

# Supplementary information

**Manuscript title:** Intraspecific variation in masting across climate gradients is inconsistent with the environmental stress hypothesis

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## **Fig. S1**

See following pages.

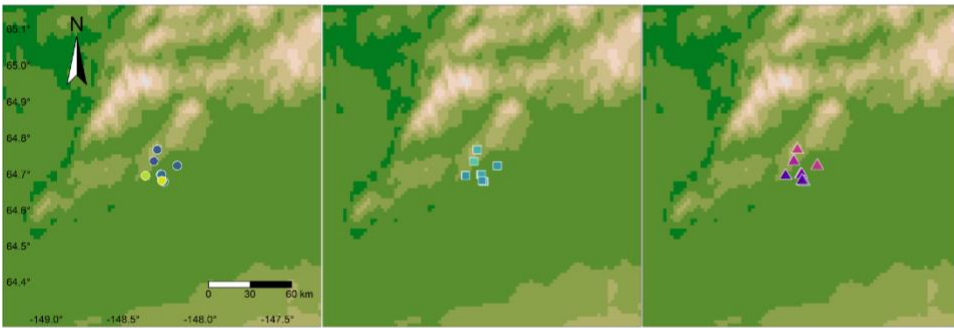
*Abies alba*



*Abies amabilis*



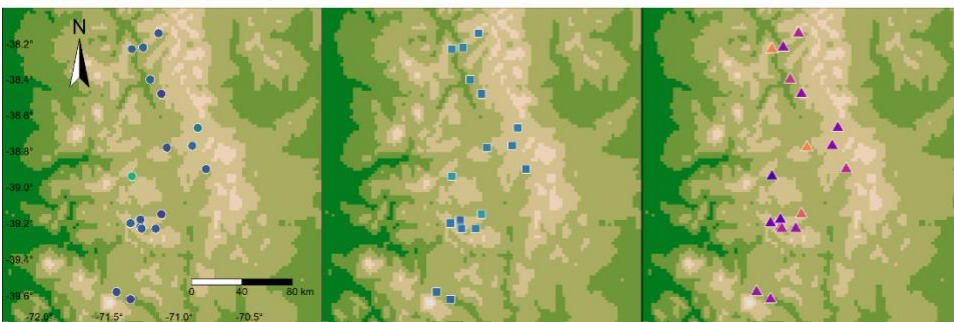
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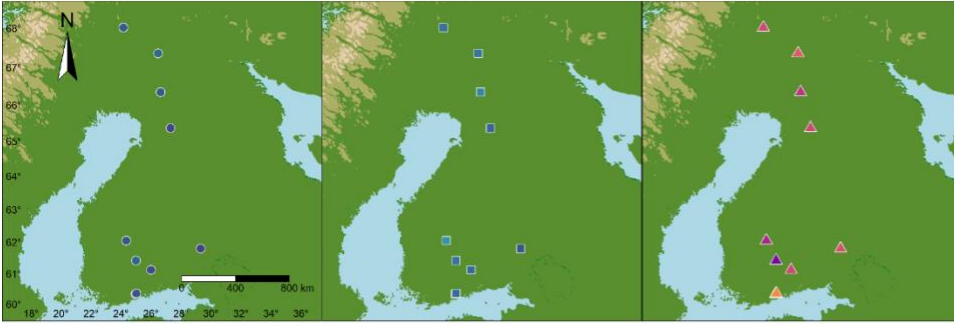
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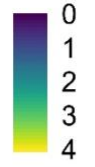
*Araucaria araucana*



*Betula pubescens*



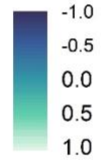
CVp



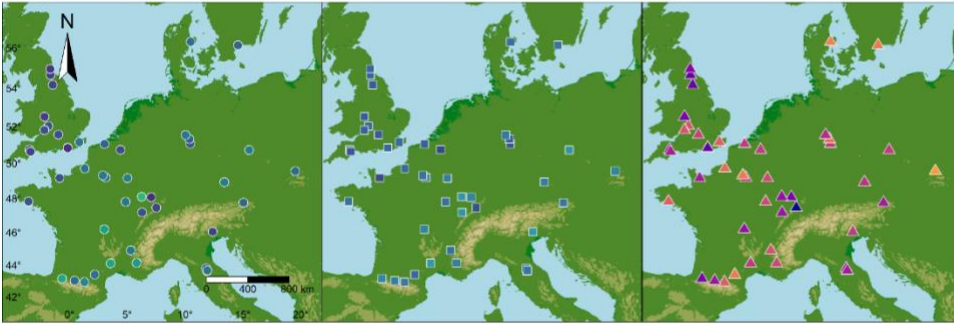
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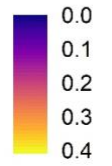
AR1



*Fagus sylvatica*



Psd



*Picea abies*



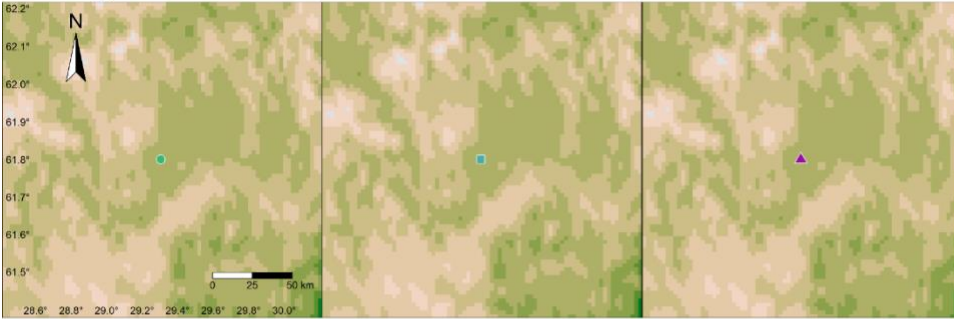
*Picea engelmannii*



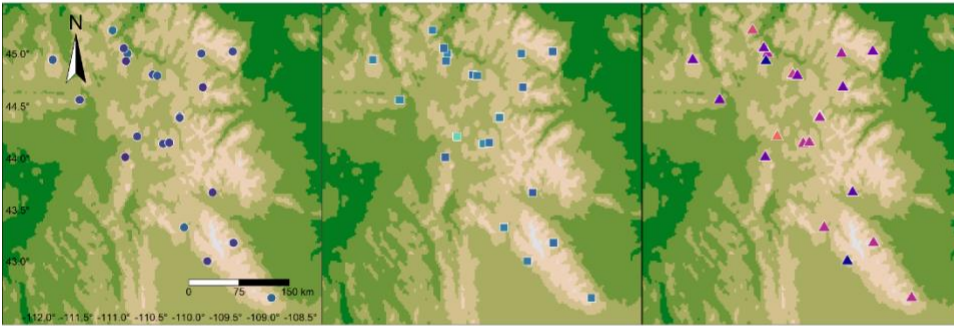
*Picea glauca*



*Picea glauca*



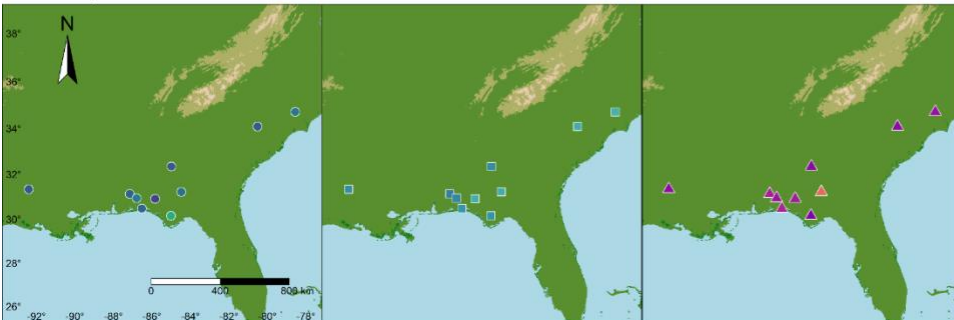
*Pinus albicaulis*



*Pinus edulis*



*Pinus palustris*



*Pinus ponderosa*



*Pinus sylvestris*



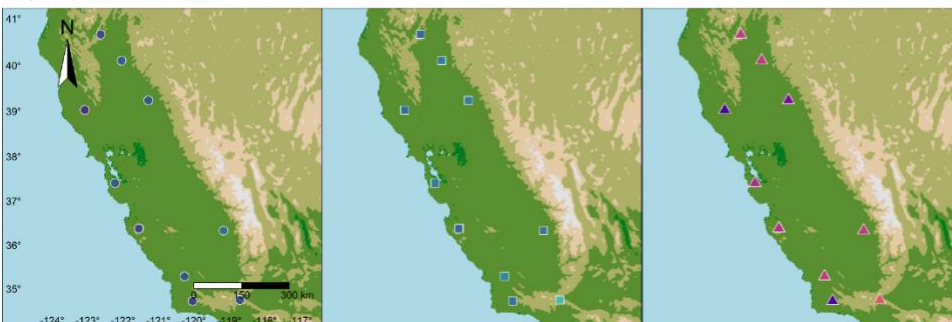
*Quercus cerris*



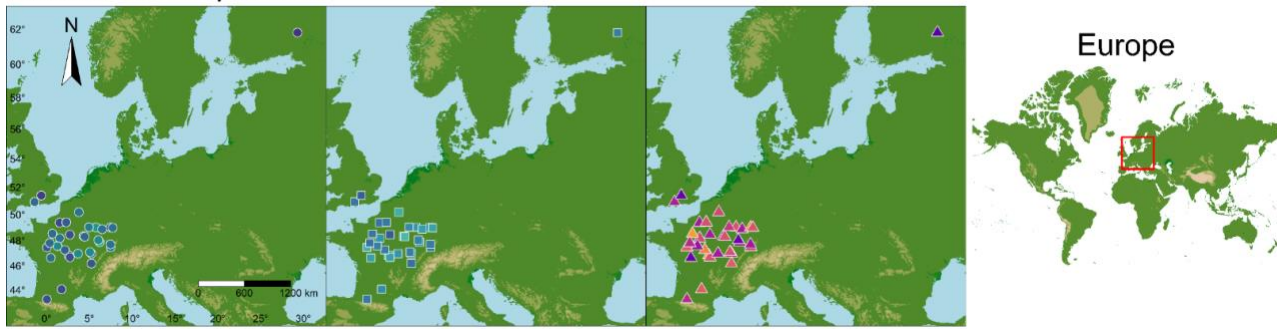
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*Quercus lobata*

