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Needle biomass turnover rates derived from the needle-shed dynamics

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INTRODUCTION

To understand carbon cycle and flows of forests, accurate information on tree-component-specific litter production of trees is needed. In the ecosystem models, the litterfall of living trees is usually predicted by the biomass component by average amounts corresponding to site conditions or by multiplying the biomass of the growing stock by the component-specific biomass turnover rate. In this study, the rates of needle biomass turnover of Scots pine and Norway spruce trees were

METHODS

Estimation of needle litterfall was based of data on needle cohort longevity (VAPU database). The percentage survival of needles in each of the needle cohorts was estimated visually and classified into one of six survival classes: 1) 0–5%, 2) 6–25%, 3) 26–50%, 4) 51–75%, 5) 76–95% and 5) 96–100% (Fig. 1). The survival classes according to the age of the needle cohort characterized the decrease in needle density over time (Fig 2.).

The biomass turnover rate of needles (r_i) in the time-period approach was calculated with the following model: as

$$r = \frac{\sum_{i=0}^{n-1}(b_i - b_{i+1}) \cdot w_i \cdot d_i}{\sum_{i=0}^{n-1}(b_i \cdot w_i)}$$

where the numerator indicates the total number of needles removed annually, and the denominator the total number of needles on a tree or single branch. The *n* indicates the number of age classes. The parameter *b* is the percentage survival of the needle cohort, *w* is a weight factor indicating weighting of needles over time and *d* is loss of weight during yellowing of needles. The dry weight of needles increases over time. Most of the needles become yellow before they are shed. Upon yellowing, needles become lighter in weight, with the absolute amounts of nutrients in them usually diminishing and being transferred to the trunk.

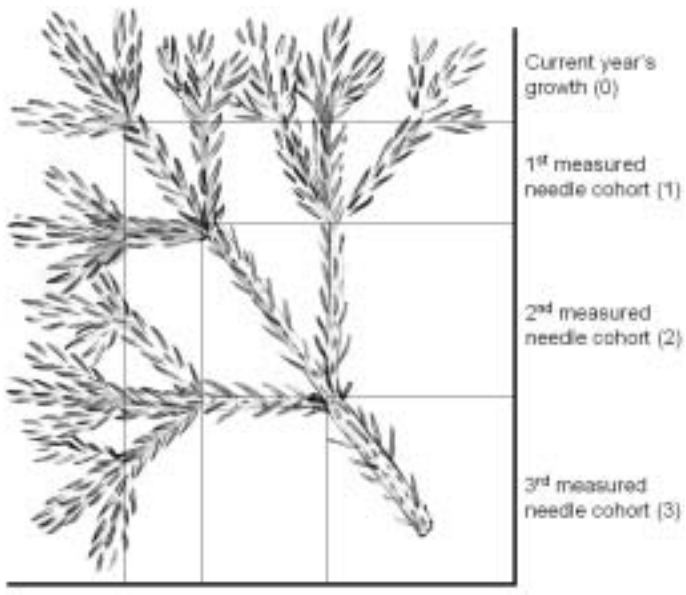

Figure 1. Needle cohorts. First-order needle cohorts are located on the main stem of the branch.

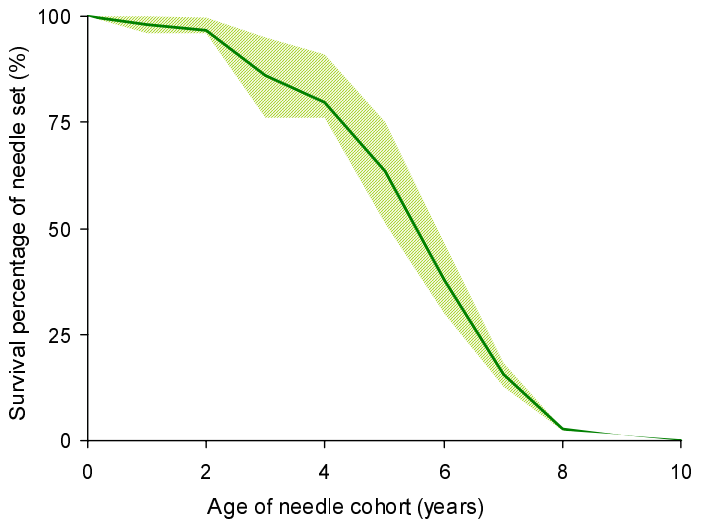

Figure 2. Needle shed dynamic of Norway spruce in southern Finland. The Y-axes represent the percentage survival of needles in each of the needle cohorts.

RESULTS

The annual biomass turnover rates of needles for southern and northern Finland are 0.21 and 0.10, respectively. For Norway spruce those same values are 0.10 and 0.05. Species-specific estimation of litter production is essential for understanding the carbon cycle and flows of forests. Biomass turnover rates can provide useful litter production estimates for large areas with average biomass values as a source of data. Estimated litterfall was compared with measured annual needle litterfall (Fig 3.).

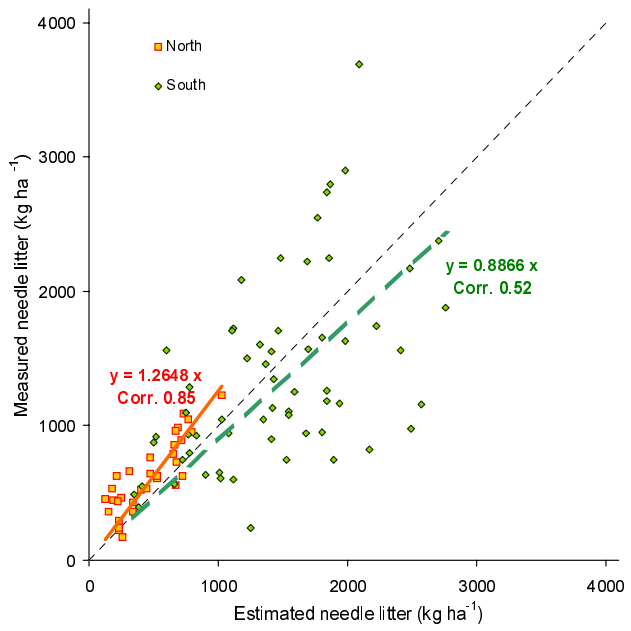

Figure 3. Comparison of modelled and measured needle litterfall in Scots pine forests.

Muukkonen, P. & A. Lehtonen. Needle and branch biomass turnover rates of Norway spruce (*Picea abies*). Revision submitted to Canadian Journal of Forest Research.
Muukkonen, P. Needle biomass turnover rates of Scots Pine (*Pinus sylvestris* L.) derived from the needle-shed dynamics. Revision submitted to Trees – Structure and Function.