

**Supplementary material**

Appendix 1. Geographic location of sampling sites, landscape and habitat variables used for analyses of habitat models, and sample sizes for three acoustic datasets used in the analyses. Asterisk \* indicates the site for which habitat survey was not performed by Amos et al (2012); this site was excluded from all analyses, but included in additional Mantel test. NA indicates sites from which data was not available (or not used).

Landscapes	TREE COVER	Sites	Latitude	Longitude	LARGE TREES	TREE HEIGHT	CANOPY	SHRUBS	Number of different elements per site	Number of songs analyzed per site	Number of element 'O' analyzed per site
Glenalbyn	17	Gl1	-36.556	143.763	4	23.4	20	15	5	7	11
		Gl1_2*	-36.5433	143.7701	NA	NA	NA	NA	7	NA	NA
Havelock	45	Ha5	-36.9991	143.8067	4	21.2	20	15	8	23	10
		Ha6	-36.9876	143.7695	0	15	20.6	5	NA	3	NA
Redcastle	75	Re1	-36.8014	144.8295	1	25.6	25	40	20	23	9
		Re3	-36.8074	144.7751	3	22.1	15	5	7	35	31
		Re4	-36.7856	144.8522	1.5	20.9	22.5	12.5	13	26	14
Shelbourne	12	Sh1	-36.7811	144.0797	0	18.5	20	15	12	10	5
		Sh3	-36.7778	144.0866	0	12	30	0	NA	3	1
Tunstalls	20	Tu2	-36.7677	143.5099	7	22.1	25	20	9	12	19
		Tu5	-36.754	143.5404	1	19.7	25	3	14	22	19
Wehla	11	We5	-36.5439	143.6105	3.5	18.5	20	13.5	8	12	9
		We6	-36.5891	143.5775	1	18.5	15	2	8	8	7
Overall		13 sites							60 elements	184 songs	135 'O' elements

Appendix 2. Results of Mantel and Partial Mantel tests of testing whether pairwise per-site repertoire dissimilarities can be explained by landscape acoustic models (site GL1\_2 excluded). Isolation-by-distance (IBD) was modelled as straight geographic distances [IBD(GEOG)], logarithm of straight geographic distances [IBD (logGEOG)] and as equal resistances in Circuitscape [IBD (CS.NULL)]. Isolation-by-resistance models are ISF, the model of increased song flow through treeless areas (an equivalent of TREE\_1\_0.5 of Amos et al. 2012, 2014), and RSF, the model of reduced song flow through treeless areas (an equivalent of TREE\_1\_2 of Amos et al. 2012, 2014).

Landscape model	Marginal test		Partial test: IBD (CS.NULL) after fitting landscape model		Partial test: landscape model after fitting IBD (CS.NULL)	
	Mantel r	p-value	Partial mantel r	p-value	Partial mantel r	p-value
IBD (GEOG)	0.391	<b>0.014</b>				
IBD (logGEOG)	0.450	<b>0.008</b>				
IBD (CS.NULL)	0.431	<b>0.011</b>				
ISF (TREE_1_0.5)	0.251	0.057	0.424	<b>0.007</b>	-0.236	0.932
RSF (TREE_1_2)	0.468	<b>0.006</b>	0.040	0.414	0.204	0.109

Appendix 3. Results of acoustic analyses of songs.