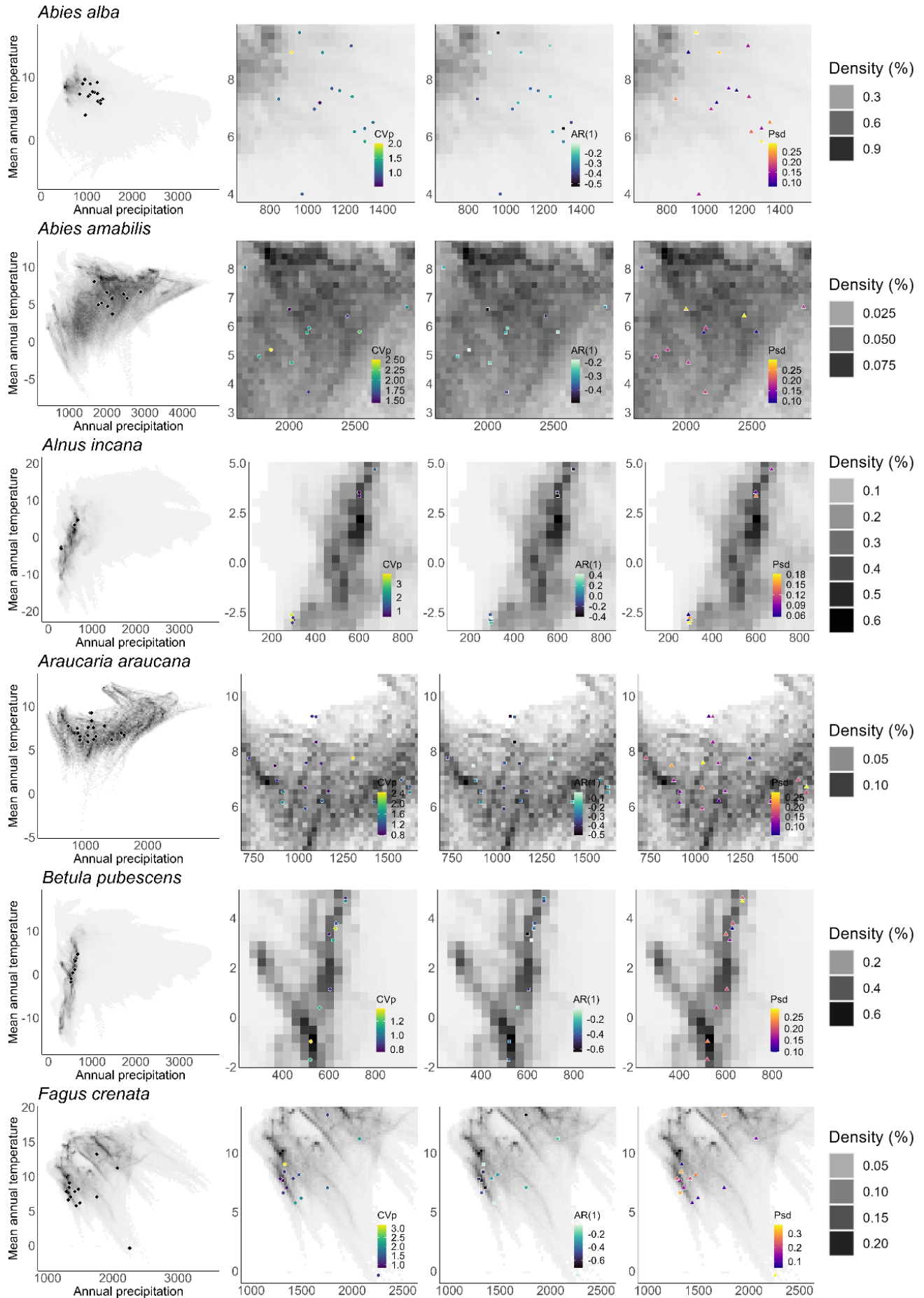


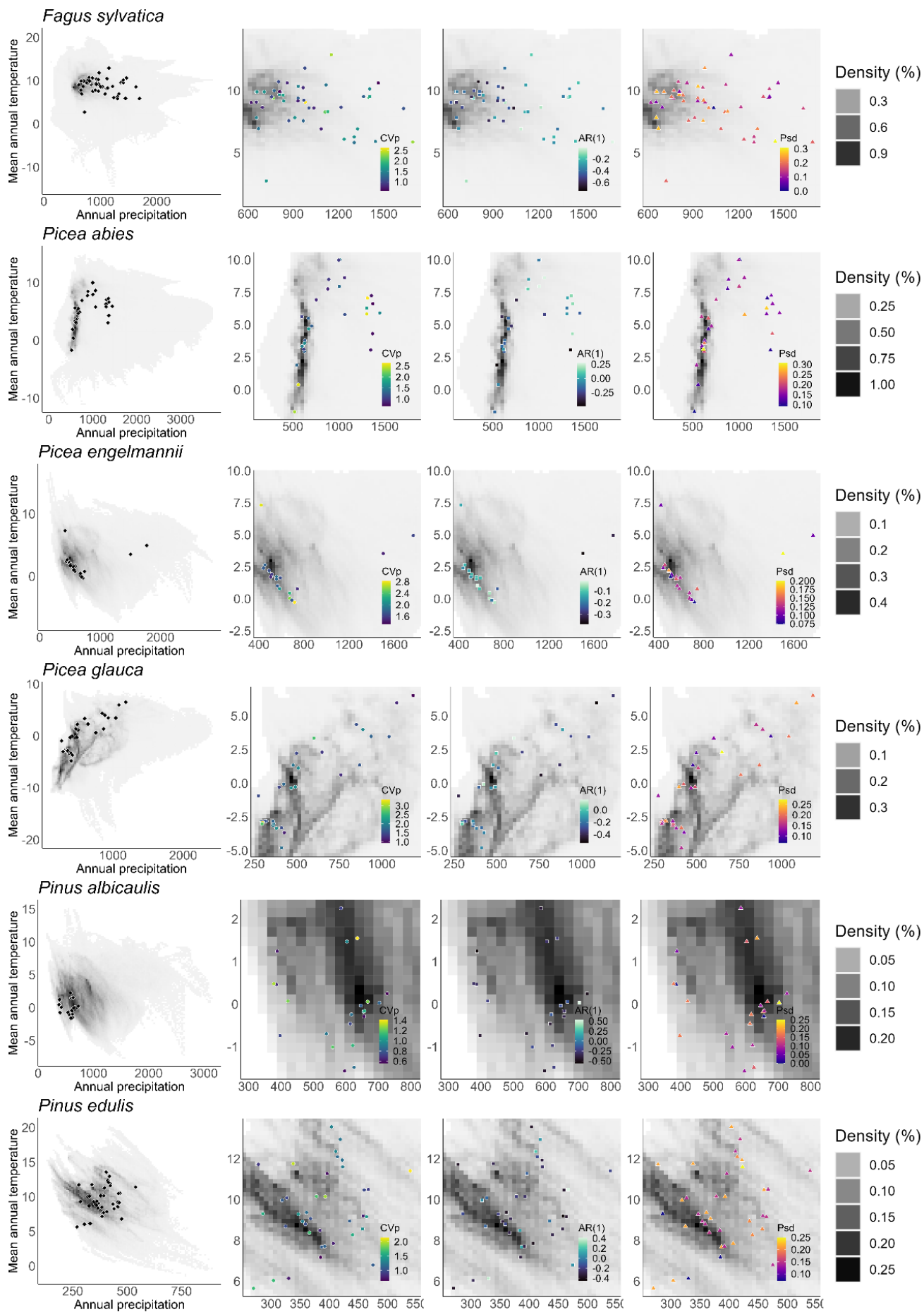
## *Quercus robur/petraea*

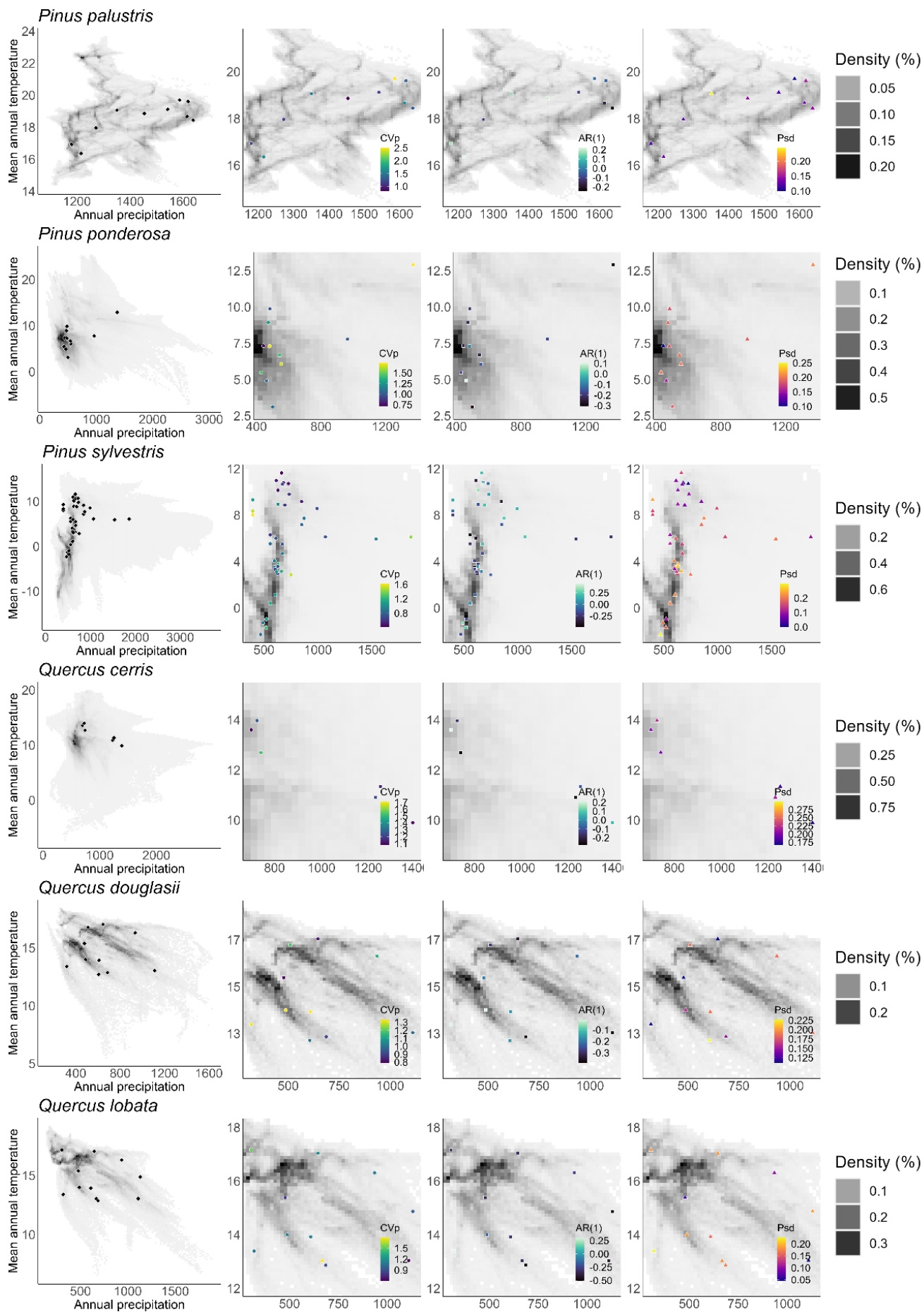


*Figure S1: Spatial range and reproductive patterns of all but the six most sampled species in our subset of MASTREE+ data (Hackett-Pain et al. 2022). When records originate from multiple regions, plots were made for each region. Basemaps were constructed with rnaturalearth (Massicotte & South, 2023) and terrain tiles obtained with elevatr (Hollister et al., 2023; Mapzen 2023). The three metrics used to capture intraspecific variation in masting were CVp: coefficient of variation of population level seed crop size [left column]; AR(1) = 1-year lagged autocorrelation [middle column]; Psd = the proportion of large seed production years [right column].*

**Fig. S2**







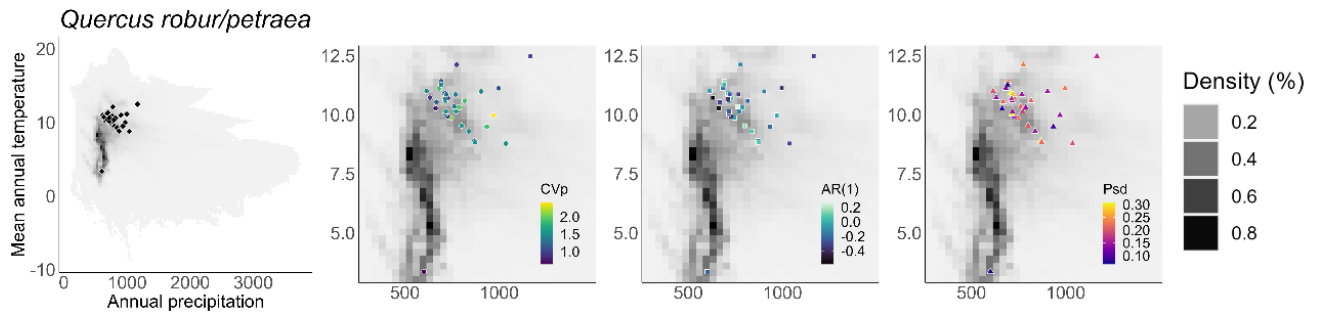
