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Morphological consequences of climate change for resident birds in intact Amazonian rainforest

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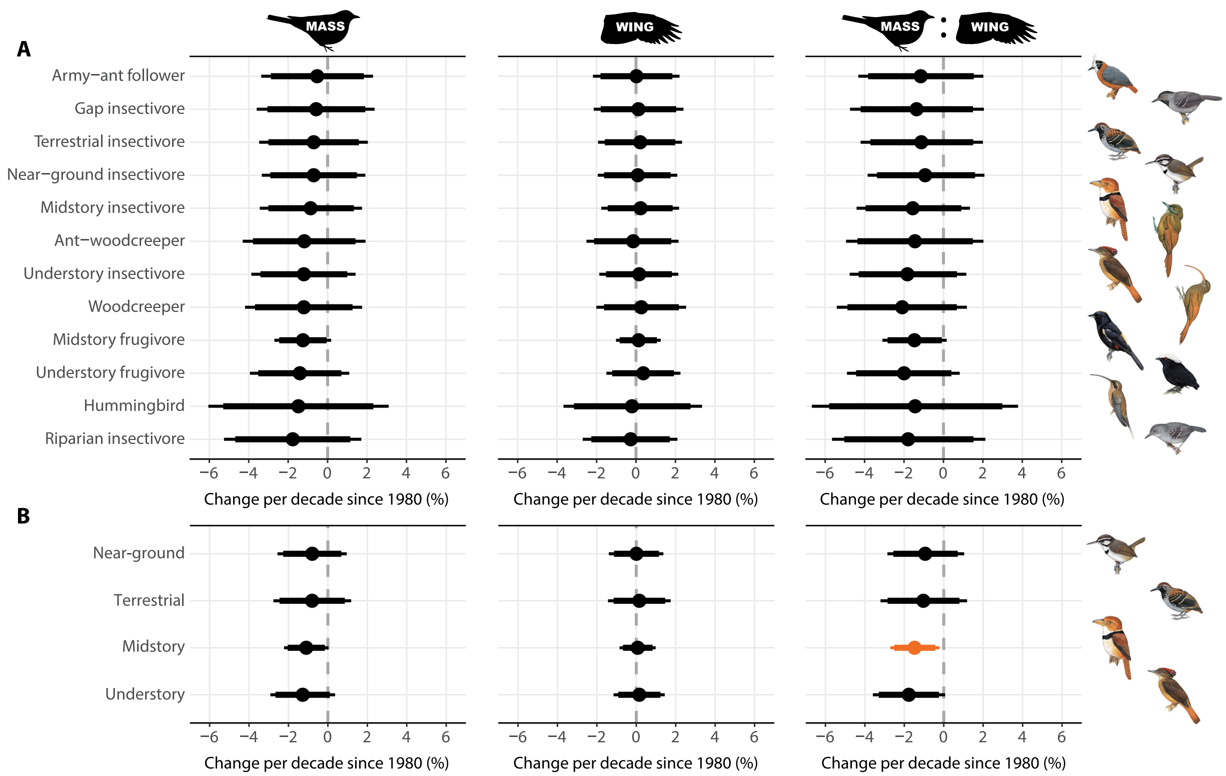

Fig. S1. Bird morphology time trends by ecological traits. (**A**) Foraging guilds. (**B**) Vertical forest stratum. In both panels, points show the overall estimate of change through time for a given group of species, from the second level (Gamma parameters) of a hierarchical model of individual species trends. Lines represent 90% and 95% credible intervals. (**A**) shows Gamma parameters for model depicted in Fig. 1D whereas (**B**) shows output from an identical model with stratum (rather than guild) as the species trait. Results correspond to models 1, 7, 13, 4, 10, and 16 (table S4).

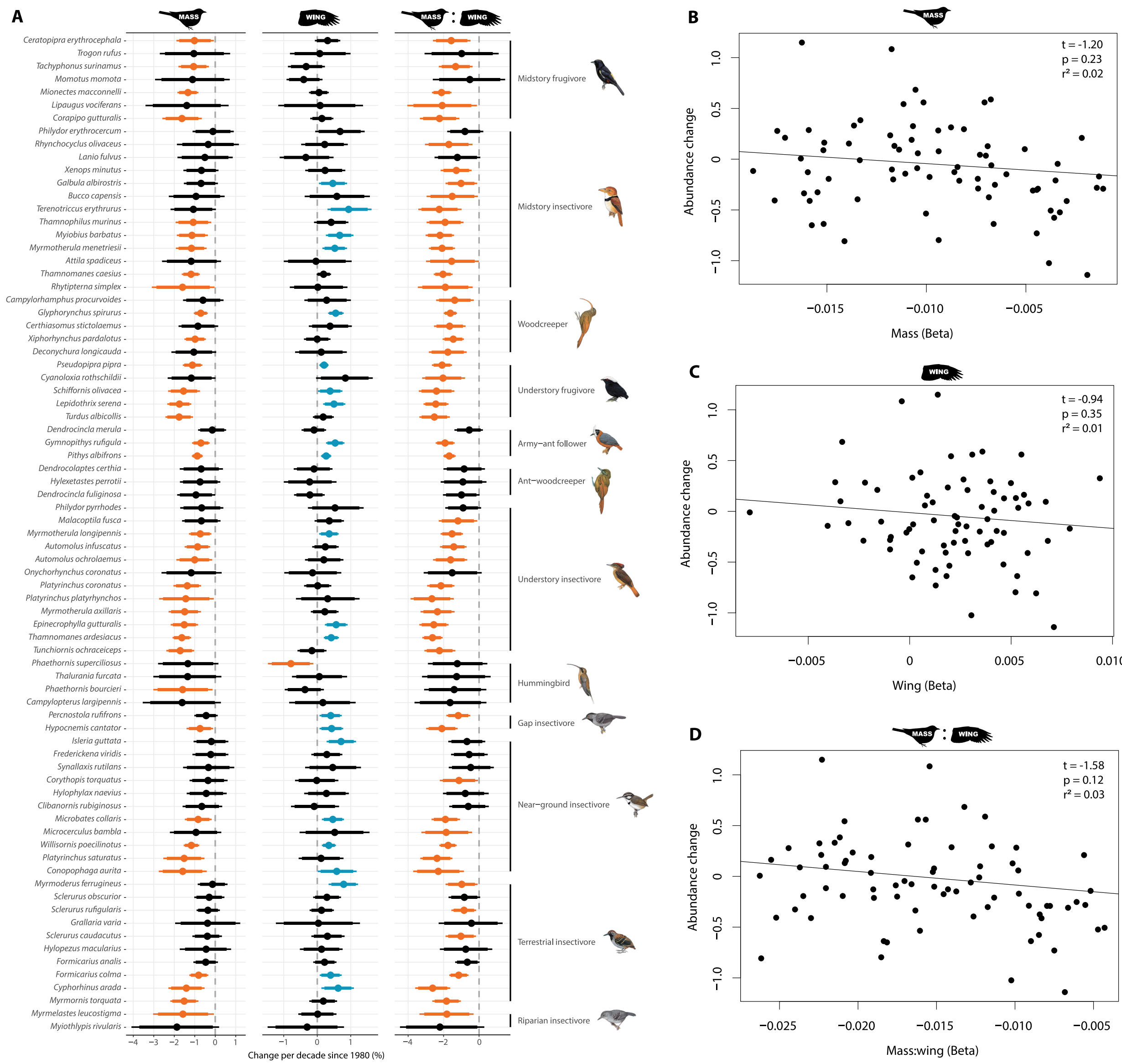

Fig. S2. Trends in morphology vs abundance. (**A**) Morphological trends in Fig. 1D were grouped by foraging guild, with species sorted by mass trends within each guild. Vertical guild position follows guild-specific abundance trends (*9*). (**B**–**D**) Phylogenetic generalized least squares (PGLS) regression between abundance and morphology trends. Results correspond to models 1, 7, 13 (table S4).

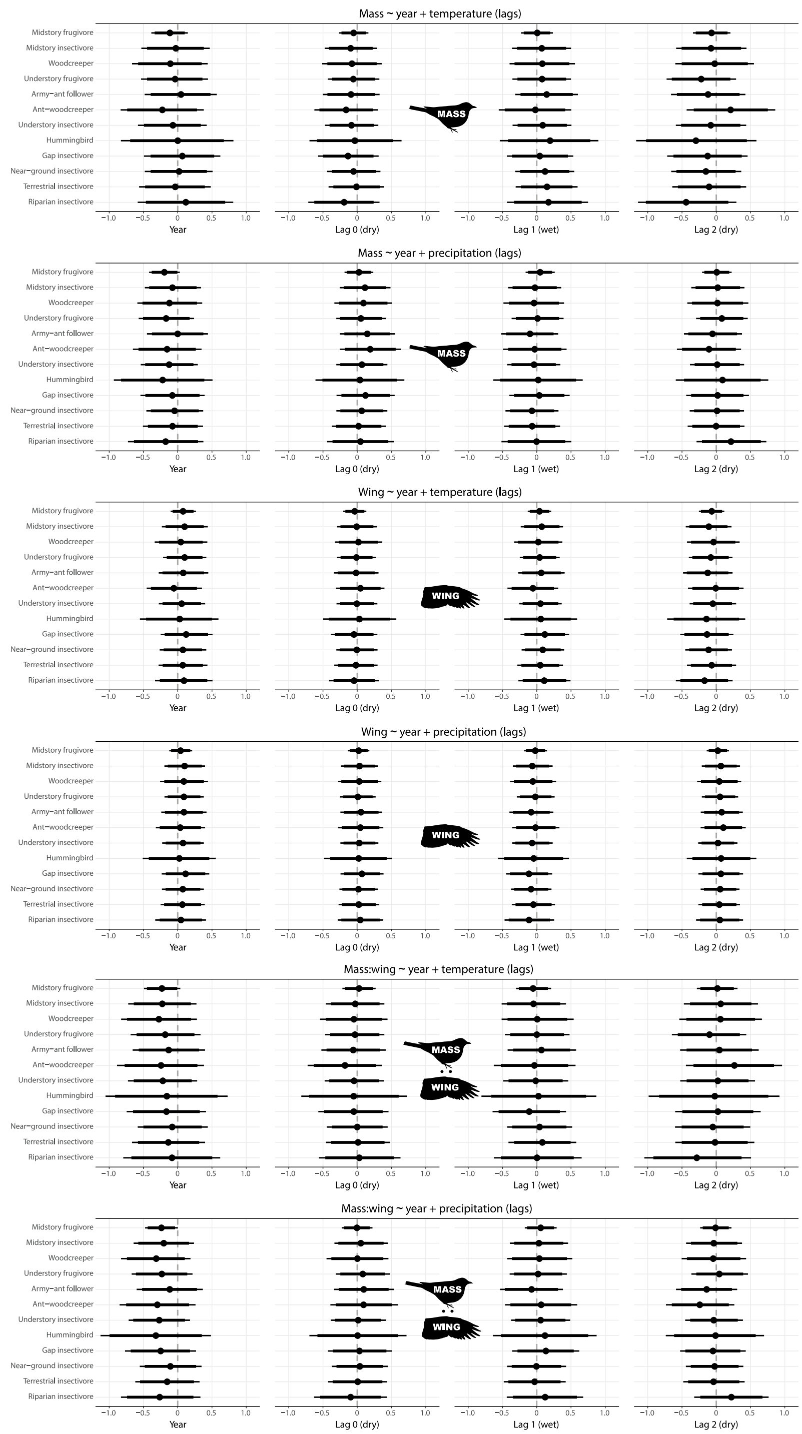

Fig. S3. Morphological responses of bird foraging guild to year and climate. Points are Gamma parameter estimates from the second level of a hierarchical model of individual species trends, indicating the overall estimated response of a given group of species to each covariate. Lines represent 90% and 95% credible intervals. Plots show Gamma values for models depicted in Fig. 4. Guilds are sorted according to abundance trends (*9*). Results correspond to models 2, 3, 8, 9, 14, and 15 (table S4).