Date	Landscape code	Site	Phrases per song	Elements per song	Song length	Maximum frequency	Minimum frequency	Frequency bandwidth	Peak frequency	Number of different elements per song
17/10/2009	Gl	1	3	6	0.549	4000	1760	2240	2540	3
17/10/2009	Gl	1	9	31	2.388	4090	990	3100	2790	4
17/10/2009	Gl	1	4	12	0.757	3960	990	2970	2540	4
17/10/2009	Gl	1	3	14	0.709	3870	1110	2760	2580	3
17/10/2009	Gl	1	4	8	0.572	4990	1200	3790	2710	4
17/10/2009	Gl	1	5	13	1.634	5080	1110	3970	2750	4
16/09/2009	Ha	5	3	10	0.586	3480	940	2540	2360	3
16/09/2009	Ha	5	4	19	1.26	2970	940	2030	2230	4
16/09/2009	Ha	5	5	11	0.905	4600	860	3740	2360	4
18/09/2009	Ha	5	2	21	0.986	3100	990	2110	2360	2
18/09/2009	Ha	5	3	10	1.335	3440	990	2450	2060	3
18/09/2009	Ha	5	3	9	0.546	3140	990	2150	2450	3
19/09/2009	Ha	5	4	13	1.135	4260	1160	3100	2320	4
19/09/2009	Ha	5	3	8	0.47	3100	1160	1940	2230	3
19/09/2009	Ha	5	7	10	1.515	3570	940	2630	2450	3
19/09/2009	Ha	5	4	13	0.992	4600	1070	3530	2540	4
19/09/2009	Ha	5	8	16	1.785	3610	860	2750	2580	7
19/09/2009	Ha	5	5	15	1.32	3870	1160	2710	2230	4
19/09/2009	Ha	5	5	13	1.141	4390	940	3450	2230	5
5/10/2009	Re	1	4	7	0.545	3660	1160	2500	2580	6
5/10/2009	Re	1	6	15	1.324	4040	990	3050	2620	11
5/10/2009	Re	1	2	7	0.406	3740	1070	2670	2490	4
5/10/2009	Re	1	2	8	0.496	4000	1110	2890	2490	3
5/10/2009	Re	1	6	13	1.573	3700	940	2760	2880	9
5/10/2009	Re	1	3	6	0.615	3180	990	2190	2710	6
5/10/2009	Re	1	4	10	0.917	3910	860	3050	2580	6

5/10/2009	Re 1	3	13	1.135	4430	1030	3400	2710	3
5/10/2009	Re 1	3	8	0.598	4520	1200	3320	2840	4
5/10/2009	Re 1	3	7	0.894	3220	1070	2150	2670	6
5/10/2009	Re 1	2	6	0.441	3610	990	2620	2750	3
5/10/2009	Re 1	3	9	0.671	3960	770	3190	2880	5
5/10/2009	Re 1	3	10	0.772	3960	1110	2850	2670	3
5/10/2009	Re 3	4	10	1.17	4260	940	3320	2970	5
5/10/2009	Re 3	2	9	0.99	4780	1200	3580	2060	3
5/10/2009	Re 3	3	11	0.967	4650	1030	3620	2710	4
5/10/2009	Re 3	3	11	1.013	4520	1070	3450	2920	4
5/10/2009	Re 3	3	12	1.141	4730	1070	3660	2840	4
5/10/2009	Re 3	3	11	0.987	4600	940	3660	2360	4
5/10/2009	Re 3	3	12	1.057	4650	1070	3580	2360	4
5/10/2009	Re 3	3	11	0.899	4690	940	3750	2320	4
5/10/2009	Re 3	2	8	0.891	3870	1160	2710	2580	3
5/10/2009	Re 3	2	9	0.996	4900	1290	3610	2750	4
5/10/2009	Re 3	6	24	2.214	4520	730	3790	2970	6
5/10/2009	Re 3	2	15	1.611	4300	1240	3060	2970	4
5/10/2009	Re 3	2	10	0.749	3700	1110	2590	2790	5
5/10/2009	Re 3	3	9	0.799	3530	990	2540	2580	4
5/10/2009	Re 3	4	15	1.553	4430	900	3530	3180	6
5/10/2009	Re 3	8	27	2.925	4300	990	3310	3270	6
5/10/2009	Re 3	4	14	1.361	4260	940	3320	2880	6
5/10/2009	Re 3	5	29	5.442	4130	900	3230	2750	5
5/10/2009	Re 3	2	5	0.574	4390	1240	3150	2750	4
5/10/2009	Re 3	3	10	0.897	3740	860	2880	2710	5
5/10/2009	Re 3	2	10	1.045	4730	1200	3530	2920	4
5/10/2009	Re 3	2	8	0.83	4340	1240	3100	2620	4
5/10/2009	Re 3	2	11	1.184	4730	1290	3440	2840	4
5/10/2009	Re 3	2	10	1.231	4820	1420	3400	2710	4

