Supplementary Material for the manuscript:

Large herbivores are linked to higher herbaceous plant diversity and functional redundancy across spatial scales

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Table S1: Collected traits and their definition. As the calculation of functional diversity indices requires no missing values for a given species, we only used traits which were available for all sp (i.e. growth form, height, hairiness, bulk density, leaf size). Hereby, the variables had to be classified as factors and the level order corresponds to the order at which the categories are listed in the table. As height was measured as continuous variable, we reclassified classified the species specific maximum height in 10 categories with the following definitions and order: 0.5-20cm, 20-27cm, 27-35cm, 35-40cm, 40-44cm, 44-52cm, 52-60cm, 60-70cm, 70-104cm, 104-715cm.

Trait	Categories/Values	Definition
Life form	Tree	> 80 % of stem/branch biomass woody, not engaging in horizontal growth at the first 75 cm (no twigs with diameter of > 0.5 cm), minimum stem diameter of more than 3 cm at 100 cm height.
	Shrub	> 80 % of stem/branch biomass woody, engaging in horizontal growth at the first 75 cm and/or stem diameter < 3m at 100 cm height
	Forb	Not woody and no Graminoid
	Graminoid	Grass or grass like (e.g., Poaceae or Cyperaceae)
Growth form	Tree single-stemmed	Woody, single stem, unbranched for at least the first 100 cm
	Tree multi-stemmed	Woody, multiple stems, otherwise unbranched on the first 5-100 cm)
	Shrub single-stemmed	Woody, branched on the first 5-100 cm
	Shrub multi-stemmed	Woody, multiple stems, branched on the first 100 cm
	Creeping graminoid	A grass that creeps on the ground (i.e., predominantly horizontal growth usually with stolons/rhizomes)
	Sparse upward graminoid	Grows upwards, but rather short (i.e., < 15 cm)
	Angry tussock graminoid	Grows in tussock, ends are pointy, medium height (e.g., 15-40 cm)
	Relaxed tussock graminoid	Grows in tussock, ends are not pointy, medium height (e.g., 15-40 cm)
	Large graminoid	Grows very tall (e.g, > 75 cm), presumably nutrient poor stems and leaves, rough material
	Creeping forb	Forb with predominantly horizontal growth
	Round forb	Forb with a roundish shape, so e.g., equal horizontal and vertical spread
	Straight forb	Forb that growth rather vertical than horizontal
	Cushion forb	Forb that does not engage much in horizontal growth but is growing low and sense
	Messy forb	Forb that does both creeping and growing upwards
Height	Trees & Shrubs: height in cm	Distance from the bottom to the top. If multiple individuals per plot – take an average of three random ind.
	Graminoids & Forbs: leaf table height in cm	Height of the 80th Quantile (Wigley et al 2020). Ignore inflorescence. If multiple individuals per plot – take an average of three random ind.
Leaf size	Absent	No leaves
	Thin linear	Linear & < 0.5 cm width. At least 10 times longer than wide.

	Thick linear	Linear & > 0.5 cm width. At least 10 times longer than wide.
	Micro/Small	< 2cm at the biggest part
	Macro/Medium	2-20 cm at the biggest part
	Mega/Large	> 20 cm at the biggest part
Hairiness	Hairs A / S / L / B	Hairs absent (A), on stems and branches (S), leaves (L) or both (B)
Bulk density	Low	When looking from the side 25 % of the area defined by an imaginary convex hull is covered by plant material
	Medium	When looking from the side 26-50 % of the area defined by an imaginary convex hull is covered by plant material
	High	When looking from the side 51-75 of the area defined by an imaginary convex hull is covered by plant material
	Extreme thick	When looking from the side < 76-100 % of the area defined by an imaginary convex hull is covered by plant material

Table S2: Reserve metadata. Herbivore species richness refers to the number of large herbivore species (>45) as provided by the reserve managers.

Reserve	Herbivore species richness	Herbivore biomass (kg/ha)	Area (ha)	MAT (°C)	MAP (mm)	Elevation (m)
Lapalala	19	35.8	41614.9	19.7	520.7	1153.0
Jembisa	12	50.5	2306.	19.1	541.9	1214.6
Syringa Sands	13	42.4	1465.3	17.4	710.6	1477.6
Dabchick	18	239.7	997.9	18.6	609.4	1295.4
Ant's Farm	19	78.7	3892.6	18.5	555.3	1331.6
Kaingo	18	45.7	16095.5	20.2	467.1	1098.9
Summerplace	14	94.2	3465.5	18.1	626.8	1391.7
Swebeswebe	11	61.9	4928.4	20.3	531.0	1089.1
Willowisp	2	0.8	241.1	19.4	567.0	1167.4
Marakele	1	0.1	1374.6	20.7	550.5	1037.9

Table S3: Estimates and statistics from the univariate GLMMs used in the main analysis. The column "p (uncor.)" includes the uncorrected p value, "p (b-h)" contains the p-value corrected for the false discovery rate using the Benjamini-Hochberg procedure, "p (bonf.)" contains the p value after Bonferroni-correction which is also used in the main mansucript. "Marg. R^2" gives the marginal R^2 (i.e., the R^2 without random effects) and the "Cond. R^2" column contains the R^2 including random effects. Models at the reserve scale do not include random effects and therefore marginal and conditional R^2 should be identical for those.

Response	Predictor	Scale	Estimate (95 % CI)	p (uncor.)	p (b-h)	p (bonf.)	Marg. R^2	Cond. R^2
Plant Functional Diversity	Herbivore Biomass	plot	0.02 (-0.05-0.1)	0.537	0.806	1.000	0.010	0.280
Plant Functional Diversity	Herbivore Species Richness	plot	-0.03 (-0.1-0.05)	0.463	0.806	1.000	0.010	0.280
Plant Functional Diversity	Herbivore Visitation	plot	0 (-0.06-0.07)	0.885	0.885	1.000	0.000	0.280
Plant Functional Redundancy	Herbivore Biomass	plot	0.01 (0-0.01)	0.124	0.184	0.370	0.020	0.170
Plant Functional Redundancy	Herbivore Species Richness	plot	0 (0-0.01)	0.184	0.184	0.553	0.010	0.170
Plant Functional Redundancy	Herbivore Visitation	plot	0.01 (0-0.02)	0.008	0.023	0.023	0.040	0.170
Plant Functional Richness	Herbivore Biomass	plot	0.19 (-0.05-0.42)	0.122	0.365	0.365	0.030	0.140
Plant Functional Richness	Herbivore Species Richness	plot	-0.01 (-0.28-0.25)	0.922	0.922	1.000	0.000	0.140
Plant Functional Richness	Herbivore Visitation	plot	0.06 (-0.11-0.24)	0.472	0.708	1.000	0.000	0.120
Plant Functional Diversity	Herbivore Biomass	reserve	0.01 (-0.05-0.08)	0.660	0.660	1.000	0.020	0.020
Plant Functional Diversity	Herbivore Species Richness	reserve	-0.04 (-0.1-0.02)	0.202	0.605	0.605	0.150	0.150
Plant Functional Diversity	Herbivore Visitation	reserve	-0.02 (-0.09-0.05)	0.557	0.660	1.000	0.040	0.040
Plant Functional Redundancy	Herbivore Biomass	reserve	0.02 (0-0.04)	0.116	0.116	0.349	0.220	0.220
Plant Functional Redundancy	Herbivore Species Richness	reserve	0.02 (0-0.04)	0.044	0.066	0.132	0.310	0.310
Plant Functional Redundancy	Herbivore Visitation	reserve	0.03 (0.01-0.04)	0.001	0.004	0.004	0.530	0.530
Plant Functional Richness	Herbivore Biomass	reserve	0.07 (-0.02-0.15)	0.144	0.216	0.431	0.190	0.190
Plant Functional Richness	Herbivore Species Richness	reserve	0.02 (-0.07-0.11)	0.666	0.666	1.000	0.020	0.020
Plant Functional Richness	Herbivore Visitation	reserve	0.07 (-0.02-0.16)	0.118	0.216	0.354	0.220	0.220
Plant Functional Diversity	Herbivore Biomass	site	0.01 (-0.08-0.09)	0.904	0.964	1.000	0.000	0.130
Plant Functional Diversity	Herbivore Species Richness	site	-0.04 (-0.12-0.04)	0.358	0.964	1.000	0.020	0.130
Plant Functional Diversity	Herbivore Visitation	site	0 (-0.07-0.08)	0.964	0.964	1.000	0.000	0.130
Plant Functional Redundancy	Herbivore Biomass	site	0.01 (-0.01-0.02)	0.298	0.387	0.893	0.030	0.090
Plant Functional Redundancy	Herbivore Species Richness	site	0.01 (-0.01-0.02)	0.387	0.387	1.000	0.020	0.090
Plant Functional Redundancy	Herbivore Visitation	site	0.02 (0-0.03)	0.009	0.026	0.026	0.120	0.120
Plant Functional Richness	Herbivore Biomass	site	0.08 (-0.02-0.19)	0.112	0.168	0.335	0.060	0.120
Plant Functional Richness	Herbivore Species Richness	site	0 (-0.12-0.12)	0.968	0.968	1.000	0.000	0.130
Plant Functional Richness	Herbivore Visitation	site	0.12 (0.02-0.22)	0.024	0.073	0.073	0.110	0.160
Forb Richness	Herbivore Biomass	plot	0.08 (-0.05-0.2)	0.241	0.362	0.723	0.030	0.300

