Carbon storages and fluxes in a chronosequence of Scots pine (*Pinus sylvestris*) stands

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The dynamics of the carbon storage and fluxes in Scots pine (*Pinus sylvestris*) chronosequence

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HIGHLIGHTS

- The annual biomass increment of the trees was the main driver of the dynamics of NEP along the chronosequence.
- The soil heterotrophic respiration (Rh)

GRAPHICAL ABSTRACT

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Background

- Global Climate Change
- Climate neutrality of Europe by 2050
- Sustainable forest management
- Forest’s are important C sink
- C storages and fluxes can be highly variable
  - ✓ Heterogenity of forests
  - ✓ Management regimes
- Clarification of C dynamics
- Estimation of post-harvesting C cycling
- Information?

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Specific aims

- Post clear-cut **C compensation point** and **C payback period**
- C accumulation dynamics of Scots pine stands rotation cycle

11 study sites

- Chronosequence of pine stands from 0-109 years
- 10 stands + clear-cut = 6 development classes

Clear-cut | Young | Pole | Middle-aged | Premature | Mature

1 year → **100 years**

- Detailed **C budget**s, with empirical estimation of all C fluxes were compiled

Belowground biomass of trees

Above and belowground biomass of understorey vegetation

Carbon budgeting

$$NEP=NPP-(Rh+L)$$

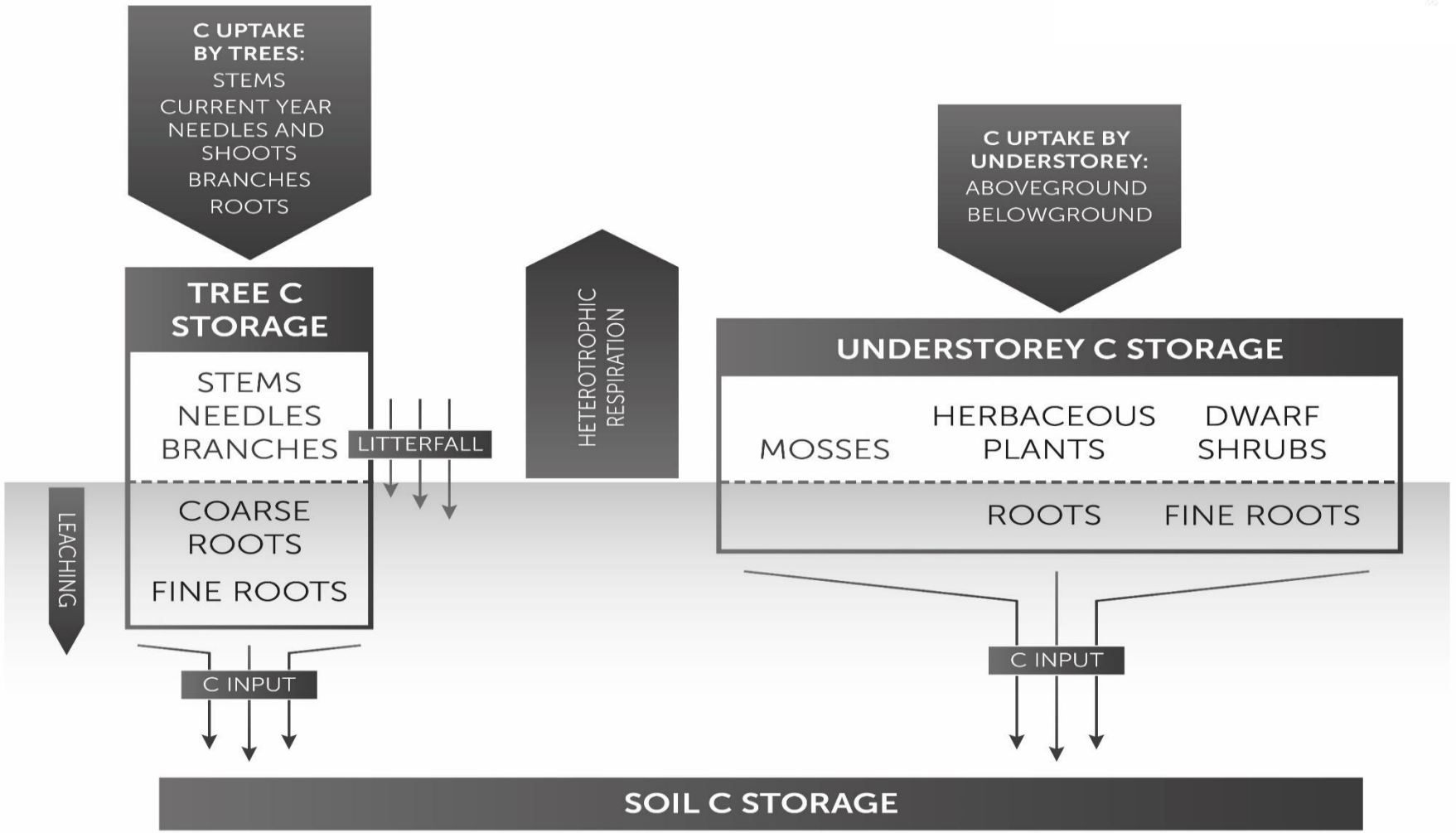

Figure 1. Estimated carbon storages and fluxes in the studied forest ecosystems, NEP-net ecosystem production, NPP-net primary production, Rh- heterotrophic respiration

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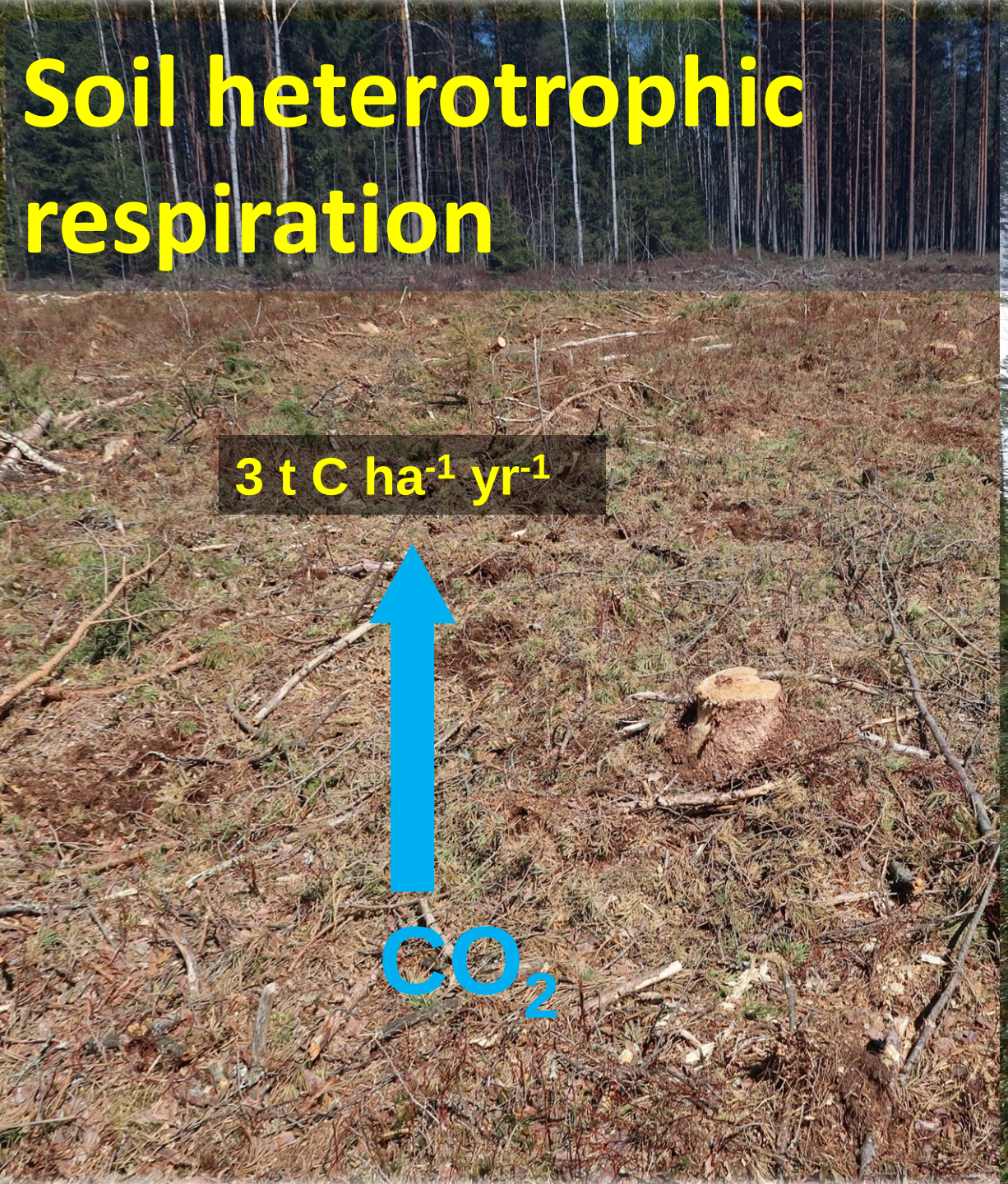
How does forest management effect C accumulation?

