

Oikos

**OIK-07689**

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doi: 10.1111/oik.07689

Appendix 1

Figure S1

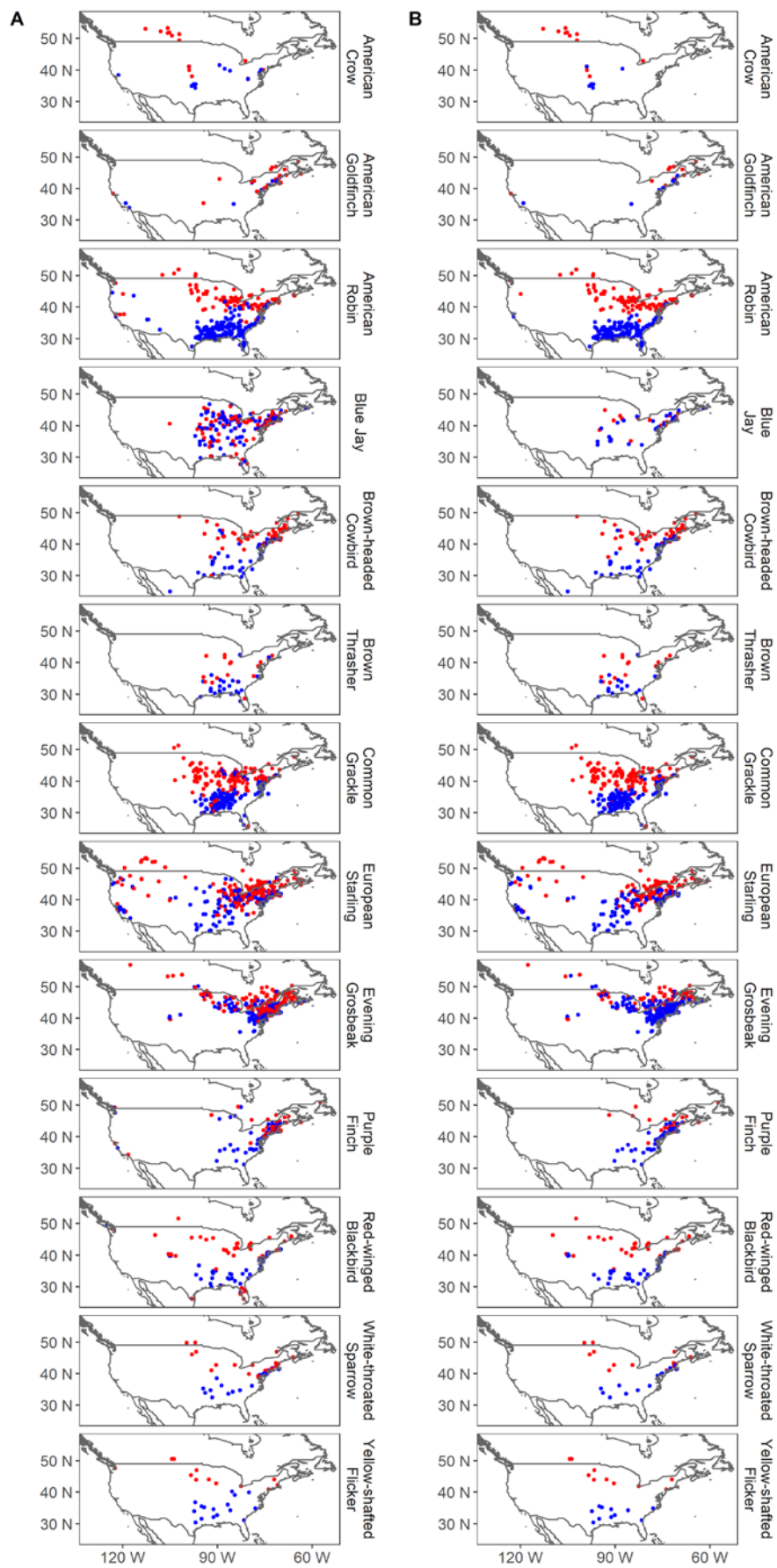


Figure S1: Comparison between the whole ringing dataset (A) and the final dataset (B) for the thirteen selected species.

Figure S2

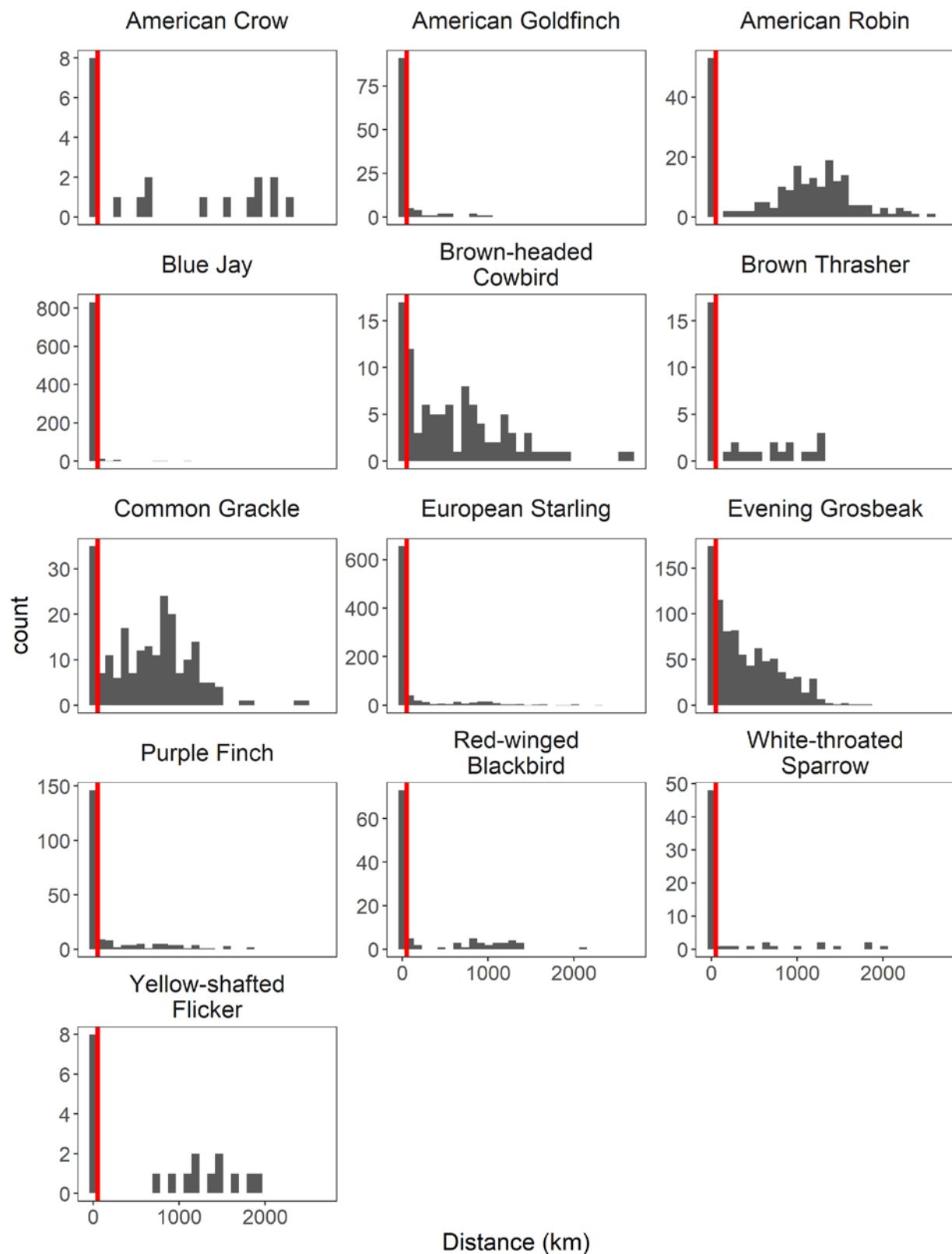


Figure S2: Distribution of distances between pairs of breeding and winter locations, for each species, across all records in the North American ringing scheme. Red line: 50km threshold chosen for excluding resident individuals. Resident individuals have a higher probability of being recaptured, hence the relative proportions of resident (<50km) versus migratory individuals in this figure is not necessarily representative of the distribution across all individuals of each species.

