Five Things to Consider When Considering Carbon

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The Laws of Thermodynamics

- Conservation of mass and energy
  - Carbon must go somewhere
  - It can not disappear within the system
- Entropy
  - No process is 100% efficient
  - Processes by nature or humans lead to losses

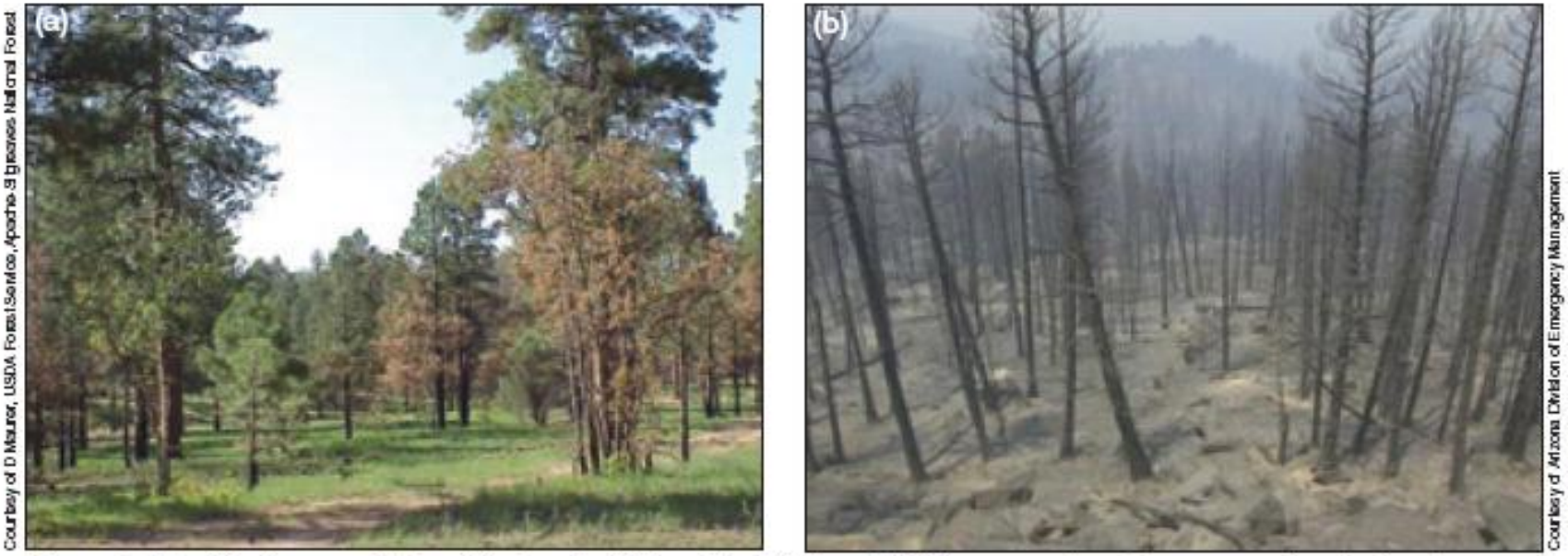
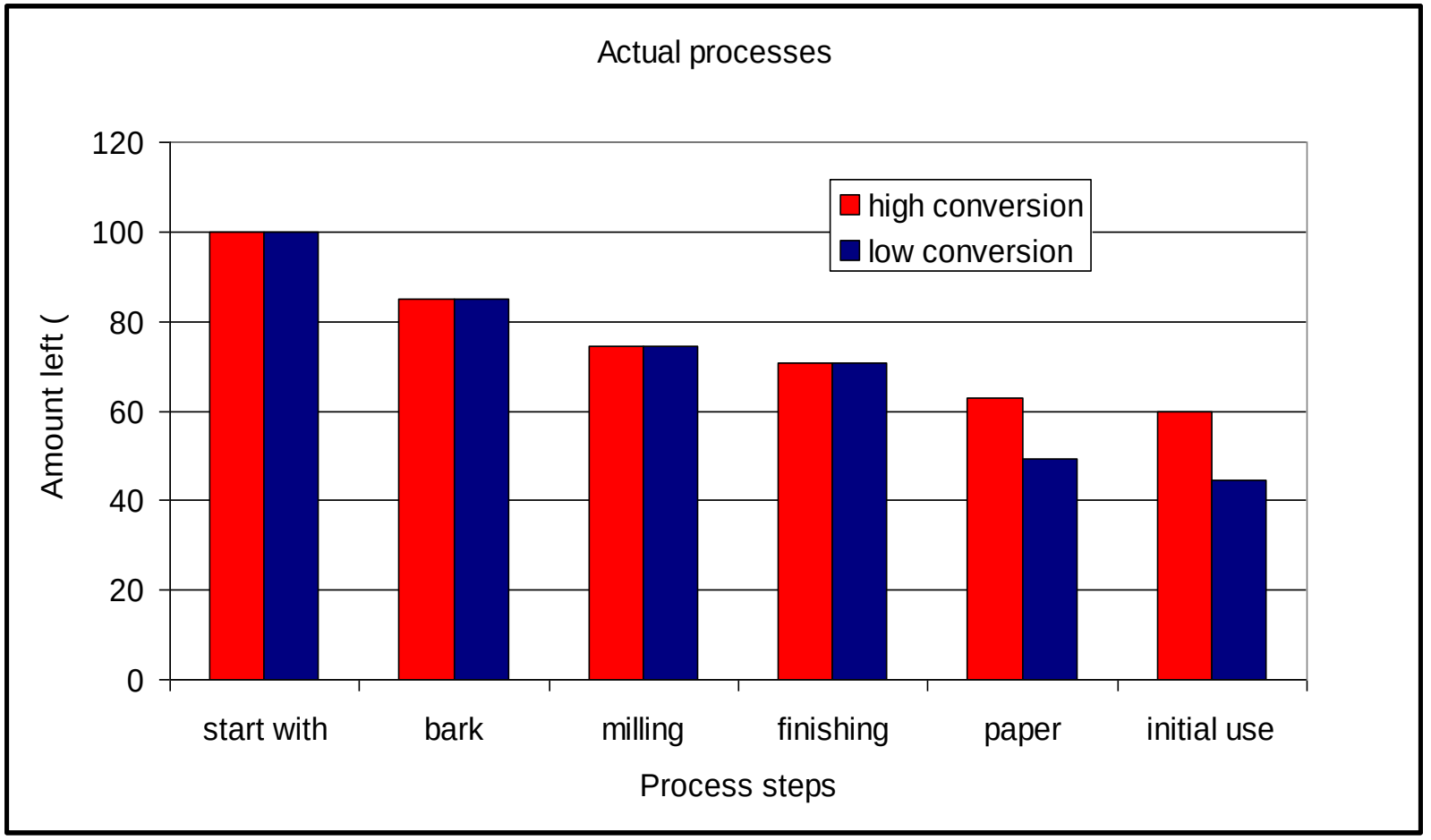


