New Phytologist

***New Phytologist* Supporting Information Figs S1–S7, Tables S1–S6 and Notes S1**

Article title: Weak tradeoff between xylem safety and xylem-specific hydraulic efficiency across the world's woody plant species

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The following Supporting Information is available for this article:

Fig. S1 Schematic describing the calculation of standard major axis residuals (SMA).

Fig. S2 Hydraulic efficiency–safety (P_{88}) plots for angiosperm species.

Fig. S3 Hydraulic efficiency–safety (P_{88}) plots for gymnosperm species.

Fig. S4 Hydraulic efficiency–safety (P_{12}) plots for angiosperm species.

Fig. S5 Hydraulic efficiency–safety (P_{12}) plots for gymnosperm species.

Fig. S6 Comparison of 'curve shapes' exhibited by fitted bivariate models (i.e. P_{50} curve).

Fig. S7 Comparison of methods used for generating P_{50} data.

Table S1 Standard major axis (SMA) comparisons in the safety–efficiency relationship when safety is considered as P_{88}

Table S2 Fit statistics for linear multiple regression models when safety is considered as P_{88}

Table S3 Standard major axis (SMA) comparisons in the safety–efficiency relationship when safety is considered as P_{12}

Table S4 Fit statistics for linear multiple regression models when safety is considered as P_{12}

Table S5 Standard major axis (SMA) comparisons after omitting 'r-shaped' vulnerability curves

Table S6 Fit statistics for linear multiple regression models after omitting ‘r-shaped’ vulnerability curves

Notes S1 Published references from which data were extracted for analyses.

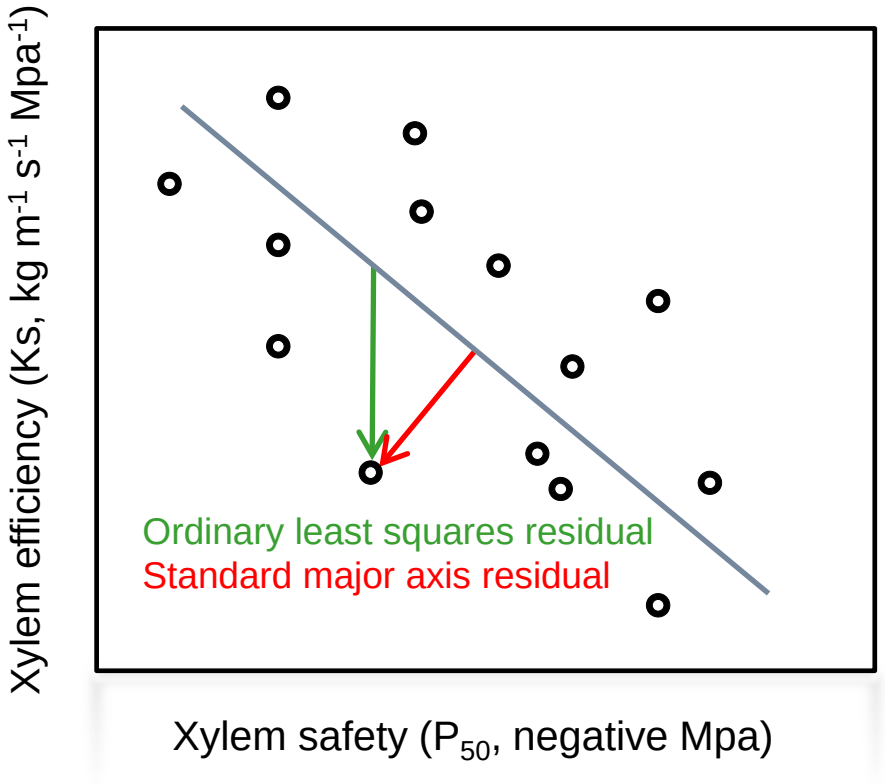


Fig. S1 Standard major axis residuals (SMA) vs ordinary least squares (OLS) residuals. Note that SMA residuals include variation on both the *x*- and *y*-axes, whereas OLS residuals include only variation on the *y*-axis. As such, OLS residuals reflect variation orthogonal to *x*, whereas SMA residuals reflect variation orthogonal to the *y*–*x* fit. By plotting the third variable against the efficiency–safety SMA residuals, the degree to which the third variable modifies the efficiency–safety relationship can be assessed.

