

Comparison of continuous-cover and clear-cut forestry: conditions for biomass extraction, carbon balances and climate effects



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The Swedish forest act

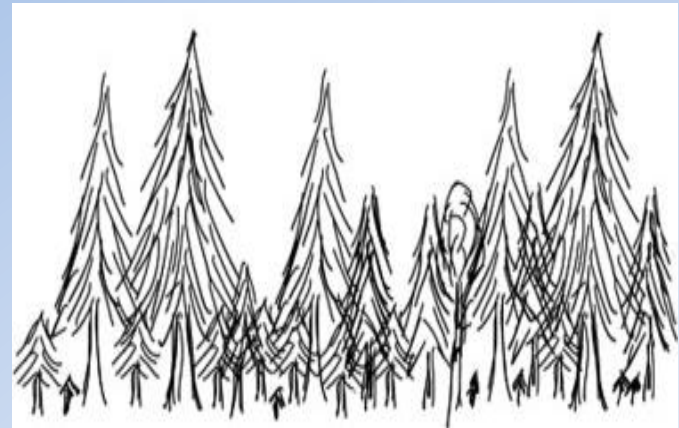
1§ The Swedish forest is a national asset and a renewable resource, which shall be managed so a sustainable yield and biological diversity are maintained

- Swedish forestry is dependent on a sustainable yield and an even flow of forest raw material
- It is only two silvicultural system today, which fulfill an even flow and sustainable yield



Rotation forestry

- Clear-cutting, regeneration
- Even and single-storied
- Stand management
- Thinnings
- All tree species
- Scarification, planting, extraction of forest residues



Selection system

- Continuous cover
- Uneven and multi-storied
- Single tree management
- Continuous selective thinnings
- Norway spruce

GPP = Gross Primary Production

The uptake of CO_2 through photosynthesis.

NPP = Net Primary Production

GPP - autotrophic respiration (**A Rh**) by plant. The total production of biomass and dead organic matter in a year.

NEP = Net Ecosystem Production

NPP - heterotrophic respiration (**H Rh**) by decomposition of litter, dead wood and soil. It is equal to net carbon stock change.

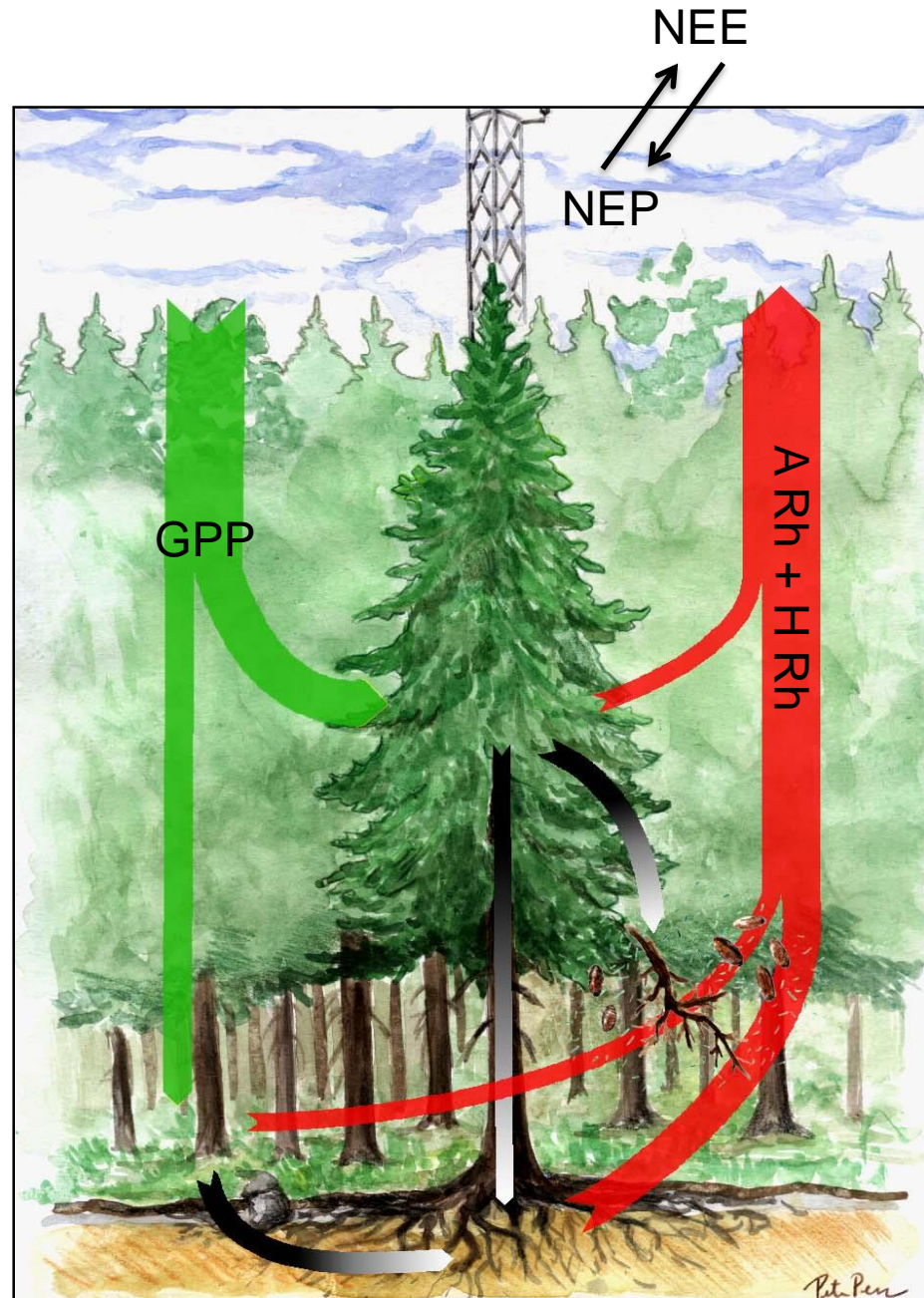
NEE = Net Ecosystem Exchange

Another way to measure NEP by integrating the fluxes of CO_2 into and out of the vegetation.

