Supporting Information

Supplement-Tables

In Germany all forest management types were dominated by *Fagus sylvatica* as the main canopy species and as the main species found in the regeneration layer. On average (Table 2) tree density in the canopy and in the regeneration layer was largest in age-class forests. Basal area and wood volume was largest in the protected forest. The fraction of *Fagus* in the canopy was lower in the protected former coppice-with-standards forest than in the uneven-aged selectively cut or age-class forest. The fraction of *Fagus* in the lowest height class of regeneration (HC1) was highest in the selectively cut forest. The fraction of *Fagus* increased with the height of the regeneration layer (height class) in all management types.

The Romanian NFI did not distinguish between management types, but separated the data according to the proportion of *Fagus* in the canopy. The average age was lower in Romania than in Germany, in part due to averaging an uneven-aged forest structure. Therefore, tree density in the canopy was slightly higher. Wood volumes were similar in both inventories. Basal area was generally higher, similar to the protected forest in Germany.

In Germany on average 14% of the plots did not contain any individuals in the lowest regeneration layer (HC1 = 0); this fraction with no regeneration increased to 68% in HC3. In Romania the situation is different where some height classes of regeneration are found on every plot, even though a larger fraction than in Germany had no regeneration in HC1 (47% in Romania versus 14% in Germany). In Romania the fraction of plots without regeneration decreased within HC3 when compared to Germany (37% with HC3=0). This fraction was independent of the degree of dominance by *Fagus* in the canopy. The difference between HC1 and HC3 of plots without regeneration indicates that new processes emerge in Romania, which mainly affect HC1.

Supplement-Table S1: Summary of stand inventory parameters of the investigated forest management types (a) in the Hainich region and (b) in Romania. The number of regeneration plots refers to plots that had at least one individual. Tree density includes plots without regeneration. Numbers represent averages ± standard deviations.

b) Romania	Uneven-aged, selectively cut forest	Age-class forest (deciduous, all age classes)	Protected forest	Total/average
No of inventory plots	1949	2786	36	4771
Average age (years)	53.6 ± 25.7	43.6 ± 24.8	44.6 ± 21.2	44.7 ± 25.6
Tree density (Individuals ha^{-1})				
canopy	777 ± 612	930 ± 777	1137 ± 845	870 ± 719
0.2-0.5 m (HC1)	12545 ± 20928	10020 ± 30947	5924 ± 10016	11020 ± 34203
0.5-1.3 m (HC2)	4180 ± 10150	3276 ± 7596	1768 ± 5012	3636 ± 8727
1.3-3 m (HC3)	3039 ± 5196	4115 ± 7201	3935 ± 5265	3674 ± 6464
Number of plots without regeneration				
HC1 & HC2 & HC3 = 0	0	0	0	0
HC1 = 0	562 (29%)	1138 (41%)	19 (53%)	1719 (36%)
HC2 = 0	910 (47%)	1544 (55%)	26 (72%)	2480 (52%)
HC3 = 0	699 (36%)	954 (34%)	13 (36%)	1666 (35%)
Basal Area (m^2 ha^{-1})	25.1 ± 13.0	22.4 ± 12.6	28.2 ± 16.0	23.6 ± 12.9
Wood volume (m^3 ha^{-1})	282.7 ± 195.2	236.4 ±175.7	288.5 ± 209.6	255.7 ± 185.5
Fraction of canopy-*Fagus* trees (%)				
canopy	29.7 ± 38.1	24.8 ± 35.6	15.2 ± 27.6	26.7 ± 36.7
0.2-0.5 m (HC1)	72.4 ± 34.1	69.7 ± 34.6	89.9 ± 21.1	71.2 ± 34.3
0.5-1.5 m (HC2)	78.7 ± 30.3	79.0 ± 29.8	100.0 ± 0	78.9 ± 30.0
1.5-3 m (HC3)	74.8 ± 33.1	73.8 ± 33.7	84.4 ± 21.7	74.3 ± 33.4
a) Thuringia/ Germany	Uneven-aged, selectively cut forest	Age-class forest (deciduous, all age classes)	Protected forest	Total/average
No of inventory plots	1097	656	171	1924
Average age (years)	104±32	91±39	98+28	99±35
Tree density (Individuals ha^{-1})				
canopy	334 ± 296	671±637	450±312	460±470
0.2-0.5 m (HC1)	18186±24227	16900±24037	18640± 26603	17788±24379
0.5-1.5 m (HC2)	10583±19095	6999±13697	4978±8812	8863±16816
1.5-3 m (HC3)	4005±13565	2622±6999	1075±2959	3273±11099
Number of plots without regeneration				
HC1 & HC2 & HC3 = 0	99 (9%)	136 (21%)	29 (17%)	264 (14%)
HC1 = 0	147 (13%)	169 (26%)	32 (19%)	348 (18%)
HC2 = 0	364 (33%)	377 (57%)	94 (55%)	835 (43%)
HC3 = 0	701 (64%)	475 (72%)	135 (79%)	1311 (68%)
Basal Area (m^2 ha^{-1})	26.8 ± 8.1	25.7 ± 10.6	35.1 ± 9.5	27.1±9.5
Wood volume (m^3 ha^{-1})	339 ± 169	415 ± 138	521 ± 164	339±160
Fraction of *Fagus*canopy trees (%)				
canopy	88.5 ± 19.3	80.2 ± 27.4	69.3 ± 27.8	83.3 ±25.9
0.2-0.5 m (HC1)	58.3 ± 36.7	45.0 ±35.4	46.5 ± 38.0	53.1±36.9
0.5-1.5 m (HC2)	78.1 ± 35.3	58.9 ± 38.4	58.2 ± 41.7	71.8±37.7
1.5-3 m (HC3)	88.1 ± 27.7	59.7 ± 39.9	48.4 ± 43.4	77.4±35.9

Supplement-Table S2: Relation between species loss and browsing or stand characteristics

Generalized linear models (GLM) were used to explore the relationship of management, canopy cover and browsing on the species loss defined as the difference in species number between the first and the second height classes. The potential effects of the factors were analyzed in GLM with an assumption of quasi-poisson error distribution (glm function in R 3.0, R Development Core Team, 2010). Only plots displaying a species loss were considered: plots with zero or negative species loss (i.e. species enrichment) were not included in analysis.

Extinction	Romania			Germany		
Species (HC1-HC2)	Estimate	Probability	Sig.	Estimate	Probability	Sig.
Intercept	-1.256	0.0002	***	-0.920	<0.0001	***
Browsed HC1	0.001	0.8688		-0.001	0.1630	
Browsed HC2	0.005	0.0221	*	0.003	<0.0001	***
Browsed HC3	-0.002	0.8558		0.001	0.9706	
Percent Fagus	-0.068	0.7473		0.093	0.4182	
Basal area	0.011	0.0506	.	0.005	0.0199	*
Management	0.007	0.9531		0.084	0.0932	
Canopy species	0.000	0.9903		0.018	0.4950	
Stand age	-0.005	0.1789		-0.001	0.0284	*
Species diversity in HC 1	0.339	<0.0001	***	0.332	<0.0001	***

Supplement-Table S3: Results of structural equation models of effects of species number in canopy, percent *Fagus* coverage in the canopy, and cover basal area (as proxy for light availability) on tree density on age class 1, browsing in age class one, and on species loss. Structural equation modeling was performed separately for each forest type in Romania and Germany. Please note that we had an insufficient number of replicates to perform structural equation modeling for protected forest in Romania. Given are the unstandardized path coefficients (estimates), standard error of regression weight (*S.E.*), the critical value for regression weight (C.R.; *z* = estimate/*S.E.*) and level of significance for regression weight (*P*). Significant paths ($P < 0.05$) are given in bold.