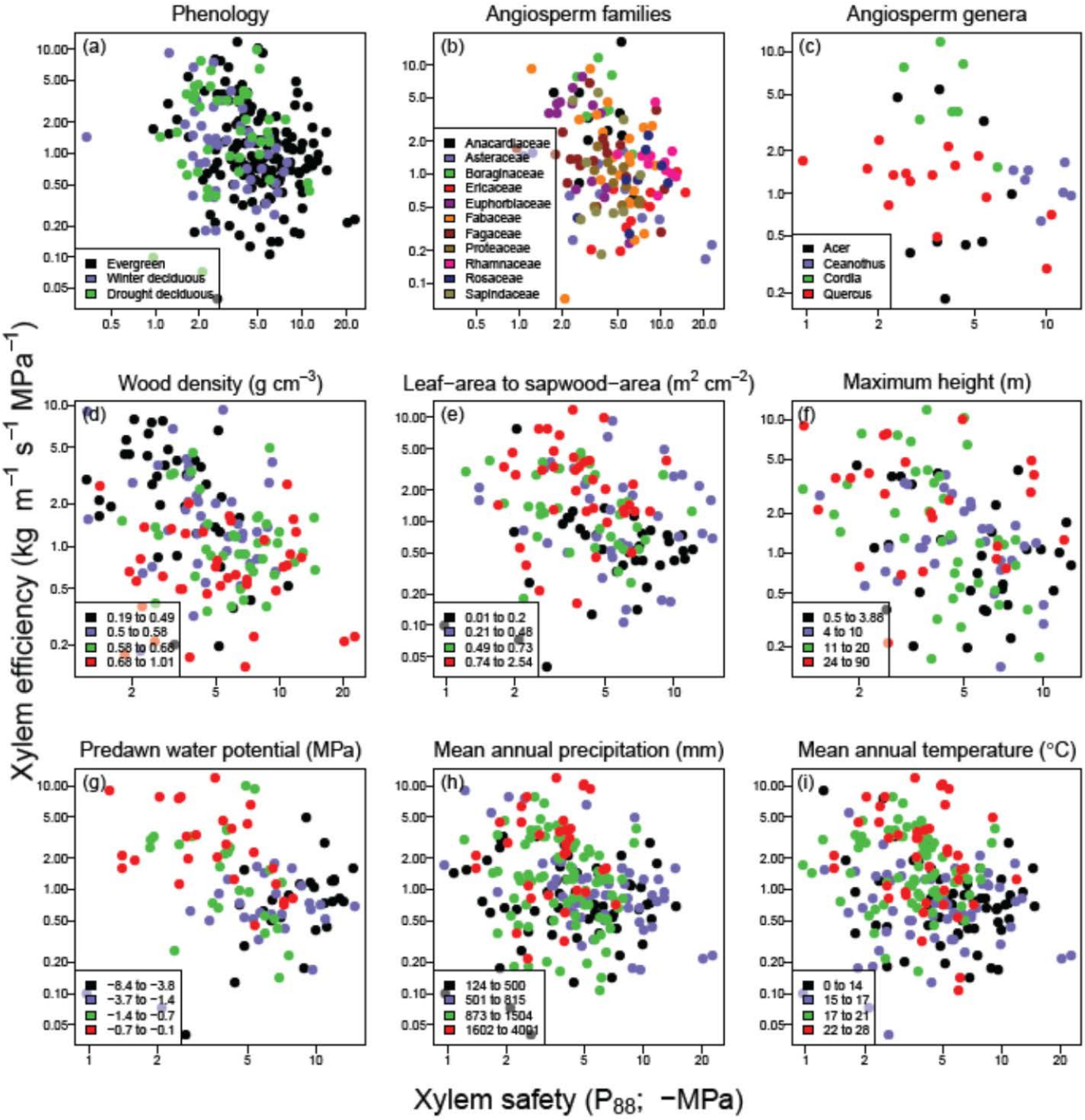


Fig. S2 Hydraulic efficiency-safety (P_{88}) plots for angiosperm species. Axes have been log10 scaled. Different colours represent different (a) leaf habits, (b, c) taxonomic groups, (d–f) plant structural traits, and (g–i) site factors. Continuous variables were binned in roughly equal groups of four with bin ranges denoted in the legends.