Two ways to measure NEE/NEP:

1) Eddy covariance technique is a atmospheric measurement technique to measure and calculate vertical turbulent fluxes of CO_2 , H_2O , GHG.

2) Measure changes in biomass stock of trees, field vegetation and soil over time and add stock changes.



We assume leakage of DOC/DIS is mostly negligible

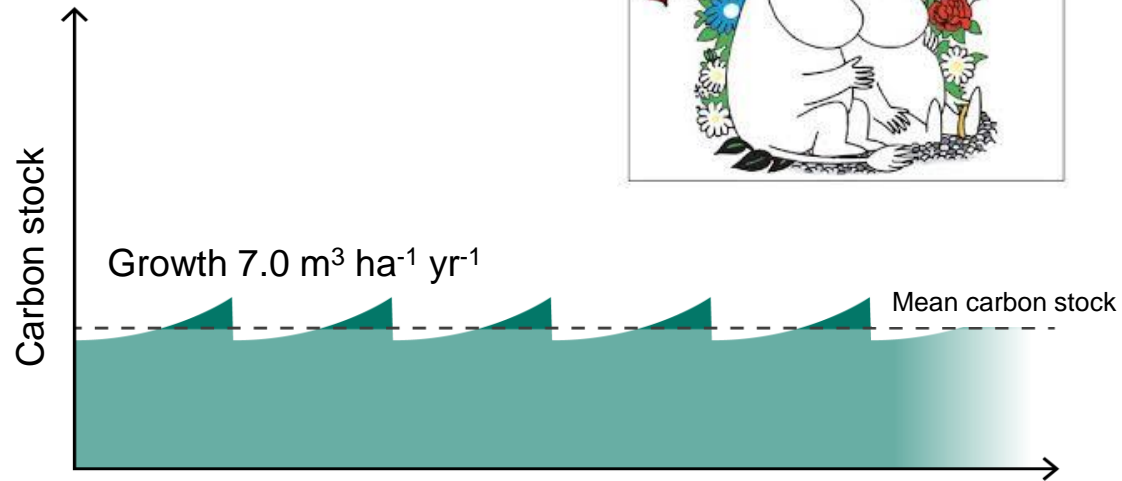
We agree on:

- NEE/NEP is a good approximation for CO₂-uptake and capacity to store CO₂ per unit time = sink strength
- There is no difference in mean carbon stock between the systems

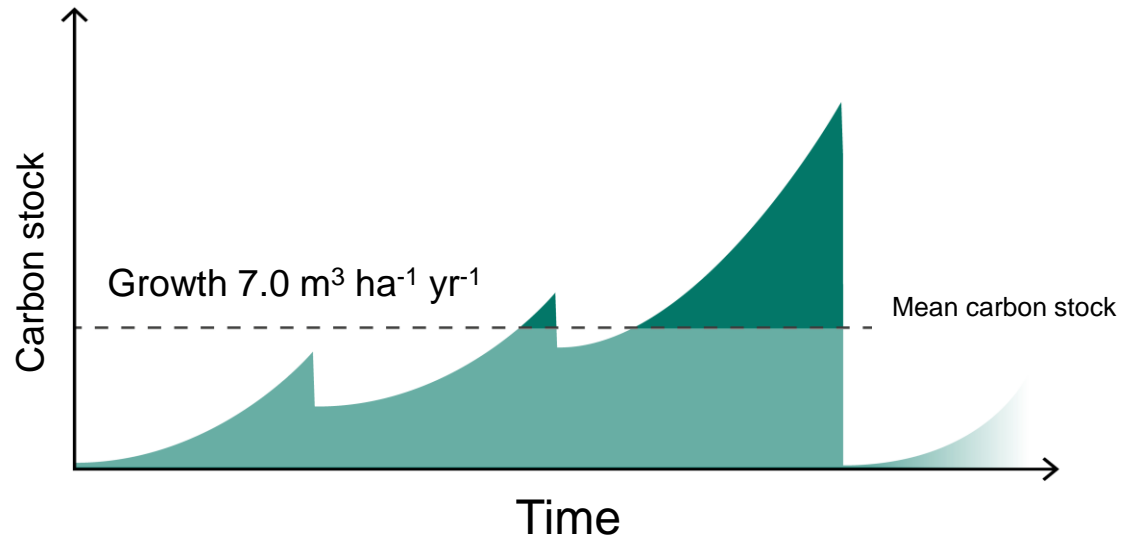
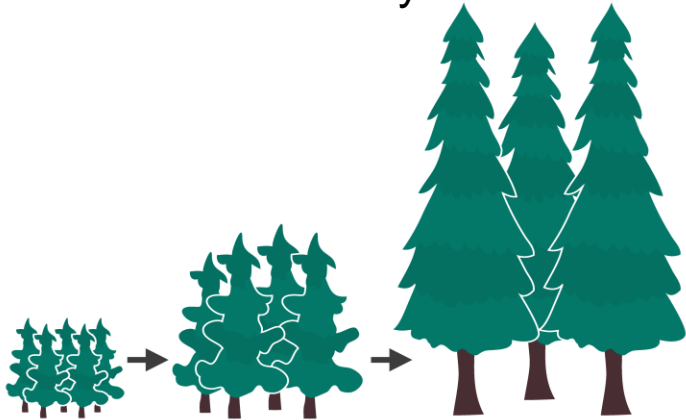