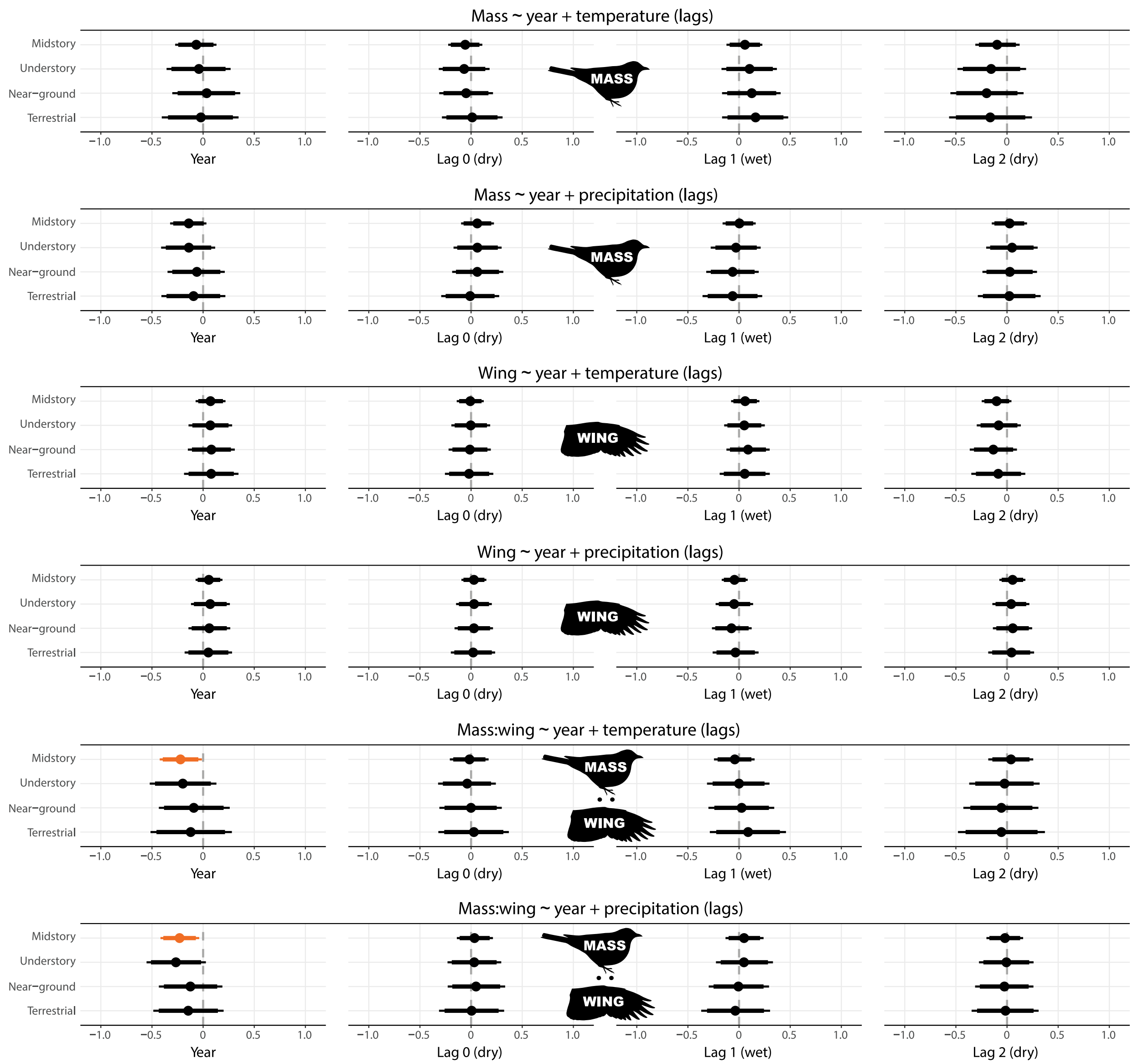

Fig. S4. Morphological responses of bird forest stratum to year and climate. Points are Gamma parameter estimates from the second level of a hierarchical model of individual species trends, indicating the overall estimated response of a given group of species to each covariate. Lines represent 90% and 95% credible intervals. Plots show Gamma values for models identical to Fig. 4, with stratum (rather than guild) as the species trait. Strata are sorted from low to high. Results correspond to models 5, 6, 11, 12, 17, and 18 (table S4).

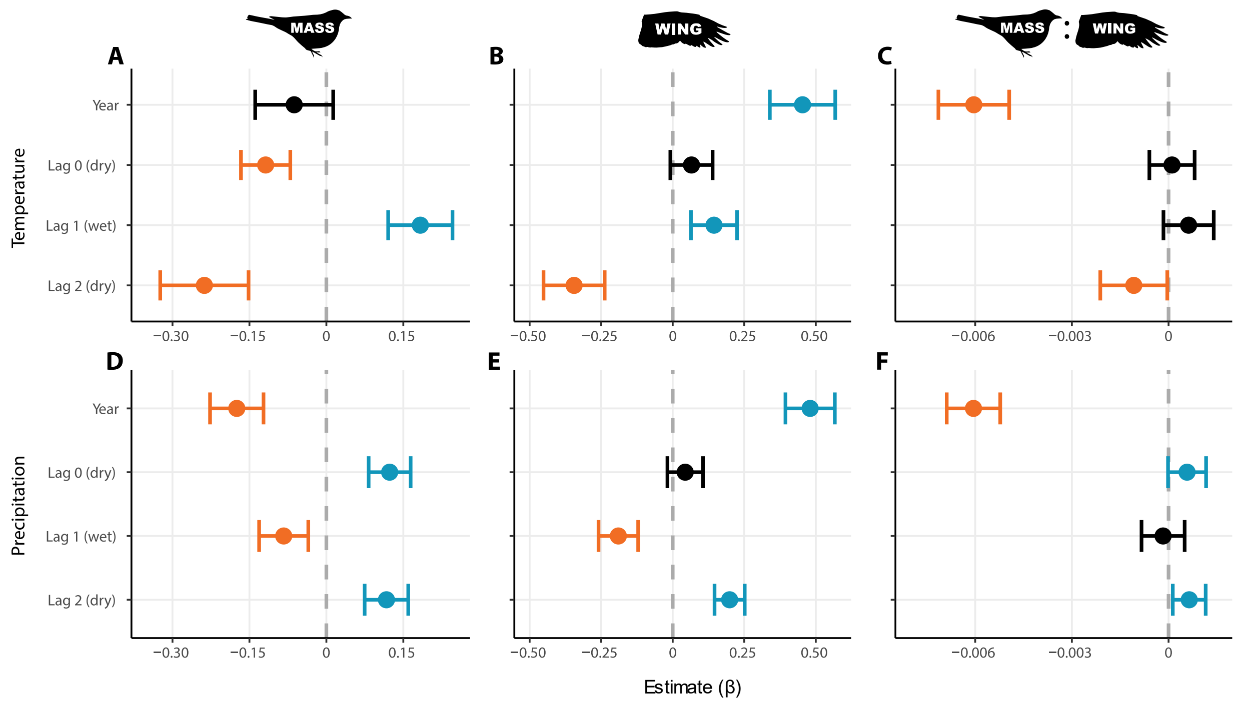

Fig. S5. Bird morphology modeled by time trend and climate covariates using linear mixed models. Models are fit by restricted maximum likelihood to the entire merged dataset and include random effects of species and month. Predictors are scaled to allow comparison across each morphological metric.

