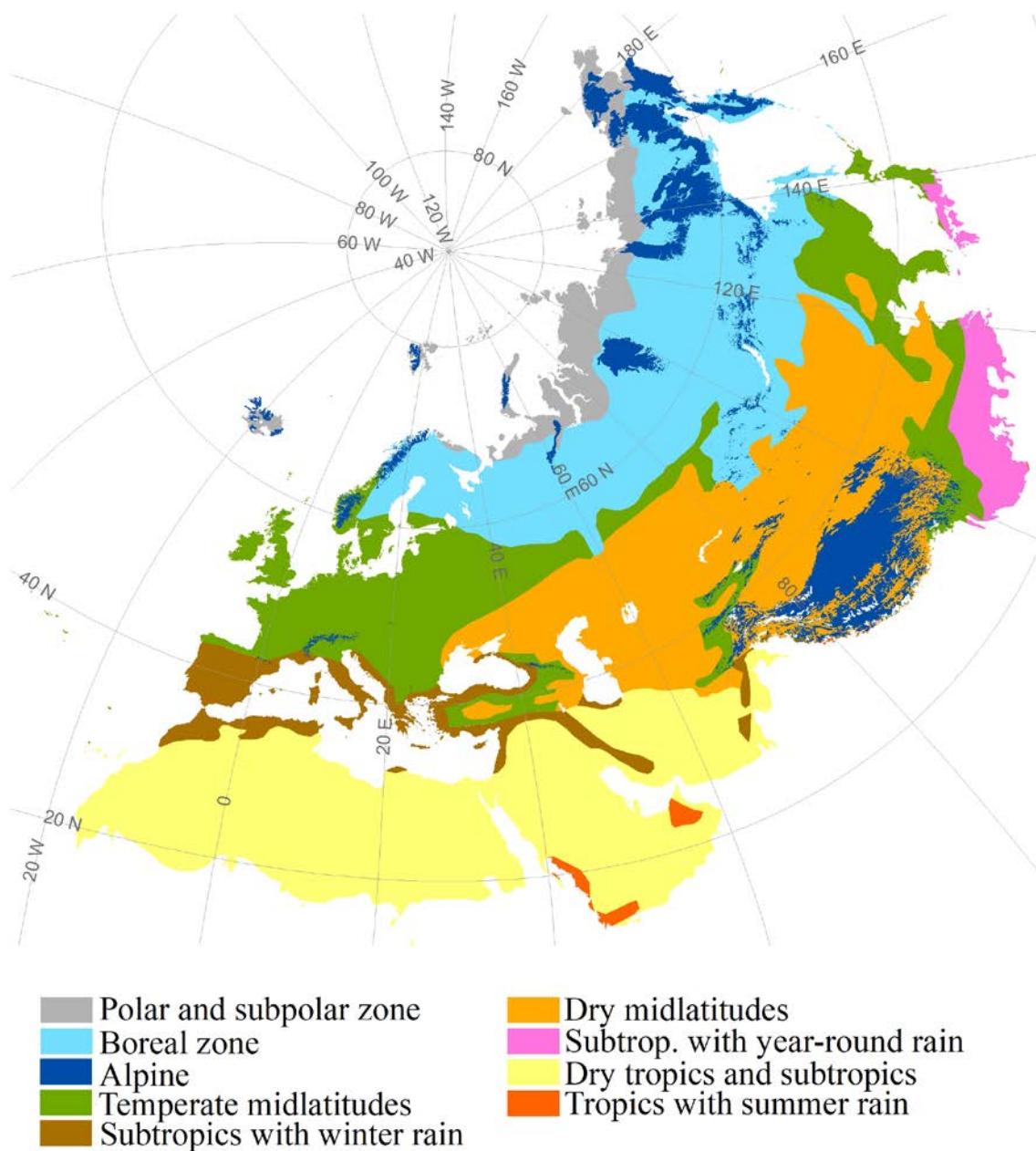
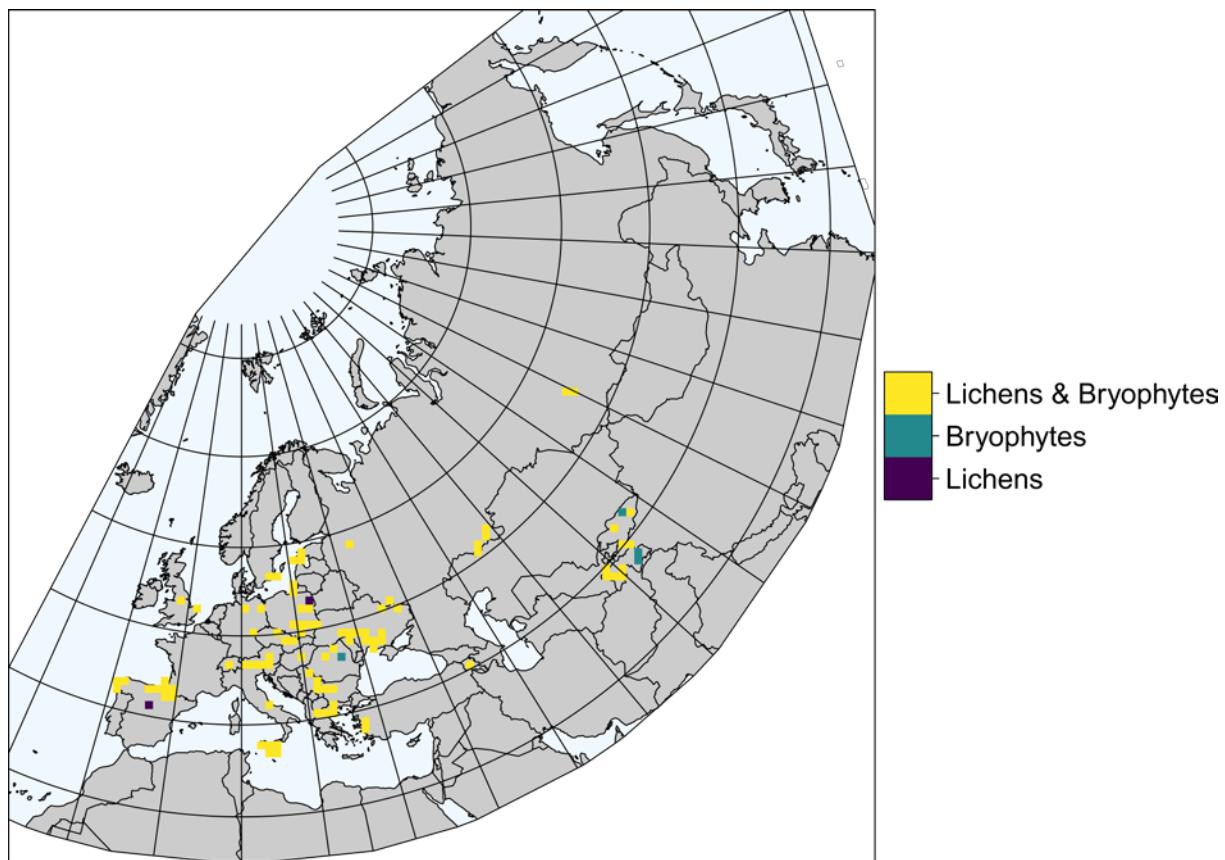


**Supporting Information 1.** Additional information on origin and properties of the analysed nested-plot series.



**Figure S1.1.** Map that shows the delimitation of the Palaearctic biogeographic realm (Olson et al., 2001) and the distribution of the nine biomes within it (only the 10th biome, the Tropics with year-round rain, is not present in the realm). We have modified the biome classification provided in Bruelheide et al. (2019), which is based on the nine ecozones of Schultz (2005) plus an additional alpine biome based on Körner et al. (2017). Note that the biomes “Polar and subpolar zone”, “Subtropics with year-round rain” and “Tropics with

“summer rain” are not represented in the study as GrassPlot currently does not contain nested-plot series from these meeting our requirements.



**Figure S1.2.** Spatial distribution of 10,000-km<sup>2</sup> grid cells that contain nested-plot series with information on bryophyte and lichen richness. Bryophyte and lichen richness was available for 757 and 780 nested-plot series, respectively. The map uses the Europe Lambert Conformal Conic projection.

**Table S1.1.** Proportion of the nested-plot series regarding taxonomic groups, methodological variables, and number of grain sizes.

Taxonomic group				
	Vascular plants	Bryophytes	Lichens	All terricolous taxa
Frequency	2057	757	780	733
Methodological settings				
	Shoot	Rooted	NA	
Frequency	1827	177	53	
	Averaged	Non-averaged		
Frequency	1890	169		
	Perfect nesting	Non-perfect nesting		
Frequency	916	1141		
Number of grain sizes				
	7	8	9	10
Frequency	1280	595	28	33
			11	13
			16	16
			26	64

**Table S1.2.** Origin of the nested-plot series with regard to biome and vegetation type.

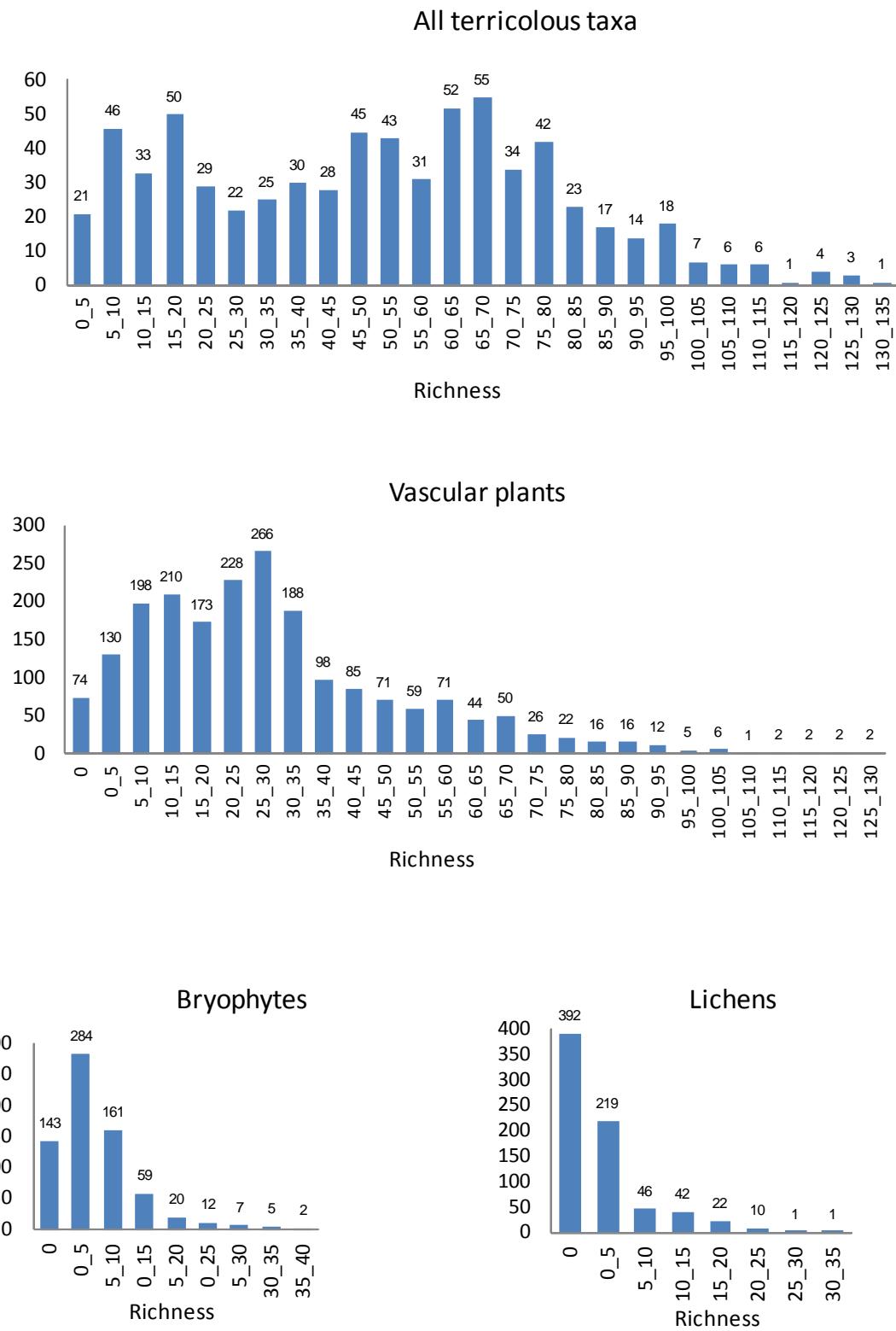
Ecological parameters			
Biome	Frequency	Vegetation type	Frequency
Alpine	97	Alpine grassland	508
Boreal zone	61	Dune	166
Dry midlatitudes	48	Garrigue	2
Dry tropics and subtropics	91	Heathland	28
Subtropics with winter rain	294	Mediterranean grassland	22
Temperate midlatitudes	1466	Mesic grassland	143
		Mesic-xeric grassland	644
		Rock and scree	1
		Rocky grassland	113
		Ruderal community	26
		Saline community	73
		Sandy dry grassland	78
		Semi-desert	13
		Tall-forb community	11
		Thorn cushion community	17
		Wet grassland	19
		Wetland	31
		Xeric grassland	138
		NA	24