Mean carbon stock between the silvicultural systems Is similar according to Finnish and Swedish studies

a Selection system

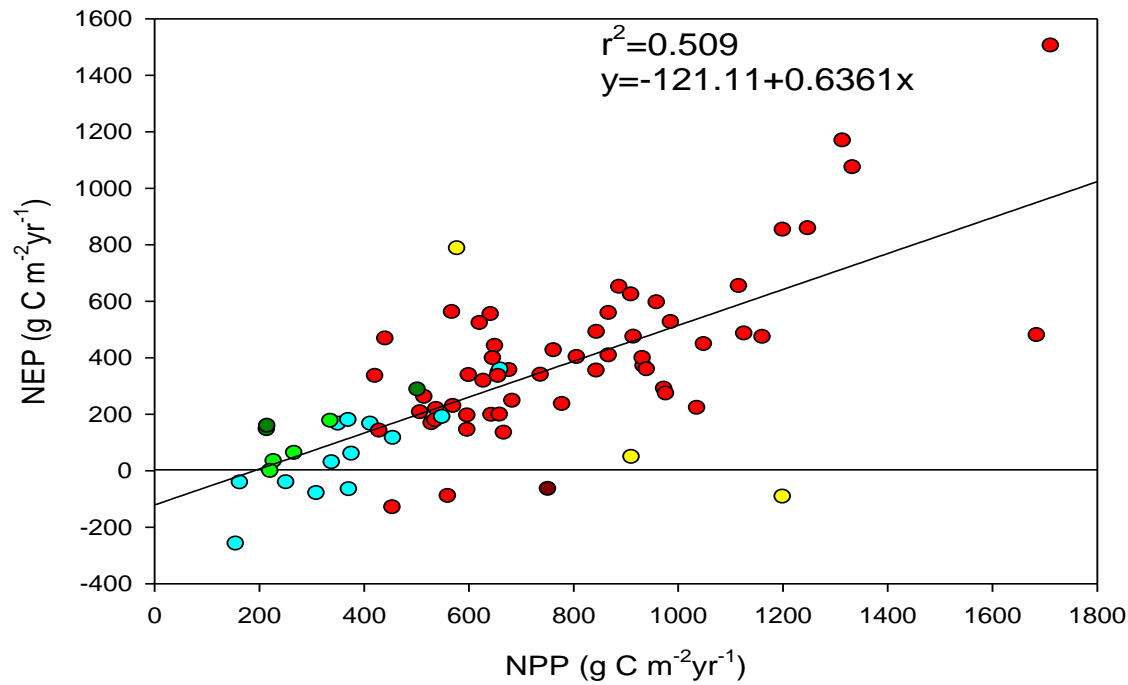


b Rotation forestry



We agree on:

- NEE is a good approximation for CO₂-uptake and capacity to store CO₂ per unit time = sink strength
- There is no difference in mean carbon stock between the systems
- Increased growth is positive for NEE/NEP/carbon balance

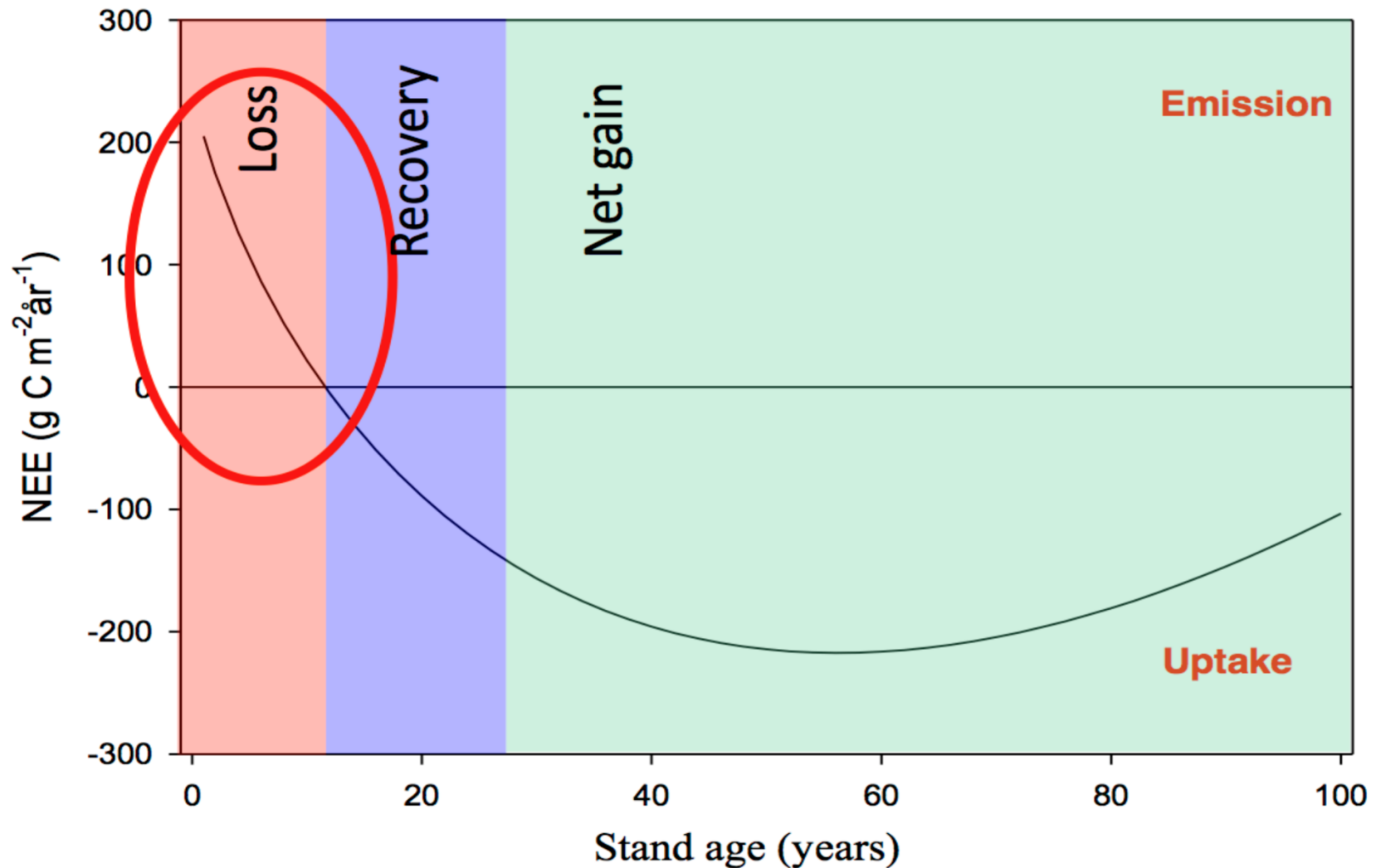


We don't agree on:

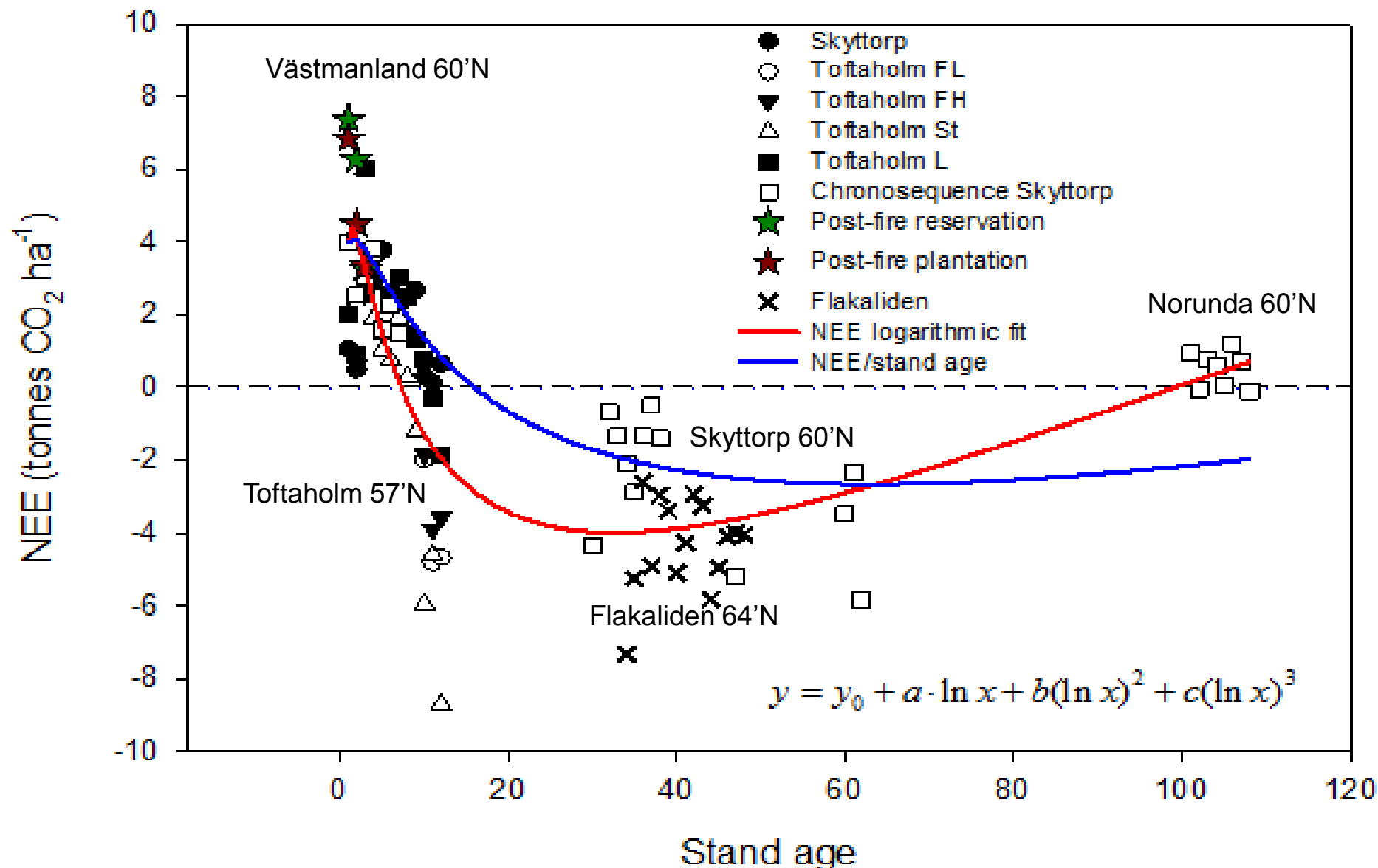
- Selection systems are better than rotation forestry in terms of carbon balance



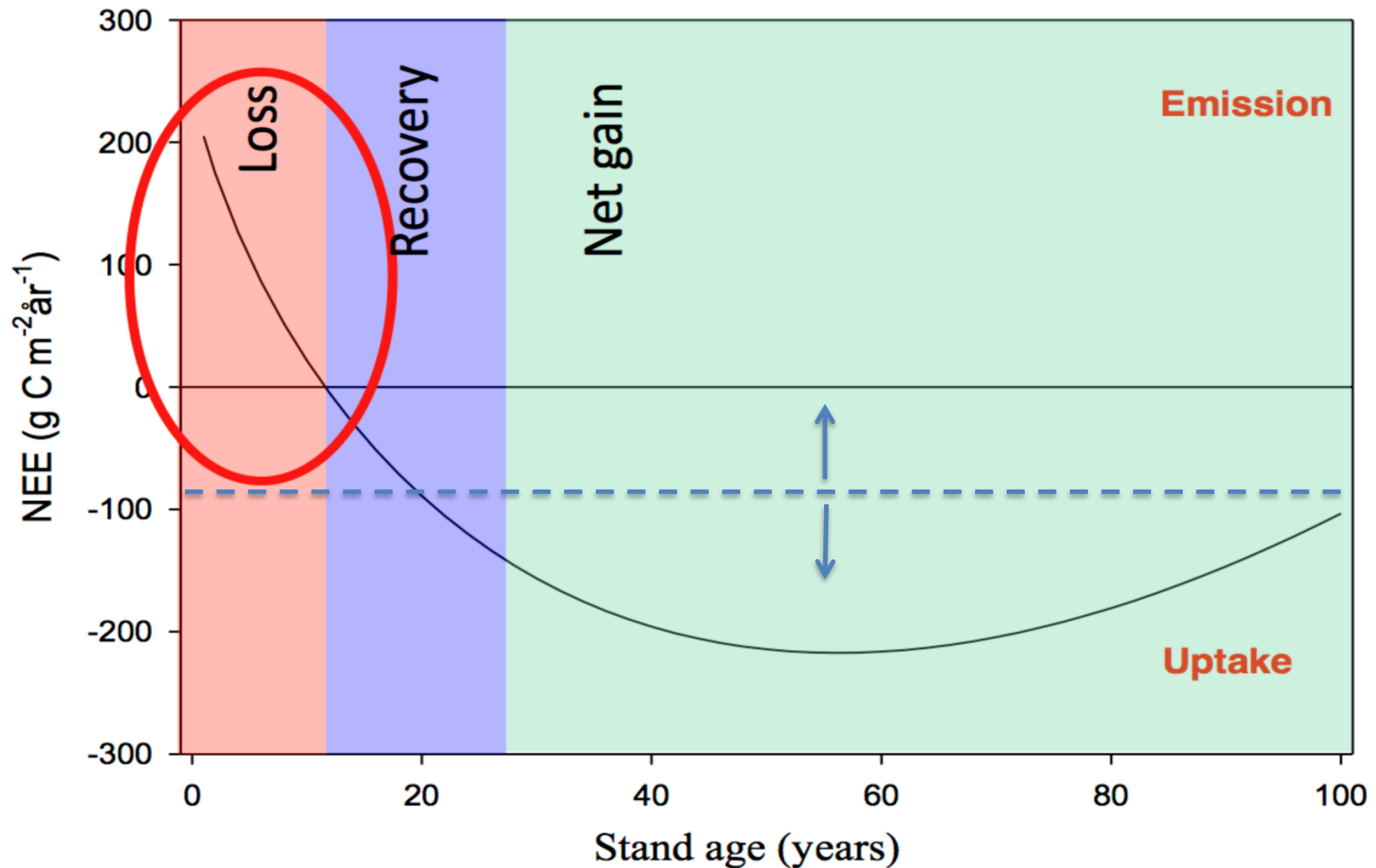
NEE as a function of age in rotation harvesting forestry -an average for Swedish conditions