Figure S3

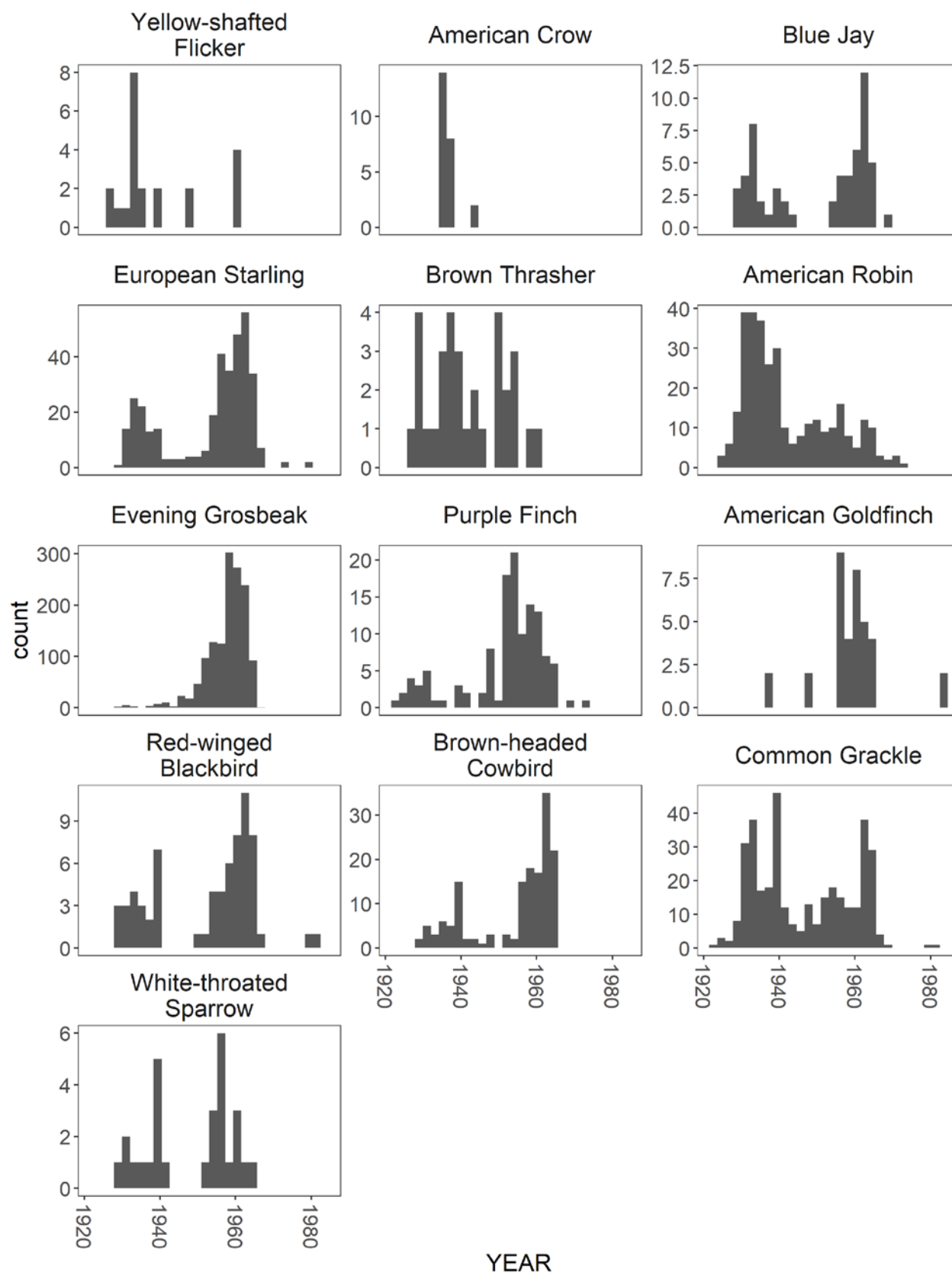
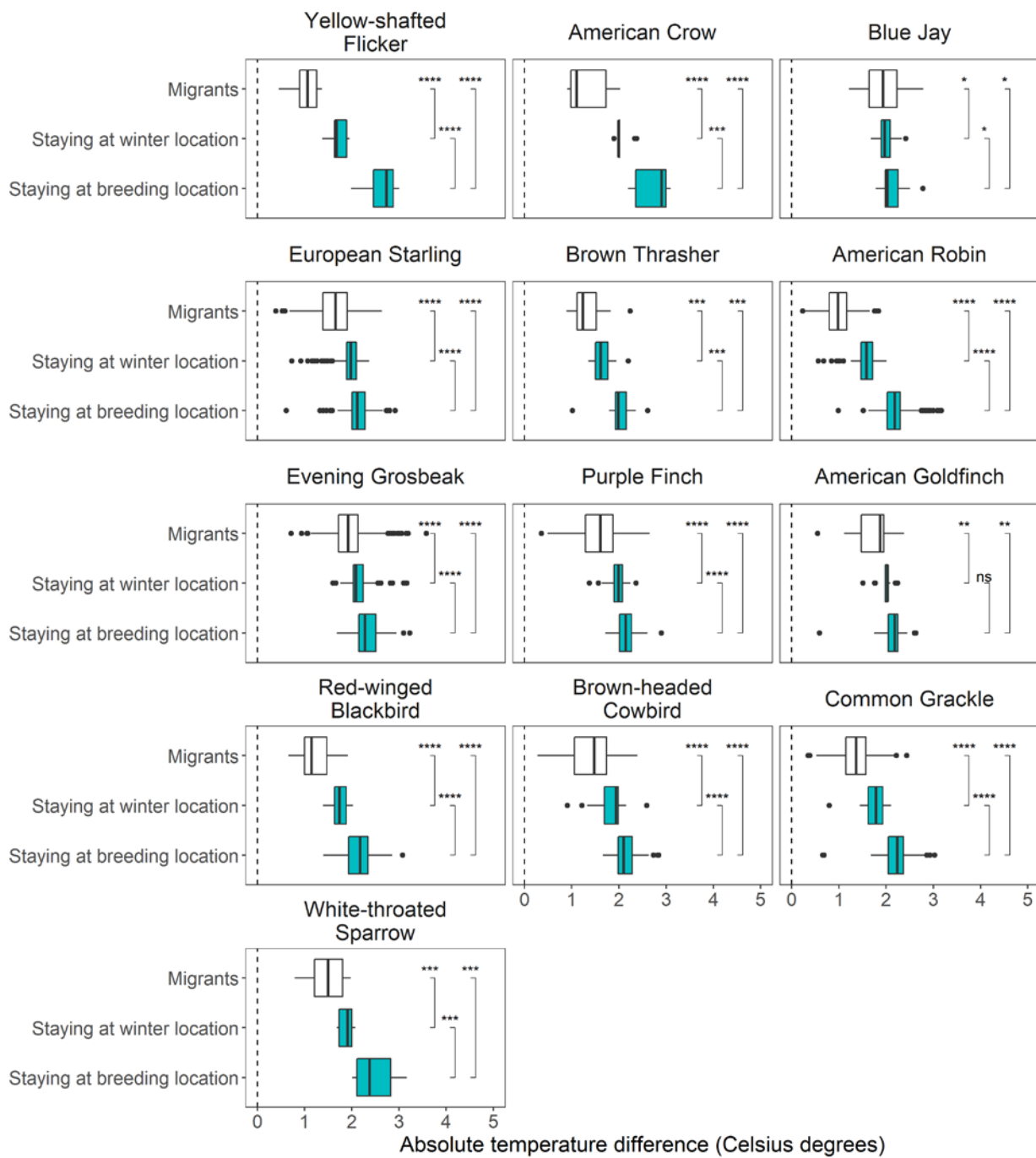


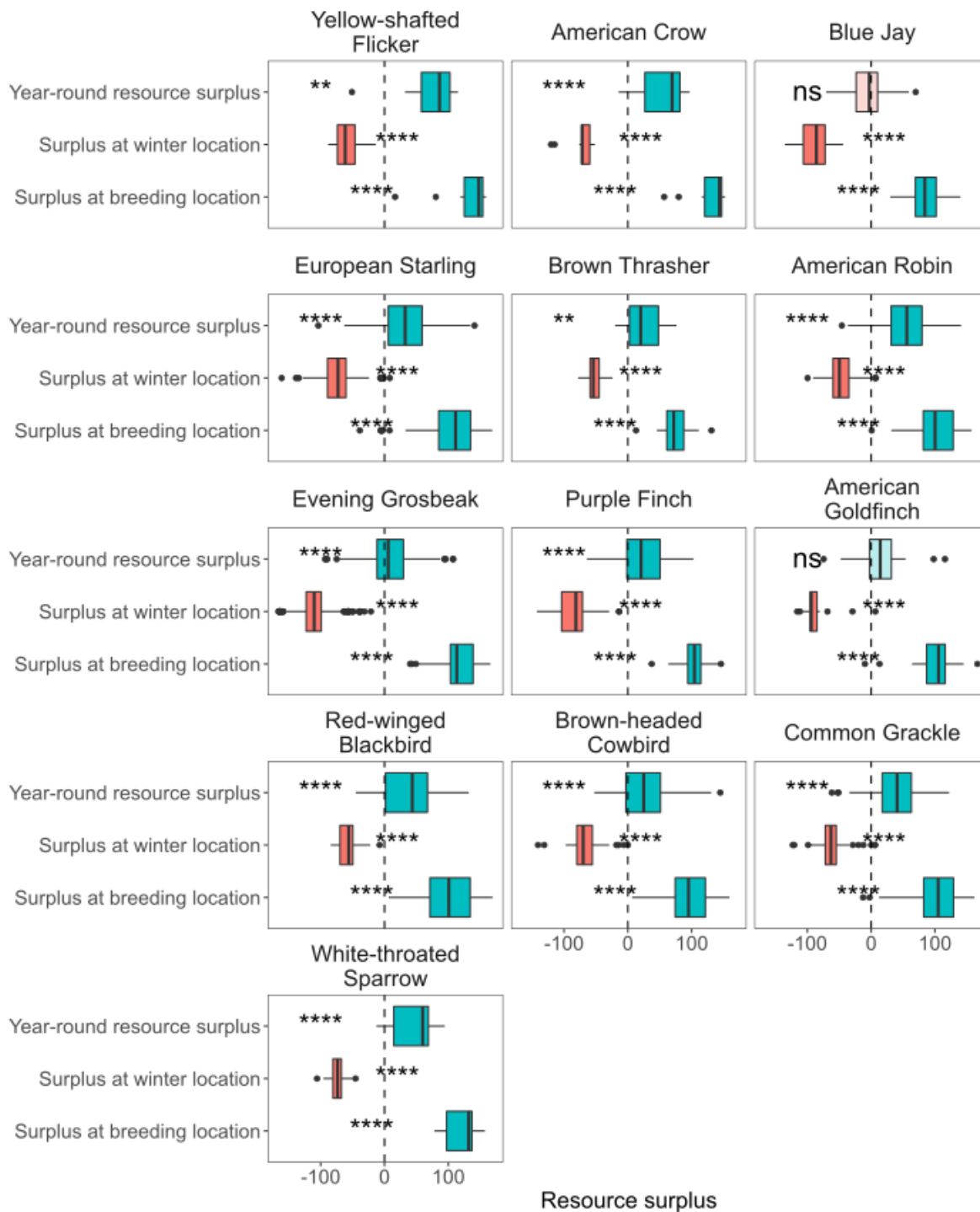
Figure S3: Distribution of ringing/recovery years, for each species, of individuals considered as ‘migratory’ (i.e. moving more than 50km between breeding and winter locations).

