Ecography

Supplementary material

Appendix 1

Species-specific parameters for tree-height and LAI calculation.

Species	H_{max}	D_{max}	A_1	A_2	C_2
Abies alba	60	2.15	0.22	1.6	6
Acer pseudoplatanus	37	2.15	0.06	1.7	12
Betula pendula	29	1.15	0.08	1.4	12
Fagus sylvatica	45	2.25	0.06	1.7	12
Fraxinus excelsior	42	1.90	0.10	1.4	12
Picea abies	58	2.10	0.22	1.6	6
Pinus cembra	26	1.80	0.22	1.6	6
Pinus sylvestris	45	1.55	0.17	1.4	6
Quercus petraea	45	2.85	0.06	1.7	12
Quercus robur	52	3.20	0.06	1.7	12
Sorbus aria	22	0.55	0.10	1.4	12

Notes: H_{max}: maximum height used for calculation of actual tree height [m]; D_{max}: maximum diameter at breast height [m] used for calculation of actual tree height and LAI; A_1, A_2 and C_2: parameter values used for LAI estimation.

Appendix 2

LAI is defined as the projected leaf area [$m^2\,m^{-2}$], and indicates the amount of shade produced by canopies. The cumulative leaf area index (*CumLAI*; eq. S1) of large predictor trees relative to a response species is a function of the size of the forest plot (*PS*; [m^2]) and the species-specific double-sided foliage area (*FolA$_i$*; [m^2]; eq. S2) of an individual tree i if it is taller than the actual median height of all species in a stand (H_{am}). This quantity is calculated from the foliage dry weight (*FolW$_i$*; [kg]; eq. S3; (Burger 1945–1953)):

$$CumLAI = \frac{1}{PS} \times \sum_{i\,|\,H_i \geq H_{am}}^{n} FolA_i \qquad (S1)$$

with

$$FolA_i = \frac{C_{2i}}{C_{1i}} \times FolW_i \qquad (S2)$$

where C_{1i} [%/100] is the dry-to-wet ratio of foliage and C_{2i} [$m^2\,kg^{-1}$] is the foliage area per unit foliage weight, and

$$FolW_i = C_{1i} \times A_{1i} \times D_{ai}^{A_{2i}} \qquad (S3)$$

where A_{1i} [kg cm^{-1}] and A_{2i} [–] are allometric parameters for foliage weight. The species-specific parameter values (C_{1i}, A_{1i} and A_{2i}) were taken from Bugmann (1994). For each target response species we estimated the LAI_L of predictor species of individuals that were larger than the median of the response species in each plot.

Appendix 3

Summary table of model accuracies of ABIOT, BIOT and FULL-models calibrated with presence-absence data (PA; K, AUC) as response variable and topo-climatic (topo-clim), species-specific proportions of abundance ($_{AB}$) and species-specific proportion of large individuals ($_{AB\_L}$) as predictors. Accuracies were derived by 10-fold cross validation (CV) and external validation on NFI_1e (NFI_1 data from plots not used for model calibration).