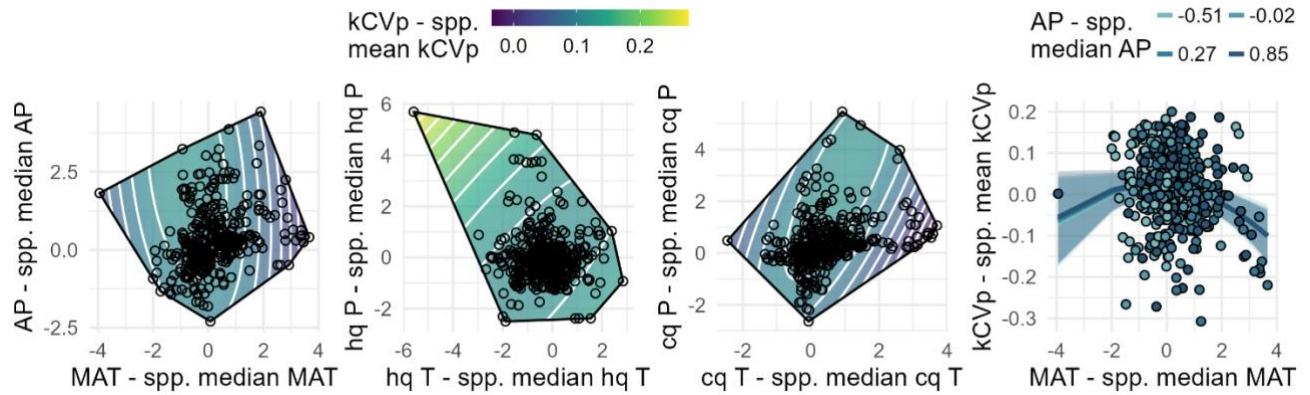


Figure S2: Large climatic gradients were sampled. Points: time series from our subset of MASTREE+ (Hackett-Pain et al. 2022). Plots show the relationships between the reproductive metrics and climate (mean annual temperature in degree Celsius, mean annual precipitation in mm) observed in species' ranges. See Materials and Methods for details about these ranges, but note that shaded areas do not equate to confirmed species presences. Rather, they correspond to grid cells which fall within a geographical distribution of the species – the darker grid cells indicate that the climate is more common in the species range, and may be a better indicator of species presence. CVp: coefficient of variation of population-level seed crop size; AR(1) = 1-year lagged autocorrelation; Psd = the proportion of large seed production years.