Forb Richness	Herbivore Species Richness	plot	-0.05 (-0.19-0.08)	0.417	0.417	1.000	0.010	0.300
Forb Richness	Herbivore Visitation	plot	0.1 (0.02-0.18)	0.015	0.044	0.044	0.050	0.280
Graminoid Richness	Herbivore Biomass	plot	0.11 (0.01-0.21)	0.037	0.112	0.112	0.050	0.150
Graminoid Richness	Herbivore Species Richness	plot	0.06 (-0.05-0.18)	0.286	0.286	0.859	0.020	0.150
Graminoid Richness	Herbivore Visitation	plot	0.05 (-0.02-0.12)	0.156	0.234	0.468	0.010	0.130
Plant Species Richness	Herbivore Biomass	plot	0.1 (0-0.2)	0.060	0.105	0.179	0.080	0.380
Plant Species Richness	Herbivore Species Richness	plot	0 (-0.12-0.12)	0.941	0.941	1.000	0.000	0.380
Plant Species Richness	Herbivore Visitation	plot	0.06 (0-0.12)	0.070	0.105	0.210	0.030	0.340
Woody Richness	Herbivore Biomass	plot	-0.04 (-0.15-0.06)	0.415	0.622	1.000	0.010	0.440
Woody Richness	Herbivore Species Richness	plot	-0.09 (-0.19-0.01)	0.064	0.193	0.193	0.040	0.440
Woody Richness	Herbivore Visitation	plot	-0.02 (-0.13-0.09)	0.720	0.720	1.000	0.000	0.440
Forb Richness	Herbivore Biomass	reserve	0.13 (0.06-0.2)	0.000	0.001	0.001	0.550	0.550
Forb Richness	Herbivore Species Richness	reserve	0.05 (-0.03-0.13)	0.247	0.247	0.741	0.130	0.130
Forb Richness	Herbivore Visitation	reserve	0.13 (0.05-0.21)	0.001	0.001	0.003	0.550	0.550
Graminoid Richness	Herbivore Biomass	reserve	0.14 (0.04-0.23)	0.006	0.008	0.017	0.400	0.400
Graminoid Richness	Herbivore Species Richness	reserve	0.12 (0-0.23)	0.043	0.043	0.128	0.340	0.340
Graminoid Richness	Herbivore Visitation	reserve	0.21 (0.1-0.32)	0.000	0.000	0.000	0.620	0.620
Plant Species Richness	Herbivore Biomass	reserve	0.09 (0.04-0.14)	0.000	0.001	0.001	0.540	0.540
Plant Species Richness	Herbivore Species Richness	reserve	0.04 (-0.01-0.1)	0.141	0.141	0.424	0.200	0.200
Plant Species Richness	Herbivore Visitation	reserve	0.1 (0.05-0.16)	0.000	0.001	0.001	0.610	0.610
Woody Richness	Herbivore Biomass	reserve	-0.04 (-0.15-0.06)	0.411	0.518	1.000	0.080	0.080
Woody Richness	Herbivore Species Richness	reserve	-0.03 (-0.13-0.07)	0.518	0.518	1.000	0.040	0.040
Woody Richness	Herbivore Visitation	reserve	-0.05 (-0.15-0.06)	0.386	0.518	1.000	0.080	0.080
Forb Richness	Herbivore Biomass	site	0.06 (-0.04-0.16)	0.261	0.392	0.784	0.050	0.320
Forb Richness	Herbivore Species Richness	site	-0.05 (-0.15-0.06)	0.396	0.396	1.000	0.030	0.330
Forb Richness	Herbivore Visitation	site	0.06 (-0.01-0.13)	0.089	0.267	0.267	0.060	0.280

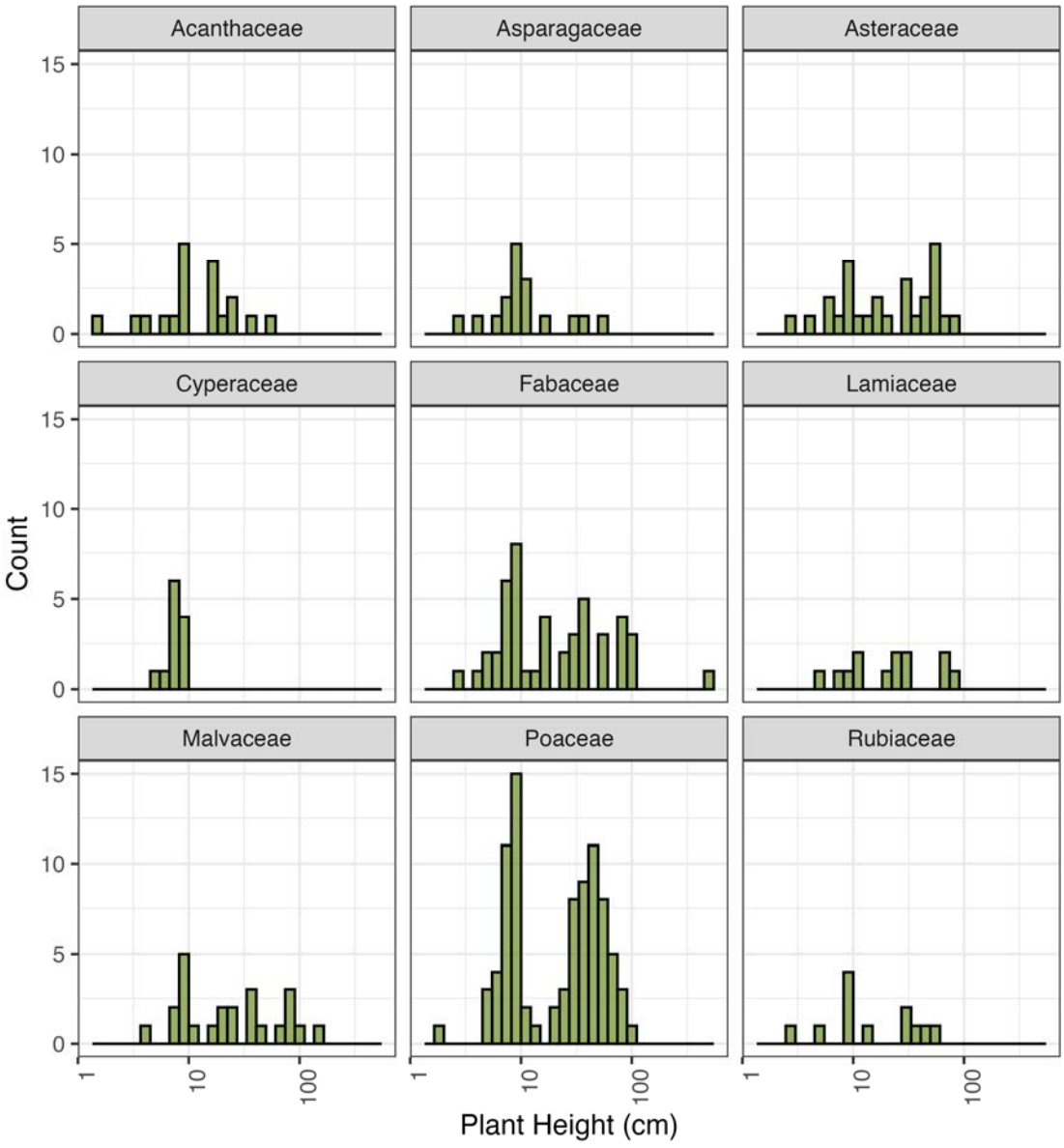

Fig. S1: Distribution of plant height in families represented with 10 or more species.

