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Supplementary information

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Declines in European bumblebee habitat suitability attributable to climate change

In the format provided by the authors and unedited

Supplementary Information

Supplementary Methods and Results: Calculation of the Boyce index

In addition to the ecological niche maps, which evaluate changes in ecological suitability related to climate change, we also compared the differentiation between the historical and counterfactual scenarios through time, using the Boyce Index (BI), a presence-only predictive performance metric. This index was computed across the full ecological suitability range [0, 1] using a sliding window approach: suitability bins had a width of 0.1 and were shifted by 0.01 at each step[1,2]. We restricted the computation of the Boyce index to species with a minimum of 30 unique presence cells in a given time period. For each species and time period, we randomly selected an equal number of evaluation points (1:1 ratio with presences) across the study area. As this process is random, we repeated this procedure ten times per trained BRT (boosted regression tree) model, leading to a total of 100 BI computations per species and per considered time period. We then calculated the mean differences of the BI between the historical and counterfactual scenarios for each species and each time period (Supplementary Fig. S6), with positive values indicating better predictions of occurrence data under historical climate data, and negative values, better predictions of occurrences under a counterfactual scenario. This comparison enables us to evaluate whether incorporating climate change enhances model performance in predicting the past and present distributions of European bumblebee species. To test whether these differences were significant, one-sided and two-sided Wilcoxon-Mann-Whitney tests were performed for each time period, species and reanalysis dataset. Specifically, we evaluated whether the BI differences were significantly greater/less than or different from zero. To correct for multiple testing, a Benjamini-Hochberg procedure was applied.

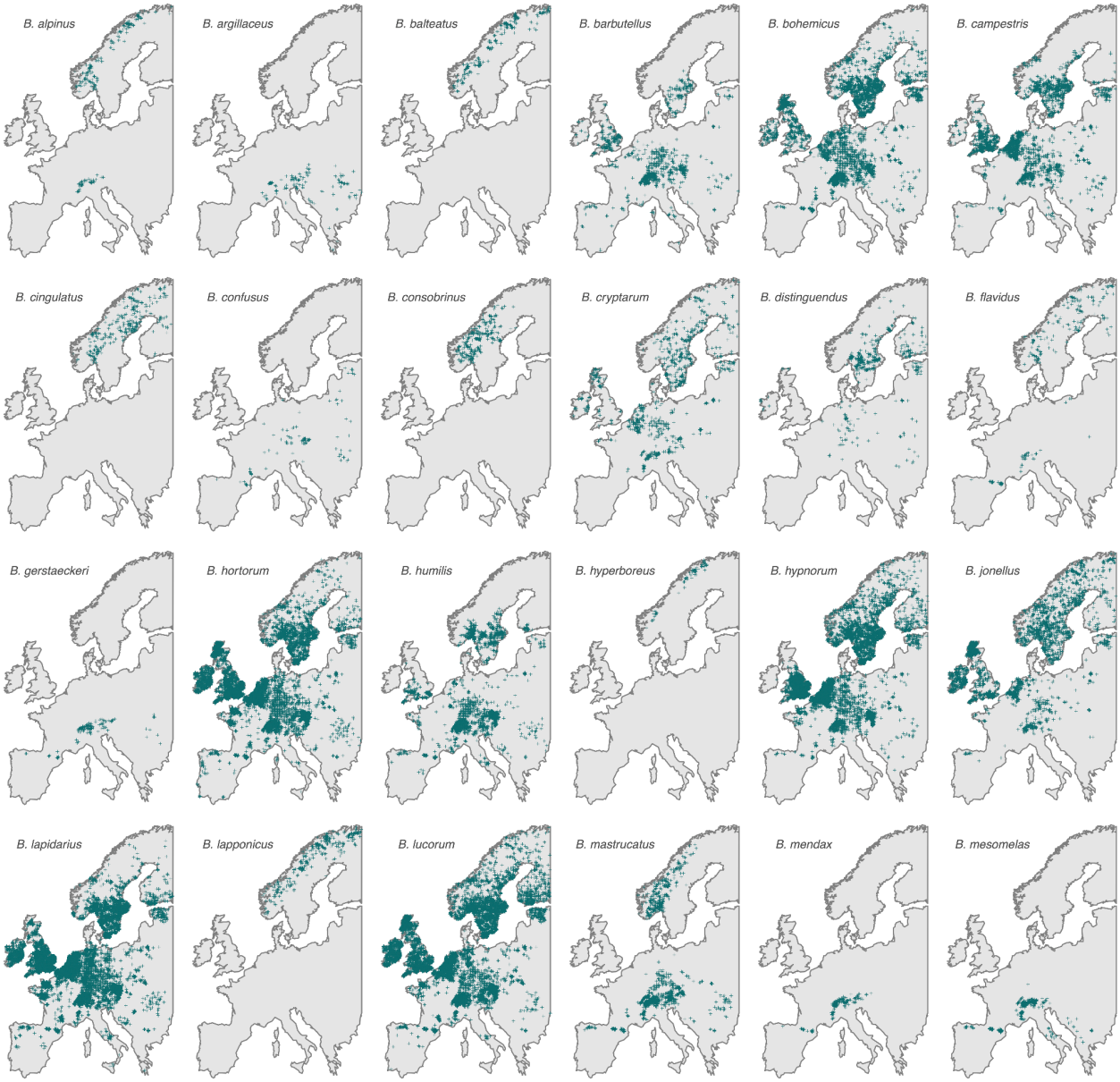
We found that, under the GSWP3-W5E5 reanalysis dataset, the mean BI differences are clustered around zero at the beginning of the 20th century but become more variable when moving towards the 21st century (Supplementary Fig. S6). This pattern is consistent with the signal previously observed with the ecological suitability index (ESI) metric (Fig. 1) and suggests an increasing influence of climate change in explaining the current distribution of European bumblebees, whether such changes reflect an expanding or contracting range. Moreover, many of the most affected species, either through great loss or increased ecological suitability, also display significant positive BI differences. Testing across each time period, we found a consistent increase in the proportion of species with significantly positive BI differences towards recent decades, indicating a growing divergence between factual and counterfactual model performance over time (Supplementary Table S1). For the most recent period (2000-2019), 66% of species (*n* = 31 out of 47) had a significantly positive BI difference, and 11 species (23%) showed similar performance between the counterfactual and factual scenarios, resulting in BI differences that are not significantly different from zero (Supplementary Table S1). This suggests that the current distribution of these species can still be reasonably well predicted even without incorporating climate change. Finally, a group of five species (11%) had significantly negative BI differences for the same period (Supplementary Table S1).

Similar temporal trends were observed across the other reanalysis datasets (20CRv3, 20CRv3-ERA5, and 20CRv3-W5E5), with increasing BI divergence between the two scenarios and a growing proportion of species showing significantly positive BI differences towards recent decades (Supplementary Fig. S6, Supplementary Table S1). Between 47% and 62% of species still showed significantly positive BI differences for the 2000-2019 period under the other reanalysis datasets (*n* = 22/47 for 20CRv3, *n* = 26/47 for 20CRv3-ERA5, and *n* = 29/47 for 20CRv3-W5E5). However, a relatively higher proportion of species had significant negative BI differences under the 20CRv3 (*n* = 12/47) and 20CRv3-ERA5 reanalysis datasets (*n* = 10/47), whereas 20CRv3-W5E5 remained similar to GSWP3-W5E5 (*n* = 4/47; Supplementary Table S1). Nevertheless, a tendency of improved model performance under the historical climate change scenario through time was observed across the four reanalysis datasets. This provides additional support that climate change has increasingly shaped the distribution of European bumblebees over the last century.