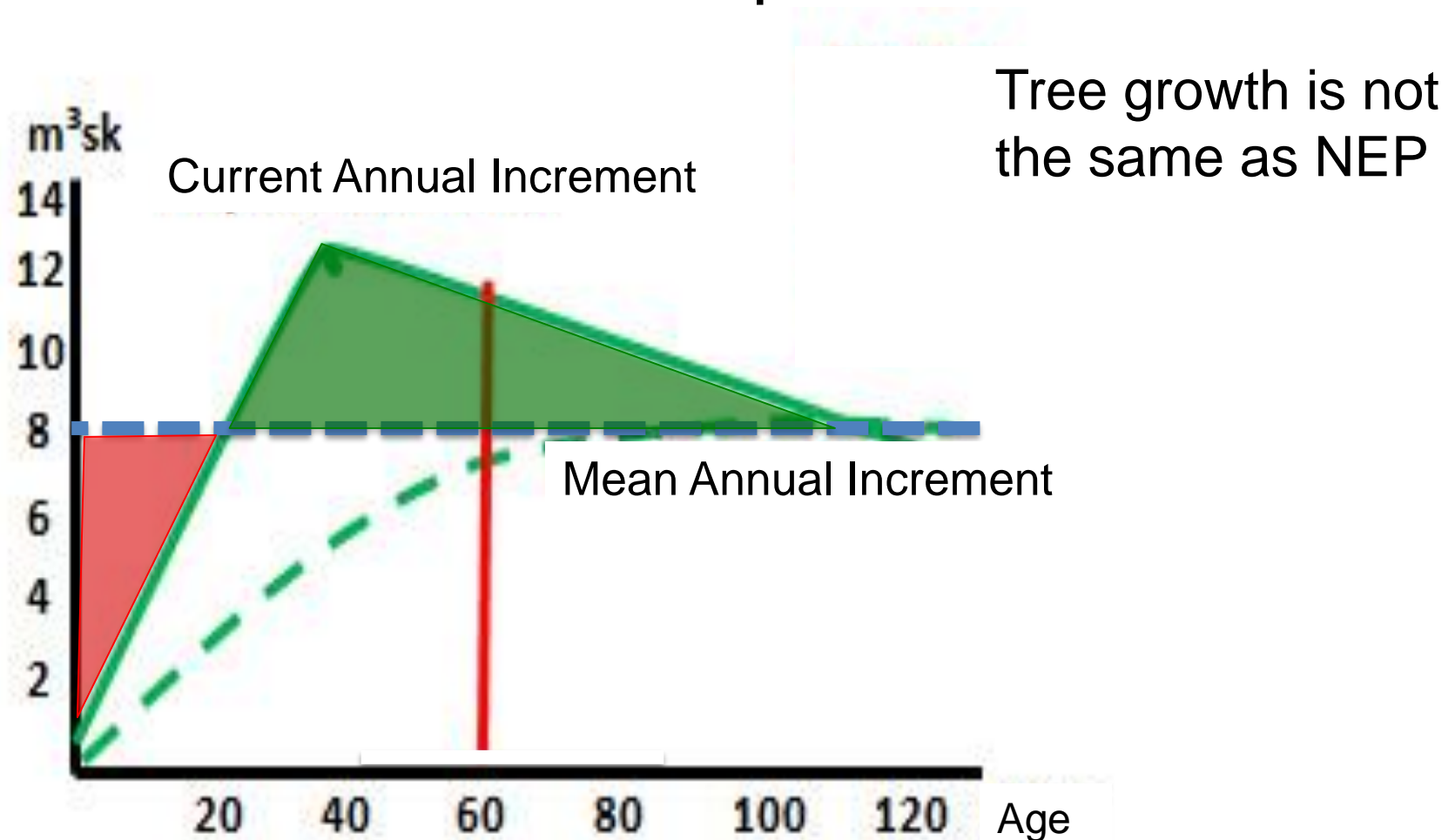
Based on Eddy-flux measurements across Sweden