**Table S1.3.** Description of the vegetation types used in GrassPlot.

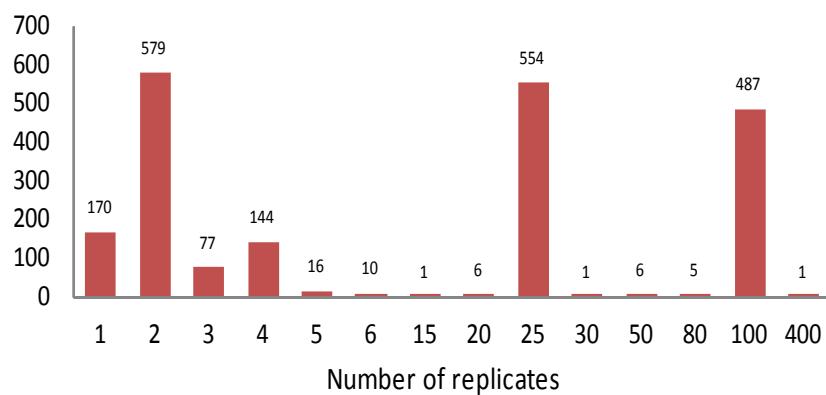
Vegetation type	Definition (modified from Mucina et al., 2016)	Phytosociological classes (those from Europe according to Mucina et al., 2016)
Alpine grassland	Vegetation belt below the snow line and above the tree-line of temperate and mediterranean mountain ranges; it is characterised by natural grasslands and low scrub vegetation	<i>Carici rupestris-Kobresietea bellardii; Cleistogenetea squarrosae p.p.; Elyno-Seslerietea p.p.; Festucetea indigestae p.p.; Juncetea trifida p.p.; Salicetea herbaceae</i>
Dune	Coastal sandy aerohaline communities; subject to sea-salt spray brought by winds	<i>Ammophiletea; Helichryso-Crucianelletea maritimae</i>
Garrigue	Mediterranean scrub formation (tomillar, romeral, garrigue, phrygana, batha) dominated by drought-tolerant shrubs of the genera <i>Cistus</i> , <i>Coridothymus</i> , <i>Rosmarinus</i> , etc. For this proposal we restrict it to thermo-supramediterranean areas	<i>Festuco hystricis-Ononidetea striatae p.p.; Ononido-Rosmarinetea</i>
Heathland	Plant formation dominated by dwarf or low shrubs with fine evergreen sclerophyllous leaves, mainly belonging to the family <i>Ericaceae</i>	<i>Calluno-Ulicetea; Loiseleurio procumbentis-Vaccinietea; Rhododendro hirsuti-Ericetea carnea</i>
Mediterranean grassland	Typical grassland of the Mediterranean Region, rich in therophytes	<i>Helianthemetea guttati; Lygeo sparti-Stipetea tenacissimae; Poetea bulbosae; Stipo giganteae-Agrostietea castellanae; Stipo-Trachynieteа distachyae</i>
Mesic grassland	Grasslands dominated by mesic plants, hence plants preferring habitats around the middle of environmental moisture gradient	<i>Calamagrostietea langsdorffii p.p.; Elyno-Seslerietea p.p.; Juncetea trifida p.p.; Molinio-Arrhenatheretea p.p.; Nardetea strictae p.p.</i>
Meso-xeric grassland	Grasslands dominated by mesic and xerophilous plants, hence plants preferring habitats around the middle or at the dry end of environmental moisture gradient	<i>Cleistogenetea squarrosae p.p.; Festuco-Brometea p.p.</i>
Rock and scree	Scree communities and chasmophytic vegetation growing in rocky crevices of cliffs and rock faces	<i>Adiantetea; Asplenietea trichomanis; Didymophyso aucheri-Dracocephaletea aucheri; Polypodieta; Thlaspietea rotundifolia</i>
Rocky grassland	Tomillar and stony grasslands developed on lithosols (normally limestone), substrate characterised by very shallow and skeletal humus-rich horizon with parent bedrock often	<i>Elyno-Seslerietea p.p.; Festuco hystricis-Ononidetea striatae p.p.; Festuco-Brometea p.p.; Helianthemo-Thymetea; Sedo-Scleranthetaea</i>

Vegetation type	Definition (modified from Mucina et al., 2016)	Phytosociological classes (those from Europe according to Mucina et al., 2016)
	protruding to the surface	
Ruderal community	Grasslands and low scrubs in heavily disturbed habitats	<i>Artemisietea vulgaris; Bidentetea; Chenopodietea; Digitario sanguinalis-Eragrostietea minoris; Epilobietea angustifolii; Papaveretea rhoeadis; Polygono-Poetea annuae; Sisymbrietea</i>
Saline community	Communities developed on soils or water having high content of soluble salts (e.g. NaCl, MgSO4), making the environment toxic for the majority of common (hence ecologically not specialized) species; these habitats support facultative or obligate halophytes	<i>Cakiletea maritimae; Crithmo-Staticetea; Festuco-Puccinellietea; Juncetea maritimi; Saginetea maritimae; Salicornietea fruticosae; Spartinetea maritimae; Therosalicornietea</i>
Sandy dry grassland	Tomillar and grasslands developed on siliceous lithosols, substrate characterised by very shallow and skeletal humus-rich horizon with parent bedrock often originating a sandy soil	<i>Festucetea indigestae p.p.; Koelerio-Corynephoretea canescens</i>
Semi-desert	Open grasslands and scrubs in very dry climates	<i>Ajanio-Cleistogenetea songoricae; Artemisietea lerchiana; Kleinio-Euphorbietae canariensis</i>
Tall forb community	Communities dominated by tall herbs growing on naturally productive areas in mountains and stream banks	<i>Molinio-Arrhenatheretea p.p.; Mulgedio-Aconitetea; Trifolio-Geranietea sanguinei</i>
Thorn cushion community	Dwarf shrubs and thorn-cushion communities in mountains from Mediterranean and sub-Mediterranean areas, adapted to winter low temperatures	<i>Astragalo microcephali-Brometea tomentelli; Festuco hystricis-Ononidetea striatae p.p.; Onobrychidetea cornutae; Prangetea ulopterae p.p.; Rumic-Astragaletea siculi</i>
Wet grassland	Grasslands dominated by hygrophilous plants, hence plants preferring habitats around the wet part of environmental moisture gradient	<i>Calamagrostietea langsdorffii p.p.; Molinio-Arrhenatheretea p.p.; Nardetea strictae p.p.</i>
Wetland	Grasslands and helophytic formations on permanently waterlogged and temporarily flooded areas; mires included	<i>Isoëto-Nanojuncetea; Littorelletea uniflorae; Montio-Cardaminetea; Oxycocco-Sphagnetea; Phragmito-Magnocaricetea; Scheuchzerio palustris-Caricetea fuscae</i>

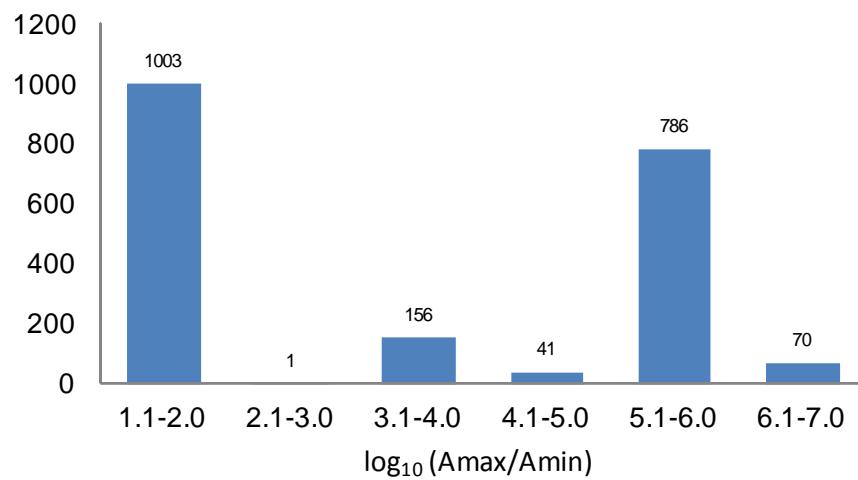
<b>Vegetation type</b>	<b>Definition (modified from Mucina et al., 2016)</b>	<b>Phytosociological classes (those from Europe according to Mucina et al., 2016)</b>
Xeric grassland	Grassland dominated by xerophilous plants, hence preferring habitats on the dry end of the environmental water gradient	<i>Cleistogenetea squarrosae</i> p.p.; <i>Festuco-Brometea</i> p.p.



**Figure S1.3.** Histograms of the richness values found in the biggest plot of a nested-plot series.



**Figure S1.4.** Histogram of the number of replicates averaged in the smallest subplots of a nested-plot series.



**Figure S1.5.** Histogram of the grain-size range of the nested-plot series.

**Table S1.4.** Overview of the 69 datasets retrieved from GrassPlot.

Dataset ID	Short dataset name	Country	Custodian	Nº nested series	Nº plots	Nº grain sizes	Reference(s)
<b>Perfect nesting without replication</b>							
CZ_A	Dengler White Carpathians	Czech Republic	Jürgen Dengler	1	7	7	
HU_D	Török nested series	Hungary	Orsolya Valkó	30	300	10	Godó et al. (2017)
NO_C	Grytnes North Norway	Norway	John-Arvid Grytnes	33	231	7	
NO_D	Grytnes South Norway	Norway	John-Arvid Grytnes	10	70	7	
RU_G	Dolnik Curonian Spit	Russia	Christian Dolnik	64	832	8 or 16	Dolnik (2003, 2006)
RU_M	Dolezal Kamchatka	Russia	Jiri Dolezal	10	80	8	
SE_A	Löbel Öland	Sweden	Swantje Löbel	31	341	11	Löbel (2002); Löbel et al. (2006); Löbel & Dengler (2008)
<b>Perfect nesting with replication at smaller grain sizes</b>							
AM_A	Dembicz Armenia	Armenia	Iwona Dembicz	1	13	7	
AS_A	Arek_Kyrgyzstan & Tajikistan	Tajikistan and Kyrgyzstan	Arkadiusz Nowak	12	156	7	
AT_E	EDGG Austria	Austria	EDGG	15	195	7	
CH_C	Dengler Wädenswil	Switzerland	Jürgen Dengler	17	221	7	Dengler & Widmer (2018)
CH_D	Dengler_Ausserberg	Switzerland	Jürgen Dengler	3	39	7	Dengler et al. (2018)

Dataset ID	Short dataset name	Country	Custodian	Nº nested series	Nº plots	Nº grain sizes	Reference(s)
CH_E	Dengler Alp Glivers	Switzerland	Jürgen Dengler	3	39	7	Hepenstrick et al. (2018)
DE_A	Dengler Upper Franconia	Germany	Jürgen Dengler	1	13	7	Hopp & Dengler (2015)
DE_F	Dengler Bayreuth	Germany	Jürgen Dengler	18	234	7	Dengler (2016)
DE_H	Langer Bayreuth	Germany	Nancy Langer	22	286	7	Langer (2016); Went (2016)
DE_K	Allers Lüneburg	Germany	Marc-André Allers	2	50	7	Dengler & Allers (2006); Allers (2007)
DE_L	Dengler Uckermark	Germany	Jürgen Dengler	23	299	7	Langer et al. (2017)
EE_A	Boch Saaremaa	Estonia	Steffen Boch	16	576	8	Boch (2005); Boch & Dengler (2006); Dengler & Boch (2008)
ES_A	EDGG Navarre	Spain	EDGG	35	455	7	Biurrun et al. (2014)
EU_F	Torca Bay of Biscay dunes	France, Spain	Marta Torca	139	3197	7	Torca et al. (2019a, 2019b)
EU_J	Janišová Carpathians	Romania, Slovakia	Monika Janišová	17	204	7	
GR_A	EDGG Greece	Greece	EDGG	14	182	7	Dengler & Demina (2012)
HU_B	Bartha Hungary sandy grasslands	Hungary	Sándor Bartha	5	1180	7	Bartha (2016)
IR_A	Naqinezhad Central Alborz	Iran	Alireza Naqinezhad	27	459	9	Talebi (2017)
IT_A	EDGG Sicily	Italy	EDGG	21	273	7	Guarino et al. (2012)
IT_C	Baumann Gran Paradiso	Italy	Esther Baumann	14	182	7	Baumann et al. (2016)
IT_D	Dengler Aosta	Italy	Jürgen Dengler	2	26	7	Wiesner et al. (2015)