References

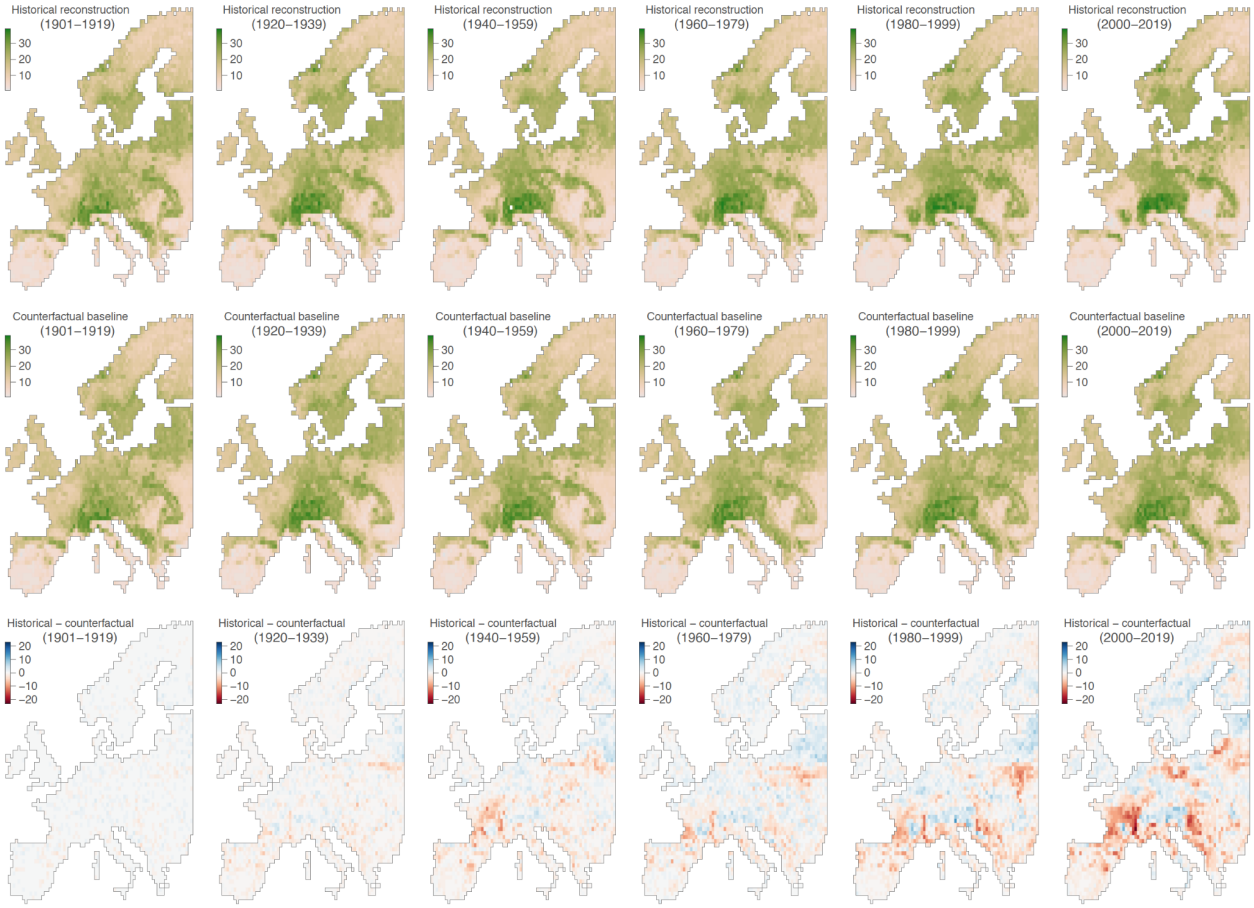
1. Boyce, M. S., Vernier, P. R., Nielsen, S. E. & Schmiegelow, F. K. A. Evaluating resource selection functions. *Ecol. Model.* 157, 281–300 (2002).
2. Hirzel, A. H., Le Lay, G., Helfer, V., Randin, C. & Guisan, A. Evaluating the ability of habitat suitability models to predict species presences. *Ecol. Model.* 199, 142–152 (2006).

Supplementary Figures and Tables

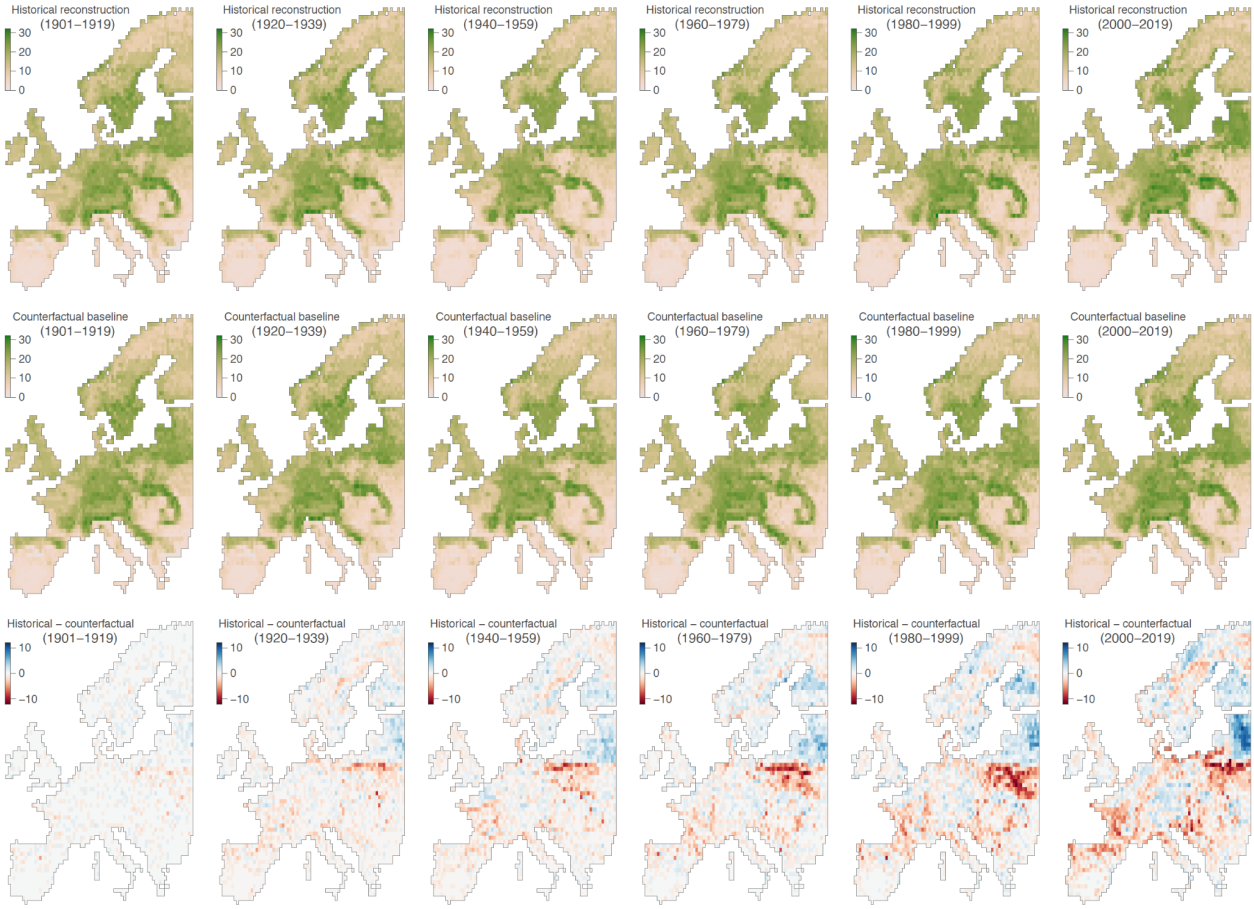


Supplementary Figure S1 (part 1/2). Map of the occurrence records for the 47 European bumblebee species considered in this study (2000-2019).

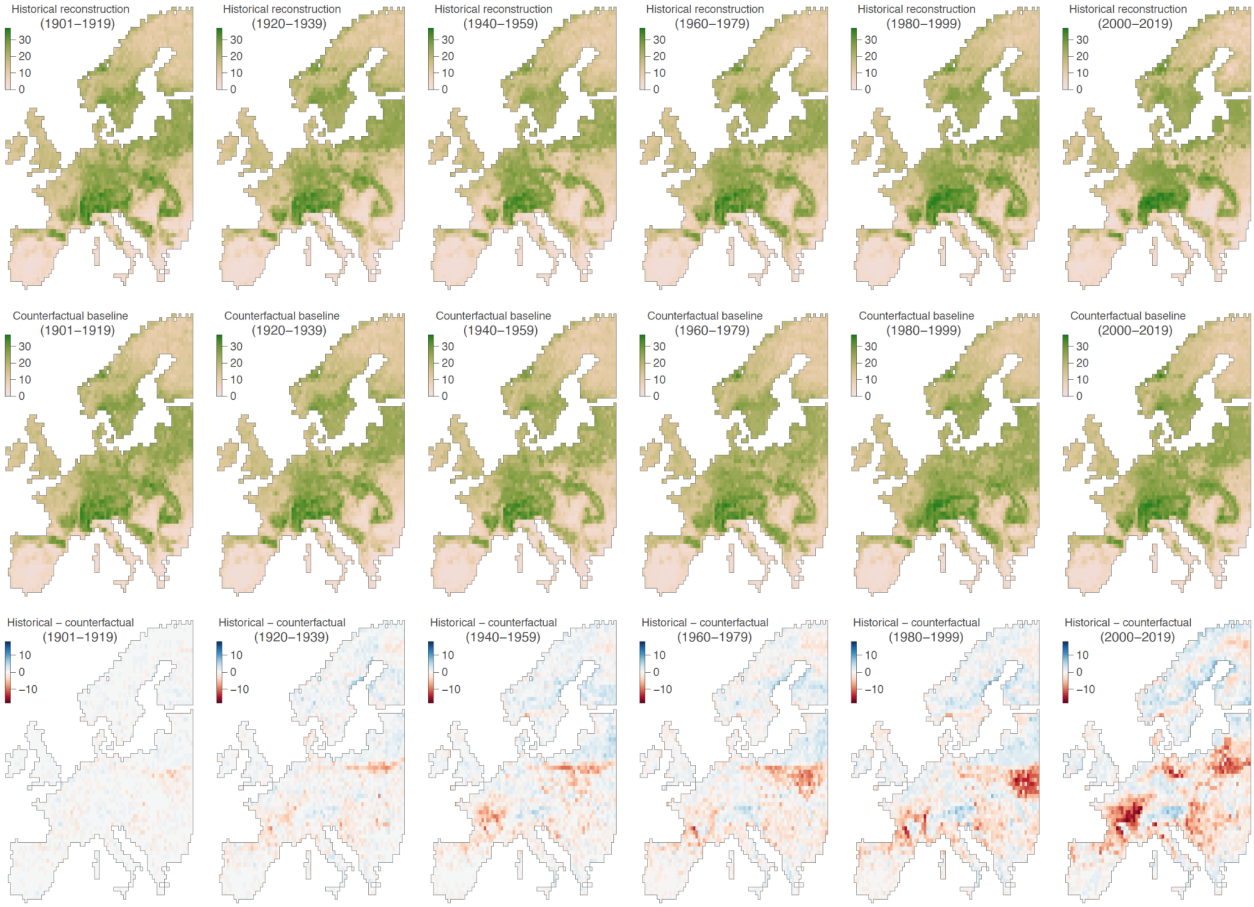
Supplementary Figure S1 (part 2/2). Map of the occurrence records for the 47 European bumblebee species considered in this study (2000-2019).