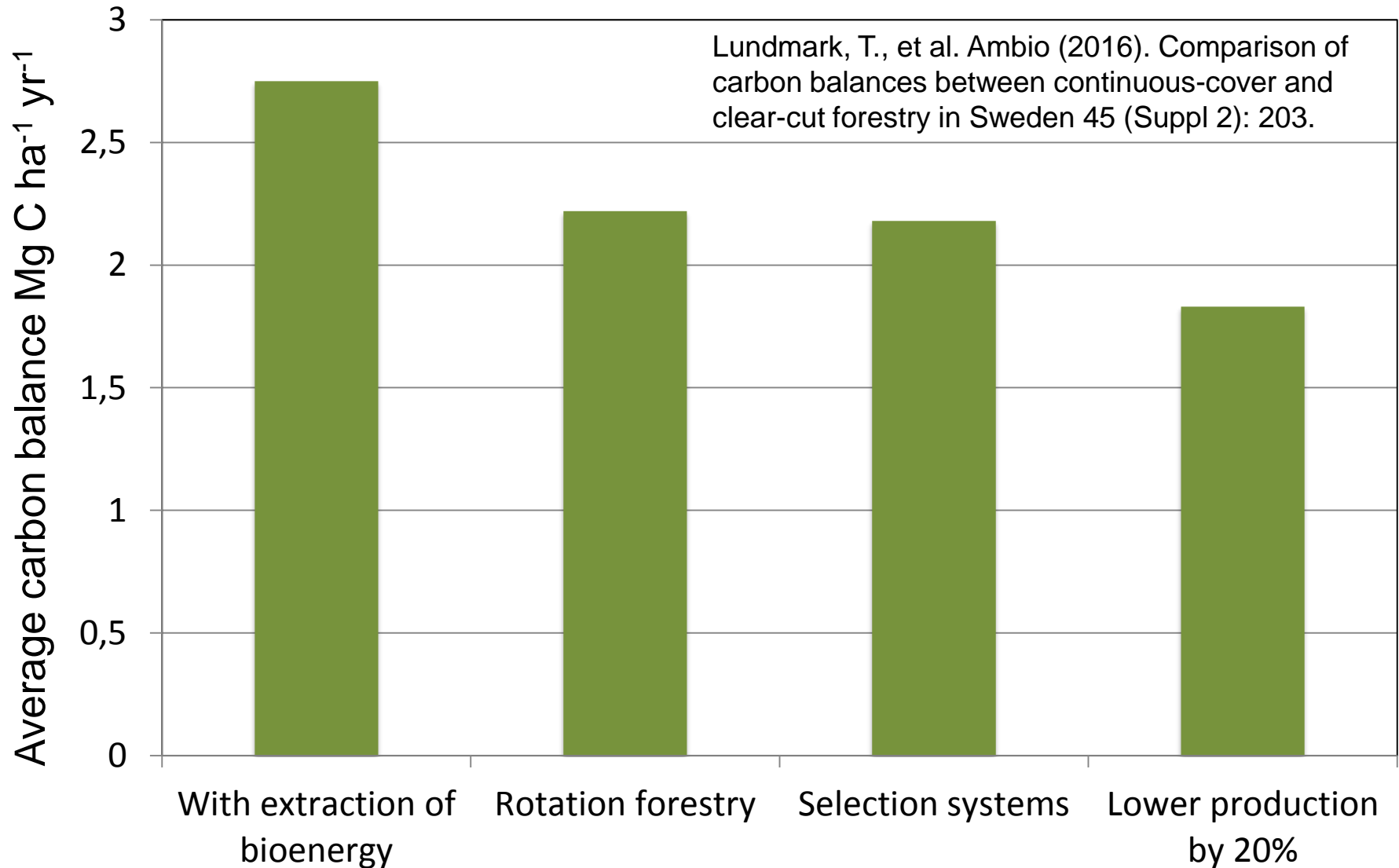
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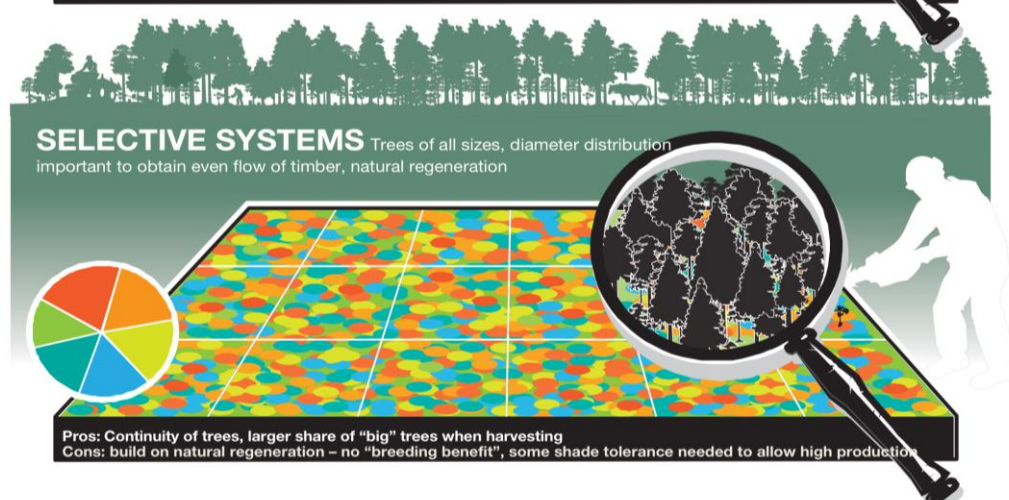
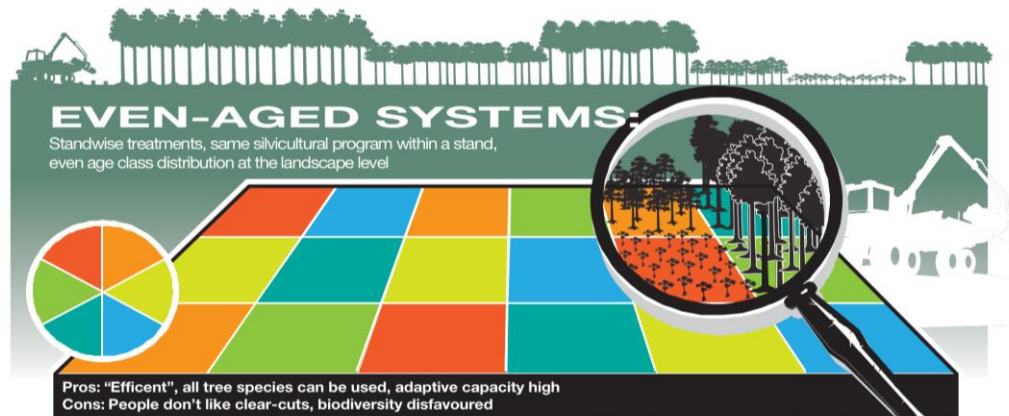
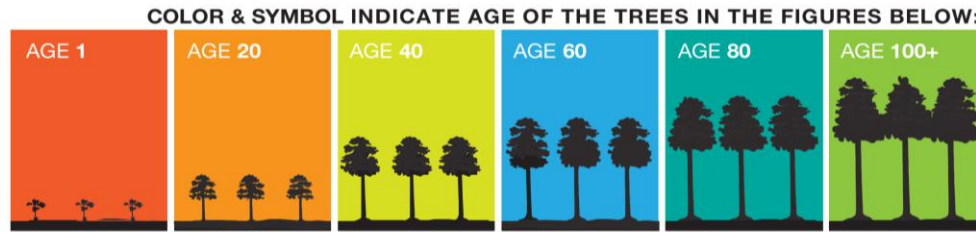
Losses of CO₂ is compensated through higher uptake and growth for the rest of the rotation period