**Fig. S3**



*Figure S3: Response surfaces for the subject-centred models of  $kCVp$ , a bounded alternative to the coefficient of variation of population level seed crop size ( $CVp$ ).  $kCVp$  is reported to be less sensitive to excess zero values than  $CVp$  and was found to increase statistical power (Lobry et al. 2023). The annual model is found in the first column, and the results of the seasonal model are found in columns 2-3. The right-most column shows the marginal effects and partial residuals.  $AP$ : annual precipitation;  $MAT$ : mean annual temperature;  $hq$ : hottest quarter of the year;  $cq$ : coldest quarter of the year;  $P$ : precipitation;  $T$ : temperature.*

# 1 Table S1

2 Table S1: Intraspecific variation in reproductive metrics, across tree species.

Species	Time series		Sites			CVp		AR(1)		Psd	
	N	Years	Latitude	Longitude	Elevation	Mean	Range	Mean	Range	Mean	Range
<i>Abies alba</i>	15	1994 – 2018	42.86 – 49.55	-0.8 – 19.61	400 – 1400	1.12 (0.33)	0.52 – 2	-0.32 (0.11)	-0.53 – -0.1	0.18 (0.07)	0.08 – 0.29
<i>Abies amabilis</i>	12	1961 – 1972	44.39 – 48.88	-123.96 – -121.35	423 – 1561	1.94 (0.29)	1.44 – 2.5	-0.3 (0.1)	-0.49 – -0.18	0.18 (0.06)	0.09 – 0.3
<i>Alnus incana</i>	12	1960 – 2008	60.35 – 64.77	-148.36 – 29.37	47 – 404	1.7 (1.02)	0.56 – 3.75	0 (0.26)	-0.4 – 0.42	0.11 (0.05)	0.06 – 0.18
<i>Araucaria araucana</i>	21	1982 – 2020	-39.62 – -38.14	-71.45 – -70.81	1000 – 1698	1.23 (0.37)	0.79 – 2.45	-0.28 (0.12)	-0.51 – -0.03	0.15 (0.06)	0.06 – 0.28
<i>Betula pubescens</i>	14	1955 – 1974	60.33 – 68.02	24.15 – 29.3	47 – 320	1.04 (0.19)	0.77 – 1.38	-0.39 (0.16)	-0.64 – -0.06	0.2 (0.04)	0.1 – 0.29
<i>Fagus crenata</i>	20	1976 – 2017	35.02 – 42.7	136.43 – 141.5	230 – 2815	1.44 (0.55)	0.83 – 3.2	-0.35 (0.2)	-0.71 – -0.06	0.18 (0.09)	0.06 – 0.36
<i>Fagus sylvatica</i>	52	1967 – 2020	42.93 – 56.29	-3.54 – 19.53	26 – 1400	1.35 (0.5)	0.56 – 2.63	-0.37 (0.18)	-0.74 – -0.01	0.17 (0.06)	0 – 0.31
<i>Picea abies</i>	31	1954 – 2018	43.44 – 68.02	-2.63 – 29.3	30 – 2040	1.39 (0.55)	0.66 – 2.63	-0.1 (0.2)	-0.5 – 0.27	0.17 (0.06)	0.09 – 0.31
<i>Picea engelmannii</i>	24	1947 – 2014	39.55 – 50.83	-121.85 – -105.86	1444 – 3474	1.85 (0.41)	1.32 – 2.83	-0.15 (0.09)	-0.39 – -0.02	0.12 (0.03)	0.07 – 0.2
<i>Picea glauca</i>	38	1954 – 2020	44.52 – 64.77	-149.01 – 29.3	9 – 974	1.82 (0.48)	0.93 – 3.34	-0.2 (0.15)	-0.54 – 0.17	0.16 (0.05)	0.07 – 0.27
<i>Pinus albicaulis</i>	22	1989 – 2020	42.64 – 45.22	-111.82 – -108.89	2144 – 3117	0.91 (0.26)	0.56 – 1.41	-0.28 (0.22)	-0.56 – 0.53	0.12 (0.06)	0 – 0.25
<i>Pinus edulis</i>	38	1969 – 2017	32.81 – 40.87	-109.05 – -102.94	1295 – 2388	1.23 (0.37)	0.64 – 2.15	-0.17 (0.21)	-0.45 – 0.42	0.17 (0.05)	0.07 – 0.25
<i>Pinus palustris</i>	10	1958 – 2019	30.15 – 34.71	-92.41 – -78.56	19 – 70	1.41 (0.46)	0.82 – 2.51	0.01 (0.17)	-0.24 – 0.22	0.14 (0.04)	0.1 – 0.25
<i>Pinus ponderosa</i>	12	1933 – 2008	35.27 – 48.37	-121.64 – -105.12	732 – 2797	1.3 (0.33)	0.71 – 1.74	-0.17 (0.11)	-0.31 – 0.1	0.19 (0.04)	0.1 – 0.25
<i>Pinus sylvestris</i>	50	1954 – 2019	40.78 – 68.47	-3.67 – 29.37	24 – 1670	0.89 (0.28)	0.41 – 1.63	-0.09 (0.23)	-0.49 – 0.45	0.16 (0.07)	0 – 0.3
<i>Quercus cerris</i>	11	1992 – 2020	43.14 – 43.74	10.7 – 12.04	299 – 977	1.3 (0.21)	1.08 – 1.71	-0.11 (0.15)	-0.28 – 0.21	0.21 (0.04)	0.17 – 0.3
<i>Quercus douglasii</i>	10	1980 – 2020	34.72 – 40.1	-123.09 – -118.71	120 – 1258	1.08 (0.21)	0.79 – 1.33	-0.21 (0.14)	-0.39 – -0.01	0.16 (0.04)	0.11 – 0.23
<i>Quercus lobata</i>	12	1970 – 2020	34.72 – 40.66	-123.09 – -118.71	120 – 1255	1.13 (0.33)	0.61 – 1.79	-0.3 (0.21)	-0.51 – 0.31	0.15 (0.06)	0.05 – 0.23
<i>Quercus robur/petraea</i>	33	1960 – 2017	43.2 – 61.8	-1.41 – 29.3	43 – 525	1.41 (0.39)	0.63 – 2.41	-0.16 (0.2)	-0.58 – 0.26	0.18 (0.06)	0.07 – 0.31

Information in the table was obtained from the open-access MASTREE+ database (Hackett-Pain et al. 2022). SRTM data (30 sec) was used to estimate missing elevation data in MASTREE+ (57.7% of sites) (Fick and Hijmans 2017). CVp: coefficient of variation of population-level seed crop size; AR(1): 1-year lagged autocorrelation; Psd: the proportion of large seed production years. N: number of time series. Values in brackets are standard deviations. Coordinates are given in decimal degrees, and elevation in meters.

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**Table S2**

Table S2: Likelihood ratio tests for the linear predictors ('Term') in the across-species models, for three masting metrics: CVp, AR(1), and Psd. Bold font added for significant predictors.

Metric	Term	Model	Df	AIC	Deviance	Chisq	Pr(>Chisq)	
CVp	AP	Reduced	31	359.101	297.101			
	AP	Full	32	360.628	296.628	0.473	0.492	
	MAT	Reduced	31	378.581	316.581			
	<b>MAT</b>	<b>Full</b>	32	361.603	297.603	18.978	<b>&gt; 0.001</b>	
	cq P	Reduced	36	367.022	295.022			
	cq P	Full	37	368.343	294.343	0.68	0.41	
	cq T	Reduced	36	379.91	307.91			
	<b>cq T</b>	<b>Full</b>	37	368.253	294.253	13.657	<b>&gt; 0.001</b>	
	hq P	Reduced	36	362.405	290.405			
	hq P	Full	37	364.266	290.266	0.14	0.709	
	hq T	Reduced	36	362.048	290.048			
	hq T	Full	37	363.89	289.89	0.157	0.692	
	AR(1)	AP	Reduced	32	-308.706	-372.706		
		AP	Full	33	-308.33	-374.33	1.624	0.203
MAT		Reduced	32	-297.412	-361.412			
<b>MAT</b>		<b>Full</b>	33	-308.005	-374.005	12.594	<b>&gt; 0.001</b>	
cq P		Reduced	37	-312.785	-386.785			
cq P		Full	38	-312.186	-388.186	1.402	0.236	
cq T		Reduced	37	-307.925	-381.925			
<b>cq T</b>		<b>Full</b>	38	-315.623	-391.623	9.698	<b>0.002</b>	
hq P		Reduced	37	-308.496	-382.496			
hq P		Full	38	-306.595	-382.595	0.099	0.753	
hq T		Reduced	37	-308.896	-382.896			
hq T		Full	38	-307.216	-383.216	0.321	0.571	
Psd		AP	Reduced	31	-1277.077	-1339.077		
		AP	Full	32	-1276.322	-1340.322	1.245	0.265
	MAT	Reduced	31	-1275.592	-1337.592			
	MAT	Full	32	-1275.588	-1339.588	1.995	0.158	
	cq P	Reduced	36	-1267.286	-1339.286			
	cq P	Full	37	-1266.487	-1340.487	1.201	0.273	
	cq T	Reduced	36	-1267.286	-1339.286			
	cq T	Full	37	-1266.487	-1340.487	1.201	0.273	
	hq P	Reduced	36	-1274.675	-1346.675			
	hq P	Full	37	-1273.178	-1347.178	0.503	0.478	
	hq T	Reduced	36	-1276.432	-1348.432			
	hq T	Full	37	-1274.659	-1348.659	0.227	0.634	

CVp: coefficient of variation of population level seed crop size; AR(1): 1-year lagged autocorrelation; Psd: the proportion of large seed production years.