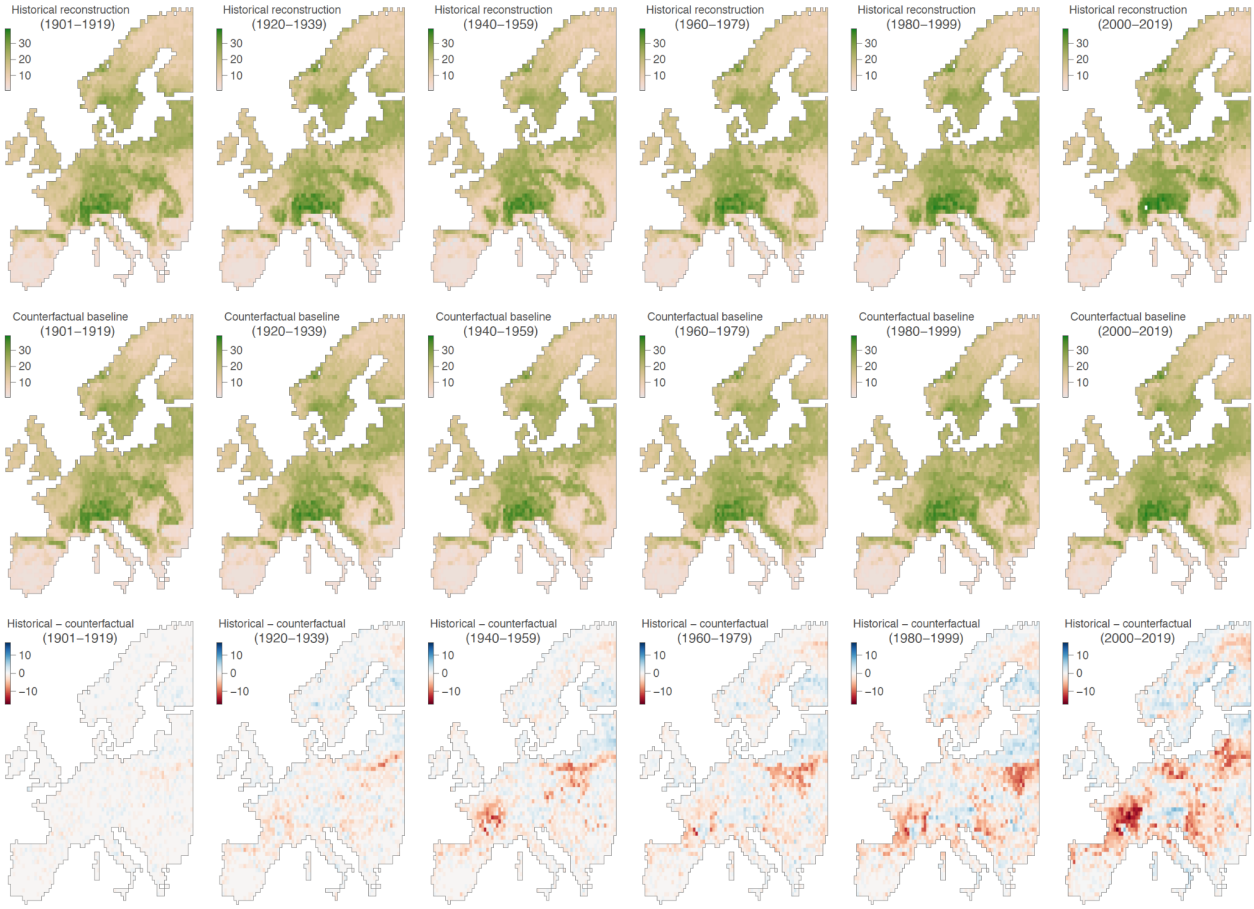
Supplementary Figure S2. Investigating the changes in ecological suitability for bumblebees in regard to climate change over the last century in Europe, as estimated with the species richness index for the results based on the ISIMIP3a reanalysis dataset GSWP3-W5E5. For each successive time period and each scenario (historical or counterfactual), we report a map of the species richness index (SRI), defined as the local number of species associated with an ecological suitability higher than the median threshold value retrieved from the optimisation step of the prevalence-pseudoabsence-calibrated Sørensen index (SI_{ppc}) computed for each of ten ecological niche models trained on present-day data (see the Methods section for further detail). The first and second rows of maps report local SRI estimates based on the reconstructions of the historical climate and a counterfactual baseline, respectively, and the third row of maps reports the difference, for each time period, between the two, i.e., between the estimates based on the reconstructions of the historical climate and a counterfactual baseline.



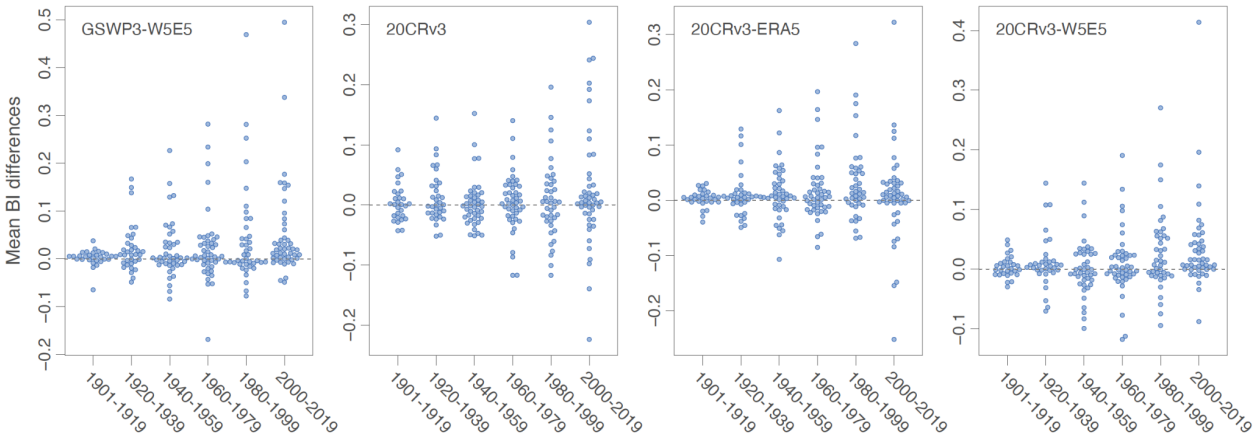
Supplementary Figure S3. Investigating the changes in species richness index for bumblebees in regard to climate change over the last century in Europe, as estimated with the species richness index for the results based on the ISIMIP3a reanalysis dataset 20CRv3. For each successive time period and each scenario (historical or counterfactual), we report a map of the species richness index (SRI), defined as the local number of species associated with an ecological suitability higher than the median threshold value retrieved from the optimisation step of the prevalence-pseudoabsence-calibrated Sørensen index (SI_{ppc}) computed for each of ten ecological niche models trained on present-day data (see the Methods section for further detail). The first and second rows of maps report local SRI estimates based on the reconstructions of the historical climate and a counterfactual baseline, respectively, and the third row of maps reports the difference, for each time period, between the two, i.e., between the estimates based on the reconstructions of the historical climate and a counterfactual baseline.