Clear-cut – main used renewal cutting method in Estonia

Clear-cut has a strong effect on C cycling

- How long will the site be a **C source**? When will be the C **compensation point**?
- How long is the **C payback period**?

Soil heterotrophic respiration



When will the stand turn to a C sink?

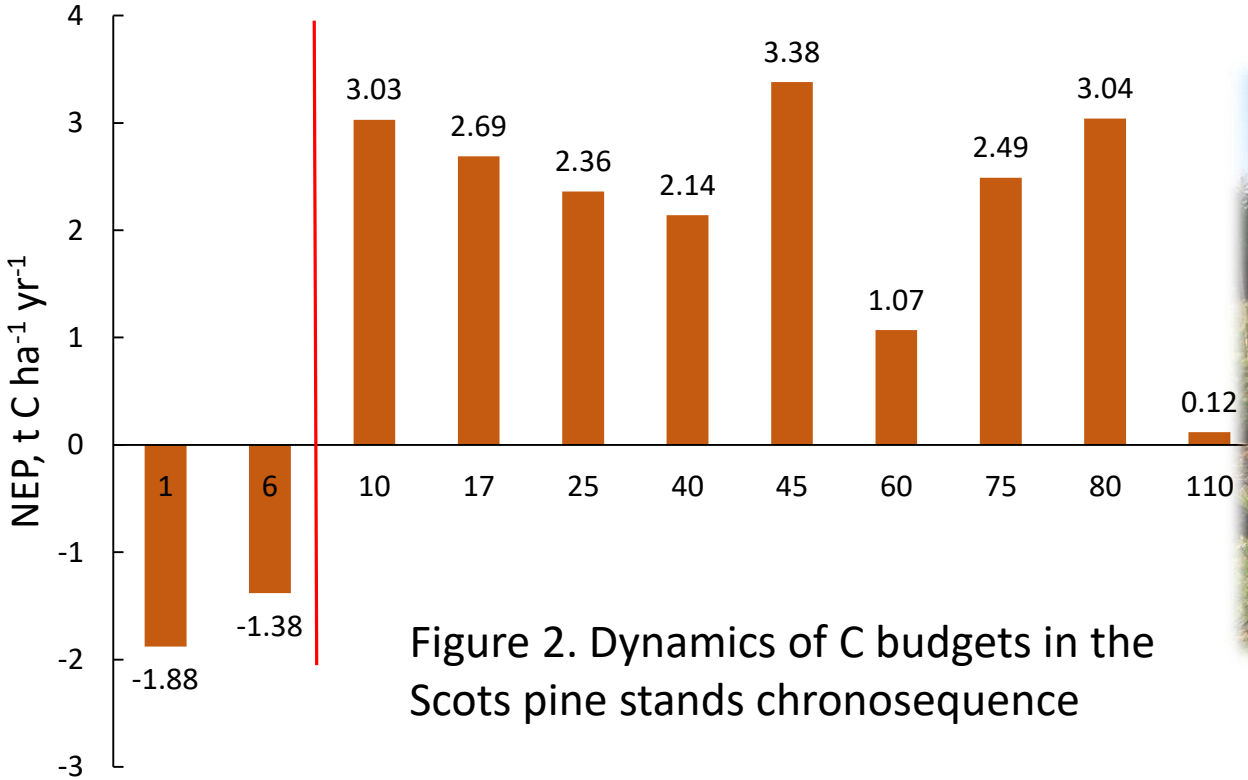


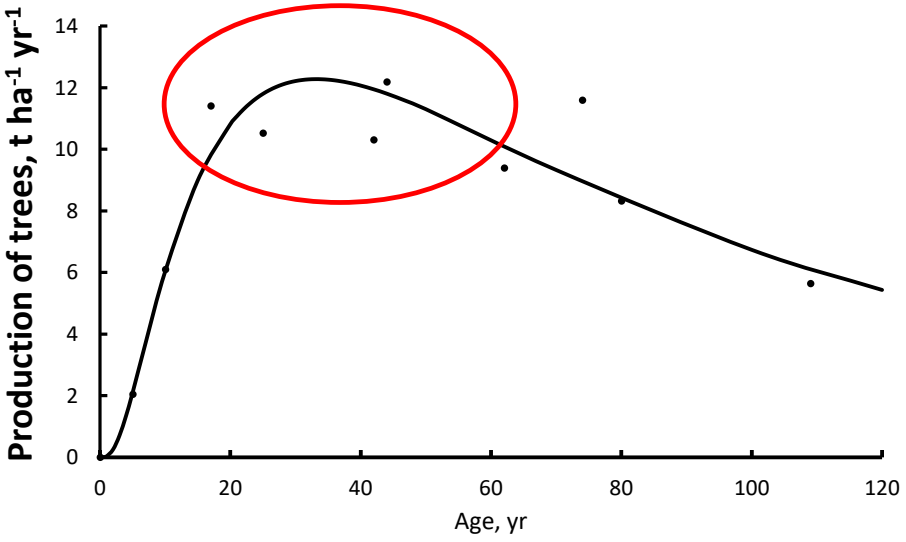
Figure 2. Dynamics of C budgets in the Scots pine stands chronosequence