**Table S3**

*Table S3: Full models for subject-centred annual and seasonal models for three masting metrics, CVp, AR(1), Psd, as well as kCVp.*

Term	CVp			AR(1)			Psd			kCVp		
	Estimate	z	P	Estimate	z	P	Estimate	z	P	Estimate	z	P
<i>Annual</i>												
Intercept	<b>6.01 × 10<sup>-1</sup></b> ( <b>2.58 × 10<sup>-1</sup></b> )	<b>2.33</b>	<b>0.02</b>	5.87 × 10 <sup>-2</sup> (7.81 × 10 <sup>-2</sup> )	0.75	0.45	5.33 × 10 <sup>-2</sup> (3.75 × 10 <sup>-2</sup> )	1.42	0.16	<b>1.13 × 10<sup>-1</sup></b> ( <b>4.85 × 10<sup>-2</sup></b> )	<b>2.33</b>	<b>0.02</b>
AP	9.73 × 10 <sup>-3</sup> (3.07 × 10 <sup>-2</sup> )	0.32	0.75	1.49 × 10 <sup>-3</sup> (1.29 × 10 <sup>-2</sup> )	0.12	0.91	<b>9.67 × 10<sup>-3</sup></b> ( <b>4.51 × 10<sup>-3</sup></b> )	<b>2.14</b>	<b>0.03</b>	4.88 × 10 <sup>-3</sup> (5.84 × 10 <sup>-3</sup> )	0.84	0.4
AP <sup>2</sup>	-1.40 × 10 <sup>-3</sup> (1.38 × 10 <sup>-2</sup> )	-0.10	0.92	-2.86 × 10 <sup>-3</sup> (5.32 × 10 <sup>-3</sup> )	-0.54	0.59	-3.75 × 10 <sup>-3</sup> (2.03 × 10 <sup>-3</sup> )	-1.84	0.07	-1.18 × 10 <sup>-3</sup> (2.66 × 10 <sup>-3</sup> )	-0.44	0.66
MAT	<b>-6.21 × 10<sup>-2</sup></b> ( <b>2.69 × 10<sup>-2</sup></b> )	<b>-2.31</b>	<b>0.02</b>	<b>-3.45 × 10<sup>-2</sup></b> ( <b>1.10 × 10<sup>-2</sup></b> )	<b>-3.13</b>	<b>&lt;0.01</b>	-1.31 × 10 <sup>-3</sup> (4.08 × 10 <sup>-3</sup> )	-0.32	0.75	-6.64 × 10 <sup>-3</sup> (5.64 × 10 <sup>-3</sup> )	-1.18	0.24
MAT × AP	1.43 × 10 <sup>-2</sup> (1.95 × 10 <sup>-2</sup> )	0.73	0.47	-1.51 × 10 <sup>-2</sup> (9.75 × 10 <sup>-3</sup> )	-1.55	0.12	2.37 × 10 <sup>-3</sup> (3.55 × 10 <sup>-3</sup> )	0.67	0.5	-1.60 × 10 <sup>-3</sup> (4.45 × 10 <sup>-3</sup> )	-0.36	0.72
MAT <sup>2</sup>	-8.66 × 10 <sup>-3</sup> (8.77 × 10 <sup>-3</sup> )	-0.99	0.32	9.95 × 10 <sup>-3</sup> (5.95 × 10 <sup>-3</sup> )	1.67	0.09	<b>-4.23 × 10<sup>-3</sup></b> ( <b>2.06 × 10<sup>-3</sup></b> )	<b>-2.05</b>	<b>0.04</b>	<b>-6.99 × 10<sup>-3</sup></b> ( <b>2.53 × 10<sup>-3</sup></b> )	<b>-2.77</b>	<b>&lt;0.01</b>
Latitude				<b>-2.50 × 10<sup>-2</sup></b> ( <b>8.93 × 10<sup>-3</sup></b> )	<b>-2.80</b>	<b>&lt;0.01</b>						
Length	2.63 × 10 <sup>-2</sup> (2.06 × 10 <sup>-2</sup> )	1.27	0.2	<b>1.50 × 10<sup>-2</sup></b> ( <b>6.01 × 10<sup>-3</sup></b> )	<b>2.49</b>	<b>0.01</b>	<b>-4.99 × 10<sup>-3</sup></b> ( <b>2.33 × 10<sup>-3</sup></b> )	<b>-2.14</b>	<b>0.03</b>	4.54 × 10 <sup>-3</sup> (3.52 × 10 <sup>-3</sup> )	1.29	0.2
Method: Count	<b>-6.39 × 10<sup>-1</sup></b> ( <b>2.54 × 10<sup>-1</sup></b> )	<b>-2.51</b>	<b>0.01</b>	-7.83 × 10 <sup>-2</sup> (7.50 × 10 <sup>-2</sup> )	-1.05	0.3	-4.79 × 10 <sup>-2</sup> (3.69 × 10 <sup>-2</sup> )	-1.30	0.19	<b>-1.13 × 10<sup>-1</sup></b> ( <b>4.79 × 10<sup>-2</sup></b> )	<b>-2.35</b>	<b>0.02</b>
Method: Seed trap	-2.38 × 10 <sup>-1</sup> (2.39 × 10 <sup>-1</sup> )	-1.00	0.32	-2.21 × 10 <sup>-2</sup> (6.95 × 10 <sup>-2</sup> )	-0.32	0.75	-3.78 × 10 <sup>-2</sup> (3.59 × 10 <sup>-2</sup> )	-1.05	0.29	-4.88 × 10 <sup>-2</sup> (4.47 × 10 <sup>-2</sup> )	-1.09	0.27
Variable: Fruit	<b>-4.35 × 10<sup>-1</sup></b> ( <b>9.82 × 10<sup>-2</sup></b> )	<b>-4.43</b>	<b>&lt;0.001</b>	9.84 × 10 <sup>-3</sup> (4.03 × 10 <sup>-2</sup> )	0.24	0.81	-2.31 × 10 <sup>-2</sup> (1.23 × 10 <sup>-2</sup> )	-1.87	0.06	<b>-8.49 × 10<sup>-2</sup></b> ( <b>2.21 × 10<sup>-2</sup></b> )	<b>-3.84</b>	<b>&lt;0.001</b>
Variable: Seed	<b>-2.43 × 10<sup>-1</sup></b> ( <b>8.14 × 10<sup>-2</sup></b> )	<b>-2.99</b>	<b>&lt;0.01</b>	-2.61 × 10 <sup>-2</sup> (2.87 × 10 <sup>-2</sup> )	-0.91	0.36	-8.84 × 10 <sup>-3</sup> (8.76 × 10 <sup>-3</sup> )	-1.01	0.31	<b>-3.79 × 10<sup>-2</sup></b> ( <b>1.63 × 10<sup>-2</sup></b> )	<b>-2.32</b>	<b>0.02</b>
<i>Seasonal</i>												
Intercept	<b>6.58 × 10<sup>-1</sup></b> ( <b>2.58 × 10<sup>-1</sup></b> )	<b>2.55</b>	<b>0.01</b>	1.24 × 10 <sup>-1</sup> (7.82 × 10 <sup>-2</sup> )	1.58	0.11	4.91 × 10 <sup>-2</sup> (3.82 × 10 <sup>-2</sup> )	1.29	0.2	<b>1.13 × 10<sup>-1</sup></b> ( <b>4.87 × 10<sup>-2</sup></b> )	<b>2.32</b>	<b>0.02</b>
hq P	-4.08 × 10 <sup>-3</sup> (2.77 × 10 <sup>-2</sup> )	-0.15	0.88	2.29 × 10 <sup>-3</sup> (1.09 × 10 <sup>-2</sup> )	0.21	0.83	-1.74 × 10 <sup>-3</sup> (3.81 × 10 <sup>-3</sup> )	-0.46	0.65	-3.95 × 10 <sup>-4</sup> (5.35 × 10 <sup>-3</sup> )	-0.07	0.94