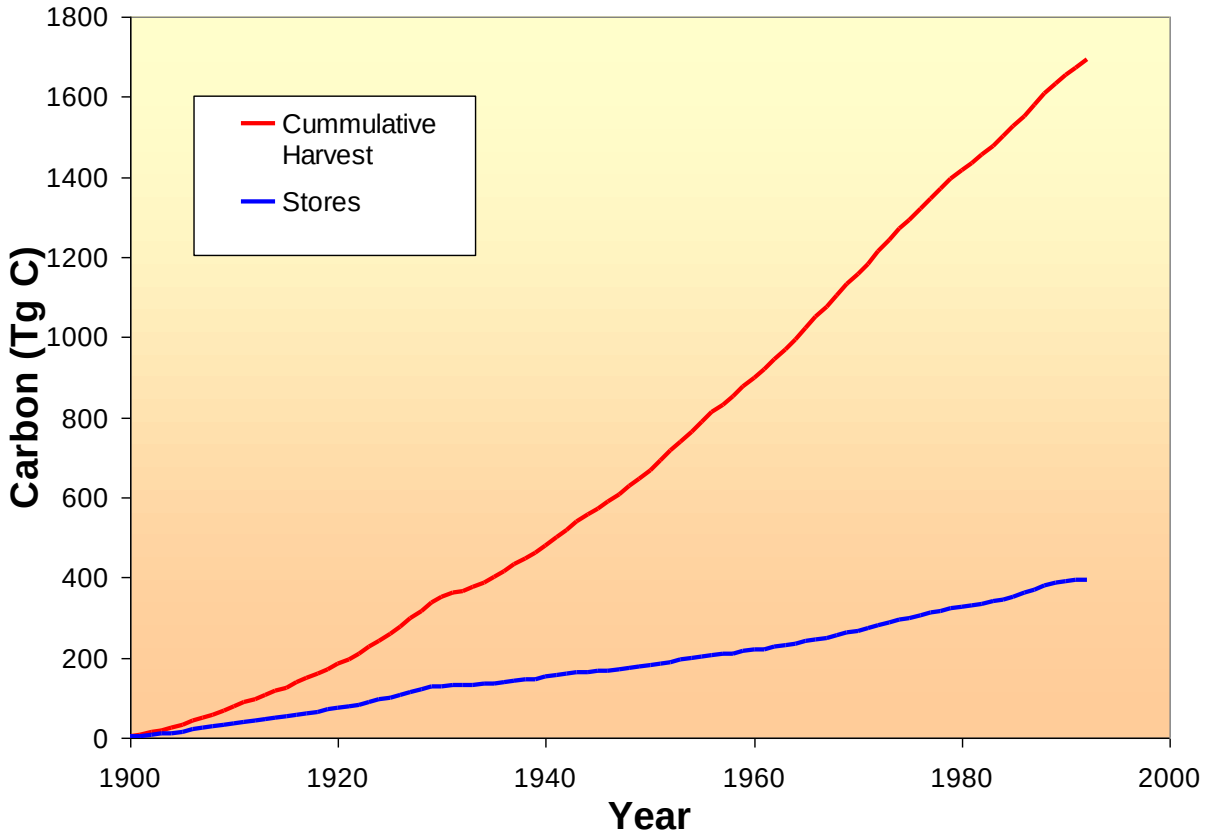
Figure 4. *Post-fire forest conditions following the Rodeo–Chediski fire. (a) Taken approximately one year after the fire in an area that had been thinned (to a basal area of about 15 m^2 ha^{-1}) and pile burned in 1997. (b) Taken immediately post-fire, in an area that was not thinned prior to the fire.*

Hurteau et al. 2007: "Of the approximately 92 000 ha that experienced high severity,stand-replacing fire in these four wildfires, approximately 4.2–6.1 million metric tons of CO2 equivalent (MMTCO2e) were released from live tree biomass. Thinning these same forests before they burned would have removed 3.9 MMTCO2e and reduced live tree fire emissions to only 0.07–0.3 MMTCO2e.

What happens as we process the harvested carbon?



Only 20% of Harvest is Stored



MODELING CARBON STORES IN OREGON AND WASHINGTON FOREST PRODUCTS: 1900–1992

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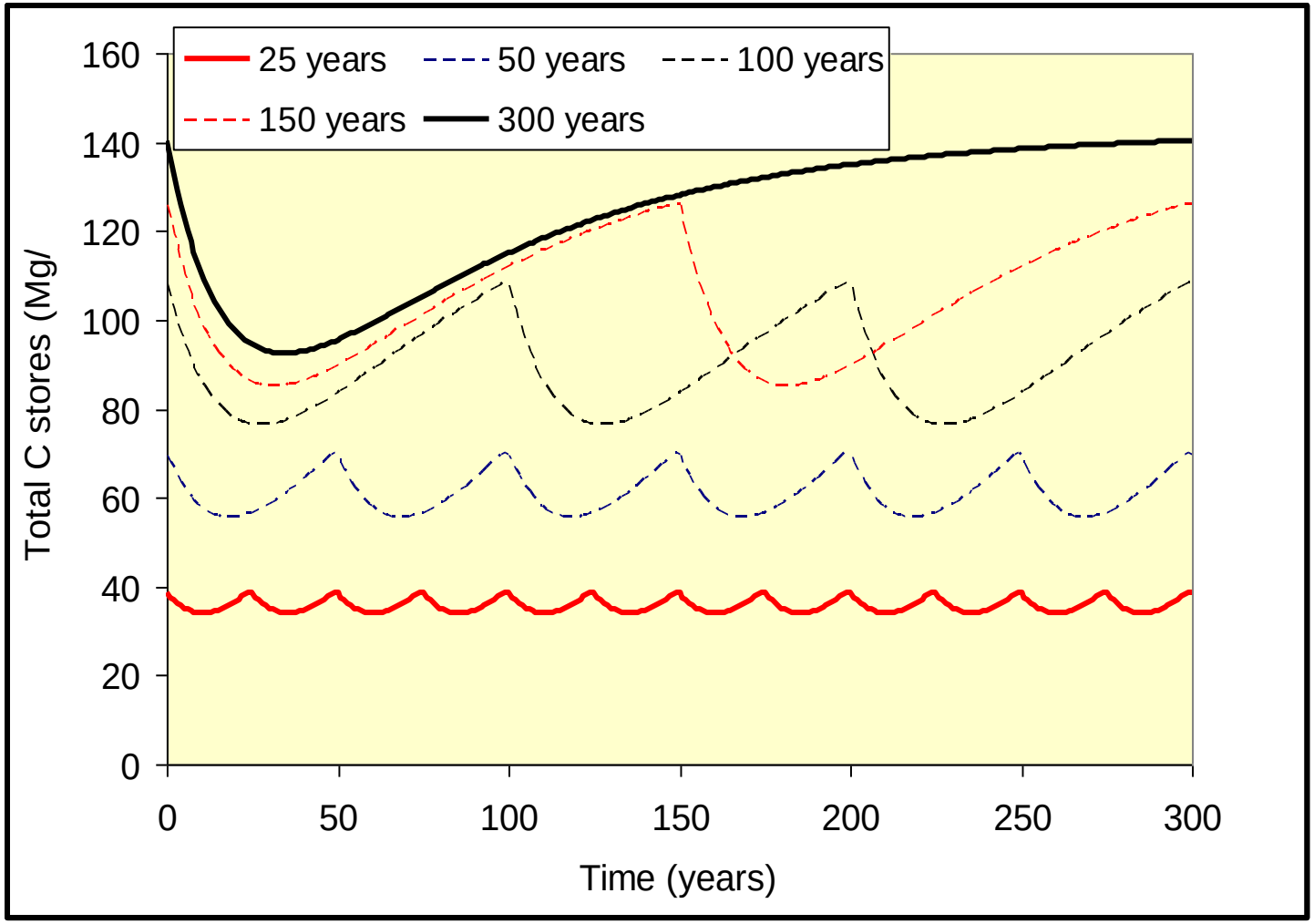
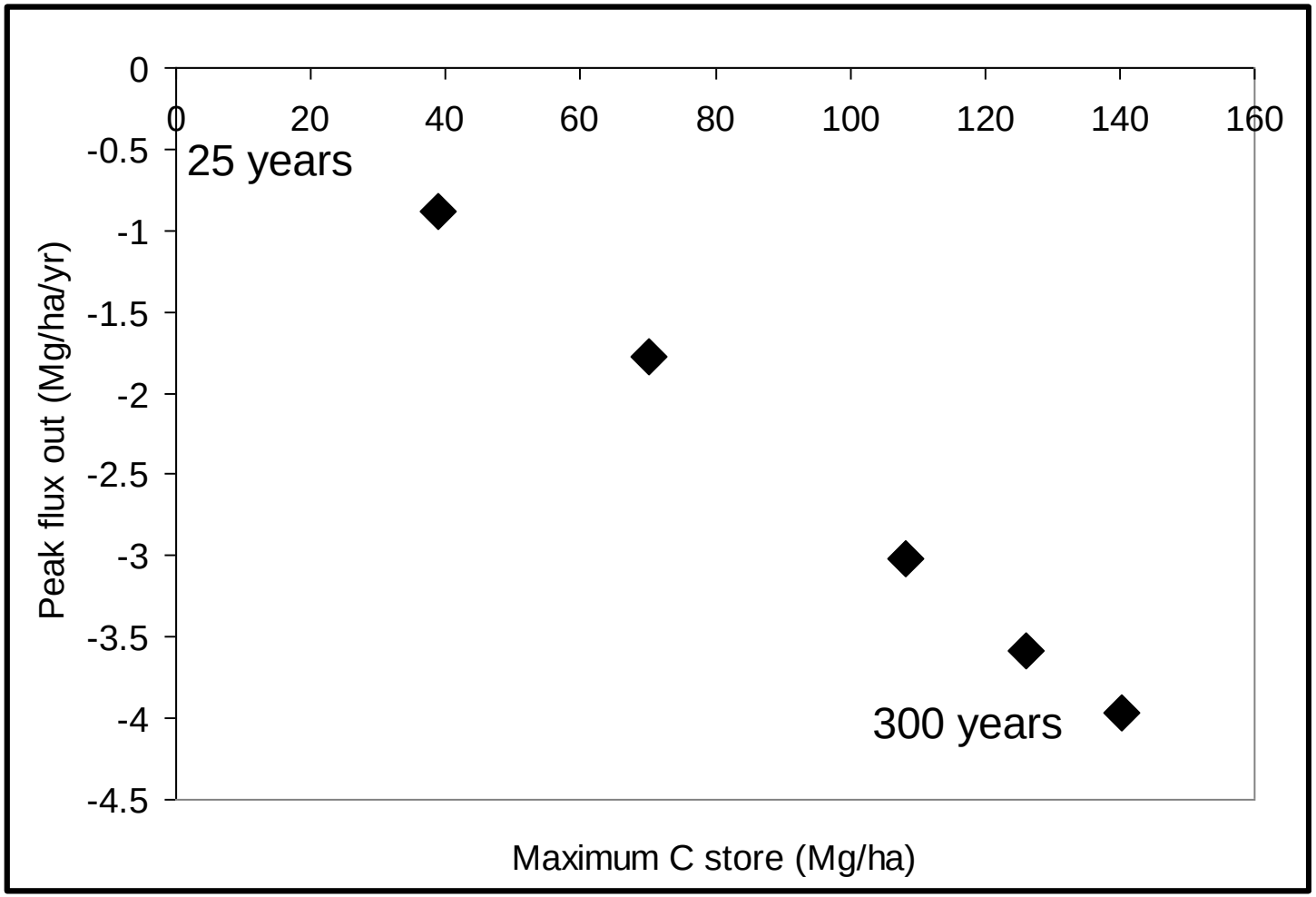
Feedbacks

