Appendices: Lianas differentially impact population growth rates of tropical tree species

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Contents

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S1 Tables

Table S1. Overview of species used in each analysis, ordered alphabetically. A cross (X) indicates a species was included.

Species	Fecundity	Reproduction	Growth	Survival
Acalypha diversifolia	X	X		
Alchornea costaricensi	X	X	X	X
Alseis blackiana	X	X	X	X
Anacardium excelsum	X	X	X	X
Apeiba membranacea	X	X	X	X
Apeiba tibourbou	X	X	X	X
Aspidosperma spruceanum	X	X		
Astrocaryum standleyanum	X	X	X	X
Astronium graveolens	X	X	X	X
Beilschmiedia pendula	X	X	X	X
Brosimum alicastrum	X	X		
Calophyllum longifolium	X	X		
Casearia aculeata	X	X		
Casearia arborea	X	X	X	X
Cassipourea elliptica	X	X		
Cecropia insignis	X	X		
Cecropia obtusifolia	X	X	X	X
Ceiba pentandra	X	X	X	X
Chrysophyllum argenteum	X	X	X	X
Chrysophyllum cainito	X	X	X	X
Cordia alliodora	X	X		
Cordia bicolor	X	X		
Coussarea curvigemmia	X	X		
Croton billbergianu	X	X		
Cupania seemannii	X	X	X	X
Desmopsis panamensis	X	X	X	X
Dipteryx oleifera	X	X		
Drypetes standleyi	X	X		
Eugenia galalonensis	X	X	X	X
Eugenia nesiotica	X	X		
Eugenia oerstediana	X	X	X	X
Faramea occidentalis	X	X	X	X
Garcinia intermedia	X	X	X	X
Guapira standleyana	X	X		
Guarea guidonia	X	X	X	X
Guatteria dumetorum	X	X		
Guettarda foliacea	X	X	X	X
Gustavia superba	X	X	X	X
Hasseltia floribunda	X	X	X	X
Heisteria concinna	X	X		
Hirtella triandra	X	X	X	X
Hura crepitans	X	X		
Hieronyma alchorneoide	X	X	X	X
Inga marginata	X	X	X	X
Jacaranda copaia	X	X	X	X
Laetia thamnia	X	X		
Lindackeria laurina	X	X		
Lonchocarpus heptaphyllus	X	X	X	X
Luehea seemannii	X	X		

Continued on next page

Table S1. Overview of species used in each analysis, ordered alphabetically. A cross (X) indicates a species was included.

Species	Fecundity	Reproduction	Growth	Survival
Macrocnemum roseum	X	X		
Mosannona garwoodii	X	X		
Miconia affinis	X	X	X	X
Miconia argentea	X	X	X	X
Miconia nervosa	X	X		
Mouriri myrtilloides	X	X	X	X
Nectandra cissiflora	X	X		
Ocotea cernua	X	X	X	X
Ocotea oblonga	X	X	X	X
Ocotea whitei	X	X	X	X
Oenocarpus mapora	X	X		
Platymiscium pinnatum	X	X		
Platypodium elegans	X	X	X	X
Pachira sessilis	X	X	X	X
Poulsenia armata	X	X		
Pouteria reticulata	X	X	X	X
Prioria copaifera	X	X		
Protium costaricense	X	X		
Protium panamense	X	X	X	X
Protium tenuifolium	X	X	X	X
Pseudobombax septenatum	X	X		
Pterocarpus rohrii	X	X	X	X
Quararibea asterolepis	X	X	X	X
Randia armata	X	X	X	X
Rinorea sylvatica	X	X	X	X
Attalea butyracea	X	X		
Simarouba amara	X	X		
Sloanea terniflora	X	X	X	X
Socratea exorrhiza	X	X	X	X
Spondias radlkoferi	X	X	X	X
Tabebuia guayacan	X	X	X	X
Tabebuia rosea	X	X	X	X
Tabernaemont arborea	X	X	X	X
Tachigali versicolor	X	X	X	X
Talisia nervosa	X	X		
Terminalia amazonia	X	X	X	X
Terminalia oblonga	X	X		
Tetragastris panamensis	X	X		
Trattinnicki aspera	X	X	X	X
Trichilia pallida	X	X		
Trichilia tuberculata			X	X
Triplaris cumingiana			X	X
Unonopsis pittieri			X	X
Virola sebifera			X	X
Virola multiflora			X	X
Virola surinamensis			X	X
Vochysia ferruginea			X	X
Xylopia macrantha			X	X
Zanthoxylum ekmanii			X	X
Zanthoxylum panamense			X	X

Table S2. The focal species used to create integral projection models, and corresponding sample sizes in the various datasets (described in the maintext). The columns seeds, recruits, seedlings, trees,and reproduction correspond to the number of individual records of seeds (dataset 2), new recruits (dataset 3) from the seedling census (dataset 4), BCI 50ha FDP census and towerplot data (dataset 1), and the data on the reproduction and liana census (dataset 6). A total of 33 have enough data

Species	Seeds	Recruits	Seedlings	Trees	Reproduction
Alchornea costaricensi	10187	77	336	828	215
Alseis blackiana	152070	70	2060	13182	1203
Apeiba membranacea	8028	127	298	570	160
Beilschmiedi pendula	1708	1935	16382	4056	77
Brosimum alicastrum	6687	97	1558	1194	262
Cecropia insignis	80899	187	834	2551	684
Chrysophyllu argenteum	39	33	407	1119	45
Chrysophyllu cainito	919	220	908	271	22
Cordia alliodora	5188	105	477	433	227
Cordia bicolor	5770	63	641	2222	503
Drypetes standleyi	639	81	1122	3080	129
Eugenia oerstediana	1717	883	6906	4039	91
Garcinia intermedia	1237	53	971	6945	792
Guarea guidonia	216	365	1013	3134	424
Guatteria dumetorum	907	505	191	2293	167
Gustavia superba	741	222	1589	1187	57
Heisteria concinna	79938	160	1072	1189	219
Hieronyma alchorneoide	155	104	70	265	36
Jacaranda copaia	97	43	284	783	416
Luehea seemannii	3385	115	540	648	508
Miconia argentea	117	186	728	2884	177
Ocotea whitei	350	68	4715	1566	261
Platypodium elegans	646	340	105	312	132
Pouteria reticulata	352	111	3869	2705	190
Quararibea asterolepis	1213	184	7317	3207	52
Simarouba amara	1472	98	784	3787	381
Tabebuia guayacan	3262	133	254	132	132
Tabebuia rosea	730	44	464	573	279
Tabernaemont arborea	3729	58	365	2544	78
Tetragastris panamensis	2343	575	3909	7213	327
Trichilia pallida	366	49	146	1157	500
Trichilia tuberculata	28841	3756	9577	20309	508
Triplaris cumingiana	716	154	247	640	355

Table S3. Sample size within each liana infestation class (see main document), for seed production and reproductive fraction, for each of focal species used to create integral projection models. The columns L0-L4 correspond to 0%, 1% - 24%, 25% - 49%, 49% - 74% and 75% - 100% of the crown area infested with lianas.