hq P <sup>2</sup>	6.14 × 10 <sup>-3</sup> (1.22 × 10 <sup>-2</sup> )	0.50	0.61	<b>-1.14 × 10<sup>-2</sup></b> ( <b>3.98 × 10<sup>-3</sup></b> )	<b>-2.87</b>	<b>&lt;0.01</b>	1.35 × 10 <sup>-3</sup> (1.60 × 10 <sup>-3</sup> )	0.84	0.4	1.33 × 10 <sup>-3</sup> (2.32 × 10 <sup>-3</sup> )	0.57	0.57
hq T	5.15 × 10 <sup>-3</sup> (2.44 × 10 <sup>-2</sup> )	0.21	0.83	2.32 × 10 <sup>-4</sup> (8.66 × 10 <sup>-3</sup> )	0.03	0.98	-1.07 × 10 <sup>-3</sup> (3.21 × 10 <sup>-3</sup> )	-0.33	0.74	1.43 × 10 <sup>-3</sup> (4.64 × 10 <sup>-3</sup> )	0.31	0.76
hq T × hq P	-4.49 × 10 <sup>-3</sup> (1.83 × 10 <sup>-2</sup> )	-0.25	0.81	<b>-2.18 × 10<sup>-2</sup></b> ( <b>7.17 × 10<sup>-3</sup></b> )	<b>-3.05</b>	<b>&lt;0.01</b>	-2.91 × 10 <sup>-3</sup> (2.70 × 10 <sup>-3</sup> )	-1.08	0.28	-2.47 × 10 <sup>-3</sup> (3.45 × 10 <sup>-3</sup> )	-0.72	0.47
hq T <sup>2</sup>	-5.03 × 10 <sup>-3</sup> (1.33 × 10 <sup>-2</sup> )	-0.38	0.7	-1.79 × 10 <sup>-3</sup> (5.07 × 10 <sup>-3</sup> )	-0.35	0.72	1.07 × 10 <sup>-3</sup> (1.91 × 10 <sup>-3</sup> )	0.56	0.58	1.66 × 10 <sup>-3</sup> (2.57 × 10 <sup>-3</sup> )	0.65	0.52
cq P	1.96 × 10 <sup>-2</sup> (3.15 × 10 <sup>-2</sup> )	0.62	0.54	1.78 × 10 <sup>-2</sup> (1.25 × 10 <sup>-2</sup> )	1.43	0.15	6.74 × 10 <sup>-3</sup> (4.87 × 10 <sup>-3</sup> )	1.39	0.17	5.56 × 10 <sup>-3</sup> (5.76 × 10 <sup>-3</sup> )	0.97	0.33
cq P <sup>2</sup>	-1.36 × 10 <sup>-2</sup> (1.01 × 10 <sup>-2</sup> )	-1.35	0.18	<b>-8.32 × 10<sup>-3</sup></b> ( <b>3.79 × 10<sup>-3</sup></b> )	<b>-2.20</b>	<b>0.03</b>	-2.23 × 10 <sup>-3</sup> (1.53 × 10 <sup>-3</sup> )	-1.46	0.14	-2.40 × 10 <sup>-3</sup> (1.92 × 10 <sup>-3</sup> )	-1.25	0.21
cq T	<b>-1.02 × 10<sup>-1</sup></b> ( <b>4.45 × 10<sup>-2</sup></b> )	<b>-2.30</b>	<b>0.02</b>	<b>-5.96 × 10<sup>-2</sup></b> ( <b>1.92 × 10<sup>-2</sup></b> )	<b>-3.10</b>	<b>&lt;0.01</b>	8.26 × 10 <sup>-3</sup> (5.98 × 10 <sup>-3</sup> )	1.38	0.17	-1.82 × 10 <sup>-3</sup> (9.62 × 10 <sup>-3</sup> )	-0.19	0.85
cq T × cq P	<b>4.46 × 10<sup>-2</sup></b> ( <b>2.11 × 10<sup>-2</sup></b> )	<b>2.11</b>	<b>0.03</b>	8.31 × 10 <sup>-3</sup> (1.40 × 10 <sup>-2</sup> )	0.59	0.55	3.42 × 10 <sup>-3</sup> (4.53 × 10 <sup>-3</sup> )	0.75	0.45	8.76 × 10 <sup>-3</sup> (6.50 × 10 <sup>-3</sup> )	1.35	0.18
cq T <sup>2</sup>	-4.68 × 10 <sup>-3</sup> (1.45 × 10 <sup>-2</sup> )	-0.32	0.75	7.67 × 10 <sup>-3</sup> (8.76 × 10 <sup>-3</sup> )	0.88	0.38	<b>-8.13 × 10<sup>-3</sup></b> ( <b>2.53 × 10<sup>-3</sup></b> )	<b>-3.21</b>	<b>&lt;0.01</b>	<b>-1.29 × 10<sup>-2</sup></b> ( <b>3.82 × 10<sup>-3</sup></b> )	<b>-3.38</b>	<b>&lt;0.001</b>
Latitude				<b>-2.68 × 10<sup>-2</sup></b> ( <b>9.19 × 10<sup>-3</sup></b> )	<b>-2.92</b>	<b>&lt;0.01</b>						
Length	2.67 × 10 <sup>-2</sup> (2.07 × 10 <sup>-2</sup> )	1.29	0.2	<b>1.53 × 10<sup>-2</sup></b> ( <b>6.54 × 10<sup>-3</sup></b> )	<b>2.35</b>	<b>0.02</b>	-4.38 × 10 <sup>-3</sup> (2.45 × 10 <sup>-3</sup> )	-1.79	0.07	5.61 × 10 <sup>-3</sup> (3.36 × 10 <sup>-3</sup> )	1.67	0.09
Method: Count	<b>-6.77 × 10<sup>-1</sup></b> ( <b>2.54 × 10<sup>-1</sup></b> )	<b>-2.66</b>	<b>&lt;0.01</b>	-1.20 × 10 <sup>-1</sup> (7.55 × 10 <sup>-2</sup> )	-1.59	0.11	-4.71 × 10 <sup>-2</sup> (3.75 × 10 <sup>-2</sup> )	-1.26	0.21	<b>-1.15 × 10<sup>-1</sup></b> ( <b>4.84 × 10<sup>-2</sup></b> )	<b>-2.38</b>	<b>0.02</b>
Method: Seed trap	-2.73 × 10 <sup>-1</sup> (2.36 × 10 <sup>-1</sup> )	-1.16	0.25	-6.55 × 10 <sup>-2</sup> (6.90 × 10 <sup>-2</sup> )	-0.95	0.34	-3.57 × 10 <sup>-2</sup> (3.65 × 10 <sup>-2</sup> )	-0.98	0.33	-5.14 × 10 <sup>-2</sup> (4.47 × 10 <sup>-2</sup> )	-1.15	0.25
Variable: Fruit	<b>-4.47 × 10<sup>-1</sup></b> ( <b>1.01 × 10<sup>-1</sup></b> )	<b>-4.43</b>	<b>&lt;0.001</b>	-7.47 × 10 <sup>-3</sup> (4.01 × 10 <sup>-2</sup> )	-0.19	0.85	-2.39 × 10 <sup>-2</sup> (1.27 × 10 <sup>-2</sup> )	-1.88	0.06	<b>-7.92 × 10<sup>-2</sup></b> ( <b>2.25 × 10<sup>-2</sup></b> )	<b>-3.53</b>	<b>&lt;0.001</b>
Variable: Seed	<b>-2.17 × 10<sup>-1</sup></b> ( <b>8.81 × 10<sup>-2</sup></b> )	<b>-2.46</b>	<b>0.01</b>	-2.68 × 10 <sup>-2</sup> (3.01 × 10 <sup>-2</sup> )	-0.89	0.37	-1.15 × 10 <sup>-2</sup> (9.26 × 10 <sup>-3</sup> )	-1.25	0.21	<b>-3.69 × 10<sup>-2</sup></b> ( <b>1.70 × 10<sup>-2</sup></b> )	<b>-2.18</b>	<b>0.03</b>