Dataset ID	Short dataset name	Country	Custodian	Nº nested series	Nº plots	Nº grain sizes	Reference(s)
IT_H	Chiarucci Parco della Chiusa	Italy	Alessandro Chiarucci	6	78	7	Suanno (2017)
IT_I	Chiarucci Radicondoli	Italy	Alessandro Chiarucci	3	111	10	Chiarucci et al. (2006)
IT_L	EDGG Apennines	Italy	EDGG	20	260	7	
IT_Q	EGC Sulmona	Italy	Giampiero Ciaschetti	1	13	7	Dengler (2018)
PL_A	EDGG Poland	Poland	EDGG	31	403	7	
PL_D	Pielech nested	Poland	Remigiusz Pielech	10	130	7	
PL_E	Kozub Biebrza	Poland	Łukasz Kozub	15	195	7	
RO_A	EDGG Transylvania	Romania	EDGG	20	260	7	Dengler et al. (2009, 2012); Turtureanu et al. (2014)
RO_B	Mardari Moldavian Plateau	Romania	Constantin Mardari	45	585	7	Mardari & Tănase (2016)
RS_A	EDGG Serbia	Serbia	EDGG	32	416	7	Krstivojević Ćuk et al. (2015); Aćić et al. (2017)
RU_A	EDGG Khakassia	Russia	EDGG	39	507	7	Janišová et al. (2013); Polyakova et al. (2016)
RU_I	Belonovskaya Novgorodskaya	Russia	Elena Belonovskaya	4	46	7	Belonovksaya & Tsarevskaya (2017)
RU_K	Mirin Belogorie	Russia	Denis Mirin	2	26	7	
RU_L	Dolnik South Ural	Russia	Christian Dolnik	7	91	7	

Dataset ID	Short dataset name	Country	Custodian	Nº nested series	Nº plots	Nº grain sizes	Reference(s)
TJ_A	Arek_Tajikistan	Tajikistan	Arkadiusz Nowak	15	195	7	
TR_B	Güler Buca İzmir	Turkey	Behlül Güler	3	39	7	
UA_A	EDGG Podolia	Ukraine	EDGG	21	273	7	Kuzemko et al. (2014, 2016)
UA_D	Janišová Chyvchyny Mts.	Ukraine	Monika Janišová	5	65	7	Janišová et al. (2016)
UA_H	Kuzemko Byzky Gard	Ukraine	Anna Kuzemko	2	26	7	
UA_I	Kuzemko Kreida	Ukraine	Anna Kuzemko	8	104	7	
UA_J	Vynokurov Southern Ukraine	Ukraine	Denys Vynokurov	11	143	7	
UA_K	Savchenko Kharkiv & Donetsk	Ukraine	Galina Savchenko	11	143	7	
UA_L	Dembicz nested Ukraine	Ukraine	Iwona Dembicz Idoia Biurrun	12	156	7	
UK_A	Archibald Great Britain	United Kingdom		6	48	8	Archibald (1949)
<b>Non-perfect nesting</b>							
BG_A	EDGG Bulgaria	Bulgaria	EDGG	15	209	8	Pedashenko et al. (2013)
AT_C	GLORIA Hochswab	Austria	Harald Pauli	59	11505	8	Gottfried et al. (2012); Pauli et al. (2012); Winkler et al. (2016)
CN_C	Zhang Tibet	China	Hui Zhang	1	798	9	Zhang (2013)
DE_B	Dengler BR Schorfheide-Chorin	Germany	Jürgen Dengler	10	750	8	Dengler et al. (2004)

Dataset ID	Short dataset name	Country	Custodian	Nº nested series	Nº plots	Nº grain sizes	Reference(s)
DE_G	Kiehl Hamburger Hallig salt marshes	Germany	Kathrin Kiehl	47	376	8	Wanner et al. (2014)
ES_J	GLORIA Ordesa	Spain	José Luis Benito	64	12480	8	Gottfried et al. (2012); Pauli et al. (2012); Winkler et al. (2016)
ES_M	GLORIA Sistema Central	Spain	Rosario Gavilán	32	6240	8	Gottfried et al. (2012); Pauli et al. (2012); Winkler et al. (2016)
ES_N	GLORIA Sierra Nevada East	Spain	María Rosa Fernández	64	12480	8	Gottfried et al. (2012); Pauli et al. (2012); Winkler et al. (2016)
ES_O	GLORIA Sierra Nevada North	Spain	María Rosa Fernández	64	12480	8	Gottfried et al. (2012); Pauli et al. (2012); Winkler et al. (2016)
ES_P	Alfaro Picos de Europa	Spain	Borja Jiménez-Alfaro	16	3120	8	Jímenez-Alfaro et al. (2010)
EU_C	Hajek spring fen nested series	Czech Republic, Poland, Slovakia	Eva Hettenbergerová	30	390	7	Hájková & Hájek (2003); Náhlíková (2009)
IR_C	GLORIA Alborz	Iran	Jalil Noroozi	64	12480	8	Gottfried et al. (2012); Pauli et al. (2012); Winkler et al. (2016)
IT_O	GLORIA Dolomites	Italy	Brigitta Erschbamer	60	11700	8	Erschbamer et al. (2011); Gottfried et al. (2012); Pauli et al. (2012); Winkler et al. (2016)
NO_B	GLORIA Norway	Norway	Pieter De Frenne	64	12480	8	Gottfried et al. (2012); Pauli et al. (2012); Winkler et al. (2016); Vanneste et al. (2017)

Dataset ID	Short dataset name	Country	Custodian	Nº nested series	Nº plots	Nº grain sizes	Reference(s)
SE_C	Peet Öland	Sweden	Robert K. Peet	6	768	7	Sykes et al. (1994); Wilson et al. (1995)
SE_D	Reitalu Öland	Sweden	Triin Reitalu	516	23736	7	Reitalu et al. (2008, 2009, 2010, 2012)
UK_B	Pakeman Outer Hebrides	United Kingdom	Robin Pakeman	30	2820	13	White et al. (2018)
<b>Total</b>				2057	139265		

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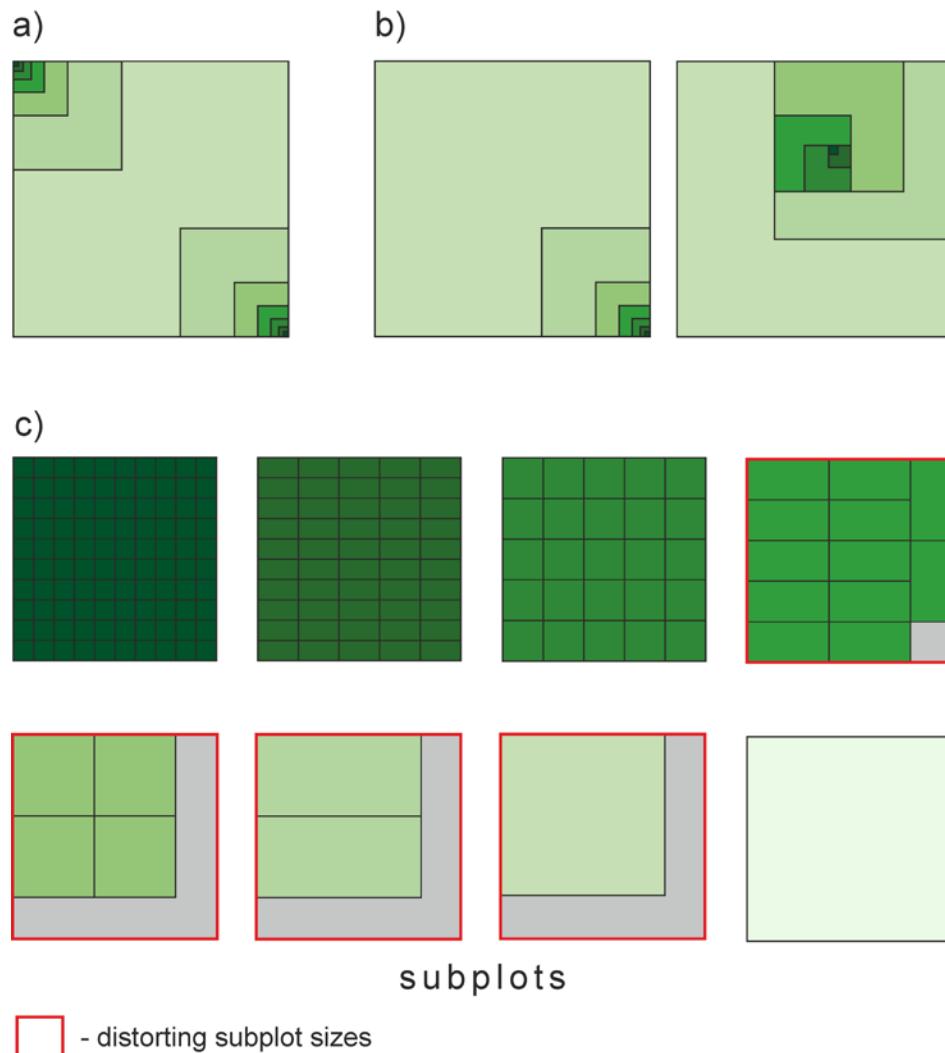
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**Supporting Information 2.** Typical examples from the variety of nested-plot sampling schemes in GrassPlot.

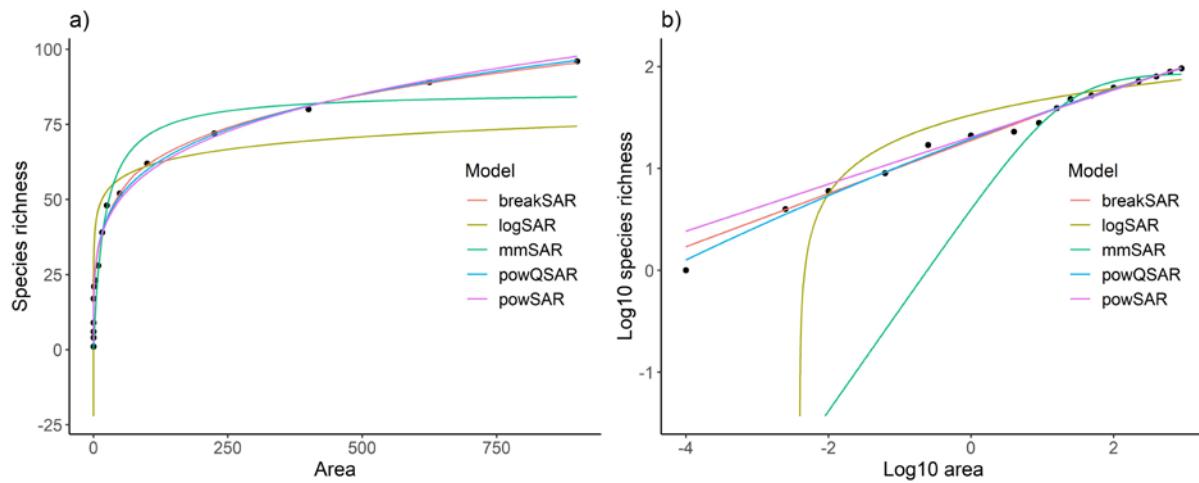


**Figure S2.1.** Visualisation of three typical ways of nested-plot sampling found in the GrassPlot database: a) Perfect nesting with replication at smaller grain sizes (field sampling standard with two replicates of each grain size except the biggest, which is used during EDGG Field Workshops; for details see Dengler et al., 2016); b) two examples of perfect nesting without replication of the subplots, c) non-perfect nesting, where the smallest subplots completely tessellate the biggest plot. In this example, a typical GLORIA sampling design is shown (Pauli et al., 2015). Only the smallest subplots (P/A) and the biggest plot (% cover) are actually sampled in the field, while all intermediate grain sizes plots are created post hoc by joining species lists of adjacent subplots. To achieve more different grain sizes, we accepted some that did not allow full tessellation of the biggest plot (see grey areas) and thus distorted the complete nesting. When the distorting sizes of subplots were removed, a complete nesting would result.