Figure S4



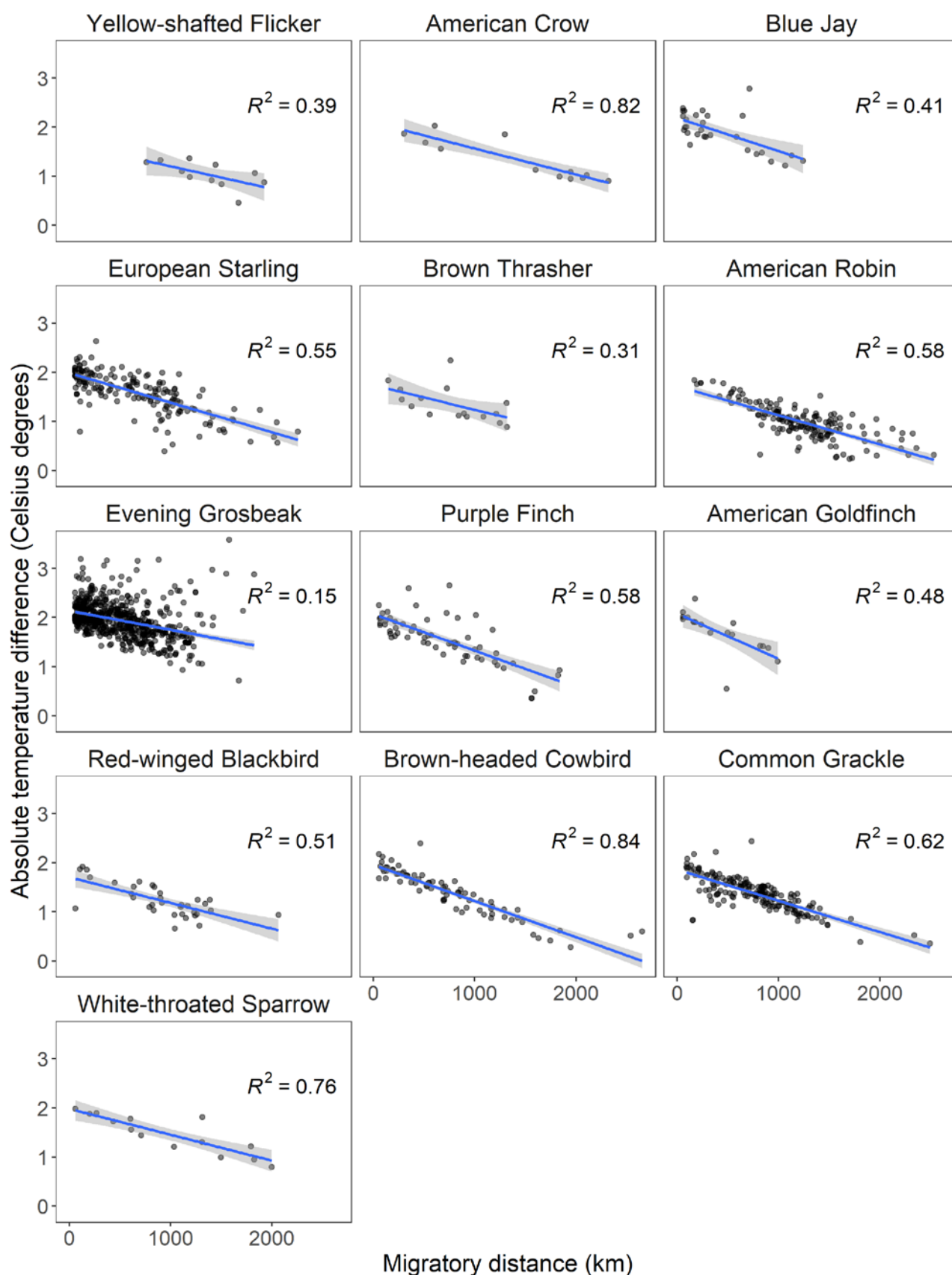
**Figure S4: Comparison between observed pairs of breeding and wintering locations and the resident behaviour equivalent in terms of niche tracking.** Temperature range (in °C) experienced by migrants measured as the difference between temperature in the breeding season and in winter, compared with the range they would have experienced if they had stayed all year at their winter location or at their breeding location. Indicated significance levels are for paired *t*-tests between each pair of conditions. Significance levels: “\*\*\*\*”: *p*-value < 0.0001, “\*\*\*”: *p*-value < 0.001, “\*\*”: *p*-value < 0.01, “\*”: *p*-value < 0.05, “ns”: *p*-value ≥ 0.05. Significance after sequential Bonferroni correction in Table 1. Colours as in Table 1 and Fig. 1.

Figure S5



**Figure S5: Year-round resource surplus per species, and its decomposition per season.** Resource surplus during the breeding season: NDVI experienced during the breeding season minus winter NDVI at the same breeding locations; resource surplus during winter: NDVI experienced during the winter minus breeding season NDVI at the same winter locations. Significance levels are for one-sample *t*-tests comparing the year-round resource surplus, or surplus at the breeding or winter location, with zero. Significance levels as in Fig. S4, colours as in Table 1 and Fig. 1.

Figure S6



**Figure S6: Relationship between migratory distance (in km) and temperature range (in Celsius degrees) between breeding and winter locations, across individuals, for each of the species analysed (data and fitted linear models).**

Figure S7

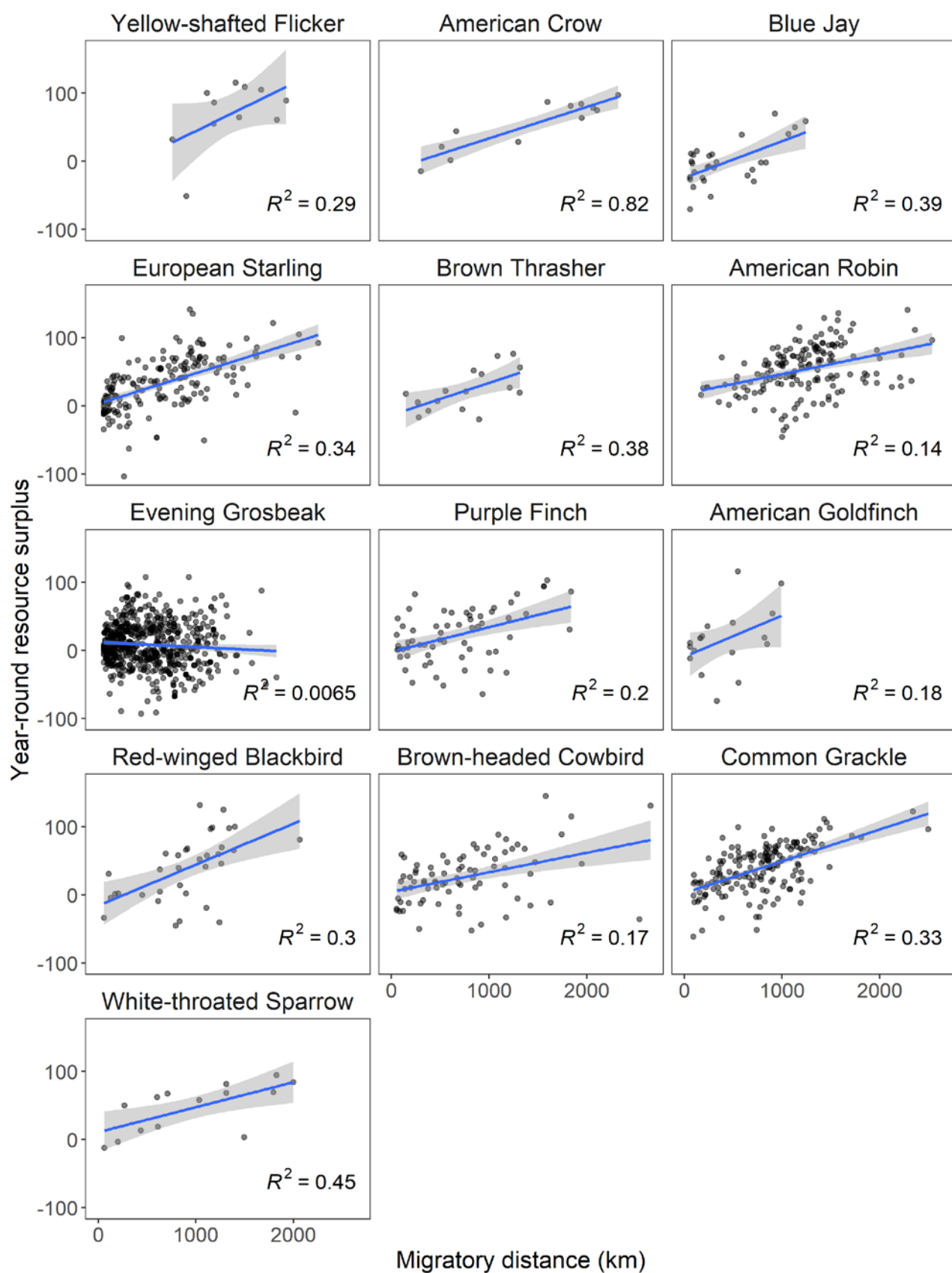
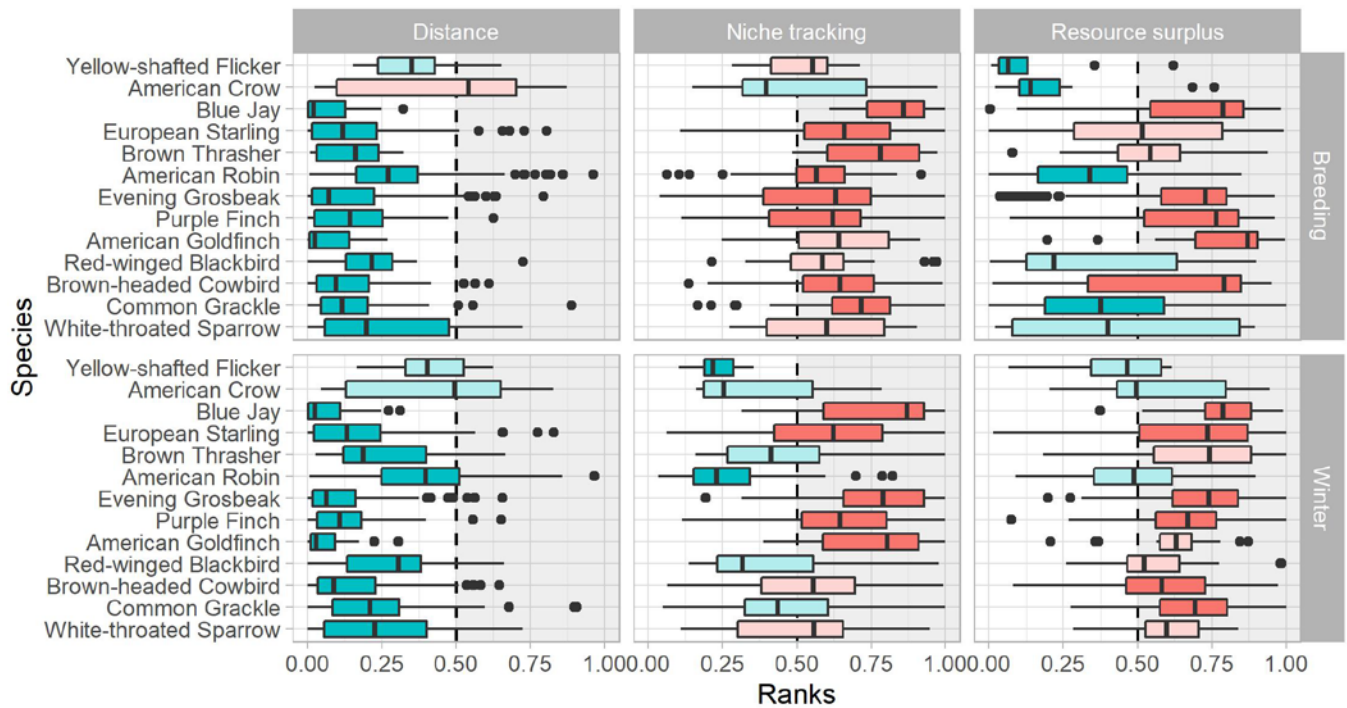