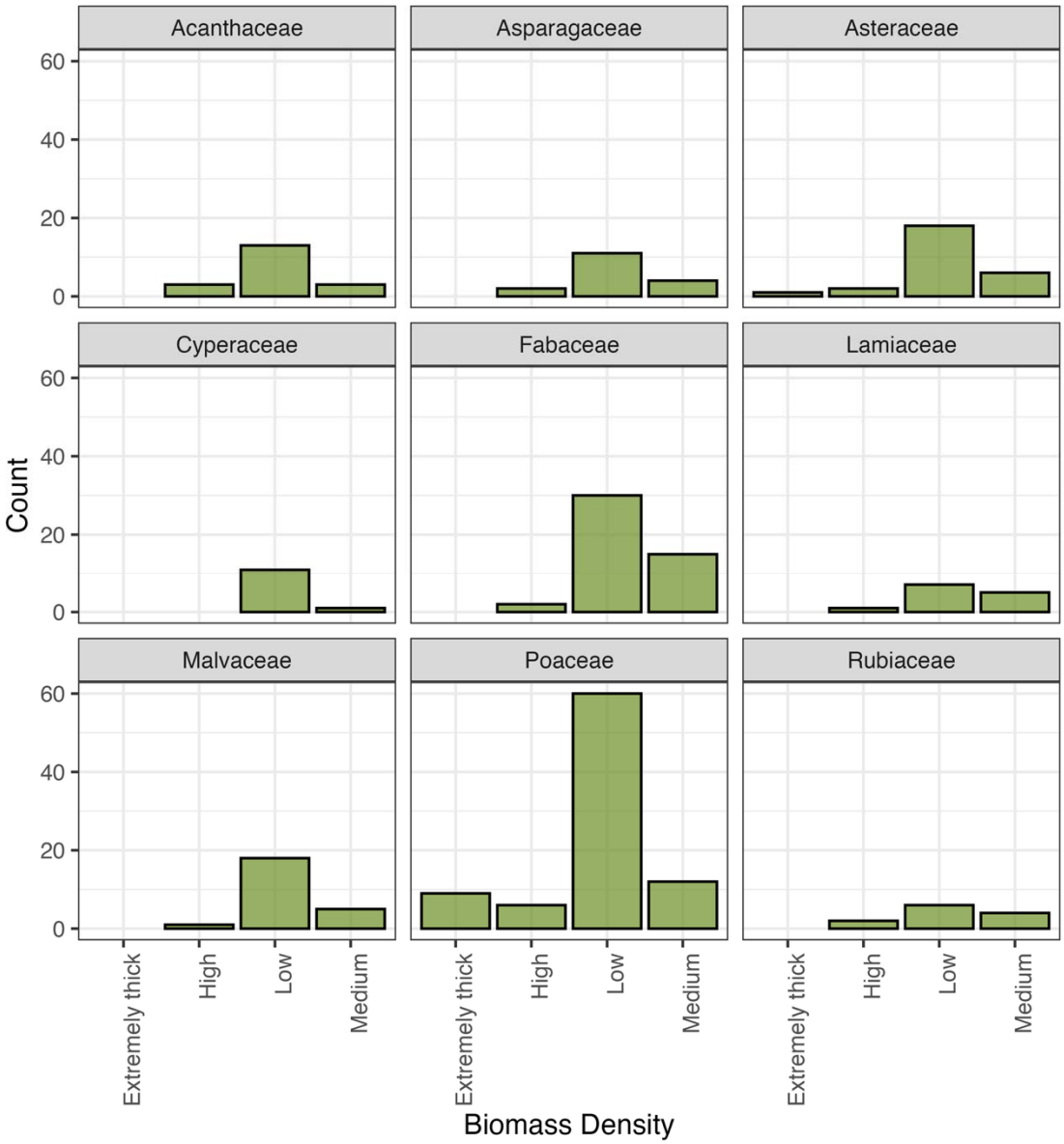

Fig. S2: Distribution of bulk density in families represented with 10 or more species.

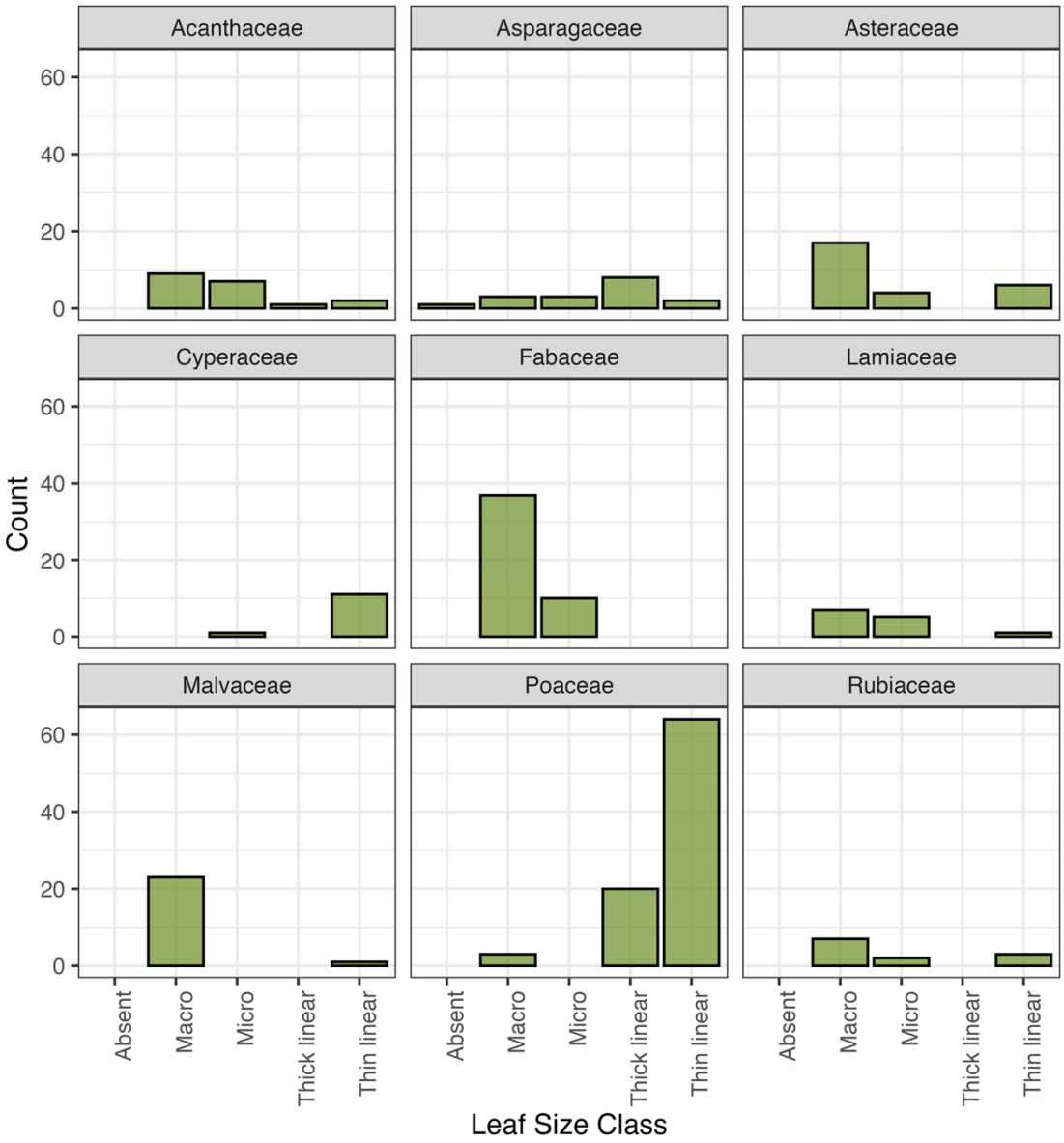

Fig. S3: Distribution of leaf size classes in families represented with 10 or more species.

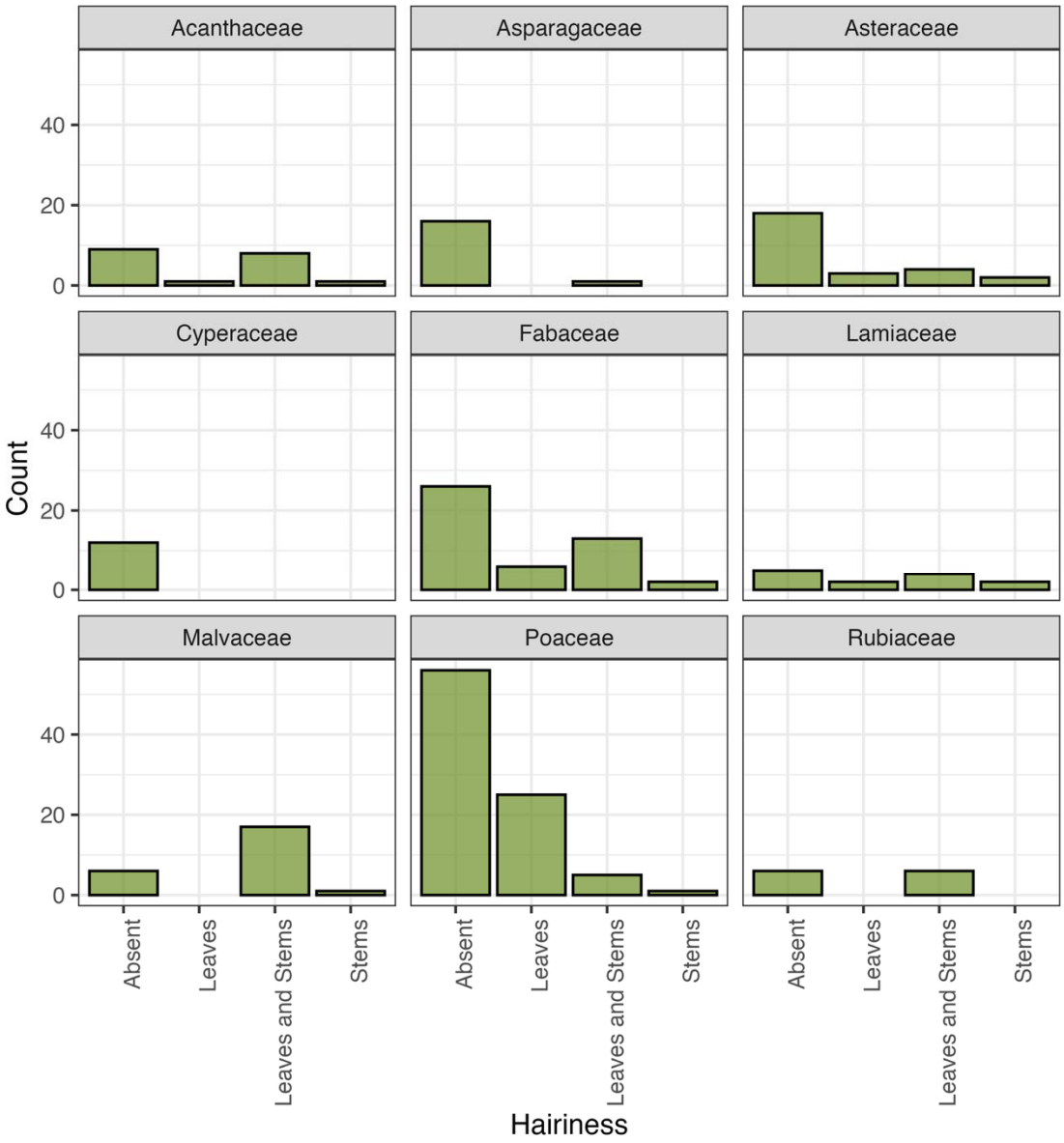

Fig. S4: Distribution of hairiness in families represented with 10 or more species.