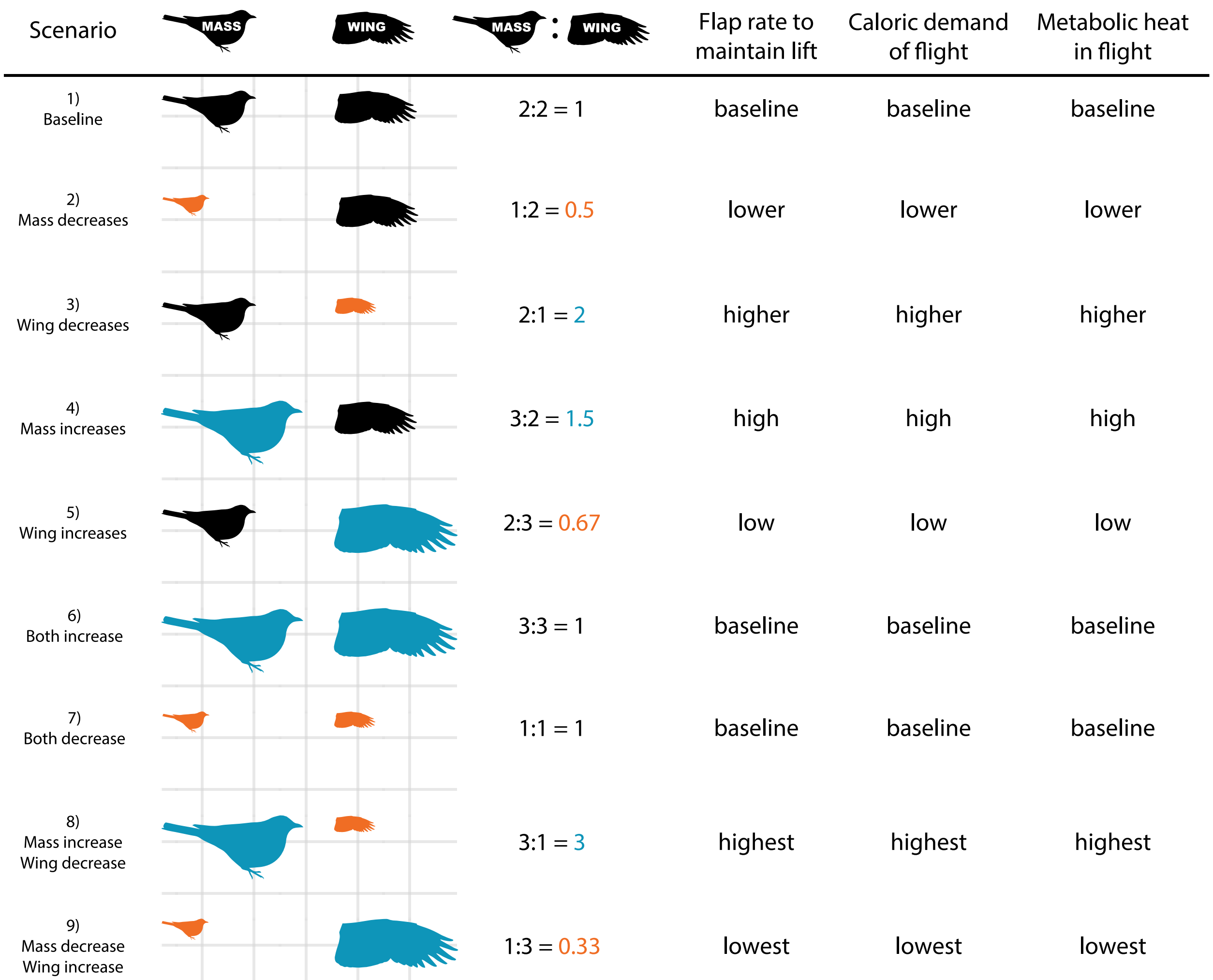

Fig. S6. Concept map for the consequences of morphological changes on avian energetics. Out of the scenarios that reduce mass:wing (two, five, nine) from a hypothetical 4-unit energy baseline (scenario one: 2 in mass + 2 in wing), scenario nine is the most economical—scenario two wastes 1 unit, scenario five costs 1 unit, but the net energy requirement for scenario nine is zero. Caloric demand of flight is based on (*40*).

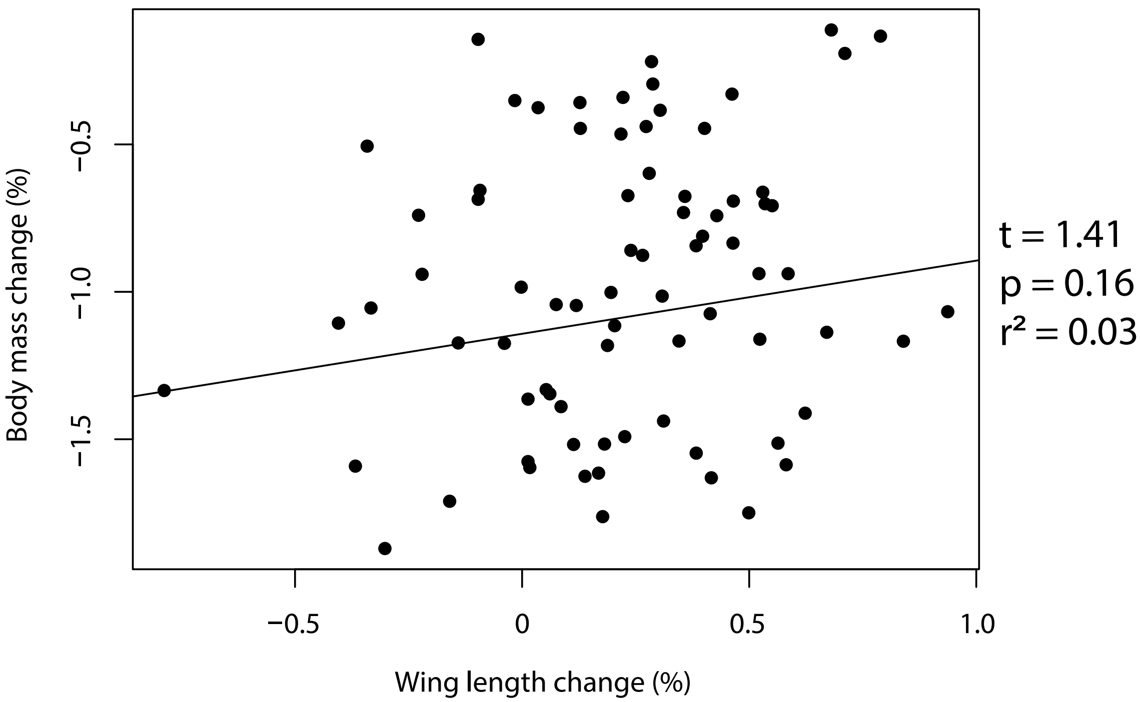

Fig. S7. Correlation between mass and wing change. Regression is based on phylogenetic generalized least squares (PGLS). Results correspond to models 1 and 7 (table S4).

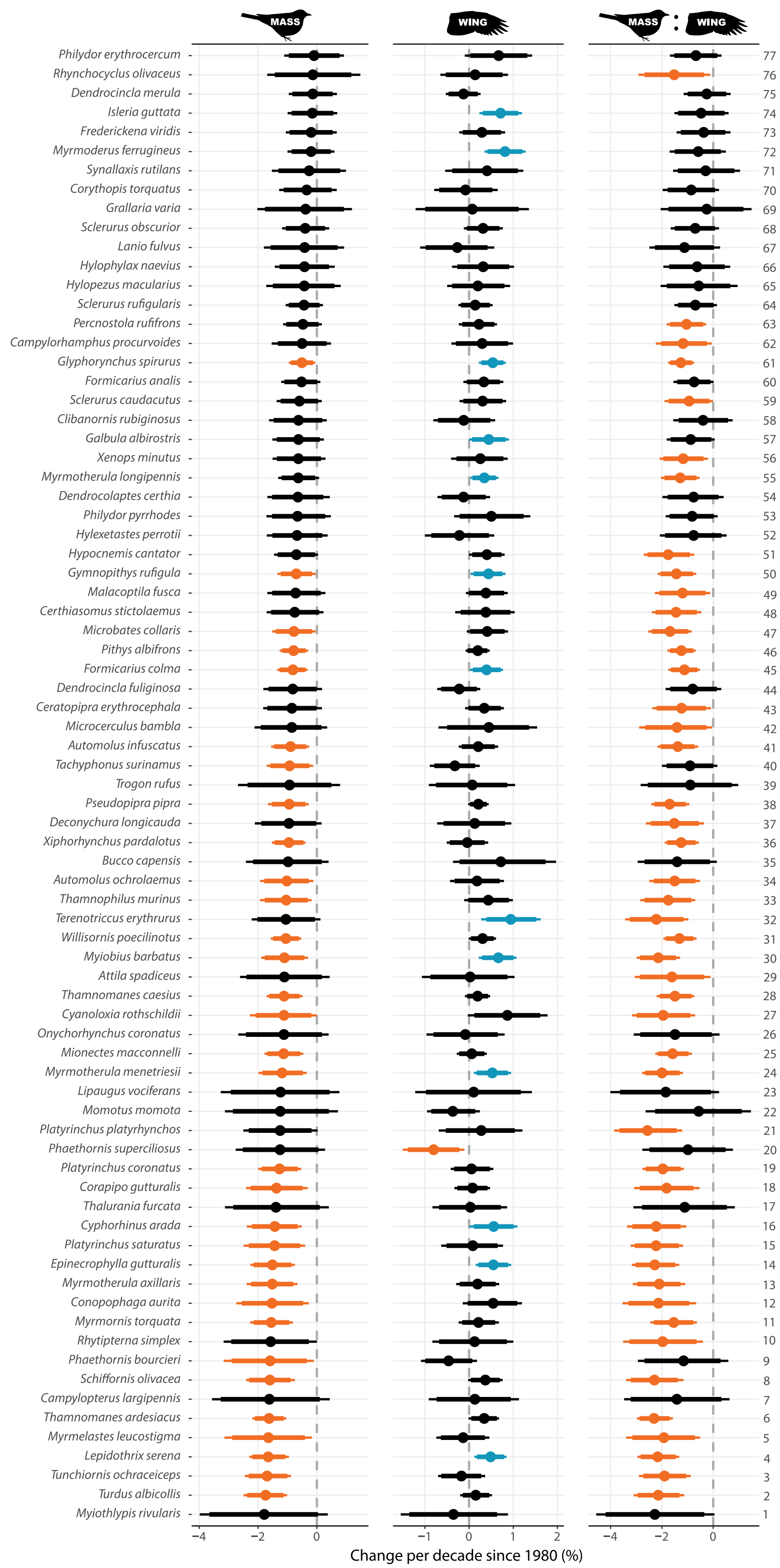

Fig. S8. HMSC models of morphological trends with a random effect of year. Model structures are identical to Fig. 1D, but a random effect of categorical year is also included here.

