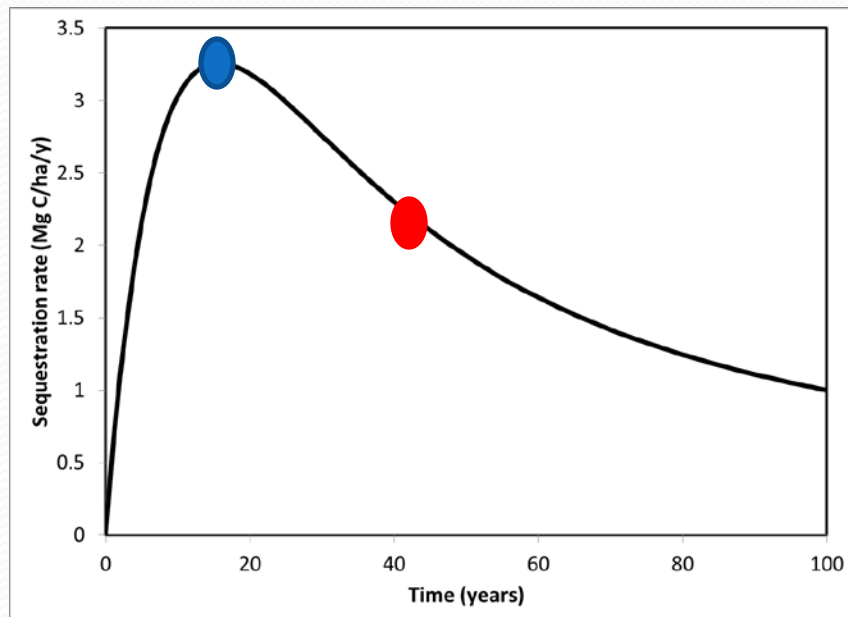
OR

The average amount stored

System average (all ages)

Sequestration rate

Stores



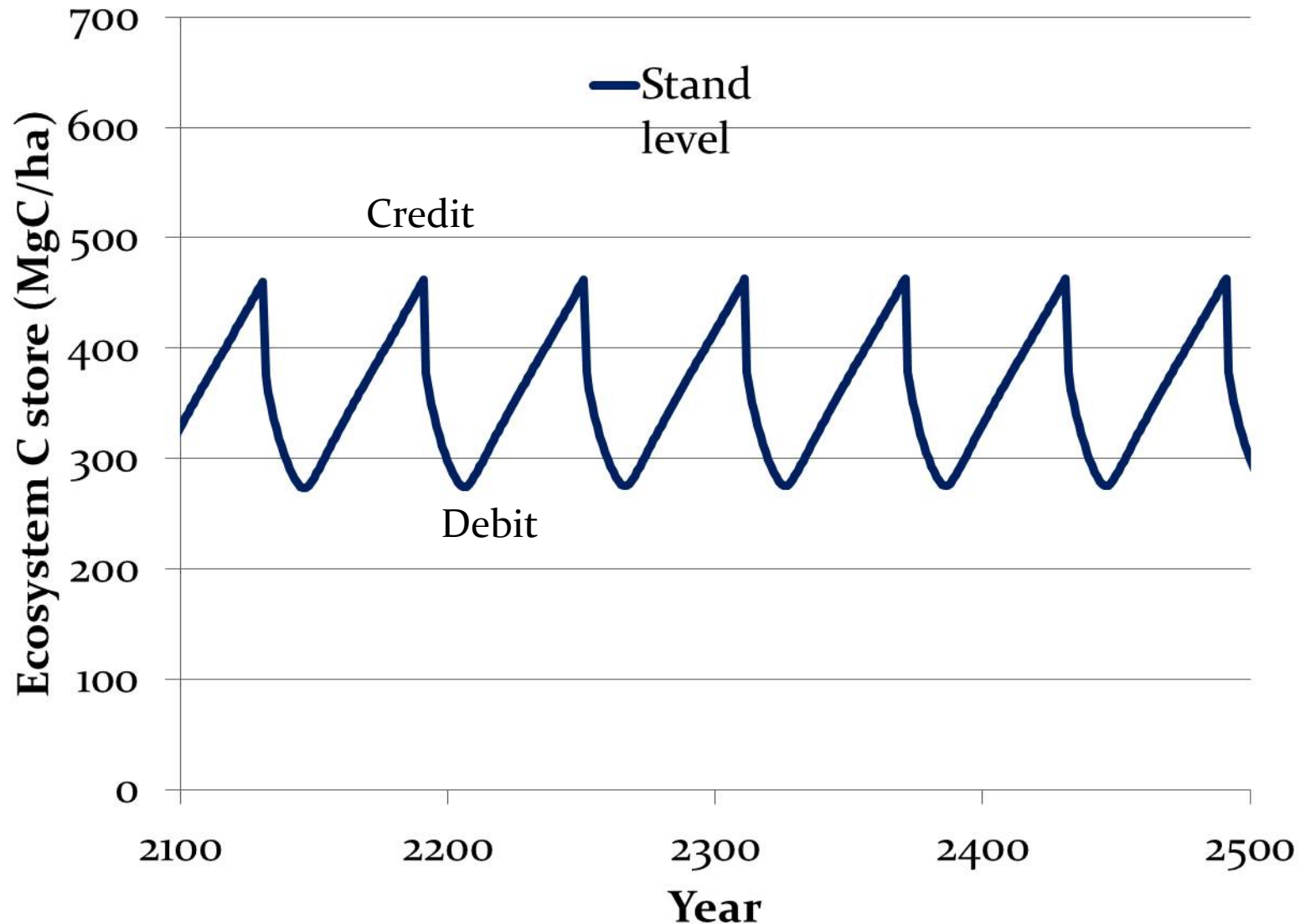
Why the mismatch? They forgot the relative leakiness (I/k)

