Supplementary Material

Article Title: Drivers of deadwood decay of 13 temperate tree species are similar between forest and grassland habitats

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# Supplementary Data

**Data Sets**. Datasets are uploaded at “BExIS – Biodiversity Exploratories Information System” (www.bexis.uni-jena.de), and can be found by entering the Data Set ID in the webpage.

“PlotID” of Data Set 1 correspond to:

- “Plots” in Data Set 2

- “EP\_Plot\_ID” in Data Set 3

- “EP\_PlotID” in Data Set 4

- “PlotID” in corresponding Publication of Data Set 5

- “EP\_Plotid” in Data Set 6.

**Data Set 1**. ID 30908: Loss of wood mass for 3900 woodblocks from 13 different tree species decayed on Hainich, Swabian Alb & Schorfheide research plots of the BEshortDead - FunWood IV Project, 2017-2018

**Data Set 2**. ID 24766: Open Climate Data of the Exploratories Project (https://www.bexis.uni-jena.de/sws/PublicClimateDataLink/Index)

**Data Set 3**. ID 1000: Basic information and coordinates of field plots of the Biodiversity Exploratories project

**Data Set 4**.

For Bexis: ID 24646: ForMI dynamics – Forest Management Intensity Index Dynamics of all forest Eps

For publication: Kahl T, Bauhus J (2014) An index of forest management intensity based on assessment of harvested tree volume, tree species composition and dead wood origin. Nature Conservation-Bulgaria 7 (7):15-27. https://doi.org/10.3897/natureconservation.7.7281

**Data Set 5**.

For Bexis: ID 26487: Land use in grasslands: raw data of yearly owner interviews

For Publication: Vogt J, Klaus VH, Both S, Furstenau C, Gockel S, Gossner MM, Heinze J, Hemp A, Holzel N, Jung K, Kleinebecker T, Lauterbach R, Lorenzen K, Ostrowski A, Otto N, Prati D, Renner S, Schumacher U, Seibold S, Simons N, Steitz I, Teuscher M, Thiele J, Weithmann S, Wells K, Wiesner K, Ayasse M, Bluthgen N, Fischer M, Weisser WW (2019) Eleven years' data of grassland management in Germany. Biodivers Data J 7:e36387. https://doi.org/10.3897/BDJ.7.e36387

**Data Set 6**. ID 22246: MinSoil 2017 - Soil pH.

# Supplementary Figures and Tables

The supporting information includes additional results for the first model and second model based on linear mixed effects models:

• Interaction test of significance for the first model;

• Test of the predictive power for both models;

• Selection of important variables based on the multimodel inference approach for the second model

## Supplementary Tables

Supplementary Table 1. Tree specific wood traits from the publication of Kahl et al. (2017).