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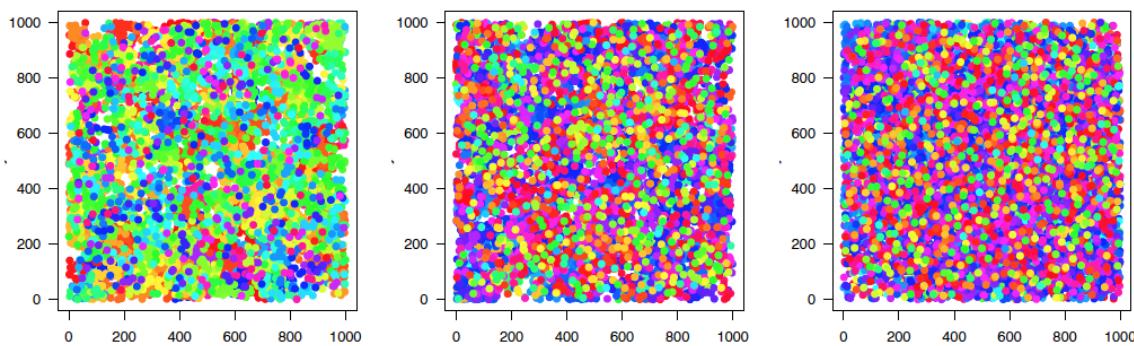
**Supporting Information 3.** Visualisation of the five compared function types in  $S$ -space and  $\log S$  space.



**Figure S3.1.** Fitted functions (in  $S$ -space) visualized for the exemplary dataset RU\_G\_N002\_900 (from the Curonian Spit National Park in Russia) both with linear axes and with both axes log-transformed to highlight differences in shape and fit. According to AICc, the best model was the power function (powSAR,  $c = 20.29$ ,  $z = 0.231$ ), followed by quadratic power function (powQSAR,  $\Delta_i = 1.33$ ,  $c = 19.56$ ,  $z_1 = 0.261$ ,  $z_2 = -0.009$ ), breakpoint power function (breakSAR,  $\Delta_i = 3.08$ ,  $c = 44.79$ ,  $z_1 = 0.060$ ,  $z_2 = 0.200$ ,  $T = 75.88$ ), Michaelis-Menten function (mmSAR,  $\Delta_i = 36.25$ ,  $b_0 = 86.04$ ,  $b_1 = 20.76$ ) and logarithmic function (logSAR,  $\Delta_i = 49.51$ ,  $b_0 = 33.37$ ,  $b_1 = 13.88$ ). This is a rather typical result for our datasets: the power function and its two variants have a good and similar fit to the data, while logarithmic function and Michaelis-Menten function have a similarly poor fit, largely underestimating richness at both the finest and the largest grain sizes of the fitted range. Moreover, the logarithmic function necessarily always predicts negative values for richness for small positive areas.

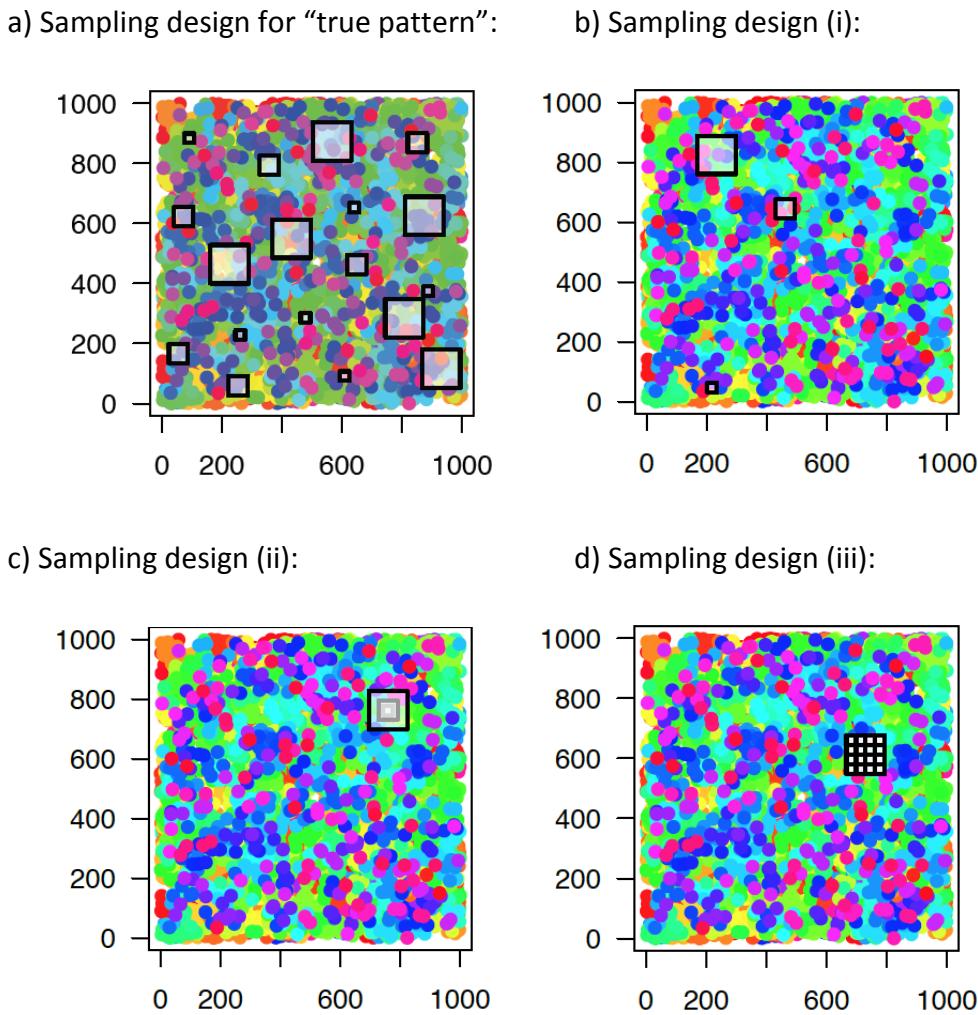
**Supporting Information 4.** Simulation to demonstrate the validity of our statistical approach.

To demonstrate that, despite the violation of the assumption of independence, the model selection results are correct, a simulation of virtual communities was undertaken using the R package mobsim (May, 2017; May et al., 2018) (Appendix S5 in Supporting Information). We created 50 different landscapes of 1000 x 1000 units size based on different (realistic) values of the mobsim community parameters (Fig. S4.1).



**Fig. S4.1.** Example of three simulated communities with different parameter settings.

We used the sampling functions in mobsim (which we expanded to match the sampling schemes under discussion (Appendix S6 in Supporting Information)) to sample from these virtual communities (Fig. S4.2). Then we fitted models with the five SAR functions (logSAR, powSAR, mmSAR, powQSAR, breakSAR) to these richness data with exactly the same procedure as for the empirical data. Each simulated landscape hence allowed us to get the “true pattern”.



**Fig. S4.2.** Adapted sampling designs (exemplified for three grain sizes); top right (a): repeated non-nested independent squares averaged for each grain size (“true pattern”); top left (b): non-nested independent squares (i); bottom right (c): nested-plot sampling at random starting points (ii); bottom left (d): nested-plot sampling at random starting points with full tessellation (iii)

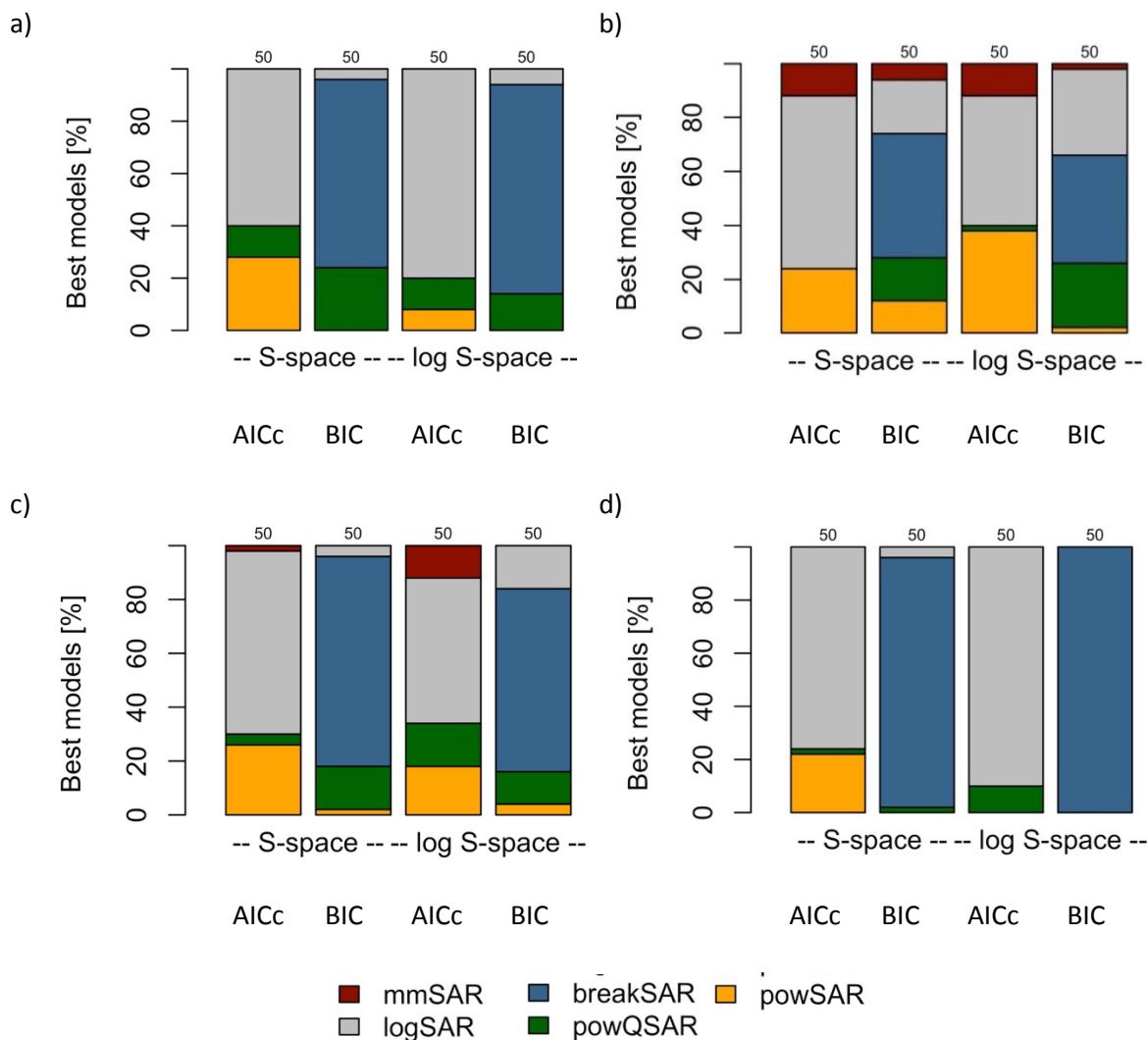
We did this by sampling five independent (non-nested) randomly distributed plots of the seven different grain sizes and then taking the average richness at each grain size (Fig. S4.2a). This way we avoided any potential problems of non-independence while at the same time through averaging we closely approach the true pattern of the landscape. We employed three other sampling approaches (Fig. S4.2b–d) to sample the same landscapes, i.e.

(i) construction of a SAR of non-nested independent squares, randomly selected at each grain size (“non-nested, single plots”),

(ii) nested-plot sampling at random starting points with one subplot per grain size (“nested, single plots”) and

(iii) nested-plot sampling at random starting points but with full tessellation of the biggest plot (i.e. maximum replication of the smaller subplots; “nested, averaged”).

Sampling designs (ii) and (iii) represent what is found in GrassPlot (mostly it is something in between these two extreme types). Sampling (i) is the sampling design that might intuitively be considered as statistically more appropriate, as it uses independent data points.



**Fig. S4.3.** Model comparison of the five functions: power (powSAR), power quadratic (powQSAR), power breakpoint (breakSAR), logarithmic (logSAR) and Michaelis-Menten (mmSAR), expressed as the fraction of cases where a given model performed best based on AICc or BICc, in both S-space and log S-space. The comparisons were run for a) averaged non-nested independent squares (considered as “true pattern”), b) non-nested independent

squares, c) nested-plot sampling at random starting points, and d) nested-plot sampling at random starting points but with full tessellation.