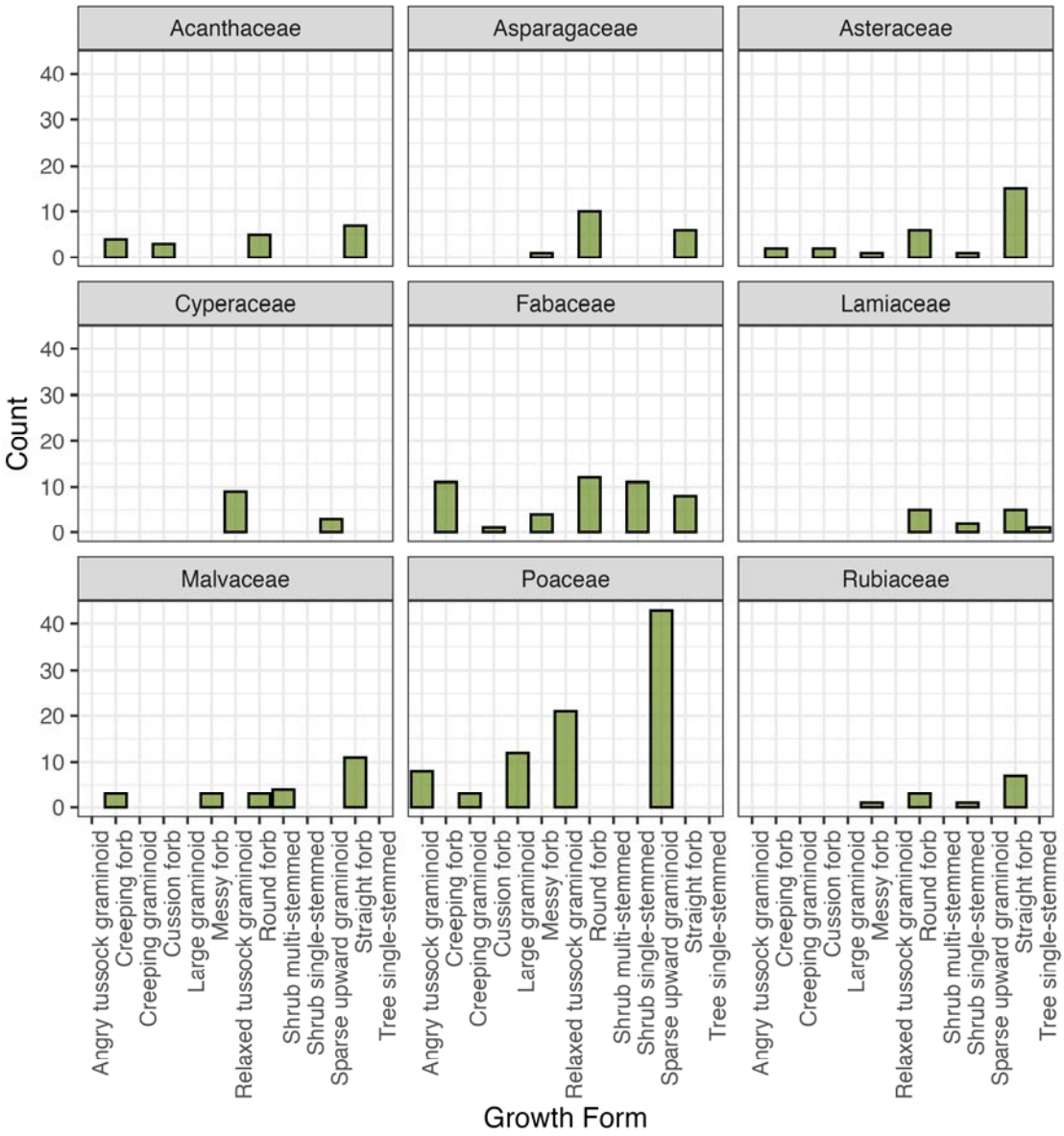

Fig. S5: Distribution of growth forms in families represented with 10 or more species.

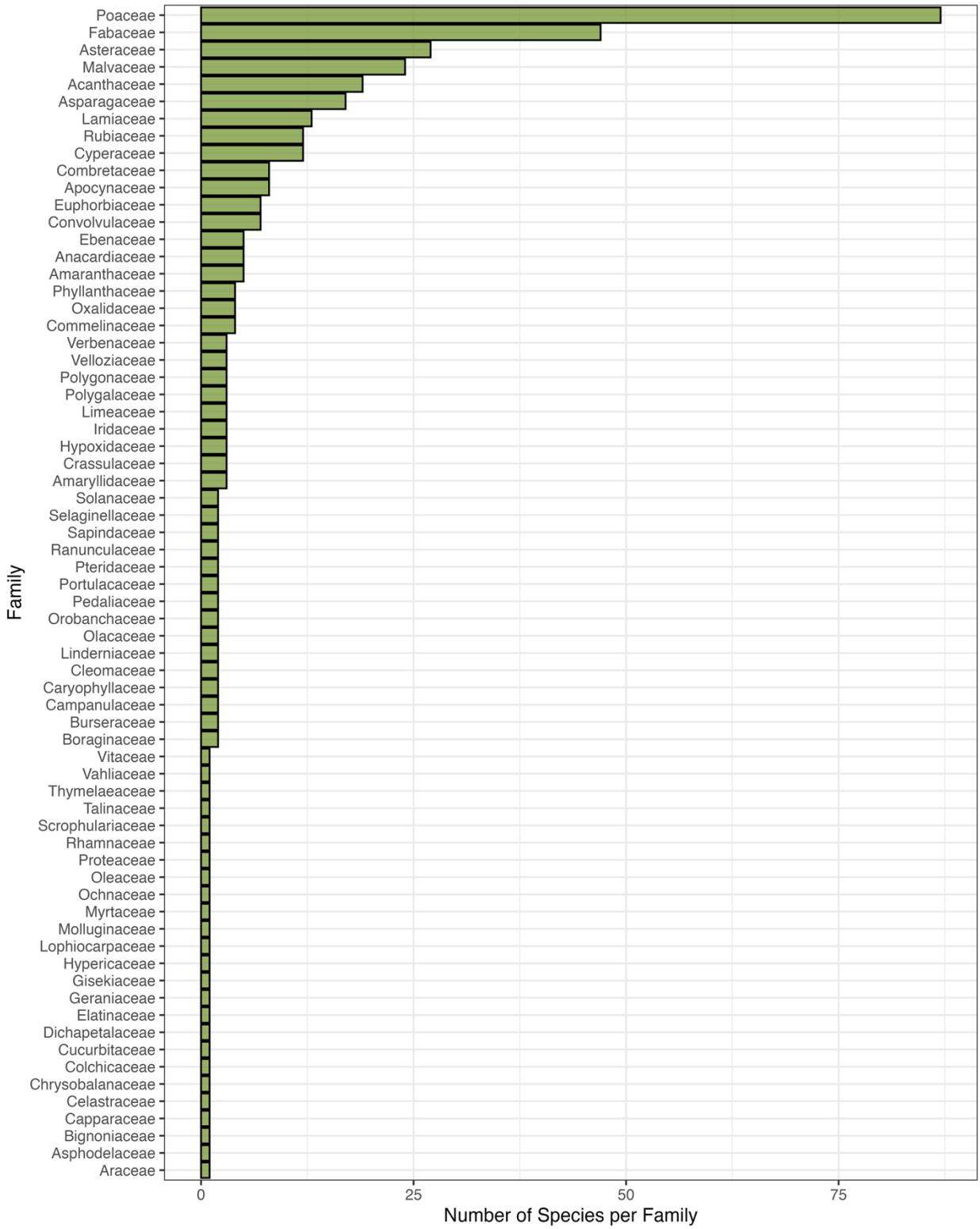

Fig. S6: Distribution of plant species in families.