5/10/2009	Re	3	3	7	0.653	3530	1070	2460	2450	5
5/10/2009	Re	3	2	7	0.598	3870	1110	2760	2670	4
5/10/2009	Re	3	2	6	0.824	3700	1240	2460	2580	4
5/10/2009	Re	3	3	8	0.755	4220	1110	3110	2540	5
5/10/2009	Re	3	2	10	1.208	4170	1200	2970	2840	4
5/10/2009	Re	3	3	11	1.135	4600	1030	3570	2790	5
5/10/2009	Re	3	2	7	0.763	4170	1240	2930	2620	4
6/10/2009	Re	3	2	8	0.865	4690	1240	3450	3010	4
8/10/2009	Re	3	3	16	1.437	4560	1290	3270	2540	4
9/10/2009	Re	4	3	6	0.636	3530	810	2720	2150	6
9/10/2009	Re	4	3	24	1.445	4130	1200	2930	2320	3
9/10/2009	Re	4	3	14	1.129	4040	1160	2880	2360	3
22/09/2009	Sh	1	2	4	0.366	3780	1070	2710	2450	3
22/09/2009	Sh	1	2	4	0.34	3700	1290	2410	2750	3
22/09/2009	Sh	1	2	4	0.343	3660	1240	2420	2670	3
23/09/2009	Sh	1	3	5	0.496	3740	1330	2410	1980	4
23/09/2009	Sh	1	8	11	1.599	3610	1200	2410	3140	5
23/09/2009	Sh	1	3	5	0.514	3700	1200	2500	2190	4
23/09/2009	Sh	1	2	3	0.331	3310	1290	2020	1930	3
26/09/2009	Sh	3	4	5	0.586	3400	1370	2030	2190	5
26/09/2009	Sh	3	4	5	0.616	3780	1370	2410	2190	5
26/09/2009	Sh	3	3	4	0.447	4260	1200	3060	2620	4
29/09/2009	Tu	2	9	21	2.319	4560	990	3570	2710	5
29/09/2009	Tu	2	6	8	1.051	4040	1070	2970	2790	5
29/09/2009	Tu	2	4	9	1.06	4520	1030	3490	2920	4
29/09/2009	Tu	2	5	6	0.633	4780	1550	3230	2670	5
21/09/2009	Tu	5	5	10	1.417	3740	1030	2710	2620	7
21/09/2009	Tu	5	3	8	1.269	3660	900	2760	2060	3
21/09/2009	Tu	5	6	14	1.881	4560	990	3570	2540	6
21/09/2009	Tu	5	6	14	1.646	4260	1070	3190	2150	6