Questions of scale

The answer depends on scale

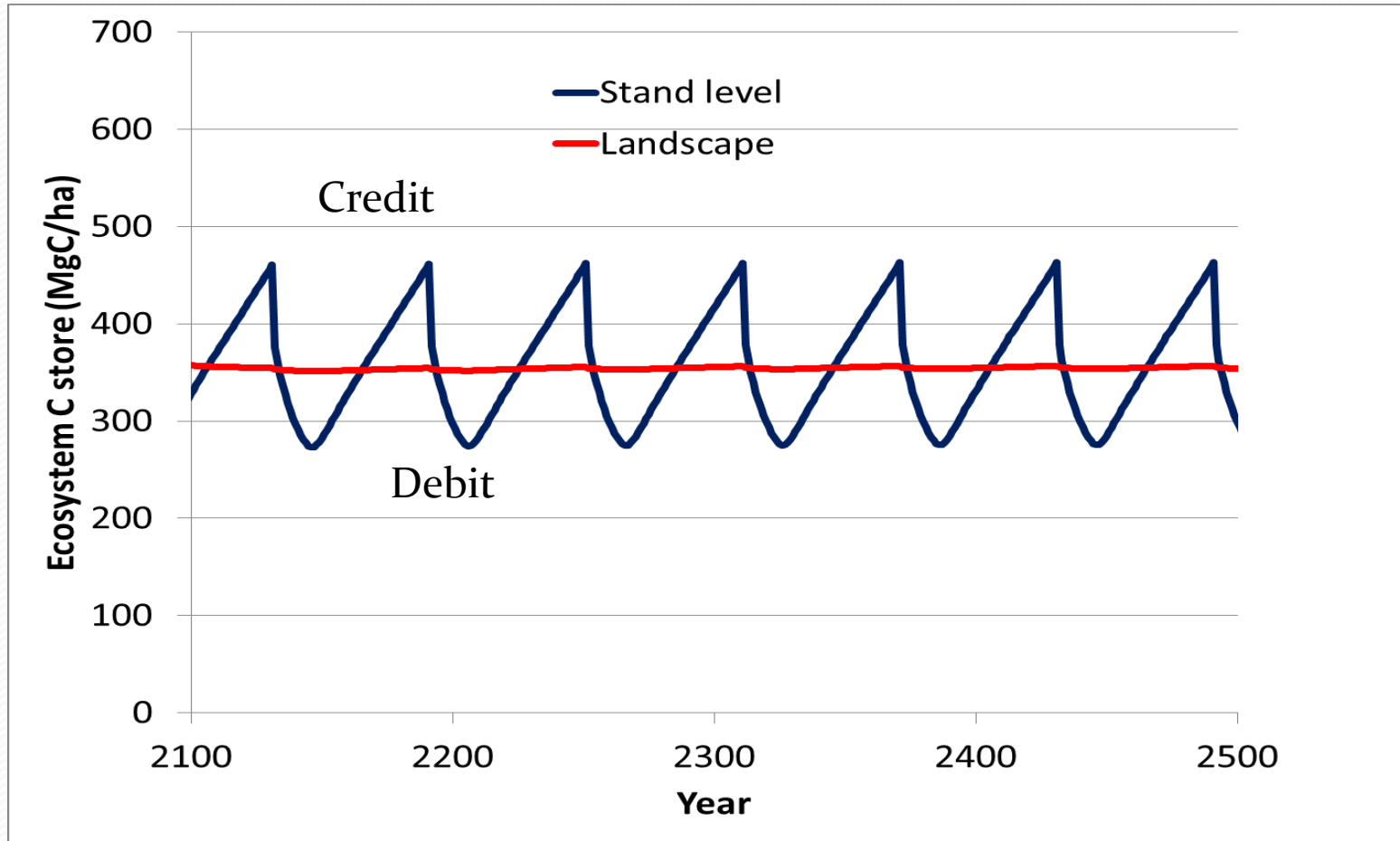
Some scales are more relevant than others for policy

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

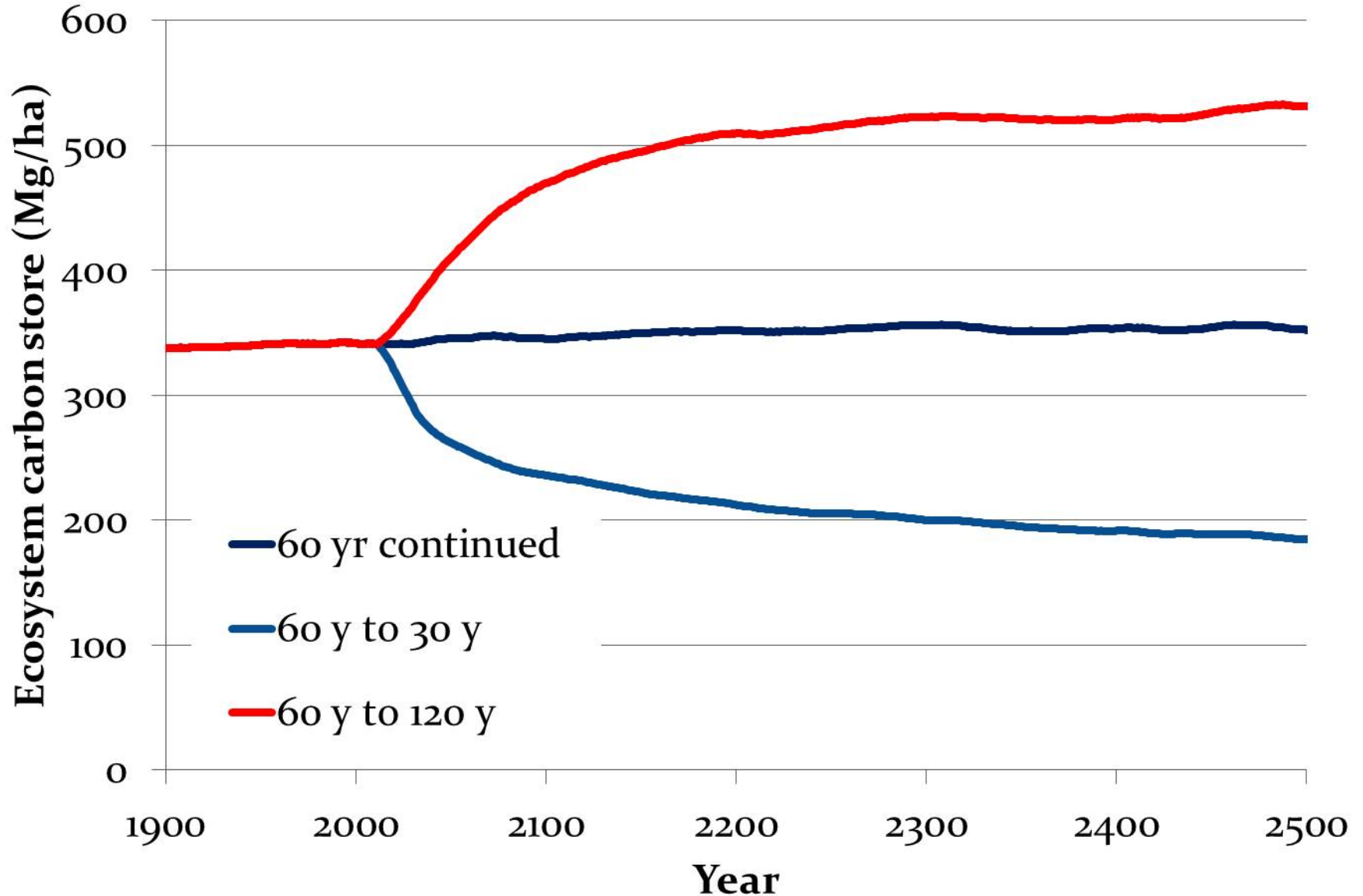



Can a steady-state have a carbon debt or credit?