*Columns = CVp: coefficient of variation of population level seed crop size; AR(1): 1-year lagged autocorrelation; Psd: the proportion of large seed production years; kCVp: a bounded alternative to CVp; P: P-value. Rows = AP: annual precipitation; MAT: mean annual temperature; hq: hottest quarter; cq: coldest quarter; P: precipitation; T: temperature. Bolded values indicate significant variables. Shading indicates polynomial predictors. The independent and dependent variables were centred (climate variables: with species' range median value; other variables: species' mean), and subsequently scaled using the root mean square. P-values were calculated with Wald tests via the summary() function. For linear climate predictors, these p-values reflect conditional hypotheses and should not be interpreted as evidence of independent contributions due to the inclusion of quadratic terms as I(x^2).*

# Table S4

Table S4: Full model results for species-specific models, relating climate gradients to intraspecific variation in masting metrics CVp, AR(1) and Psd.

Metric	Term	<i>F. sylvatica</i>			<i>P. abies</i>			<i>P. edulis</i>			<i>P. glauca</i>			<i>P. sylvestris</i>			<i>Q. robur/petraea</i>		
		Estimate	z	P	Estimate	z	P	Estimate	z	P	Estimate	z	P	Estimate	z	P	Estimate	z	P
CVp	AP	$1.36 \times 10^{-4}$ ( $4.55 \times 10^{-4}$ )	0.30	0.77	$2.93 \times 10^{-3}$ ( $1.37 \times 10^{-3}$ )	2.15	<b>0.03</b>	$-1.67 \times 10^{-3}$ ( $1.19 \times 10^{-3}$ )	-1.40	0.16	$-4.23 \times 10^{-4}$ ( $9.02 \times 10^{-4}$ )	-0.47	0.64	$1.86 \times 10^{-3}$ ( $8.96 \times 10^{-4}$ )	2.08	<b>0.04</b>	$2.09 \times 10^{-3}$ ( $1.85 \times 10^{-3}$ )	1.13	0.26
	AP <sup>2</sup>	$-5.22 \times 10^{-7}$ ( $5.99 \times 10^{-7}$ )	-0.87	0.38	$-3.70 \times 10^{-6}$ ( $1.78 \times 10^{-6}$ )	-2.08	<b>0.04</b>	$2.26 \times 10^{-5}$ ( $1.19 \times 10^{-5}$ )	1.90	0.06	$-2.40 \times 10^{-6}$ ( $3.38 \times 10^{-6}$ )	-0.71	0.48	$-2.44 \times 10^{-7}$ ( $4.18 \times 10^{-7}$ )	-0.58	0.56	$-3.34 \times 10^{-6}$ ( $3.61 \times 10^{-6}$ )	-0.93	0.35
	MAT	$-4.04 \times 10^{-2}$ ( $4.71 \times 10^{-2}$ )	-0.86	0.39	$-1.29 \times 10^{-1}$ ( $5.42 \times 10^{-2}$ )	-2.38	<b>0.02</b>	$1.31 \times 10^{-2}$ ( $3.02 \times 10^{-2}$ )	0.44	0.66	$1.70 \times 10^{-1}$ ( $8.64 \times 10^{-2}$ )	1.96	<b>0.05</b>	$-5.07 \times 10^{-2}$ ( $2.58 \times 10^{-2}$ )	-1.96	<b>0.05</b>	$3.51 \times 10^{-2}$ ( $4.96 \times 10^{-2}$ )	0.71	0.48
	MAT <sup>2</sup>	$2.17 \times 10^{-2}$ ( $9.61 \times 10^{-3}$ )	2.26	<b>0.02</b>	$1.04 \times 10^{-2}$ ( $9.43 \times 10^{-3}$ )	1.11	0.27	$-5.67 \times 10^{-3}$ ( $1.39 \times 10^{-2}$ )	-0.41	0.68	$-2.14 \times 10^{-2}$ ( $2.12 \times 10^{-2}$ )	-1.01	0.31	$2.08 \times 10^{-3}$ ( $3.07 \times 10^{-3}$ )	0.68	0.50	$-2.83 \times 10^{-2}$ ( $2.84 \times 10^{-2}$ )	-1.00	0.32
	MAT x AP	$9.07 \times 10^{-7}$ ( $9.73 \times 10^{-5}$ )	0.01	0.99	$2.84 \times 10^{-4}$ ( $1.57 \times 10^{-4}$ )	1.81	0.07	$6.17 \times 10^{-4}$ ( $5.33 \times 10^{-4}$ )	1.16	0.25	$2.04 \times 10^{-4}$ ( $4.73 \times 10^{-4}$ )	0.43	0.67	$-1.95 \times 10^{-4}$ ( $1.20 \times 10^{-4}$ )	-1.62	0.10	$-4.62 \times 10^{-5}$ ( $5.66 \times 10^{-4}$ )	-0.08	0.93
	Length	$2.73 \times 10^{-2}$ ( $1.08 \times 10^{-2}$ )	2.52	<b>0.01</b>	$-9.24 \times 10^{-3}$ ( $7.84 \times 10^{-3}$ )	-1.18	0.24	$3.22 \times 10^{-2}$ ( $2.18 \times 10^{-2}$ )	1.48	0.14	$3.52 \times 10^{-2}$ ( $5.48 \times 10^{-3}$ )	6.42	<b>&lt;0.001</b>	$8.63 \times 10^{-4}$ ( $4.72 \times 10^{-3}$ )	0.18	0.85	$2.02 \times 10^{-2}$ ( $1.81 \times 10^{-2}$ )	1.12	0.26
	Method: Count	$-1.39 \times 10^0$ ( $2.72 \times 10^{-1}$ )	-5.11	<b>&lt;0.001</b>	$-1.28 \times 10^0$ ( $3.72 \times 10^{-1}$ )	-3.44	<b>&lt;0.001</b>							$-8.00 \times 10^{-1}$ ( $2.82 \times 10^{-1}$ )	-2.84	<b>&lt;0.01</b>	$-4.50 \times 10^{-1}$ ( $2.94 \times 10^{-1}$ )	-1.53	0.13
	Variable : Fruit				$-1.61 \times 10^0$ ( $3.28 \times 10^{-1}$ )	-4.89	<b>&lt;0.001</b>							$-8.75 \times 10^{-1}$ ( $2.45 \times 10^{-1}$ )	-3.57	<b>&lt;0.001</b>			
Variable : Seed	$5.71 \times 10^{-1}$ ( $1.49 \times 10^{-1}$ )	3.84	<b>&lt;0.001</b>	$-6.12 \times 10^{-1}$ ( $3.43 \times 10^{-1}$ )	-1.78	0.07				$2.68 \times 10^{-1}$ ( $1.20 \times 10^{-1}$ )	2.24	<b>0.03</b>	$-7.27 \times 10^{-1}$ ( $1.58 \times 10^{-1}$ )	-4.60	<b>&lt;0.001</b>	$6.08 \times 10^{-2}$ ( $3.62 \times 10^{-1}$ )	0.17	0.87	
AR(1)	AP	$1.62 \times 10^{-4}$ ( $1.68 \times 10^{-4}$ )	0.97	0.33	$1.57 \times 10^{-3}$ ( $2.89 \times 10^{-4}$ )	5.45	<b>&lt;0.001</b>	$5.64 \times 10^{-4}$ ( $7.71 \times 10^{-4}$ )	0.73	0.46	$7.88 \times 10^{-5}$ ( $3.44 \times 10^{-4}$ )	0.23	0.82	$1.56 \times 10^{-3}$ ( $1.01 \times 10^{-3}$ )	1.55	0.12	$2.40 \times 10^{-3}$ ( $1.01 \times 10^{-3}$ )	2.37	<b>0.02</b>
	AP <sup>2</sup>	$1.12 \times 10^{-7}$ ( $2.21 \times 10^{-7}$ )	0.51	0.61	$-2.15 \times 10^{-6}$ ( $3.76 \times 10^{-7}$ )	-5.72	<b>&lt;0.001</b>	$-3.69 \times 10^{-6}$ ( $7.70 \times 10^{-6}$ )	-0.48	0.63	$1.48 \times 10^{-7}$ ( $1.29 \times 10^{-6}$ )	0.11	0.91	$-4.85 \times 10^{-7}$ ( $4.70 \times 10^{-7}$ )	-1.03	0.30	$-4.07 \times 10^{-6}$ ( $1.98 \times 10^{-6}$ )	-2.06	<b>0.04</b>
	MAT	$-3.57 \times 10^{-2}$ ( $1.74 \times 10^{-2}$ )	-2.05	<b>0.04</b>	$-8.39 \times 10^{-2}$ ( $1.15 \times 10^{-2}$ )	-7.32	<b>&lt;0.001</b>	$-2.62 \times 10^{-3}$ ( $1.95 \times 10^{-2}$ )	-0.13	0.89	$3.47 \times 10^{-3}$ ( $3.30 \times 10^{-2}$ )	0.11	0.92	$-9.12 \times 10^{-2}$ ( $2.91 \times 10^{-2}$ )	-3.14	<b>&lt;0.01</b>	$-8.42 \times 10^{-3}$ ( $2.72 \times 10^{-2}$ )	-0.31	0.76
	MAT <sup>2</sup>	$4.26 \times 10^{-3}$ ( $3.55 \times 10^{-3}$ )	1.20	0.23	$-1.20 \times 10^{-2}$ ( $1.99 \times 10^{-3}$ )	-6.01	<b>&lt;0.001</b>	$3.80 \times 10^{-3}$ ( $9.01 \times 10^{-3}$ )	0.42	0.67	$9.68 \times 10^{-3}$ ( $8.08 \times 10^{-3}$ )	1.20	0.23	$7.09 \times 10^{-3}$ ( $3.45 \times 10^{-3}$ )	2.05	<b>0.04</b>	$1.77 \times 10^{-2}$ ( $1.56 \times 10^{-2}$ )	1.14	0.26
	MAT x AP	$6.24 \times 10^{-5}$ ( $3.59 \times 10^{-5}$ )	1.74	0.08	$1.69 \times 10^{-4}$ ( $3.31 \times 10^{-5}$ )	5.10	<b>&lt;0.001</b>	$1.16 \times 10^{-4}$ ( $3.45 \times 10^{-4}$ )	0.34	0.74	$-1.82 \times 10^{-4}$ ( $1.80 \times 10^{-4}$ )	-1.01	0.31	$-1.49 \times 10^{-4}$ ( $1.35 \times 10^{-4}$ )	-1.11	0.27	$-2.43 \times 10^{-4}$ ( $3.11 \times 10^{-4}$ )	-0.78	0.43
	Length	$-4.35 \times 10^{-3}$ ( $4.00 \times 10^{-3}$ )	-1.09	0.28	$-4.61 \times 10^{-3}$ ( $1.66 \times 10^{-3}$ )	-2.78	<b>&lt;0.01</b>	$-3.95 \times 10^{-3}$ ( $1.41 \times 10^{-2}$ )	-0.28	0.78	$5.88 \times 10^{-3}$ ( $2.09 \times 10^{-3}$ )	2.81	<b>&lt;0.01</b>	$-6.13 \times 10^{-4}$ ( $5.31 \times 10^{-3}$ )	-0.12	0.91	$9.45 \times 10^{-4}$ ( $9.91 \times 10^{-3}$ )	0.10	0.92
	Method: Count	$-1.43 \times 10^{-2}$ ( $1.00 \times 10^{-1}$ )	-0.14	0.89	$-3.71 \times 10^{-1}$ ( $7.86 \times 10^{-2}$ )	-4.71	<b>&lt;0.001</b>							$-2.13 \times 10^{-1}$ ( $3.17 \times 10^{-1}$ )	-0.67	0.50	$-2.15 \times 10^{-1}$ ( $1.61 \times 10^{-1}$ )	-1.33	0.18