Figure S7: *Relationship between migratory distance (in km) and year-round resource surplus, across individuals, for each of the species analysed (data and fitted linear models).*



Figure S8



**Figure S8: Relative position of observed migratory destinations (pairs of breeding and wintering locations) for each species in relation to virtual alternatives (constrained to go no further than 2,654.6 km, the maximum distance travelled by any individual in the dataset), along three axes: migratory distance, niche tracking, and access to resources. In all cases, lower ranks indicate a higher degree of optimisation along the respective axis (for niche tracking: lower temperature differences between breeding and wintering location; for access to resources: lower resource deficit). Blue boxplots: median < 0.05 (individuals perform better along this axis than alternatives), pink boxplots: median > 0.05 (individuals perform worse than alternatives). Dark boxplots: ranks significantly different from 0 (t-test, significance level: 0.05 and sequential Bonferroni correction); light boxplots: ranks not significantly different from 0.**

Figure S9 – Yellow-shafted Flicker

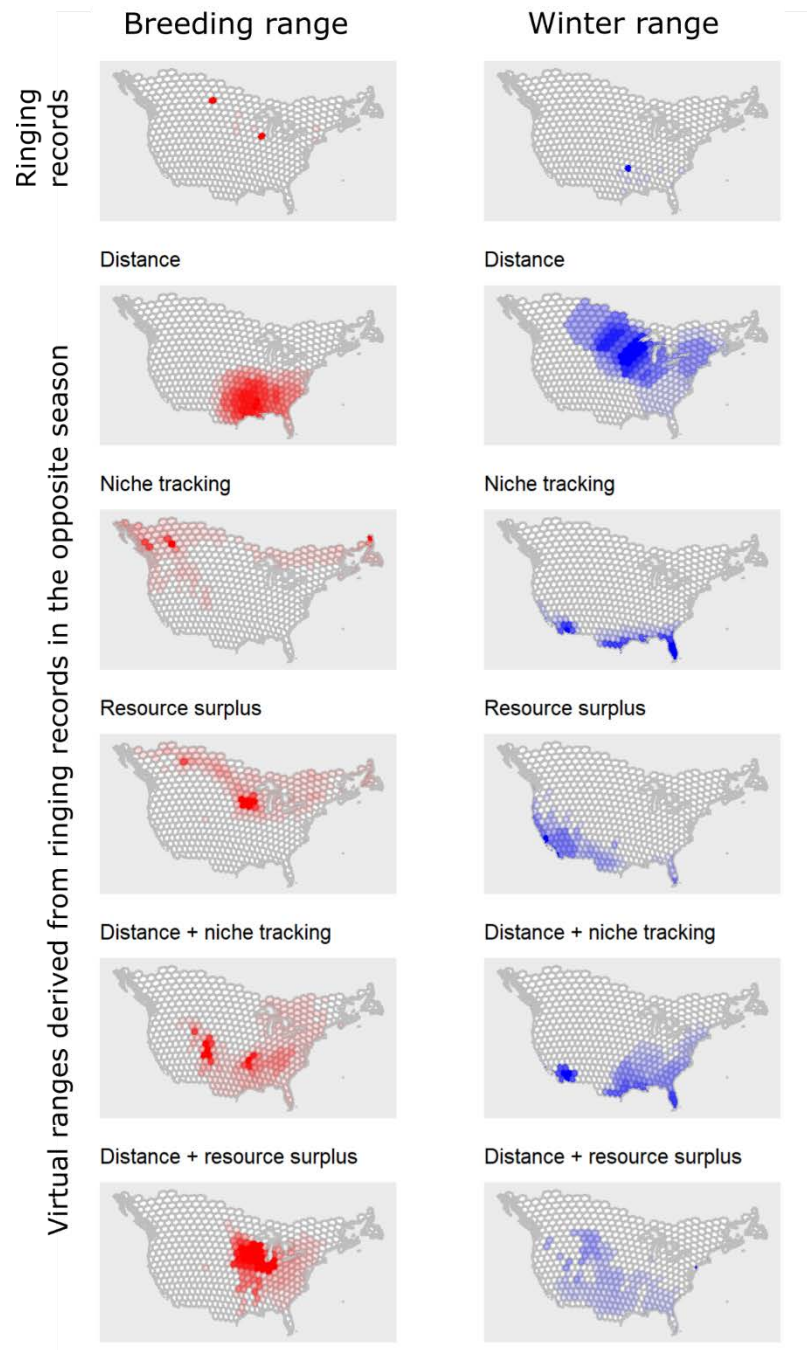


Figure S9: *Yellow-shafted flicker*. Visualisation of the importance of each variable, based on predicted optimal ranges in each season. Breeding and winter distributions reflect the location of the analysed ringing records, aggregated at the hexagon level. Virtual ranges for any given season are derived from ringing records in the opposite season, by predicting what those individuals' locations would have been if they had migrated while optimising along one axis (distance, niche tracking or resource surplus) or combination of two axes (see Methods for more details).

Figure S10 – American Crow

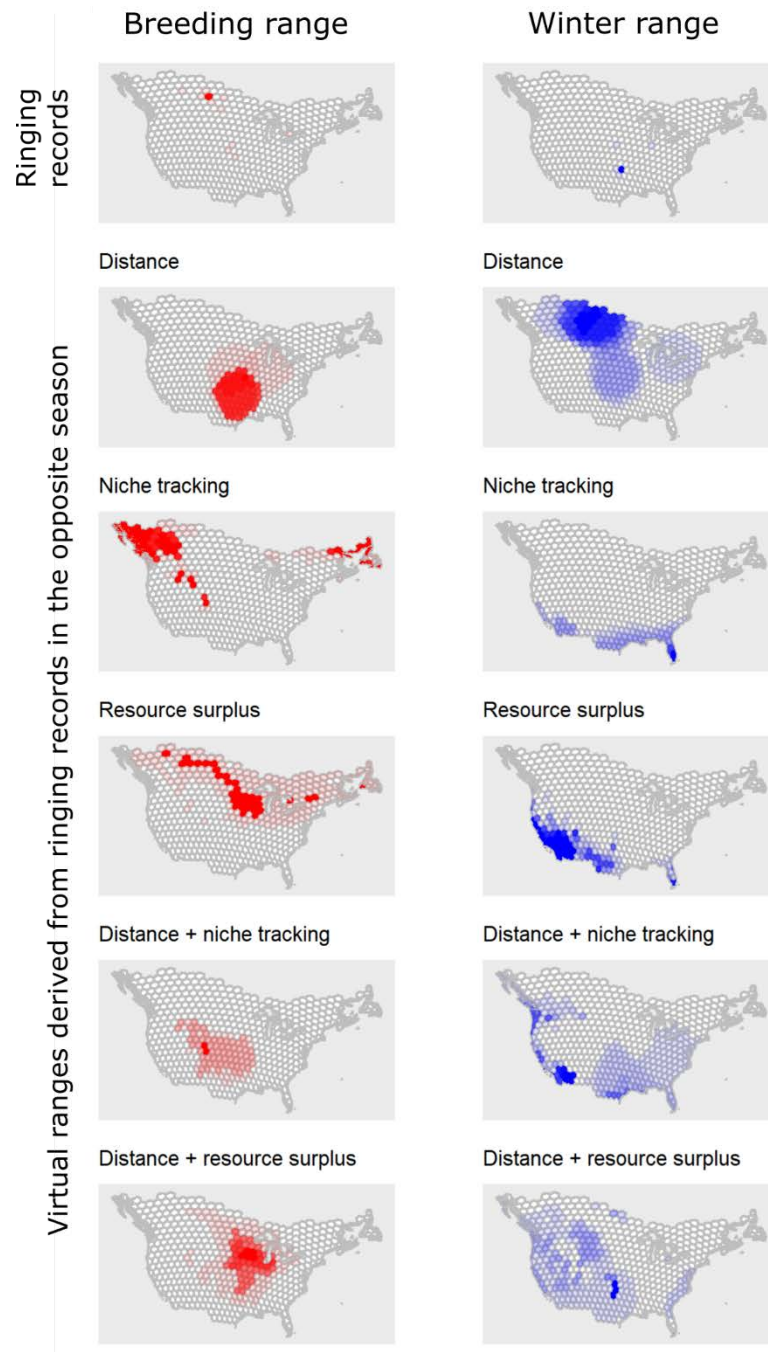


Figure S10: *American crow*. Legend as in Fig. S9.