- There is a feedback between the live and dead carbon in the forest
  - The amount coming in tends to equal the amount going out if disturbance is repeated
- Nutrient cycling maintains the systems productivity
  - Decomposition is not a useless process

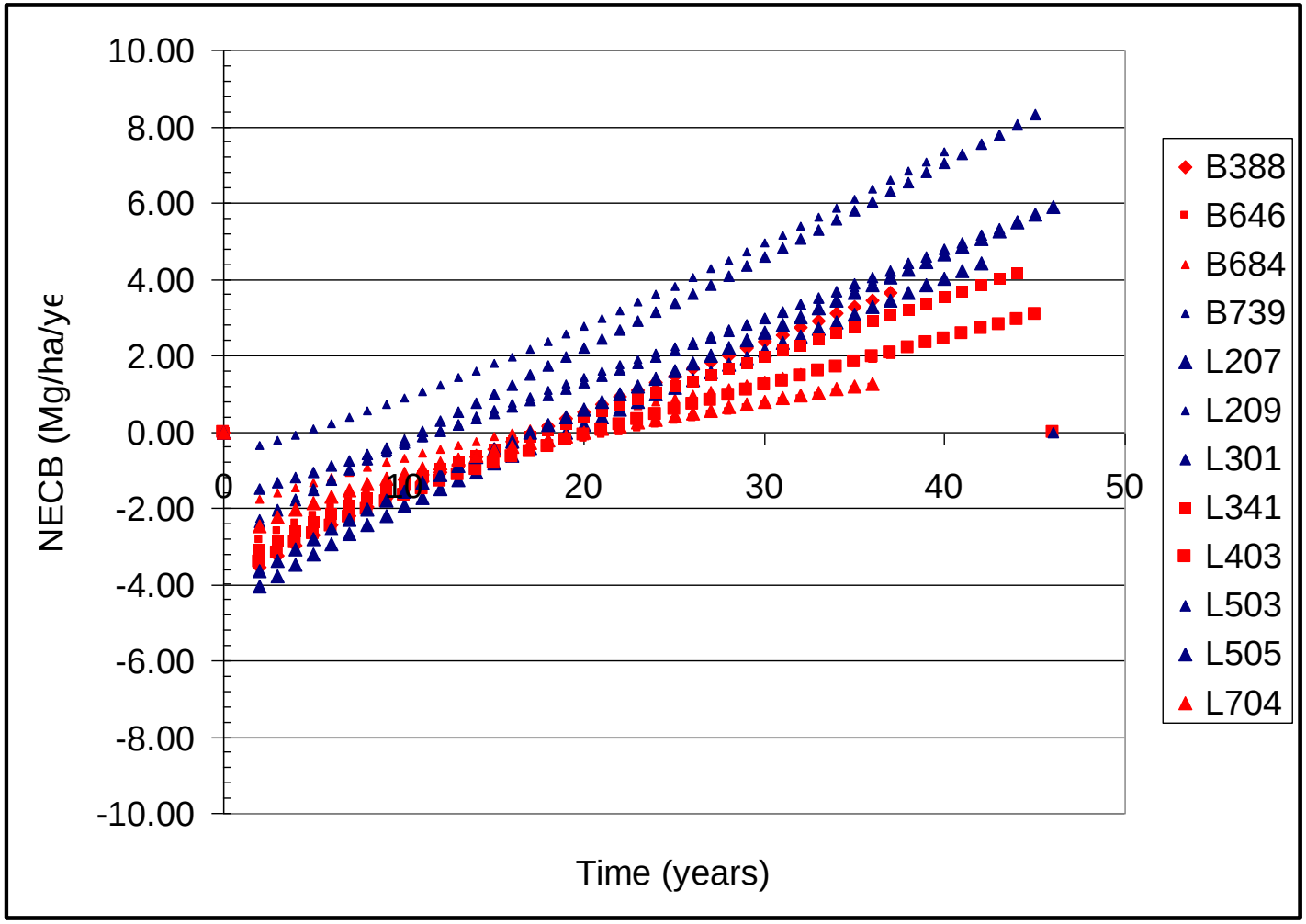
As the interval of disturbance increases the amount of C stored increases



There is a feedback between live and dead parts of the system



The Carbon Balance is influenced by how much dead we start with versus the speed of tree growth



Lags

- The system has inertia/momentum
  - Once the system is started on a path it may continue for some time
- Losses from the forest do not always equal the gains in the rest of the system

