Assessment of dead wood dynamics in Swiss Forest Reserves

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Introduction

Coarse woody debris (CWD) is recognized as a key structural element of forests and as an indicator of ecologically sustainable forest management. Therefore increasing efforts are made to manage CWD as a habitat component in forest ecosystems. For this a basic understanding of patterns and rates of CWD decomposition in different forests is crucial. Here, we analysed the decomposition of *Fagus sylvatica*, *Picea abies* and *Abies alba* in Swiss forest reserves. In combination with the assessment of CWD pools (quantity and quality), recruitment rates from live trees, and fall rates of standing dead trees CWD dynamics in Swiss natural forests will be modelled.

Research Hypotheses

- The decomposition rates and dynamics of *F. sylvatica*, *P. abies* and *A. alba* differ.
- Moreover, the decomposition rates depend on log dimension, decay stage and position, as well as climatic variables (temperature, precipitation).

Materials and Methods

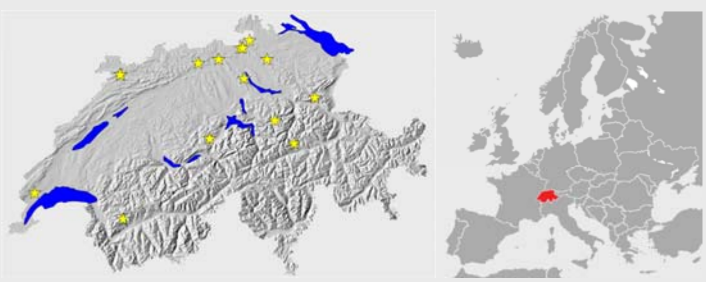

Fig. 1: Location of Swiss Forest Reserves studied.

- The study was carried out in 14 Swiss forest reserves (Fig.1).
- Volume and mass loss of individual trees as well as decay stage (4 stages) were assessed based on type and time since death in long-term permanent inventory plots. Plots were established earliest in the 1960s and remeasured on average every 10 years since.
- The sampling design consisted of three different tree species in three elevation steps (depending on species occurrence) and three dbh classes (<20, 20-40, >40 cm, dbh at last inventory before death). Within these categories we aimed to sample at least three different periods of death and to capture all decay stages with 5 replicates. Overall, 123 *F. sylvatica* logs, 105 *P. abies* logs and 34 *A. alba* logs were sampled.

First Results

- The remaining mass of *F. sylvatica* and *P. abies* exponentially decreased over time (Fig. 2). The data base was insufficient to evaluate this pattern for *A. alba*.

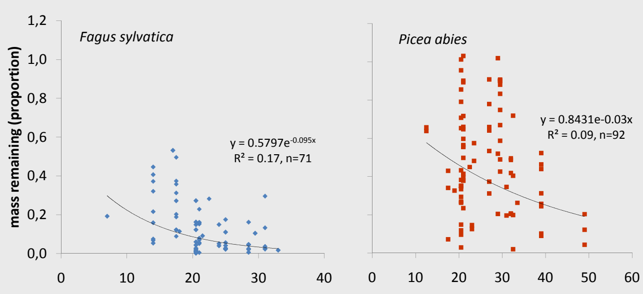

Fig. 2: Mass remaining (proportion) over time of *F. sylvatica* and *P. abies.*

- The average decomposition constants *k* (based on mass loss and a negative exponential model) varied significantly across species (Kruskal-Wallis Test, $p<0.001$); *k* values were higher in *F. sylvatica* than in *P. abies* and *A. alba* (Mann-Whitney *U* Test*, both $p<0.001$), *k* values of *P. abies* and *A. alba* were not different (Fig. 3).
- In relation to dbh class, *k* values were higher for dbh<20 cm as well as for dbh between 20 and 40 cm than for dbh>40 cm for *F. sylvatica* (*, $p<0.001$ and $p<0.05$) and *P. abies* (*, $p<0.001$). No sig. difference was detected between dbh<20 and 20-40 cm, and for *A. alba* between any diameter class.