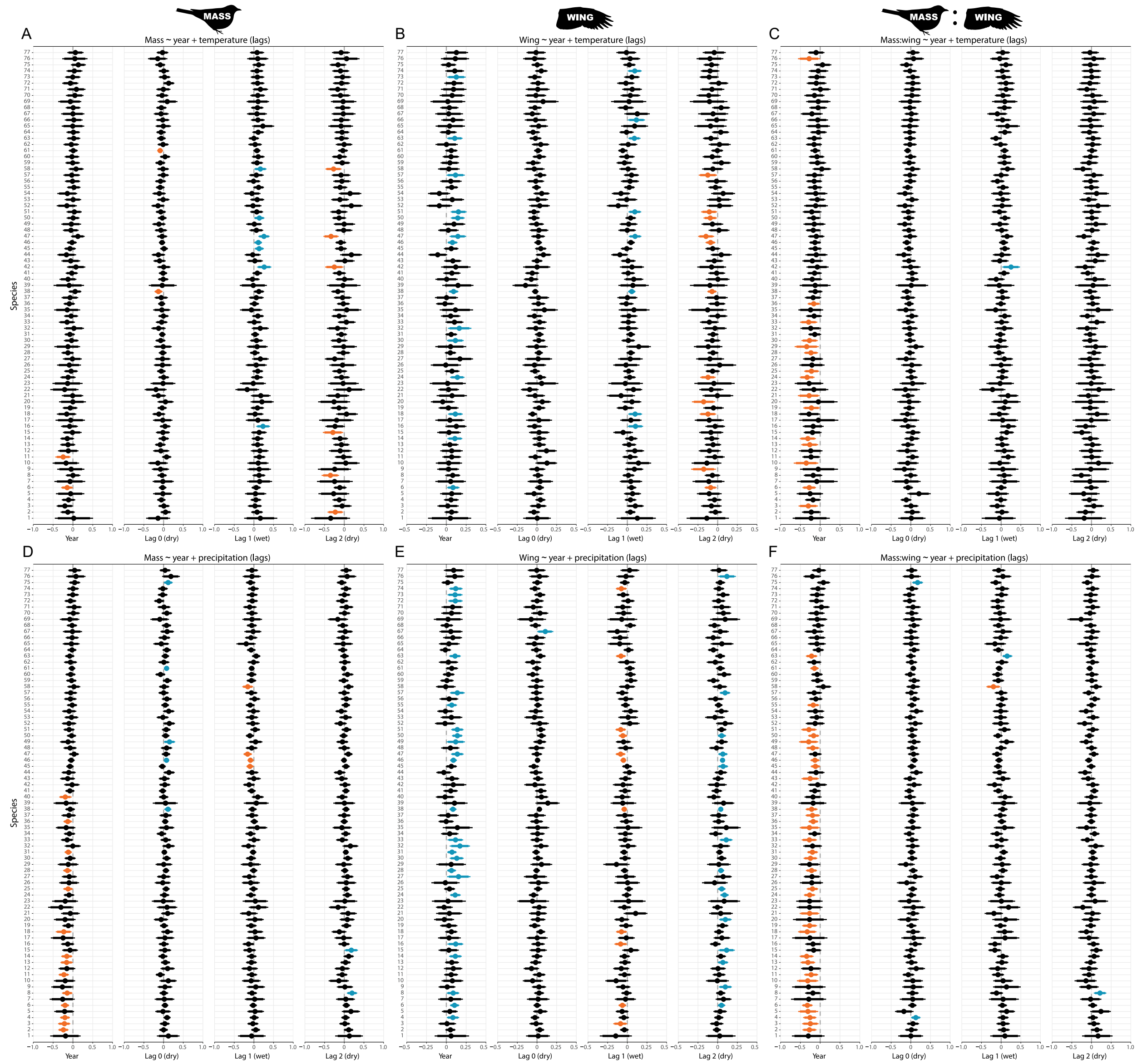

Fig. S9. Morphology by species modeled by time trend and climate covariates with a random effect of year. Model structures are identical to Fig. 4, but a random effect of categorical year is also included here.

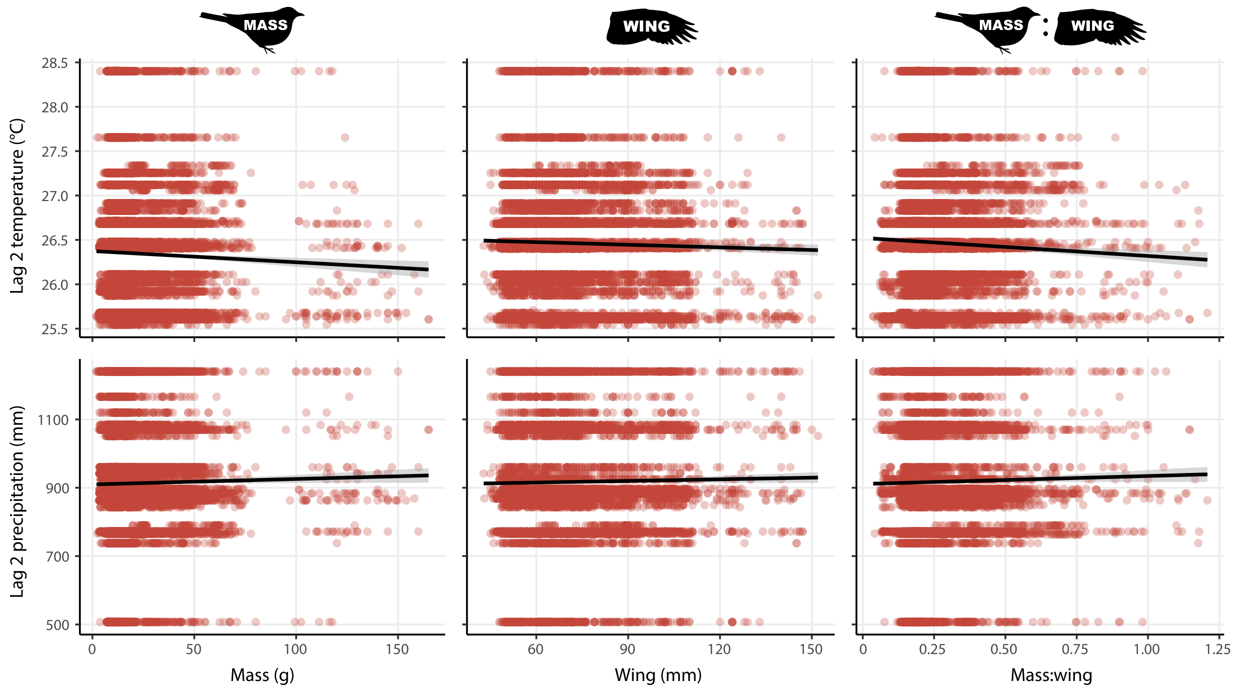

Fig. S10. Raw morphology and lag 2 climate scatterplots. Black lines and ribbons represent best-fit linear regressions and 95% CIs for their predictions. The most severe season (28.4 °C, 507 mm) corresponds to the widespread drought in 2016 (*84*).

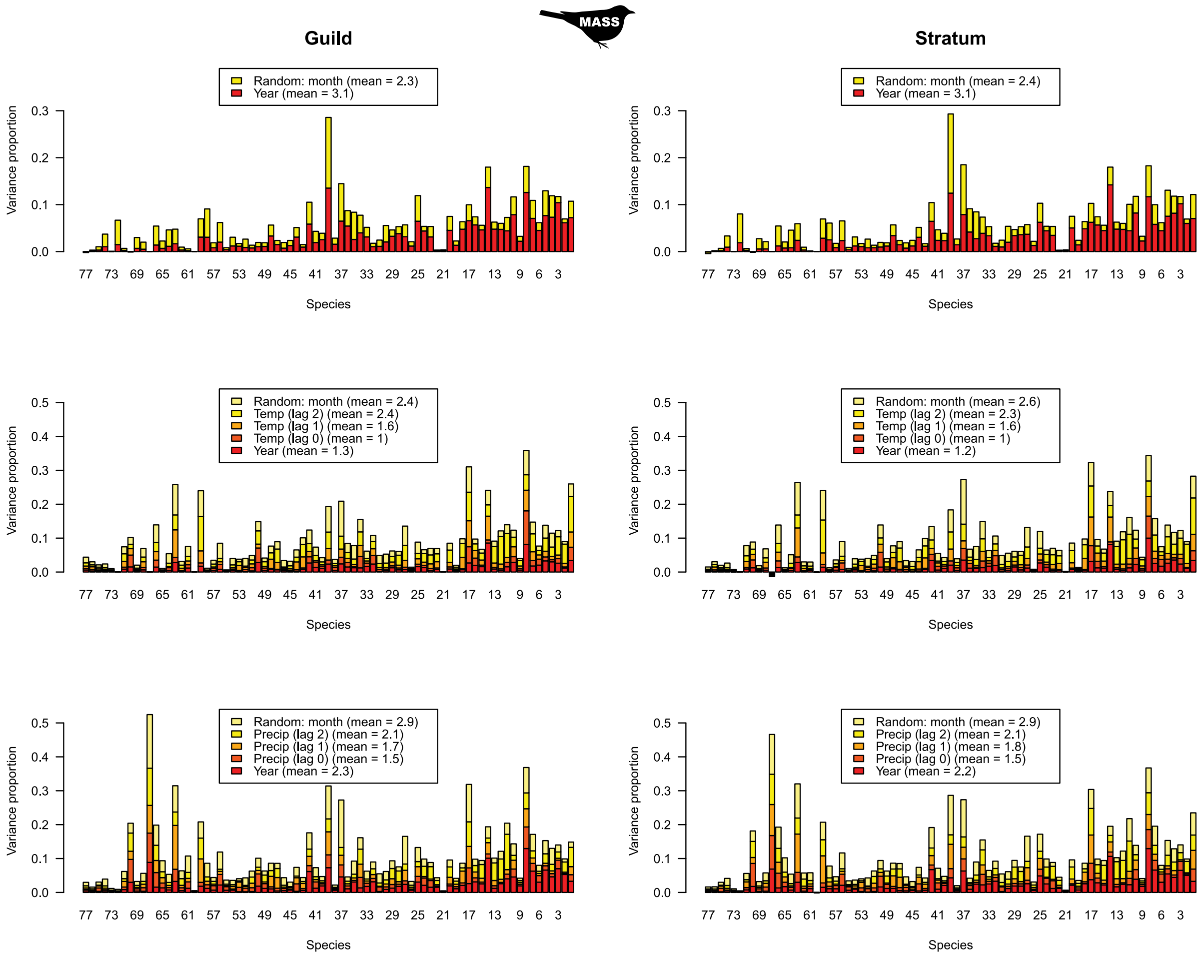

Fig. S11. Variance partitioning for mass models. Vertical bars show the proportion of variance explained by each covariate, corrected for each species' R^2 value for a given model. Legends show mean proportion for each covariate. For more details, see models 1–6 in Table S4. Species are ordered on the x-axis following declining mass in Fig. 1D.