(A) Romania - Selectively cut forest

Variables			Estimate	*S.E.*	C.R.	*P*
Browsing HC1	←	Species number canopy	17,676,960,257	14,945,010,859	1,183	,237
Browsing HC1	←	Percent *Fagus* in canopy	-,111	,085	-1,309	,191
Tree denisty HC1	←	Cover basal area	,005	,030	,182	,856
Tree denisty HC1	←	Percent *Fagus* in canopy	-,076	,173	-,441	,659
Tree denisty HC1	←	Browsing HC1	,008	,054	,139	,889
Species loss	←	Cover basal area	,000	,000	,624	,533
Species loss	←	**Browsing HC1**	**,000**	**,000**	**3,326**	***
Species loss	←	**Tree denisty HC1**	**,000**	**,000**	**10,760**	***
Species loss	←	**Species number canopy**	**16,580**	**2,361**	**7,021**	***

(B) Romania – Age class forest

Variables			Estimate	*S.E.*	C.R.	*P*
Browsing HC1	←	Species number canopy	15,928,152,968	17,900,823,707	,890	,374
Browsing HC1	←	Percent *Fagus* in canopy	-,104	,114	-,916	,360
Tree density HC1	←	Cover basal area	-,008	,022	-,352	,725
Tree density HC1	←	Percent *Fagus* in canopy	-,107	,156	-,684	,494
Tree denisty HC1	←	**Browsing HC1**	**,135**	**,034**	**4,011**	***
Species loss	←	Light (cover basal area)	,000	,000	1,368	,171
Species loss	←	**Browsing HC1**	**,000**	**,000**	**4,822**	***
Species loss	←	**Tree denisty HC1**	**,000**	**,000**	**11,621**	***
Species loss	←	**Species number canopy**	**,195**	**,022**	**8,944**	***

Supplement-Table S3 (continuation)

(C) Germany – Protected forest

Variables			Estimate	*S.E.*	C.R.	*P*
Tree density HC1	←	Percent *Fagus*	-1.13	0.75	-1.51	0.131
Browsing	←	**Species canopy**	**4.24**	**2.11**	**2.01**	**0.044**
Browsing	←	**Tree density HC1**	**5.86**	**0.94**	**6.25**	**<0.001**
Extinction	←	**Species canopy**	**0.20**	**0.08**	**2.58**	**0.010**
Extinction	←	**Browsing**	**0.01**	**0.00**	**3.33**	**<0.001**
Extinction	←	**Percent *Fagus***	**1.00**	**0.35**	**2.83**	**0.005**
Extinction	←	**Tree density HC1**	**0.09**	**0.03**	**2.63**	**0.008**
Extinction	←	**Light**	**0.02**	**0.01**	**1.75**	**0.080**

(D) Germany - Selectively cut forest

Variables			Estimate	*S.E.*	C.R.	*P*
Tree density HC1	←	**Percent *Fagus***	**1.38**	**0.31**	**4.46**	**<0.001**
Tree density HC1	←	**Light**	**0.04**	**0.01**	**3.94**	**<0.001**
Extinction	←	Species canopy	0.08	0.05	1.70	0.090
Browsing	←	**Tree density HC1**	**2.65**	**0.32**	**8.21**	**<0.001**
Extinction	←	**Tree density HC1**	**0.07**	**0.01**	**5.08**	**<0.001**
Extinction	←	**Light**	**0.03**	**0.00**	**6.12**	**<0.001**
Browsing	←	Percent *Fagus*	-4.02	3.33	-1.21	0.228
Extinction	←	Percent *Fagus*	0.36	0.20	1.87	0.062

(E) Germany - Age class forest

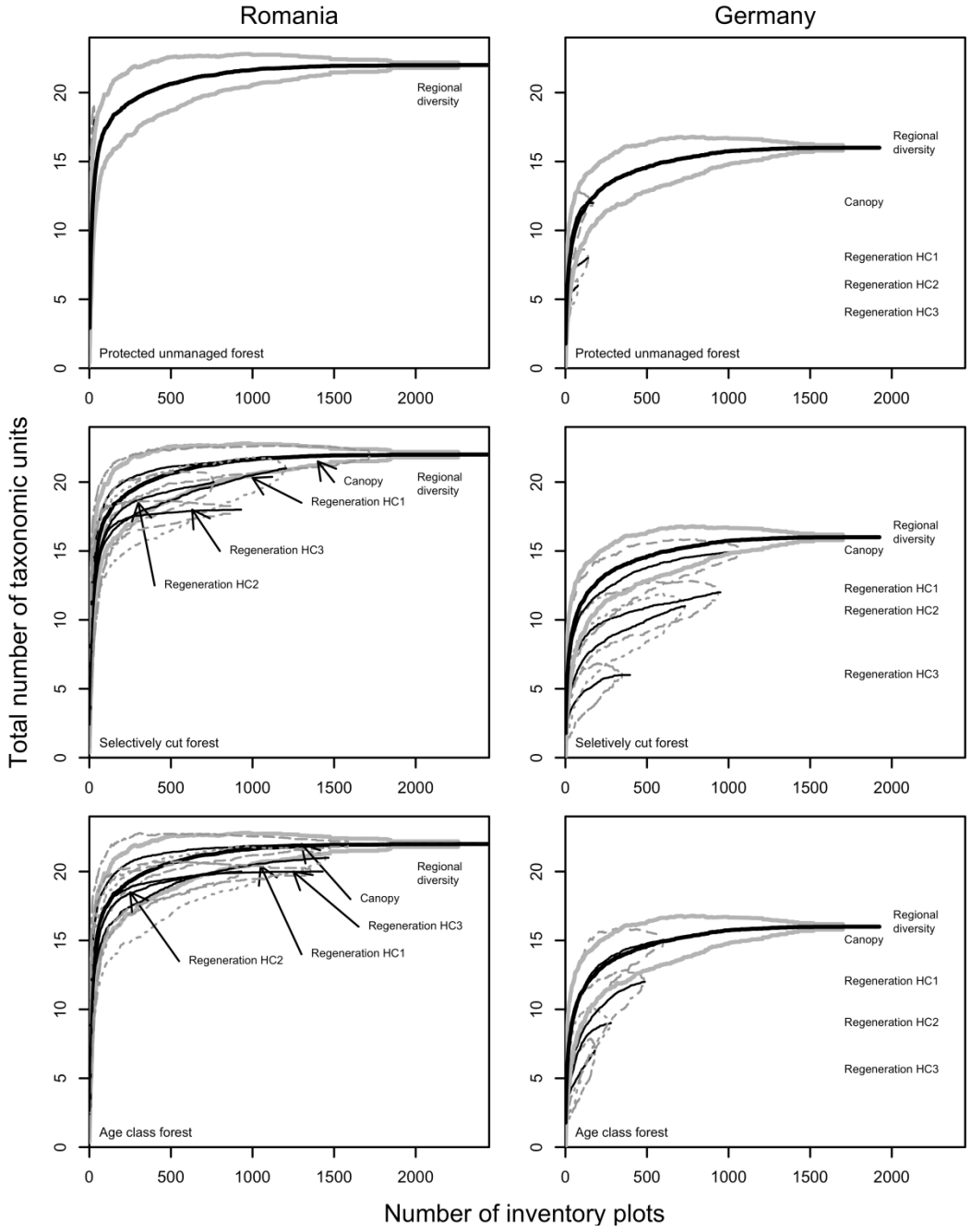
Variables				Estimate	S.E.	C.R.	P
Tree density HC1	←	**Percent *Fagus***	**1.81**	**0.32**	**5.63**	**<0.001**	
Tree density HC1	←	**Light**	**0.04**	**0.01**	**4.39**	**<0.001**	
Browsing	←	Species canopy	-2.69	1.48	-1.82	0.068	
Browsing	←	**Tree density HC1**	**3.77**	**0.54**	**6.98**	**<0.001**	
Extinction	←	**Species canopy**	**0.12**	**0.06**	**2.09**	**0.037**	
Extinction	←	**Browsing**	**0.00**	**0.00**	**3.51**	**<0.001**	
Extinction	←	**Tree density HC1**	**0.14**	**0.02**	**7.84**	**<0.001**	
Extinction	←	**Light**	**0.03**	**0.00**	**8.10**	**<0.001**	
Extinction	←	Percent *Fagus*	0.29	0.18	1.62	0.105	

Supplement-Table S4: Browsing intensity as measured by the loss of the terminal bud and expressed as percentage of affected tree individuals compared to the total tree density and related to forest management and different height classes of the regeneration. Significance between management types was tested by ANOVA.