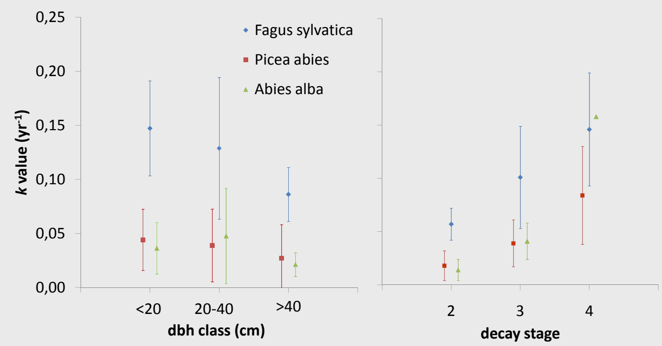

Fig. 3: Relationship between dibh class and *k* value (mean±SD); total mean: *F. sylvatica*: 0.122 (±0.06), n=71, *P. abies*: 0.038 (±0.03), n=92, *A. alba*: 0.036 (±0.03), n=30.

Fig. 4: Relationship between decay stage and *k* value (mean±SD) for *F. sylvatica*, *P. abies* and *A. alba*.

- *k* values increased significantly with increasing decay stage (ds; Mann-Whitney *U* Test, $p<0.001$), except from ds 2 to 3 for *F. sylvatica* and to ds 4 for *A. alba* (Fig.4). This effect could be due to the narrow sampling time frame (14-34 years for *F. sylvatica* and 18-49 years for *P. abies* (Fig.1)), which could have lead to under- resp. overestimated *k* values for ds 2 and 4.
- *k* values of *P. abies* were significantly higher <800 m than >800 m (0.054±0.04 and 0.027±0.017; Mann-Whitney *U* Test, $p<0.001$). No sig. difference was observed for *F. sylvatica* and *A. alba*.
- Log position did not sig. affect *k* values. Nethertheless *k* values were higher for logs than for snags of *P. abies* (0.041±0.033 and 0.031±0.027 resp.).
- About 41% of the variation in *k* of *F. sylvatica* could be explained with elevation, original dbh, time since death and current wood density (Tab. 1 left). For *P. abies* 43% of the variation in *k* could be explained with elevation, position, original dbh and current wood density (Tab. 1 right).

Tab. 1: Prediction of *k* value (linear model sqrt(k)~) for *F. sylvatica* (left) and *P. abies* (right; no model improvement if *A. alba* was included); residuals were evaluated via normal qq plot.

Coefficients	Estimate ± SE	*t* value	*P* value
(Intercept)	0.7444 ± 0.0632	11.78	<0.0001
Elevation	-1.08e-04 ± 4.48e-05	-2.41	<0.05
Original dbh	-0.0017 ± 4.55e-04	-3.66	<0.001
Time since death	-0.0049± 0.0015	-3.17	<0.01
Current density	-0.7413 ± 0.1461	-5.07	<0.0001
Residual SE: 0.06, df=66, adjusted **r^2=0.41**			

Coefficients	Estimate ± SE	*t* value	*P* value
(Intercept)	0.5073 ± 0.0431	11.78	<0.0001
Elevation	-7.18e-05 ± 1.41e-05	-5.09	<0.0001
Position	-0.0102 ± 0.0047	-2.17	<0.05
Original dbh	-6.33e-04± 3.33e-04	-1.90	<0.1
Current density	-0.5180 ± 0.1147	-4.52	<0.0001
Residual SE: 0.056, df=84, adjusted **r^2=0.43**			

Conclusions

- *k* values of *F. sylvatica* were sig. higher when compared to *P. abies* and *A. alba*, but did not differ between *P. abies* and *A. alba*.
- Dbh significantly influenced decomposition rates of all three tree species. Elevation had a sig. effect on *k* values of *P. abies*.
- Up to 43% of the variation in *k* values could be explained with a linear model comprising elevation, original dbh and current wood density as well as time since death for *F. sylvatica* and log position for *P. abies*.

Acknowledgements

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