- **C Compensation point** was reaced at the age of 7 years
- **Cumulative C** loss for the period, when the site was a C source was 10 t C ha^{-1}
- **C payback period** was 12 years after the clear-cut

C accumulation *vs.* C storage of trees: typical pattern of forest stand development

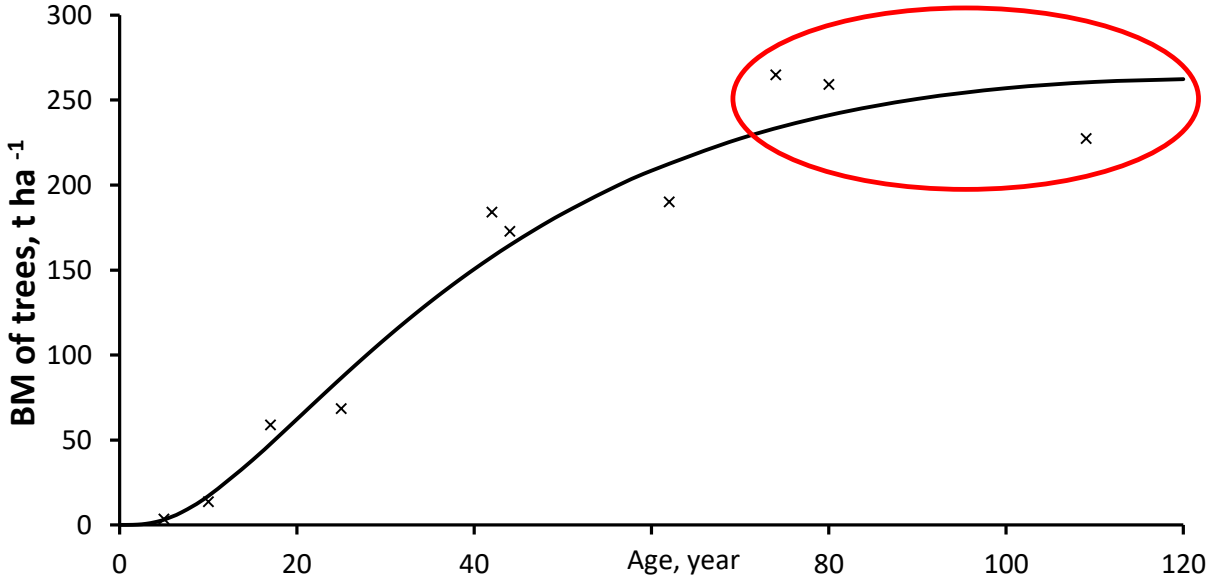
- Largest C storage: in mature stands
- Largest C accumulation: young and middle-aged stands