Species	L0	L1	L2	L3	L4
Alchornea costaricensi	37	47	47	27	53
Alseis blackiana	228	168	118	79	212
Apeiba membranacea	83	65	40	31	47
Beilschmiedi pendula	27	22	6	6	16
Brosimum alicastrum	136	99	46	34	37
Cecropia insignis	587	12	4	0	11
Chrysophyllu argenteum	5	11	3	5	24
Chrysophyllu cainito	3	6	5	4	2
Cordia alliodora	116	22	6	3	12
Cordia bicolor	183	99	111	87	78
Drypetes standleyi	64	34	13	10	8
Eugenia oerstediana	36	15	16	17	7
Garcinia intermedia	430	244	93	45	84
Guarea guidonia	352	212	45	33	35
Guatteria dumetorum	81	51	35	32	43
Gustavia superba	26	18	6	4	3
Heisteria concinna	114	127	50	18	20
Hieronyma alchorneoide	318	294	82	75	56
Jacaranda copaia	258	30	15	12	20
Luehea seemannii	72	113	68	52	65
Miconia argentea	56	27	25	9	60
Ocotea whitei	101	80	50	31	20
Platypodium elegans	29	20	13	8	27
Pouteria reticulata	83	46	22	21	33
Quararibea asterolepis	45	14	8	4	8
Simarouba amara	186	54	44	45	87
Tabebuia guayacan	31	14	14	10	15
Tabebuia rosea	64	31	15	20	86
Tabernaemont arborea	27	28	12	8	12
Tetragastris panamensis	121	131	86	71	59
Trichilia pallida	239	202	87	52	38
Trichilia tuberculata	297	181	113	72	50
Triplaris cumingiana	293	14	19	7	19

Table S4. Sample size within each liana infestation class (see main document), for growth and survival, for each of focal species used to create integral projection models. The columns L0-L4 correspond to 0%, 1% - 24%, 25% - 49%, 49% - 74% and 75% - 100% of the crown area infested with lianas.

Species	L0	L1	L2	L3	L4
Alchornea costaricensi	14	39	47	18	29
Alseis blackiana	52	54	34	32	99
Apeiba membranacea	4	1	6	8	23
Beilschmiedi pendula	8	3	5	2	11
Brosimum alicastrum	44	10	10	14	12
Cecropia insignis	189	6	2	1	2
Chrysophyllu argenteum	3	12	13	4	23
Chrysophyllu cainito	3	5	6	4	2
Cordia alliodora	69	10	8	3	9
Cordia bicolor	98	54	79	63	75
Drypetes standleyi	4	4	7	4	6
Eugenia oerstediana	41	18	18	17	11
Garcinia intermedia	162	99	68	26	45
Guarea guidonia	8	9	19	7	15
Guatteria dumetorum	12	5	4	1	4
Gustavia superba	50	44	20	14	29
Heisteria concinna	6	15	2	4	8
Hieronyma alchorneoide	7	13	6	9	11
Jacaranda copaia	185	20	14	7	14
Luehea seemannii	28	32	31	23	41
Miconia argentea	60	28	26	9	64
Ocotea whitei	17	30	28	19	13
Platypodium elegans	6	11	2	1	13
Pouteria reticulata	4	7	5	2	8
Quararibea asterolepis	16	14	9	5	10
Simarouba amara	103	24	20	21	38
Tabebuia guayacan	11	5	10	4	6
Tabebuia rosea	13	13	7	4	34
Tabernaemont arborea	5	8	6	6	17
Tetragastris panamensis	8	23	25	20	41
Trichilia pallida	73	81	48	23	11
Trichilia tuberculata	28	40	29	21	64
Triplaris cumingiana	117	6	10	1	11

Table S5. AIC values for the size dependent fraction of reproductive individuals, including Δ AIC values. Model null, size, main and full correspond to mixed effect models including no predictions, using only size, size including additive effects of liana load and full interactions between size and liana load respectively.

Model	AIC	Δ AIC
Null	19219	3512
Size	16498	791
Main	15710	3
Full	15707	0

Table S6. AIC values for the size dependent seed production (fraction of crown bearing reproductive structures), including Δ AIC values. Model null, size, main and full correspond to mixed effect models including no predictions, using only size, size including additive effects of liana load and full interactions between size and liana load respectively.

Model	AIC	Δ AIC
Null	2300	450
Size	2082	233
Main	1850	0
Full	1875	25

Table S7. AIC values for the size dependent basal area growth, including Δ AIC values. Model null, size, main and full correspond to mixed effect models including no predictions, using only size, size including additive effects of liana load and full interactions between size and liana load respectively.

Model	AIC	Δ AIC
Null	94670	11665
Size	94543	11538
Main	83062	57
Full	83005	0

Table S8. AIC values for the size dependent survival, including Δ AIC values. Model null, size, main and full correspond to mixed effect models including no predictions, using only size, size including additive effects of liana load and full interactions between size and liana load respectively.

Model	AIC	Δ AIC
Null	5191	587
Size	5075	471
Main	4603	0
Full	4609	6

Table S9. Fit coefficients (fixed-effects) of the AIC selected mixed models (and standard errors). Intercept and slope values are the "species mean" coefficients relating to size-dependent reproduction, fecundity, growth and survival for liana free trees. Coefficients L1-L4 relate to main effects of lianas for each crown infestation class (see main text), while the L(1-4):size are the coefficients relating to size - infestation class interactions.