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

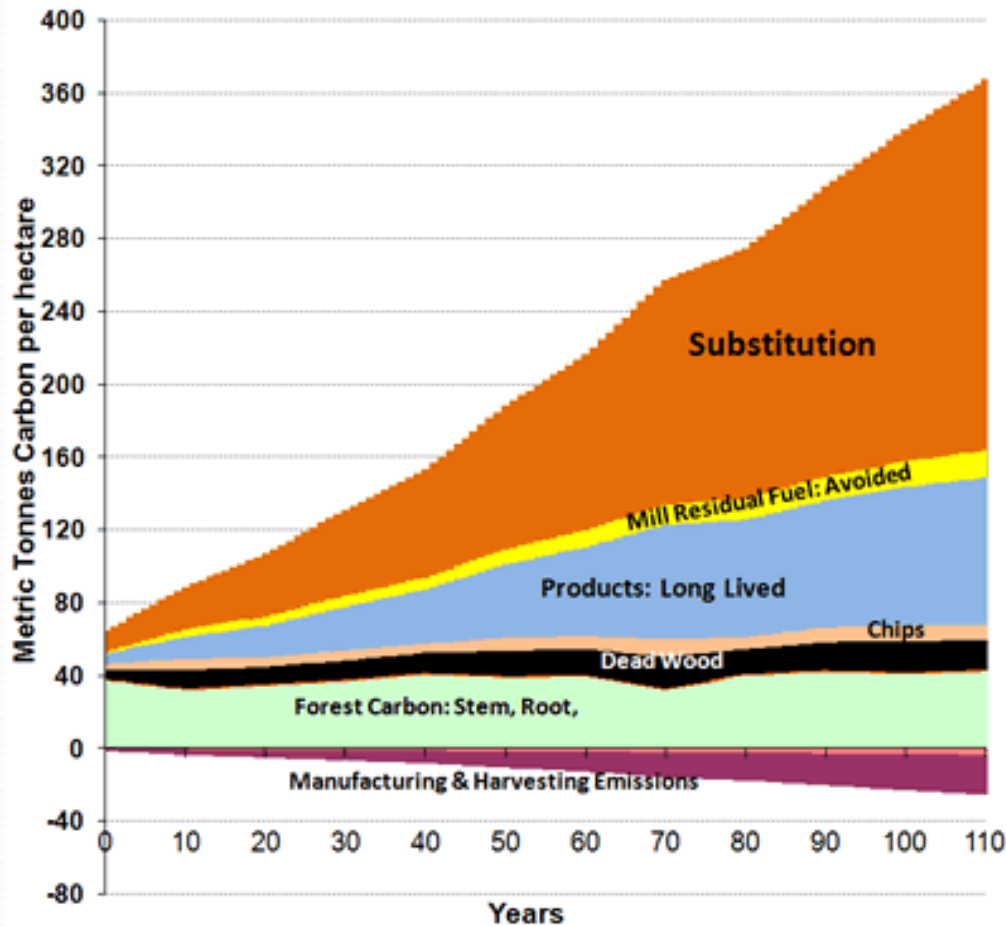




An example of dubious carbon science:

Product substitution will
result in a large carbon sink

The Classic Products Substitution Story

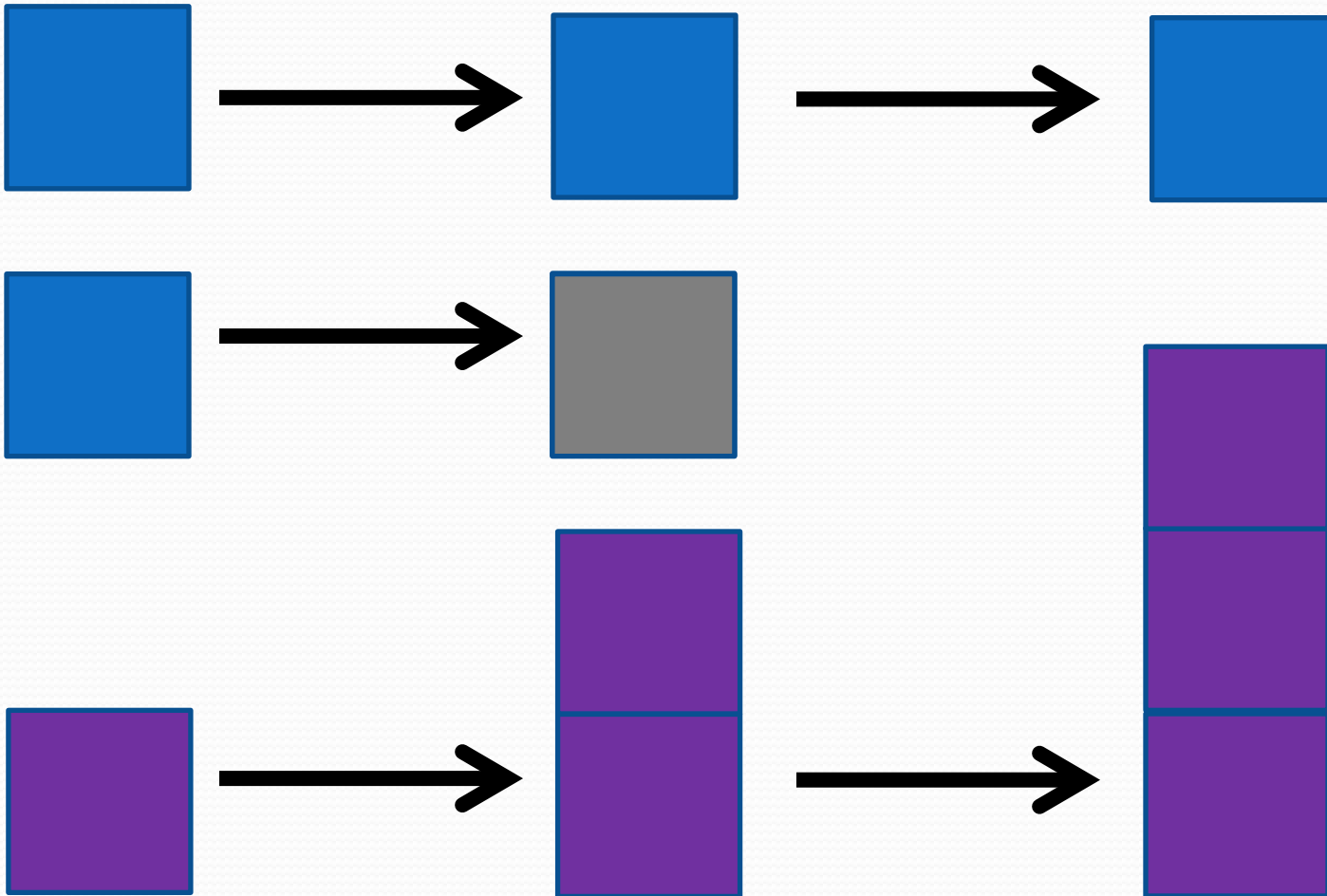


Long lived products store
About 1/3 of sector C

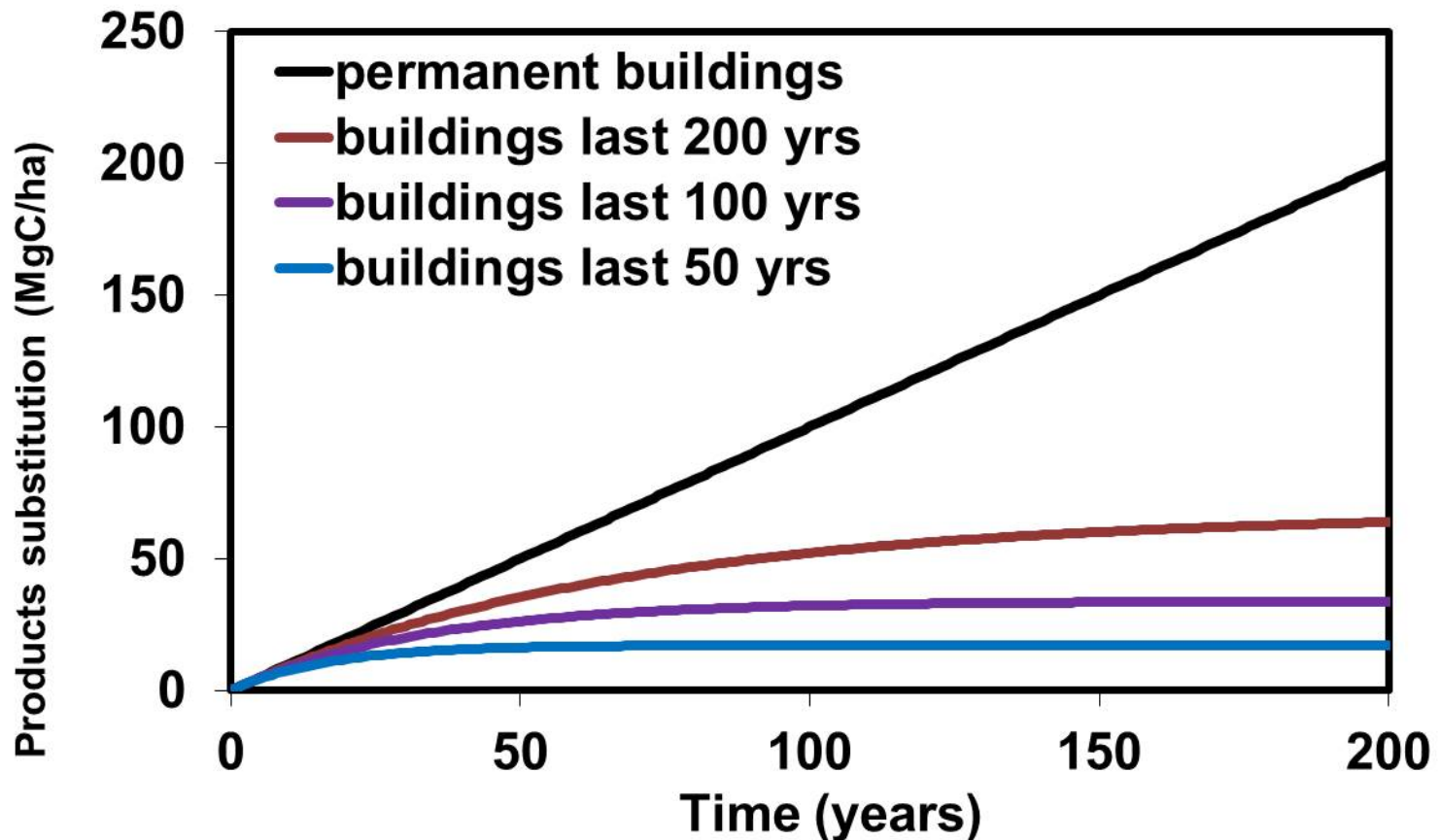
Substitution (a virtual store)
increases to infinity because
the substitution is infinite

Note that adding an additional
leak via harvest did not decrease
the forest carbon-curios