Figure 3. Dynamics of tree production in Scots pine chronosequence



Annual production of trees

Figure 4. Dynamics of tree biomass in Scots pine chronosequence



C storage of trees

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NB! Heterotrophic respiration does not depend on stand age

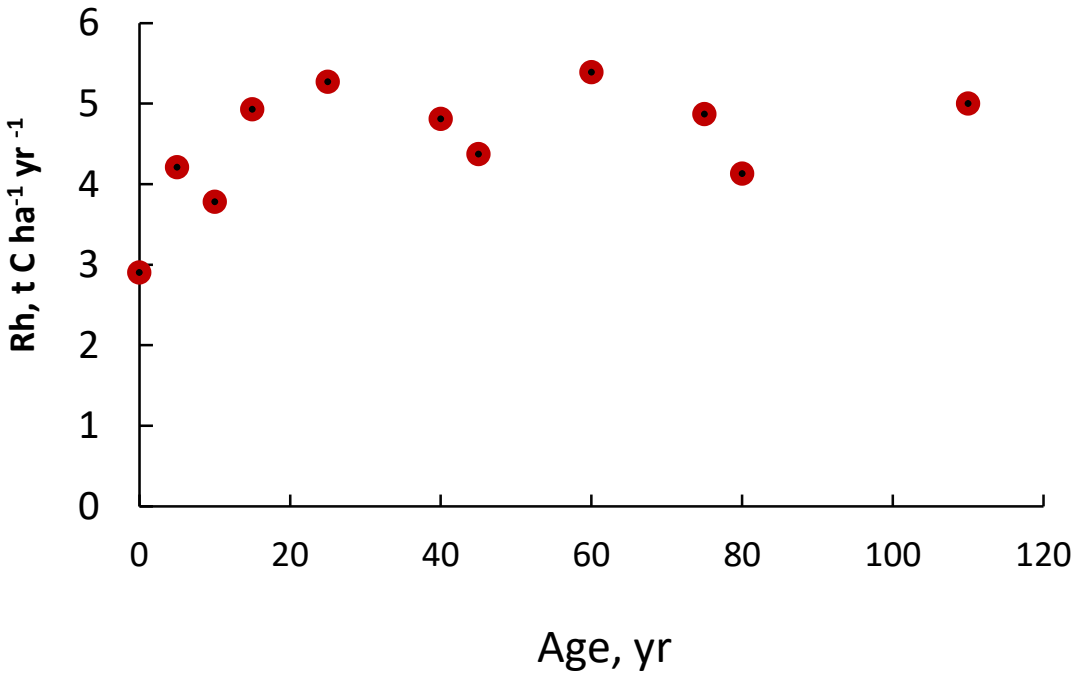

Figure 6. Dynamics of heterotrophic respiration (Rh) in Scots pine chronosequence

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Understorey vegetation – *unknown quantity?*

- Important in annual NPP and C cycling
- Data about the belowground part of the understorey is even more limited