Figure S4.3a shows the model selection result for the simulated 50 landscapes derived from the averaged species richness values collected from independent (non-nested) randomly distributed plots. For the artificially created simulation data, in most cases the logSAR function was selected. This differs strongly from the results for the empirical data, indicating that none of our different selected parameter combinations was able to produce a species distribution pattern that resembles that found in real grassland data.

However, our question was not which type of SAR is produced by the simulation but how well the resulting SAR curve shape would be detected by the different sampling approaches. The simulation shows that the different sampling approaches closely reproduce the true pattern. In most cases, we find the same function as for the “true pattern” (Fig. S4.3b–d). In order to measure the accuracy of the model selection, Table S4.1 summarizes how often for the three sampling designs the true model was selected considering the different performance indices. It is evident that, across the four assessment methods, “Nested, averaged” detected the “true pattern” best, followed by “Nested, single plots”, while “Non-nested, single plots” exhibited the poorest performance, with on average less than 40% accuracy.

**Table S4.1.** Accuracy of model selection based on AICc and BIC for non-nested independent squares, nested-plot sampling at random starting points and nested-plot sampling at random starting points with full tessellation both in S-space and log S-space.

Sampling design	S-space		log S-space	
	AICc	BIC	AICc	BIC
Non-nested, single plots	42%	38%	38%	36%
Nested, single plots	54%	52%	48%	54%
Nested, averaged	50%	66%	70%	80%

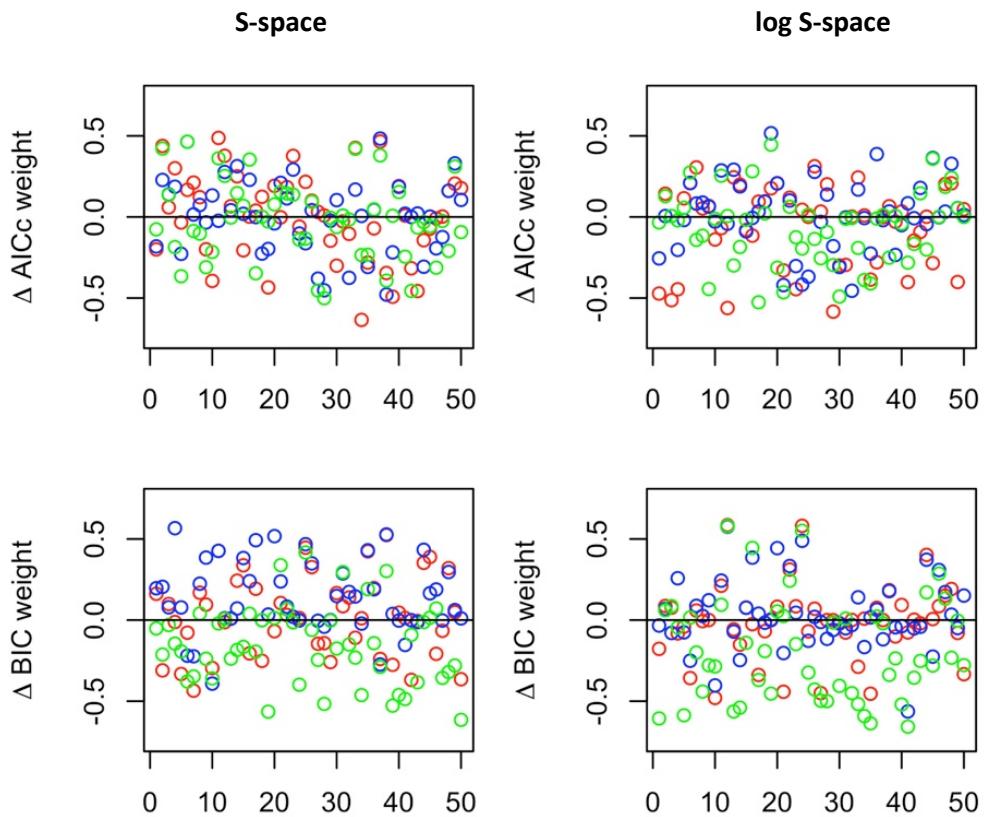
Akaike weights for the five SAR functions were similar to the “true pattern” for all three tested sampling designs. The mean absolute differences between the results from the sampling designs and the “true pattern” showed small differences (Table S4.2). Only in a few cases was the mean difference in AIC weights significantly different from zero (Table S4.3), with “nested, averaged” performing best. The differences were generally small, suggesting that there were no obvious systematic deviances in the results (Fig. S4.4). Significant negative values for the power function in three of four cases for “nested, averaged” suggest

that this type of sampling (prevailing in GrassPlot) even slightly underestimates the relative performance of the power function.

Moreover, our simulation results (Tables S4.1–4.3) suggest that sampling non-nested, i.e. independent, plots (the intuitively “statistically correct approach”) does not guarantee improved model selection. On the contrary, this method was worst at finding the true pattern. Generally, “nested, averaged” (the prevailing method in GrassPlot) performed best followed by “nested, single plots”, and this was true in both S-spaces and for AICc and BIC (Tables S4.1–S4.2).

For the simulation, we used a sampling design with five averaged non-nested independent squares to reflect the “true value”. This approach yielded good results, but we expect even better results would be obtained if more replicates were used.

In conclusion, this simulation supports our view that we can trust our statistical approach to find (at least in the majority of cases) the pattern with the same ranking of functions that would have been found with a substantial sampling of numerous independent, non-nested plots. In fact, the superiority of the power function might have even been slightly underestimated.



**Fig. S4.4.** Differences in AICc and BIC weights between the values calculated using the different sampling designs (green: non-nested independent squares; blue: nested-plot sampling at random starting points with full tessellation; red: nested-plot sampling at random starting point) and the “true values”, both in *S*-space and log *S*-space and for the selected best function.

**Table S4.2.** Mean absolute differences in AICc and BIC weights between the results from the three sampling designs and the “true pattern” (sampled pattern - true pattern), both in  $S$ -space and log  $S$ -space and for all five tested functions.

Sampling design	Function	S-space		log S-space	
		mean  Δ w(AICc)	mean  Δ w(BIC)	mean  Δ w(AICc)	mean  Δ w(BIC)
Non-nested, single plots	powSAR	0,373	0,095	0,350	0,069
	powQSAR	0,108	0,281	0,153	0,260
	breakSAR	0,000	0,413	0,000	0,504
	logSAR	0,438	0,194	0,492	0,311
	mmSAR	0,128	0,054	0,144	0,039
	Σ Sum	1,046	1,037	1,139	1,183
Nested, single plots	powSAR	0,333	0,028	0,260	0,031
	powQSAR	0,156	0,315	0,174	0,250
	breakSAR	0,000	0,401	0,000	0,401
	logSAR	0,378	0,150	0,431	0,193
	mmSAR	0,035	0,002	0,118	0,003
	Σ Sum	0,902	0,895	0,983	0,876
Nested, averaged	powSAR	0,314	0,028	0,098	0,002
	powQSAR	0,131	0,258	0,219	0,193
	breakSAR	0,000	0,374	0,000	0,275
	logSAR	0,385	0,104	0,318	0,098
	mmSAR	0,006	0,001	0,049	0,001
	Σ Sum	0,835	0,765	0,684	0,569

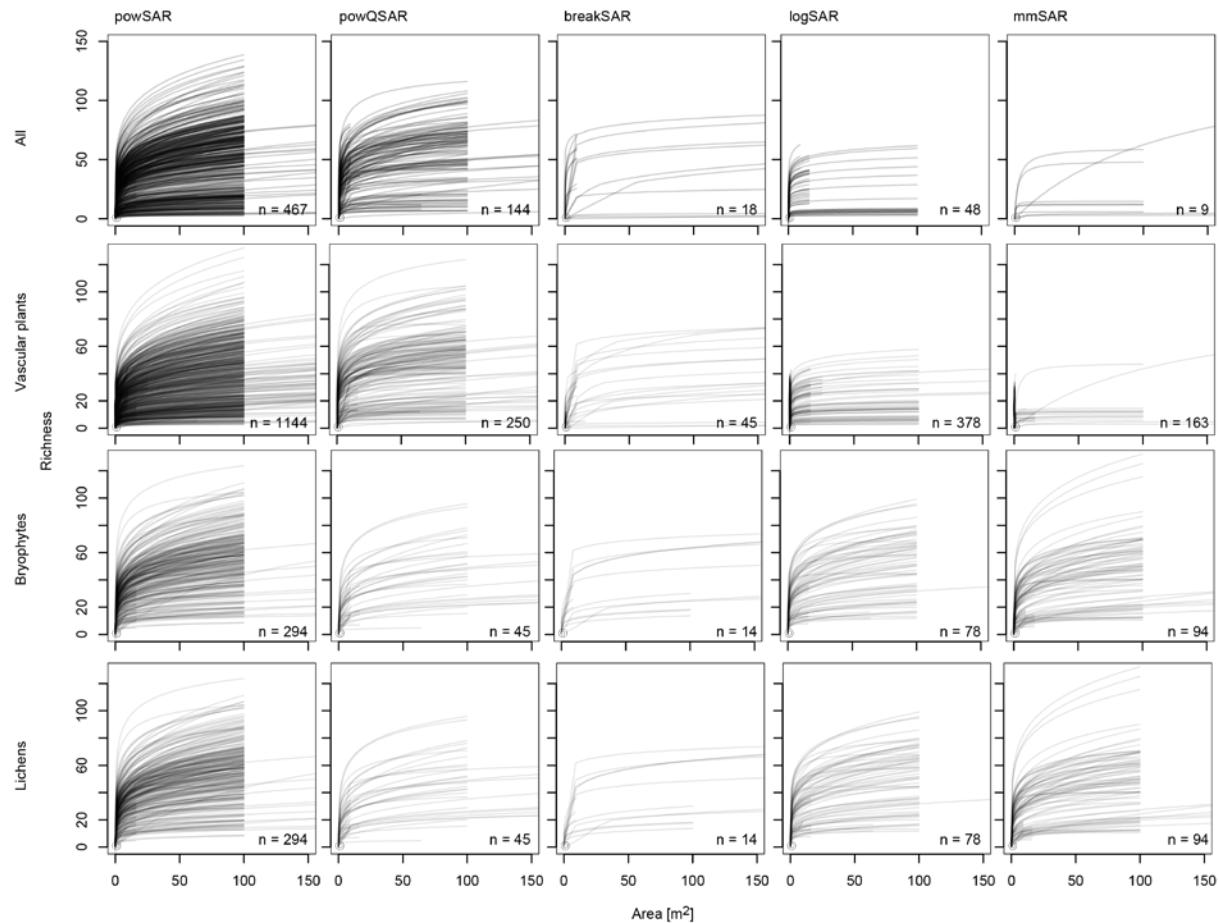
**Table S4.3.** Mean differences in AICc and BIC weights between the results from the three sampling designs and the “true pattern” (sampled pattern - true pattern), both in *S*-space and log *S*-space and for all five tested functions. Marked values are significantly different from zero (*t*-test; \* =  $p \leq 0.05$ ; \*\* =  $p \leq 0.01$ ; \*\*\* =  $p \leq 0.001$ ).