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tree**  **Species** | **Calcium** | **Carbon** | **Lignin** | **Magne sium** | **Mangan** | **Nitrogen** | **Organic extractives** | **Phenol** | **Phosphorous** | **Potassium** | **Sulfur** | **Wood Density** |
|  | **µg/g** | **%** | **%** | **µg/g** | **µg/g** | **%** | **%** | **%** | **µg/g** | **µg/g** | **µg/g** | **g/cm3** |
| *Acer* | 2307.6 | 46 | 28.4 | 357 | 30.8 | 0.14 | 0.8 | 0.05 | 202.5 | 1569 | 172 | 9.6 |
| *Betula* | 1288.4 | 45.6 | 23.4 | 111 | 11.1 | 0.06 | 1.2 | 0.04 | 125.7 | 1034 | 120 | 10.3 |
| *Carpinus* | 1850.3 | 45.4 | 23.6 | 190 | 68.2 | 0.19 | 0.8 | 0.1 | 133.9 | 1350 | 160 | 12.2 |
| *Fagus* | 1017.3 | 45.8 | 26.9 | 291 | 96.3 | 0.12 | 0.5 | 0.03 | 93.6 | 1416 | 125 | 13.0 |
| *Fraxinus* | 726.1 | 46 | 26.6 | 206 | 4.9 | 0.12 | 1.88 | 0.17 | 85.5 | 1836 | 129 | 11.4 |
| *Larix* | 4411.3 | 45.1 | 28.4 | 202 | 26.6 | 0.19 | 1.4 | 0.1 | 145.9 | 343 | 47 | 10.0 |
| *Picea* | 1316.6 | 46.6 | 27.6 | 134 | 138.1 | 0.07 | 0.9 | 0.05 | 37.3 | 436 | 61 | 8.1 |
| *Pinus* | 916.5 | 48.3 | 28.7 | 141 | 94.9 | 0.03 | 7.2 | 0.05 | 25.5 | 330 | 43 | 8.9 |
| *Populus* | 1697.6 | 45.7 | 25.5 | 511 | 6.7 | 0.08 | 0.9 | 0.03 | 116.6 | 2213 | 126 | 7.7 |
| *Prunus* | 820.7 | 46 | 24 | 151 | 12.2 | 0.13 | 3.3 | 0.12 | 67.2 | 871 | 69 | 9.1 |
| *Pseudotsuga* | 282.7 | 46.6 | 28.8 | 27 | 65.9 | 0.05 | 1.7 | 0.1 | 37.4 | 435 | 49 | 8.7 |
| *Quercus* | 866.5 | 46.1 | 26.7 | 44 | 19.1 | 0.13 | 1.6 | 0.49 | 23 | 592 | 109 | 11.9 |
| *Tilia* | 949.6 | 46.8 | 23.1 | 206 | 131.8 | 0.13 | 2.8 | 0.04 | 68.2 | 686 | 74 | 8.9 |

Supplementary Table 2. Number of plots by collection for the different land use types in the grassland habitat in the three biodiversity exploratories separated by tree species.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | *Acer* | *Betula* | *Carpinus* | *Fagus* | *Fraxinus* | *Larix* | *Picea* | *Pinus* | *Populus* | *Prunus* | *Pseudo-tsuga* | *Quercus* | *Tilia* |
| **Schorfheide-Chorin** | **Meadows** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| fertilized | 7 | 7 | 7 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 5 | 7 | 7 |
| unfertilized | 11 | 10 | 11 | 11 | 9 | 11 | 9 | 10 | 10 | 11 | 9 | 11 | 10 |
| **Pastures** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| fertilized |  |  |  |  |  |  |  |  |  |  |  |  |  |
| unfertilized | 22 | 21 | 22 | 21 | 21 | 20 | 20 | 20 | 20 | 21 | 22 | 22 | 21 |
| **Mown pastures** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| fertilized | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| unfertilized | 7 | 7 | 7 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 7 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Hainich-Dün** | **Meadows** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| fertilized | 7 | 7 | 7 | 6 | 6 | 4 | 6 | 7 | 6 | 7 | 7 | 6 | 6 |
| unfertilized |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Pastures** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| fertilized | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| unfertilized | 18 | 17 | 17 | 18 | 18 | 13 | 16 | 15 | 13 | 17 | 17 | 15 | 17 |
| **Mown pastures** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| fertilized | 13 | 12 | 13 | 14 | 14 | 12 | 11 | 14 | 13 | 12 | 13 | 11 | 11 |
| unfertilized | 8 | 7 | 7 | 8 | 8 | 7 | 6 | 7 | 6 | 7 | 7 | 6 | 6 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | *Acer* | *Betula* | *Carpinus* | *Fagus* | *Fraxinus* | *Larix* | *Picea* | *Pinus* | *Populus* | *Prunus* | *Pseudo-tsuga* | *Quercus* | *Tilia* |
| **Schwabian Alb** | **Meadows** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| fertilized | 17 | 18 | 18 | 15 | 18 | 17 | 17 | 17 | 17 | 18 | 18 | 16 | 17 |
| unfertilized | 3 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 3 | 4 | 3 | 4 |
| **Pastures** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| fertilized | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| unfertilized | 17 | 17 | 17 | 17 | 16 | 17 | 16 | 16 | 17 | 15 | 17 | 16 | 17 |
| **Mown pastures** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| fertilized | 8 | 9 | 9 | 8 | 9 | 9 | 7 | 7 | 9 | 9 | 9 | 9 | 9 |
| unfertilized |  |  |  |  |  |  |  |  |  |  |  |  |  |