Supplementary Figure S4. Investigating the changes in species richness index for bumblebees with regard to climate change over the last century in Europe, as estimated with the species richness index for the results based on the ISIMIP3a reanalysis dataset 20CRv3-ERA5. For each successive time period and each scenario (historical or counterfactual), we report a map of the species richness index (SRI), defined as the local number of species associated with an ecological suitability higher than the median threshold value retrieved from the optimisation step of the prevalence-pseudoabsence-calibrated Sørensen index (SI_{ppc}) computed for each of ten ecological niche models trained on present-day data (see the Methods section for further detail). The first and second rows of maps report local SRI estimates based on the reconstructions of the historical climate and a counterfactual baseline, respectively, and the third row of maps reports the difference, for each time period, between the two, i.e., between the estimates based on the reconstructions of the historical climate and a counterfactual baseline.



Supplementary Figure S5. Investigating the changes in species richness index for bumblebees in regard to climate change over the last century in Europe, as estimated with the species richness index for the results based on the ISIMIP3a reanalysis dataset 20CRv3-W5E5. For each successive time period and each scenario (historical or counterfactual), we report a map of the species richness index (SRI), defined as the local number of species associated with an ecological suitability higher than the median threshold value retrieved from the optimisation step of the prevalence-pseudoabsence-calibrated Sørensen index (SI_{ppc}) computed for each of ten ecological niche models trained on present-day data (see the Methods section for further detail). The first and second rows of maps report local SRI estimates based on the reconstructions of the historical climate and a counterfactual baseline, respectively, and the third row of maps reports the difference, for each time period, between the two, i.e., between the estimates based on the reconstructions of the historical climate and a counterfactual baseline.



Supplementary Figure S6. Comparison of the adequacy between historical occurrence records for European bumblebee species and their ecological suitability estimates based on historical climate or a counterfactual baseline. We report, for six successive periods, the distribution of species-specific mean differences between (i) the Boyce index (BI) computed when considering past ecological suitability estimated according to the historical climate and (ii) the BI value computed when considering past ecological suitability estimated according to the counterfactual climate. A positive BI difference hence indicates that historical climate data lead to a better prediction of past occurrence data, while a negative BI difference rather indicates that counterfactual data lead to a better prediction of past occurrence data. These results are reported for each of the four ISIMIP3a reanalysis datasets — GSWP3-W5E5, 20CRv3, 20CRv3-ERA5, and 20CRv3-W5E5 — considered in the present study.

Supplementary Table S1 (part 1/3, for the periods 1900-1919 and 1920-1939). Results of the one-sided and two-sided Wilcoxon-Mann-Whitney tests conducted to assess whether Boyce index differences were significantly greater/less than or different from zero for each period. The Boyce Index (BI) is a presence-only predictive performance metric used in the present study to test whether historical climate conditions improved the predictive performance of our species-specific ecological niche models for observed bumblebee occurrences relative to the counterfactual climatic scenario. BI differences between the historical and counterfactual scenarios were computed for each species, with positive values indicating better predictions of occurrence data under historical climate data, and negative values, better predictions of occurrences under a counterfactual scenario. In this table, we report the p-values of the one-sided and two-sided Wilcoxon-Mann-Whitney tests conducted to assess whether BI differences were significantly greater/less than or different from zero for each period. To correct for multiple testing, a Benjamini-Hochberg procedure was applied, and p-values corresponding to significant differences are marked by an asterisk.

1900-1919	Wilcoxon-Mann-Whitney test p-values for BI *different from* zero				Wilcoxon-Mann-Whitney test p-values for BI *greater* than zero				Wilcoxon-Mann-Whitney test p-values for BI *less* than zero			
	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5
Bombus alpinus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus argillaceus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus balteatus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus barbutellus	0.235	0.985	0.014	0.171	0.117	0.492	0.007	0.915	0.883	0.509	0.993	0.085
Bombus bohemicus	0.535	0.990	0.190	0.360	0.267	0.495	0.095	0.180	0.734	0.506	0.906	0.821
Bombus campestris	0.067	0.372	0.944	0.717	0.033	0.815	0.472	0.643	0.967	0.186	0.529	0.358
Bombus cingulatus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus confusus	0.919	0.041	0.257	0.119	0.542	0.020	0.129	0.059	0.460	0.980	0.872	0.941
Bombus consobrinus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus cryptarum	0.335	0.495	0.102	0.586	0.167	0.754	0.949	0.708	0.833	0.247	0.051	0.293
Bombus distinguendus	0.209	0.365	0.029	0.110	0.896	0.818	0.986	0.055	0.104	0.182	0.015	0.945
Bombus flavidus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus gerstaeckeri	-	-	-	-	-	-	-	-	-	-	-	-
Bombus hortorum	0.253	0.846	0.892	0.758	0.874	0.423	0.555	0.622	0.126	0.578	0.446	0.379
Bombus humilis	0.795	0.044	0.528	0.038	0.398	0.022	0.264	0.019	0.604	0.978	0.737	0.981
Bombus hyperboreus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus hypnorum	0.326	0.003*	0.389	0.055	0.163	0.998	0.195	0.027	0.838	0.002*	0.806	0.973
Bombus jonellus	0.104	0.356	0.689	0.164	0.052	0.178	0.344	0.918	0.949	0.823	0.657	0.082
Bombus lapidarius	0.014	0.179	0.069	0.758	0.007	0.090	0.966	0.379	0.993	0.911	0.034	0.622
Bombus lapponicus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus lucorum	0.795	0.002*	<0.001*	0.979	0.398	0.001*	<0.001*	0.490	0.604	0.999	>0.999	0.512
Bombus mastrucatus	0.612	0.017	0.382	0.072	0.306	0.009	0.810	0.036	0.695	0.991	0.191	0.964
Bombus mendax	-	-	-	-	-	-	-	-	-	-	-	-
Bombus mesomelas	0.602	0.457	0.158	0.740	0.700	0.228	0.079	0.631	0.301	0.773	0.921	0.370
Bombus monticola	-	-	-	-	-	-	-	-	-	-	-	-
Bombus mucidus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus muscorum	0.546	0.679	0.250	0.727	0.273	0.339	0.125	0.638	0.728	0.662	0.876	0.364
Bombus norvegicus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus pascuorum	0.560	0.012	0.691	0.133	0.721	0.994	0.656	0.066	0.280	0.006	0.346	0.934
Bombus pomorum	0.914	0.607	0.612	0.906	0.457	0.698	0.306	0.549	0.544	0.304	0.695	0.453
Bombus pratorum	0.244	<0.001*	0.109	0.639	0.122	>0.999	0.054	0.319	0.878	<0.001*	0.946	0.682
Bombus pyrenaeus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus pyrrhopygus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus quadricolor	0.843	0.153	0.177	0.397	0.580	0.924	0.912	0.803	0.422	0.077	0.089	0.198
Bombus ruderarius	0.432	0.344	0.247	0.344	0.216	0.172	0.124	0.172	0.785	0.829	0.877	0.829
Bombus ruderatus	0.021	0.176	0.862	0.188	0.011	0.913	0.570	0.094	0.989	0.088	0.431	0.906
Bombus rupestris	0.480	0.014	0.649	0.508	0.761	0.007	0.677	0.747	0.240	0.993	0.324	0.254
Bombus semenoviellus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus sichelii	-	-	-	-	-	-	-	-	-	-	-	-
Bombus soroeensis	0.617	0.712	0.843	0.219	0.308	0.645	0.422	0.891	0.693	0.356	0.580	0.109
Bombus sporadicus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus subterraneus	0.908	0.849	0.631	0.450	0.454	0.577	0.316	0.776	0.547	0.424	0.685	0.225
Bombus sylvarum	0.467	0.187	0.544	0.367	0.234	0.907	0.729	0.183	0.768	0.094	0.272	0.818
Bombus sylvestris	0.634	<0.001*	0.331	0.067	0.684	<0.001*	0.166	0.033	0.317	>0.999	0.835	0.967
Bombus terrestris	0.006	0.125	0.166	0.446	0.997	0.062	0.917	0.778	0.003	0.938	0.083	0.223
Bombus vestalis	0.240	0.153	0.416	0.158	0.120	0.077	0.208	0.079	0.881	0.924	0.793	0.921
Bombus veteranus	0.015	0.851	0.651	0.753	0.993	0.426	0.326	0.625	0.007	0.576	0.676	0.377
Proportion of significant difference	**0/29**	**4/29**	**1/29**	**0/29**	**0/29**	**2/29**	**1/29**	**0/29**	**0/29**	**2/29**	**0/29**	**0/29**