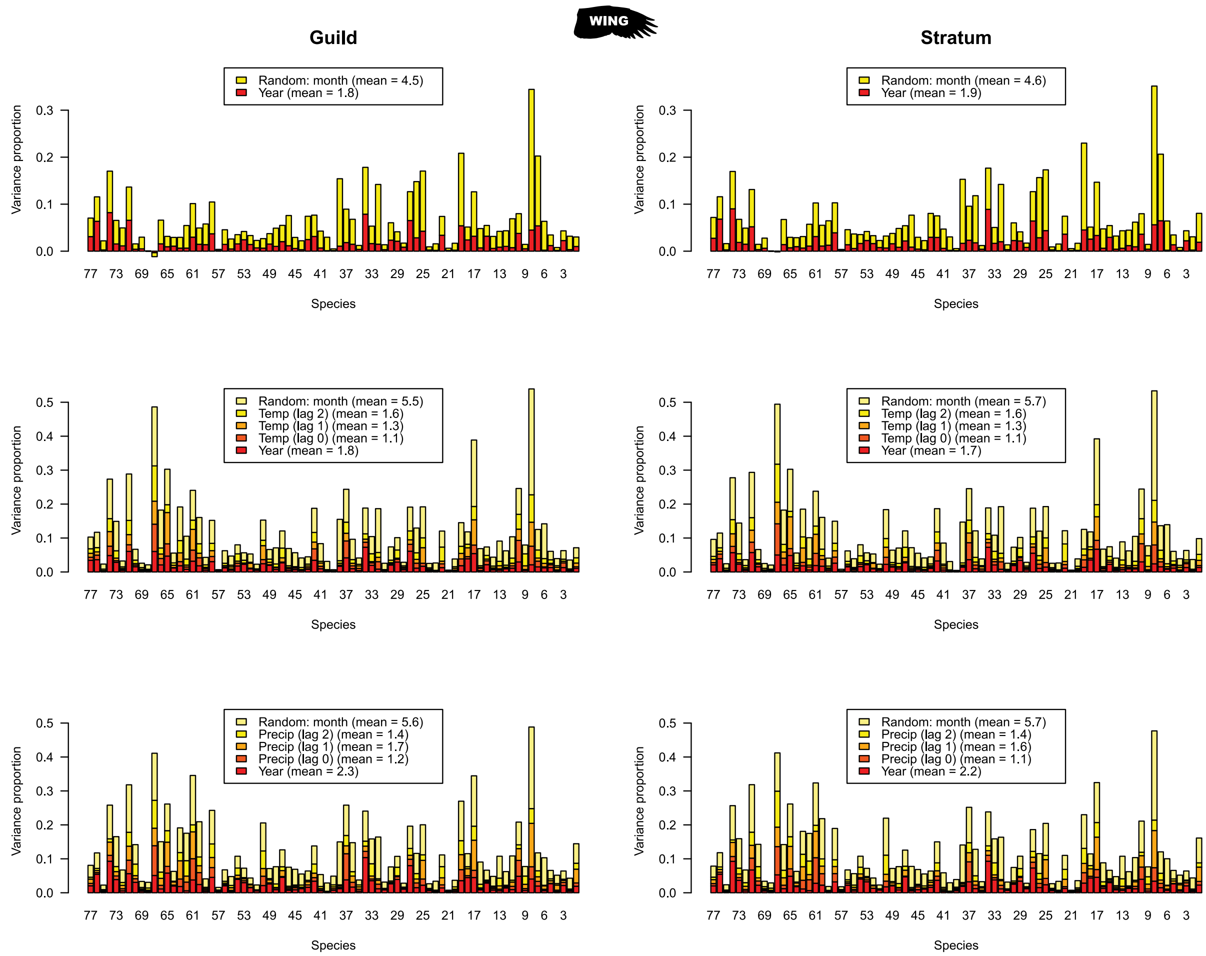

Fig. S12. Variance partitioning for wing models. Vertical bars show the proportion of variance explained by each covariate, corrected for each species' R^2 value for a given model. Legends show mean proportion for each covariate. For more details, see models 7–12 in Table S4. Species are ordered on the x-axis following declining mass in Fig. 1D.

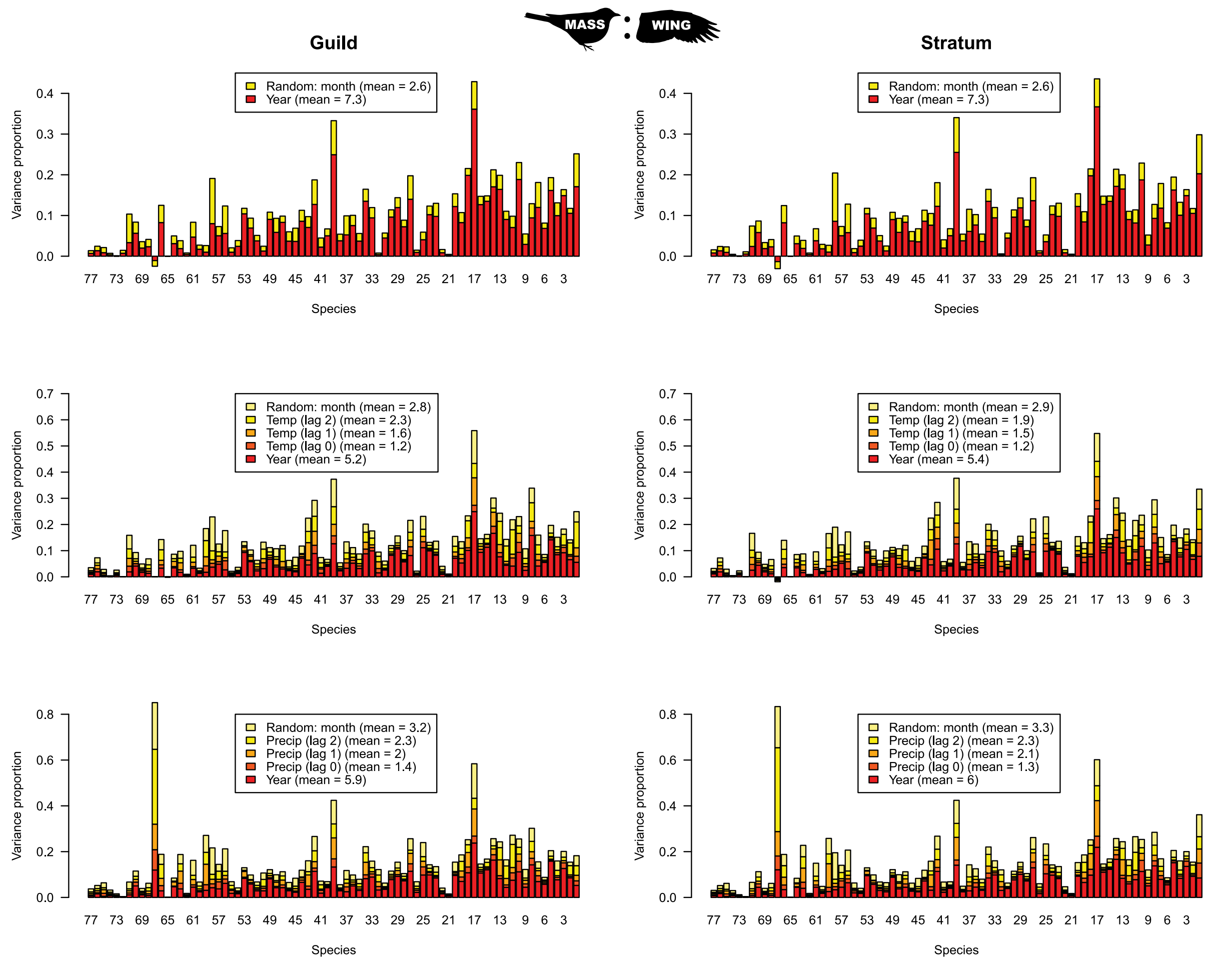

Fig. S13. Variance partitioning for mass:wing models. Vertical bars show the proportion of variance explained by each covariate, corrected for each species' R^2 value for a given model. Legends show mean proportion for each covariate. For more details, see models 13–18 in Table S4. Species are ordered on the x-axis following declining mass in Fig. 1D.

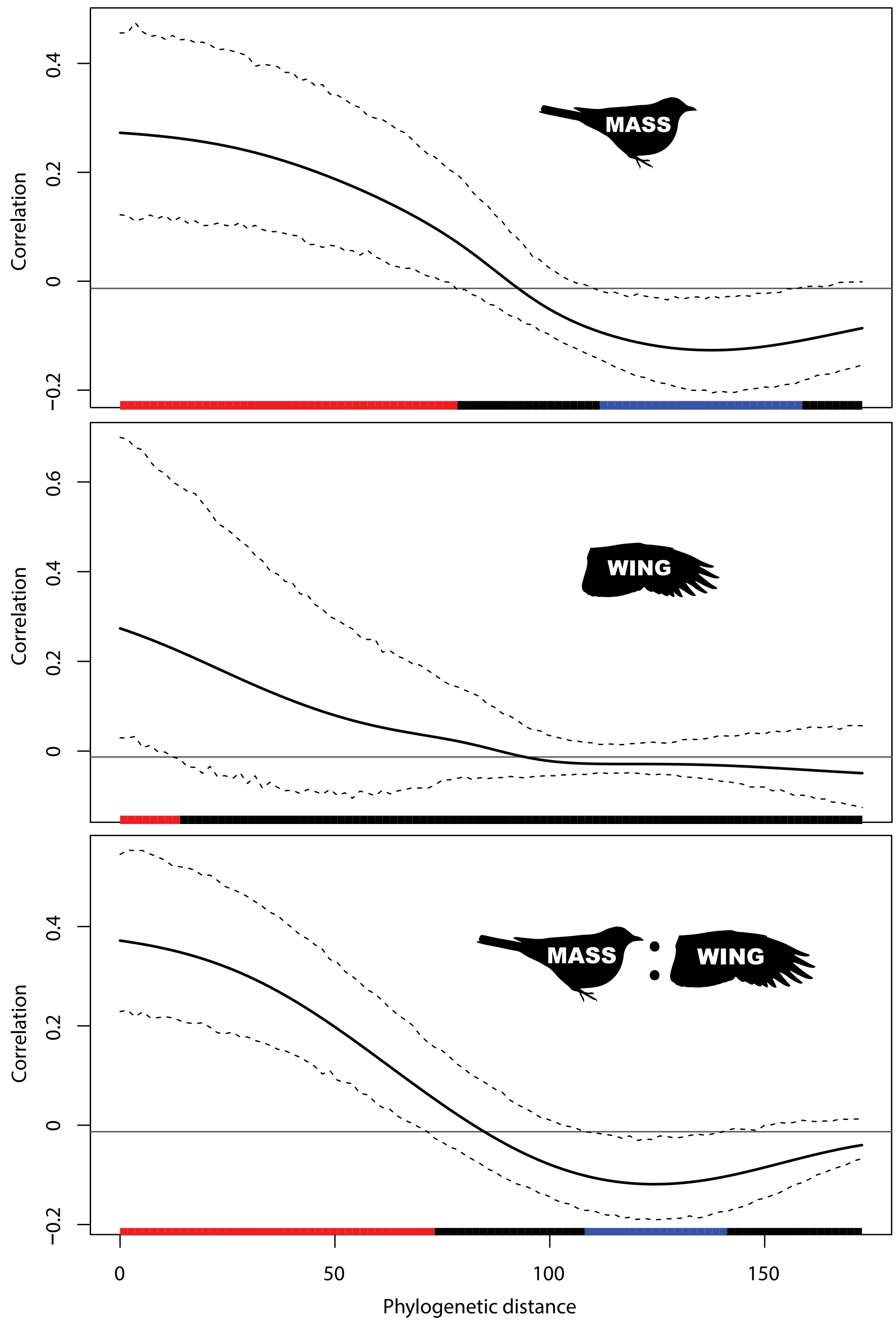

Fig. S14. Phylogenetic correlation in morphological changes through time. The bold black line represents Moran's I, an index of autocorrelation, compared to the null hypothesis (solid horizontal line). Dashed lines represent 95% confidence intervals, based on nonparametric bootstrap resampling. Colored x-axis bars show regions of significant positive (red) and negative (blue) autocorrelation. Plots were created using the *phylosignal* R package (*77*). Morphological change estimates are from models 1, 7, and 13 (table S4).