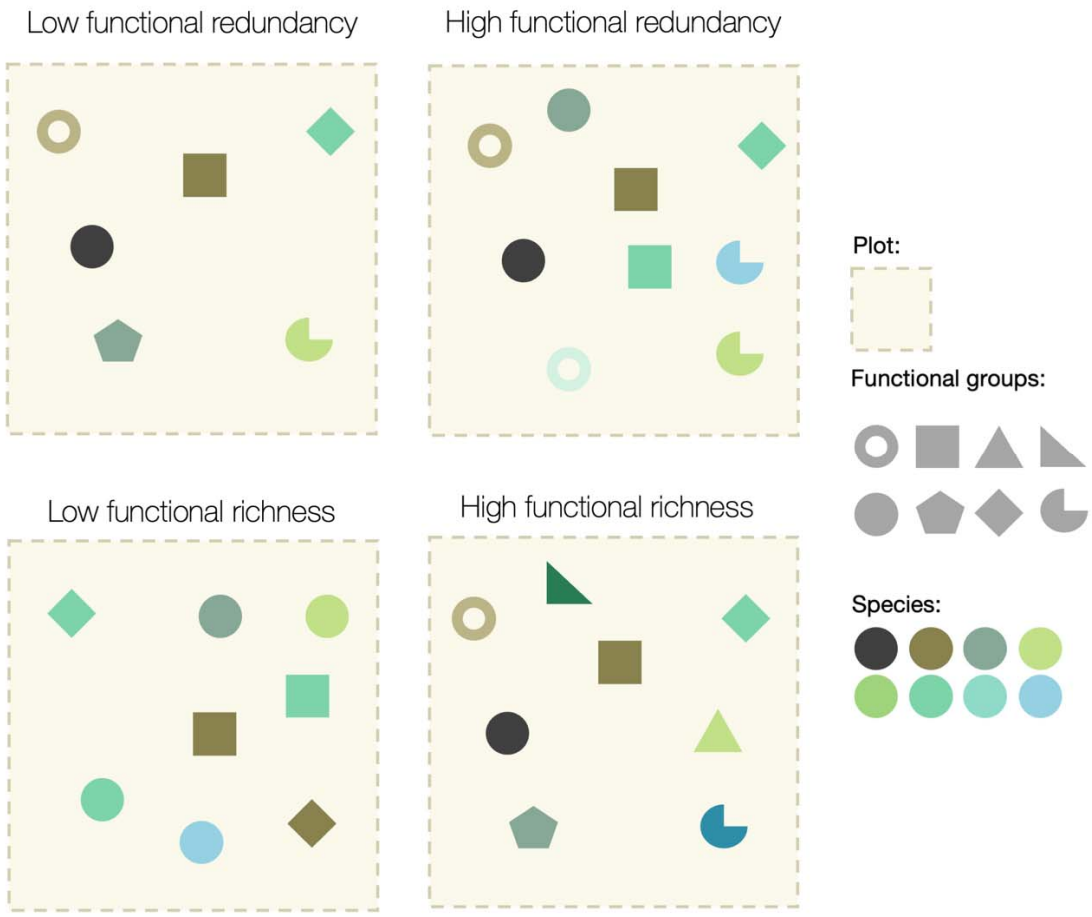

Fig. S7: Conceptual overview of hypothetical plots with high and low functional diversity and redundancy.

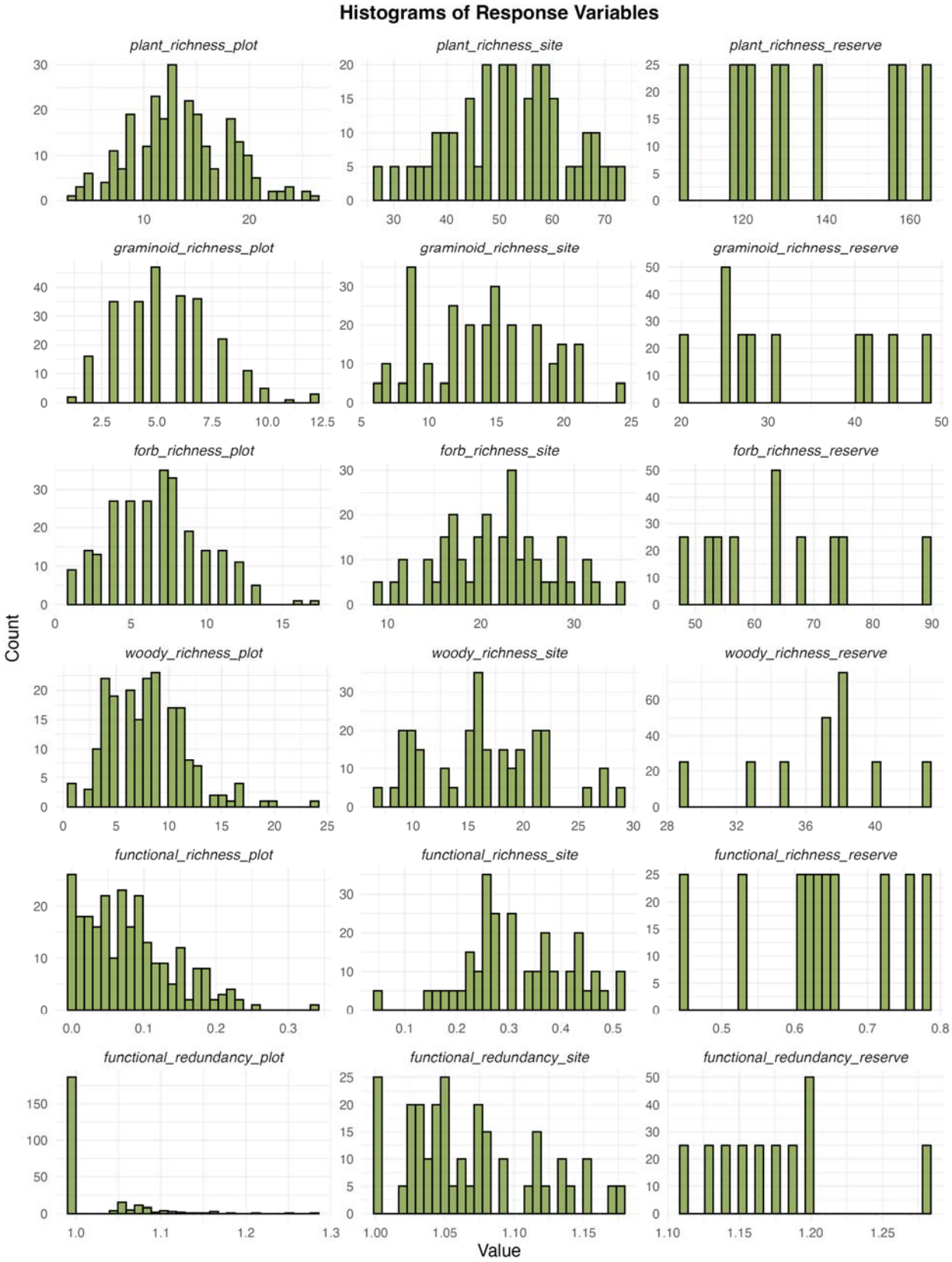

Fig. S8: Distributions of response variables.

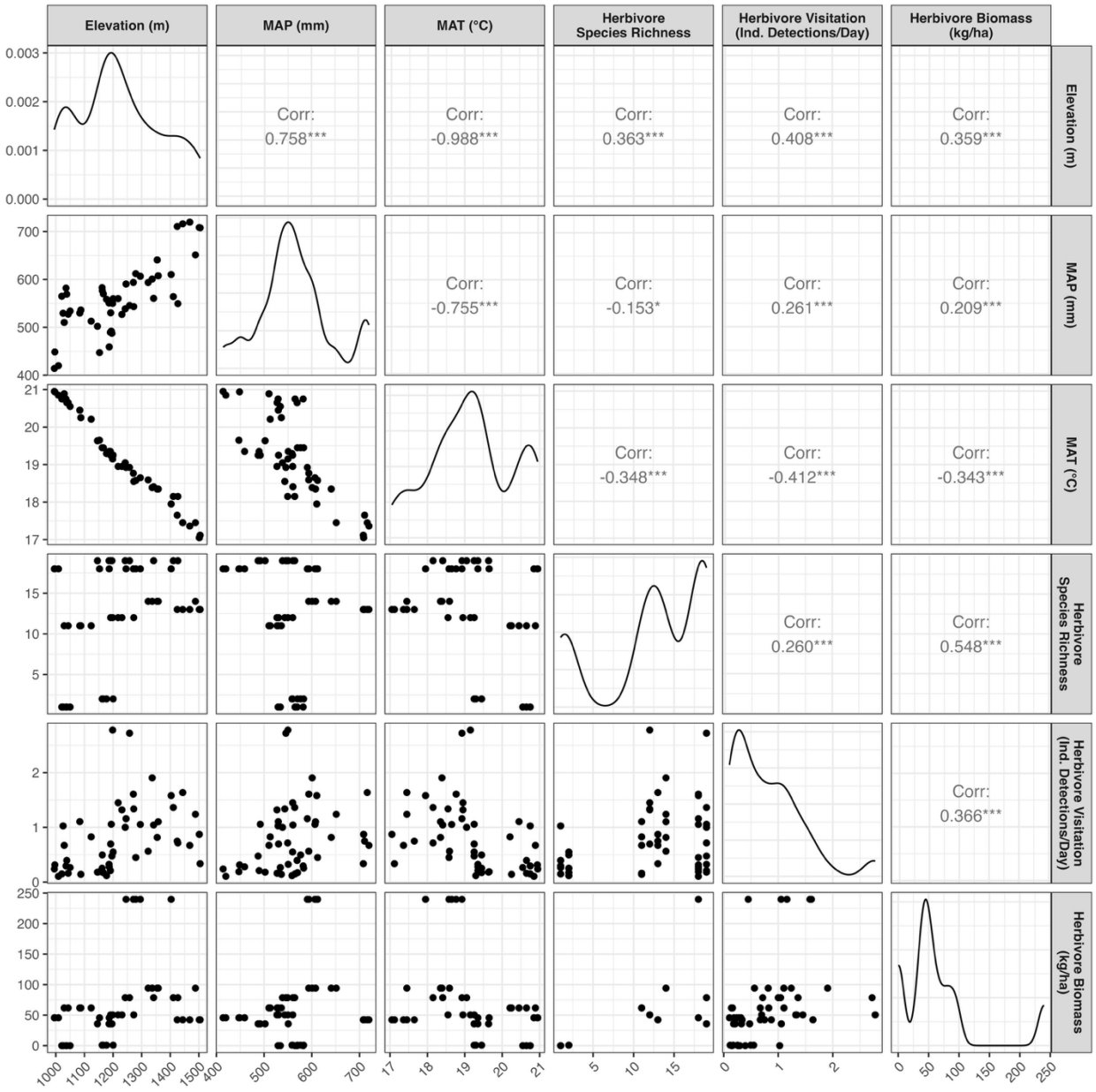

Fig. S9: Relationships between predictor variables. Environmental variables are on site scale. The unit for herbivore visitation is independent trigger events per day.