	Fecundity	Reproduction	Growth	Survival
Intercept	0.6833 (0.0224)	-0.4628 (0.2924)	2772.214 (308.1966)	2.067 (0.1346)
Slope	0.1762 (0.0218)	2.8014 (0.2603)	-37.3389 (193.466)	-0.1963 (0.1003)
L1	-0.0763 (0.0132)	0.034 (0.0909)	-443.3472 (135.146)	0.1746 (0.1549)
L2	-0.1141 (0.0215)	-0.2458 (0.1182)	-855.2915 (199.6878)	0.0702 (0.1717)
L3	-0.167 (0.0233)	-0.5911 (0.1321)	-999.2213 (179.128)	-0.2263 (0.1926)
L4	-0.1895 (0.0338)	-1.9947 (0.1899)	-1337.3534 (200.4283)	-0.5799 (0.179)
L1:size			103.2487 (127.7744)	
L2:size			395.7886 (159.3142)	
L3:size			-529.8031 (175.0574)	
L4:size			-207.356 (160.3242)	

S2 Figures

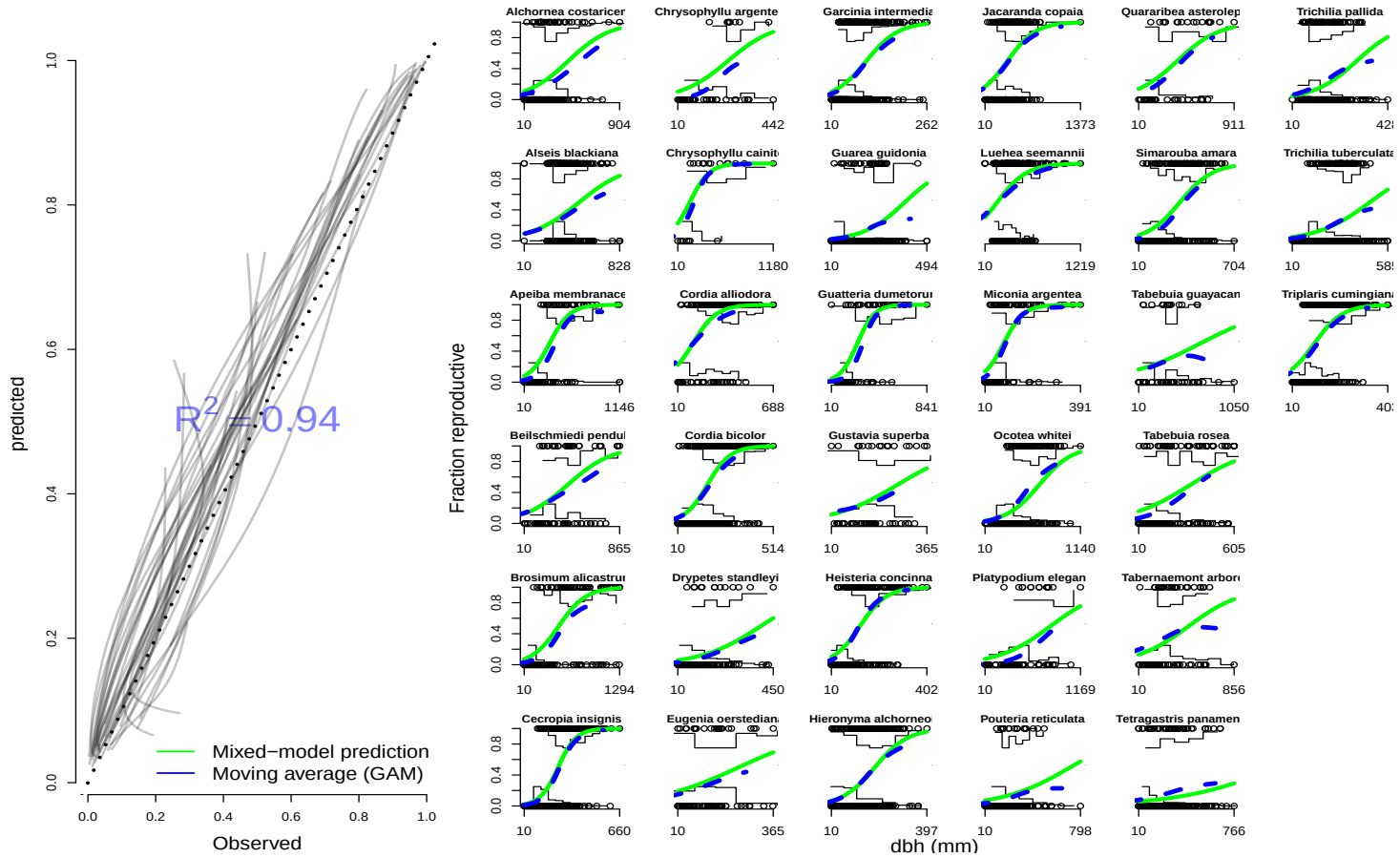

Figure S1. The proportion of reproductive individuals as a function of tree size (dbh). The large panel on the left shows the agreement between the model predictions (y-axis) from the mixed-model (see maintext) and an general additive model (GAM) fit for each species on the data (x-axis). The smaller panels on the right show model fits per species over size (dbh in mm). Here, the green line shows the predicted values by the fitted mixed effect model (corresponding to the y-axis on the large left panel), while the blue lines indicates a GAM predicted moving average (corresponding to the x-axis on the large left panel). The step-wise lines are indicative of the relative density of the reproductive status at a given size.

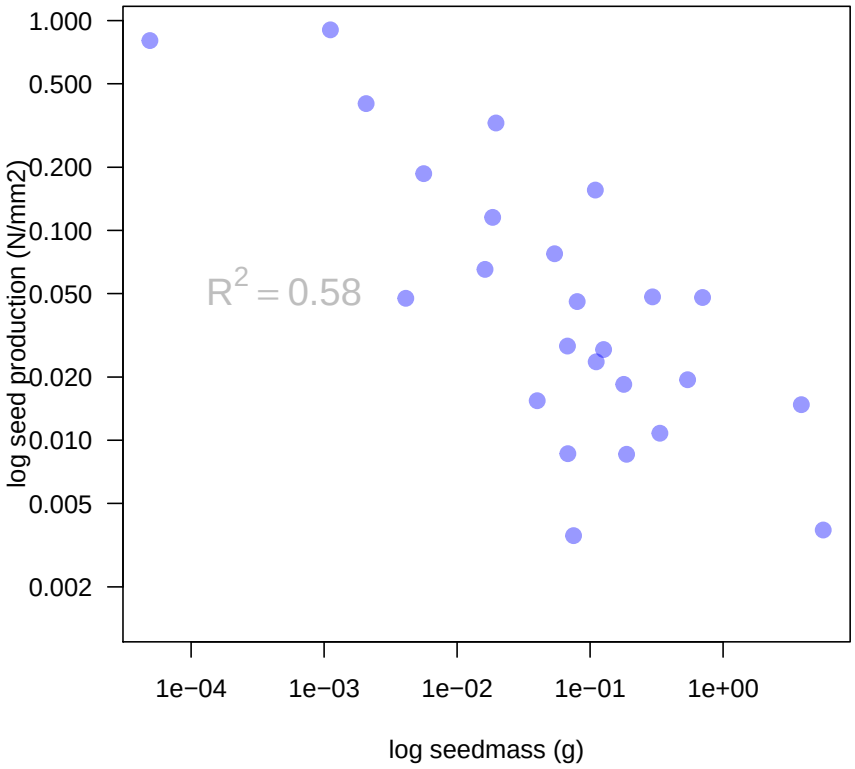

Figure S2. Estimates of seed production, in numbers of seeds produced per unit basal area plotted against seed dry mass (g) from Wright *et al.* 2010.