	Variable : Fruit			$2.53 \times 10^{-1}$ ( $6.93 \times 10^{-2}$ )	3.65	<b>&lt;0.001</b>							$2.18 \times 10^{-2}$ ( $2.75 \times 10^{-1}$ )	0.08	0.94				
	Variable : Seed	$2.33 \times 10^{-1}$ ( $5.49 \times 10^{-2}$ )	4.24	<b>&lt;0.001</b>	$-7.63 \times 10^{-2}$ ( $7.25 \times 10^{-2}$ )	-1.05	0.29			$8.66 \times 10^{-2}$ ( $4.56 \times 10^{-2}$ )	1.90	0.06	$-3.10 \times 10^{-1}$ ( $1.78 \times 10^{-1}$ )	-1.75	0.08	$-1.37 \times 10^{-1}$ ( $1.99 \times 10^{-1}$ )	-0.69	0.49	
<b>Psd</b>	AP	$-4.13 \times 10^{-5}$ ( $7.75 \times 10^{-5}$ )	-0.53	0.59	$3.77 \times 10^{-4}$ ( $2.17 \times 10^{-4}$ )	1.74	0.08	$-1.41 \times 10^{-5}$ ( $1.61 \times 10^{-4}$ )	-0.09	0.93	$-8.91 \times 10^{-5}$ ( $1.40 \times 10^{-4}$ )	-0.64	0.53	$4.50 \times 10^{-4}$ ( $2.77 \times 10^{-4}$ )	1.62	0.10	$5.05 \times 10^{-5}$ ( $3.26 \times 10^{-4}$ )	0.15	0.88
	AP <sup>2</sup>	$-2.53 \times 10^{-6}$ $8.00^{\wedge}(1.02 \times 10^{-7})$	-0.25	0.80	$-5.40 \times 10^{-7}$ ( $2.83 \times 10^{-7}$ )	-1.91	0.06	$-4.02 \times 10^{-7}$ ( $1.61 \times 10^{-6}$ )	-0.25	0.80	$-4.70 \times 10^{-7}$ ( $5.26 \times 10^{-7}$ )	-0.89	0.37	$-2.56 \times 10^{-7}$ ( $1.29 \times 10^{-7}$ )	-1.98	<b>0.05</b>	$-7.84 \times 10^{-7}$ ( $6.38 \times 10^{-7}$ )	-1.23	0.22
	MAT	$-4.44 \times 10^{-3}$ ( $8.03 \times 10^{-3}$ )	-0.55	0.58	$-1.19 \times 10^{-2}$ ( $8.62 \times 10^{-3}$ )	-1.38	0.17	$5.36 \times 10^{-3}$ ( $4.06 \times 10^{-3}$ )	1.32	0.19	$7.87 \times 10^{-3}$ ( $1.34 \times 10^{-2}$ )	0.59	0.56	$-1.58 \times 10^{-2}$ ( $7.98 \times 10^{-3}$ )	-1.98	<b>0.05</b>	$1.83 \times 10^{-2}$ ( $8.77 \times 10^{-3}$ )	2.09	<b>0.04</b>
	MAT <sup>2</sup>	$-4.71 \times 10^{-4}$ ( $1.64 \times 10^{-3}$ )	-0.29	0.77	$-3.89 \times 10^{-3}$ ( $1.50 \times 10^{-3}$ )	-2.60	<b>&lt;0.01</b>	$3.84 \times 10^{-4}$ ( $1.88 \times 10^{-3}$ )	0.20	0.84	$-3.66 \times 10^{-3}$ ( $3.29 \times 10^{-3}$ )	-1.11	0.27	$5.22 \times 10^{-4}$ ( $9.49 \times 10^{-4}$ )	0.55	0.58	$-4.77 \times 10^{-3}$ ( $5.02 \times 10^{-3}$ )	-0.95	0.34
	MAT x AP	$-1.38 \times 10^{-5}$ ( $1.66 \times 10^{-5}$ )	-0.84	0.40	$4.33 \times 10^{-5}$ ( $2.49 \times 10^{-5}$ )	1.74	0.08	$1.00 \times 10^{-5}$ ( $7.18 \times 10^{-5}$ )	0.14	0.89	$8.52 \times 10^{-5}$ ( $7.35 \times 10^{-5}$ )	1.16	0.25	$-2.15 \times 10^{-5}$ ( $3.71 \times 10^{-5}$ )	-0.58	0.56	$7.67 \times 10^{-5}$ ( $1.00 \times 10^{-4}$ )	0.77	0.44
	Length	$-2.87 \times 10^{-3}$ ( $1.84 \times 10^{-3}$ )	-1.56	0.12	$-9.78 \times 10^{-4}$ ( $1.25 \times 10^{-3}$ )	-0.79	0.43	$-2.00 \times 10^{-4}$ ( $2.94 \times 10^{-3}$ )	-0.07	0.95	$-9.58 \times 10^{-4}$ ( $8.53 \times 10^{-4}$ )	-1.12	0.26	$-1.97 \times 10^{-3}$ ( $1.46 \times 10^{-3}$ )	-1.35	0.18	$-3.98 \times 10^{-3}$ ( $3.19 \times 10^{-3}$ )	-1.25	0.21
	Method: Count	$1.59 \times 10^{-3}$ ( $4.62 \times 10^{-2}$ )	0.03	0.97	$1.04 \times 10^{-1}$ ( $5.92 \times 10^{-2}$ )	1.76	0.08							$-1.08 \times 10^{-1}$ ( $8.72 \times 10^{-2}$ )	-1.24	0.21	$-1.02 \times 10^{-1}$ ( $5.20 \times 10^{-2}$ )	-1.97	<b>0.05</b>
	Variable : Fruit			$8.79 \times 10^{-2}$ ( $5.22 \times 10^{-2}$ )	1.68	0.09							$-1.61 \times 10^{-1}$ ( $7.57 \times 10^{-2}$ )	-2.13	<b>0.03</b>				
	Variable : Seed	$4.37 \times 10^{-2}$ ( $2.53 \times 10^{-2}$ )	1.73	0.08	$1.08 \times 10^{-1}$ ( $5.46 \times 10^{-2}$ )	1.98	<b>0.05</b>				$-1.80 \times 10^{-2}$ ( $1.86 \times 10^{-2}$ )	-0.96	0.33	$-1.24 \times 10^{-1}$ ( $4.88 \times 10^{-2}$ )	-2.53	<b>0.01</b>	$8.57 \times 10^{-2}$ ( $6.40 \times 10^{-2}$ )	1.34	0.18

Columns = *F. sylvatica*: *Fagus sylvatica*; *P. abies*: *Picea abies*; *P. edulis*: *Pinus edulis*; *P. glauca*: *Picea glauca*; *P. sylvestris*: *Pinus sylvestris*; *Q. robur/petraea*: *Q. robur/petraea*. *P*: *P*-value.

Rows= *CVp*: coefficient of variation of population level seed crop size; *AR(1)*: 1-year lagged autocorrelation; *Psd*: the proportion of large seed production years; *AP*: annual precipitation; *MAT*: mean annual temperature.

Bolded values indicate significant values. Shading indicates polynomial predictors. The climate predictors were centred with species' range median values. *P*-values were calculated with Wald tests.

## References Fig. S1-3 and Table S2-4

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## Section S2

Below, we compare our covered gradients compared to reported species limits (or the limits of species' presence) for the 6 species with the most data. We acknowledge that these reported species limits (predominantly based on Joint Research Centre et al. (2016)) contain uncertainties. Yet, they indicate that the gradients sampled in our analysis are broadly representative.

*Table Section S2: Species climate limits compared with our sampling gradient*

Species	Variable	Source of limits	Limits	Sampled
<i>Fagus sylvatica</i>	Temperature (MAT, degree celcius)	Hacket-Pain et al. 2016	Low: ~ 6.5 High: 13.5	Low: 2.7 High: 12.9
		Joint research centre et al. 2016	Low: ~ 3 High: 14	
	Precipitation (AP, mm)	Hacket-Pain et al. 2016	Low: ~ 500 High: 1272	Low: 620 High: 1694
		Joint research centre et al. 2016	Low: ~ 500 High: ~ 1500	
<i>Picea abies</i>	Temperature	Joint research centre et al. 2016	Low: ~ -3 High: ~ 11	Low: -1.7 High: 10
	Precipitation	Joint research centre et al. 2016	Low: ~ 450 High: ~ 2500	Low: 520 High: 1446
<i>Pinus edulis</i>	Temperature	Burns 1990	Low: 4 High: 16	Low: 5.7 High: 13.6
	Precipitation	Burns 1990	Low: 250 High: 560 (locally 690)	Low: 270 High: 539
<i>Picea glauca</i>	Temperature	Thompson et al. 2023	Low: - 10 High: 6	Low: -4.8 High: 6.5
	Precipitation	Burns 1990	Low: 250 High: 1270	Low: 274 High: 1185
<i>Pinus sylvestris</i>	Temperature	Joint research centre et al. 2016	Low: ~ -3 High: ~ 14	Low: -2.3 High: 11.6
	Precipitation	Joint research centre et al. 2016	Low: 400 High: 2500	Low: 397 High: 1864
<i>Quercus robur/petraea</i>	Temperature	Joint research centre et al. 2016	Low: 5 High: 15	Low: 3.4 High: 12.5
	Precipitation	Joint research centre et al. 2016	Low: ~ 500 High: ~ 1900	Low: 601 High: 1166

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