Supplementary Table 3. Number of plots by collection for the different management intensity types in the forest habitat in the three biodiversity exploratories separated by tree species.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | *Acer* | *Betula* | *Carpinus* | *Fagus* | *Fraxinus* | *Larix* | *Picea* | *Pinus* | *Popu-lus* | *Prunus* | *Pseudo-tsuga* | *Quercus* | *Tilia* |
| **Schorfheide-Chorin** | **Unmanaged forest** | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 4 | 5 | 3 | 5 | 5 |
| **Age class forest** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***Fagus* (Beech)** | 16 | 16 | 16 | 16 | 16 | 15 | 15 | 16 | 16 | 16 | 16 | 14 | 16 |
| ***Quercus* (Oak)** | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| ***Picea* (Spruce)** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***Pinus* (Pine)** | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 21 | 22 | 22 | 22 | 21 | 22 |
| **Selection forest** (trees harvested selectively) |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | *Acer* | *Betula* | *Carpinus* | *Fagus* | *Fraxinus* | *Larix* | *Picea* | *Pinus* | *Popu-lus* | *Prunus* | *Pseudo-tsuga* | *Quercus* | *Tilia* |
| **Hainich-Dün** | **Unmanaged forest** | 13 | 13 | 13 | 12 | 13 | 13 | 12 | 12 | 13 | 12 | 12 | 13 | 13 |
| **Age class forest** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***Fagus* (Beech)** | 23 | 22 | 23 | 23 | 21 | 20 | 22 | 23 | 23 | 23 | 24 | 24 | 23 |
| ***Quercus* (Oak)** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***Picea* (Spruce)** | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 3 | 4 | 4 |
| ***Pinus* (Pine)** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Selection forest** (trees harvested selectively) | 9 | 9 | 8 | 7 | 9 | 9 | 9 | 9 | 9 | 8 | 9 | 8 | 9 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Schwabian Alb** | **Unmanaged forest** | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **Age class forest** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***Fagus* (Beech)** | 30 | 30 | 33 | 27 | 31 | 31 | 28 | 28 | 31 | 32 | 33 | 33 | 32 |
| ***Quercus* (Oak)** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***Picea* (Spruce)** | 9 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 11 | 12 | 12 | 11 | 11 |
| ***Pinus* (Pine)** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Selection forest** (trees harvested selectively) |  |  |  |  |  |  |  |  |  |  |  |  |  |