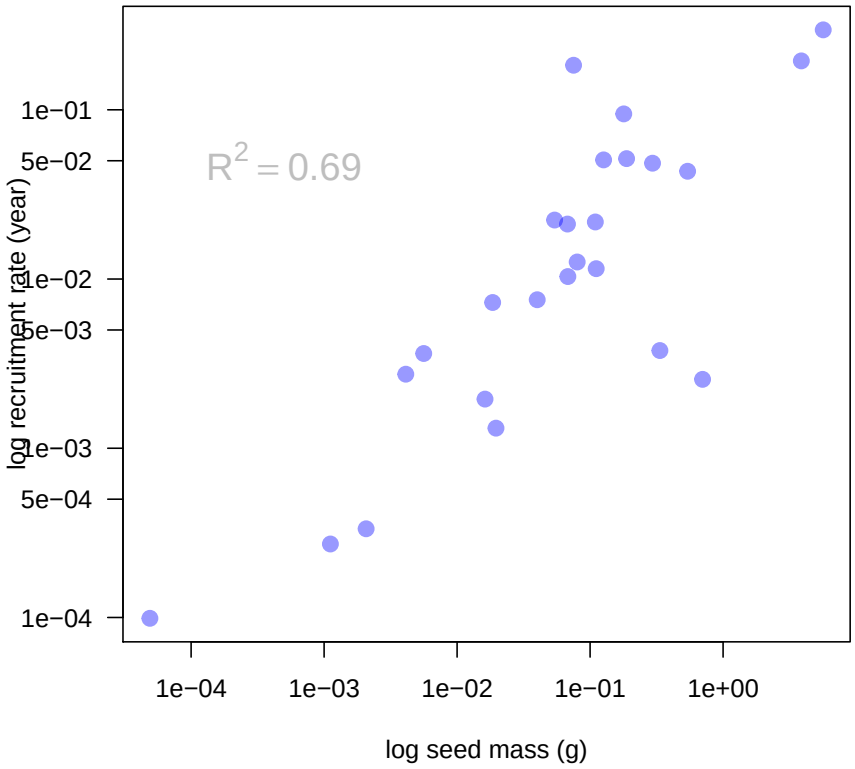

Figure S3. Estimates of the annual seed to seedling transition rate plotted against seed dry mass (g) from Wright *et al.* 2010.

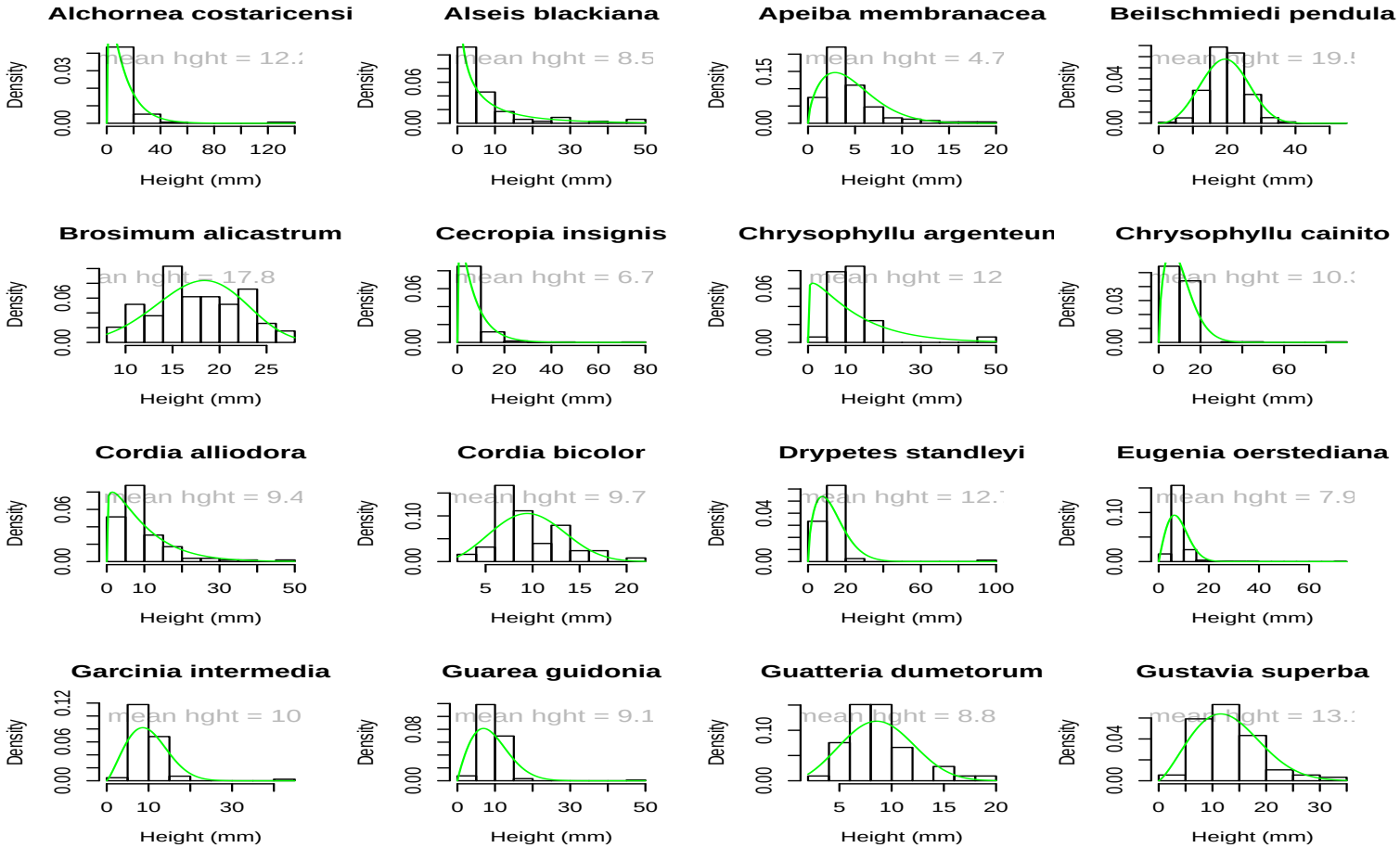

Figure S4. Distribution of initial heights of establishing seedlings, including fit models (green lines). Seedling heights of zero indicate very small seedlings that could not be measured without danger of inflicting damage. The above multi-panel graph is number 1 of 3 plots containing all species.