21/09/2009	Tu	5	3	5	0.453	3740	1030	2710	2150	4
21/09/2009	Tu	5	3	5	0.505	3830	1500	2330	2710	4
21/09/2009	Tu	5	3	6	0.581	3570	1070	2500	2580	4
21/09/2009	Tu	5	3	6	0.578	3660	1160	2500	2580	4
21/09/2009	Tu	5	1	4	0.932	2620	860	1760	2150	1
21/09/2009	Tu	5	8	11	1.309	4170	1070	3100	2710	5
21/09/2009	Tu	5	5	6	0.601	4040	1070	2970	2060	4
21/09/2009	Tu	5	5	8	0.813	3910	1200	2710	2710	4
21/09/2009	Tu	5	6	17	2.342	4340	1160	3180	2620	5
21/09/2009	Tu	5	10	11	1.274	3870	1110	2760	2710	4
21/09/2009	Tu	5	4	10	1.059	4260	1110	3150	2150	5
21/09/2009	Tu	5	4	7	0.607	3740	1160	2580	2360	5
21/09/2009	Tu	5	4	7	0.958	3780	1110	2670	2320	5
21/09/2009	Tu	5	6	17	2.345	4390	1110	3280	2620	5
21/09/2009	Tu	5	10	11	1.274	3910	1110	2800	2710	4
21/09/2009	Tu	5	3	6	0.569	3870	1200	2670	2620	4
21/09/2009	Tu	5	3	6	0.575	3740	1240	2500	2620	4
21/09/2009	Tu	5	3	4	0.38	3960	1030	2930	2230	4
14/10/2009	We	5	5	8	1.155	4690	1110	3580	2190	4
14/10/2009	We	5	4	10	1.449	4260	680	3580	2190	4
14/10/2009	We	5	3	5	0.758	4220	990	3230	2020	3
14/10/2009	We	5	4	7	0.957	4090	1030	3060	2060	4
14/10/2009	We	5	3	5	0.595	3870	860	3010	2230	3
15/10/2009	We	5	3	6	0.566	4560	1200	3360	2410	3
15/10/2009	We	5	5	9	0.926	3740	900	2840	2450	5
16/10/2009	We	6	3	14	1.179	4300	900	3400	2880	3
16/10/2009	We	6	4	6	0.642	3870	1290	2580	3010	4
16/10/2009	We	6	4	9	0.787	4040	860	3180	2790	4
16/10/2009	We	6	6	21	1.544	3830	730	3100	2670	4
16/10/2009	We	6	3	7	0.581	4130	810	3320	2710	4

Appendix 4. Results of acoustic analyses of element 'O'

Landscape code	Site	O duration	Maximum frequency	Minimum frequency	Frequency bandwidth	Peak frequency	Number of O per song
Gl	1	0.325	4000	2580	1420	2840	4
Gl	1	0.026	3700	2670	1030	2790	1
Gl	1	0.043	3570	2490	1080	3010	1
Gl	1	0.122	3700	2410	1290	2790	2
Gl	1	0.198	4990	2970	2020	3010	3
Gl	1	0.215	4820	2790	2030	2970	3
Gl	1	0.517	4090	2540	1550	3100	6
Gl	1	0.871	5080	2920	2160	3350	4
Gl	1	0.304	4000	2540	1460	2880	2
Ha	5	0.215	4600	1980	2620	3050	3
Ha	5	0.519	4900	1800	3100	3140	5
Ha	5	0.209	3740	2840	900	3220	2
Ha	5	0.601	4260	2110	2150	3180	6
Ha	5	0.351	4600	2970	1630	3570	4
Ha	5	0.189	3610	1760	1850	2970	2
Ha	5	0.383	3780	2490	1290	3140	4
Ha	5	0.233	4390	2230	2160	3660	2
Ha	5	0.087	3700	2880	820	3050	2
Ha	5	0.035	3870	2970	900	3180	1
Re	1	0.029	3610	2750	860	3050	1
Re	1	0.156	3870	2620	1250	2880	2
Re	1	0.151	4040	2410	1630	2970	2
Re	1	0.032	3910	2670	1240	2790	1
Re	1	0.032	3740	2710	1030	3100	1
Re	1	0.566	4430	2190	2240	2710	5
Re	1	0.375	4260	2230	2030	2840	3
Re	1	0.168	4520	2230	2290	2840	2
Re	1	0.034	4170	2710	1460	3050	1
Re	3	0.285	4260	2410	1850	3180	1
Re	3	0.447	4780	2540	2240	2970	4
Re	3	0.293	4650	2450	2200	3100	3
Re	3	0.339	4520	2540	1980	3050	3
Re	3	0.487	4730	2150	2580	3180	4
Re	3	0.308	4600	2190	2410	2920	3
Re	3	0.412	4650	2230	2420	2970	4
Re	3	0.229	4690	2280	2410	3440	3
Re	3	0.032	3870	2670	1200	2790	1
Re	3	0.319	4900	2670	2230	3350	3
Re	3	0.851	4300	2320	1980	2970	9
Re	3	0.444	4000	2110	1890	2920	5
Re	3	0.374	4730	2670	2060	2920	4