Supplementary Table 4. Model based test of mass loss between the habitats forest and grassland of deadwood separate by tree species identity (Model 1). Adjusted p-values and significances were calculated using Satterthwaite´s method.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Tree species Identity** | **Ratio** | **SE** | **Df** | **Z ratio** | **P value** | **Significance** |
| ***Acer platanoides*** | 0.695 | 0.048 | 2525.9 | -5.280 | 1.29 x 10-7 | \*\*\* |
| ***Betula pendula*** | 0.354 | 0.025 | 2550.3 | -14.946 | <2 x 10-16 | \*\*\* |
| ***Carpinus betulus*** | 0.588 | 0.040 | 2475.4 | -7.803 | 6.06 x 10-15 | \*\*\* |
| ***Fagus sylvatica*** | 0.418 | 0.029 | 2572.8 | -12.521 | <2 x 10-16 | \*\*\* |
| ***Fraxinus excelsior*** | 0.521 | 0.036 | 2541.6 | -9.412 | <2 x 10-16 | \*\*\* |
| ***Larix decidua*** | 0.766 | 0.054 | 2589.3 | -3.811 | 0.0001 | \*\*\* |
| ***Picea abies*** | 0.611 | 0.043 | 2635.4 | -6.950 | 3.66 x 10-12 | \*\*\* |
| ***Pinus sylvestris*** | 0.672 | 0.047 | 2575.9 | -5.701 | 1.19 x 10-8 | \*\*\* |
| ***Populus tremula*** | 0.597 | 0.042 | 2578.8 | -7.385 | 1.52 x 10-13 | \*\*\* |
| ***Prunus avium*** | 0.508 | 0.035 | 2544.0 | -9.765 | <2 x 10-16 | \*\*\* |
| ***Pseudotsuga menziesii*** | 0.501 | 0.035 | 2532.3 | -10.006 | <2 x 10-16 | \*\*\* |
| ***Quercus robus*** | 0.943 | 0.066 | 2562.5 | -0.847 | 0.3971 | n.s. |
| ***Tilia cordata*** | 0.388 | 0.027 | 2528.3 | -13.708 | <2 x 10-16 | \*\*\* |
| **Hainich- Dün** | 0.561 | 0.020 | 293.4 | -16.439 | <2 x 10-16 | \*\*\* |
| **Schorfheide-Chorin** | 0.561 | 0.020 | 293.4 | -16.439 | <2 x 10-16 | \*\*\* |
| **Swabian-Alb** | 0.561 | 0.020 | 293.4 | -16.439 | <2 x 10-16 | \*\*\* |

Supplementary Table 5. The predictive capacity of model 1 and 2 to describe our data by calculation of the R-squared (R2). Conditional R2 is related to both fixed and random factors and marginal R describes only fixed factors.

|  |  |  |  |
| --- | --- | --- | --- |
| **Main Model after single term deletion (Model 1)** | | | |
|  |  | **Forest and Grassland combined** | |
| Conditional R2 | | 0.651 | |
| Marginal R2 | | 0.562 | |
| **Final Model (Model 2)** | | | |
|  | | **Forest** | **Grassland** |
| Conditional R2 | | 0.612 | 0.624 |
| Marginal R2 | | 0.495 | 0.476 |

**2.2 Supplementary Figures**

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**Supplementary Figure 1**. Exposure (A, C) and recovery (B, D) of deadwood from 13 tree species in forest (A, B) and grassland (C, D) plots.



Supplementary Figure 2. Relative importance of independent variables for the best model of forest with combined forest management intensity (ForMI). Calculation based on weights by Akaike information criterion (AIC) and selection of variables with an importance value > 0.75 (Model 2). Definition of the ForMI index can be found by Kahl and Bahus (2014).



Supplementary Figure 3. Relative importance of independent variables for the best model of forest with single forest management intensity (ForMI) components; proportion of tree species that are not part of the natural community (Inonat), proportion of harvested wood volume (Iharv), proportion of deadwood wit saw cuts (Idwcut). Calculation based on weights by Akaike information criterion (AIC) and selection of variables with an importance value > 0.75 (Model 2). Definition of the ForMI index and its components can be found by Kahl and Bahus (2014).

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Supplementary Figure 4. Relative importance of independent variables for the best model of grassland with combined land use intensity (LUI). Calculation based on weights by Akaike information criterion (AIC) and selection of variables with an importance value > 0.75 (Model 2). Definition of the LUI index can be found by Blüthgen et al. (2012).



Supplementary Figure S5. Relative importance of independent variables for the best model of grassland with single land-use intensity (LUI) components; total grazing, total mowing and total fertilization. Calculation based on weights by Akaike information criterion (AIC) and selection of variables with an importance value > 0.75 (Model 2). Definition of the LUI index can be found by Blüthgen et al. (2012).

References

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