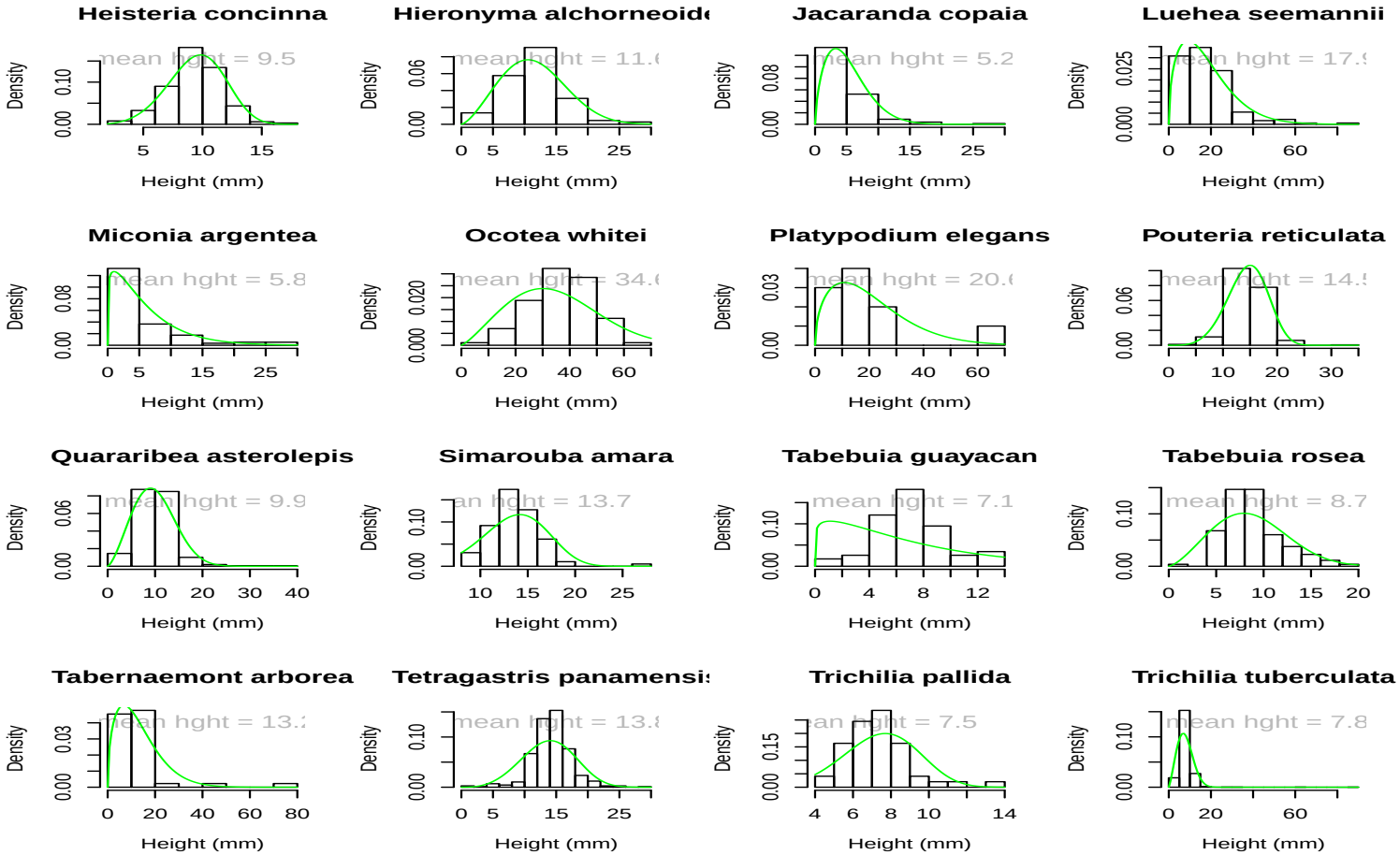

Figure S5. Distribution of initial heights of establishing seedlings, including fit models (green lines). Seedling heights of zero indicate very small seedlings that could not be measured without danger of inflicting damage. The above multi-panel graph is number 2 of 3 plots containing all species.

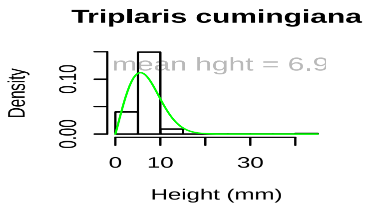

Figure S6. Distribution of initial heights of establishing seedlings, including fit models (green lines). Seedling heights of zero indicate very small seedlings that could not be measured without danger of inflicting damage. The above multi-panel graph is number 3 of 3 plots containing all species.