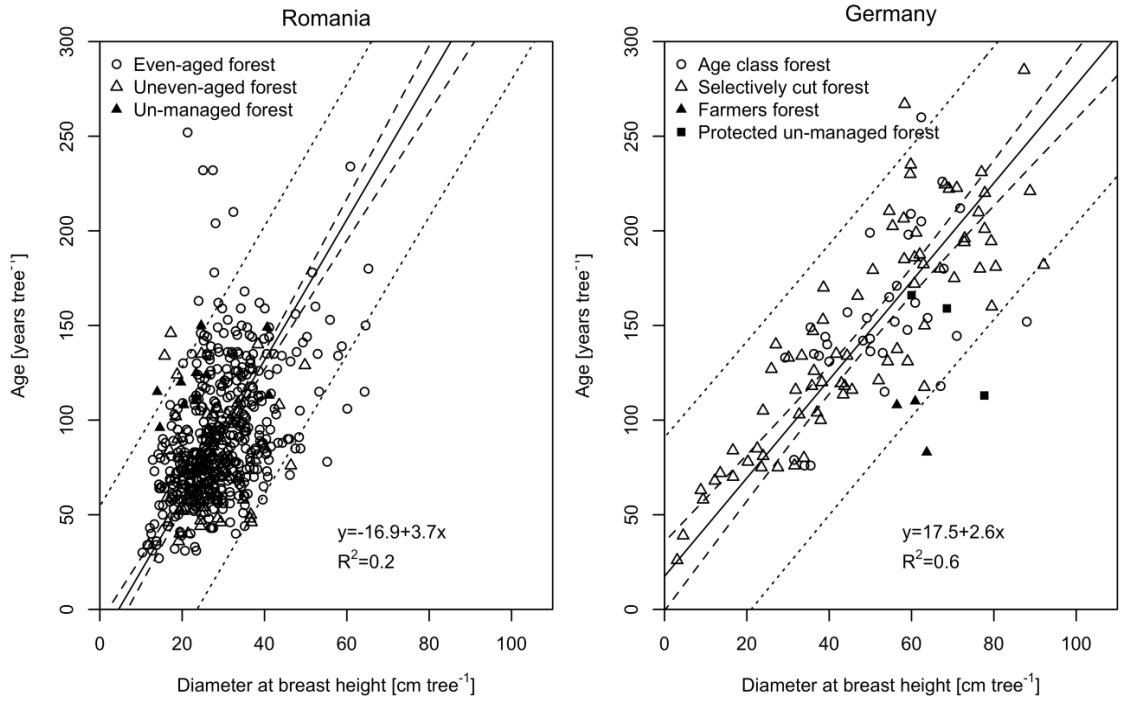
Height	Germany			Romania		
	Age class	Selective	Protected	Age class	Selective	Protected
HC1	38.8±33.9a	20.4±27.2b	41.1±36.1a	6.5±21.9 a	3.6±16.6 b	0.0±0.0 c
HC2	35.7±34.7a	16.1±27.6b	44.9±40.1a	5.7±21.3 a	4.2±17.8 a	10.0±31.6 a
HC3	9.3±23.3a	4.0±14.8b	14.8±30.9a	0.9±8.0 a	0.9±8.4 a	0.0±0.0 b

Supplement-Figures

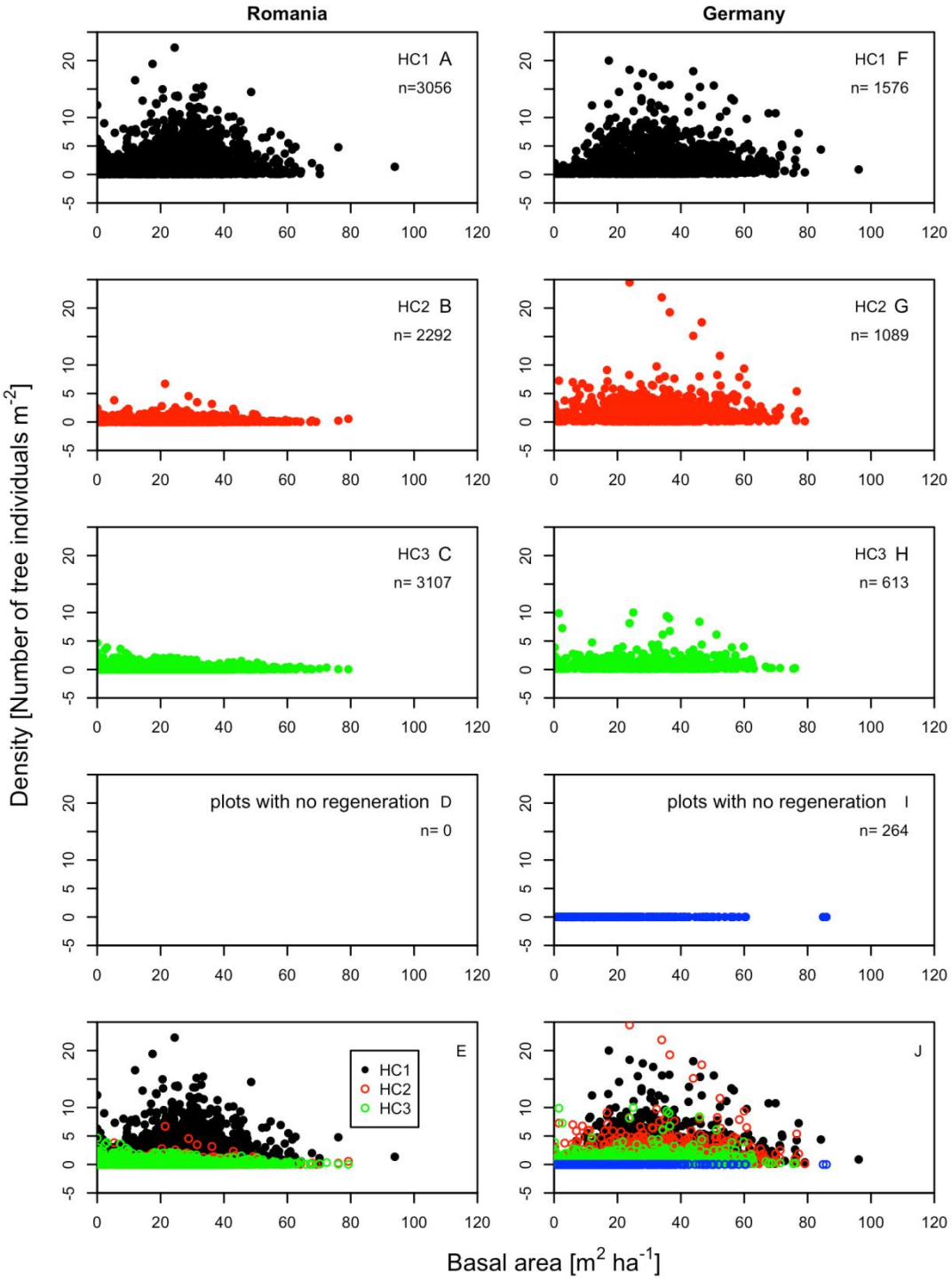
Supplement-Fig. S1: Total number of tree taxonomic units (species and genera) as related to the number of investigated inventory plots for canopy, Height Class 1, 2 and 3. The dotted lines represent the 90% confidence interval. The species list does not separate species in *Quercus*, *Tilia*, *Ulmus*, *Malus*, *Pyrus* and *Prunus*. The analysis is based on a plot-based rarefraction with random permutation that includes only those plots where regeneration of a specific height is present. Top panel: Thuringia, Germany, Lower panel: Romania



Supplement-Fig. S2: The relation between tree age and DBH for a total of 114 trees originating from all types of management under investigation (a) in Thuringia and (b) in Romania. A reduced major axis regression (RMA) was applied because uncertainties exist along both the x- and y-axes. The dotted lines display the 95% prediction interval (estimation of an interval in which future observations will fall, with a 95% probability); the dashed lines display the 95% confidence interval of the regression line. Farmers' forests are small parcelled forest properties embedded in larger forest stands.



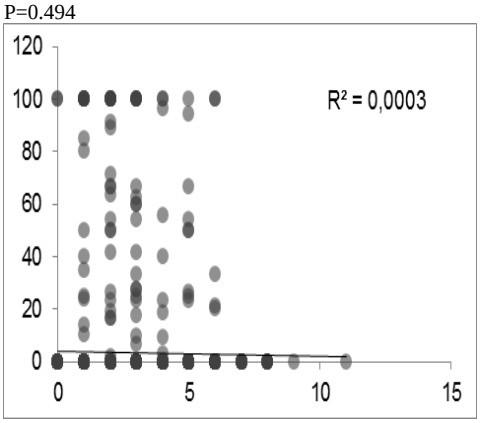
Supplement-Fig. S3: Tree density in the regeneration layer as related to basal area of canopy trees (as surrogate for light intensity), including plots without any regeneration. Note that plots without regeneration exist independent of basal area, which indicates an effect of browsing.