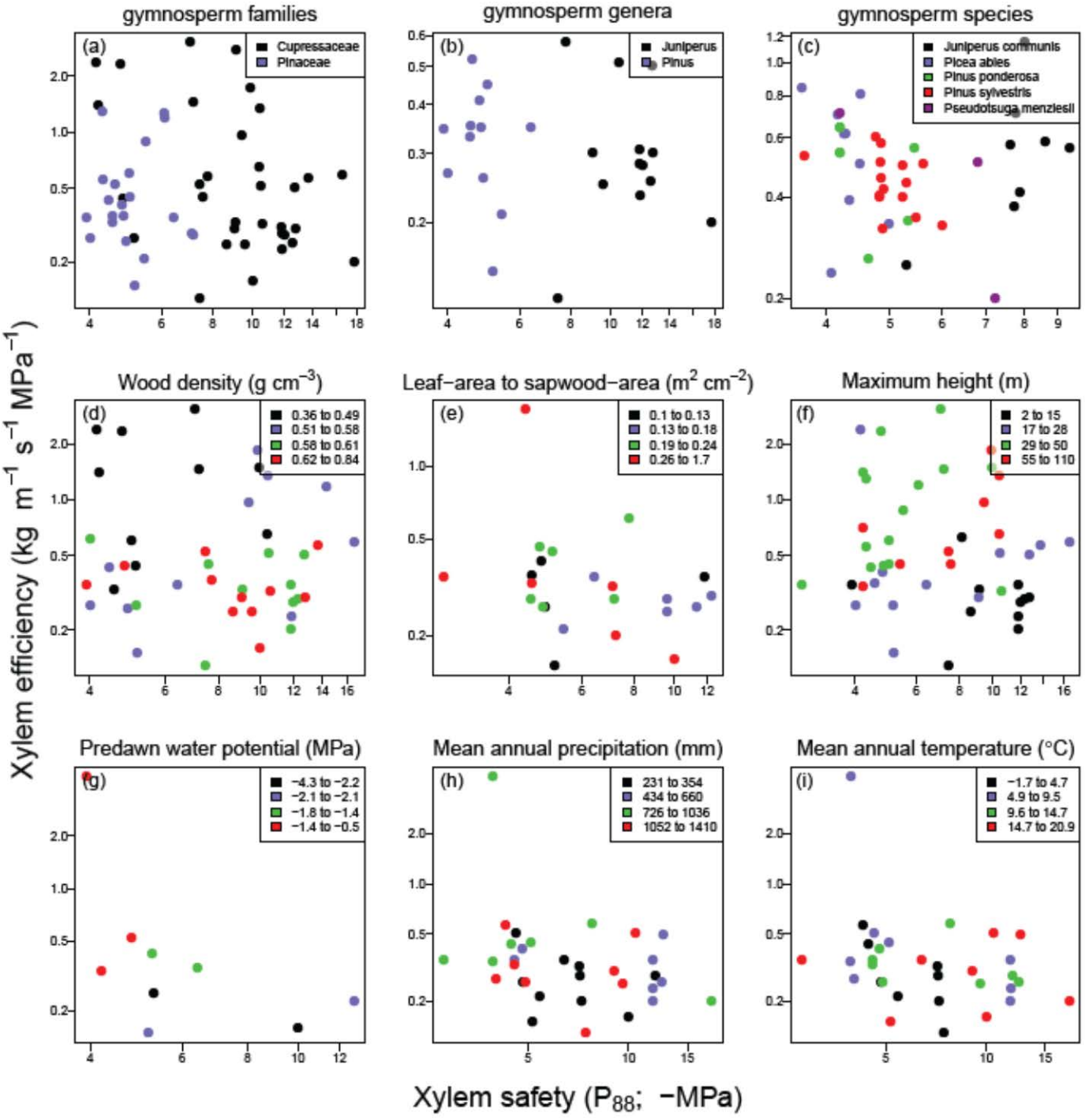


Fig. S3 Hydraulic efficiency-safety (P_{88}) plots for gymnosperm species. Axes have been log10 scaled. Different colours represent different (a–c) taxonomic groups, (d–f) plant structural traits, and (g–i) site factors. Continuous variables were binned in roughly equal groups of four with bin ranges denoted in the legends.