The true nature of product substitutions: they are finite



The fact buildings don't last forever has consequences





Other issues needing to be addressed ASAP

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

Conclusions

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

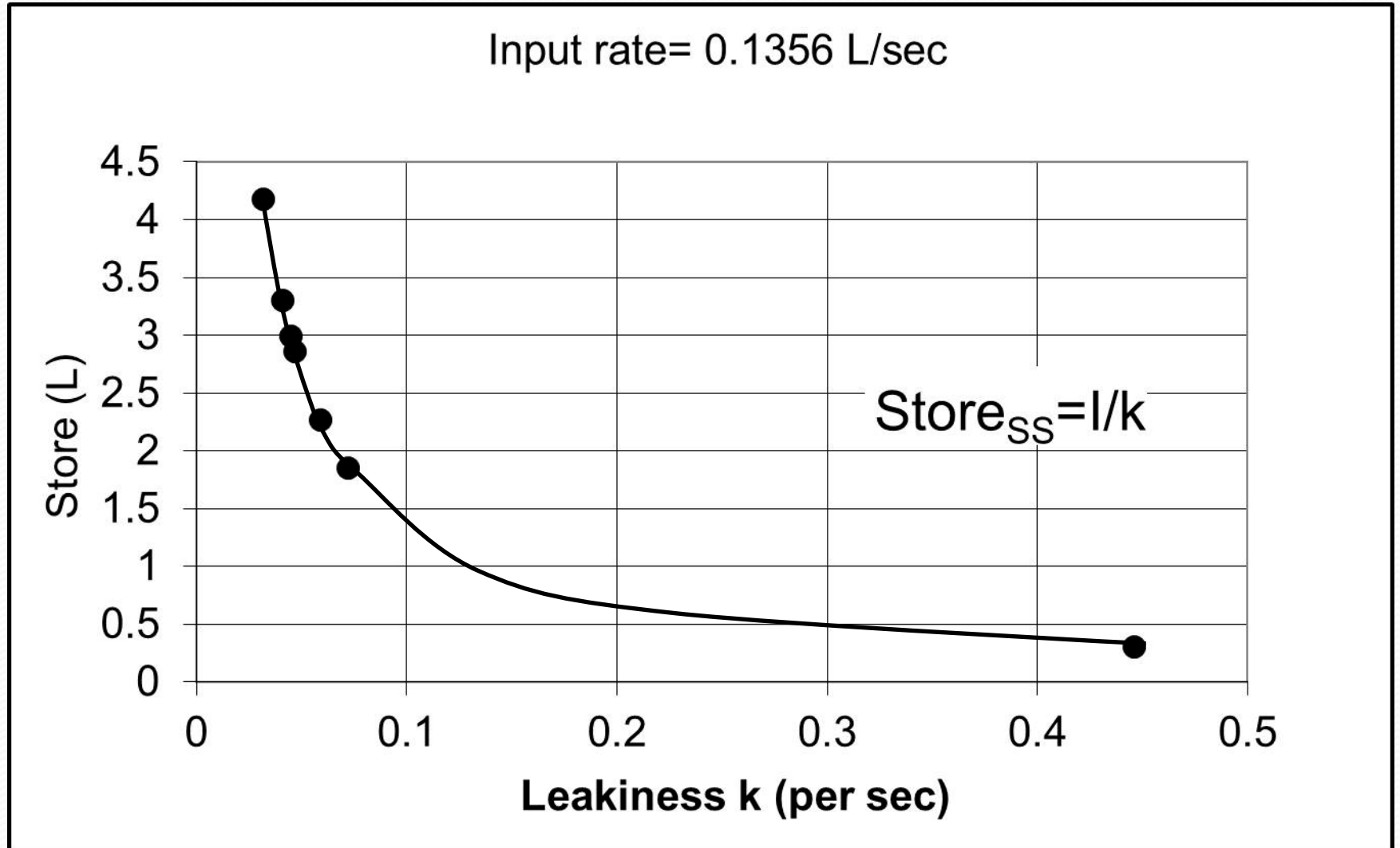
Internet

100%

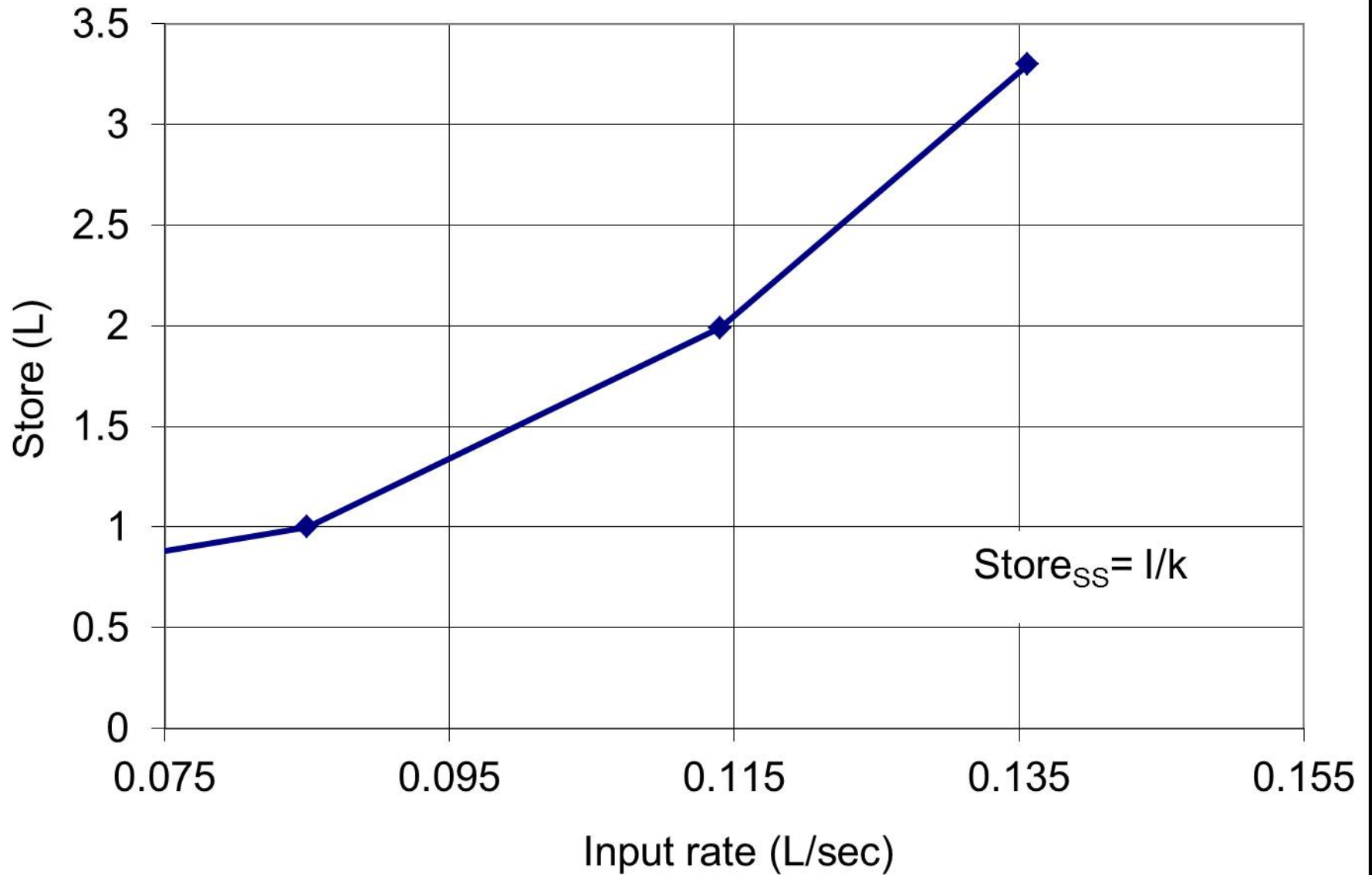
<http://landcarb.forestry.oregonstate.edu/>

Thanks!!