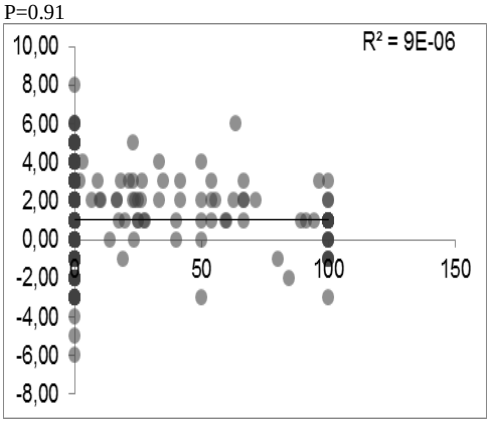
Supplement Fig S4: Single Correlations (not including interactions) of the structural equation model (See Fig. 4): Numbers in the title of each plot refer to the arrow of the initial model (Fig 4A) and to the final model for each forest type

Scatter diagram for Fig 4 B. Romania, Selectively cut forest

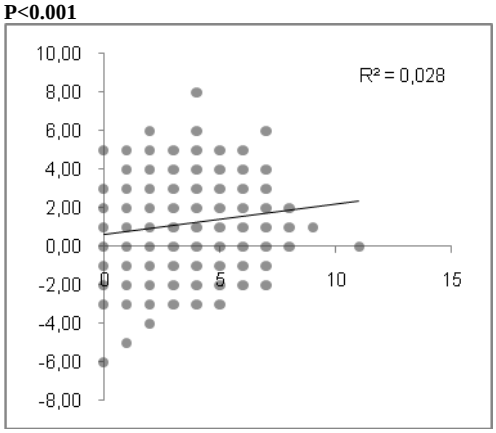
1: Correlation between Species number canopy and Browsing HC1: P=0.494



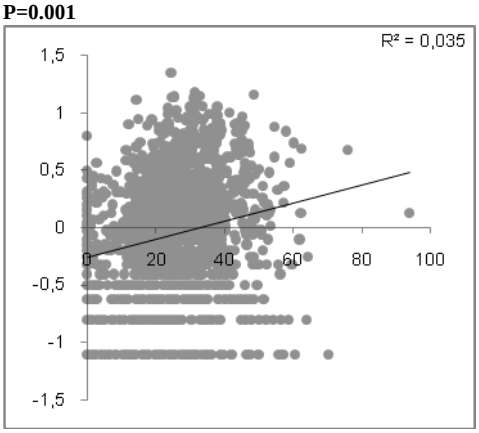
2: Correlation between Browsing HC1 and Species loss: P=0.91



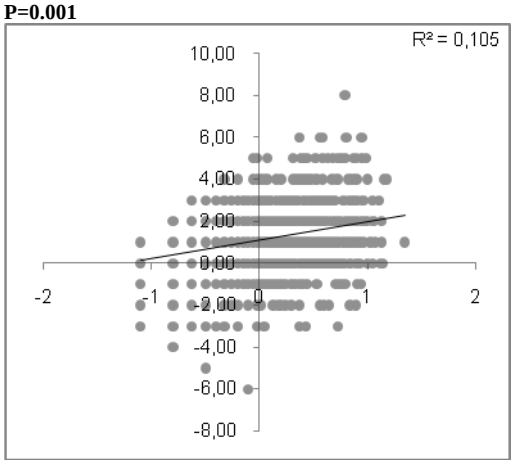
3: Correlation between Species number canopy and Species loss: **P<0.001**



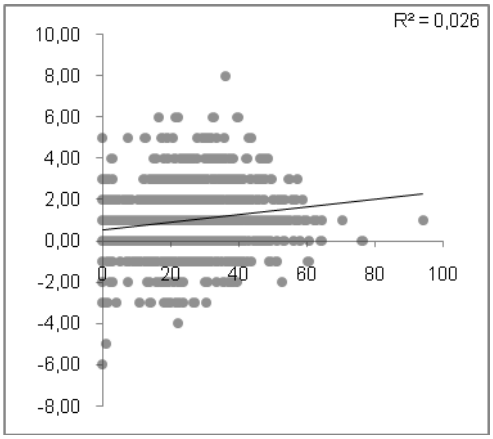
4: Correlation between Light ad log 10 Tree density HC1: **P=0.001**



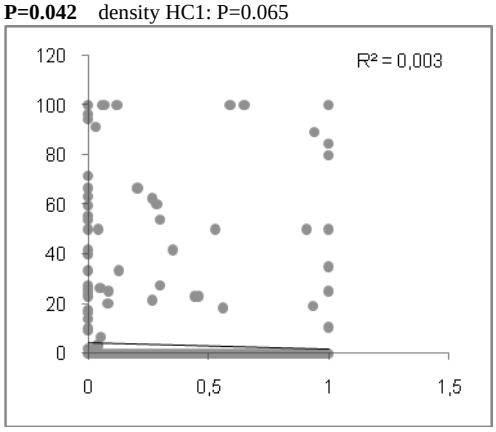
5: Correlation between log10 Tree density HC1 and Species loss: **P=0.001**



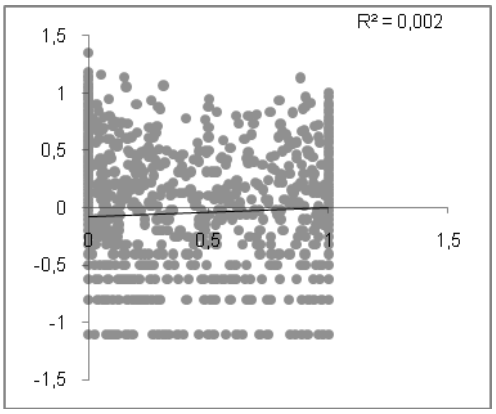
6: Correlation between Light and Species loss: **P<0.001**



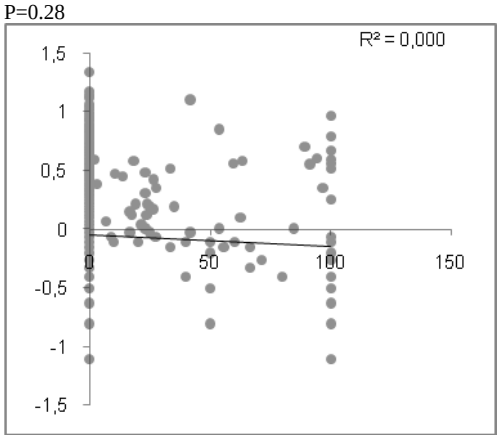
7: Correlation between Percent *Fagus* in canopy and Browsing HC1: **P=0.042** density HC1: P=0.065



8: Correlation between Percent *Fagus* in canopy and log10 Tree

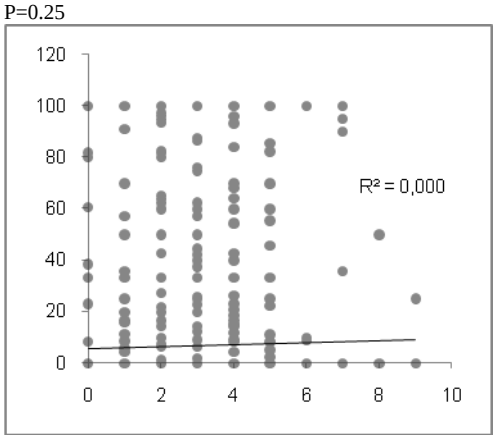


9: Correlation between log10 Tree density HC1 and Browsing HC1: P=0.28

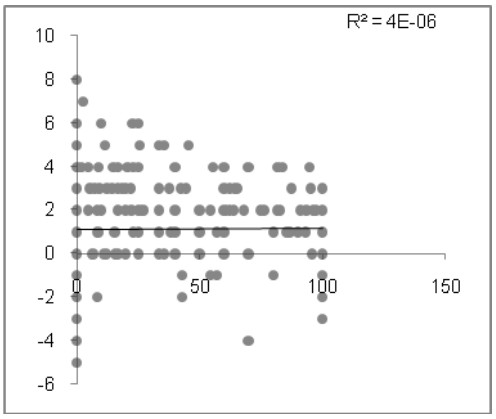


Scatter diagram for Fig. 4C: Romania, Age class forest

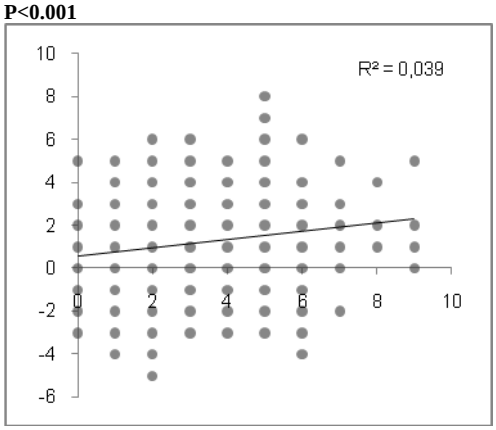
1: Correlation between Species number canopy and Browsing HC1:
P=0.25



