Influence of tree species composition on Soil Carbon Storage and C to N ratio in Mixed Pine-Beech forests at different scales

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Introduction

The study of mixed forests is gaining great relevance due to evidence that they can provide numerous ecosystem services more efficiently [3], including their function as atmospheric CO_2 sinks. Depending on the species present, the production and composition of litterfall will be different, and therefore, the quality and quantity of soil organic matter (SOM) that reaches the soil [1]. There is an increasing number of studies focusing on the effect of mixture on SOM [2], but it is necessary to increase knowledge about its quantity and quality, and its evolution when the characteristics of the mixture are modified.

Objectives

Determine which scale; plot-level or subplot-level, is better to apply when studying the effect of tree stand composition on SOM.

Assess the effect of the percentage of species mixture on:

(1) litterfall accumulation and decomposition

(2) carbon distribution along the soil profile

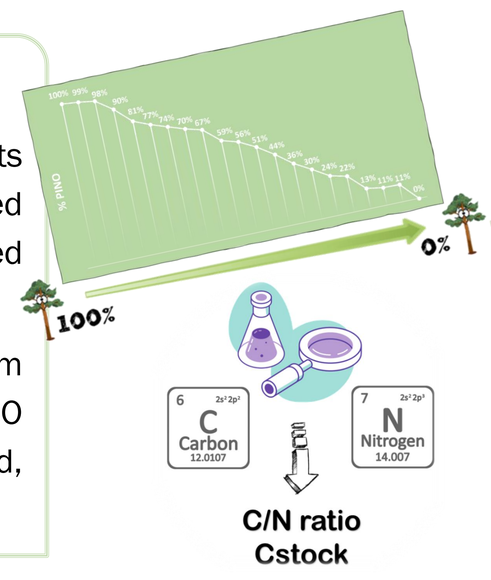
(3) C/N ratio of the accumulated SOM

Fig. 1 Study site location: Schrobenhausen (Germany), Niepołomice (Poland)

Material and methods

Nine forest plots (three triplets) of mixed and pure stands of Scots pine (*Pinus sylvestris* L.) and beech (*Fagus sylvatica* L.) were selected for the study (Fig. 1), and 40 subplots (5m radius) were established within the triplets, covering a wide range of species mixture.

Organic and mineral soil horizons were collected up to 40 cm depth and analyzed for TOC and TN by dry combustion in a LECO CNS928 autoanalyzer. Cstocks and C/N ratios were calculated, and data were analyzed at two scales (plot and subplot level).



Results & Discussion

Which scale is better to use?

The subplot-level approach was consistent with most of the differences detected at the plot-level, however, it emphasized the difference between beech and mixed stands. Moreover, it allowed us to appreciate quadratic trends and discern in each case which mixture percentage is optimal. Then, subplot-level turned to be a better option for this type of studies.

Organic horizon (Forest floor)

No effect of mixture percentage on total biomass was observed, but there was an effect when studying each fraction separately ($p < 0.001$). Humified fraction represented >80% of the biomass in stands with a high presence of pine (Fig. 2a). The lowest values in the C/N ratio (C/N = 20-25) were reached in mixtures with 25-50% pine where, additionally, there were no differences between fractions (Fig. 2b). We postulate that the presence of higher quality litter (beech leaves) may be causing a positive priming effect, accelerating the decomposition of the residues that are more difficult to degrade. Cstock in each fraction also varied with the percentage of pine ($p < 0.001$) (Fig. 2c).

Mineral horizon

Total organic C was the only parameter that varied with the mixture percentage ($p < 0.1$), showing minimum values around 50% mixture (Fig. 2d).

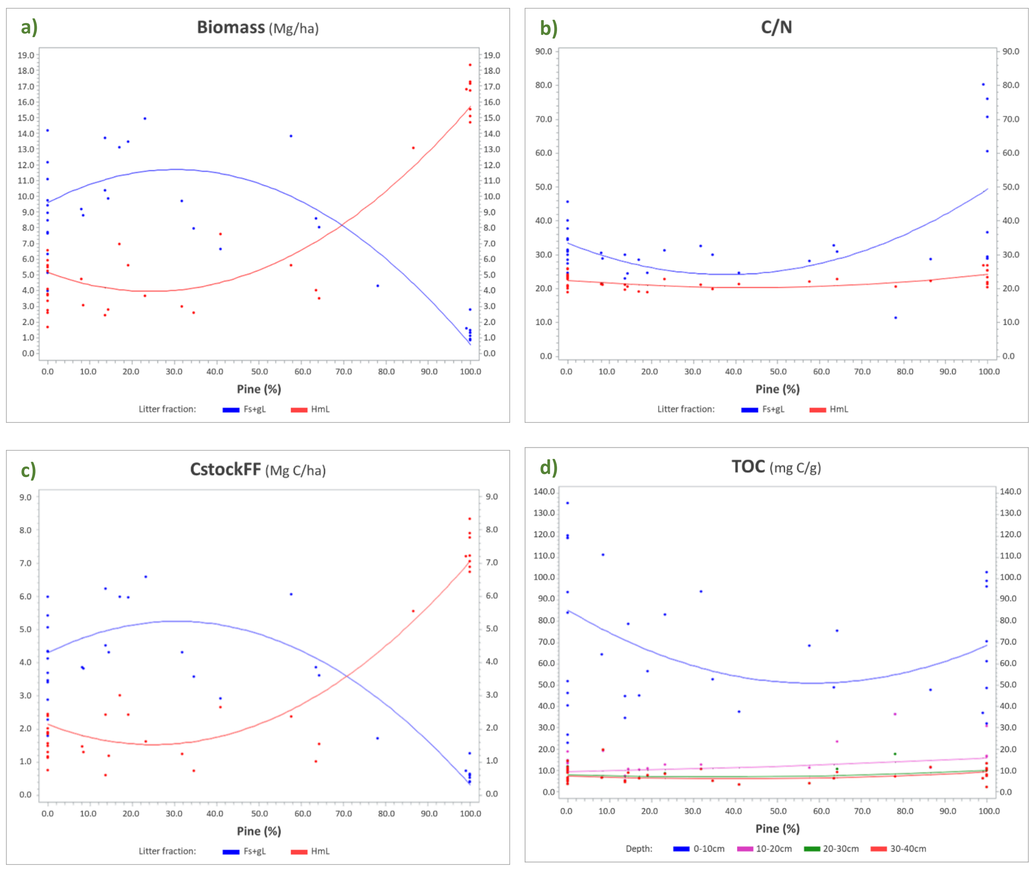


Fig. 2 Forest floor evolution of a) Biomass (Mg ha^{-1}), b) C to N ratio, c) C stock (Mg C ha^{-1}) with pine proportion, and d) Mineral soil TOC (Mg C ha^{-1}).

Conclusions

- Percentage of species mixture mainly influenced quantity and quality of organic matter in the forest floor rather than in the mineral soil.
- The highest-quality soil organic matter (SOM) was found in the litterfall of stands with a 25-50% pine composition.
- Subplot-level is a better option when studying the effect of tree stand composition on SOM, as it allows for the detection of effects that may be diluted or masked by a plot-level approach.

References

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