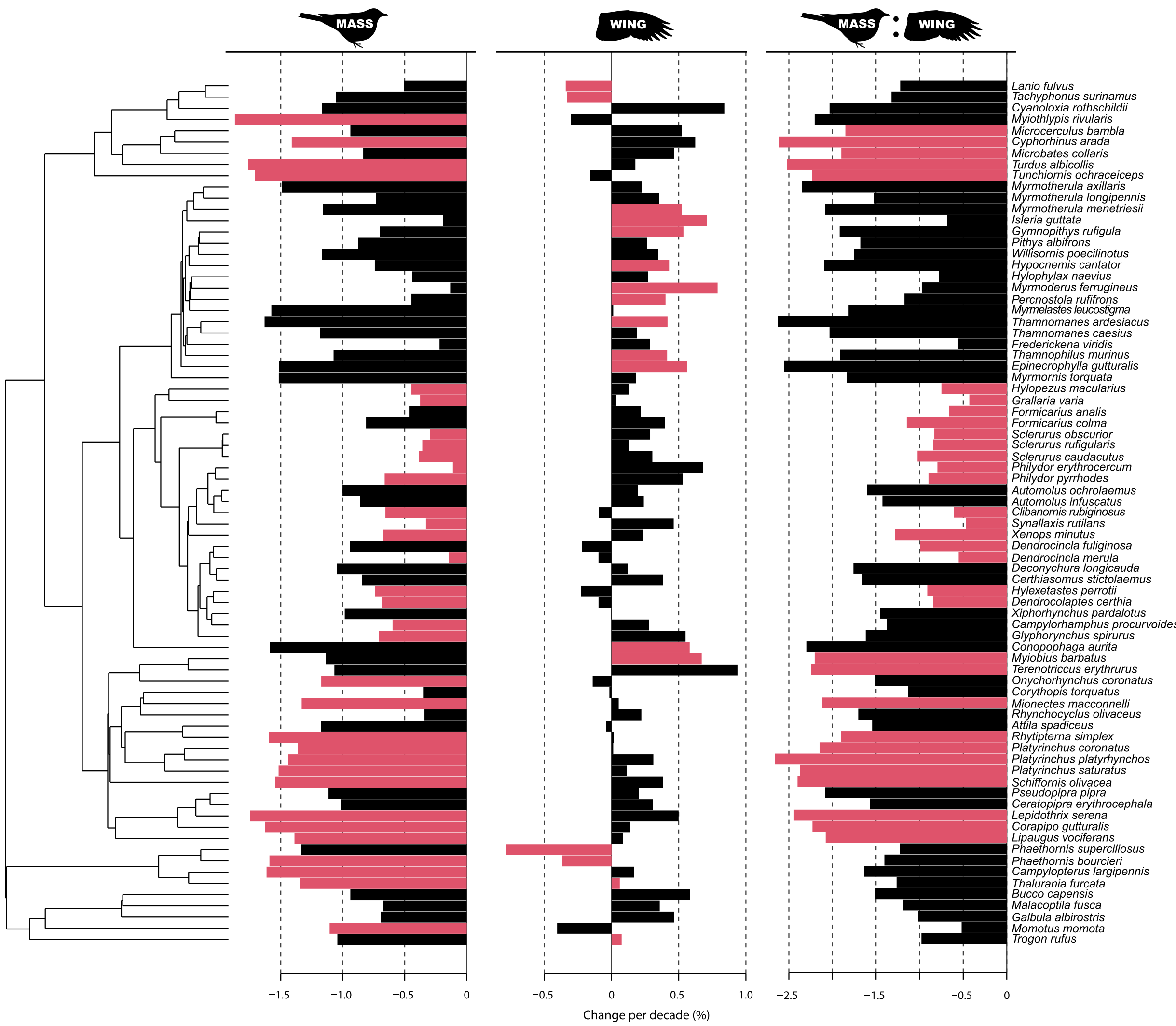

Fig. S15. Phylogenetic correlation in species-specific morphological change over time. Bars show median rate of change per decade, as a percentage of model-estimated median 1980 mass, wing length, or mass:wing ratio. Red bars indicate species with values more similar to their neighbors than expected by chance, meaning that the local indicator of phylogenetic association (LIPA; local Moran's I) is significantly positive ($p < 0.05$) based on permutation tests. Phylogenetic tree is from birdtree.org (*74*). Plots were created using the *phylosignal* R package (*77*). Morphological change estimates are from models 1, 7, and 13 (table S4).

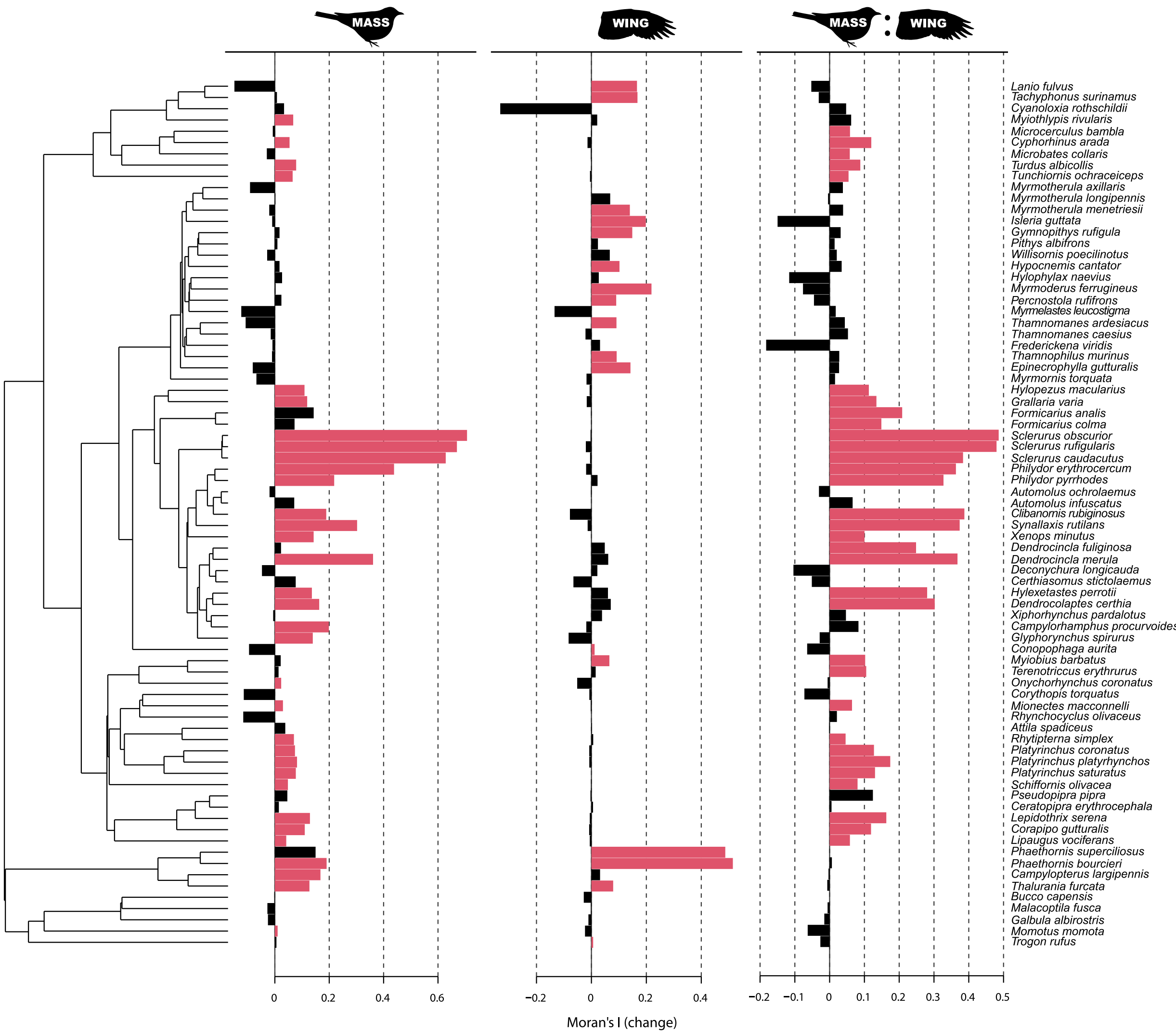

Fig. S16. Phylogenetic correlation in species-specific morphological change over time: Moran's I. Bars show the local indicator of phylogenetic association (LIPA; local Moran's I) for each species. Red bars indicate species with values more similar to their neighbors than expected by chance, meaning that the local Moran's I for that species is significantly positive ($p < 0.05$) based on permutation tests. Phylogenetic tree is from birdtree.org (*74*). Plots were created using the *phylosignal* R package (*77*). Morphological change estimates are from models 1, 7, and 13 (table S4).