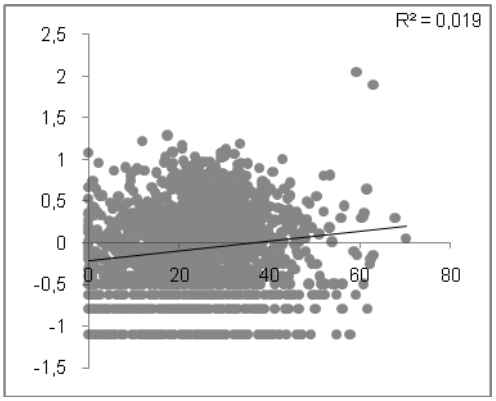
2: Correlation between Browsing HC1 and Species loss:
P=0.93



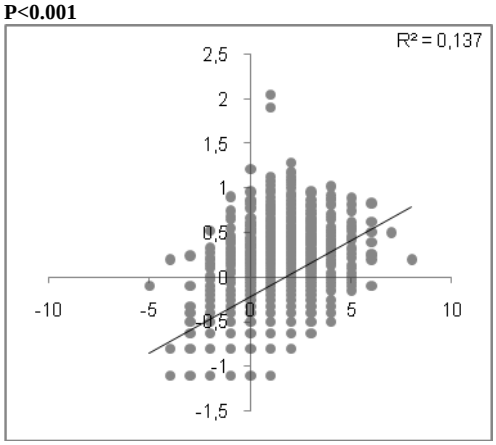
3: Correlation between Species number canopy and Species loss:
P<0.001



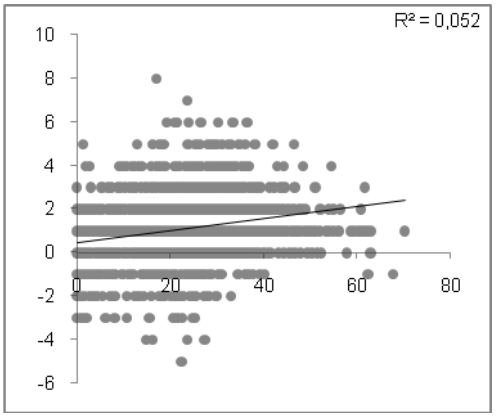
4: Correlation between Light and log10 Tree density HC1:
P<0.001



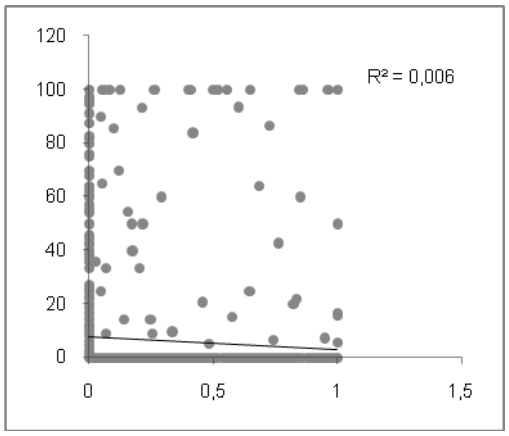
5: Correlation between log10 Tree density HC1 and Species loss:
P<0.001



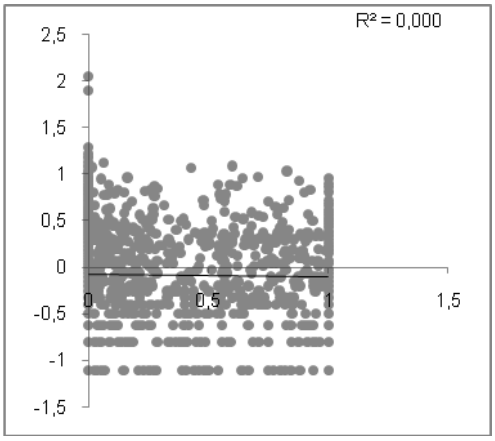
6: Correlation between Light and Species loss:
P=0.001



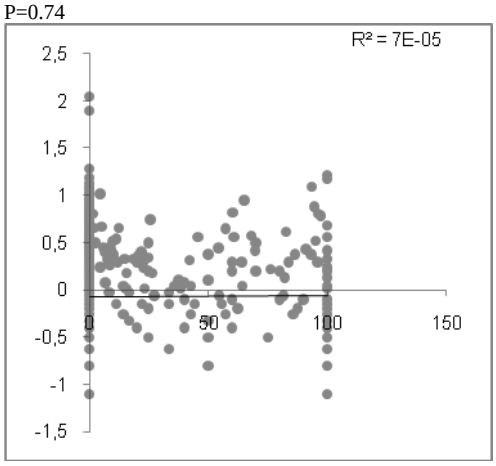
7: Correlation between Percent *Fagus* in canopy and Browsing HC1: **P=0.0013** density HC1:P=0.37



8: Correlation between Percent *Fagus* in canopy and log10 Tree

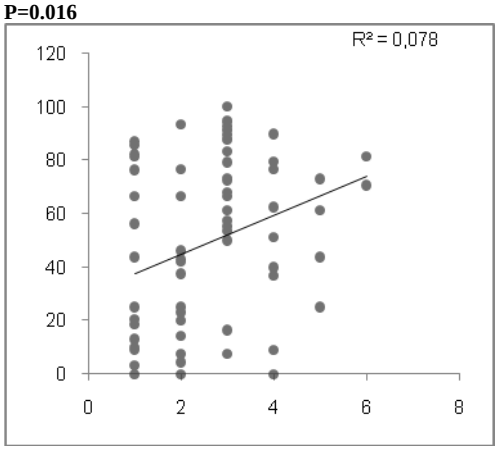


9: Correlation between log10 Tree density HC1 and Browsing HC1: P=0.74

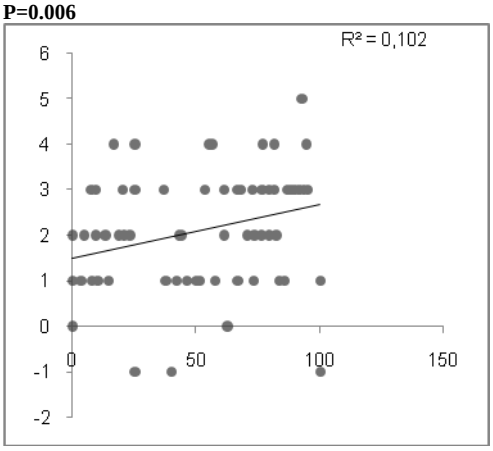


Scatter diagram for Fig. 4 D: Germany, Unmanaged forest

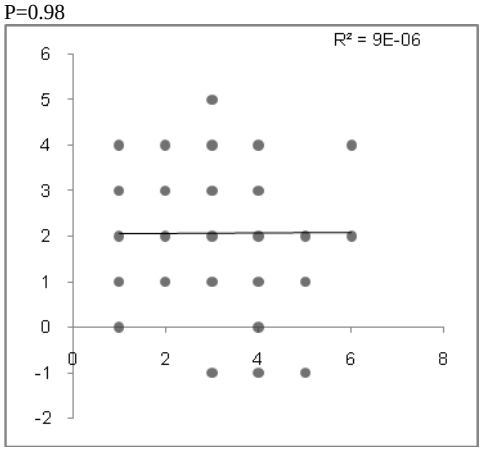
1: Correlation between Species number canopy and Browsing HC1: **P=0.016**