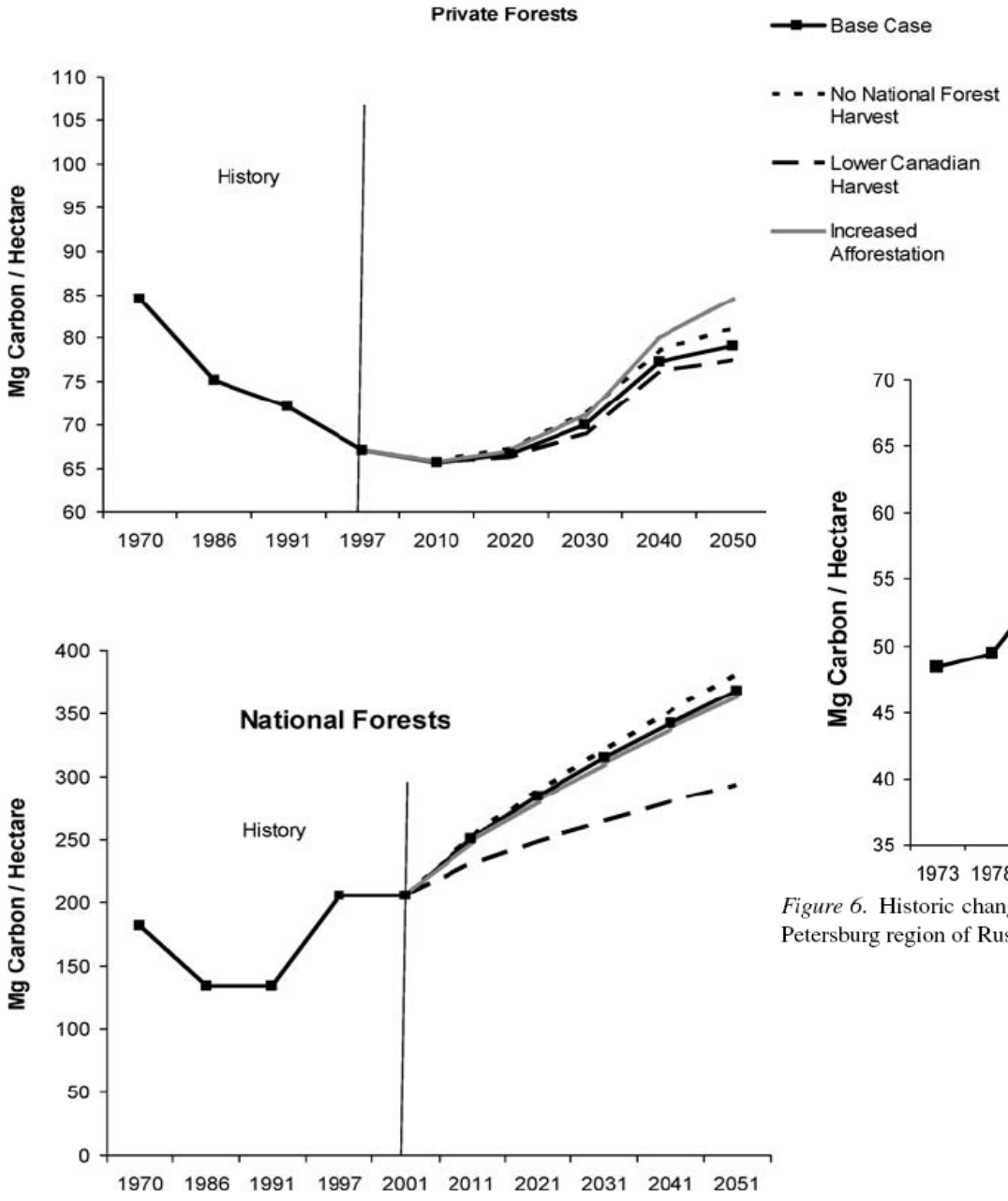


Figure 5. Historic change and future projections of carbon stores in live forest biomass for private ownerships and National Forests in the PNWW region. Units are in megagrams of carbon per hectare.

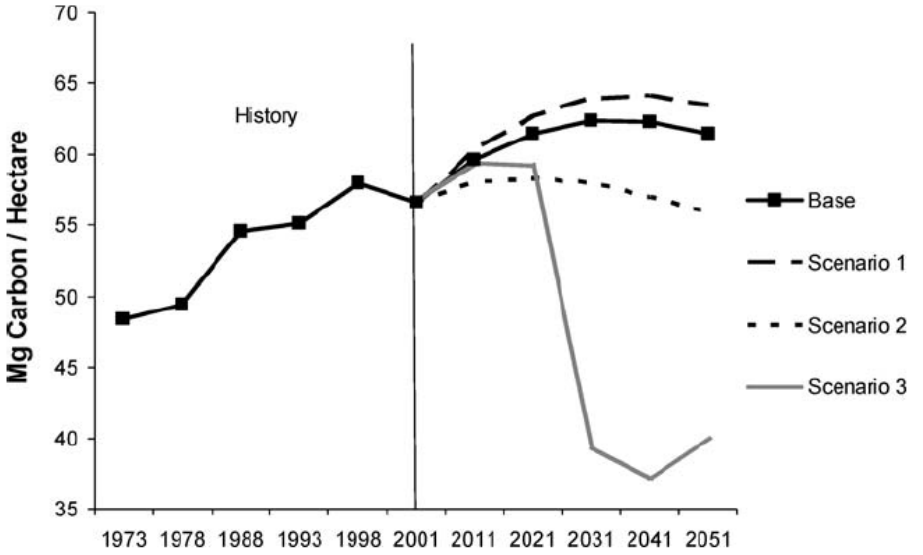
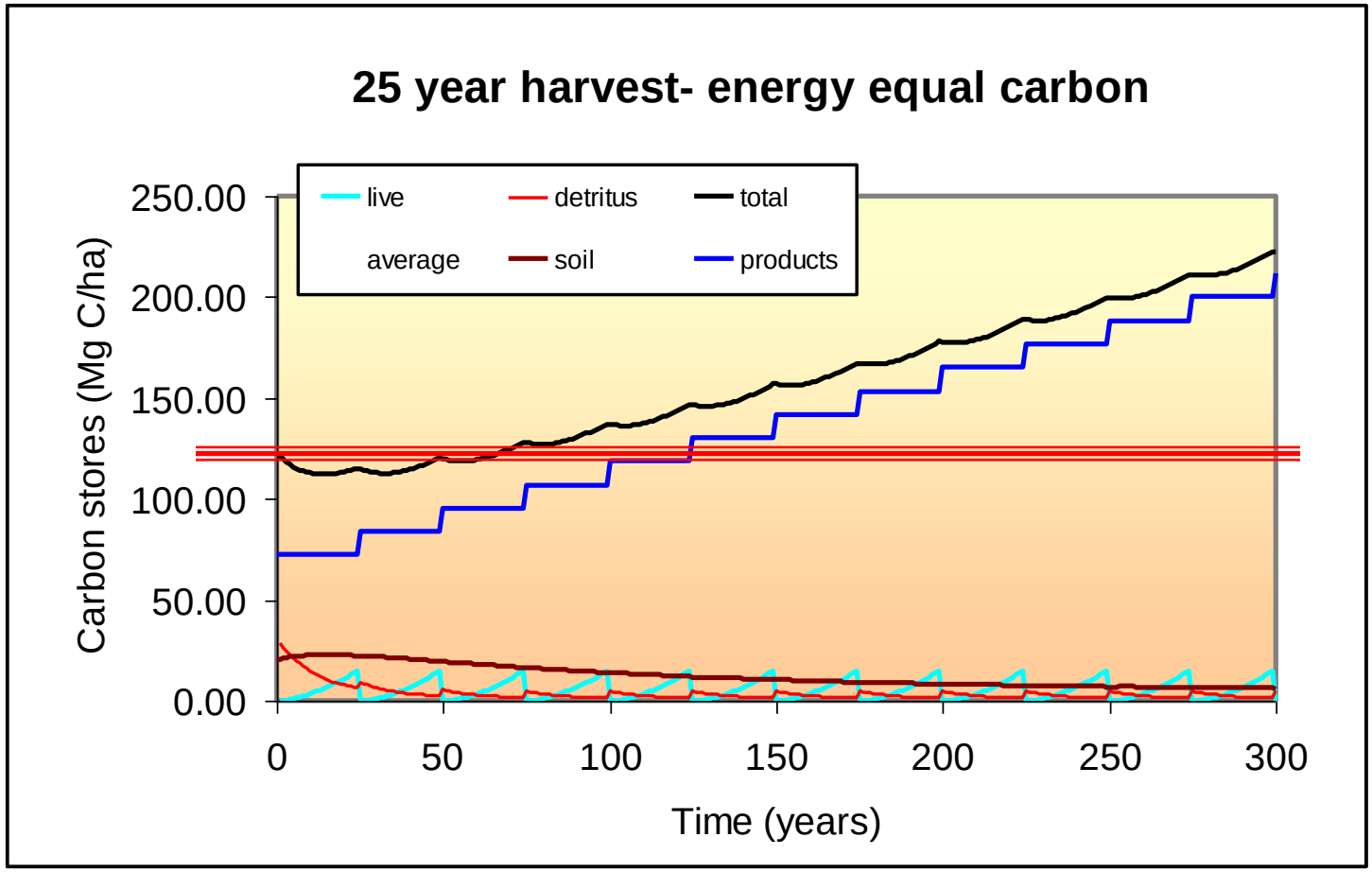


Figure 6. Historic change and future projections of carbon stores in live forest biomass for the St. Petersburg region of Russia. Units are megagrams of carbon per hectare.