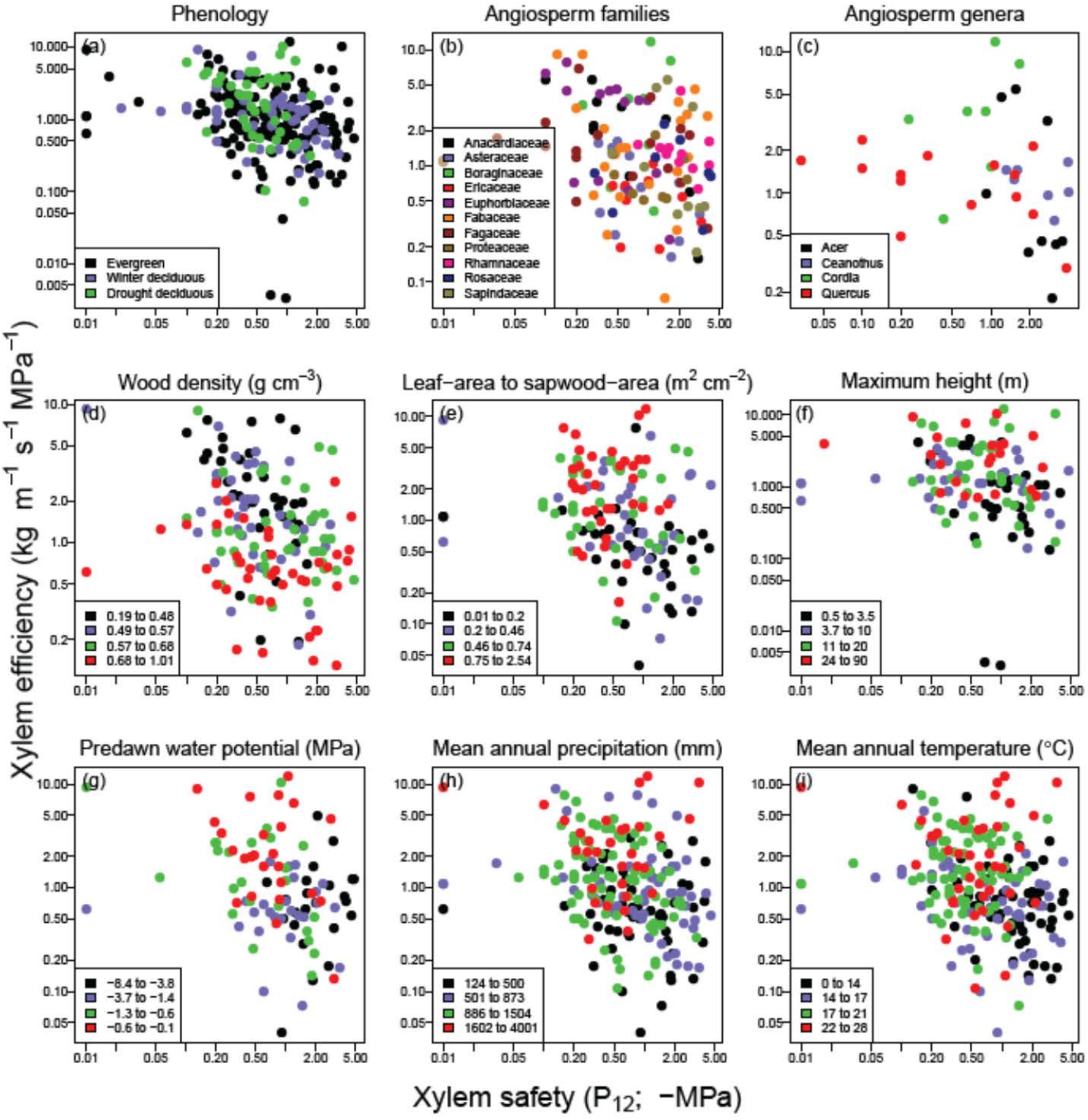


Fig. S4 Hydraulic efficiency-safety (P_{12}) plots for angiosperm species. Axes have been log10 scaled. Different colours represent different (a) leaf habits, (b, c) taxonomic groups, (d–f) plant structural traits, and (g–i) site factors. Continuous variables were binned in roughly equal groups of four with bin ranges denoted in the legends.