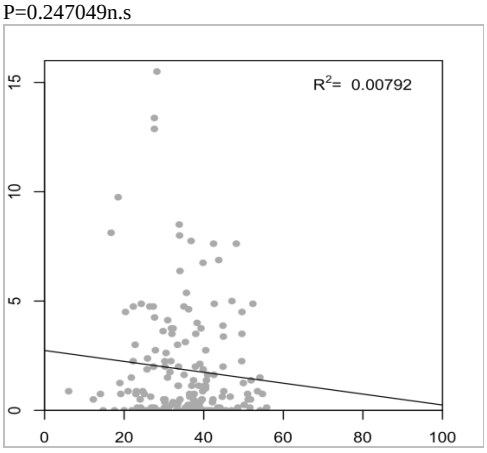
2: Correlation between Browsing HC1 and Species loss: **P=0.006**



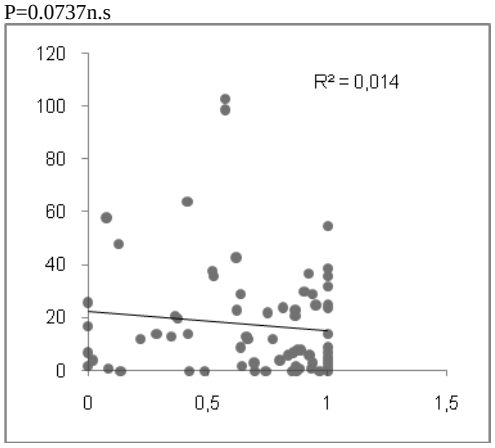
3: Correlation between Species number canopy and Species loss P=0.98



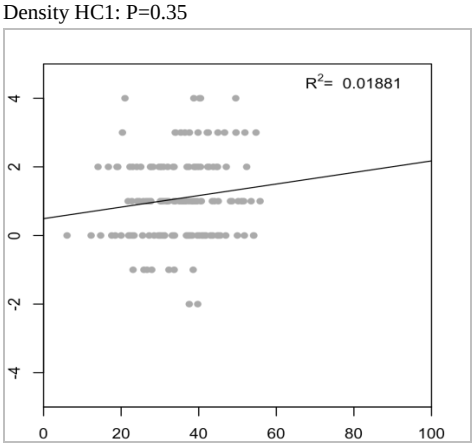
4: Correlation between Light and Tree Density HC1: P=0.247049n.s



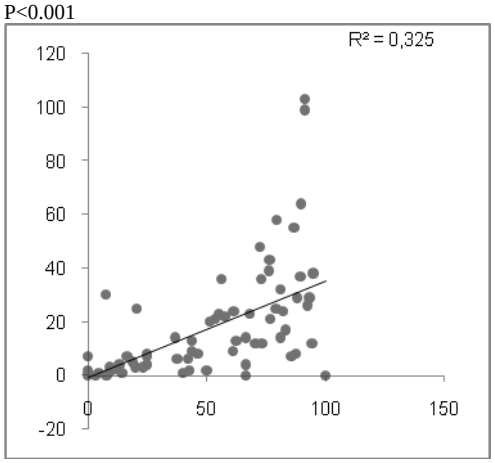
6: Correlation between Light and Species loss: P=0.0737n.s



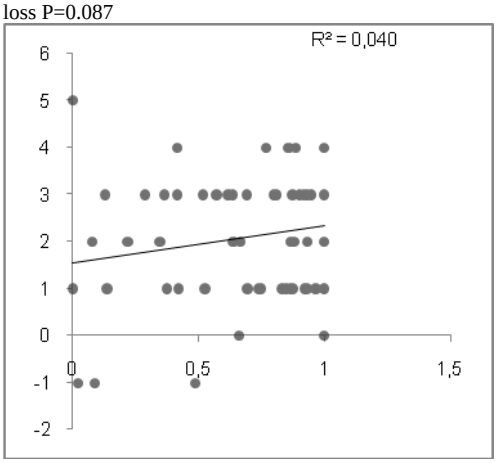
8: Correlation between Percent *Fagus* in canopy and Tree Density HC1: P=0.35



9:Correlation between Tree Density HC1 and Browsing HC1: P<0.001

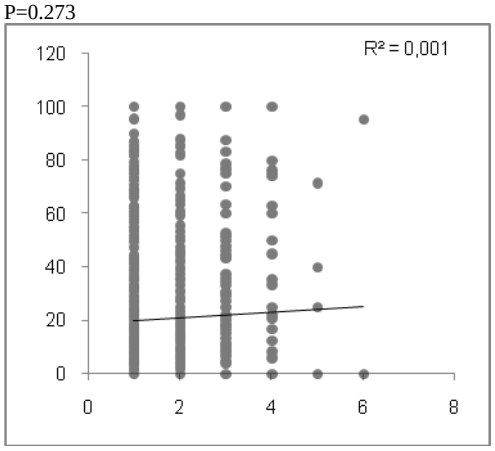


10: Correlation between Percent *Fagus* in canopy and Species loss P=0.087

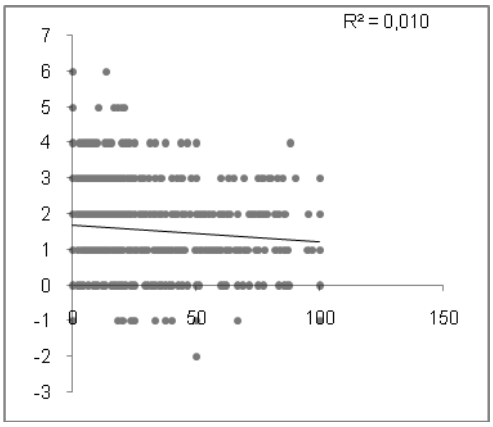


Scatter diagram for Fig. 4 E: Germany, Selectively cut forest

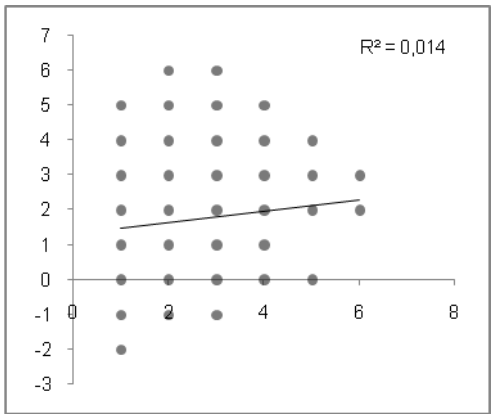
1:Correlation between Species number canopy and Browsing HC1:
P=0.273



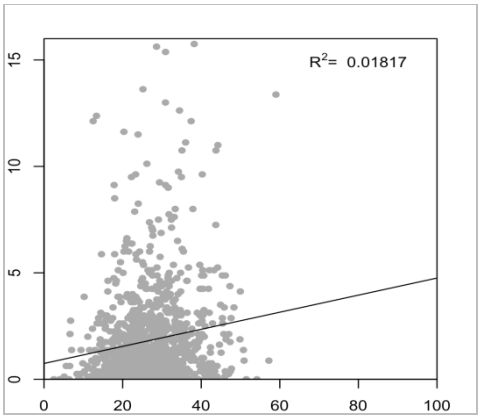
2: Correlation between Browsing HC1 and Species loss:
P=0.002



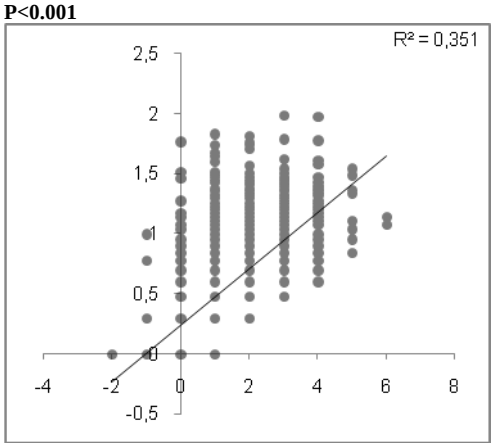
3:Correlation between Species number canopy and Extinction:
P<0.001