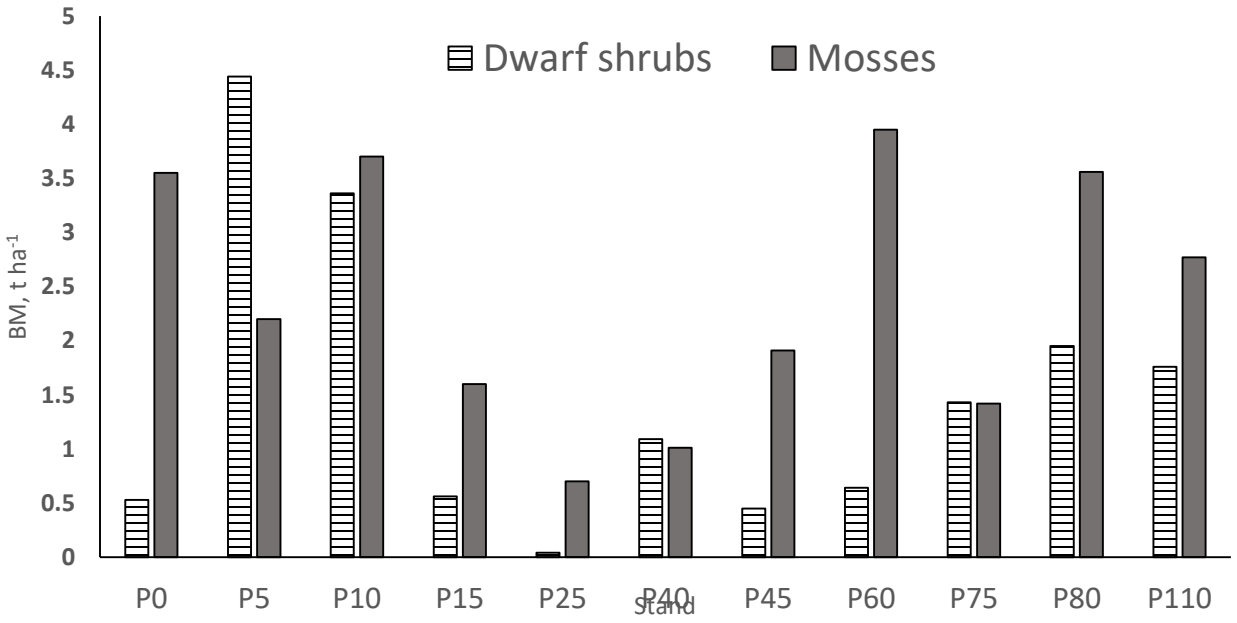


Figure 7. Aboveground biomass of understorey vegetation

NB! Understorey vegetation contributed **8 - 46%** to annual NPP in the studied stands and **100%** in the clear-cut area.