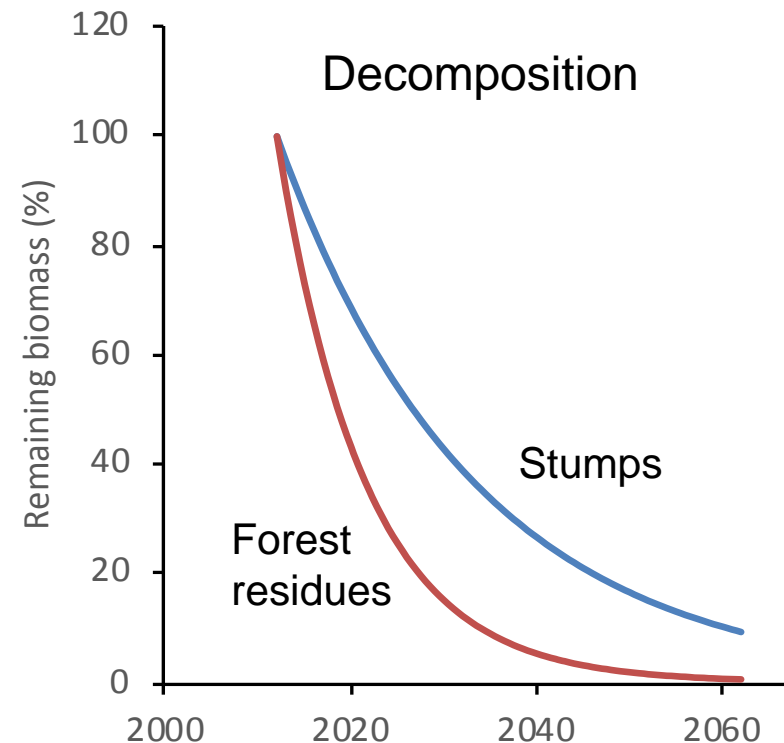
Rotation forestry and selection systems -a Life Cycle Analysis (LCA)



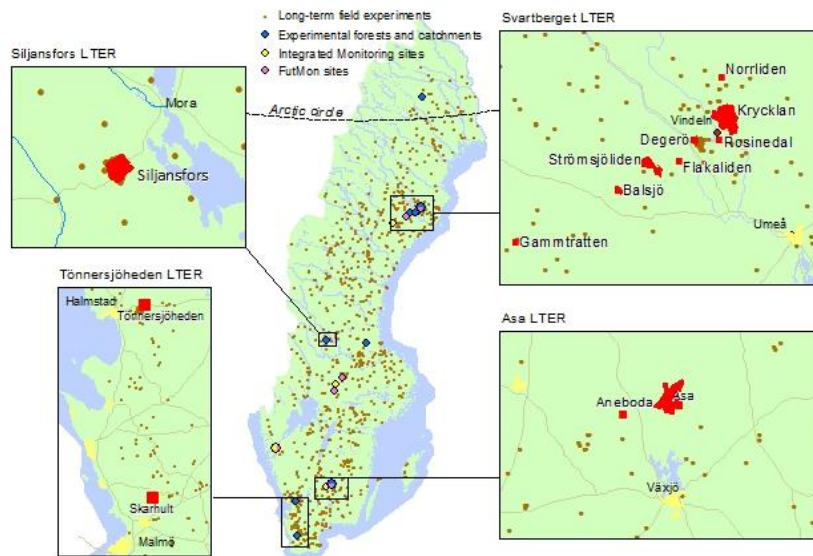
Differ decomposition of roots and stumps in selection systems compared with harvest in rotation forestry?



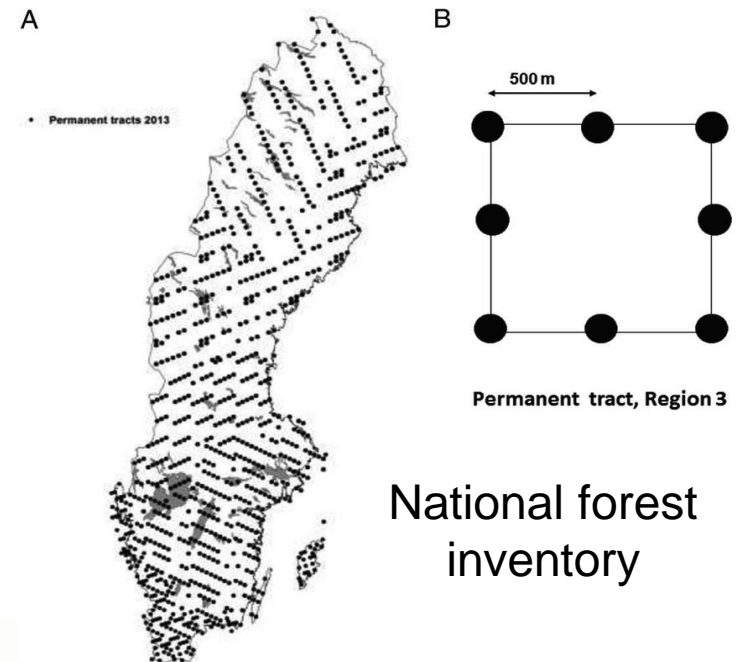
Harvest 200.000 ha in rotation forestry or thin 1 million ha in selection systems, does it matter in terms of emissions