Sampling design	Function	S-space		log S-space	
		mean $\Delta w(AICc)$	mean $\Delta w(BIC)$	mean $\Delta w(AICc)$	mean $\Delta w(BIC)$
Non-nested, single plots	powSAR	0,047	0,076**	0,242***	0,067***
	powQSAR	-0,089**	-0,029	-0,078	0,042
	breakSAR	<0,000	-0,183**	<0,000	-0,344***
	logSAR	-0,083	0,082	-0,274***	0,196**
	mmSAR	0,125***	0,054*	0,110**	0,038**
Nested, single plots	powSAR	0,055	-0,005	0,106	0,028
	powQSAR	-0,042	-0,059	0,034	-0,037
	breakSAR	<0,000	0,045	<0,000	-0,071
	logSAR	-0,042	0,018	-0,219**	0,078
	mmSAR	0,029	0,001	0,080*	0,002
Nested, averaged	powSAR	-0,045	-0,027**	-0,080**	-0,002*
	powQSAR	-0,056	-0,212***	0,009	-0,103*
	breakSAR	0,000	0,273***	0,000	0,156**
	logSAR	0,103	-0,033	0,075	-0,051
	mmSAR	-0,002	-0,001*	-0,003	-0,001*

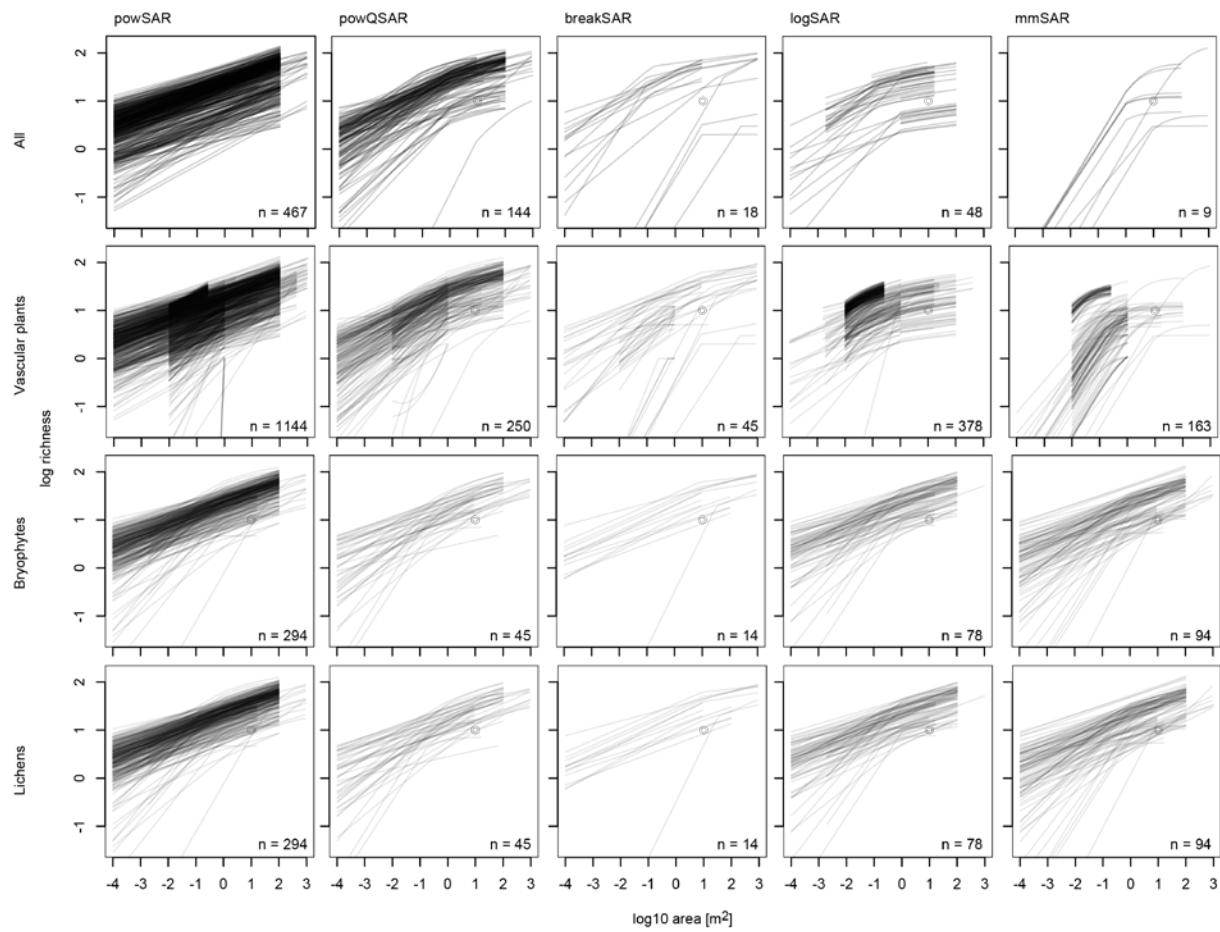
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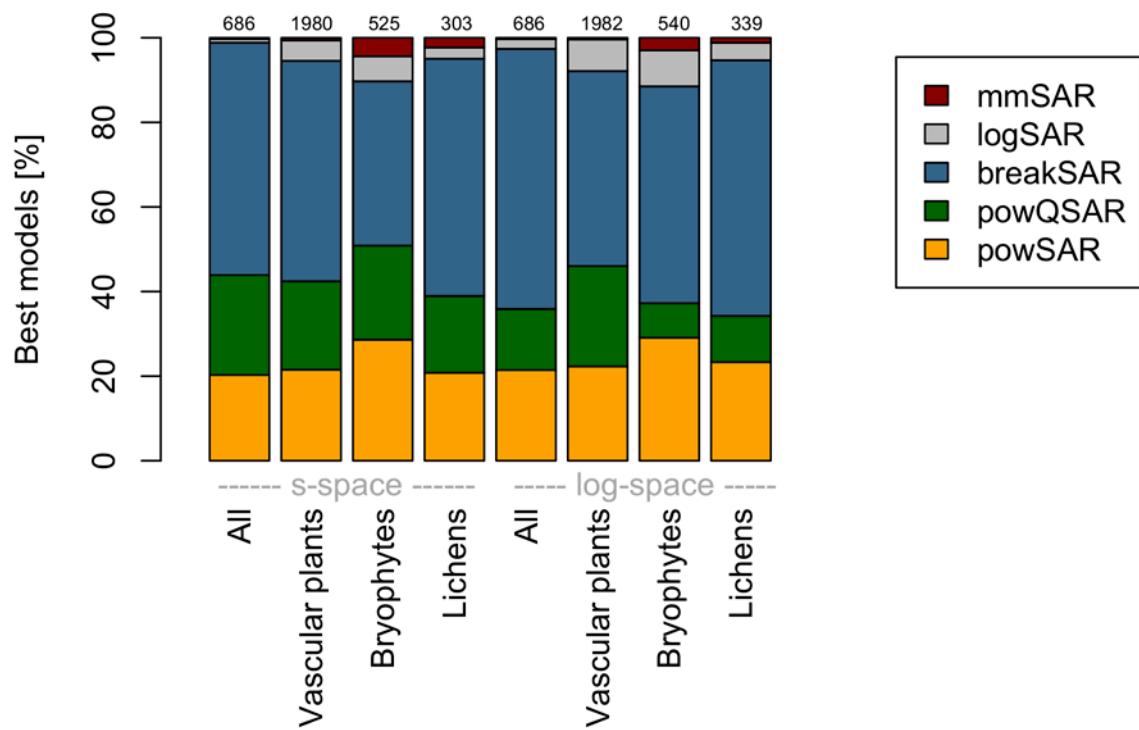
**Supporting Information 8.** Further detailed results.



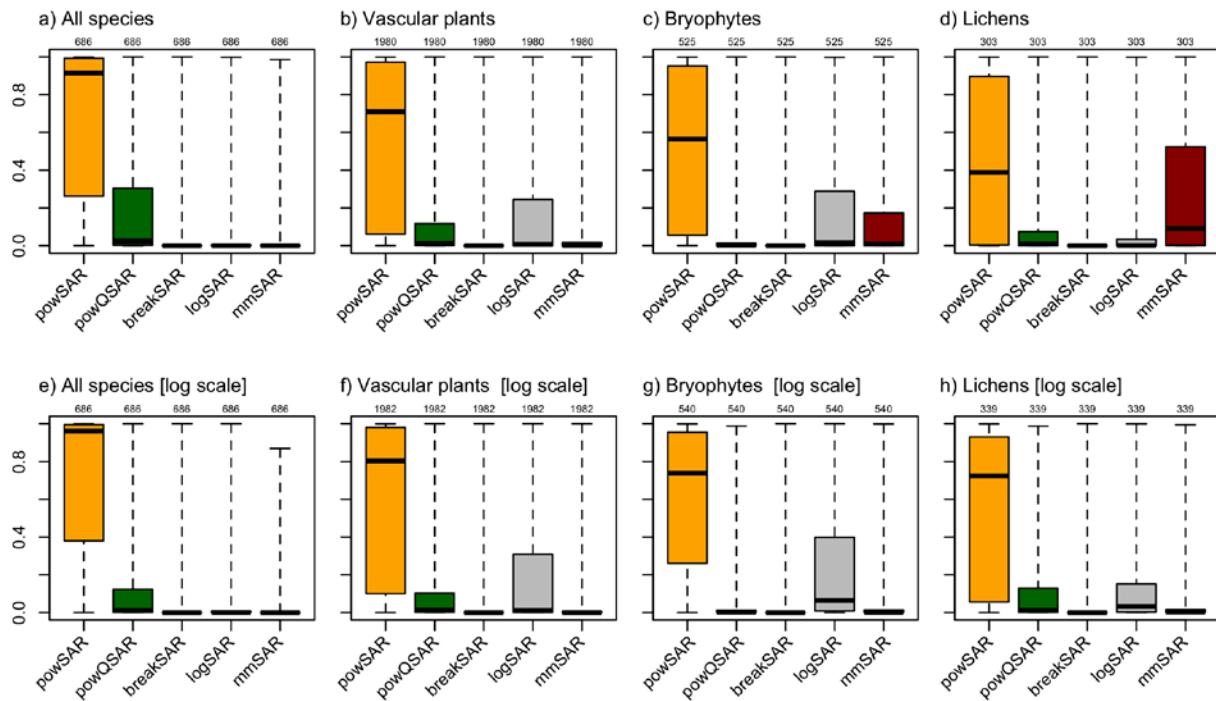
**Figure S8.1.** Visualisation of the best performing functions for each of the datasets (modelled in *S*-space).



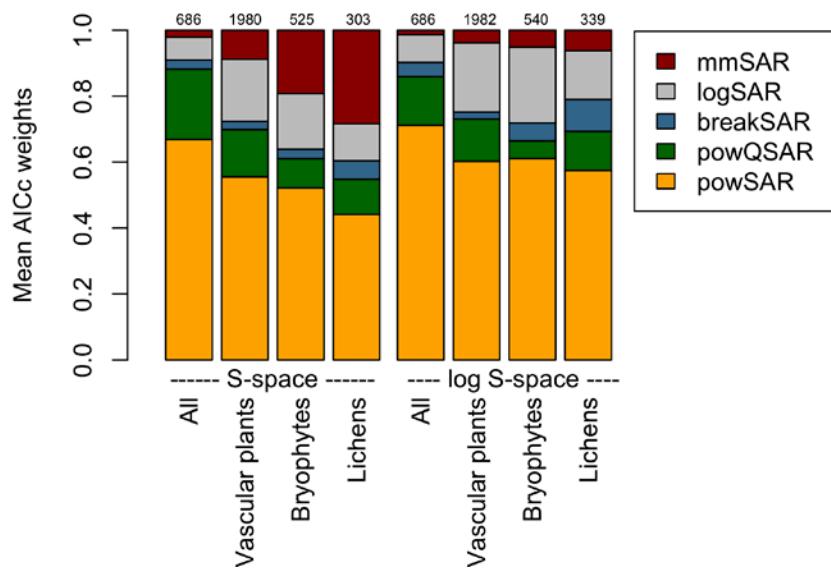
**Figure S8.2.** Visualisation of the same functions as in Fig. S8.1, but with logarithmised axes to allow better comparison.



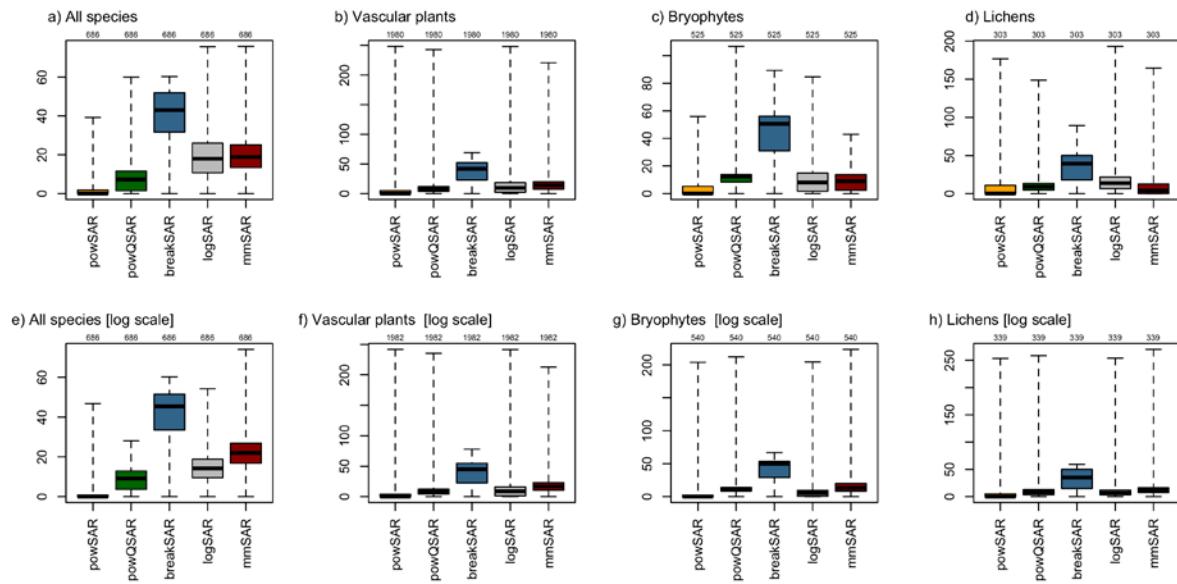
**Figure S8.3.** Model performance in comparison of the five function types: power (powSAR), power quadratic (powQSAR), power breakpoint (breakSAR), logarithmic (logSAR) and Michaelis-Menten (mmSAR), expressed as fraction of cases where a given model performed best based on BIC. The comparisons were run for the complete terricolous macroscopic vegetation (all species), vascular plants, terricolous bryophytes and terricolous lichens, and both in *S*-space and log *S*-space.