Biofuels:
Energy, not Carbon, is substituted



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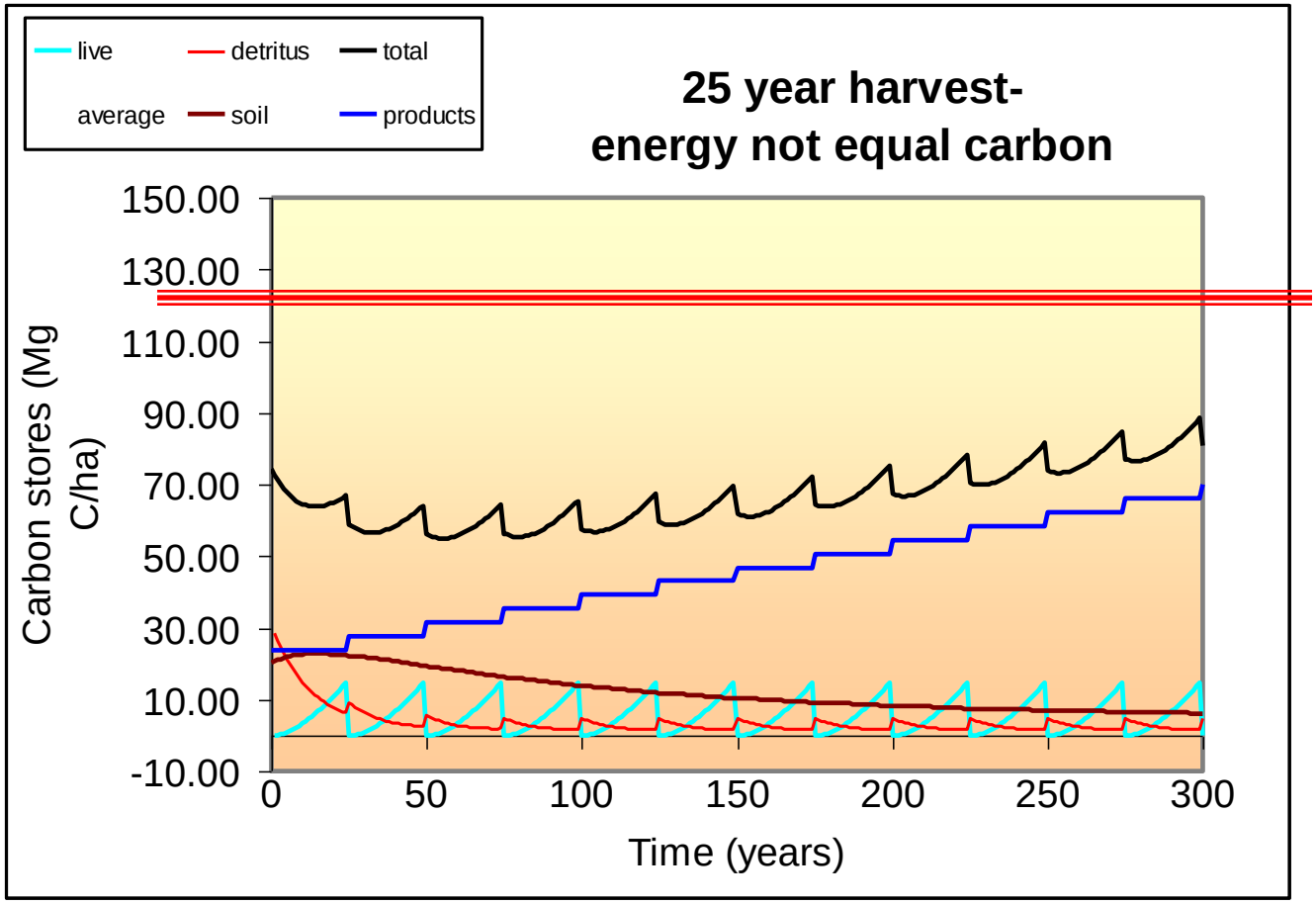
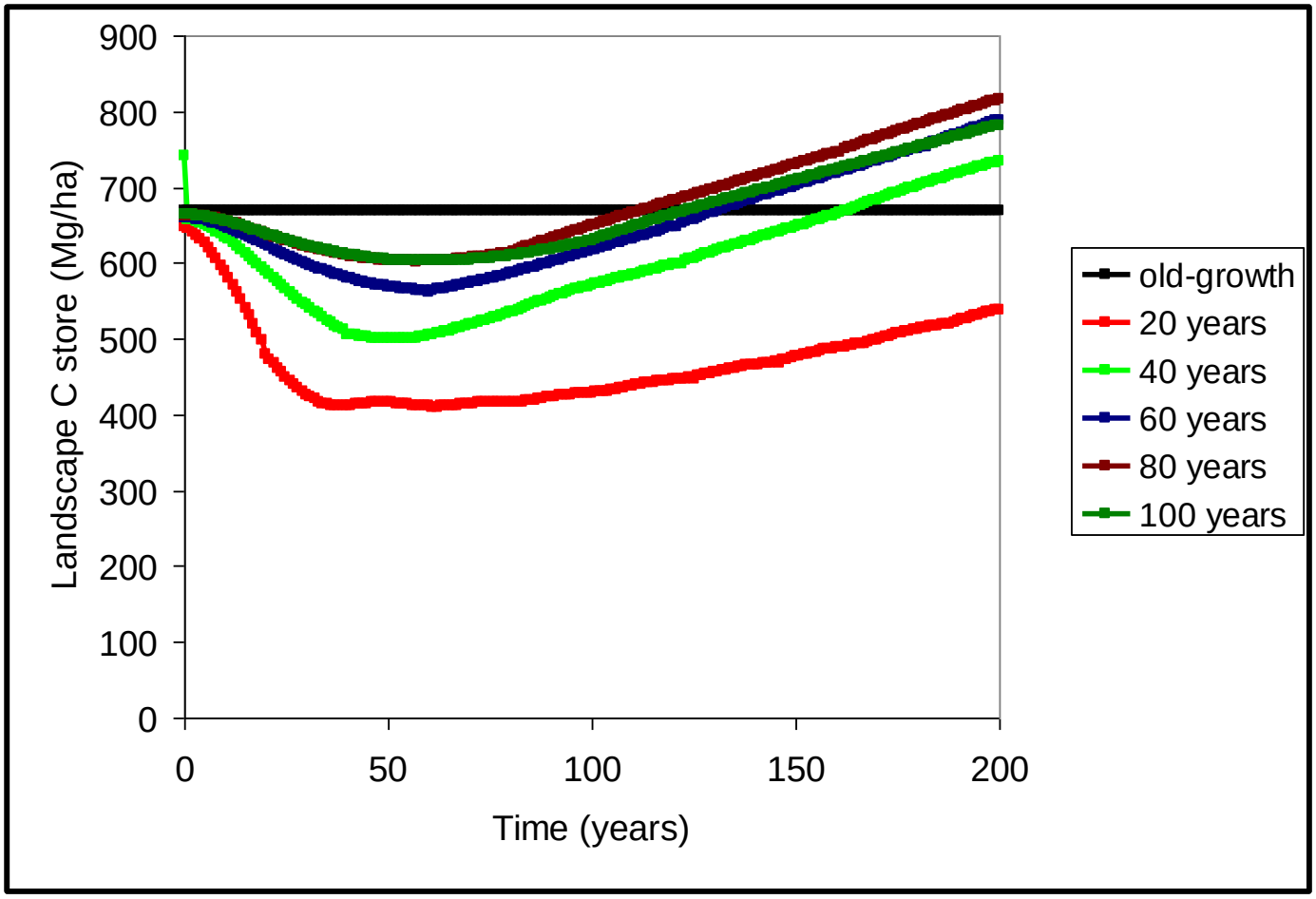


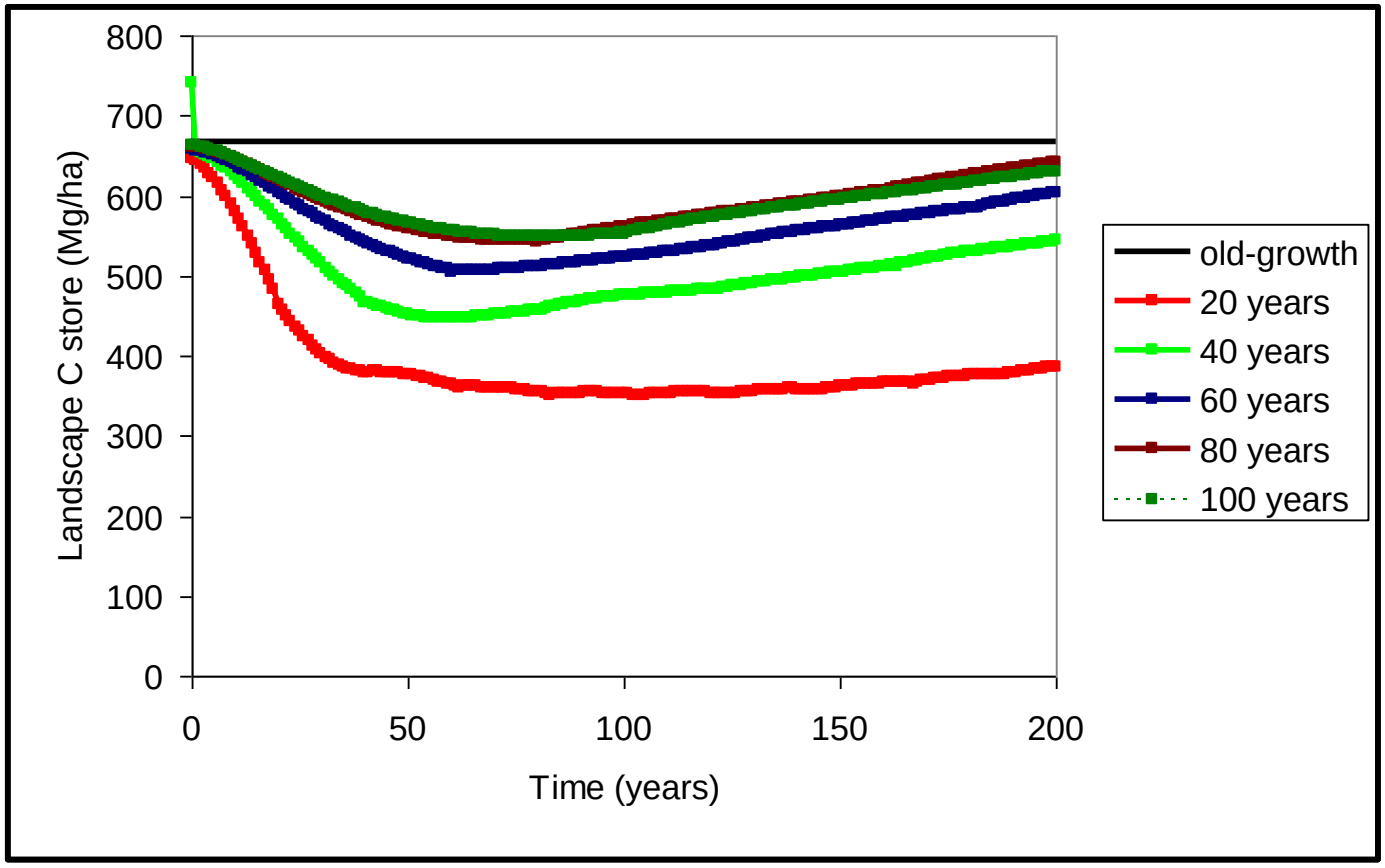
Total Carbon Balance-totals- ideal conditions