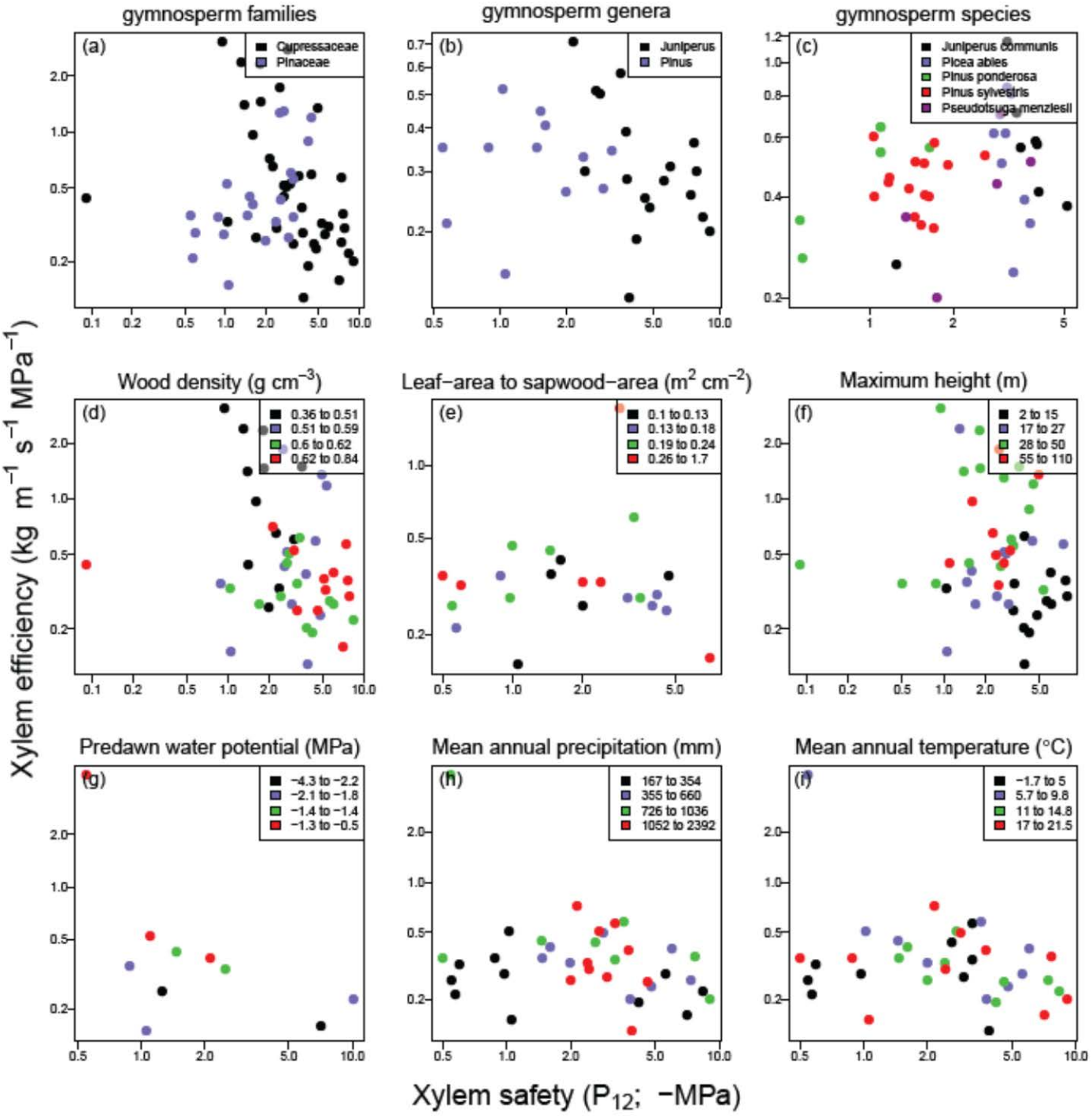
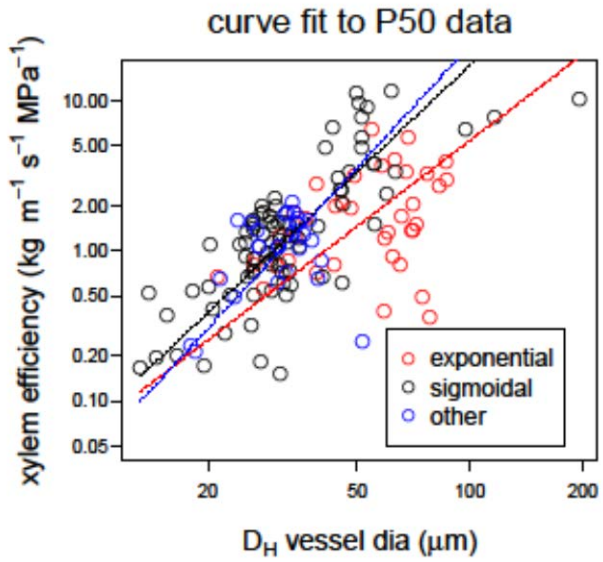
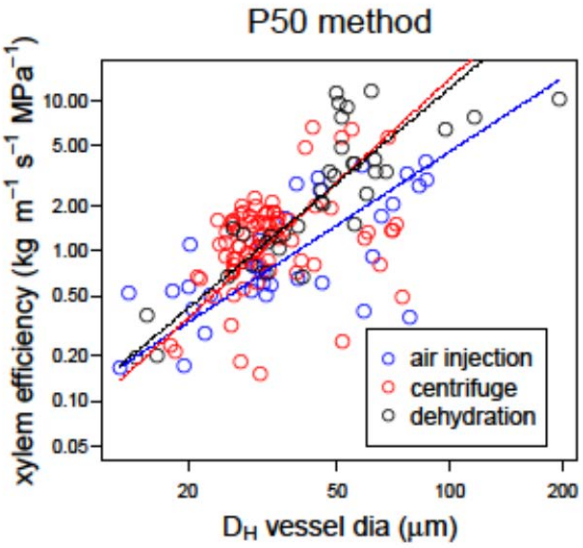


Fig. S5 Hydraulic efficiency-safety (P_{12}) plots for gymnosperm species. Axes have been log10 scaled. Different colours represent different (a–c) taxonomic groups, (d–f) plant structural traits, and (g–i) site factors. Continuous variables were binned in roughly equal groups of four with bin ranges denoted in the legends.