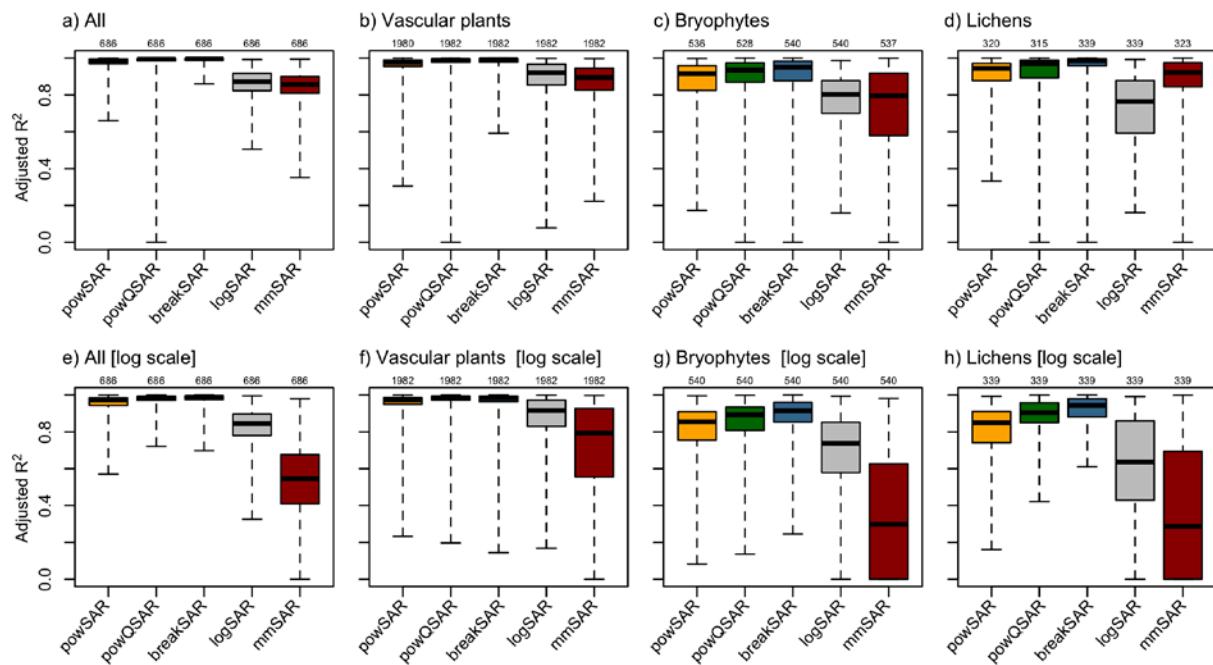
**Figure S8.4.** Model performance in comparison of the five function types power (powSAR), power quadratic (powQSAR), power breakpoint (breakSAR), logarithmic (logSAR) and Michaelis-Menten (mmSAR), expressed as Akaike weights based on AICc. The comparisons were run for the complete terricolous vegetation (all), vascular plants, terricolous bryophytes and lichens, and both in S-space and log S-space.



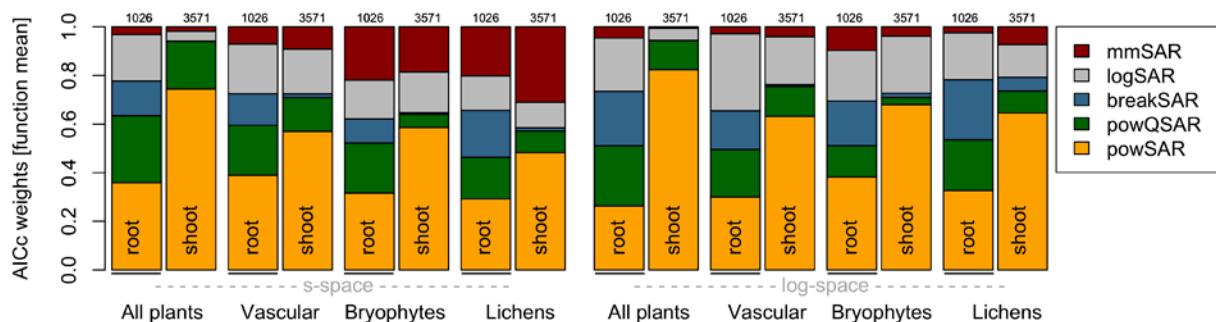
**Figure S8.5.** Display of the same data as in Fig. S4.1, but now the mean Akaike weights across all series are shown (which sum up to 1 by definition).



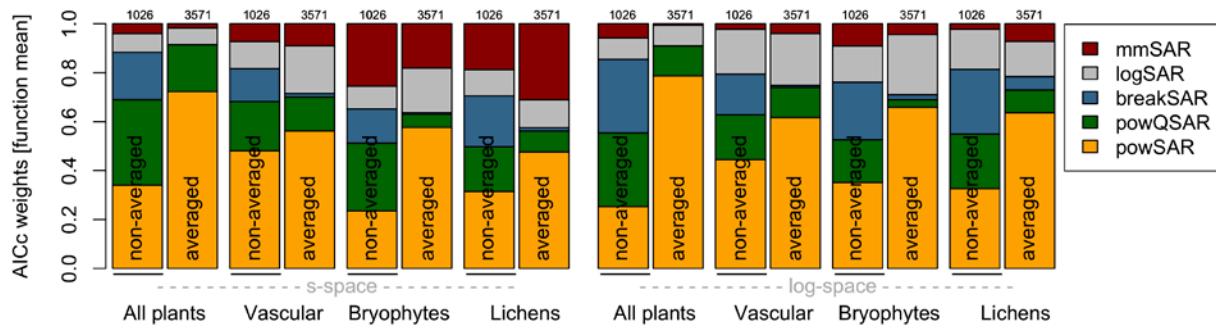
**Figure S8.6.** Model performance in comparison of the five function types power (powSAR), power quadratic (powQSAR), power breakpoint (breakSAR), logarithmic (logSAR) and Michaelis-Menten (mmSAR), expressed as delta-AICc. The comparisons were run for the complete terricolous vegetation (all species), vascular plants, terricolous bryophytes and lichens, and both in S-space and log S-space.



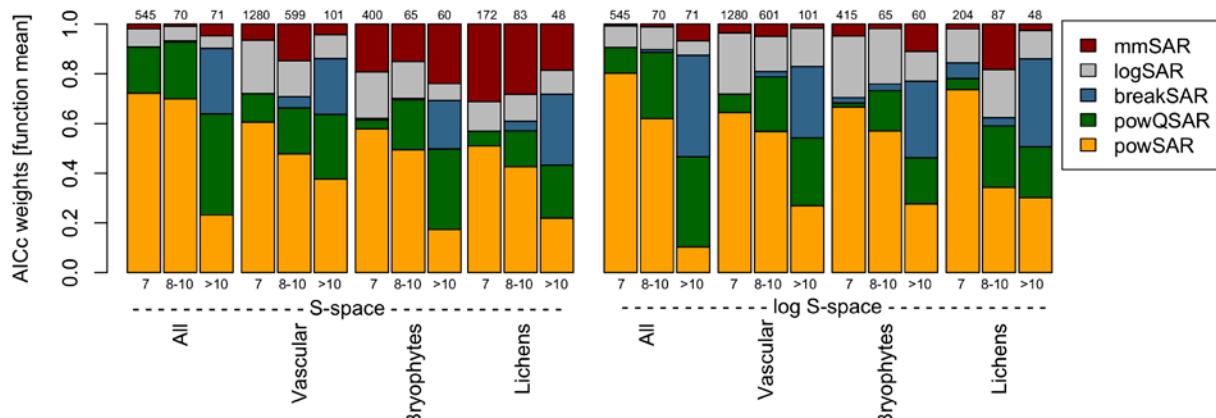
**Figure S8.7.** Model performance in comparison of the five function types power (powSAR), power quadratic (powQSAR), power breakpoint (breakSAR), logarithmic (logSAR) and Michaelis-Menten (mmSAR), expressed as  $R^2_{\text{adj}}$ . The comparisons were run for the complete terricolous vegetation (all species), vascular plants, terricolous bryophytes and lichens, and both in  $S$ -space and log  $S$ -space.



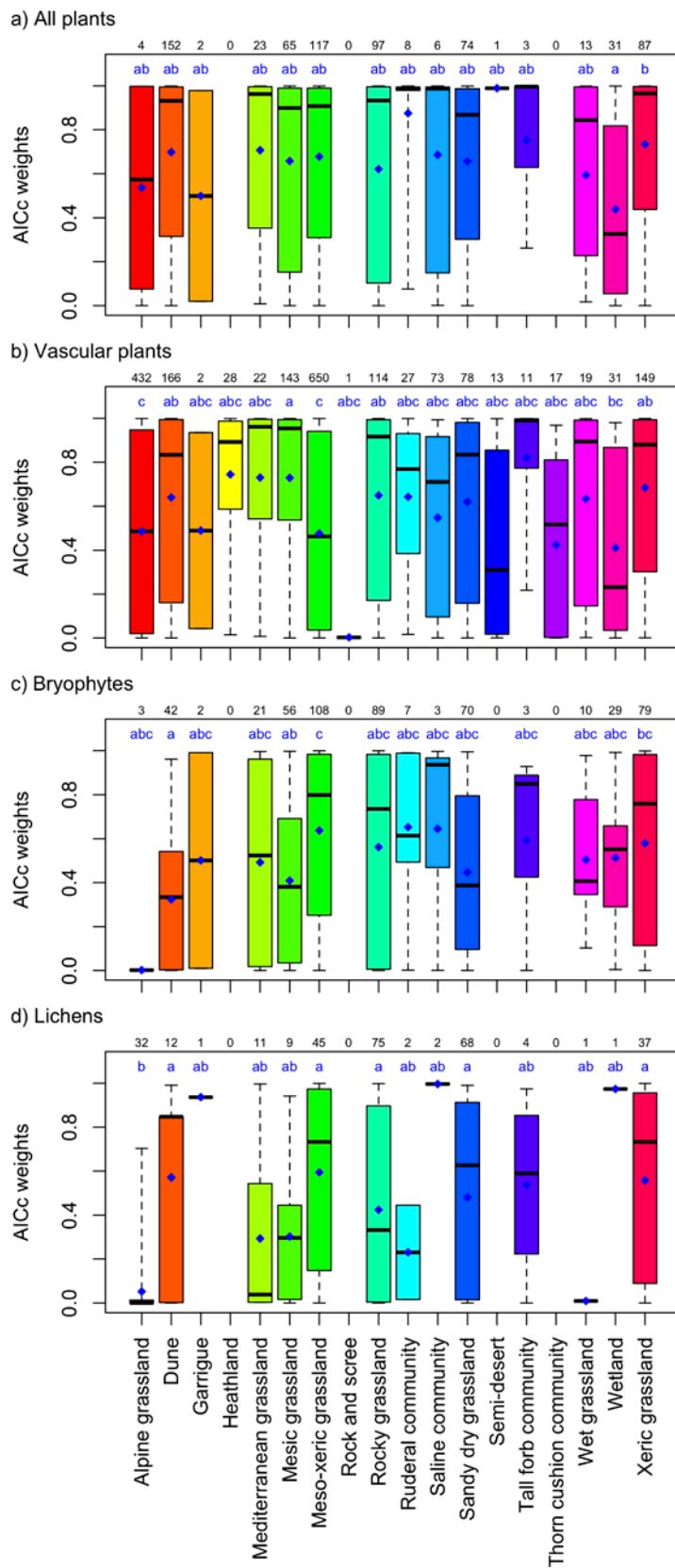
**Figure S8.8.** Relative performance of the five functions expressed as mean Akaike weights in rooted vs. shoot sampling.