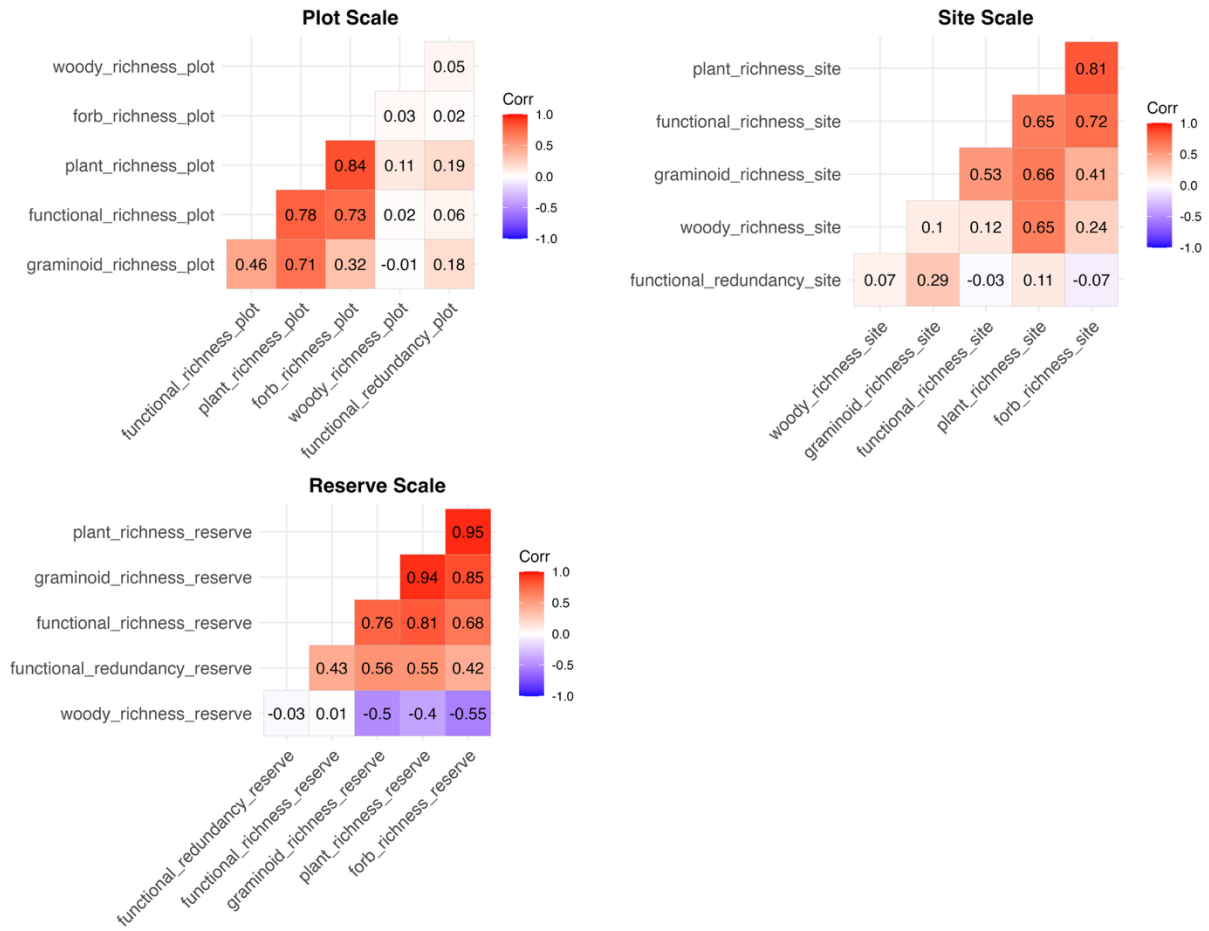

Fig. S10: Correlations between response variables

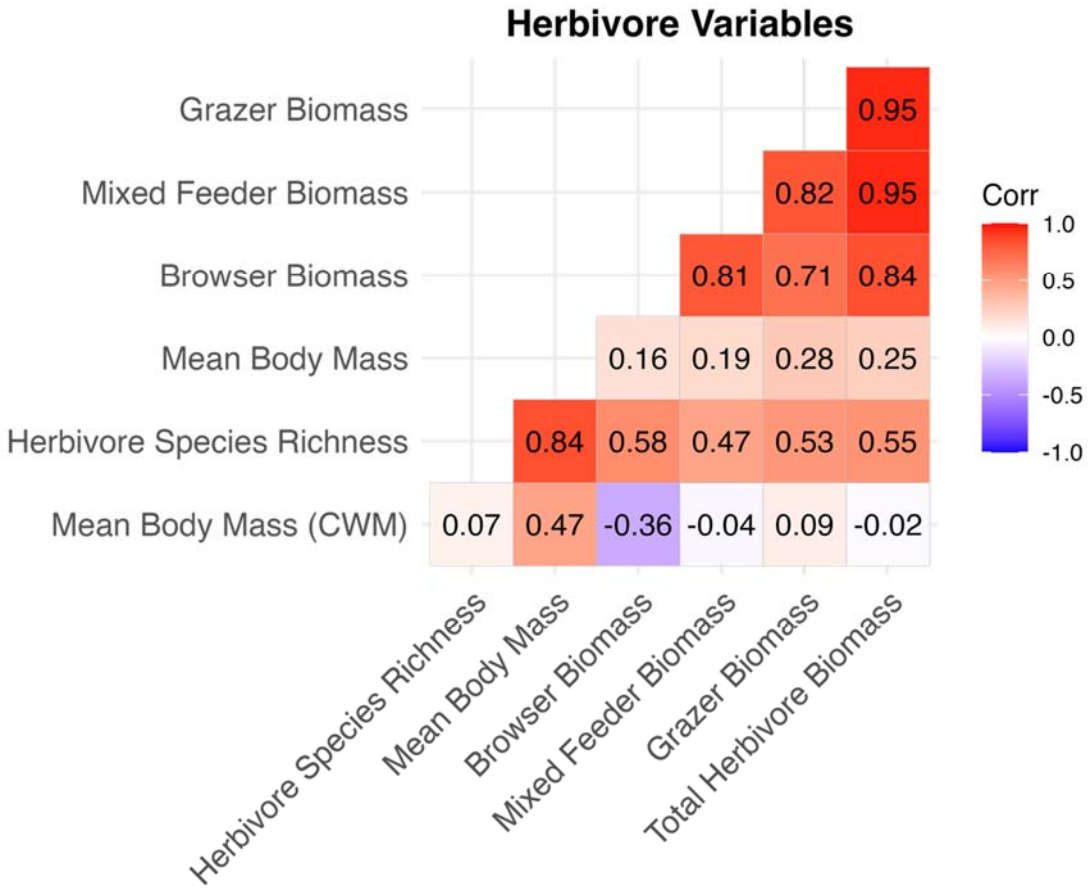

Fig. S11: Correlations between different herbivore related metrics

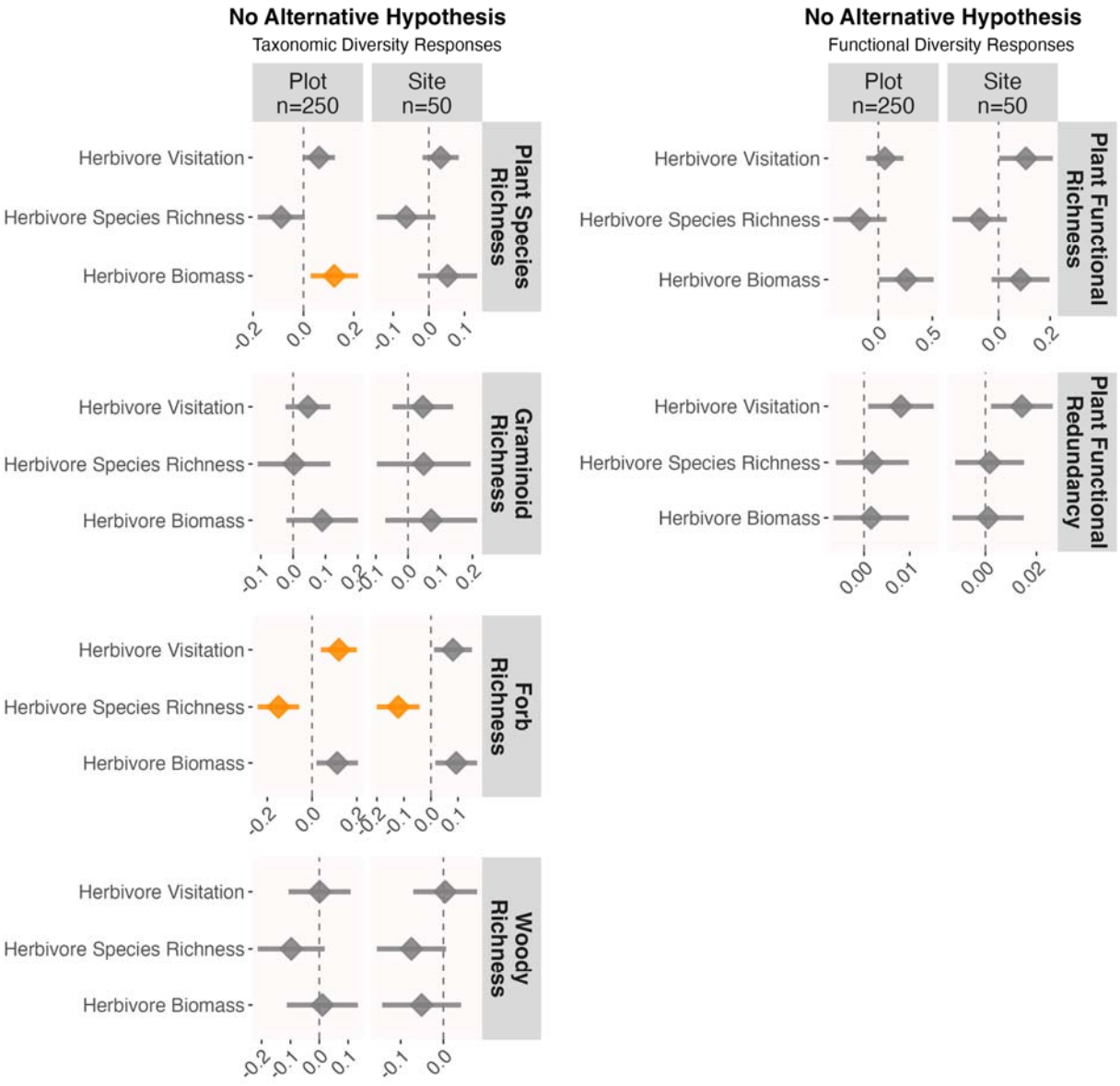

Fig. S12: Estimates and trends from GLMMs with all three herbivore predictors (but no alternative abiotic hypothesis). a) Each panel corresponds to a response variable while the predictor variables are on the y axis. The error bars represent the 95% confidence interval and the color indicates whether the variable has a significant effect (after Bonferroni-correction); grey = non-significant, orange = significant

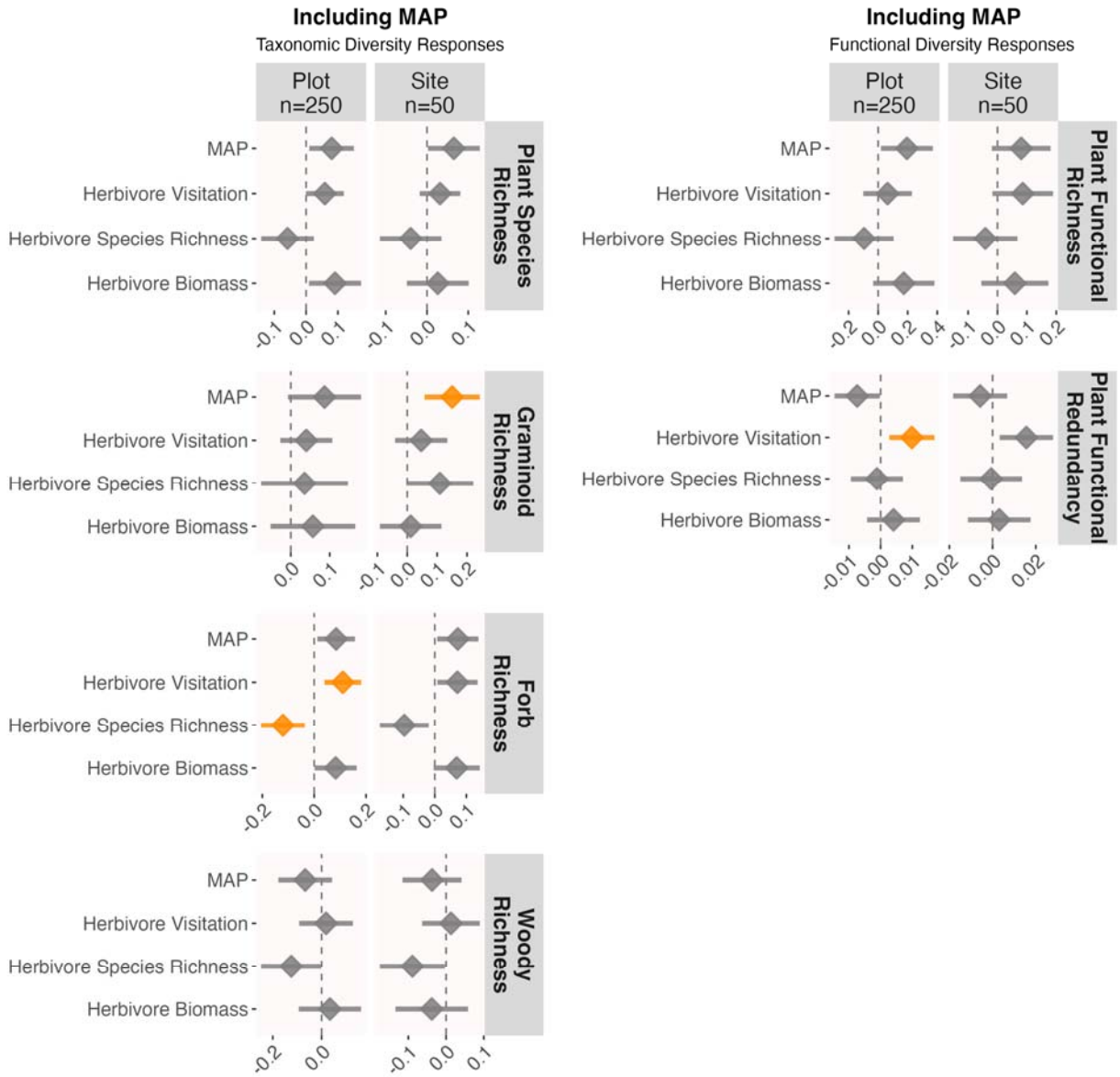