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



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



Another 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

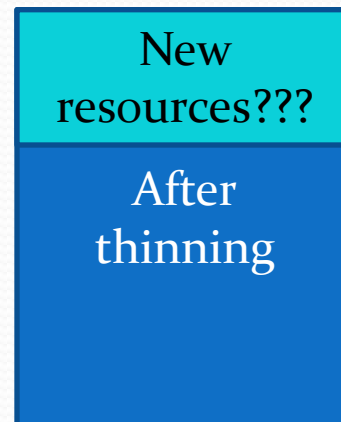
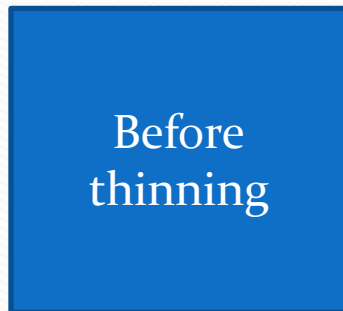
- $1 < 1.1$

Wait a minute!

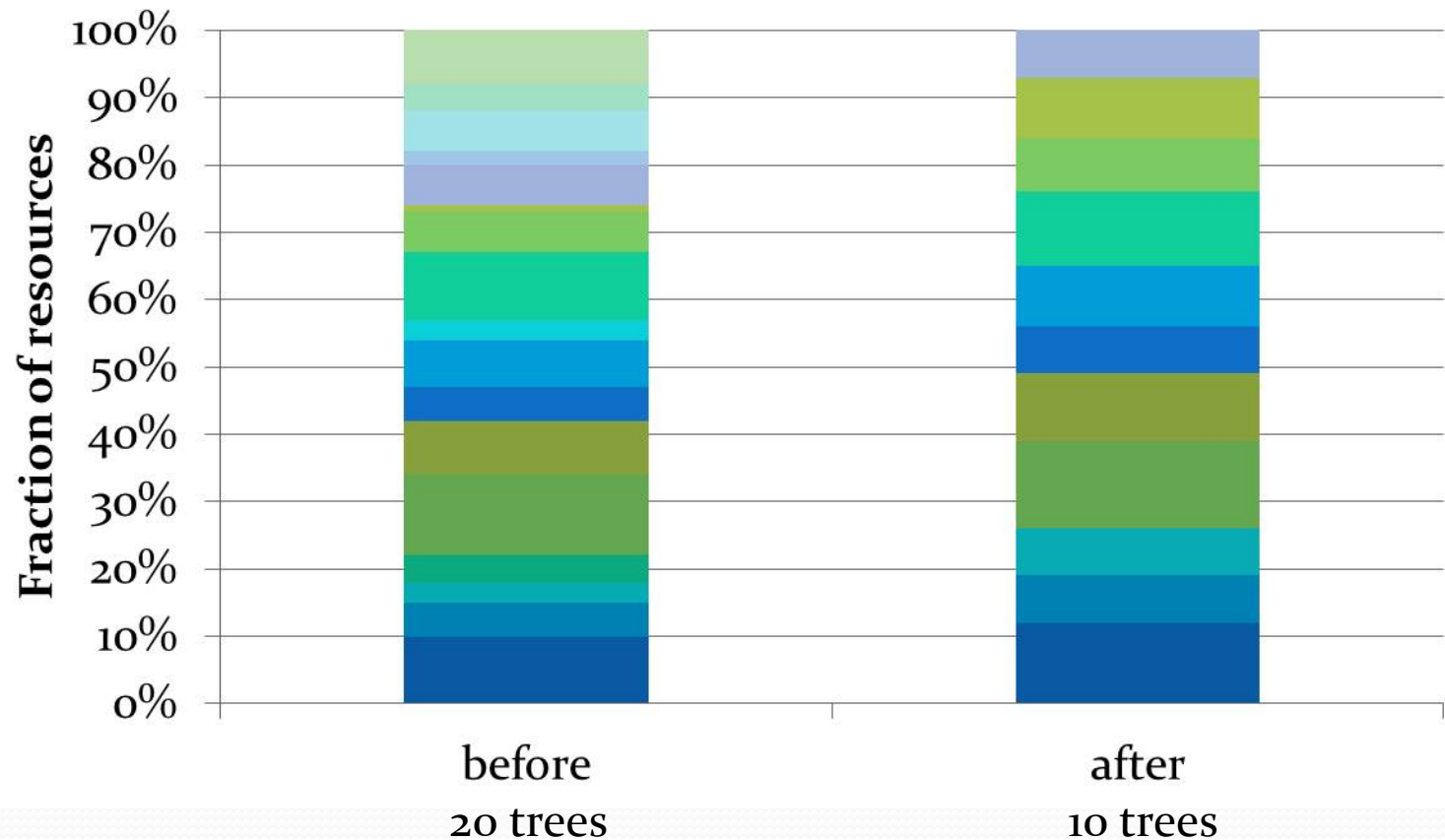
- Aren't there fewer trees after thinning?
- Before After
- $1 < 1.1$ incomplete comparison
- $1 \times 100 \approx 1.1 \times 90$ complete comparison
- To store more total growth must increase, not stay the same