Fine roots – *often neglected trait in C studies*

- FRB or FRP did not depend on stand age

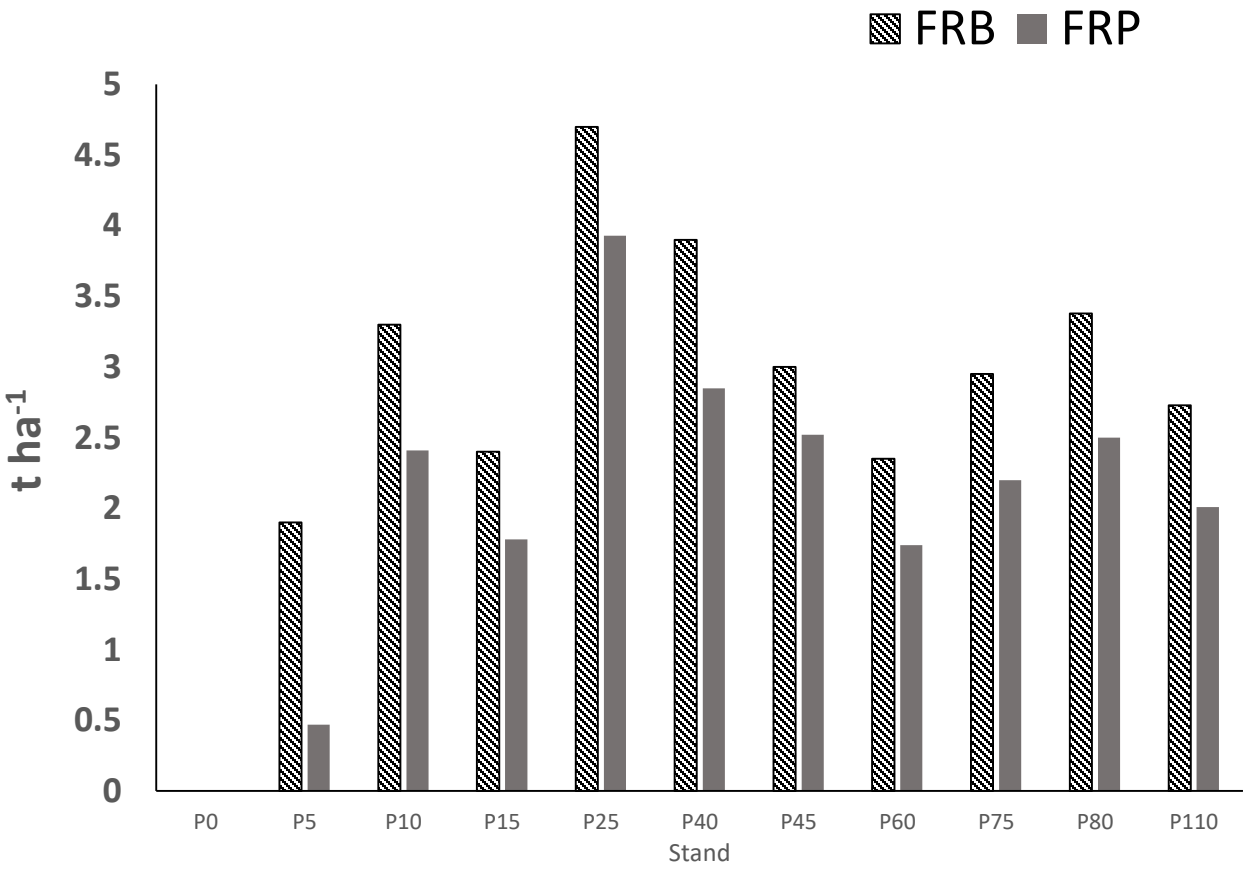
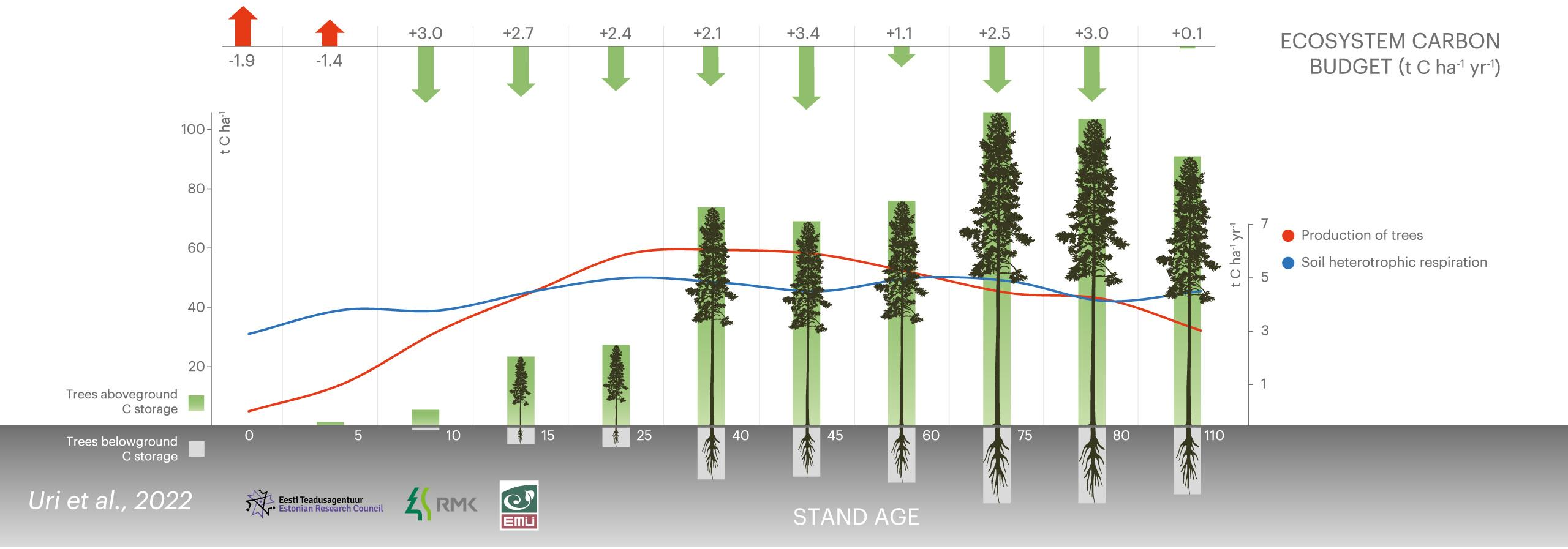