Fig. S13: Estimates and trends from GLMMs with all three herbivore predictors and mean annual precipitation (MAP). a) Each panel corresponds to a response variable while the predictor variables are on the y axis. The error bars represent the 95% confidence interval and the color indicates whether the variable has a significant effect (after Bonferroni-correction); grey = non-significant, orange = significant

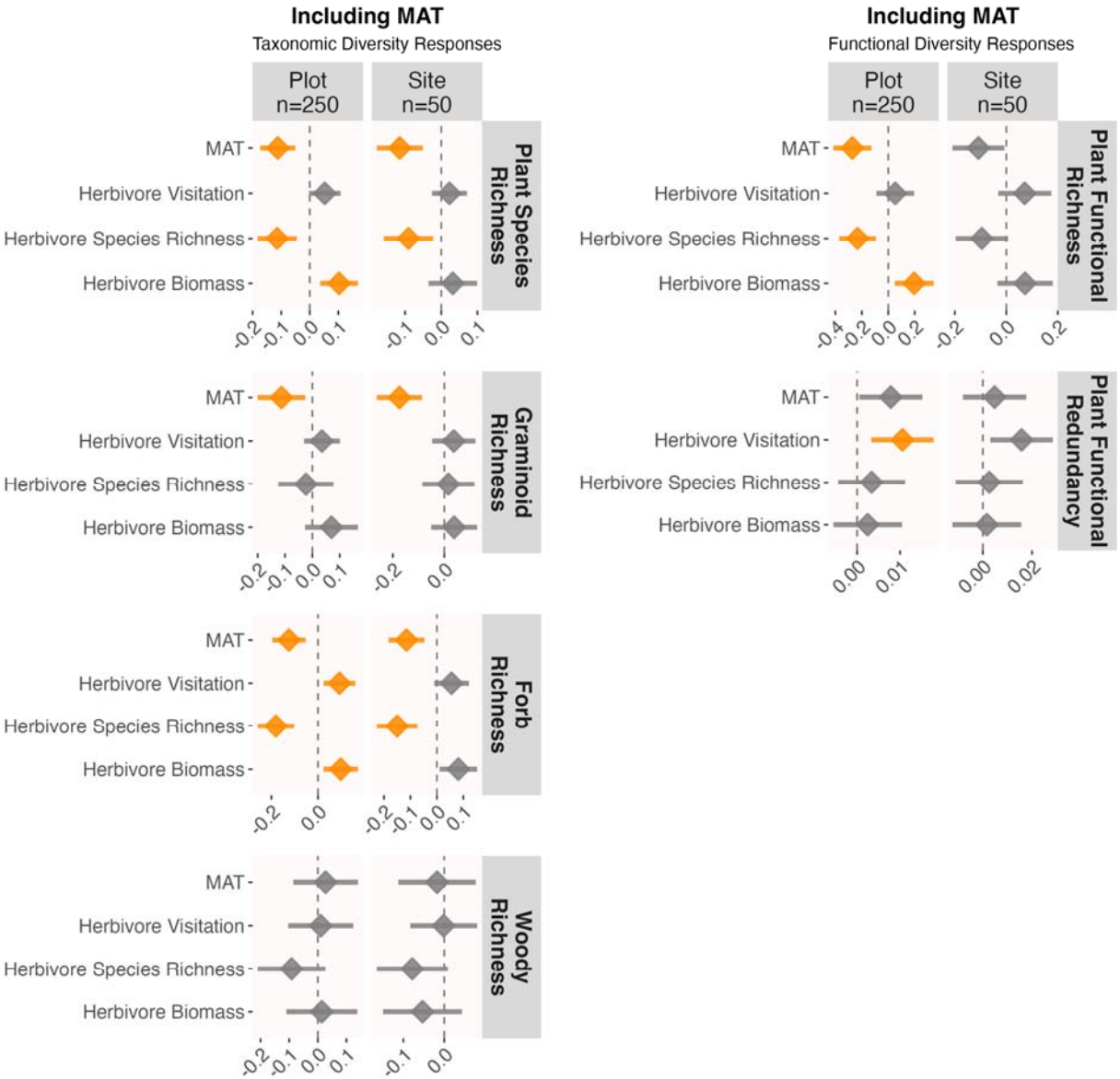

Fig. S14: Estimates and trends from GLMMs with all three herbivore predictors and mean annual temperature (MAT). a) Each panel corresponds to a response variable while the predictor variables are on the y axis. The error bars represent the 95% confidence interval and the color indicates whether the variable has a significant effect (after Bonferroni-correction); grey = non-significant, orange = significant