Group	Slope	Intercept	r^2	*P*
Exponential	1.90	-3.07	0.13	0.026
Sigmoidal	2.36	-3.48	0.60	<0.001
Other	2.69	-4.02	0.11	0.081
Slope compare				0.318
Intercept compare				<0.001

Fig. S6 Comparison of 'curve shapes' exhibited by fitted bivariate models (i.e. P_{50} curve) for angiosperm species in the database. Trendlines with significantly higher elevation coefficients indicate greater efficiency at a given hydraulically weighted vessel diameter, and therefore, suggests a methodological artifact. However, although exponential curves are thought to be associated with 'open' vessels (i.e. less resistance), samples fit with exponential curves tended to have *lower* efficiency, not higher.



Group	Slope	Intercept	r^2	*P*
Air injection	1.63	-2.60	0.46	<0.001
Centrifuge	2.28	-3.41	0.13	0.001
Dehydration	2.10	-3.12	0.70	<0.001
Slope compare				0.143
Intercept compare				0.013

Fig. S7 Comparison of methods used for generating P_{50} data. Trendlines exhibiting significantly higher elevation indicates greater efficiency at a given hydraulically weighted vessel diameter and therefore suggests a methodological artifact. Only methods which reported both efficiency and hydraulically weighted vessel diameter are included here. 'Air injection' includes the double-ended method only. 'Centrifuge' does not include data collected using the Cavitron method (Cochard, 2002).

Cochard H. 2002. A technique for measuring xylem hydraulic conductance under high negative pressures. *Plant, Cell & Environment* **25**: 815-819.

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Table S1 Standard major axis (SMA) efficiency–safety models fit to individual angiosperm and gymnosperm groups

Angiosperms	r^2	Slope	Intercept	*P*	df
All angiosperm species	0.048	-1.67	1.09	**<0.001**	239
Phenology					
Evergreen	0.053	-1.81	1.27	**0.004**	149
Winter deciduous	0.122	-1.59	0.80	**0.019**	43
Drought deciduous	0.005	1.90	-0.75	0.643	43
Families					
Anacardiaceae	0.025	-2.32	1.76	0.662	8
Asteraceae	0.500	-0.82	0.31	**0.010**	10
Boraginaceae	0.310	-2.38	2.07	0.194	5
Ericaceae	0.526	1.20	-1.35	**0.018**	8
Euphorbiaceae	0.485	-2.92	1.64	**0.006**	12
Fabaceae	0.074	-2.39	1.75	0.222	20
Fagaceae	0.058	-1.14	0.77	0.335	16
Proteaceae	0.229	-1.62	1.03	0.136	9
Rhamnaceae	0.054	-1.78	1.84	0.493	9
Rosaceae	0.336	1.53	-1.34	0.132	6
Sapindaceae	0.017	-3.41	2.01	0.717	8
Genera					
Acer	0.012	-3.54	2.12	0.776	7
Ceanothus	0.056	-1.51	1.55	0.609	5
Cordia	0.310	-2.38	2.07	0.194	5
Quercus	0.311	-0.89	0.53	**0.031**	13

Gymnosperms	r^2	Slope	Intercept	*P*	df
All gymnosperm species	0.004	-1.73	1.14	0.624	57
Families					
Cupressaceae	0.184	-2.37	1.99	**0.013**	31
Pinaceae	0.000	3.38	-2.75	0.935	19
Genera					
Juniperus	0.003	-1.75	1.30	0.859	11

Pinus	0.027	-2.60	1.27	0.609	10
Species					
Juniperus communis	0.378	2.75	-2.72	0.104	6
Picea abies	0.111	-5.16	2.98	0.382	7
Pinus ponderosa	0.186	-2.92	1.61	0.334	5
Pinus sylvestris	0.198	-1.80	0.90	0.097	13

Safety is defined as the xylem water potential at which maximal conductivity declines by 88**%**.

Statistically significant *P*-values ($\alpha = 0.05$) are denoted with bold text.