Re	3	0.133	4340	2670	1670	3100	2
Re	3	0.508	4730	2580	2150	2880	5
Re	3	0.807	4820	2620	2200	2970	7
Re	3	0.04	3530	2670	860	2790	1
Re	3	0.351	3700	2580	1120	2920	3
Re	3	0.041	4220	2790	1430	3440	1
Re	3	0.775	4170	2540	1630	3050	7
Re	3	0.551	4600	2230	2370	3140	5
Re	3	0.267	4040	2320	1720	3010	3
Re	3	0.264	4690	2540	2150	3010	3
Re	3	0.804	4560	2790	1770	3140	8
Re	3	0.031	4390	2670	1720	3660	1
Re	3	0.287	4520	1930	2590	2970	4
Re	3	0.427	4430	2280	2150	3180	5
Re	3	0.322	4300	2230	2070	3270	4
Re	3	0.209	4260	2670	1590	2970	3
Re	3	0.032	4130	2840	1290	3910	1
Re	3	0.313	4040	2320	1720	2970	4
Re	4	0.302	4040	2150	1890	3350	3
Re	4	0.035	4090	2230	1860	2840	1
Re	4	0.508	4690	2450	2240	3050	5
Re	4	0.232	4600	2490	2110	3350	3
Re	4	0.235	4470	2450	2020	3180	3
Re	4	0.22	4470	2580	1890	3310	3
Re	4	0.372	4600	2620	1980	3350	4
Re	4	0.247	4430	2490	1940	4220	3
Re	4	0.348	4430	2540	1890	3220	4
Re	4	0.253	4650	2110	2540	3220	3
Re	4	0.313	4520	2450	2070	3180	4
Re	4	0.476	4560	2320	2240	3270	5
Re	4	0.032	4130	2540	1590	2840	1
Sh	1	0.314	4390	2880	1510	3610	4
Sh	1	0.131	3660	1290	2370	2620	2
Sh	1	0.127	3740	1800	1940	2750	2
Sh	1	0.131	3700	2110	1590	2450	2
Sh	1	0.436	4470	2880	1590	3050	4
Sh	1	0.035	4260	2540	1720	2840	1
Tu	2	0.035	4340	2190	2150	3440	1
Tu	2	0.491		2580		3010	5
Tu	2	0.679	4220	2060	2160	2840	7
Tu	2	0.03	4000	2450	1550	2670	1
Tu	2	0.032	3780	2280	1500	3480	1
Tu	2	0.168	3960	2230	1730	3010	2
Tu	2	0.029	3700	2360	1340	3050	1
Tu	2	0.625	4520	2230	2290	3050	5

Tu	2	0.212	4780	2620	2160	3220	3
Tu	2	0.142	4780	2490	2290	3480	2
Tu	2	0.229	4220	2320	1900	3010	3
Tu	2	0.159	3870	2150	1720	3100	2
Tu	2	0.79	4090	2410	1680	3270	7
Tu	2	0.148	4040	2710	1330	3010	2
Tu	2	0.592	4470	2710	1760	3140	6
Tu	2	0.041	4690	2710	1980	3220	1
Tu	2	0.041	4560	2580	1980	2920	1
Tu	2	0.29	4130	2540	1590	3270	3
Tu	2	0.131	3960	2360	1600	3350	2
Tu	5	0.032	3740	2710	1030	2840	1
Tu	5	0.22	4260	2360	1900	3050	3
Tu	5	0.035	3740	2710	1030	2880	1
Tu	5	0.122	4040	2750	1290	3480	2
Tu	5	0.368	3910	2020	1890	2620	4
Tu	5	0.23	3910	2320	1590	2880	2
Tu	5	0.032	3270	2360	910	2970	1
Tu	5	0.461	4260	2790	1470	3050	5
Tu	5	0.227	3910	2410	1500	2880	2
Tu	5	0.035	3270	2410	860	2970	1
Tu	5	0.099	3350	2540	810	2840	2
Tu	5	0.029	3610	2710	900	3050	1
Tu	5	0.125	3870	2360	1510	2920	2
Tu	5	0.377	4560	2280	2280	2920	5
Tu	5	0.403	3870	2580	1290	2920	5
Tu	5	0.551	4340	2490	1850	2880	7
Tu	5	0.13	3870	2110	1760	2840	2
Tu	5	0.552	4390	2490	1900	2880	7
Tu	5	0.127	3910	2110	1800	2840	2
We	5	0.032	3830	2580	1250	2920	1
We	5	0.29	4260	1890	2370	2710	3
We	5	0.029	3870	2410	1460	2750	1
We	5	0.441	4390	1890	2500	2750	4
We	5	0.029	3440	2620	820	2880	1
We	5	0.136	4300	2110	2190	2970	2
We	5	0.186	4690	2110	2580	2670	2
We	5	0.136	3960	2450	1510	2920	2
We	6	0.32	4300	2790	1510	3140	3
We	6	0.035	3870	2710	1160	3100	1
We	6	0.038	3830	2790	1040	3050	1
We	6	0.14	3870	2620	1250	2970	1
We	6	0.346	4040	2620	1420	2970	4
We	6	0.238	4130	2490	1640	3050	3
We	6	0.035	3700	2490	1210	2970	1