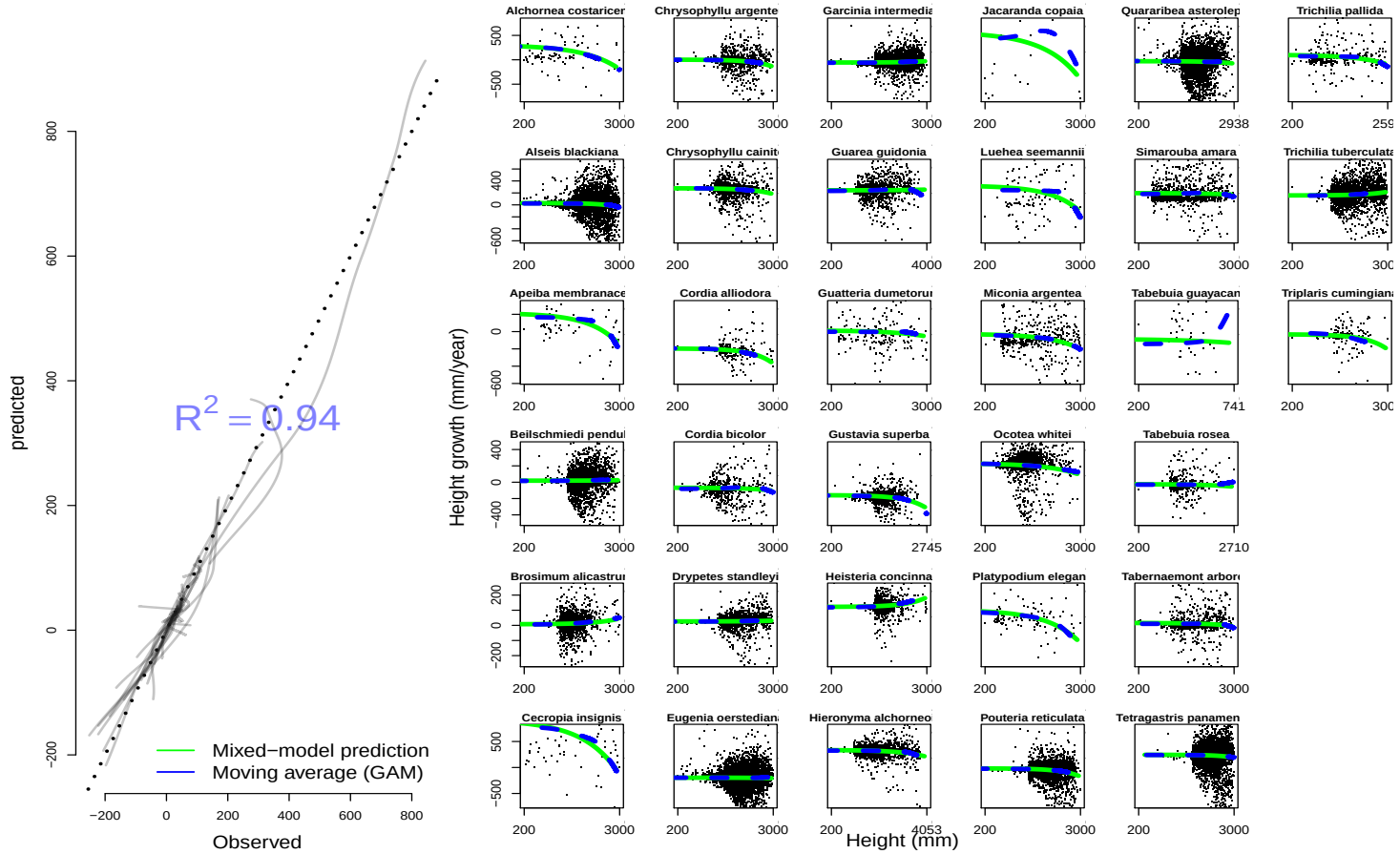

Figure S7. Yearly height growth of seedlings as a function of seedling height (mm). The large panel on the left shows the agreement between the model predictions (y-axis) from the mixed-model (see maintext) and an general additive model (GAM) fit for each species on the data (x-axis). The smaller panels on the right show model fits per species over size (height in mm). Here, the green line shows the predicted values by the fitted mixed effect model (corresponding to the y-axis on the large left panel), while the blue lines indicates a GAM predicted moving average (corresponding to the x-axis on the large left panel). The step-wise lines are indicative of the relative density of the data at a given size.

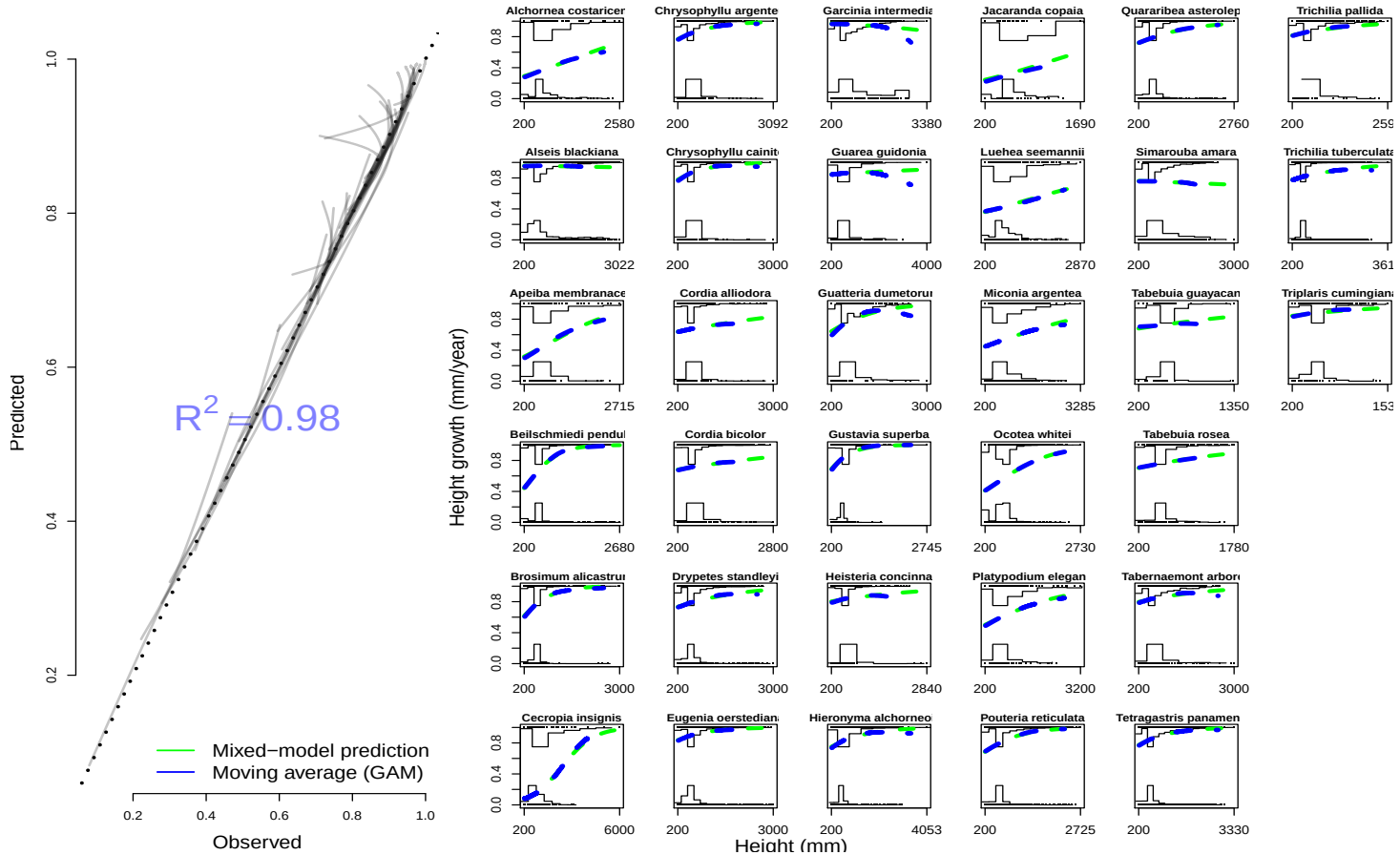

Figure S8. Yearly survival of seedlings as a function of seedling height (mm). The large panel on the left shows the agreement between the model predictions (y-axis) from the mixed-model (see maintext) and an general additive model (GAM) fit for each species on the data (x-axis). The smaller panels on the right show model fits per species over size (height in mm). Here, the green line shows the predicted values by the fitted mixed effect model (corresponding to the y-axis on the large left panel), while the blue lines indicates a GAM predicted moving average (corresponding to the x-axis on the large left panel). The step-wise lines are indicative of the relative density of the data at a given size. Individual survival and mortality states (1 and 0 values) are plotted as black dots that have been slightly jittered.