Forest products= 75% Biofuels=12% Substitution 75% of harvest



Total Carbon Balance-less than ideal

Forest products= 75% Biofuels=6% Substitution 35% of harvest

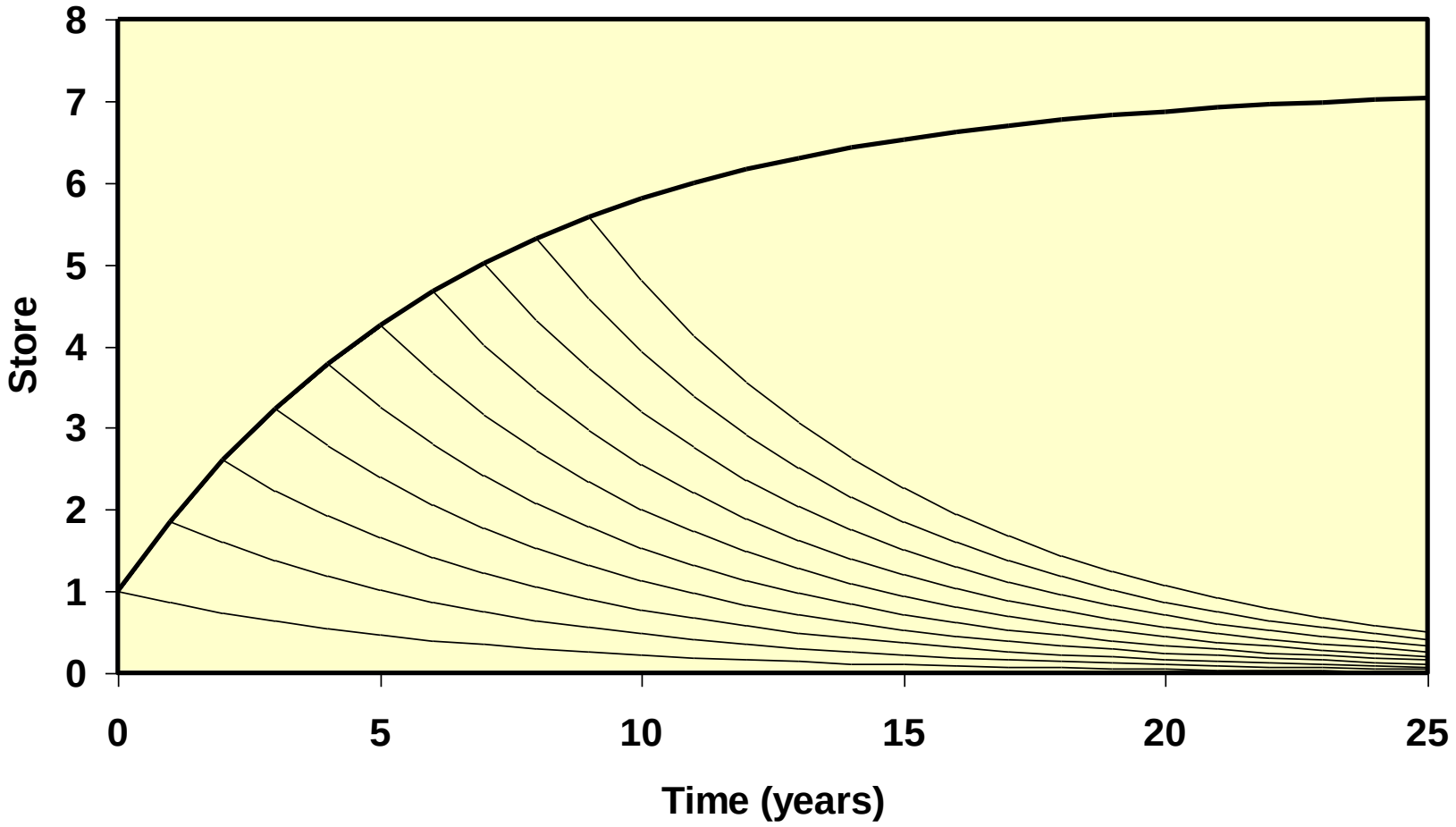


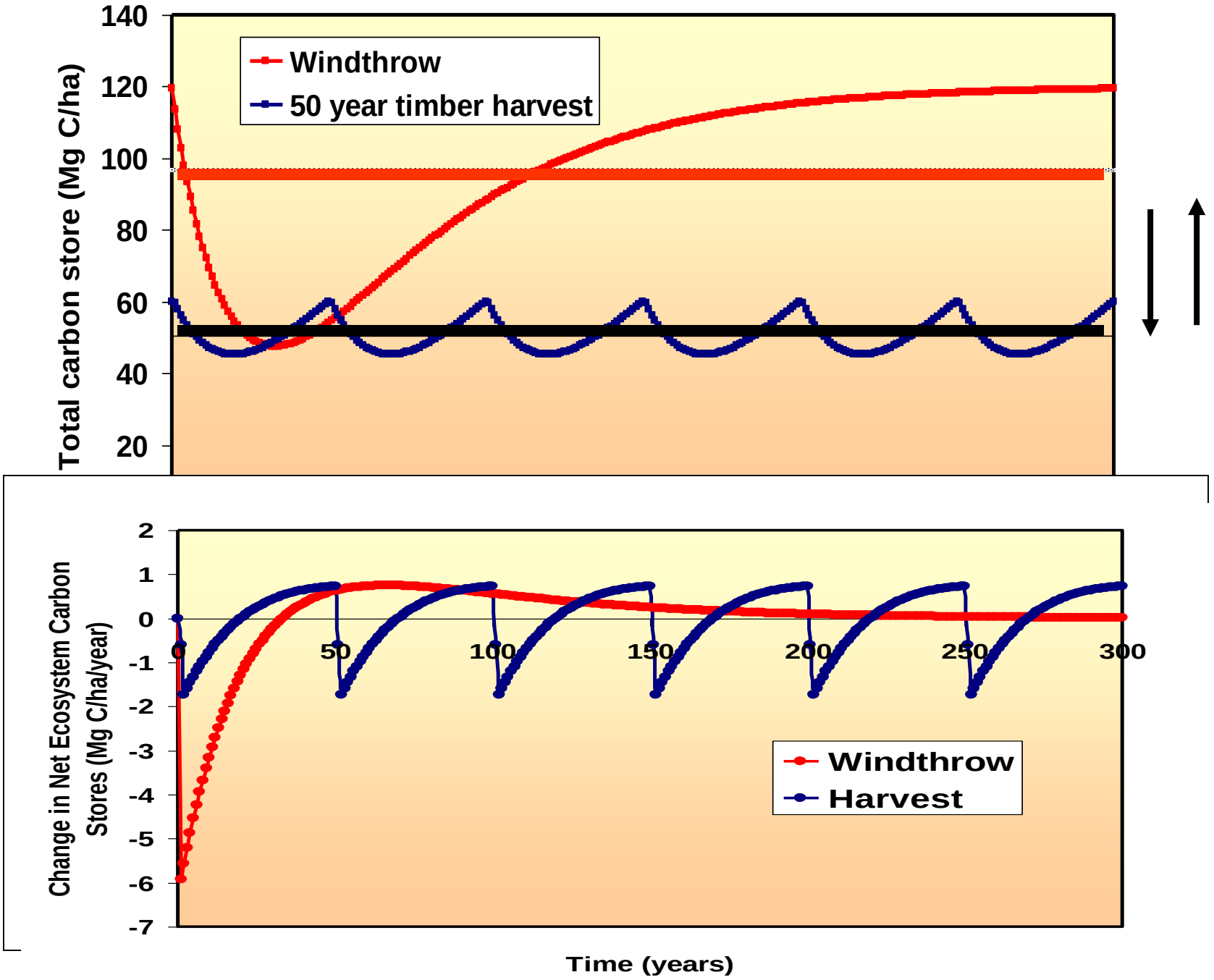
Scaling Results

- You need to get the rest of the story

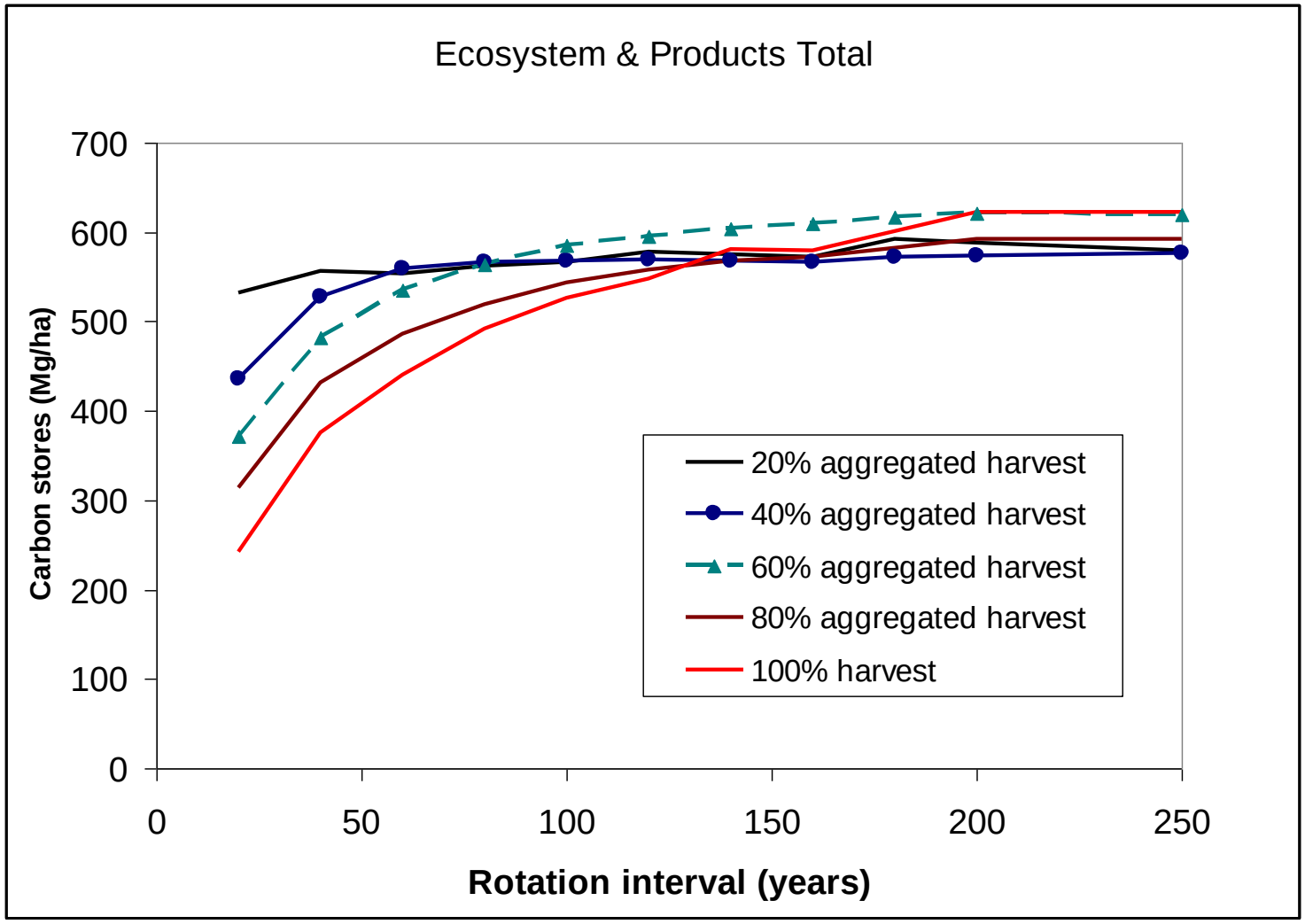
- Results at one scale may not translate directly into another