Figure 8. dynamics of fine root biomass (FRB) and fine root production (FRP) of pine

THE DYNAMICS OF THE CARBON STORAGE AND FLUXES IN SCOTS PINE CHRONOSEQUENCE



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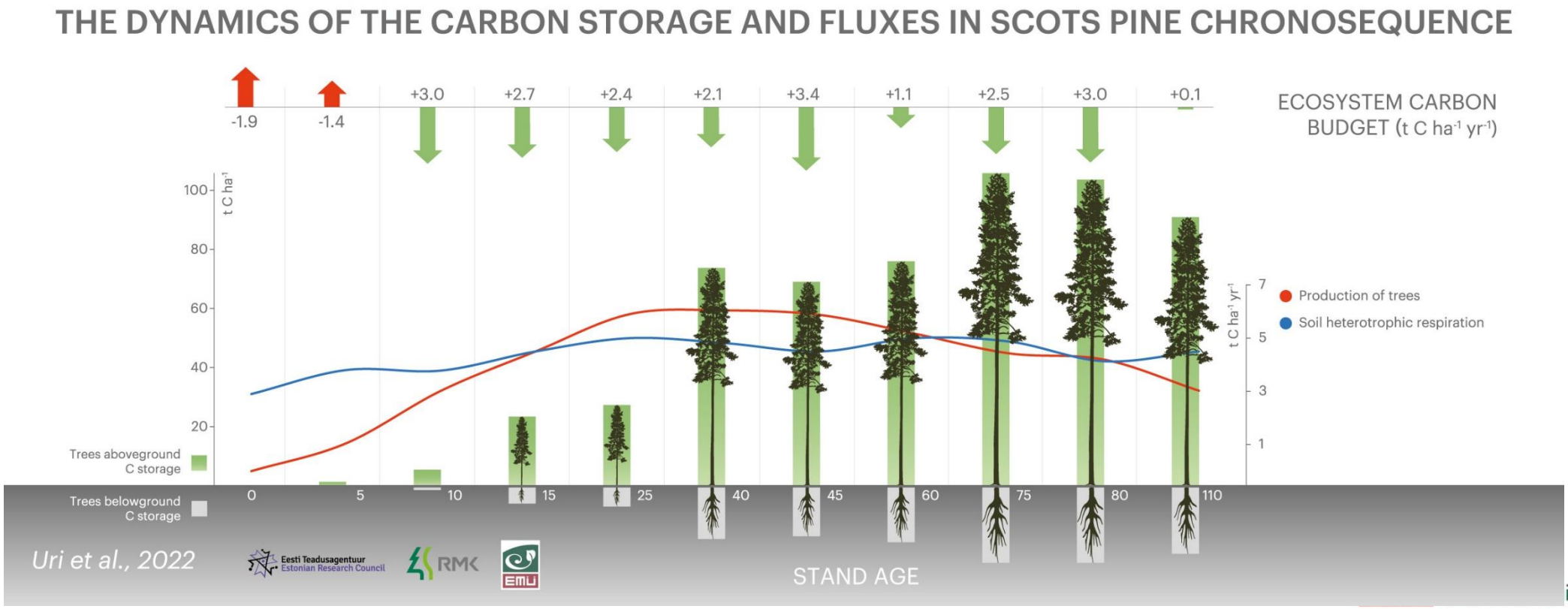
Clear-cut has a strong effect on C cycling

- Compensation point: 7 year-old Scots pine stand
- C payback period: 12 years
- C storage increases with stand age (TREES)
- Production of the trees is most intensive in young and middle-aged stands (RED)
- Heterotrophic respiration does not depend on stand age (BLUE)
- Largest C sink was recorded in 45 year-old stand



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