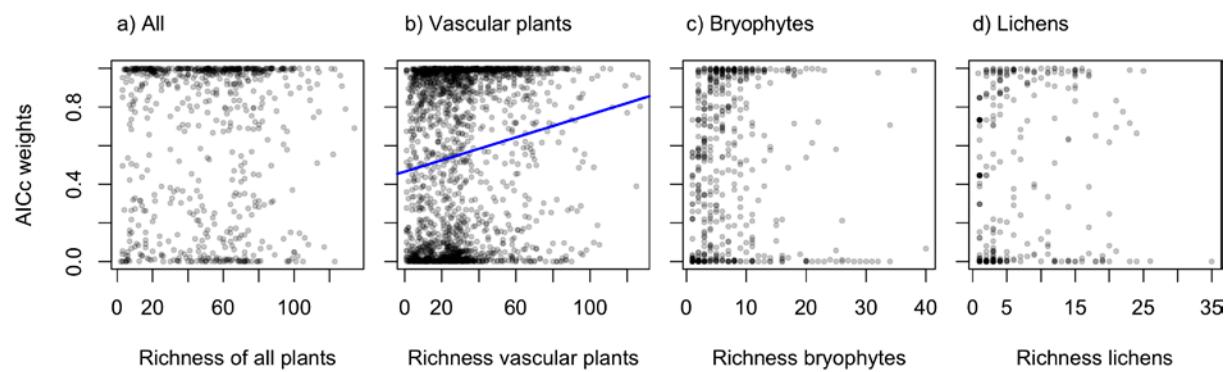
**Figure S8.9.** Relative performance of the five functions expressed as mean Akaike weights in nested-plot series were smaller grain sizes were replicated and their richness averaged and cases with only one subplot per grain size (non-averaged).



**Figure S8.10.** Superiority of the power function expressed as Akaike weights vs. the number of grain sizes included in a series. The displayed values are for the S-space (results in log S-space were consistent).



**Figure S8.11.** Superiority of the power function expressed as Akaike weights vs. the vegetation types represented by the GrassPlot database. The displayed values are for the  $S$ -space (results in log  $S$ -space were consistent).



**Figure S8.12.** Superiority of the power function expressed as Akaike weights vs. the number of species in the biggest plot. The displayed values are for the  $S$ -space (results in log  $S$ -space were consistent).

**Supporting Information 9.** Parameter estimates of the five models in the two S-spaces for the four taxonomic groups.**Table S9.1.** Parameter estimates for the power function.  $z < 0$ : number of all SAR cases when parameter  $z$  was below 0;  $z > 1$ : number of all SAR cases when parameter  $z$  was above 1;  $N$ : total number of performed SAR models for a given subset of data.

	parameter $c$						parameter $z$									
	mean	SD	min.		max.		quantile		mean	SD	min.		max.		quantile	
			.025	.975	.025	.975	.025	.975			.025	.975	.025	.975	.025	.975
<b>S-space</b>																
All	20.8	12.1	0.18	58.6	2.08	45.5	0.20	0.05	0.08	0.54	0.12	0.31	0	0	686	
Vasc. plants	21.7	14.9	0.18	73.9	2.19	53.1	0.26	0.11	0.02	0.88	0.13	0.56	0	10	1970	
Bryophytes	3.42	3.88	0.06	26.4	0.15	16.6	0.19	0.12	0.00	0.75	0.04	0.46	0	0	536	
Lichens	2.80	3.33	0.02	19.1	0.14	12.2	0.28	0.14	0.05	0.88	0.11	0.65	0	1	319	
<b>log S-space</b>																
All	20.2	11.9	0.49	67	2.02	46.3	0.24	0.06	0.10	0.59	0.14	0.38	0	0	686	
Vasc. plants	21.70	15.6	0.34	70.6	2.12	56.7	0.29	0.11	0.02	0.95	0.14	0.59	0	2	1980	
Bryophytes	3.40	4.24	0.20	30.6	0.29	17.3	0.20	0.10	0.00	0.53	0.04	0.39	0	0	540	
Lichens	2.66	3.36	0.07	23	0.21	12.1	0.24	0.09	0.03	0.66	0.10	0.46	0	0	339	

**Table S9.2.** Parameter estimates for the quadratic power function.  $z_1 < 0$ : number of all SAR cases when parameter  $z_1$  was below 0;  $z_1 > 1$ : number of all SAR cases when parameter  $z_1$  was above 1;  $N$ : total number of performed SAR models for a given subset of data.

	parameter $c$						parameter $z_1$						parameter $z_2$								
	mean	SD	min.		max.		quantile		mean	SD	min.		max.		quantile						
			.025	.975	.025	.975	.025	.975			.025	.975	.025	.975	.025	.975					
<b>S-space</b>																					
All	22.00	13.09	0.29	65.42	2.33	49.66	0.21	0.06	0.06	0.82	0.12	0.34	-0.01	0.02	-0.13	0.06	-0.06	0.02	1	2	683
Vasc. plants	20.51	13.85	0.29	96.08	2.47	51.82	0.23	0.13	0.00	0.95	0.03	0.61	-0.03	0.07	-0.71	0.29	-0.17	0.10	138	19	1825
Bryophytes	3.78	4.56	0.00	32.18	0.44	19.44	0.19	0.13	0.00	0.97	0.02	0.58	-0.03	0.16	-3.23	0.09	-0.17	0.05	12	6	510
Lichens	3.24	3.91	0.00	21.62	0.00	14.52	0.28	0.17	0.00	0.96	0.07	0.79	-0.09	0.26	-3.08	0.16	-0.74	0.05	36	11	268
<b>log S-space</b>																					
All	21.74	13.39	0.26	72.72	1.92	51.54	0.21	0.05	0.03	0.53	0.11	0.32	-0.01	0.02	-0.12	0.07	-0.07	0.03	0	0	686
Vasc. plants	20.20	13.56	0.26	93.56	2.24	49.36	0.24	0.13	0.00	0.98	0.04	0.61	-0.02	0.05	-0.27	0.19	-0.12	0.08	100	12	1870
Bryophytes	3.51	4.40	0.12	32.57	0.20	17.79	0.19	0.11	0.00	0.78	0.02	0.44	0.00	0.04	-0.11	0.15	-0.07	0.07	6	0	534
Lichens	2.65	3.57	0.07	17.06	0.15	13.37	0.26	0.11	0.01	0.84	0.06	0.52	0.01	0.05	-0.27	0.11	-0.10	0.09	18	0	321

**Table S9.3.** Parameter estimates for the breakpoint power function.  $z_1 < 0$  (and  $z_2 < 0$ ): number of all SAR cases when parameter  $z_1$  (or  $z_2$  respectively) was below 0;  $z_1 > 1$  (and  $z_2 > 1$ ): number of all SAR cases when parameter  $z_1$  (or  $z_2$  respectively) was above 1;  $N$ : total number of performed SAR models for a given subset of data.

	parameter $c$						parameter $z_1$						$z_1 < 0$ $z_1 > 1$		
	mean		SD		min.		max.		quantile						
					.025	.975									
<b>S-space</b>															
All	28.20	19.80	0.02	168.18	2.86	73.32	0.14	0.14	0.00	1.00	0.00	0.46	0	1	
Vasc. plants	23.42	15.17	0.02	93.81	3.11	56.96	0.18	0.16	0.00	1.00	0.00	0.64	44	16	
Bryophytes	11.93	20.56	0.04	192.95	0.10	51.34	0.35	0.38	0.00	1.00	0.00	1.00	5	4	
Lichens	7.44	11.58	0.04	58.65	0.05	49.91	0.53	0.40	0.00	1.00	0.00	1.00	20	2	
<b>log S-space</b>															
All	41.26	79.58	0.25	900.62	0.88	141.28	0.27	0.15	0.00	0.86	0.00	0.67	0	0	
Vasc. plants	28.58	66.33	0.08	1024.42	0.93	101.06	0.32	0.17	0.00	1.00	0.00	0.73	0	4	
Bryophytes	12.23	28.31	0.06	248.36	0.13	100.09	0.21	0.21	0.00	0.77	0.00	0.71	0	1	
Lichens	14.05	73.48	0.05	900.27	0.06	100.00	0.20	0.23	0.00	0.89	0.00	0.73	5	0	
<b>S-space</b>															
All	0.17	0.07	0.00	0.54	0.00	0.28	11.32	45.39	0.00	640.78	0.00	85.89	1	0	685
Vasc. plants	0.17	0.11	0.00	0.88	0.00	0.43	8.63	38.07	0.00	710.01	0.01	68.44	15	45	1826
Bryophytes	0.14	0.11	0.00	1.00	0.00	0.41	12.76	49.13	0.00	640.73	0.00	101.14	3	5	530
Lichens	0.18	0.15	0.00	0.86	0.00	0.64	17.29	56.73	0.00	640.01	0.01	95.34	2	20	317
<b>log S-space</b>															
All	0.20	0.09	0.00	1.00	0.05	0.38	1.91	11.93	0.00	244.80	0.00	11.23	0	0	683
Vasc. plants	0.25	0.20	0.00	1.00	0.00	1.00	2.14	11.31	0.00	275.32	0.00	23.30	4	0	1557
Bryophytes	0.22	0.19	0.00	1.00	0.00	0.69	2.91	13.98	0.00	206.75	0.00	25.00	0	2	535
Lichens	0.31	0.22	0.00	1.00	0.00	0.90	3.67	23.54	0.00	369.96	0.00	17.89	0	7	326

**Table S9.4.** Parameter estimates for the logarithmic function. *N*: total number of performed SAR models for a given subset of data.

	parameter c						parameter z						<i>N</i>
	mean	SD	min.	max.	quantile .025	.975	mean	SD	min.	max.	quantile .025	.975	
<b>S-space</b>													
All	26.85	15.03	0.71	74.32	2.56	57.11	7.99	4.52	0.36	22.18	0.80	16.74	686
Vasc. plants	21.83	12.99	0.37	70.20	2.31	45.95	7.46	4.45	0.20	21.11	0.79	16.45	1982
Bryophytes	4.13	4.24	0.25	28.74	0.46	18.49	1.10	1.21	0.01	8.60	0.11	5.24	540
Lichens	3.35	3.62	0.24	20.40	0.25	13.19	1.06	1.04	0.05	5.40	0.11	3.75	339
<b>log S-space</b>													
All	20.12	11.53	0.61	57.20	2.13	44.37	4.64	2.72	0.12	13.04	0.42	10.54	686
Vasc. plants	18.93	12.06	0.20	51.48	1.77	42.22	5.84	4.28	0.09	22.64	0.46	15.47	1982
Bryophytes	4.48	5.17	0.18	38.10	0.28	20.09	0.97	1.21	0.03	9.46	0.05	4.55	551
Lichens	3.27	3.73	0.18	46.69	0.27	13.28	0.68	0.89	0.01	11.67	0.05	3.04	540

**Table S9.5.** Parameter estimates for the Michaelis-Menten function. *N*: total number of performed SAR models for a given subset of data.

	parameter c						parameter z						<i>N</i>
	mean	SD	min.	max.	quantile .025	.975	mean	SD	min.	max.	quantile .025	.975	
<b>S-space</b>													
All	45.44	26.54	2.11	151.67	4.60	93.89	4.29	28.36	0.00	660.64	0.02	16.00	686
Vasc. plants	30.34	25.96	1.18	437.30	3.58	81.51	5.63	59.22	0.00	1851.83	0.01	24.47	1982
Bryophytes	6.97	12.83	0.59	268.63	0.91	25.65	12.50	85.95	0.00	1498.14	0.00	77.42	537
Lichens	8.53	26.23	0.59	330.59	0.70	23.95	20.41	86.10	0.00	874.15	0.01	232.55	323
<b>log S-space</b>													
All	22.24	13.06	0.70	68.12	2.28	50.97	0.00	0.01	0.00	0.28	0.00	0.03	686
Vasc. plants	18.47	11.34	0.24	164.12	2.48	38.62	0.18	4.38	0.00	137.85	0.00	0.23	1982
Bryophytes	5.30	6.19	0.20	44.77	0.37	23.47	0.00	0.01	0.00	0.13	0.00	0.03	551
Lichens	3.81	0.05	0.20	27.69	0.37	16.15	0.00	0.01	0.00	0.08	0.00	0.02	540