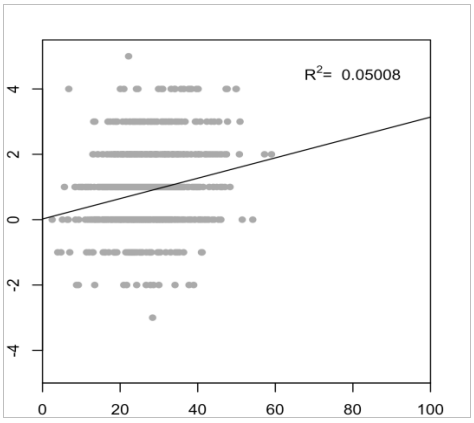
4:Correlation between Light and log10Tree Density HC1:
P=7.462e-



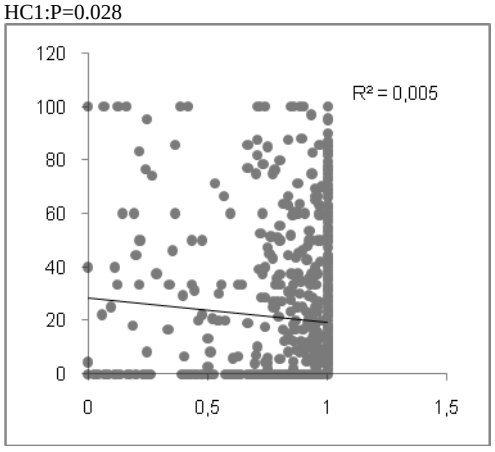
5: Correlation between log10 Tree density HC1 and Species loss:
P<0.001



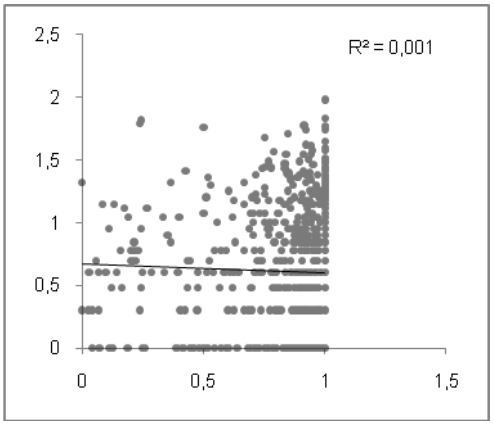
6: Correlation between Light and Species loss:
P=6.43e-14***



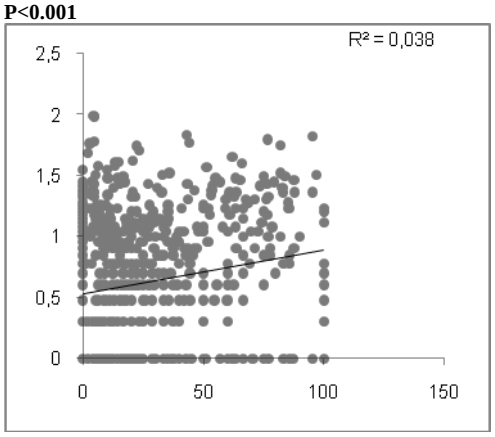
7: Correlation between Percent *Fagus* in canopy and Browsing HC1: HC1:P=0.028



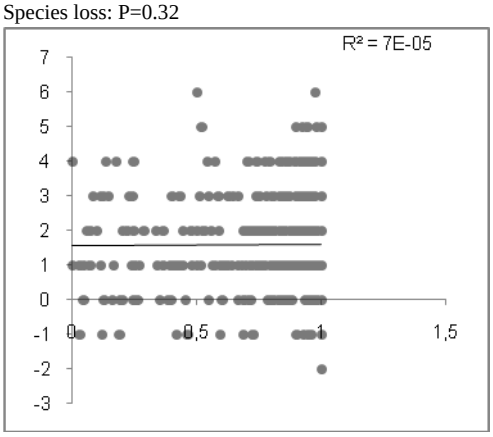
8:Correlation between Percent *Fagus* in canopy and log10 Tree Density P=0.79



9: Correlation between log10 Tree density HC1 and Browsing HC1: **P<0.001**

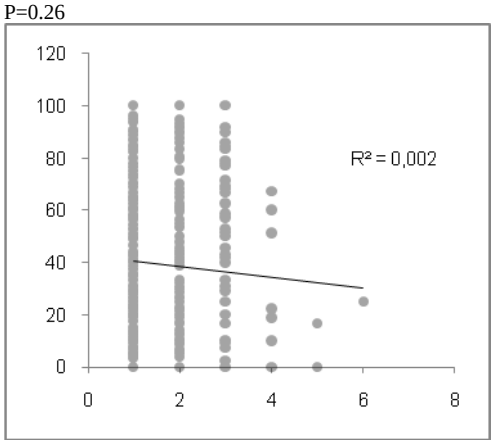


10:Correlation between Percent *Fagus* in canopy and Species loss: P=0.32

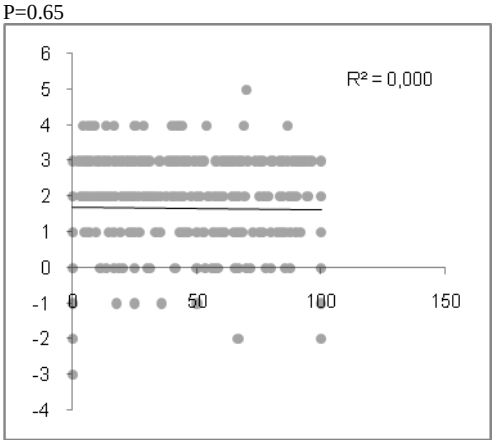


Scatter diagram for Fig. 4 F: Germany, Ageclass forest

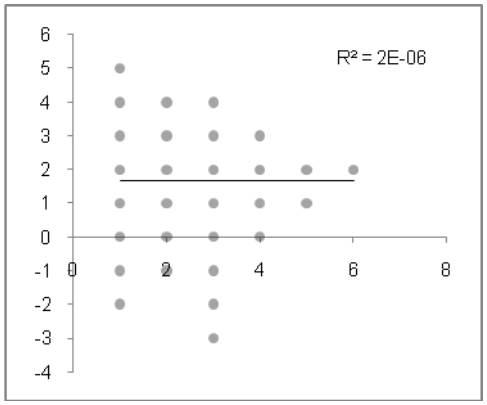
1: Correlation between Species number canopy and Browsing HC1:
P=0.26



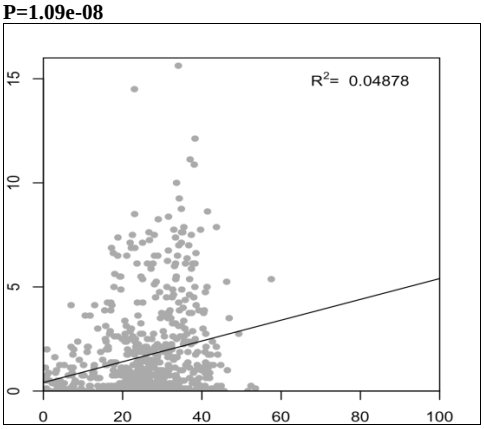
2: Correlation between Browsing HC1 and Species loss:
P=0.65



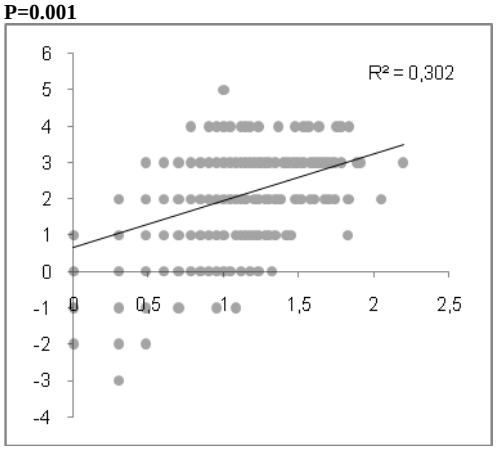
3: Correlation between Species number canopy and Species loss:
P=0.98