Appendix 5. Spearman correlation between acoustic parameters

	Valid	Spearman	t(N-2)	P-level
number of elements per song & song length	116	<b>0.84</b>	16.64	<i>0.000000</i>
number of elements per song & maximum frequency	116	0.36	4.13	<i>0.00007</i>
number of elements per song & minimum frequency	116	-0.36	-4.06	<i>0.00009</i>
number of elements per song & frequency bandwidth	116	0.46	5.6	<i>0.000000</i>
number of elements per song & peak frequency	116	0.23	3.1	<i>0.0025</i>
number of elements per song & dif. element per song	116	0.24	2.7	<i>0.009</i>
song length & maximum frequency	116	0.36	4.13	<i>0.00007</i>
song length & minimum frequency	116	-0.32	-3.58	<i>0.0005</i>
song length & frequency bandwidth	116	0.45	5.45	<i>0.000000</i>
song length & peak frequency	116	0.25	2.76	<i>0.007</i>
song length & dif. element per song	116	0.35	4.01	<i>0.0001</i>
maximum frequency & minimum frequency	116	0.12	1.33	0.19
maximum frequency & frequency bandwidth	116	<b>0.93</b>	<b>27.22</b>	<b><i>0.000000</i></b>
maximum frequency & peak frequency	116	0.31	3.44	<i>0.0008</i>
maximum frequency & dif. element per song	116	0.092261	0.99	0.32
minimum frequency & frequency bandwidth	116	-0.21	-2.27	<i>0.02</i>
minimum frequency & peak frequency	116	0.04	0.39	0.7
minimum frequency & dif. element per song	116	-0.190	-2.04	<i>0.04</i>
frequency bandwidth & peak frequency	116	0.29	3.28	<i>0.001</i>
frequency bandwidth & dif. element per song	116	0.16	1.78	0.08
peak frequency & dif. element per song	116	0.27	2.96	<i>0.004</i>

Appendix 6. Spearman correlation between habitat characteristics

	Valid	Spearman	t(N-2)	P-level
LARGE TREES & CANOPY	12	-0.30	-1.01	0.34
LARGE TREES & SHRUBS	12	0.5	1.82	0.098
LARGE TREES & TREE HEIGHT	12	0.56	2.16	0.056
LARGE TREES & TREE COVER	12	0.22	0.71	0.49
CANOPY & SHRUBS	12	-0.20	-0.65	0.53
CANOPY & TREE HEIGHT	12	-0.31	-1.04	0.33
CANOPY & TREE COVER	12	-0.03	-0.09	0.93
SHRUBS & TREE HEIGHT	12	<b>0.69</b>	<b>3.03</b>	<b>0.013</b>
SHRUBS & TREE COVER	12	0.37	1.24	0.24
TREE HEIGHT & TREE COVER	12	<b>0.77</b>	<b>3.88</b>	<b>0.003</b>