Figure S11 – Blue Jay

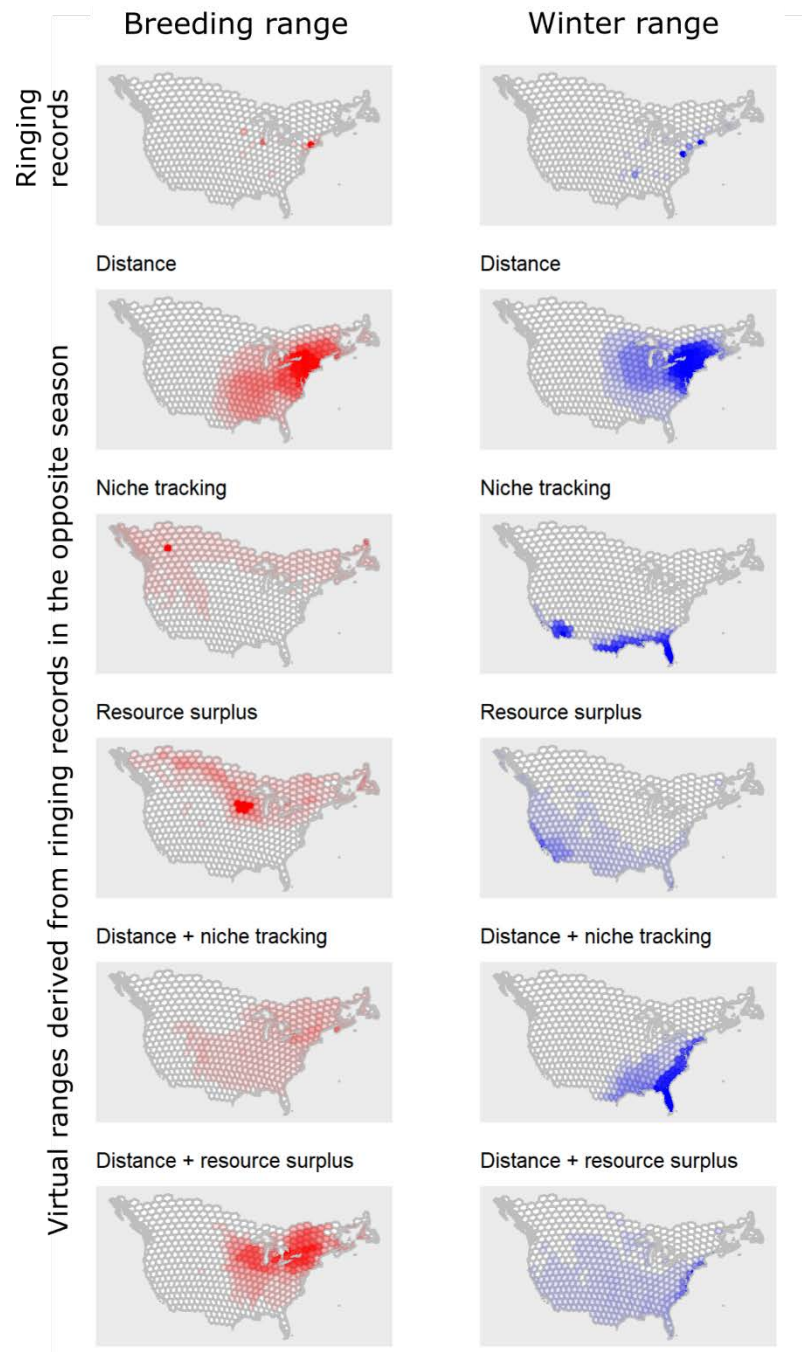


Figure S11: **Blue Jay**. Legend as in Fig. S9.

Figure S12 – European Starling

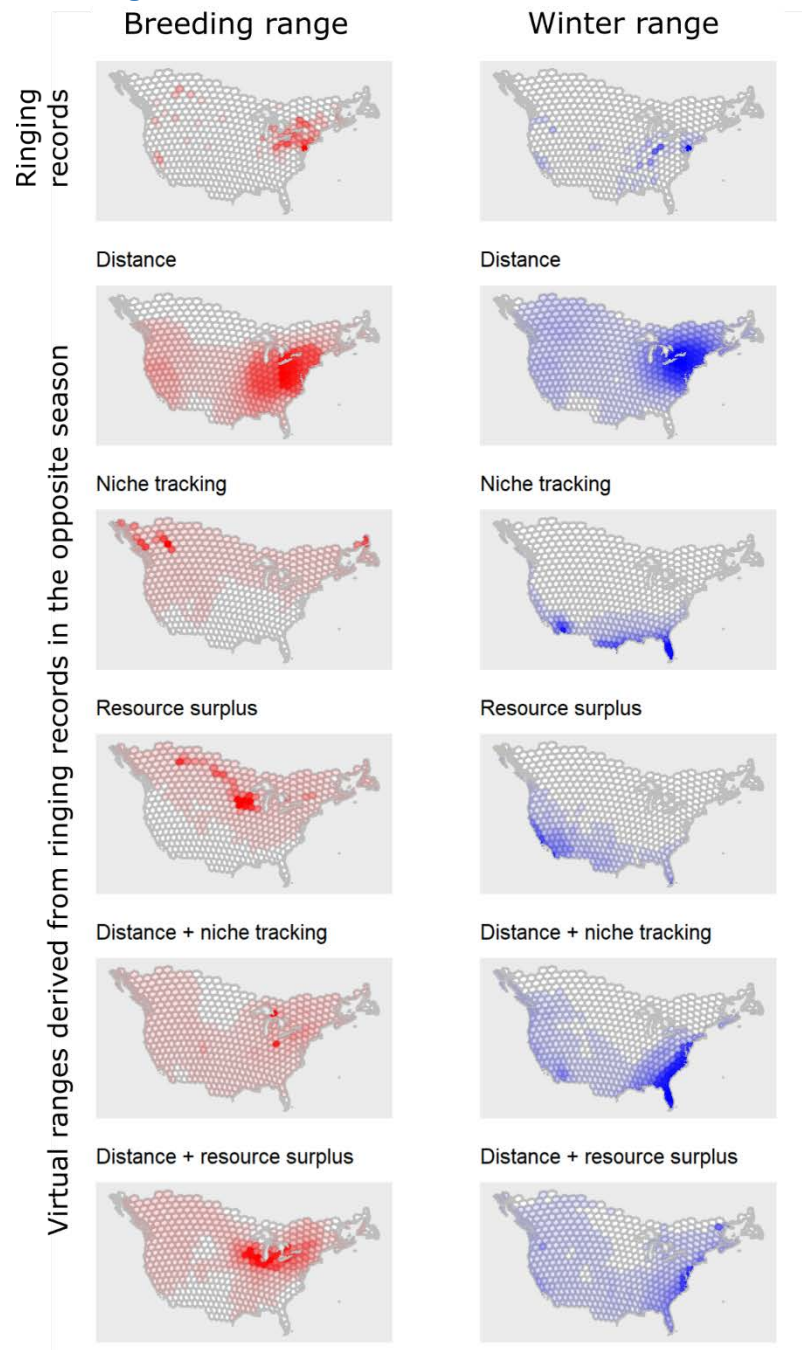


Figure S12: *European starling*. Legend as in Fig. S9.



Figure S13 – Brown Thrasher

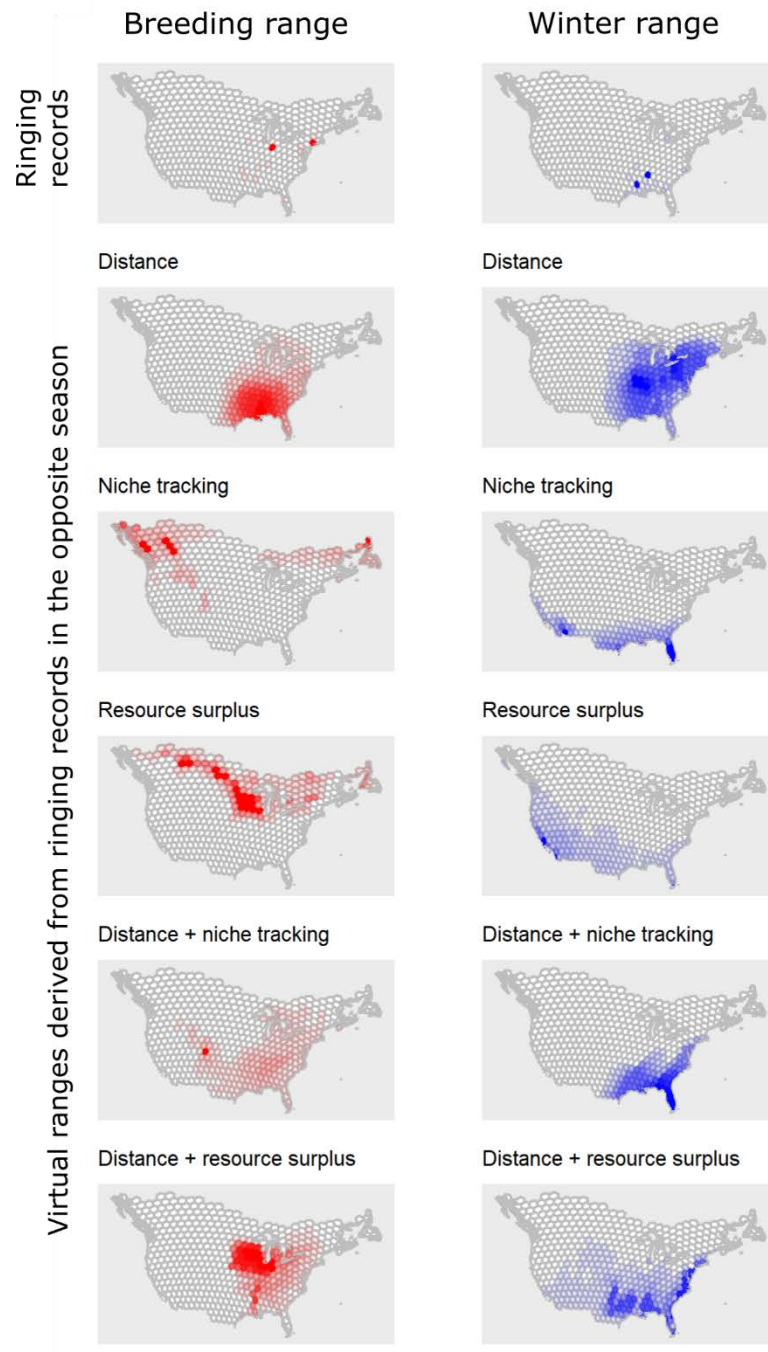


Figure S13: **Brown thrasher**. Legend as in Fig. S9.