| | ABIOT | | | | $BIOT_{AB}$ | | | | $BIOT_{AB\_L}$ | | | | $FULL_{AB}$ | | | | $FULL_{AB\_L}$ | | | |
| | CV | | EXT | | CV | | EXT | | CV | | EXT | | CV | | EXT | | CV | | EXT | |
	K	AUC	K	AUC	K	AUC	K	AUC	K	AUC	K	AUC	K	AUC	K	AUC	K	AUC	K	AUC
Abies alba	0.34	0.78	0.35	0.78	0.37	0.81	0.37	0.81	0.32	0.7	0.31	0.69	0.57	0.89	0.58	0.9	0.49	0.86	0.48	0.86
Acer pseudoplatanus	0.19	0.73	0.16	0.7	0.18	0.77	0.19	0.77	0.12	0.68	0.11	0.67	0.35	0.85	0.33	0.84	0.24	0.77	0.2	0.74
Betula pendula	0.22	0.83	0.17	0.8	0.15	0.83	0.12	0.81	0.12	0.78	0.09	0.78	0.25	0.89	0.19	0.88	0.21	0.87	0.17	0.86
Fagus sylvatica	0.45	0.81	0.44	0.81	0.45	0.83	0.42	0.82	0.2	0.66	0.23	0.68	0.64	0.91	0.64	0.91	0.5	0.83	0.49	0.83
Fraxinus excelsior	0.2	0.78	0.2	0.78	0.27	0.8	0.25	0.8	0.15	0.67	0.13	0.63	0.39	0.89	0.39	0.89	0.28	0.83	0.24	0.81
Picea abies	0.37	0.78	0.35	0.76	0.43	0.76	0.41	0.77	0.54	0.8	0.53	0.8	0.58	0.87	0.57	0.87	0.61	0.88	0.59	0.87
Pinus cembra	0.36	0.98	0.33	0.98	0.21	0.93	0.21	0.94	0.21	0.9	0.19	0.89	0.42	0.99	0.4	0.98	0.39	0.98	0.37	0.98
Pinus sylvestris	0.19	0.81	0.19	0.81	0.17	0.78	0.16	0.78	0.3	0.84	0.3	0.84	0.31	0.88	0.3	0.88	0.38	0.92	0.37	0.92
Quercus petraea	0.14	0.86	0.16	0.87	0.14	0.84	0.15	0.85	0.08	0.72	0.09	0.76	0.24	0.92	0.25	0.93	0.16	0.88	0.18	0.89
Quercus robur	0.12	0.87	0.11	0.86	0.06	0.76	0.07	0.79	0.04	0.66	0.04	0.66	0.16	0.9	0.16	0.91	0.13	0.88	0.12	0.87
Sorbus aria	0.07	0.75	0.06	0.74	0.04	0.74	0.04	0.73	0.09	0.72	0.06	0.7	0.08	0.8	0.08	0.81	0.11	0.82	0.08	0.78
Mean	0.24	0.82	0.23	0.81	0.22	0.8	0.22	0.81	0.2	0.74	0.19	0.74	0.36	0.89	0.35	0.89	0.32	0.87	0.3	0.86
Stdv	0.12	0.07	0.12	0.07	0.14	0.05	0.13	0.05	0.15	0.08	0.14	0.08	0.18	0.05	0.18	0.04	0.17	0.06	0.17	0.07

Appendix 4

Summary table of model accuracies of ABIOT, BIOT and FULL-models calibrated with proportions of basal areas (BA; MAE, RMSE and R^2) as response variable and topo-climatic (topo-clim), species specific proportions of abundance ($_{AB}$) and species specific proportion of large individuals ($_{AB\_L}$) as predictors. Accuracies were derived by 10-fold cross validation (CV) and external validation on NFI_1e (NFI_1 data from plots not used for model calibration).