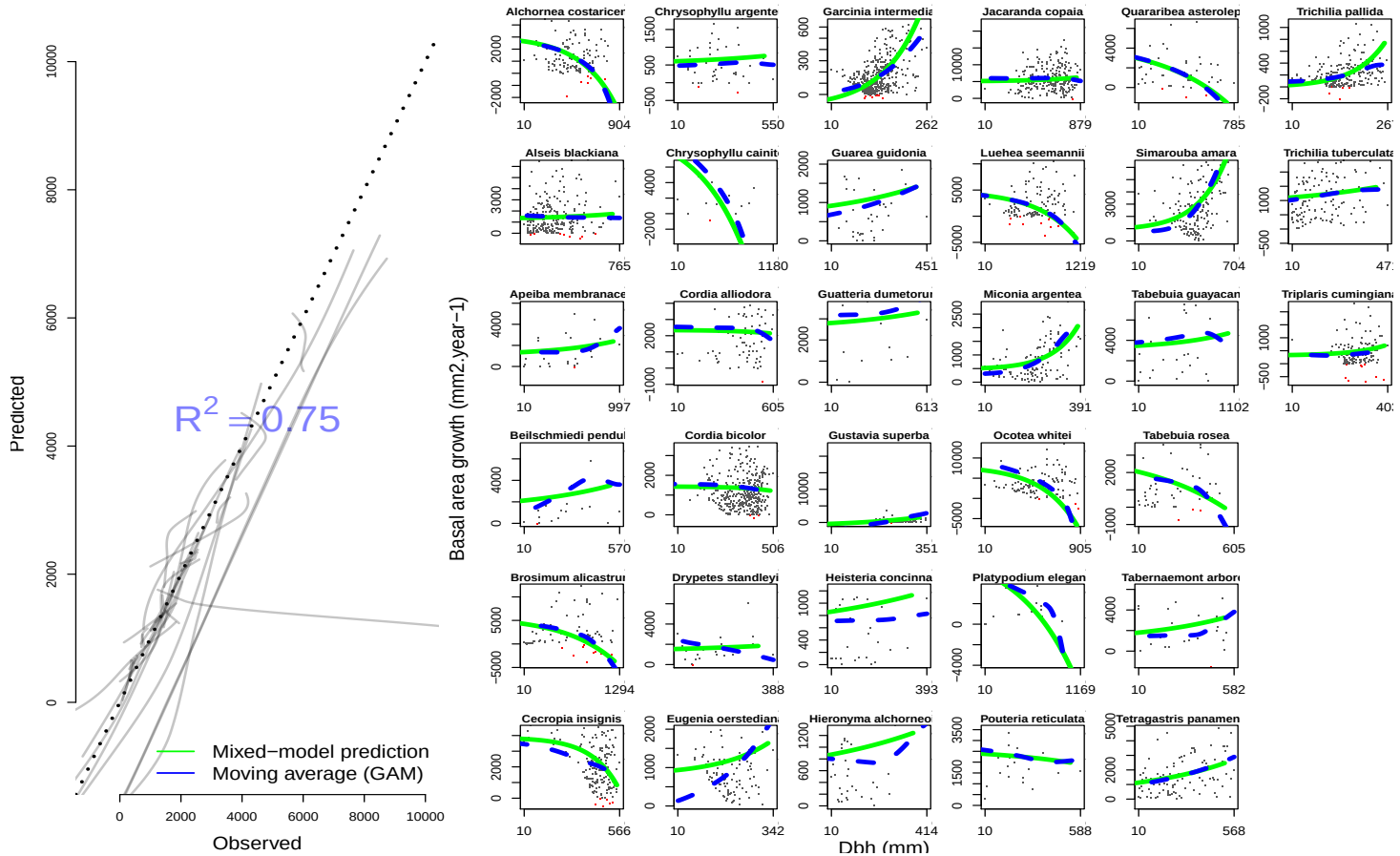

Figure S9. Yearly basal area growth of trees (mm^2), as a function of dbh (mm). The large panel on the left shows the agreement between the model predictions (y-axis) from the mixed-model (see maintext) and an general additive model (GAM) fit for each species on the data (x-axis). The smaller panels on the right show model fits per species over size (height in mm). Here, the green line shows the predicted values by the fitted mixed effect model (corresponding to the y-axis on the large left panel), while the blue lines indicates a GAM predicted moving average (corresponding to the x-axis on the large left panel).