Figure S14 – American Robin

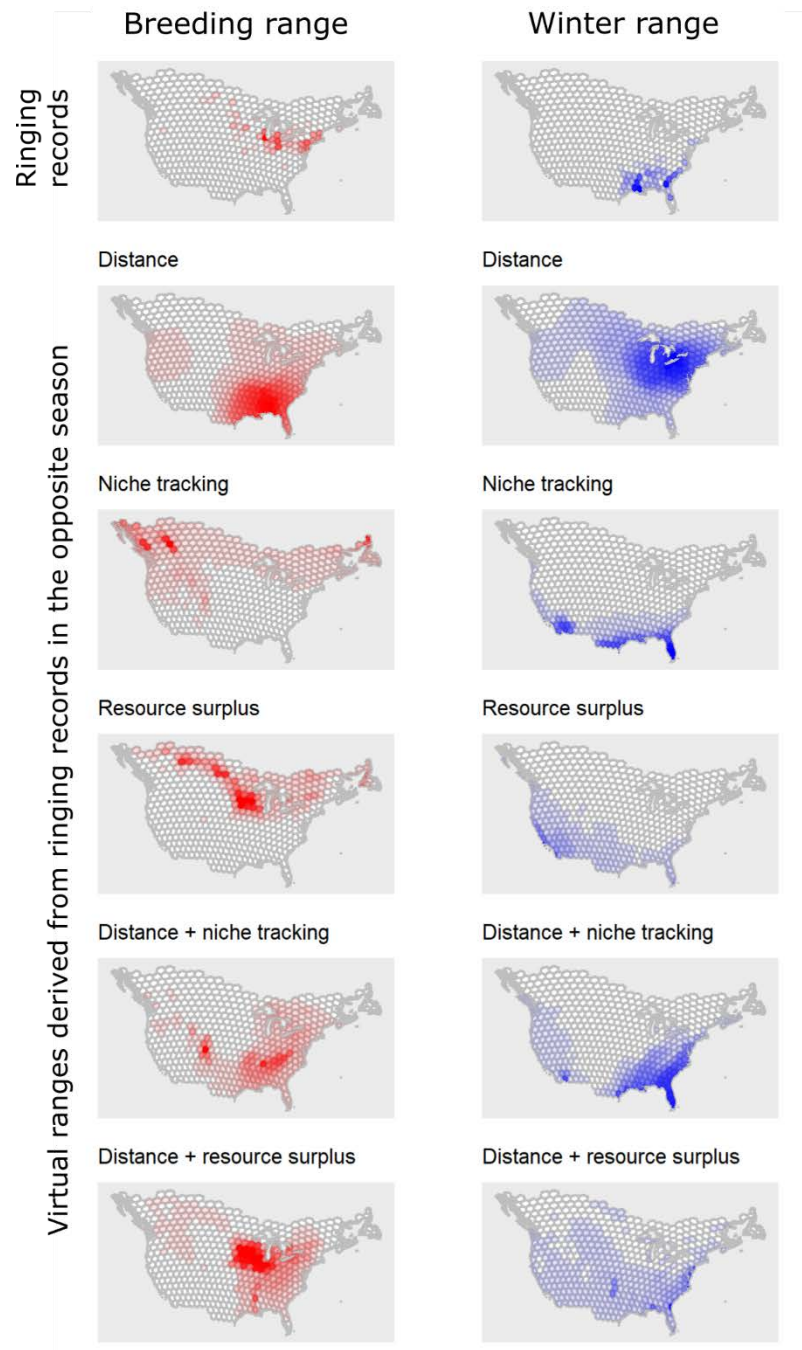


Figure S14: *American robin*. Legend as in Fig. S9.

Figure S15 – Evening Grosbeak

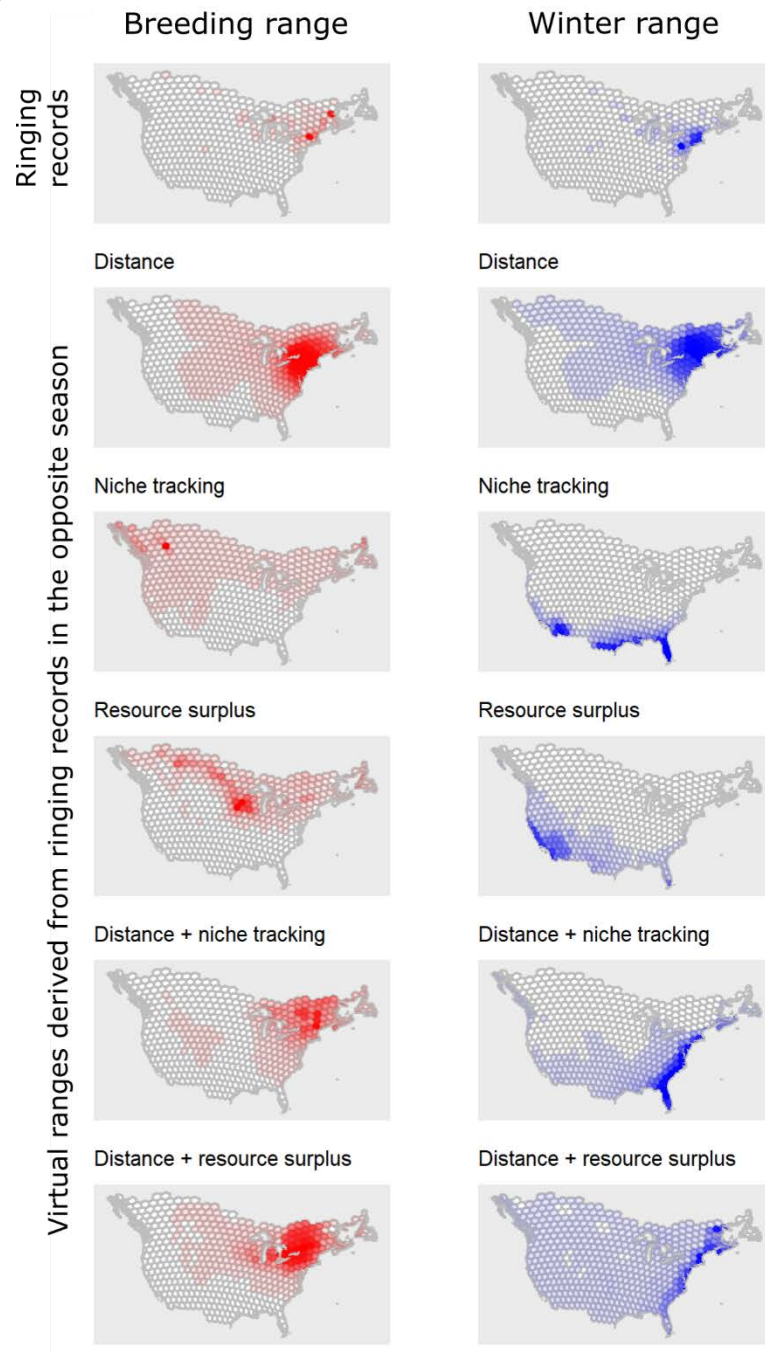


Figure S15: *Evening grosbeak*. Legend as in Fig. S9.



Figure S16 – Purple Finch

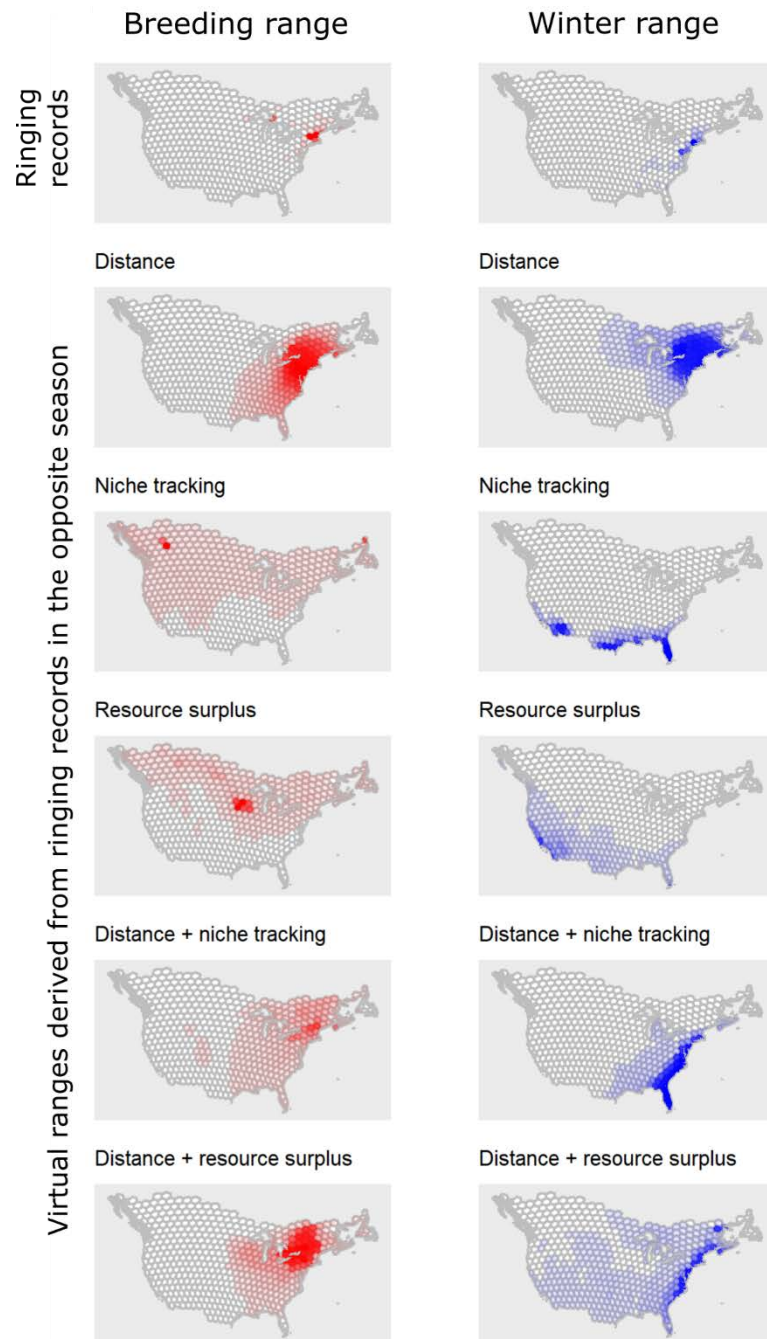


Figure S16: **Purple finch**. Legend as in Fig. S9.

Figure S17 – American Goldfinch

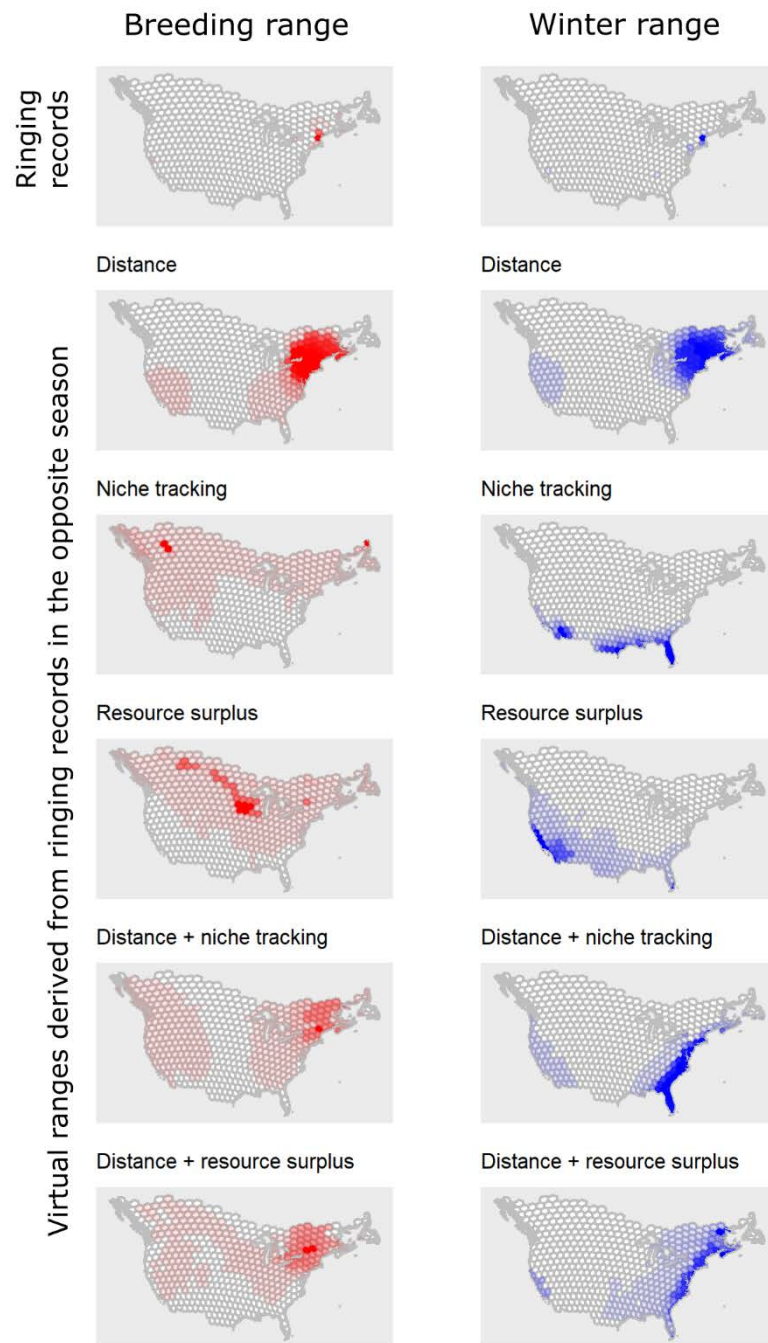


Figure S17: *American goldfinch*. Legend as in Fig. S9.