Table S2. Fit statistics for linear multiple regression models, with efficiency and safety as predictor variables and various structural and climatological traits as the dependent third variable

	r^2_{P88}	r^2_{Ks}	r^2_{resid}	df
Angiosperms				
Wood density	0.068*	0.194***	0.018	152
Leaf-area to sapwood-area	0.021	0.184***	0.042*	142
Maximum height	0.044	0.101**	0.007	120
Predawn water potential	0.297***	0.173***	0.009	101
Mean annual precipitation	0.004	0.142***	0.035**	228
Mean annual temperature	0.026	0.172***	0.034**	229
Number of freezing days	0.002	0.115***	0.077***	182
Gymnosperms				
Wood density	0.153**	0.220***	0.003	40
Leaf-area to sapwood-area	0.019	0.268*	0.082	20
Maximum height	0.048	0.286***	0.051	44
Predawn water potential	0.263	0.640**	0.060	6
Mean annual precipitation	0.037	0.028	0.004	29
Mean annual temperature	0.063	0.003	0.041	29
Number of freezing days	0.020	0.028	0.004	29

Safety is defined as the xylem water potential at which maximal conductivity declines by 88**%**. Coefficient of determination values represent the proportion of total variation in the third variable explained by hydraulic safety (r^2_{P88}) and hydraulic efficiency (r^2_{Ks}). The percent residual variation in the safety–efficiency fit (orthogonal variation, i.e. standard major axis residuals) that is explained by the third variable (r^2_{resid}) is also reported and indicates whether the third variable is a meaningful predictor of where species are located away from the safety–efficiency trend-line. Asterisks indicate levels of significance (*, P = 0.05; **, P = 0.01; ***, P = 0.001).

Table S3 Standard major axis (SMA) efficiency–safety models fit to individual angiosperm and gymnosperm groups

Angiosperms	r^2	Slope	Intercept	*P*	df
All angiosperm species	0.075	-1.03	-0.20	**<0.001**	240
Phenology					
Evergreen	0.051	-1.00	-0.22	**0.005**	150
Winter deciduous	0.174	-0.76	-0.15	**0.004**	44
Drought deciduous	0.126	-1.64	-0.29	**0.018**	42
Families					
Anacardiaceae	0.659	-1.02	-0.01	**0.004**	8
Asteraceae	0.268	-1.03	-0.32	0.085	10
Boraginaceae	0.037	1.85	0.62	0.650	6
Ericaceae	0.023	-0.87	-0.33	0.699	7
Euphorbiaceae	0.250	-1.30	-0.15	0.069	12
Fabaceae	0.023	-1.17	0.02	0.514	19
Fagaceae	0.088	-0.53	-0.01	0.248	15
Proteaceae	0.087	-0.22	-0.15	0.380	9
Rhamnaceae	0.062	-1.00	0.44	0.462	9
Rosaceae	0.000	0.70	-0.19	0.983	6
Sapindaceae	0.178	-1.78	0.43	0.225	8
Genera					
Acer	0.286	-2.66	0.81	0.138	7
Ceanothus	0.135	-0.69	0.32	0.418	5
Cordia	0.229	1.48	0.73	0.277	5
Quercus	0.196	-0.41	-0.08	0.113	12

Gymnosperms	r^2	Slope	Intercept	*P*	df
All gymnosperm species	0.012	-0.91	0.02	0.394	62
Families					
Cupressaceae	0.175	-1.00	0.18	**0.009**	36
Pinaceae	0.357	0.88	-0.58	**0.004**	23
Genera					

Juniperus	0.262	-0.96	0.12	**0.030**	16
Pinus	0.013	0.58	-0.58	0.725	10
Species					
Juniperus communis	0.149	1.07	-0.84	0.346	6
Picea abies	0.312	-4.48	1.98	0.118	7
Pinus ponderosa	0.731	0.88	-0.31	**0.014**	5
Pinus sylvestris	0.003	0.81	-0.50	0.845	13
Pseudotsuga menziesii	0.481	1.11	-0.81	0.194	3

Safety is defined as the xylem water potential at which maximal conductivity declines by 12**%**.

Statistically significant *P*-values ($\alpha = 0.05$) are denoted with bold text.