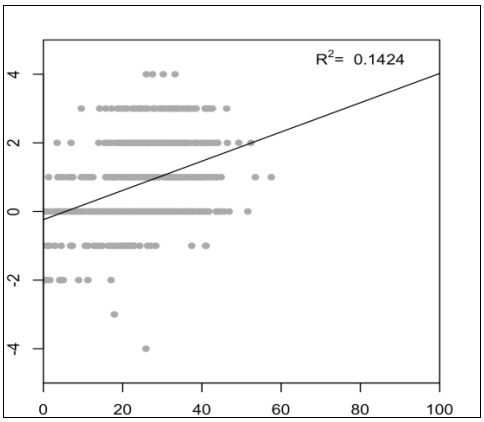
4: Correlation between Light and log10Tree Density HC1:
P=1.09e-08



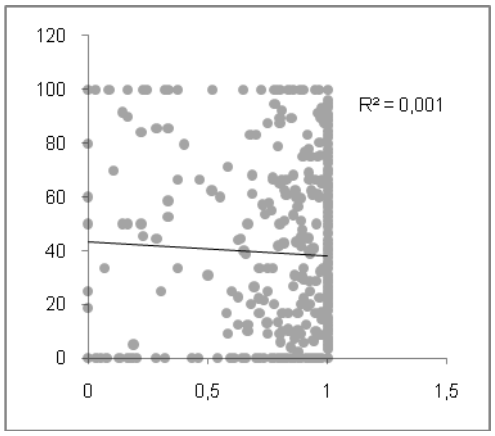
5: Correlation between log10 Tree Density HC1 and Extinction:
P=0.001



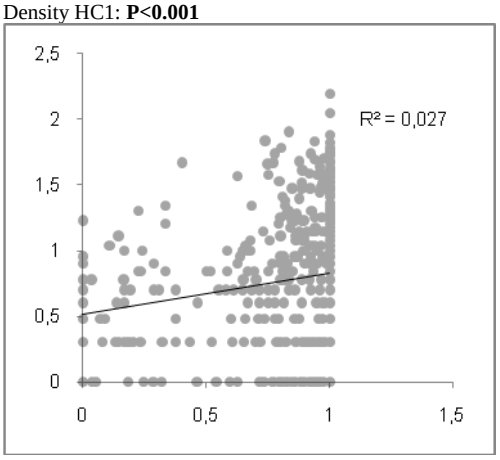
6: Correlation between Light and Species loss:
P=<2e-16***



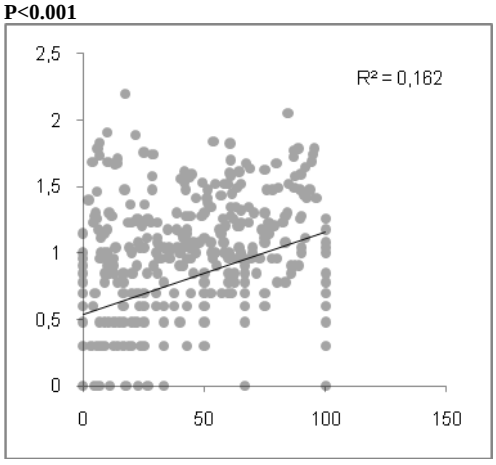
7: Correlation between Percent *Fagus* in canopy and Browsing HC1: P=0.35



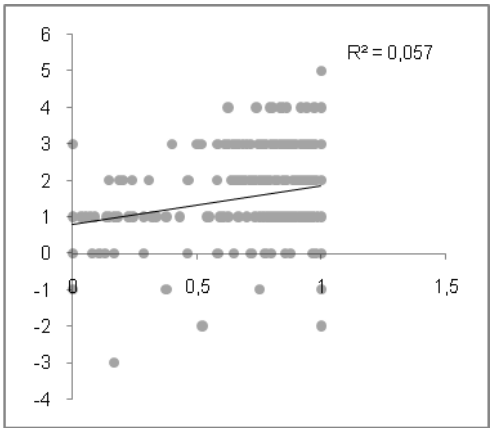
8: Correlation between Percent *Fagus* in canopy and log10 Tree Density HC1: **P<0.001**



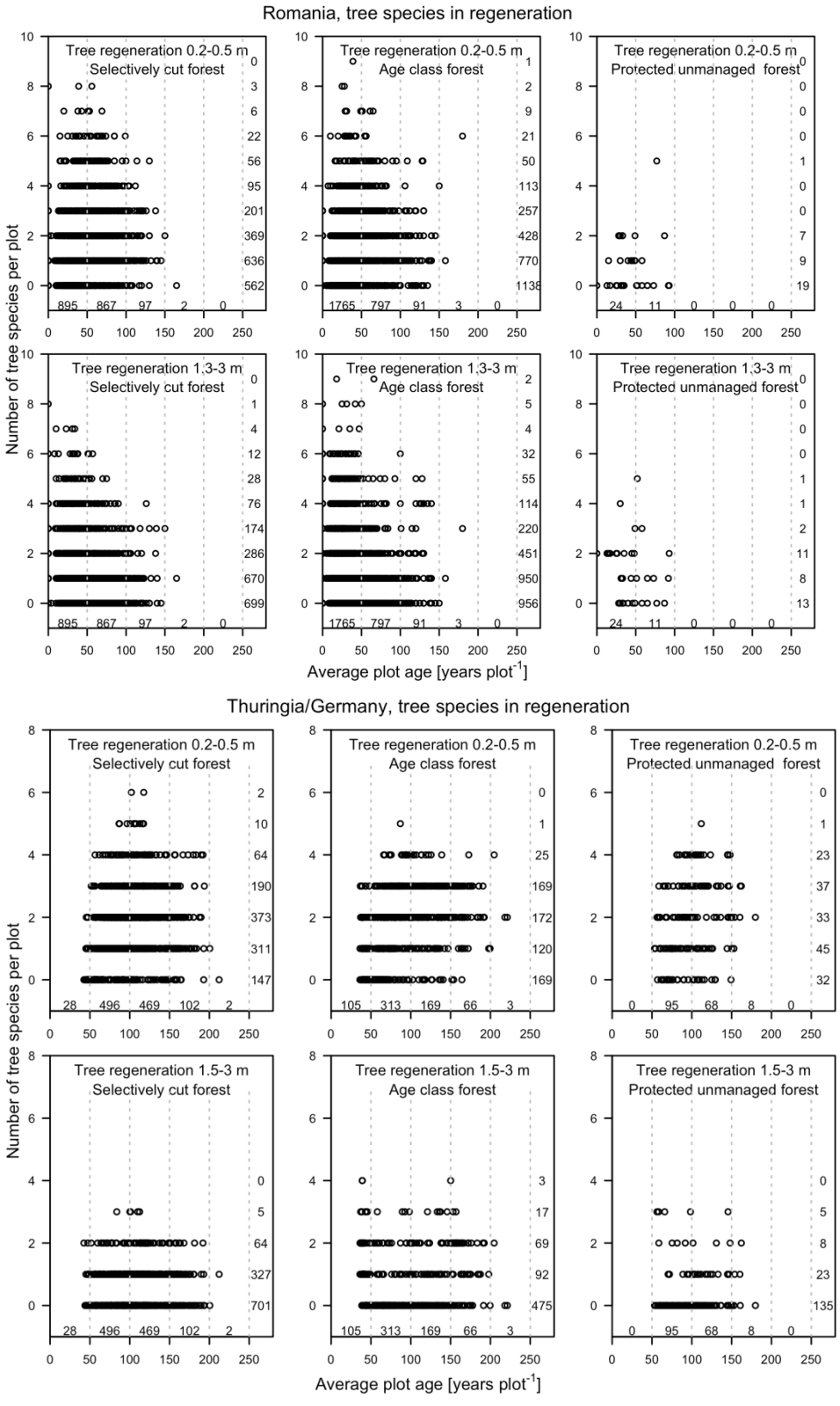
9: Correlation between log10Tree Density HC1 and Browsing HC1: **P<0.001**



10: Correlation between Percent *Fagus* in canopy and Browsing HC1: **P=0.001**



Supplement-Fig. S5: Scatter diagram of tree species number per inventory plot (500 m^2) in the regeneration layer of 0.2 to 0.5 m (left) and of 1.50 -3 m (right) as related to average stand age in Romania (A) and Germany (B). The total number of plots is the same as in Fig. 4. The numbers at the base of the plots and on the right vertical axis indicate the number of points in each row or segment.



Supplement-Fig. S6: Browsing in HC1 expressed as percentage of affected individuals as related to canopy stand age for different management types. The numbers at the margin of the plot indicate the total number of dots in each row and column grouped according to the management type