  - Do dead trees store carbon?
  - Can a forest remain the same age forever?
  - Do disturbances always lead to loss of C?

Individual versus Collections

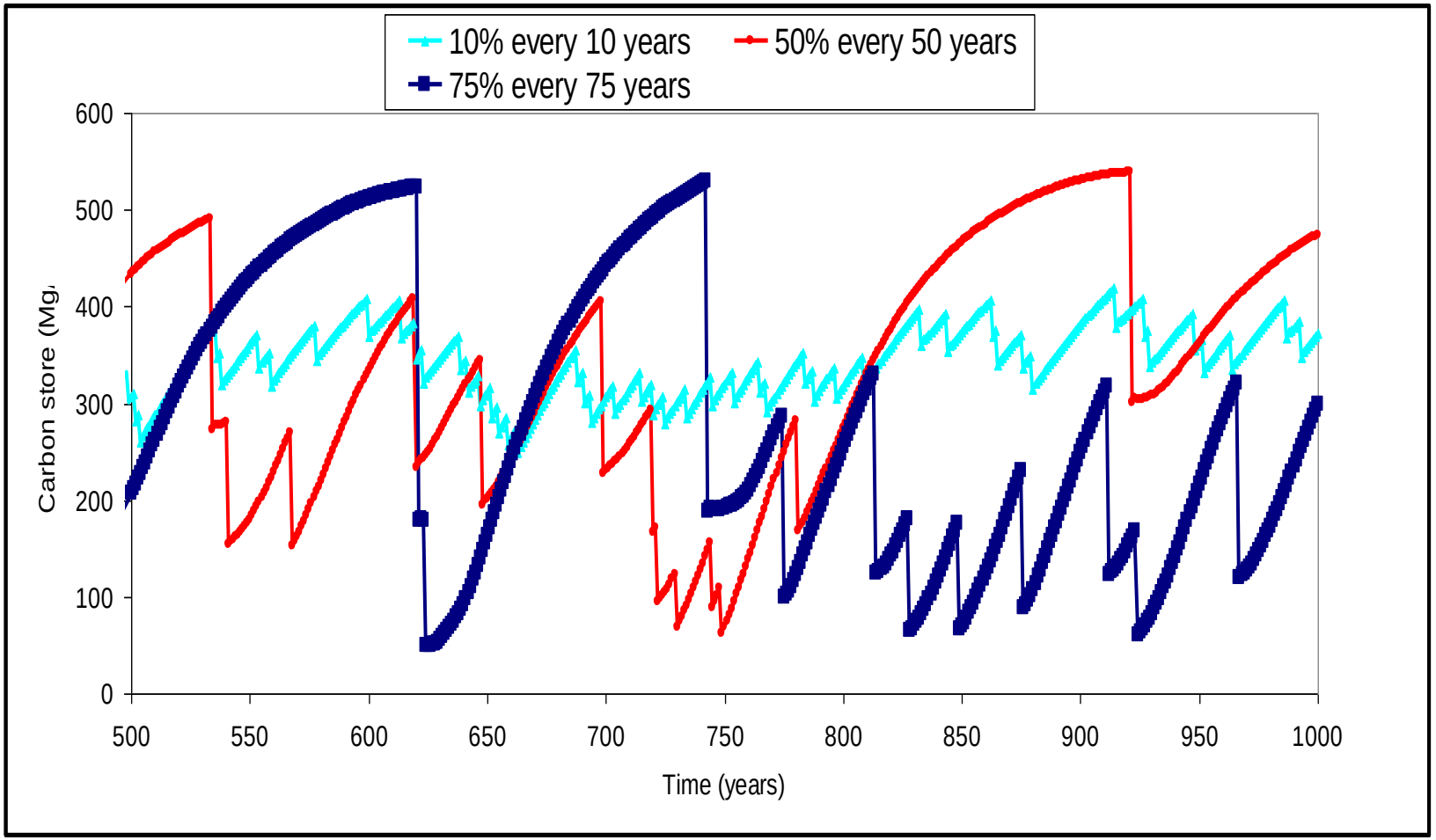



Total carbon store (Mg C/ha)
140
120
100
80
60
40
20
Windthrow
50 year timber harvest
Change in Net Ecosystem Carbon Stores (Mg C/ha/year)
2
1
0
-1
-2
-3
-4
-5
-6
-7
0
50
100
150
200
250
300
Windthrow
Harvest
Time (years)