1920-1939	Wilcoxon-Mann-Whitney test p-values for BI *different from* zero				Wilcoxon-Mann-Whitney test p-values for BI *greater* than zero				Wilcoxon-Mann-Whitney test p-values for BI *less* than zero			
	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5
Bombus alpinus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus argillaceus	0.674	0.308	0.347	0.822	0.664	0.154	0.174	0.590	0.337	0.847	0.827	0.411
Bombus balteatus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus barbutellus	0.039	0.015	0.732	0.756	0.019	0.007*	0.635	0.623	0.981	0.993	0.366	0.378
Bombus bohemicus	0.694	0.993	0.119	0.073	0.654	0.497	0.059	0.964	0.347	0.505	0.941	0.036
Bombus campestris	0.038	0.192	<0.001*	<0.001*	0.019	0.905	<0.001*	<0.001*	0.981	0.096	>0.999	>0.999
Bombus cingulatus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus confusus	0.022	0.004*	0.555	0.010*	0.011*	0.002*	0.278	0.005*	0.989	0.998	0.723	0.995
Bombus consobrinus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus cryptarum	0.444	0.148	0.077	0.440	0.779	0.926	0.962	0.781	0.222	0.074	0.038	0.220
Bombus distinguendus	0.041	0.624	0.064	0.001*	0.020	0.689	0.968	>0.999	0.980	0.312	0.032	<0.001*
Bombus flavidus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus gerstaeckeri	-	-	-	-	-	-	-	-	-	-	-	-
Bombus hortorum	<0.001*	0.352	0.546	0.878	>0.999	0.176	0.273	0.439	<0.001*	0.825	0.728	0.562
Bombus humilis	0.027	0.476	0.469	0.816	0.014*	0.763	0.235	0.593	0.987	0.238	0.766	0.408
Bombus hyperboreus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus hypnorum	<0.001*	0.438	0.041	0.897	<0.001*	0.782	0.020	0.553	>0.999	0.219	0.980	0.449
Bombus jonellus	0.290	0.022	<0.001*	<0.001*	0.856	0.989	>0.999	>0.999	0.145	0.011	<0.001*	<0.001*
Bombus lapidarius	<0.001*	0.966	0.903	0.023	>0.999	0.483	0.451	0.011*	<0.001*	0.519	0.550	0.989
Bombus lapponicus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus lucorum	<0.001*	0.001*	0.206	0.021	>0.999	<0.001*	0.103	0.010*	<0.001*	>0.999	0.897	0.990
Bombus mastrucatus	0.356	0.469	0.175	0.122	0.178	0.235	0.087	0.061	0.823	0.766	0.913	0.939
Bombus mendax	-	-	-	-	-	-	-	-	-	-	-	-
Bombus mesomelas	0.911	0.519	0.234	0.013*	0.546	0.742	0.884	0.994	0.456	0.260	0.117	0.006
Bombus monticola	<0.001*	<0.001*	0.622	0.323	>0.999	<0.001*	0.311	0.839	<0.001*	>0.999	0.690	0.161
Bombus mucidus	0.050	0.340	0.567	<0.001*	0.975	0.831	0.718	>0.999	0.025	0.170	0.283	<0.001*
Bombus muscorum	0.003*	0.549	0.158	0.082	0.001*	0.727	0.921	0.041	0.999	0.274	0.079	0.960
Bombus norvegicus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus pascuorum	<0.001*	0.119	0.034	0.033	>0.999	0.941	0.017	0.016	<0.001*	0.059	0.983	0.984
Bombus pomorum	<0.001*	0.013*	<0.001*	<0.001*	<0.001*	0.006*	<0.001*	<0.001*	>0.999	0.994	>0.999	>0.999
Bombus pratorum	<0.001*	0.003*	0.583	<0.001*	<0.001*	0.999	0.292	<0.001*	>0.999	0.001*	0.709	>0.999
Bombus pyrenaeus	0.188	0.002*	0.504	0.389	0.094	0.001*	0.252	0.195	0.906	0.999	0.749	0.806
Bombus pyrrhopygus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus quadricolor	0.922	0.110	0.252	0.459	0.461	0.945	0.875	0.229	0.540	0.055	0.126	0.772
Bombus ruderarius	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus ruderatus	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus rupestris	0.050	0.519	0.088	0.551	0.025	0.260	0.044	0.275	0.975	0.742	0.956	0.726
Bombus semenoviellus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus sichelii	0.709	0.408	0.042	0.719	0.355	0.204	0.979	0.360	0.647	0.797	0.021	0.642
Bombus soroeensis	0.083	0.244	0.651	0.745	0.042	0.878	0.326	0.629	0.959	0.122	0.676	0.373
Bombus sporadicus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus subterraneus	0.310	0.049	0.027	0.979	0.846	0.975	0.986	0.512	0.155	0.025	0.014	0.490
Bombus sylvarum	0.457	0.273	0.015	0.008*	0.228	0.137	0.007*	0.004*	0.773	0.864	0.993	0.996
Bombus sylvestris	<0.001*	0.897	0.605	0.240	<0.001*	0.553	0.699	0.881	>0.999	0.449	0.302	0.120
Bombus terrestris	0.624	0.054	0.161	0.537	0.689	0.973	0.920	0.733	0.312	0.027	0.081	0.269
Bombus vestalis	0.444	0.004*	0.006*	0.412	0.222	0.002*	0.003*	0.206	0.779	0.998	0.997	0.795
Bombus veteranus	0.016*	0.457	<0.001*	<0.001*	0.008*	0.228	<0.001*	<0.001*	0.992	0.773	>0.999	>0.999
Proportion of significant difference	**13/34**	**9/34**	**7/34**	**12/34**	**10/34**	**9/34**	**7/34**	**10/34**	**5/34**	**1/34**	**1/34**	**3/34**

Supplementary Table S1 (part 2/3, for the periods 1940-1959 and 1960-1979). Results of the one-sided and two-sided Wilcoxon-Mann-Whitney tests conducted to assess whether Boyce index differences were significantly greater/less than or different from zero for each period. The Boyce Index (BI) is a presence-only predictive performance metric used in the present study to test whether historical climate conditions improved the predictive performance of our species-specific ecological niche models for observed bumblebee occurrences relative to the counterfactual climatic scenario. BI differences between the historical and counterfactual scenarios were computed for each species, with positive values indicating better predictions of occurrence data under historical climate data, and negative values, better predictions of occurrences under a counterfactual scenario. In this table, we report the p-values of the one-sided and two-sided Wilcoxon-Mann-Whitney tests conducted to assess whether BI differences were significantly greater/less than or different from zero for each period. To correct for multiple testing, a Benjamini-Hochberg procedure was applied, and p-values corresponding to significant differences are marked by an asterisk.