| | ABIOT | | | | | | BIOT$_{AB}$ | | | | | | BIOT$_{AB\_L}$ | | | | | | FULL$_{AB}$ | | | | | | FULL$_{AB\_L}$ | | | | | |
| | CV | | | EXT | | | CV | | | EXT | | | CV | | | EXT | | | CV | | | EXT | | | CV | | | EXT | | |
	MAE	RMSE	R^2	MAE	RMSE	R^2	MAE	RMSE	R^2	MAE	RMSE	R^2	MAE	RMSE	R^2	MAE	RMSE	R^2	MAE	RMSE	R^2	MAE	RMSE	R^2	MAE	RMSE	R^2	MAE	RMSE	R^2
Abies alba	0.15	0.79	12.86	0.15	0.21	14.01	0.13	1.51	25.19	0.13	1.20	24.80	0.16	1.24	6.07	0.17	0.94	5.55	0.08	1.16	53.79	0.09	0.85	55.18	0.13	0.94	25.91	0.13	0.77	26.31
Acer pseudoplatanus	0.04	0.53	1.96	0.04	0.52	1.31	0.05	0.57	8.77	0.05	0.68	8.03	0.05	0.77	0.91	0.05	0.90	0.18	0.04	0.39	16.66	0.04	0.53	20.10	0.05	0.75	3.24	0.05	0.89	2.28
Betula pendula	0.02	0.40	12.99	0.02	0.28	8.68	0.02	0.39	6.74	0.02	0.22	5.95	0.02	0.43	4.50	0.02	0.27	4.46	0.02	0.39	23.08	0.02	0.26	21.05	0.02	0.43	18.98	0.02	0.28	16.55
Fagus sylvatica	0.18	0.33	18.79	0.18	0.04	17.44	0.16	0.15	32.02	0.16	0.43	31.51	0.22	0.50	7.80	0.22	0.31	7.42	0.11	0.42	59.17	0.11	0.29	58.15	0.17	0.71	29.82	0.17	0.47	27.23
Fraxinus excelsior	0.05	0.65	4.80	0.05	0.36	4.85	0.05	0.32	14.71	0.05	0.11	13.74	0.06	0.57	4.02	0.05	0.34	3.50	0.04	0.33	26.77	0.04	0.16	27.73	0.05	0.54	12.48	0.05	0.37	13.44
Picea abies	0.29	3.08	26.52	0.30	3.17	23.93	0.21	4.69	43.38	0.21	5.14	41.10	0.28	5.50	26.26	0.29	6.13	23.64	0.16	3.92	61.77	0.16	3.97	61.75	0.24	4.72	41.59	0.24	4.99	39.11
Pinus cembra	0.01	0.02	35.25	0.01	0.01	30.56	0.02	0.17	10.91	0.02	0.29	7.72	0.02	0.01	8.03	0.02	0.12	4.96	0.01	0.05	38.12	0.01	0.07	33.46	0.01	0.00	32.62	0.01	0.01	29.52
Pinus sylvestris	0.06	0.24	15.94	0.06	0.36	8.63	0.06	1.14	4.91	0.06	1.26	2.49	0.05	1.10	9.57	0.06	1.28	2.49	0.04	1.04	25.16	0.04	1.18	18.08	0.04	0.95	32.09	0.04	1.14	17.91
Quercus petraea	0.02	0.10	5.13	0.02	0.15	7.47	0.02	0.13	6.46	0.02	0.14	9.78	0.02	0.03	2.07	0.02	0.00	4.16	0.02	0.13	21.50	0.02	0.21	18.16	0.02	0.06	10.16	0.02	0.08	15.03
Quercus robur	0.02	0.02	2.71	0.02	0.05	6.01	0.02	0.20	1.19	0.02	0.22	−0.36	0.02	0.14	−0.67	0.02	0.15	−1.41	0.01	0.16	1.60	0.01	0.21	3.37	0.01	0.12	2.37	0.01	0.16	4.74
Sorbus aria	0.00	0.07	0.81	0.00	0.02	0.42	0.01	0.22	0.70	0.01	0.15	0.68	0.01	0.23	0.18	0.01	0.16	−0.19	0.01	0.21	3.87	0.01	0.13	1.75	0.01	0.23	2.13	0.01	0.16	0.86
Mean	0.08	0.57	12.52	0.08	0.47	11.21	0.07	0.86	14.09	0.07	0.89	13.22	0.08	0.96	6.25	0.08	0.97	5.16	0.05	0.75	30.13	0.05	0.71	28.98	0.07	0.86	19.22	0.07	0.85	17.54
Stdv	0.09	0.87	11.06	0.09	0.91	9.44	0.07	1.35	13.72	0.09	1.47	13.51	0.09	1.56	7.46	0.10	1.76	6.69	0.05	1.11	20.77	0.05	1.13	20.99	0.08	1.33	14.01	0.08	1.42	12.16