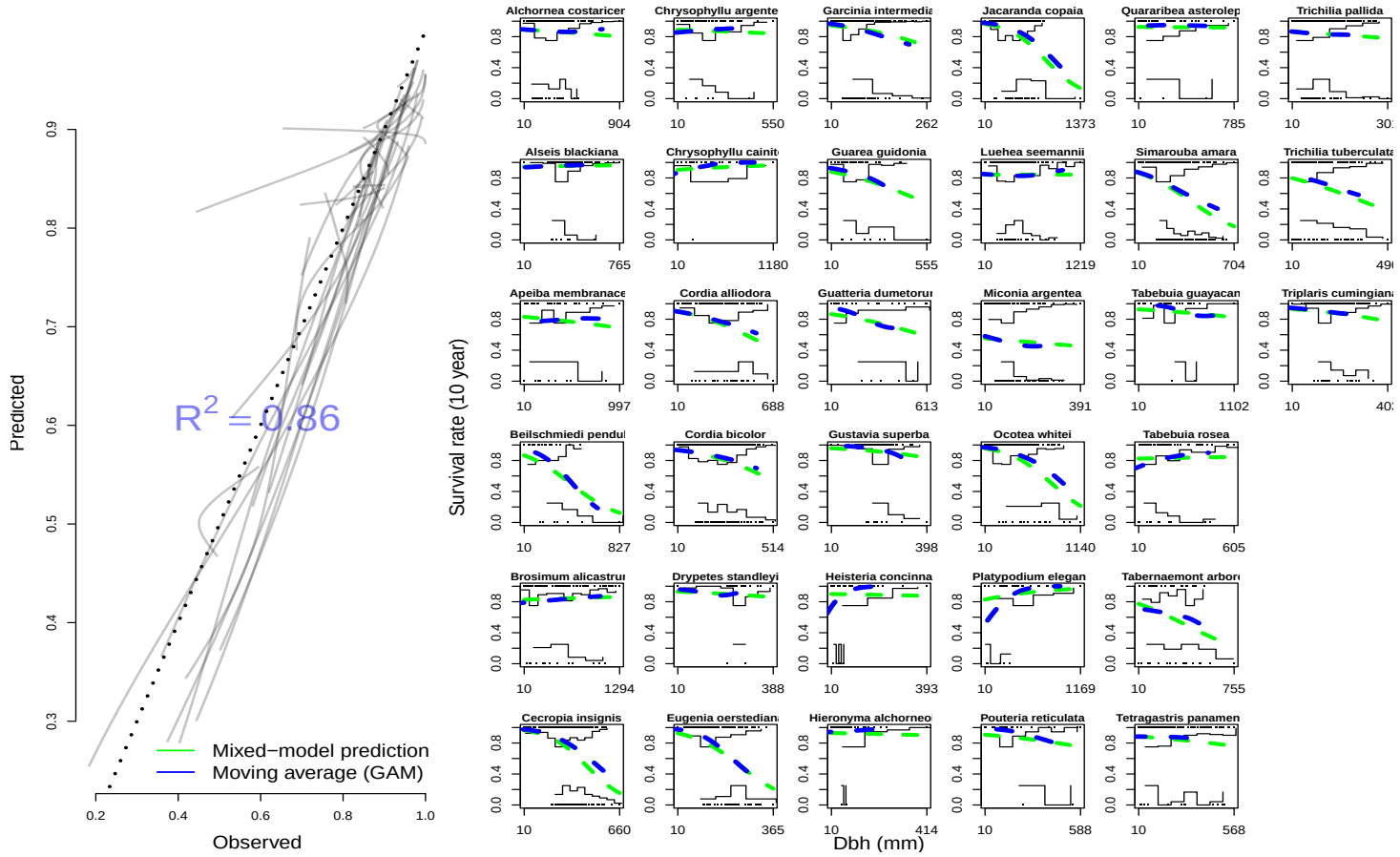

Figure S10. Decade survival of trees as a function of dbh (mm). The large panel on the left shows the agreement between the model predictions (y-axis) from the mixed-model (see maintext) and an general additive model (GAM) fit for each species on the data (x-axis). The smaller panels on the right show model fits per species over size (height in mm). Here, the green line shows the predicted values by the fitted mixed effect model (corresponding to the y-axis on the large left panel), while the blue lines indicates a GAM predicted moving average (corresponding to the x-axis on the large left panel). The stepwise lines show the relative density of mortality and survival events at different sizes classes. Individual survival and mortality states (1 and 0 values) are plotted as black dots that have been slightly jittered.

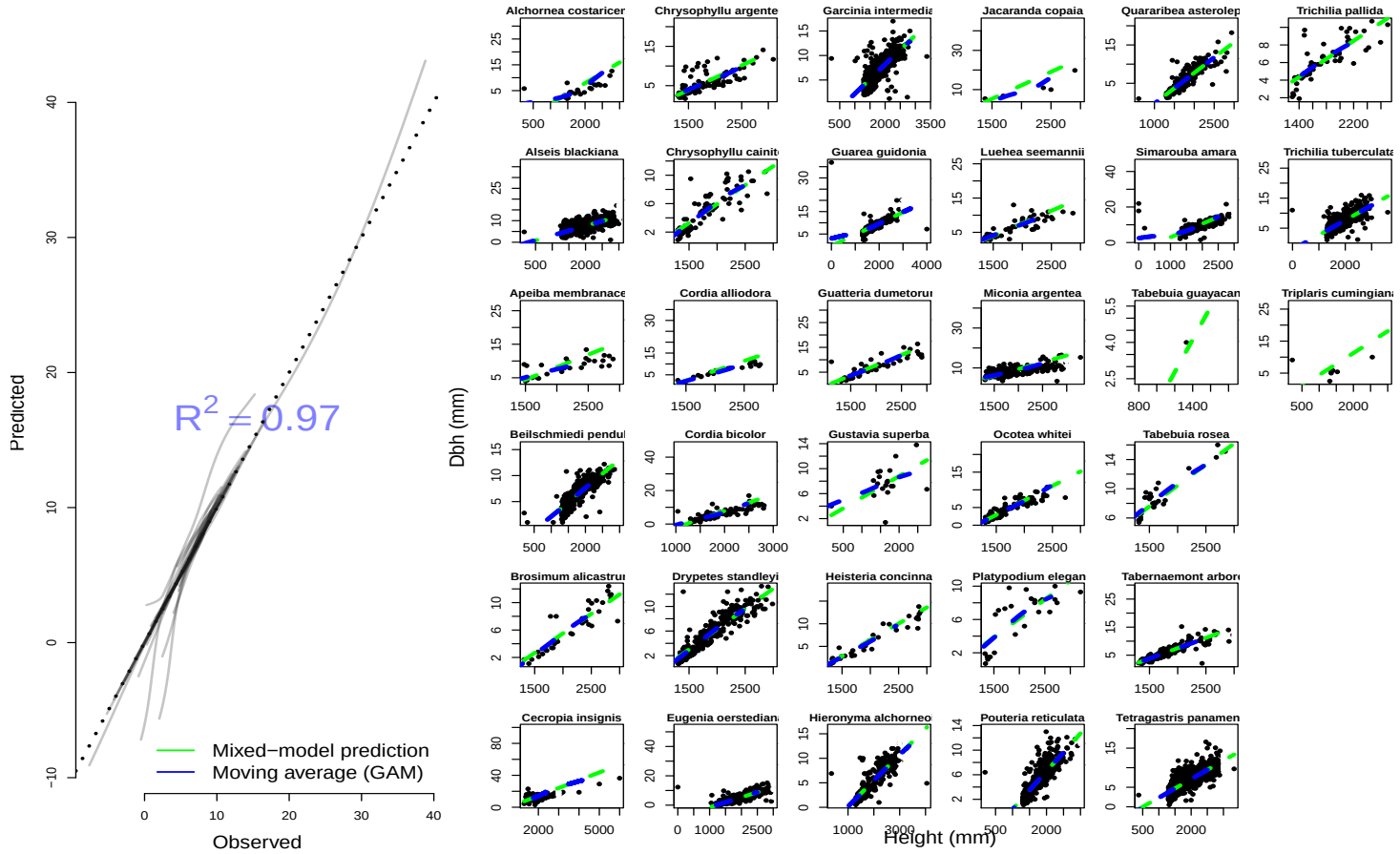

Figure S11. The diameter at breast height (dbh in mm) plotted against seedling height (mm), measured at the same time for each species. The large panel on the left shows the agreement between the model predictions (y-axis) from the mixed-model (see maintext) and an general additive model (GAM) fit for each species on the data (x-axis). The smaller panels on the right show model fits per species over size (height in mm). Here, the green line shows the predicted values by the fitted mixed effect model (corresponding to the y-axis on the large left panel), while the blue lines indicates a GAM predicted moving average (corresponding to the x-axis on the large left panel). Individual survival and mortality states (1 and 0 values) are plotted as black dots that have been slightly jittered.