## Appendix 7. Variability of song characteristics per site

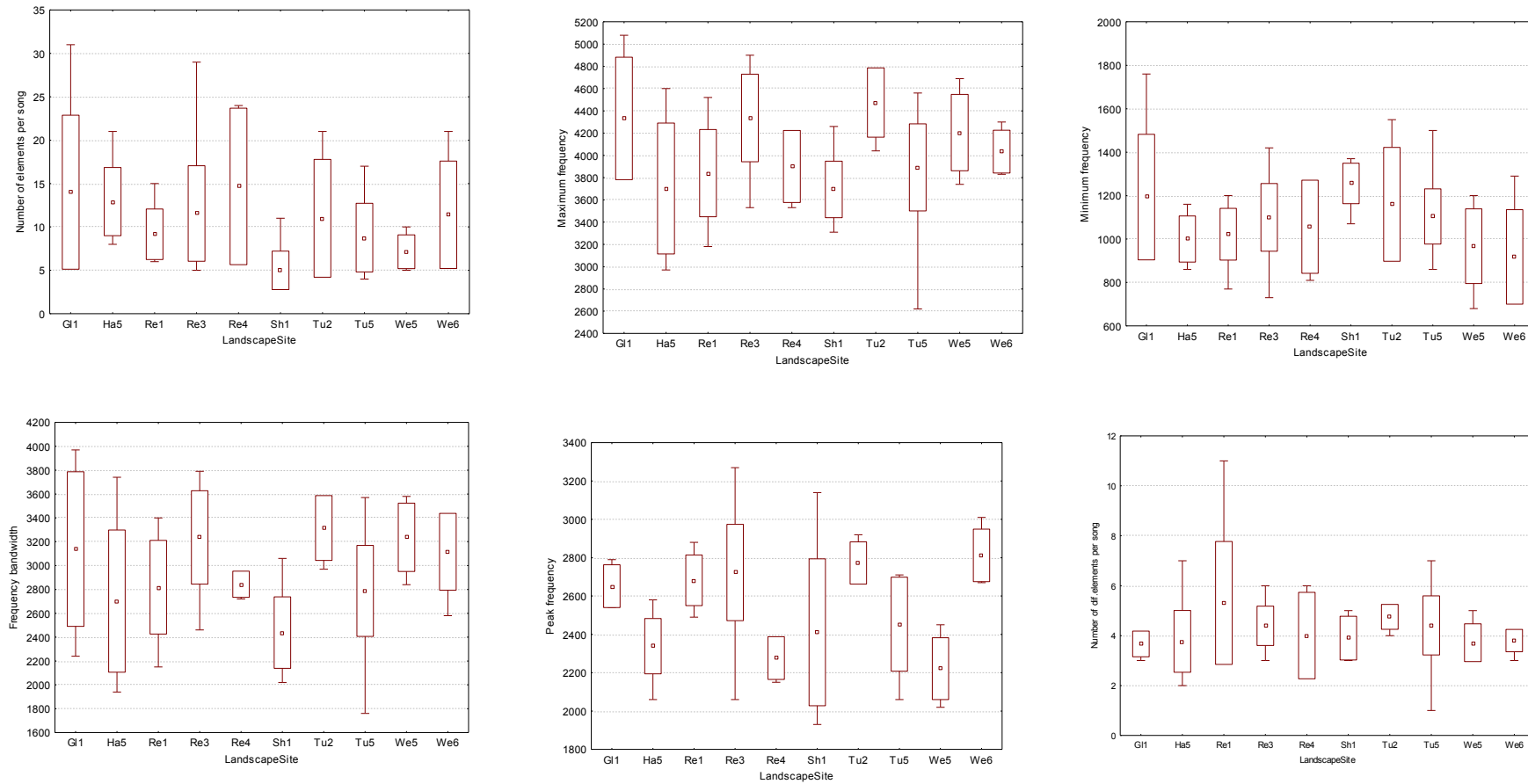


Fig. 1 . Variability in song characteristics per site, letters are the abbreviation of landscape, numeral is for site, point in the middle is mean, box- SD, whiskers- min-max