1940-1959	Wilcoxon-Mann-Whitney test p-values for BI *different from* zero				Wilcoxon-Mann-Whitney test p-values for BI *greater* than zero				Wilcoxon-Mann-Whitney test p-values for BI *less* than zero			
	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5
Bombus alpinus	0.101	0.743	0.771	<0.001*	0.051	0.630	0.386	>0.999	0.950	0.371	0.616	<0.001*
Bombus argillaceus	<0.001*	0.488	0.001*	0.719	<0.001*	0.757	<0.001*	0.360	>0.999	0.244	>0.999	0.642
Bombus balteatus	0.537	0.974	0.461	0.099	0.733	0.514	0.230	0.049	0.269	0.487	0.771	0.951
Bombus barbutellus	0.544	0.916	0.252	0.732	0.272	0.458	0.126	0.366	0.729	0.543	0.875	0.635
Bombus bohemicus	0.001*	0.036	0.003*	0.106	0.001*	0.982	0.002*	0.948	>0.999	0.018	0.998	0.053
Bombus campestris	0.014*	0.038	<0.001*	<0.001*	0.993	0.019	<0.001*	<0.001*	0.007*	0.981	>0.999	>0.999
Bombus cingulatus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus confusus	<0.001*	0.544	0.001*	0.012*	<0.001*	0.272	<0.001*	0.006*	>0.999	0.729	>0.999	0.994
Bombus consobrinus	0.378	0.115	<0.001*	0.119	0.812	0.943	>0.999	0.941	0.189	0.057	<0.001*	0.059
Bombus cryptarum	<0.001*	0.026	0.025*	0.006*	>0.999	0.987	0.987	0.997	<0.001*	0.013	0.013	0.003*
Bombus distinguendus	0.252	0.725	0.900	0.035	0.875	0.362	0.450	0.983	0.126	0.639	0.551	0.018*
Bombus flavidus	0.539	0.933	0.186	0.033	0.731	0.535	0.907	0.984	0.270	0.466	0.093	0.017*
Bombus gerstaeckeri	-	-	-	-	-	-	-	-	-	-	-	-
Bombus hortorum	0.235	<0.001*	0.172	0.046	0.883	<0.001*	0.086	0.023	0.117	>0.999	0.915	0.977
Bombus humilis	<0.001*	0.032	<0.001*	0.231	<0.001*	0.016	<0.001*	0.115	>0.999	0.984	>0.999	0.885
Bombus hyperboreus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus hypnorum	0.444	0.070	0.098	0.013*	0.779	0.035	0.951	0.994	0.222	0.965	0.049	0.006*
Bombus jonellus	<0.001*	0.455	<0.001*	<0.001*	>0.999	0.774	>0.999	>0.999	<0.001*	0.227	<0.001*	<0.001*
Bombus lapidarius	<0.001*	0.001*	<0.001*	<0.001*	>0.999	<0.001*	>0.999	>0.999	<0.001*	>0.999	<0.001*	<0.001*
Bombus lapponicus	0.369	0.461	0.360	0.387	0.817	0.771	0.180	0.194	0.184	0.230	0.821	0.807
Bombus lucorum	0.340	0.977	0.016*	0.843	0.831	0.488	0.008*	0.580	0.170	0.513	0.992	0.422
Bombus mastrucatus	0.387	0.238	0.020*	0.014*	0.194	0.882	0.010*	0.993	0.807	0.119	0.990	0.007*
Bombus mendax	0.166	0.517	0.033	0.756	0.083	0.743	0.016*	0.623	0.917	0.258	0.984	0.378
Bombus mesomelas	0.072	0.041	0.003*	0.112	0.964	0.020	0.998	0.944	0.036	0.980	0.002*	0.056
Bombus monticola	<0.001*	0.030	0.231	0.535	<0.001*	0.015	0.115	0.267	>0.999	0.985	0.885	0.734
Bombus mucidus	0.002*	0.501	<0.001*	<0.001*	0.999	0.750	<0.001*	<0.001*	0.001*	0.251	>0.999	>0.999
Bombus muscorum	0.865	<0.001*	0.593	0.347	0.432	>0.999	0.296	0.827	0.569	<0.001*	0.705	0.174
Bombus norvegicus	<0.001*	0.922	0.001*	0.214	<0.001*	0.461	0.001*	0.107	>0.999	0.540	0.999	0.894
Bombus pascuorum	<0.001*	<0.001*	0.283	0.028*	>0.999	<0.001*	0.859	0.986	<0.001*	>0.999	0.141	0.014*
Bombus pomorum	<0.001*	0.295	0.200	0.001*	<0.001*	0.853	0.100	0.001*	>0.999	0.148	0.900	0.999
Bombus pratorum	0.254	0.001*	0.008*	0.887	0.874	0.001*	0.004*	0.558	0.127	0.999	0.996	0.443
Bombus pyrenaeus	0.020*	0.071	0.003*	0.001*	0.990	0.036	0.998	>0.999	0.010	0.965	0.002*	0.001*
Bombus pyrrhopygus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus quadricolor	0.208	0.093	0.011*	0.681	0.897	0.954	0.006*	0.661	0.104	0.047	0.994	0.341
Bombus ruderarius	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus ruderatus	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus rupestris	<0.001*	0.231	0.223	<0.001*	<0.001*	0.885	0.111	<0.001*	>0.999	0.115	0.889	>0.999
Bombus semenoviellus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus sichelii	0.876	0.506	0.004*	0.004*	0.438	0.748	0.998	0.998	0.564	0.253	0.002*	0.002*
Bombus soroeensis	0.841	<0.001*	0.195	0.008*	0.420	>0.999	0.903	0.996	0.581	<0.001*	0.098	0.004*
Bombus sporadicus	0.005*	0.059	0.058	<0.001*	0.997	0.971	0.971	>0.999	0.003*	0.029	0.029	<0.001*
Bombus subterraneus	0.010*	0.508	0.008*	0.019*	0.005*	0.747	0.996	0.991	0.995	0.254	0.004*	0.009*
Bombus sylvarum	0.002*	0.039	<0.001*	<0.001*	0.001*	0.981	<0.001*	<0.001*	0.999	0.020	>0.999	>0.999
Bombus sylvestris	0.058	0.022	0.306	<0.001*	0.029	0.989	0.848	<0.001*	0.971	0.011	0.153	>0.999
Bombus terrestris	0.004*	0.203	0.681	0.023*	0.002*	0.899	0.341	0.988	0.998	0.101	0.661	0.012*
Bombus vestalis	<0.001*	0.009*	<0.001*	<0.001*	<0.001*	0.004*	<0.001*	<0.001*	>0.999	0.996	>0.999	>0.999
Bombus veteranus	<0.001*	0.012	<0.001*	0.001*	<0.001*	0.006*	<0.001*	<0.001*	>0.999	0.994	>0.999	>0.999
Proportion of significant difference	**23/42**	**9/42**	**24/42**	**24/42**	**15/42**	**8/42**	**17/42**	**11/42**	**7/42**	**2/42**	**7/42**	**15/42**

1960-1979	Wilcoxon-Mann-Whitney test p-values for BI *different from* zero				Wilcoxon-Mann-Whitney test p-values for BI *greater* than zero				Wilcoxon-Mann-Whitney test p-values for BI *less* than zero			
	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5
Bombus alpinus	0.158	0.275	0.132	0.031	0.921	0.863	0.066	0.015*	0.079	0.137	0.935	0.985
Bombus argillaceus	0.001*	0.135	0.704	0.795	0.001*	0.933	0.352	0.604	0.999	0.068	0.649	0.398
Bombus balteatus	0.591	0.005*	<0.001*	0.026	0.706	0.003*	>0.999	0.987	0.295	0.997	<0.001*	0.013
Bombus barbutellus	<0.001*	0.003*	0.013*	0.305	<0.001*	0.002*	0.006*	0.152	>0.999	0.998	0.994	0.848
Bombus bohemicus	<0.001*	0.109	0.005*	0.104	>0.999	0.946	0.997	0.948	<0.001*	0.055	0.003*	0.052
Bombus campestris	<0.001*	0.094	0.263	<0.001*	<0.001*	0.047	0.132	<0.001*	>0.999	0.953	0.869	>0.999
Bombus cingulatus	0.727	0.027	<0.001*	0.116	0.638	0.013*	<0.001*	0.943	0.364	0.987	>0.999	0.058
Bombus confusus	<0.001*	0.058	<0.001*	<0.001*	<0.001*	0.029	<0.001*	<0.001*	>0.999	0.971	>0.999	>0.999
Bombus consobrinus	0.461	0.153	0.001*	0.495	0.771	0.924	>0.999	0.247	0.230	0.077	<0.001*	0.754
Bombus cryptarum	<0.001*	0.034	0.727	0.171	>0.999	0.983	0.364	0.915	<0.001*	0.017	0.638	0.085
Bombus distinguendus	0.696	0.007*	0.047	0.426	0.348	0.003*	0.024	0.788	0.653	0.997	0.976	0.213
Bombus flavidus	0.919	0.147	0.117	0.467	0.542	0.074	0.942	0.768	0.460	0.927	0.059	0.234
Bombus gerstaeckeri	-	-	-	-	-	-	-	-	-	-	-	-
Bombus hortorum	<0.001*	<0.001*	0.003*	0.679	>0.999	>0.999	0.999	0.339	<0.001*	<0.001*	0.001*	0.662
Bombus humilis	<0.001*	0.737	0.001*	0.064	<0.001*	0.369	<0.001*	0.032	>0.999	0.633	>0.999	0.968
Bombus hyperboreus	<0.001*	0.003*	0.521	0.003*	>0.999	0.999	0.740	0.999	<0.001*	0.001*	0.261	0.001*
Bombus hypnorum	<0.001*	0.389	0.275	0.370	<0.001*	0.195	0.137	0.816	>0.999	0.806	0.863	0.185
Bombus jonellus	<0.001*	0.004*	<0.001*	0.583	<0.001*	0.998	<0.001*	0.292	>0.999	0.002*	>0.999	0.709
Bombus lapidarius	<0.001*	<0.001*	<0.001*	0.002*	>0.999	>0.999	>0.999	0.999	<0.001*	<0.001*	<0.001*	0.001*
Bombus lapponicus	0.115	0.166	0.627	0.486	0.943	0.083	0.688	0.758	0.057	0.917	0.313	0.243
Bombus lucorum	0.027*	0.526	<0.001*	0.004*	0.987	0.738	>0.999	0.998	0.013	0.263	<0.001*	0.002*
Bombus mastrucatus	0.012*	0.032	0.041	0.283	0.006*	0.984	0.980	0.859	0.994	0.016	0.020	0.141
Bombus mendax	0.884	0.018*	0.133	0.735	0.559	0.009*	0.067	0.367	0.442	0.991	0.934	0.634
Bombus mesomelas	<0.001*	0.428	0.021*	0.053	<0.001*	0.787	0.990	0.026	>0.999	0.214	0.010*	0.974
Bombus monticola	<0.001*	<0.001*	<0.001*	0.005*	<0.001*	<0.001*	<0.001*	0.002*	>0.999	>0.999	>0.999	0.998
Bombus mucidus	0.025*	0.537	<0.001*	<0.001*	0.013*	0.733	<0.001*	<0.001*	0.988	0.269	>0.999	>0.999
Bombus muscorum	<0.001*	0.303	<0.001*	<0.001*	<0.001*	0.152	<0.001*	<0.001*	>0.999	0.849	>0.999	>0.999
Bombus norvegicus	0.121	0.042	0.434	0.785	0.060	0.979	0.217	0.392	0.940	0.021	0.784	0.609
Bombus pascuorum	0.782	0.064	0.012*	0.785	0.391	0.968	0.994	0.609	0.610	0.032	0.006*	0.392
Bombus pomorum	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus pratorum	0.228	<0.001*	0.694	0.001*	0.114	<0.001*	0.654	<0.001*	0.887	>0.999	0.347	>0.999
Bombus pyrenaeus	0.595	0.002*	0.165	0.005*	0.298	0.001*	0.918	0.998	0.704	0.999	0.083	0.002*
Bombus pyrrhopygus	0.002*	<0.001*	0.013*	<0.001*	0.999	>0.999	0.994	>0.999	0.001*	<0.001*	0.007*	<0.001*
Bombus quadricolor	0.756	0.027	0.676	0.034	0.378	0.014*	0.663	0.983	0.623	0.986	0.338	0.017
Bombus ruderarius	<0.001*	0.598	0.007*	0.001*	<0.001*	0.299	0.003*	<0.001*	>0.999	0.702	0.997	>0.999
Bombus ruderatus	<0.001*	0.025	<0.001*	<0.001*	<0.001*	0.013*	<0.001*	<0.001*	>0.999	0.988	>0.999	>0.999
Bombus rupestris	<0.001*	0.014*	<0.001*	0.101	<0.001*	0.007*	<0.001*	0.050	>0.999	0.993	>0.999	0.950
Bombus semenoviellus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus sichelii	0.129	0.089	<0.001*	<0.001*	0.936	0.956	>0.999	>0.999	0.065	0.045	<0.001*	<0.001*
Bombus soroeensis	0.495	<0.001*	<0.001*	<0.001*	0.247	<0.001*	<0.001*	<0.001*	0.754	>0.999	>0.999	>0.999
Bombus sporadicus	0.033	0.979	0.001*	0.002*	0.983	0.490	>0.999	0.999	0.017	0.512	<0.001*	0.001*
Bombus subterraneus	0.063	0.382	<0.001*	<0.001*	0.032	0.191	<0.001*	<0.001*	0.969	0.810	>0.999	>0.999
Bombus sylvarum	<0.001*	0.914	0.315	0.019*	<0.001*	0.457	0.157	0.991	>0.999	0.544	0.844	0.009
Bombus sylvestris	<0.001*	<0.001*	0.014*	0.321	>0.999	<0.001*	0.993	0.840	<0.001*	>0.999	0.007*	0.161
Bombus terrestris	0.275	0.001*	<0.001*	0.517	0.863	>0.999	>0.999	0.743	0.137	<0.001*	<0.001*	0.258
Bombus vestalis	<0.001*	0.020*	<0.001*	<0.001*	<0.001*	0.010*	<0.001*	<0.001*	>0.999	0.990	>0.999	>0.999
Bombus veteranus	0.014*	0.333	<0.001*	<0.001*	0.007*	0.834	<0.001*	<0.001*	0.993	0.167	>0.999	>0.999
Proportion of significant difference	**27/45**	**18/45**	**29/45**	**21/45**	**19/45**	**15/45**	**16/45**	**14/45**	**7/45**	**6/45**	**13/45**	**7/45**