- SLU experimental forests runs more than 1000 long-term field experiments, where change in carbon stock is monitored and measurements of NPP and special studies with soil carbon changes are conducted. Models are based on national forest inventory and field experiments and gives robust estimations of forest carbon balance/NEP



Long-term field-experiments

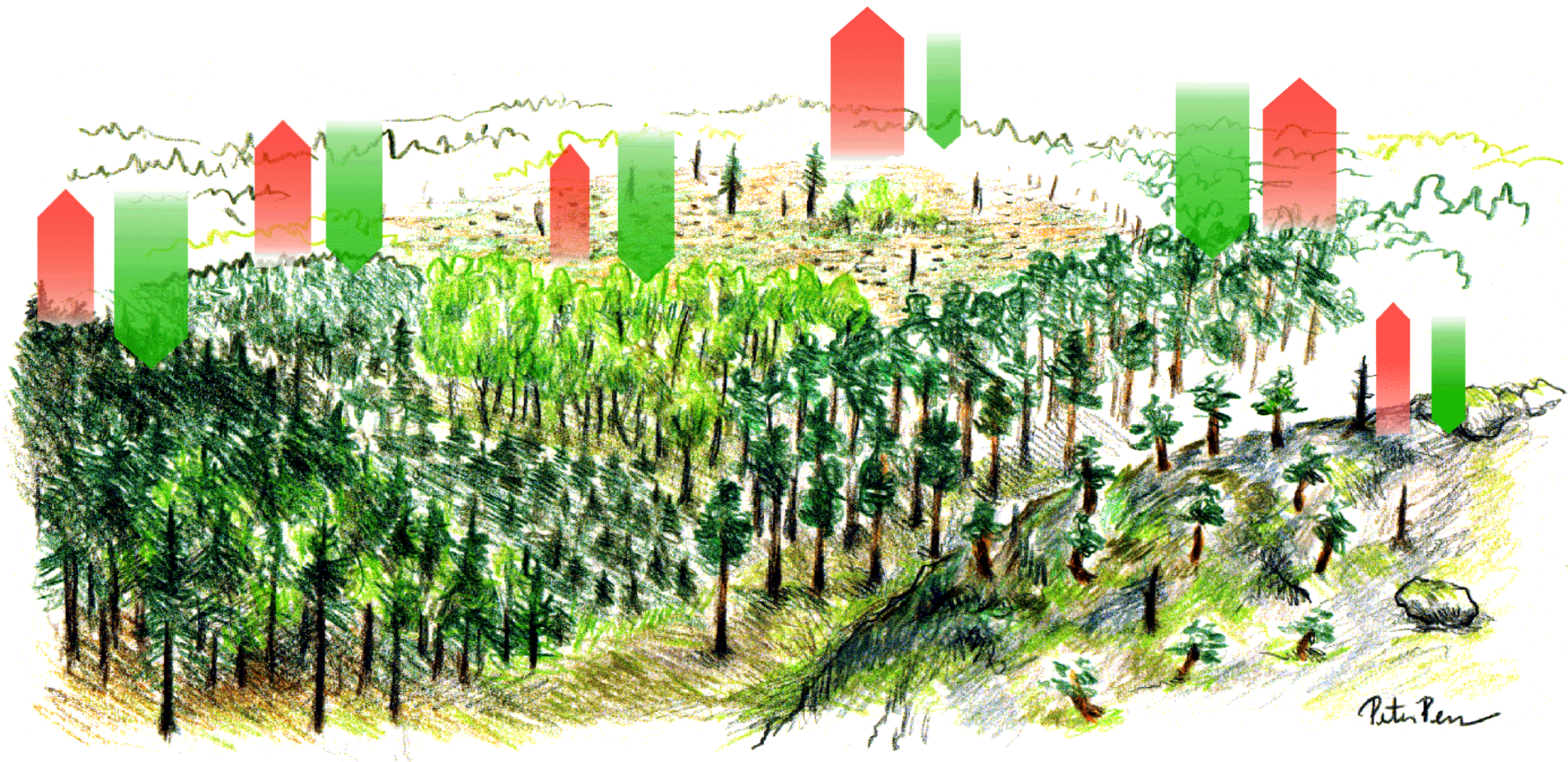


National forest inventory



Combined with laser scanning

Measured changes of carbon in tree biomass,
field vegetation and soil should be similar to
long-term NEE/NEP measured with
eddy covariance technique



Things to consider

- Extraction of forest residues is only possible in rotation forestry
- Use of genetical improved plant material and enhanced production in rotation forestry
- Higher production in rotation forestry by 10-20%
- Possibility to change and use different tree species in rotation forestry
- Forest land directly suitable for selection forestry without conversion is less than 5% of total forested area
- Large losses in production and carbon balance for conversion from rotation forestry to selection systems during 30-50 years
- Norwegian study shows that carbon storage was 10-15% larger in rotation forestry for a 81 year period

Things to consider

- Soil scarification with increased CO₂ emissions is avoided in selection forestry
- Risks are considered to be greater in rotation forestry, mostly by moose grazing of Scots pine plants, while root-rot will likely be more common in selection forestry
- Will the decomposition curve of forest residues and stumps differ between the systems (harvest in rotation forestry vs incremental thinnings in selection systems)
- Field vegetation might differ between the systems and be important for NEP and soil C storage
- A warmer climate may increase carbon sequestration and soil carbon respiration, so net effect may differ between management systems
- These systems provide also other services and should be considered

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- If the two s
- Rotation fo
the same a
- Conversion
short-term



- More research is needed

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matter at all?
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Thanks for listening!