Table S4 Fit statistics for linear multiple regression models, with efficiency and safety as predictor variables and various structural and climatological traits as the dependent third variable

	r^2_{P12}	r^2_{Ks}	r^2_{resid}	df
Angiosperms				
Wood density	0.008	0.255***	0.116***	160
Leaf-area to sapwood-area	0.020	0.215***	0.059**	141
Maximum height	0.006	0.182***	0.065**	119
Predawn water potential	0.122**	0.150***	0.001	95
Mean annual precipitation	0.024	0.171***	0.024*	221
Mean annual temperature	0.064**	0.153***	0.011	222
Number of freezing days	0.014	0.118***	0.026*	174
Gymnosperms[a]				
Wood density	0.131*	0.191**	0.003	45
Maximum height	0.061	0.292***	0.060	46
Predawn water potential	0.220	0.643**	0.006	7
Mean annual precipitation	0.028	0.104*	0.102	34
Mean annual temperature	0.118*	0.007	0.084	34
Number of freezing days	0.003	0.001	0.000	34

Safety is defined as the xylem water potential at which maximal conductivity declines by 12%. Coefficient of determination values represent the proportion of total variation in the third variable explained by hydraulic safety (r^2_{P12}) and hydraulic efficiency (r^2_{Ks}). The percent residual variation in the safety–efficiency fit (orthogonal variation, i.e. standard major axis residuals) that is explained by the third variable (r^2_{resid}) is also reported and indicates whether the third variable is a meaningful predictor of where species are located away from the safety–efficiency trend-line. Asterisks indicate levels of significance (*, P = 0.05; **, P = 0.01; ***, P = 0.001). [a]The safety-efficiency relationship for gymnosperm leaf-area to sapwood-area exhibited a positive slope and was omitted from the analysis.

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Table S5 Standard major axis (SMA) models fit to individual angiosperm and gymnosperm groups after omitting 'r-shaped' vulnerability curves

Angiosperms	r^2	Slope	Intercept	*P*	df
All angiosperm species	0.081	-1.74	0.80	**<0.001**	269
Phenology					
Evergreen	0.054	-1.70	0.82	**0.003**	160
Winter deciduous	0.065	-1.89	0.83	**0.025**	76
Drought deciduous	0.016	-1.85	0.71	0.494	29
Families					
Anacardiaceae	0.259	-3.32	1.51	0.162	7
Asteraceae	0.050	-0.93	0.20	0.593	6
Boraginaceae	0.056	-2.79	1.44	0.539	7
Ericaceae	0.473	2.07	-1.45[bc]	**0.028**	8
Euphorbiaceae	0.404	-1.80	0.55[c]	**0.006**	15
Fabaceae	0.007	-2.52	1.35	0.756	14
Fagaceae	0.628	-1.91	1.17[b]	**0.004**	9
Proteaceae	0.132	-1.38	0.52	0.271	9
Rhamnaceae	0.045	-2.40	2.01	0.554	8
Rosaceae	0.241	-2.29	1.86[a]	**0.033**	17
Sapindaceae	0.208	-3.22	1.50	0.159	9
Genera					
Acer	0.243	-3.59	1.73	0.148	8
Ceanothus	0.032	-1.41	1.21	0.701	5
Cordia	0.010	2.46	-0.23	0.812	6
Quercus	0.875	-2.37	1.48	**0.002**	5

Safety is defined as the xylem water potential at which maximal conductivity declines by 50%. Statistically significant *P*-values ($\alpha = 0.05$) are denoted with bold text.

Table S6 Models fit after omitting exponential vulnerability curves

	r^2_{P50}	r^2_{Ks}	r^2_{resid}	df
Angiosperms				
Wood density	0.108***	0.166***	0.004	152
Leaf-area to sapwood-area	0.136***	0.175***	0.001	143
Maximum height	0.024	0.151***	0.031	115
Predawn water potential	0.282***	0.183***	0.006	102
Mean annual precipitation	0.128***	0.116***	0.000	249
Mean annual temperature	0.075***	0.028*	0.006	249
Number of freezing days	0.058**	0.046*	0.003	168

Fit statistics for linear multiple regression models, with efficiency and safety as predictor variables and various structural and climatological traits as the dependent third variable. Safety is defined as the xylem water potential at which maximal conductivity declines by 50**%**. Coefficient of determination values represent the proportion of total variation in the third variable explained by hydraulic safety (r^2_{P50}) and hydraulic efficiency (r^2_{Ks}). The percent residual variation in the efficiency–safety fit (orthogonal variation, i.e. standard major axis residuals) that is explained by the third variable (r^2_{resid}) is also reported and indicates whether the third variable is a meaningful predictor of where species are located away from the efficiency–safety trend-line. Asterisks indicate levels of significance (*, $P = 0.05$; **, $P = 0.01$; ***, $P = 0.001$).

Notes S1 Published references from which data were extracted for analyses.

Includes all angiosperm and gymnosperm species (branch xylem) where both efficiency (K_S) and safety (P_{50}) data were reported. Observations where efficiency measurements exceeded 40 kg m^{-1} s^{-1} MPa^{-1} were assumed in error and omitted.

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