Supplementary Table S1 (part 3/3, for the periods 1980-1999 and 2000-2019). Results of the one-sided and two-sided Wilcoxon-Mann-Whitney tests conducted to assess whether Boyce index differences were significantly greater/less than or different from zero for each period. The Boyce Index (BI) is a presence-only predictive performance metric used in the present study to test whether historical climate conditions improved the predictive performance of our species-specific ecological niche models for observed bumblebee occurrences relative to the counterfactual climatic scenario. BI differences between the historical and counterfactual scenarios were computed for each species, with positive values indicating better predictions of occurrence data under historical climate data, and negative values, better predictions of occurrences under a counterfactual scenario. In this table, we report the p-values of the one-sided and two-sided Wilcoxon-Mann-Whitney tests conducted to assess whether BI differences were significantly greater/less than or different from zero for each period. To correct for multiple testing, a Benjamini-Hochberg procedure was applied, and p-values corresponding to significant differences are marked by an asterisk.

1980-1999	Wilcoxon-Mann-Whitney test p-values for BI *different from* zero				Wilcoxon-Mann-Whitney test p-values for BI *greater* than zero				Wilcoxon-Mann-Whitney test p-values for BI *less* than zero			
	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5
Bombus alpinus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus argillaceus	0.046	0.631	0.966	0.231	0.023*	0.316	0.483	0.115	0.977	0.685	0.519	0.885
Bombus balteatus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus barbutellus	0.006*	<0.001*	0.017*	<0.001*	0.003*	<0.001*	0.008*	<0.001*	0.997	>0.999	0.992	>0.999
Bombus bohemicus	<0.001*	<0.001*	0.906	0.018*	>0.999	>0.999	0.453	0.991	<0.001*	<0.001*	0.549	0.009*
Bombus campestris	<0.001*	0.897	<0.001*	<0.001*	<0.001*	0.449	<0.001*	<0.001*	>0.999	0.553	>0.999	>0.999
Bombus cingulatus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus confusus	<0.001*	0.099	<0.001*	<0.001*	<0.001*	0.049	<0.001*	<0.001*	>0.999	0.951	>0.999	>0.999
Bombus consobrinus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus cryptarum	0.761	<0.001*	0.990	0.085	0.380	>0.999	0.506	0.958	0.621	<0.001*	0.495	0.042
Bombus distinguendus	0.654	<0.001*	0.916	<0.001*	0.674	>0.999	0.543	>0.999	0.327	<0.001*	0.458	<0.001*
Bombus flavidus	0.224	0.228	0.025*	0.356	0.889	0.887	0.988	0.178	0.112	0.114	0.012	0.823
Bombus gerstaeckeri	0.156	0.094	0.588	<0.001*	0.922	0.953	0.294	>0.999	0.078	0.047	0.707	<0.001*
Bombus hortorum	<0.001*	0.011*	0.157	0.010*	>0.999	0.006*	0.922	0.005*	<0.001*	0.995	0.079	0.995
Bombus humilis	0.250	0.132	0.048	0.478	0.876	0.066	0.024*	0.762	0.125	0.935	0.976	0.239
Bombus hyperboreus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus hypnorum	0.185	<0.001*	0.050	<0.001*	0.908	>0.999	0.975	>0.999	0.093	<0.001*	0.025	<0.001*
Bombus jonellus	<0.001*	0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999	<0.001*	<0.001*	<0.001*	<0.001*
Bombus lapidarius	<0.001*	0.037	<0.001*	<0.001*	>0.999	0.982	>0.999	>0.999	<0.001*	0.018	<0.001*	<0.001*
Bombus lapponicus	0.595	0.140	<0.001*	0.235	0.704	0.931	<0.001*	0.117	0.298	0.070	>0.999	0.883
Bombus lucorum	0.008*	0.020*	0.052	<0.001*	0.996	0.010*	0.026*	<0.001*	0.004*	0.990	0.974	>0.999
Bombus mastrucatus	0.174	0.001*	<0.001*	0.539	0.914	<0.001*	<0.001*	0.731	0.087	>0.999	>0.999	0.270
Bombus mendax	0.001*	0.131	0.172	<0.001*	<0.001*	0.065	0.915	<0.001*	>0.999	0.935	0.086	>0.999
Bombus mesomelas	<0.001*	0.889	<0.001*	<0.001*	<0.001*	0.557	<0.001*	<0.001*	>0.999	0.445	>0.999	>0.999
Bombus monticola	0.651	0.008*	0.041	<0.001*	0.676	0.004*	0.020*	<0.001*	0.326	0.996	0.980	>0.999
Bombus mucidus	<0.001*	0.031*	0.001*	0.878	<0.001*	0.985	<0.001*	0.439	>0.999	0.015*	>0.999	0.562
Bombus muscorum	0.014*	<0.001*	0.184	<0.001*	0.993	>0.999	0.092	>0.999	0.007*	<0.001*	0.909	<0.001*
Bombus norvegicus	<0.001*	0.008*	<0.001*	<0.001*	<0.001*	0.996	<0.001*	<0.001*	>0.999	0.004*	>0.999	>0.999
Bombus pascuorum	<0.001*	0.004*	<0.001*	<0.001*	>0.999	0.998	<0.001*	>0.999	<0.001*	0.002*	>0.999	<0.001*
Bombus pomorum	<0.001*	0.019*	<0.001*	<0.001*	<0.001*	0.991	<0.001*	<0.001*	>0.999	0.010*	>0.999	>0.999
Bombus pratorum	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus pyrenaeus	0.646	0.524	0.015*	0.378	0.678	0.739	0.993	0.812	0.323	0.262	0.007*	0.189
Bombus pyrrhopygus	-	-	-	-	-	-	-	-	-	-	-	-
Bombus quadricolor	0.036	0.087	<0.001*	0.001*	0.018*	0.957	<0.001*	<0.001*	0.982	0.044	>0.999	>0.999
Bombus ruderarius	<0.001*	0.001*	<0.001*	<0.001*	<0.001*	0.001*	<0.001*	<0.001*	>0.999	0.999	>0.999	>0.999
Bombus ruderatus	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus rupestris	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus semenoviellus	<0.001*	0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus sichelii	0.005*	<0.001*	0.004*	<0.001*	0.002*	<0.001*	0.002*	<0.001*	0.998	>0.999	0.998	>0.999
Bombus soroeensis	0.001*	<0.001*	0.170	0.124	0.999	>0.999	0.085	0.938	0.001*	<0.001*	0.916	0.062
Bombus sporadicus	<0.001*	0.996	<0.001*	<0.001*	>0.999	0.498	>0.999	>0.999	<0.001*	0.503	<0.001*	<0.001*
Bombus subterraneus	0.087	0.002*	0.012*	0.008*	0.957	0.999	0.994	0.004*	0.044	0.001*	0.006*	0.996
Bombus sylvarum	<0.001*	<0.001*	0.006*	0.183	<0.001*	>0.999	0.997	0.909	>0.999	<0.001*	0.003*	0.091
Bombus sylvestris	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus terrestris	0.066	<0.001*	<0.001*	<0.001*	0.967	>0.999	>0.999	>0.999	0.033	<0.001*	<0.001*	<0.001*
Bombus vestalis	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus veteranus	0.003*	<0.001*	<0.001*	<0.001*	0.001*	<0.001*	<0.001*	<0.001*	0.999	>0.999	>0.999	>0.999
Proportion of significant difference	**27/41**	**28/41**	**28/41**	**31/41**	**20/41**	**14/41**	**23/41**	**21/41**	**9/41**	**14/41**	**7/41**	**10/41**