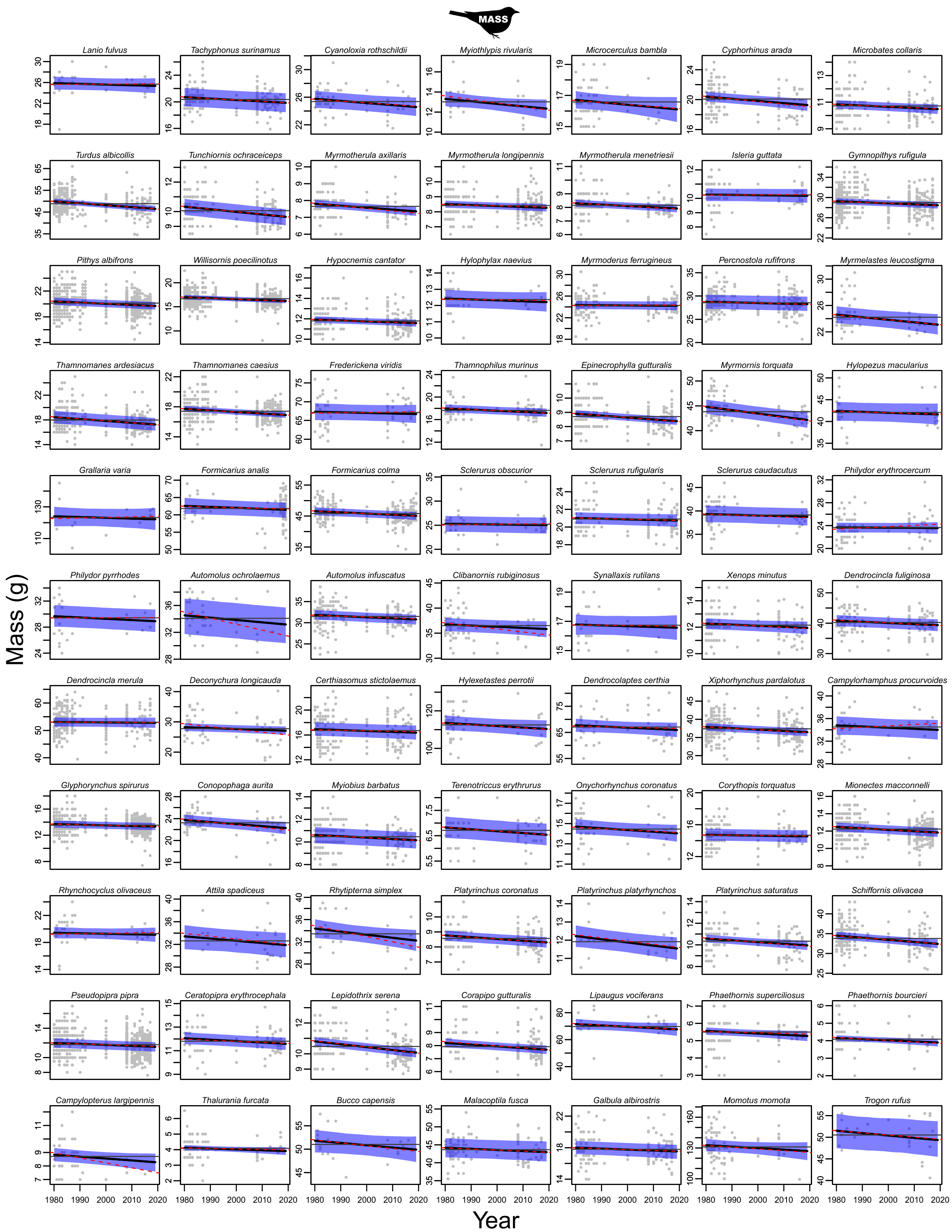

Fig. S17. Time trends in mass by species. Points show raw data values. Solid black line represents the median estimate of mass trend with 95% credible interval ribbon from an HMSC model including phylogeny and foraging guild (model 1 in Table S4). Dashed red line is a simple linear model for that species. Gray horizontal line is the overall mean value for that species.

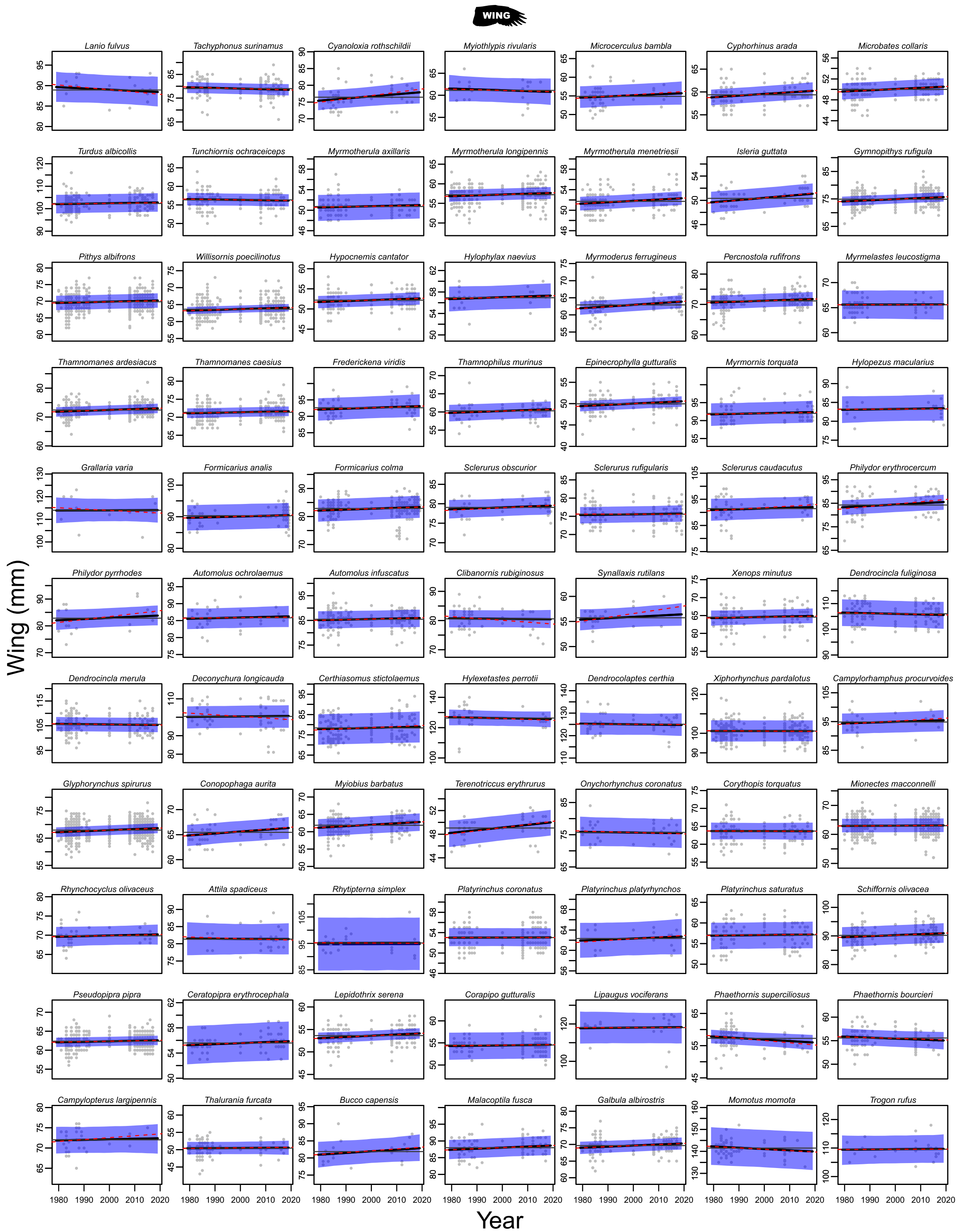

Fig. S18. Time trends in wing length by species. Points show raw data values. Solid black line represents the median estimate of wing trends with 95% credible interval ribbon from an HMSC model including phylogeny and foraging guild (model 7 in Table S4). Dashed red line is a simple linear model for that species. Gray horizontal line is the overall mean value for that species.

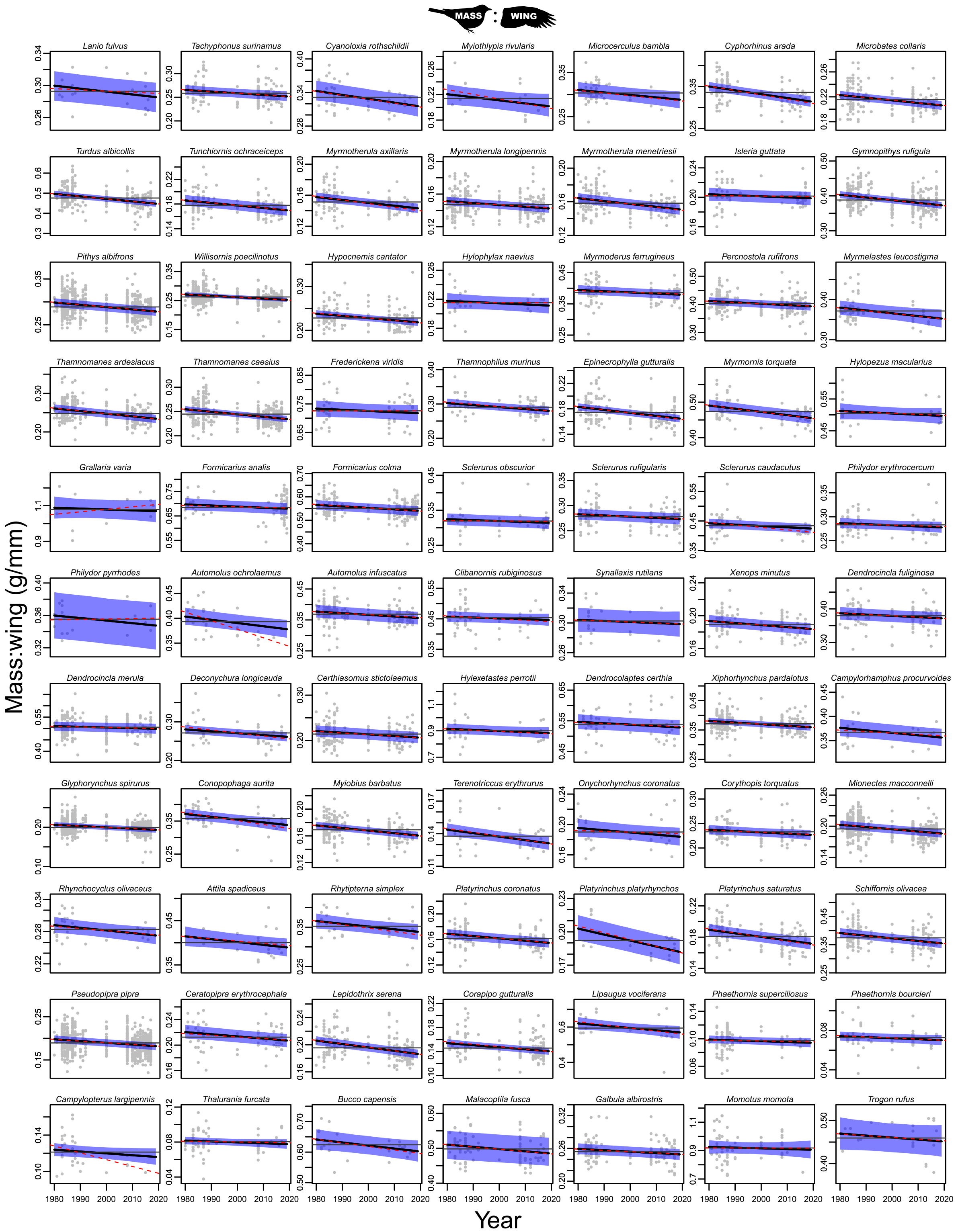

Fig. S19. Time trends in mass:wing by species. Points show raw data values. Solid black line represents the median estimate with 95% credible interval ribbon from an HMSC model including phylogeny and foraging guild (model 13 in Table S4). Dashed red line is a simple linear model for that species. Gray horizontal line is the overall mean value for that species.