For total growth to increase the following must be true

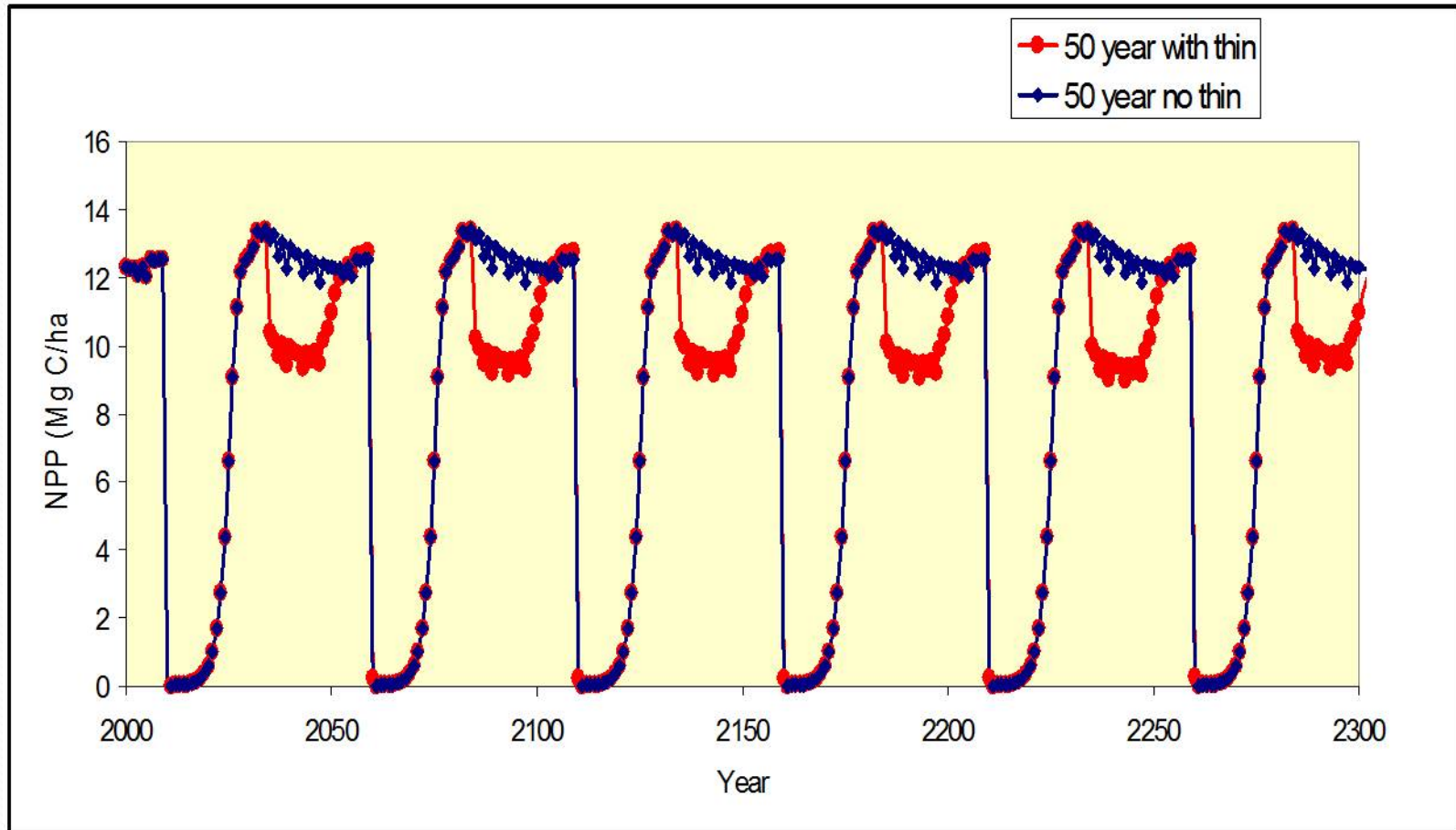
- The recovery of tree production after thinning must be instantaneous (BUT IT IS NOT)
- Thinning must increase the total amount of resources available to trees so that total production of thinned trees can increase (HOW?)



Thinning redistributes the same resources among few individuals

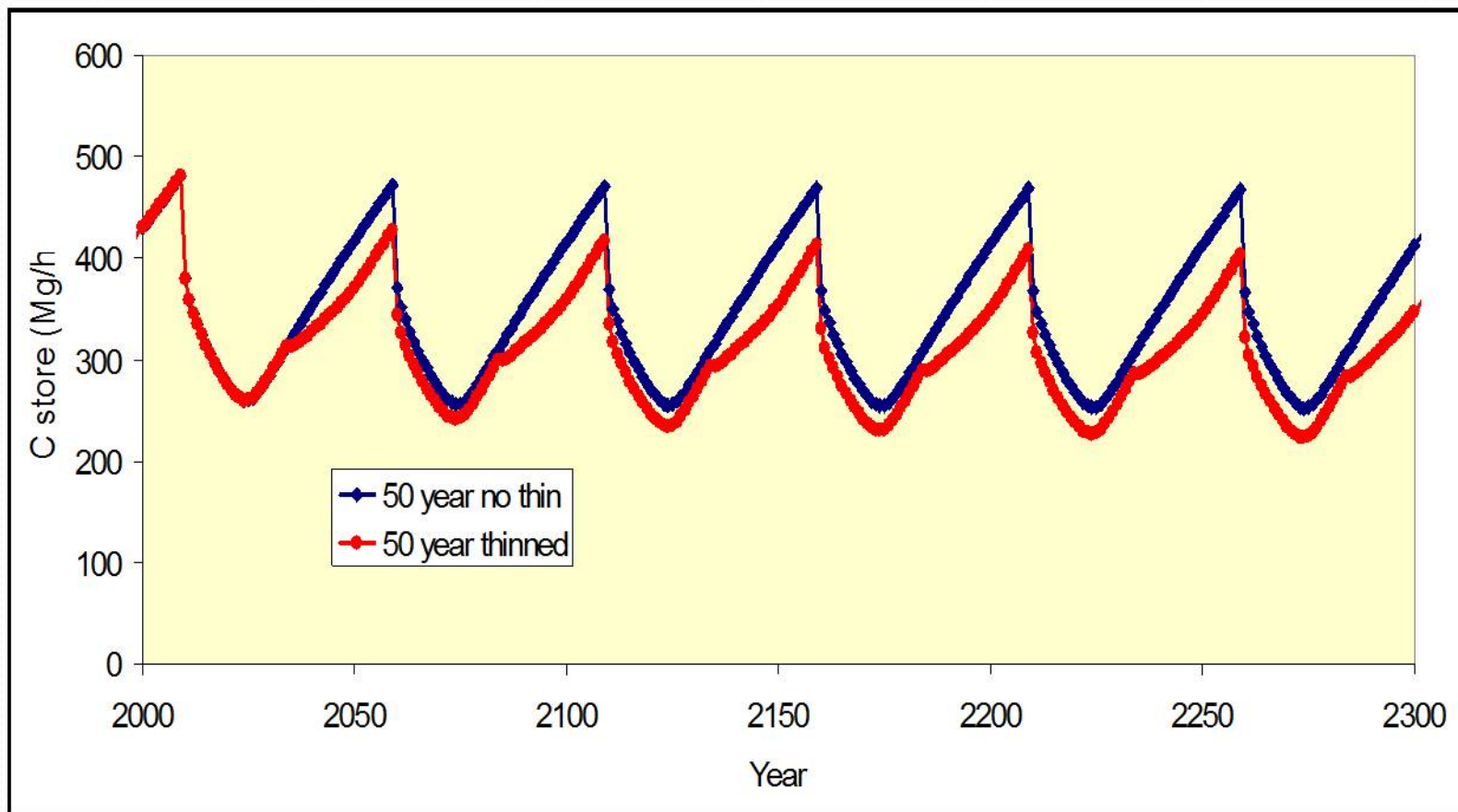


Thinning does not increase the input to the forest!