2000-2019	Wilcoxon-Mann-Whitney test p-values for BI *different from* zero				Wilcoxon-Mann-Whitney test p-values for BI *greater* than zero				Wilcoxon-Mann-Whitney test p-values for BI *less* than zero			
	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5	GSWP3-W5E5	20CRv3	20CRv3-ERA5	20CRv3-W5E5
Bombus alpinus	<0.001*	0.003*	<0.001*	0.020*	>0.999	0.999	>0.999	0.990	<0.001*	0.001*	<0.001*	0.010
Bombus argillaceus	<0.001*	0.273	<0.001*	<0.001*	<0.001*	0.864	<0.001*	<0.001*	>0.999	0.137	>0.999	>0.999
Bombus balteatus	0.003*	0.001*	0.968	0.006*	0.002*	>0.999	0.517	0.003*	0.998	<0.001*	0.484	0.997
Bombus barbutellus	0.269	0.015*	0.583	0.408	0.866	0.008*	0.709	0.204	0.134	0.992	0.292	0.797
Bombus bohemicus	<0.001*	0.054	<0.001*	<0.001*	<0.001*	0.027	<0.001*	<0.001*	>0.999	0.973	>0.999	>0.999
Bombus campestris	0.003*	<0.001*	<0.001*	<0.001*	0.002*	<0.001*	<0.001*	<0.001*	0.999	>0.999	>0.999	>0.999
Bombus cingulatus	<0.001*	<0.001*	<0.001*	0.008*	>0.999	>0.999	>0.999	0.996	<0.001*	<0.001*	<0.001*	0.004*
Bombus confusus	<0.001*	0.001*	<0.001*	<0.001*	<0.001*	0.001*	<0.001*	<0.001*	>0.999	0.999	>0.999	>0.999
Bombus consobrinus	0.078	<0.001*	<0.001*	0.024*	0.039	>0.999	>0.999	0.988	0.961	<0.001*	<0.001*	0.012
Bombus cryptarum	0.014*	<0.001*	0.816	0.008*	0.007*	>0.999	0.593	0.004*	0.993	<0.001*	0.408	0.996
Bombus distinguendus	<0.001*	0.138	0.013*	<0.001*	<0.001*	0.932	0.006*	<0.001*	>0.999	0.069	0.994	>0.999
Bombus flavidus	0.170	0.002*	0.369	0.036*	0.916	0.999	0.817	0.982	0.085	0.001*	0.184	0.018
Bombus gerstaeckeri	<0.001*	0.002*	0.001*	<0.001*	<0.001*	0.999	>0.999	<0.001*	>0.999	0.001*	<0.001*	>0.999
Bombus hortorum	0.038*	0.001*	0.949	0.903	0.981	0.001*	0.475	0.451	0.019	0.999	0.527	0.550
Bombus humilis	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus hyperboreus	0.117	<0.001*	<0.001*	<0.001*	0.942	>0.999	>0.999	>0.999	0.059	<0.001*	<0.001*	<0.001*
Bombus hypnorum	0.358	0.004*	0.053	0.399	0.822	0.002*	0.027*	0.199	0.179	0.998	0.974	0.802
Bombus jonellus	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999	<0.001*	<0.001*	<0.001*	<0.001*
Bombus lapidarius	0.854	0.629	0.024*	0.478	0.574	0.687	0.012*	0.239	0.427	0.315	0.988	0.762
Bombus lapponicus	0.047	<0.001*	<0.001*	<0.001*	0.023*	>0.999	>0.999	<0.001*	0.977	<0.001*	<0.001*	>0.999
Bombus lucorum	<0.001*	0.008*	0.054	<0.001*	>0.999	0.004*	0.973	>0.999	<0.001*	0.996	0.027	<0.001*
Bombus mastrucatus	<0.001*	0.664	0.111	0.201	<0.001*	0.332	0.945	0.900	>0.999	0.669	0.056	0.101
Bombus mendax	0.605	0.930	0.383	0.311	0.302	0.536	0.192	0.156	0.699	0.465	0.809	0.845
Bombus mesomelas	<0.001*	0.001*	0.011*	<0.001*	<0.001*	<0.001*	0.006*	<0.001*	>0.999	>0.999	0.994	>0.999
Bombus monticola	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus mucidus	<0.001*	0.085	0.004*	0.007*	<0.001*	0.043	0.002*	0.003*	>0.999	0.958	0.998	0.997
Bombus muscorum	<0.001*	0.015*	<0.001*	<0.001*	<0.001*	0.008*	<0.001*	<0.001*	>0.999	0.992	>0.999	>0.999
Bombus norvegicus	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus pascuorum	0.231	0.004*	0.955	0.686	0.885	0.998	0.524	0.343	0.115	0.002*	0.477	0.658
Bombus pomorum	<0.001*	0.344	0.001*	<0.001*	<0.001*	0.172	<0.001*	<0.001*	>0.999	0.829	>0.999	>0.999
Bombus pratorum	<0.001*	0.957	0.679	0.030*	>0.999	0.479	0.662	0.985	<0.001*	0.523	0.339	0.015
Bombus pyrenaeus	0.022*	0.028*	<0.001*	0.947	0.011*	0.014*	>0.999	0.473	0.989	0.986	<0.001*	0.528
Bombus pyrrhopygus	0.069	0.011*	<0.001*	0.737	0.035	0.995	>0.999	0.369	0.966	0.005*	<0.001*	0.633
Bombus quadricolor	0.478	0.351	0.510	0.032*	0.762	0.175	0.255	0.016*	0.239	0.826	0.746	0.984
Bombus ruderarius	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus ruderatus	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus rupestris	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus semenoviellus	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus sichelii	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus soroeensis	<0.001*	0.004*	<0.001*	0.001*	<0.001*	0.002*	<0.001*	<0.001*	>0.999	0.998	>0.999	>0.999
Bombus sporadicus	0.023*	0.123	<0.001*	0.800	0.012*	0.939	>0.999	0.400	0.988	0.062	<0.001*	0.601
Bombus subterraneus	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus sylvarum	<0.001*	0.430	<0.001*	<0.001*	<0.001*	0.786	<0.001*	<0.001*	>0.999	0.215	>0.999	>0.999
Bombus sylvestris	<0.001*	0.224	<0.001*	<0.001*	<0.001*	0.889	<0.001*	<0.001*	>0.999	0.112	>0.999	>0.999
Bombus terrestris	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus vestalis	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Bombus veteranus	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	>0.999	>0.999	>0.999	>0.999
Proportion of significant difference	**36/47**	**34/47**	**35/47**	**37/47**	**31/47**	**22/47**	**26/47**	**29/47**	**5/47**	**12/47**	**10/47**	**4/47**