Figure S18 – Red-winged Blackbird

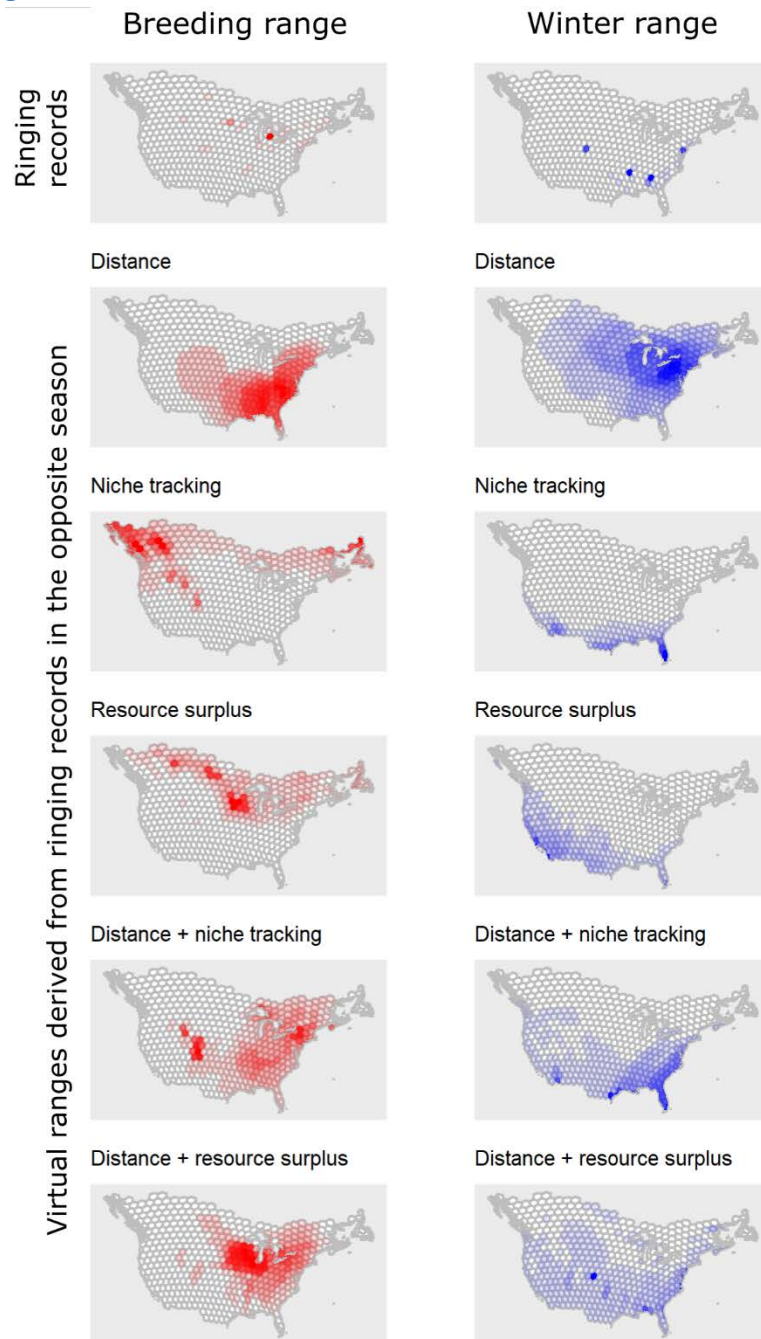


Figure S18: **Red-winged blackbird**. Legend as in Fig. S9.

Figure S19 – Brown-headed Cowbird

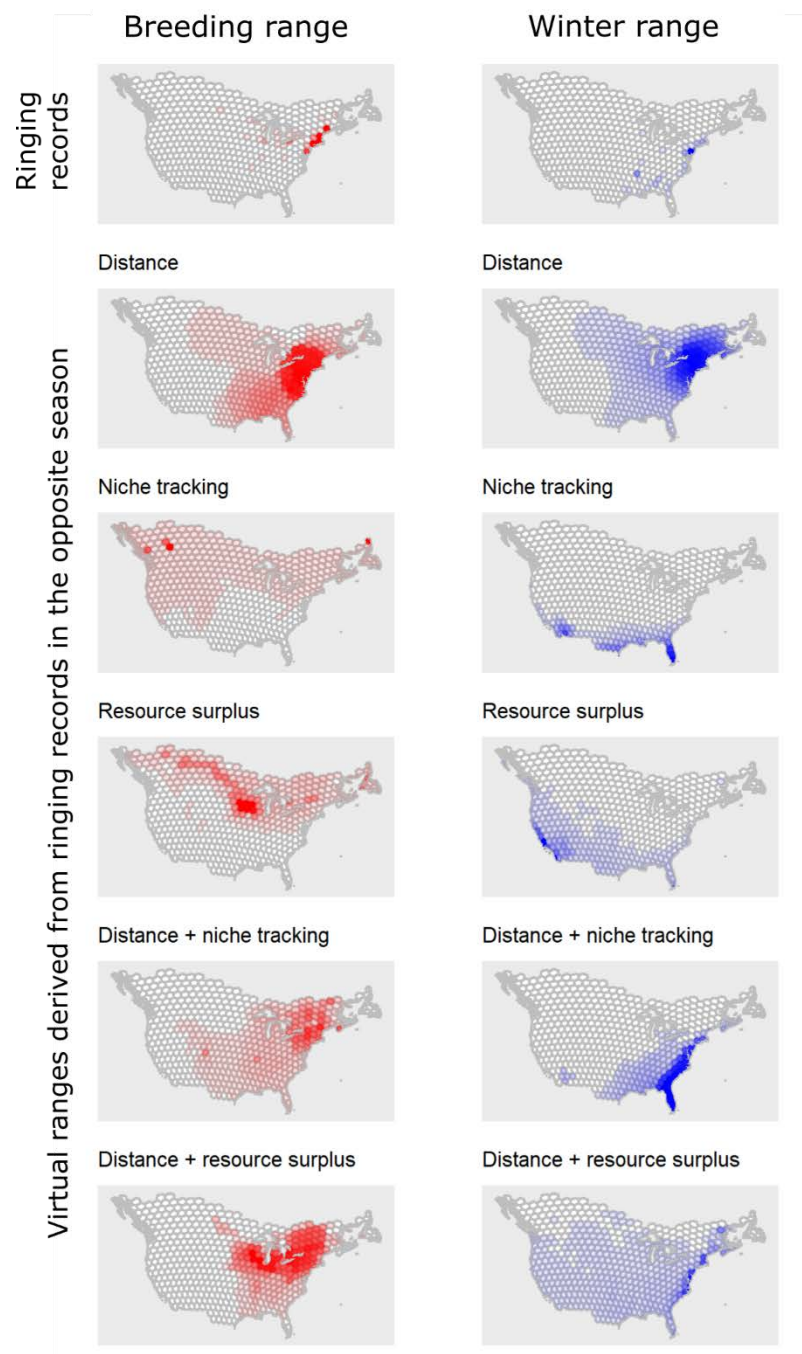


Figure S19: **Brown-headed cowbird**. Legend as in Fig. S9.

Figure S20 – Common Grackle

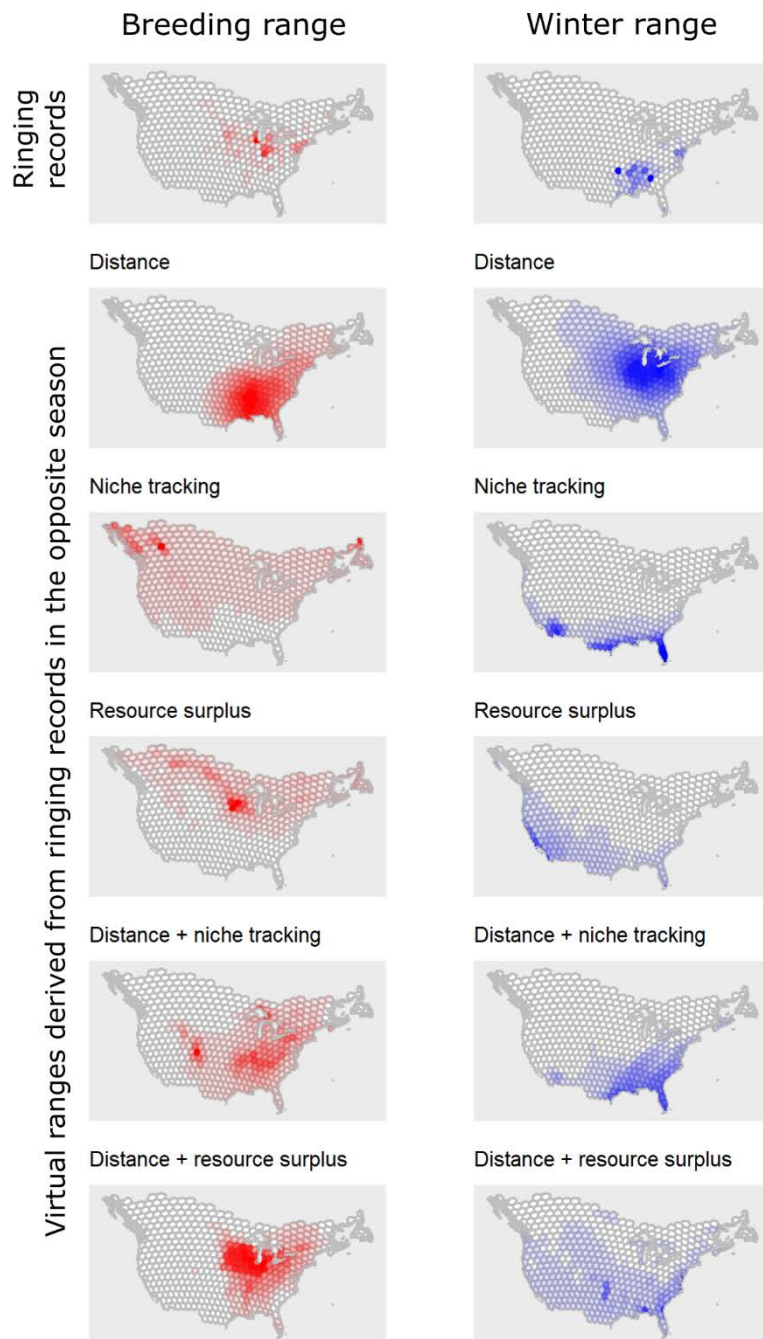


Figure S20: *Common grackle*. Legend as in Fig. S9.