	Thinned	Not thinned	
NPP	7.93	8.83	11% less
	Mg C/ha/y		

Thinning decreases forest carbon stores



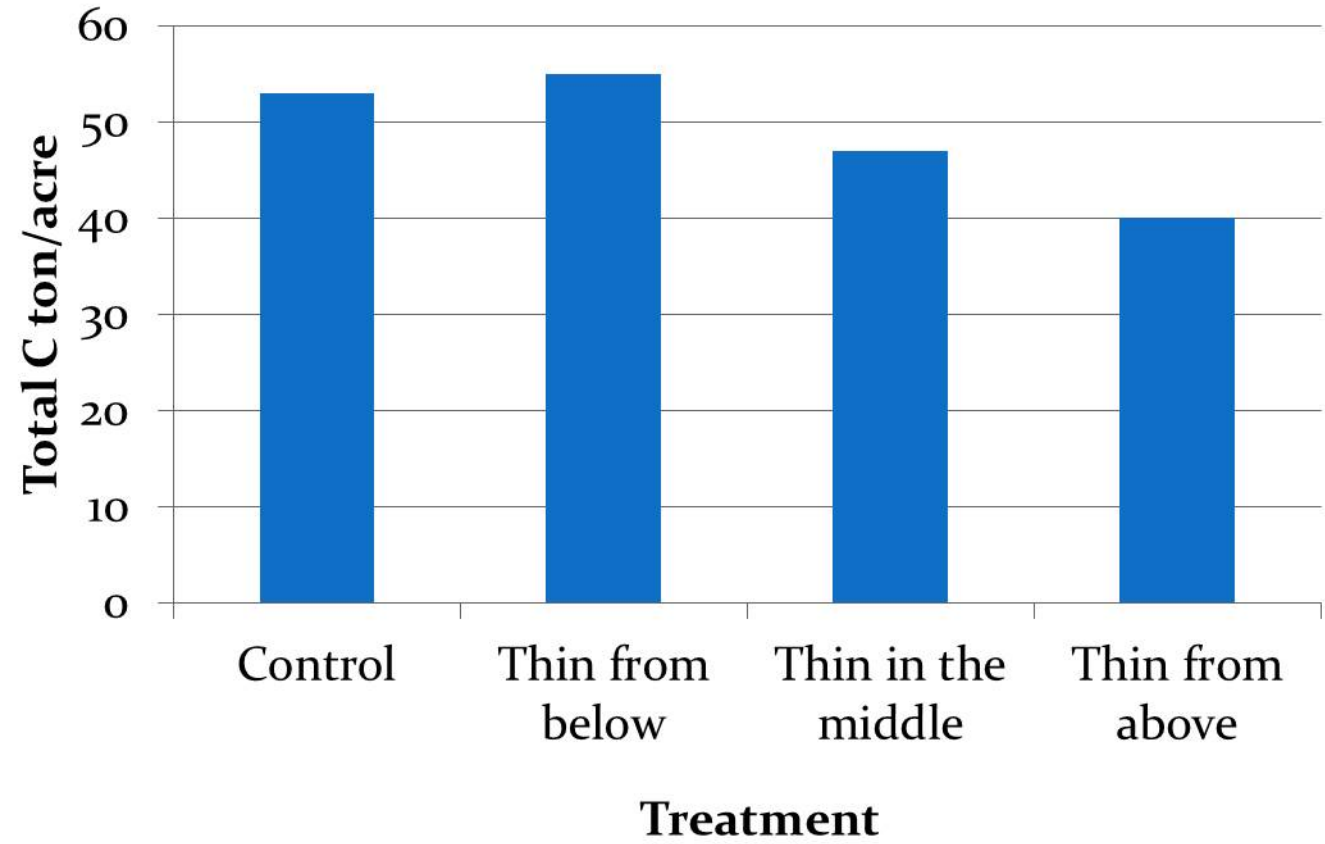
Thinned **Not thinned**
Store 298 341 13% less
Mg C/ha

Table 1. Ca

Carbon Pool

- Live biomass
- Deadwood
- Slash
- Products
- Total

Data are metric t beginning of the



Carbon Pool	Control
Live biomass	43 (40)
Deadwood	10
Slash	0
Products	0
Total	53

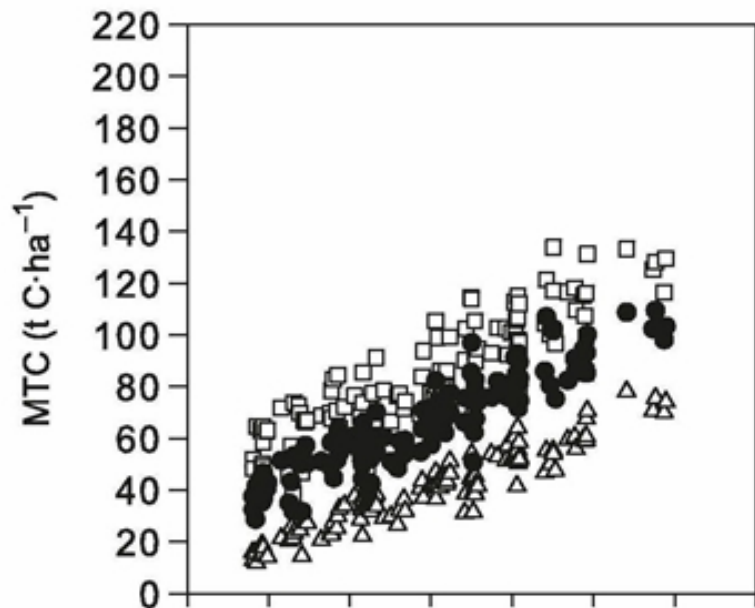
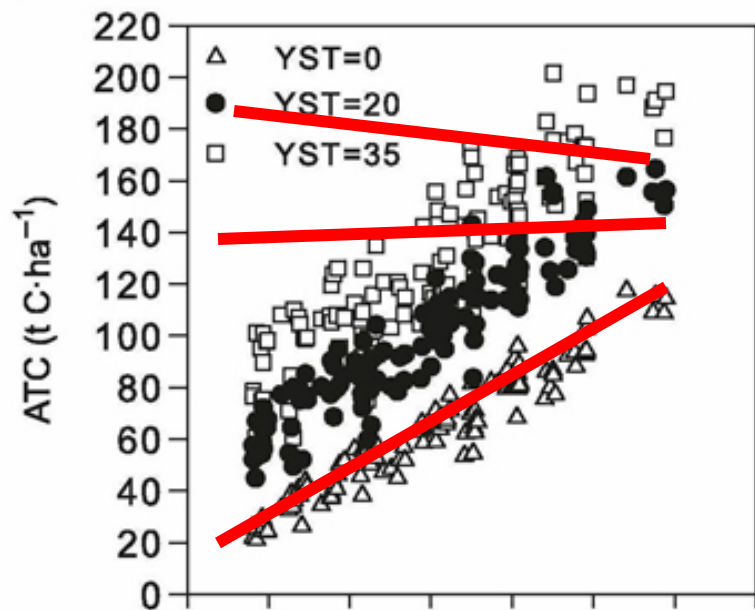
on stocks at the

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