Partial Harvest of Stands



Simple Test: Lets trade off the amount taken versus the interval of disturbance



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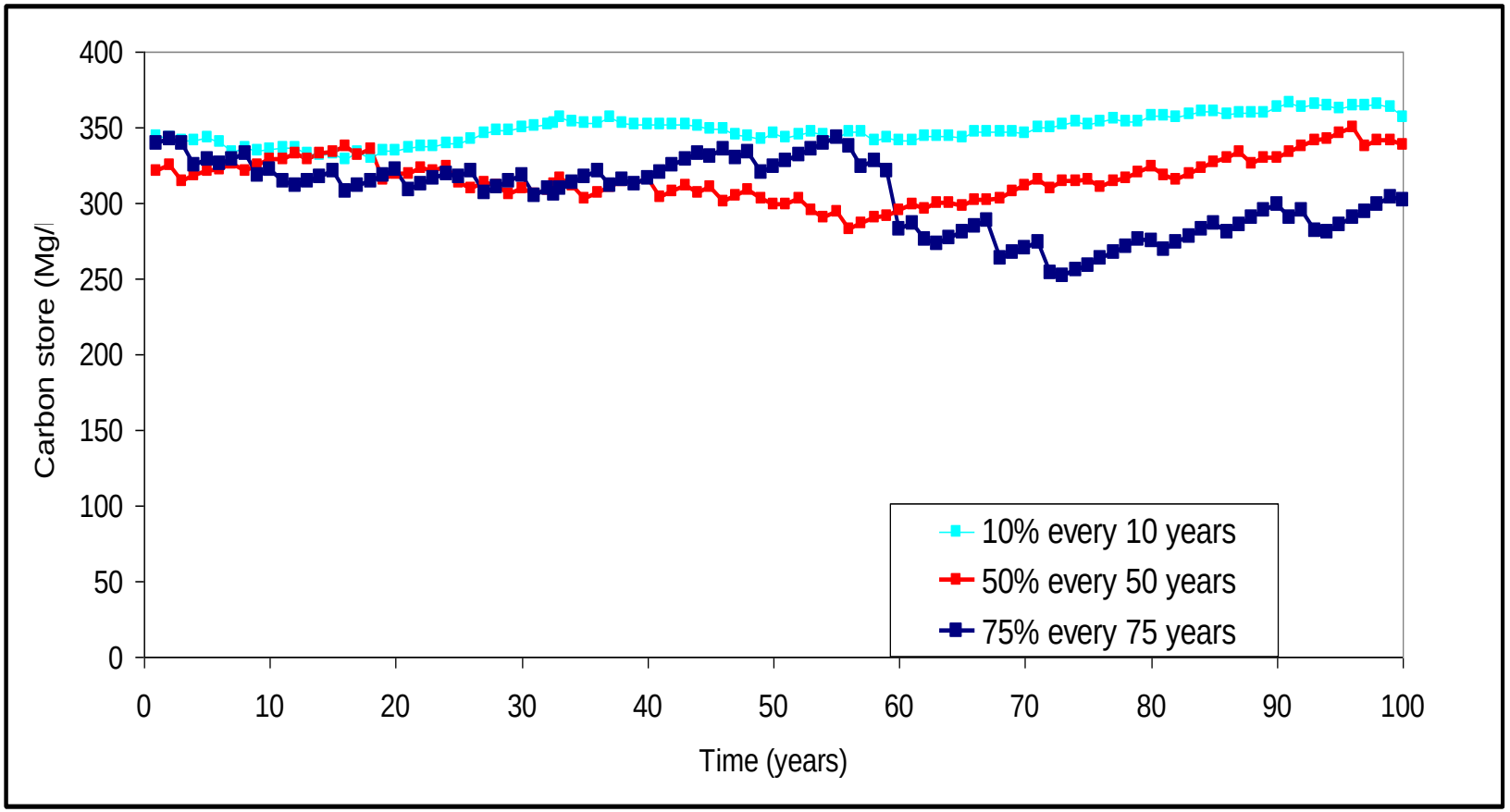
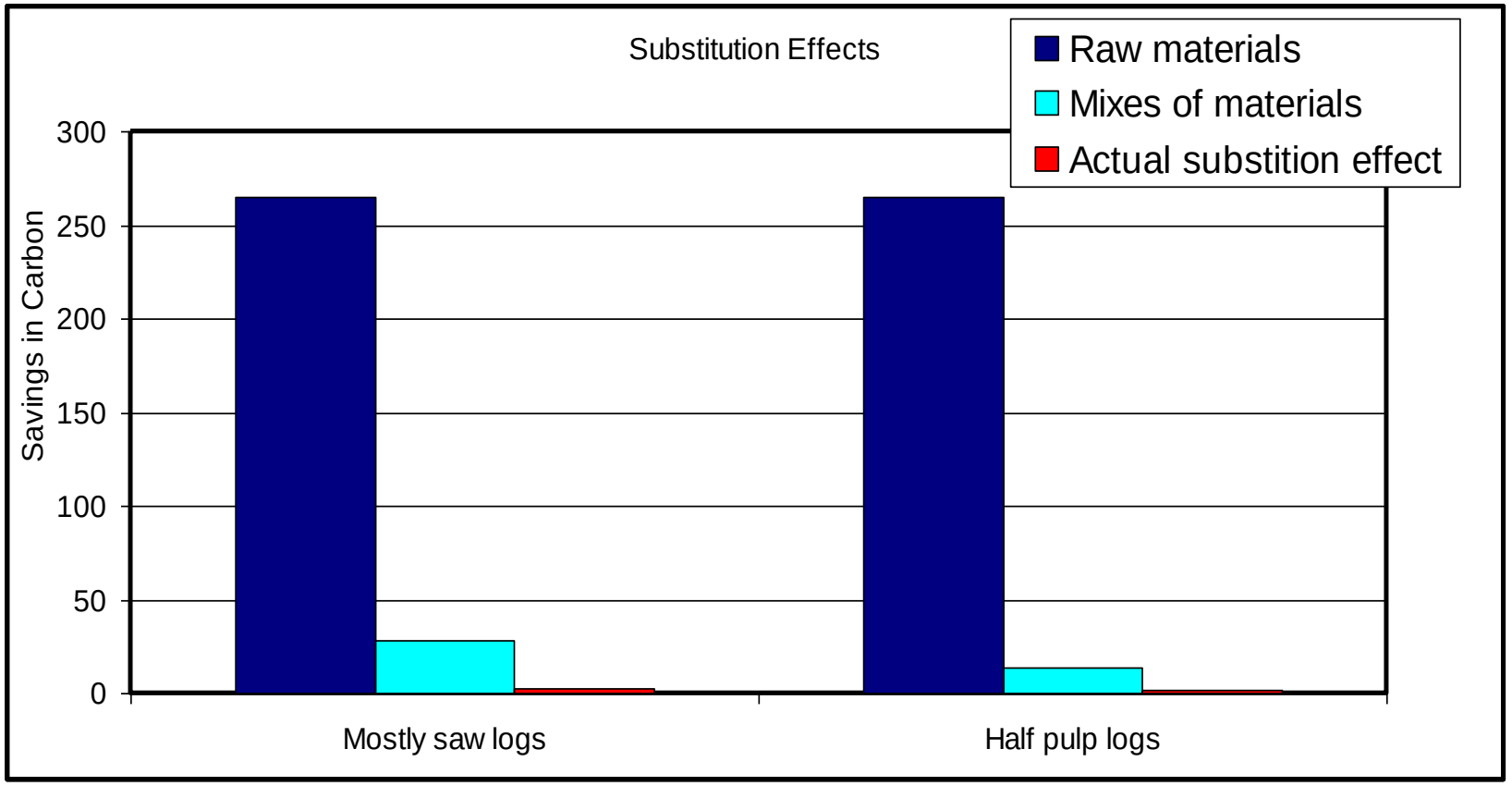


How large is the difference?



The Starting Point Matters

- Going from “A” to “C” means something
- Going to “C” does not
  - Are you starting at A, Z, or C?

Effect of Initial Conditions: Stand level

40 year harvest interval