Figure S21 – White-throated Sparrow

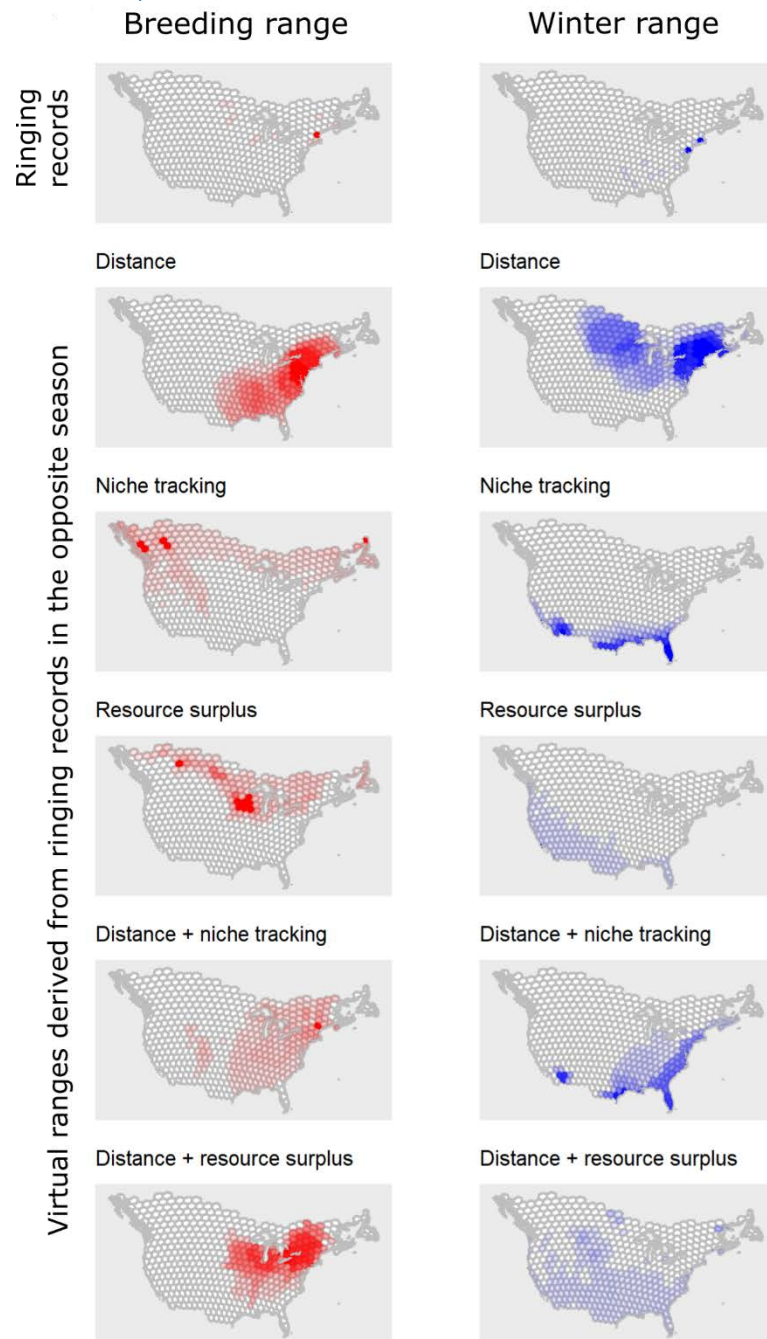


Figure S21: *White-throated sparrow*. Legend as in Fig. S9.

Table S1

*Comparison between niche tracking (absolute temperature difference between winter and the breeding season) of migratory birds and niche tracking they would have achieved by staying either at their winter or at their summer locations. Results of paired t-tests.*

Common name	<u>Migrating vs. staying at the winter location</u>				<u>Migrating vs. staying at the summer location</u>			
	t	df	p-value	mean difference	t	df	p-value	mean difference
Yellow-shafted Flicker	-11.2	10	5.42E-07	-0.68	-11.2	10	5.36E-07	-1.57
American Crow	-7.21	11	1.73E-05	-0.71	-6.74	11	3.21E-05	-1.39
Blue Jay	-2.16	28	0.0394	-0.11	-2.33	28	0.0272	-0.22
European Starling	-17.1	177	3.34E-39	-0.34	-14.6	177	4.04E-32	-0.54
Brown Thrasher	-4.75	15	2.59E-04	-0.29	-4.78	15	2.44E-04	-0.64
American Robin	-34.1	158	1.15E-74	-0.58	-32.9	158	1.37E-72	-1.24
Evening Grosbeak	-22.2	688	7.78E-83	-0.2	-22.7	688	2.12E-85	-0.38
Purple Finch	-9.21	61	3.72E-13	-0.39	-8.34	61	1.14E-11	-0.58
American Goldfinch	-3.95	17	0.00104	-0.28	-3.74	17	0.00165	-0.41
Red-winged Blackbird	-11.9	33	1.89E-13	-0.52	-10.2	33	9.33E-12	-0.97
Brown-headed Cowbird	-13.2	76	2.30E-21	-0.43	-12	76	2.68E-19	-0.73
Common Grackle	-22.8	175	2.95E-54	-0.4	-22.1	175	1.46E-52	-0.85
White-throated Sparrow	-4.92	13	2.78E-04	-0.41	-5.19	13	1.73E-04	-1.01

Table S2

*Comparison between total annual resource surplus experienced by migrants and 0 (i.e. the surplus they would have achieved by staying either at their winter or at their breeding locations). Results of one-sample *t*-tests.*

<b>Common name</b>	<b>t</b>	<b>df</b>	<b>p-value</b>	<b>mean value</b>
Yellow-shafted Flicker	4.84	10	6.78E-04	69.63
American Crow	5.06	11	3.65E-04	53.85
Blue Jay	-0.391	28	0.699	-2.3
European Starling	11.2	177	2.66E-22	32.24
Brown Thrasher	3.08	15	0.00758	23.29
American Robin	19.1	159	4.48E-43	53.47
Evening Grosbeak	7.01	688	5.80E-12	8.34
Purple Finch	4.56	61	2.51E-05	22.31
American Goldfinch	1.38	17	0.185	14.91
Red-winged Blackbird	4.68	33	4.73E-05	38.65
Brown-headed Cowbird	5.91	77	8.87E-08	26.39
Common Grackle	15.6	176	4.09E-35	39.05
White-throated Sparrow	4.89	13	2.93E-04	46.46



Table S3

*Relationship between migratory distance (in km) and temperature range (in Celsius degrees) between breeding and winter locations, across individuals, for each of the species analysed. Results of linear models (slopes).*

<b>Common name</b>	<b>Estimate</b>	<b>Standard error</b>	<b>t-value</b>	<b>p-value</b>
Yellow-shafted Flicker	-4.55E-05	1.88E-05	-2.42	3.84E-02
American Crow	-5.30E-05	7.92E-06	-6.7	5.38E-05
Blue Jay	-6.72E-05	1.54E-05	-4.36	1.72E-04
European Starling	-6.02E-05	4.08E-06	-14.8	1.27E-32
Brown Thrasher	-5.00E-05	2.01E-05	-2.49	2.60E-02
American Robin	-5.92E-05	4.03E-06	-14.7	2.63E-31
Evening Grosbeak	-3.86E-05	3.51E-06	-11	4.47E-26
Purple Finch	-7.43E-05	8.21E-06	-9.05	8.14E-13
American Goldfinch	-9.18E-05	2.38E-05	-3.85	1.40E-03
Red-winged Blackbird	-5.23E-05	9.06E-06	-5.78	2.07E-06
Brown-headed Cowbird	-7.36E-05	3.77E-06	-19.5	3.73E-31
Common Grackle	-6.36E-05	3.77E-06	-16.8	2.12E-38
White-throated Sparrow	-5.28E-05	8.52E-06	-6.19	4.63E-05

Table S4

*Relationship between migratory distance (in km) and annual resource gain, across individuals, for each of the species analysed. Results of linear models (slopes).*

<b>Common name</b>	<b>Estimate</b>	<b>Standard error</b>	<b>t-value</b>	<b>p-value</b>
Yellow-shafted Flicker	7.01E-02	3.63E-02	1.93	8.54E-02
American Crow	4.61E-02	6.80E-03	6.77	4.91E-05
Blue Jay	5.37E-02	1.29E-02	4.16	2.87E-04
European Starling	4.48E-02	4.73E-03	9.46	2.01E-17
Brown Thrasher	4.72E-02	1.61E-02	2.92	1.11E-02
American Robin	2.90E-02	5.81E-03	5	1.50E-06
Evening Grosbeak	-7.16E-03	3.38E-03	-2.12	3.47E-02
Purple Finch	3.60E-02	9.34E-03	3.85	2.90E-04
American Goldfinch	6.04E-02	3.27E-02	1.85	8.32E-02
Red-winged Blackbird	6.02E-02	1.61E-02	3.74	7.17E-04
Brown-headed Cowbird	2.85E-02	7.32E-03	3.9	2.06E-04
Common Grackle	4.66E-02	5.03E-03	9.26	7.36E-17
White-throated Sparrow	3.66E-02	1.17E-02	3.14	8.57E-03