## Appendix 8. Variability of element "O" characteristics per site

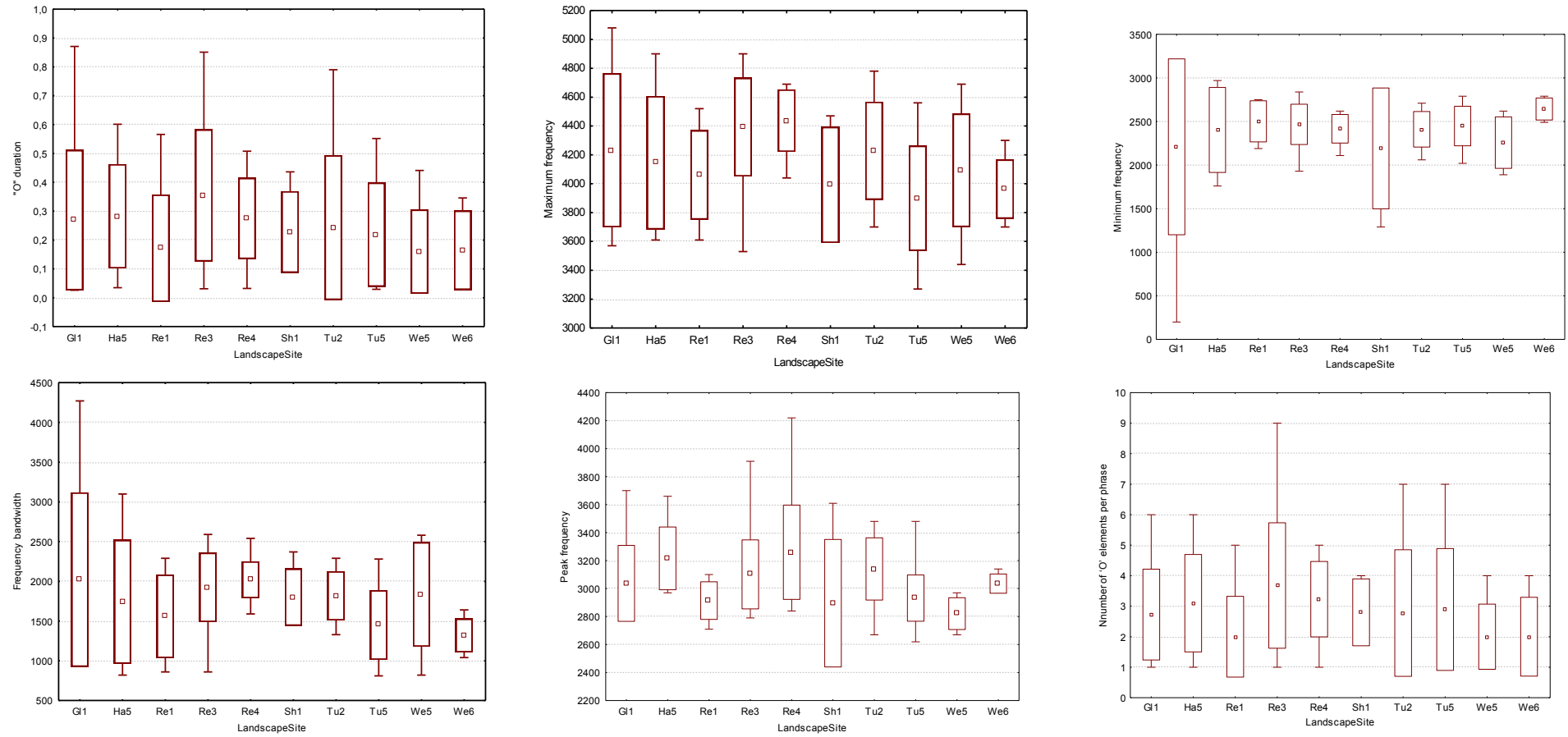


Fig. 1 . Variability in element "O" characteristics per site, letters are the abbreviation of landscape, numeral is for site, point in the middle is mean, box- SD, whiskers- min-max.