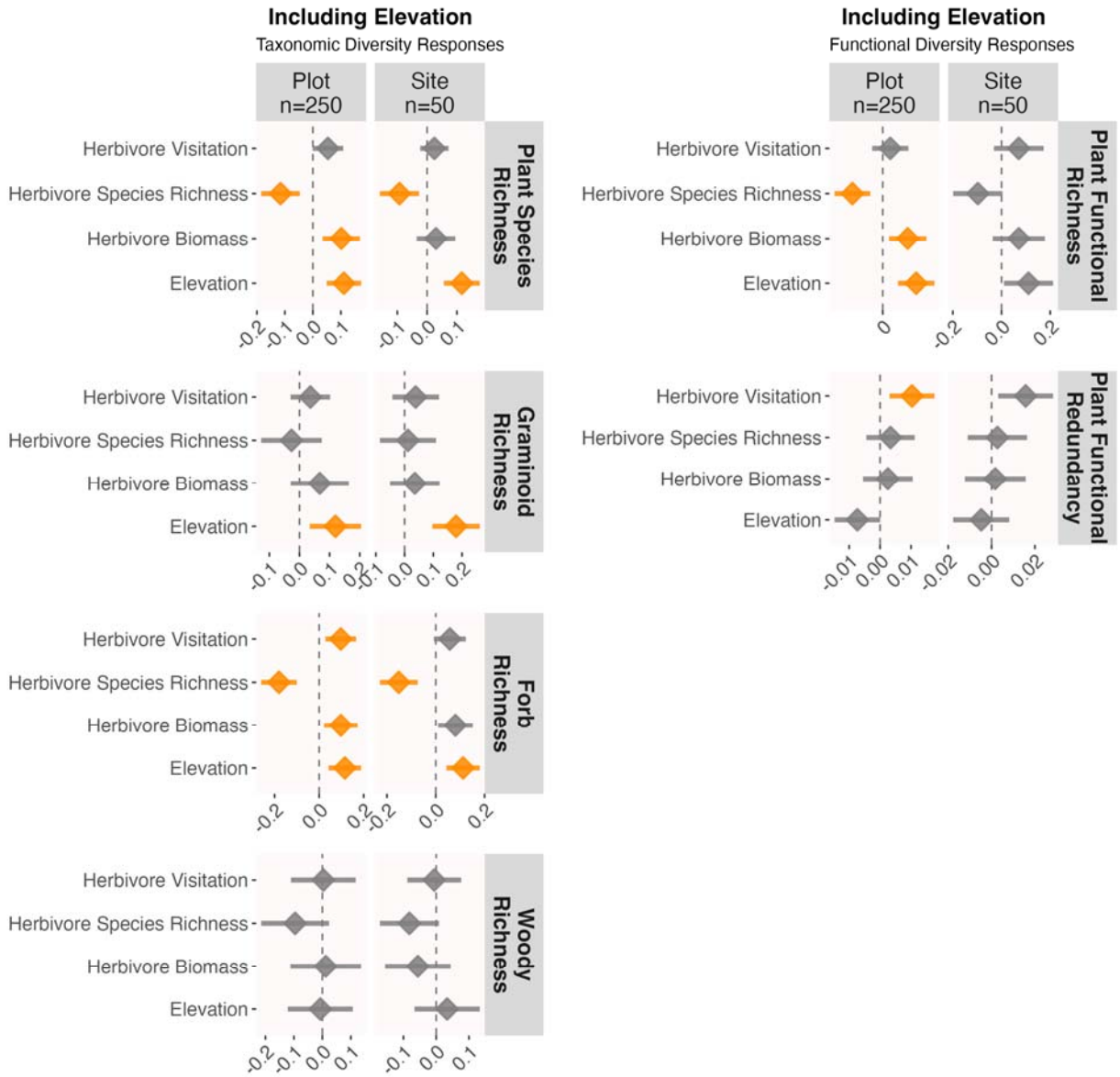

Fig. S15: Estimates and trends from GLMMs with all three herbivore predictors and elevation. a) Each panel corresponds to a response variable while the predictor variables are on the y axis. The error bars represent the 95% confidence interval and the color indicates whether the variable has a significant effect (after Bonferroni-correction); grey = non-significant, orange = significant

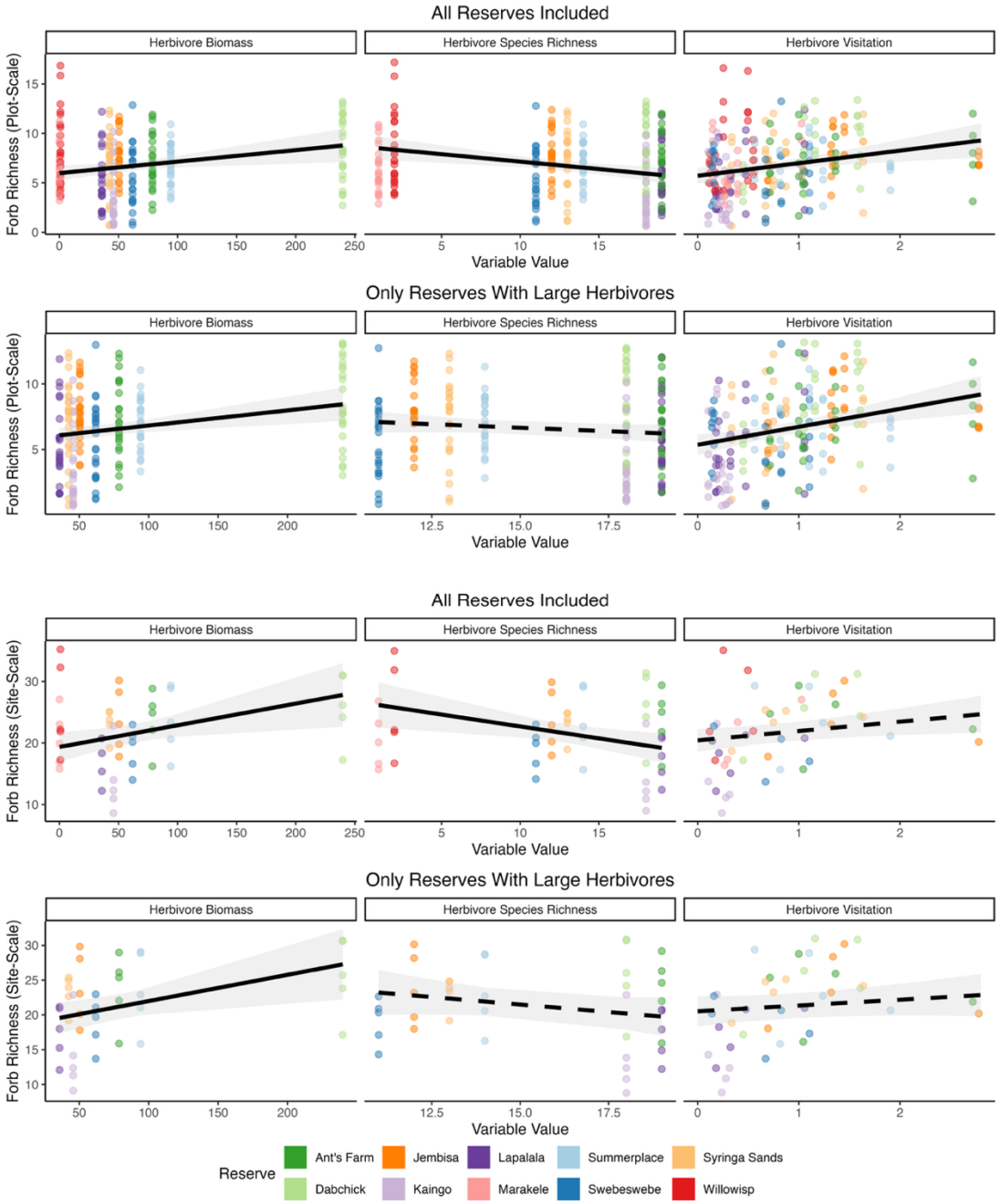

Fig. S16: Model predictions and raw data for the relationship between forb richness and herbivore regime. The points represent the raw data and the lines the predictions from a model with forb richness as response and all three herbivore regime variables as predictors. The models were fitted both with and without the two reserves without large herbivores (Willowisp, Marakele). Solid lines indicate a significant relationship, dashed lines a non-significant relationship. Note that the effect of herbivore species richness lost significance once the reserves without large herbivores were excluded while the other relationships remained stable. Models were fitted on plot scale (upper two rows) and site scale (lower two rows) and included a random effect for site ID nested in reserve at plot scale and reserve at site scale.