Table S1. Time trend of bird morphology examined using linear mixed models. Models are fit with maximum likelihood to the entire dataset and include species and month as random effects. Significance of the time-trend parameter (year) is assessed using the Satterthwaite's method.

	Mass				**Wing**				**Mass:wing**			
Predictors	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*
(Intercept)	69.28	61.52 – 77.03	17.50	**<0.001**	39.17	30.18 – 48.15	8.55	**<0.001**	1.30	1.21 – 1.38	29.83	**<0.001**
Year	-0.02	-0.02 – -0.02	-14.79	**<0.001**	0.02	0.01 – 0.02	9.23	**<0.001**	-0.00	-0.00 – -0.00	-25.57	**<0.001**
Random Effects												
σ^2	5.29				7.61				0.00			
τ_{00}	611.75 $_{species}$				424.61 $_{species}$				0.04 $_{species}$			
	0.00 $_{month}$				0.00 $_{month}$				0.00 $_{month}$			
ICC	0.99				0.98				0.98			
n	77 $_{species}$				77 $_{species}$				77 $_{species}$			
	6 $_{month}$				6 $_{month}$				6 $_{month}$			
Observations	14842				11582				11009			
Marginal R^2 / Conditional R^2	0.000 / 0.991				0.000 / 0.982				0.001 / 0.982			
AIC	67578.121				57036.770				-48878.082			

Table S2. Bird morphology modeled by time trend and lagged seasonal temperature using linear mixed models. Models are fit with maximum likelihood to the entire dataset and include species and month as random effects. Significance of parameters is assessed using the Satterthwaite's method.

	Mass				**Wing**				**Mass:wing**			
Predictors	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*
(Intercept)	42.87	31.89 – 53.85	7.65	**<0.001**	14.81	-0.22 – 29.84	1.93	0.053	1.21	1.06 – 1.35	16.41	**<0.001**
Year	-0.00	-0.01 – 0.00	-1.62	0.106	0.03	0.02 – 0.04	7.78	**<0.001**	-0.00	-0.00 – -0.00	-10.79	**<0.001**
Temp lag 0 (dry)	-0.19	-0.27 – -0.11	-4.83	**<0.001**	0.10	-0.01 – 0.22	1.74	0.081	0.00	-0.00 – 0.00	0.30	0.766
Temp lag 1 (wet)	0.35	0.23 – 0.47	5.73	**<0.001**	0.27	0.12 – 0.43	3.51	**<0.001**	0.00	-0.00 – 0.00	1.56	0.118
Temp lag 2 (dry)	-0.37	-0.50 – -0.24	-5.44	**<0.001**	-0.53	-0.70 – -0.37	-6.33	**<0.001**	-0.00	-0.00 – -0.00	-2.04	**0.041**
Random effects												
σ^2	5.27				7.57				0.00			
τ_{00}	611.70 $_{species}$				424.31 $_{species}$				0.04 $_{species}$			
	0.00 $_{month}$				0.00 $_{month}$				0.00 $_{month}$			
ICC	0.99				0.98				0.98			
n	77 $_{species}$				77 $_{species}$				77 $_{species}$			
	6 $_{month}$				6 $_{month}$				6 $_{month}$			
Observations	14842				11582				11009			
Marginal R^2 / Conditional R^2	0.000 / 0.991				0.000 / 0.982				0.001 / 0.982			
AIC	67533.936				56993.767				-48876.644			

Table S3. Bird morphology modeled by time trend and lagged seasonal precipitation using linear mixed models. Models are fit with maximum likelihood to the entire dataset and include species and month as random effects. Significance of parameters is assessed using the Satterthwaite's method.

	Mass				**Wing**				**Mass:wing**			
Predictors	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*
(Intercept)	52.18	42.93 – 61.44	11.06	**<0.001**	6.45	-6.80 – 19.70	0.95	0.340	1.19	1.07 – 1.32	18.43	**<0.001**
Year	-0.01	-0.02 – -0.01	-6.58	**<0.001**	0.03	0.03 – 0.04	10.92	**<0.001**	-0.00	-0.00 – -0.00	-14.29	**<0.001**
Precip lag 0 (dry)	0.00	0.00 – 0.00	5.90	**<0.001**	0.00	-0.00 – 0.00	1.38	0.168	0.00	-0.00 – 0.00	1.91	0.057
Precip lag 1 (wet)	-0.00	-0.00 – -0.00	-3.40	**0.001**	-0.00	-0.00 – -0.00	-5.38	**<0.001**	-0.00	-0.00 – 0.00	-0.50	0.619
Precip lag 2 (dry)	0.00	0.00 – 0.00	5.44	**<0.001**	0.00	0.00 – 0.00	7.40	**<0.001**	0.00	0.00 – 0.00	2.47	**0.013**
Random effects												
σ^2	5.26				7.56				0.00			
τ_{00}	611.75 $_{species}$				424.44 $_{species}$				0.04 $_{species}$			
	0.00 $_{month}$				0.00 $_{month}$				0.00 $_{month}$			
ICC	0.99				0.98				0.98			
n	77 $_{species}$				77 $_{species}$				77 $_{species}$			
	6 $_{month}$				6 $_{month}$				6 $_{month}$			
Observations	14842				11582				11009			
Marginal R^2 / Conditional R^2	0.000 / 0.991				0.000 / 0.983				0.001 / 0.982			
AIC	67506.383				56974.802				-48882.735			

Table S4. Structure and fit of Bayesian joint species models used in this study. Models 1–18 included the effect of phylogeny and trait. Models 19–27 merge species, which are then treated as a random effect, and do not include phylogeny or trait.

Index	Model	Response variable	Predictor covariates	Trait	Mean R^2
1	Time	Mass	Year	Guild	0.054
2	Temperature	"	Year + $Temp\_Lag0_{dry}$ + $Temp\_Lag1_{wet}$ + $Temp\_Lag2_{dry}$	"	0.087
3	Precipitation	"	Year + $Precip\_Lag0_{dry}$ + $Precip\_Lag1_{wet}$ + $Precip\_Lag2_{dry}$	"	0.105
4	Time	"	Year	Stratum	0.055
5	Temperature	"	Year + $Temp\_Lag0_{dry}$ + $Temp\_Lag1_{wet}$ + $Temp\_Lag2_{dry}$	"	0.086
6	Precipitation	"	Year + $Precip\_Lag0_{dry}$ + $Precip\_Lag1_{wet}$ + $Precip\_Lag2_{dry}$	"	0.105
7	Time	Wing	Year	Guild	0.063
8	Temperature	"	Year + $Temp\_Lag0_{dry}$ + $Temp\_Lag1_{wet}$ + $Temp\_Lag2_{dry}$	"	0.114
9	Precipitation	"	Year + $Precip\_Lag0_{dry}$ + $Precip\_Lag1_{wet}$ + $Precip\_Lag2_{dry}$	"	0.122
10	Time	"	Year	Stratum	0.066
11	Temperature	"	Year + $Temp\_Lag0_{dry}$ + $Temp\_Lag1_{wet}$ + $Temp\_Lag2_{dry}$	"	0.114
12	Precipitation	"	Year + $Precip\_Lag0_{dry}$ + $Precip\_Lag1_{wet}$ + $Precip\_Lag2_{dry}$	"	0.120
13	Time	Mass:wing	Year	Guild	0.099
14	Temperature	"	Year + $Temp\_Lag0_{dry}$ + $Temp\_Lag1_{wet}$ + $Temp\_Lag2_{dry}$	"	0.131
15	Precipitation	"	Year + $Precip\_Lag0_{dry}$ + $Precip\_Lag1_{wet}$ + $Precip\_Lag2_{dry}$	"	0.149
16	Time	"	Year	Stratum	0.099
17	Temperature	"	Year + $Temp\_Lag0_{dry}$ + $Temp\_Lag1_{wet}$ + $Temp\_Lag2_{dry}$	"	0.129
18	Precipitation	"	Year + $Precip\_Lag0_{dry}$ + $Precip\_Lag1_{wet}$ + $Precip\_Lag2_{dry}$	"	0.150
19	Time	Mass	Year	NA	0.026
20	Temperature	"	Year + $Temp\_Lag0_{dry}$ + $Temp\_Lag1_{wet}$ + $Temp\_Lag2_{dry}$	NA	0.035
21	Precipitation	"	Year + $Precip\_Lag0_{dry}$ + $Precip\_Lag1_{wet}$ + $Precip\_Lag2_{dry}$	NA	0.041
22	Time	Wing	Year	NA	0.009
23	Temperature	"	Year + $Temp\_Lag0_{dry}$ + $Temp\_Lag1_{wet}$ + $Temp\_Lag2_{dry}$	NA	0.014
24	Precipitation	"	Year + $Precip\_Lag0_{dry}$ + $Precip\_Lag1_{wet}$ + $Precip\_Lag2_{dry}$	NA	0.016
25	Time	Mass:wing	Year	NA	0.071
26	Temperature	"	Year + $Temp\_Lag0_{dry}$ + $Temp\_Lag1_{wet}$ + $Temp\_Lag2_{dry}$	NA	0.072
27	Precipitation	"	Year + $Precip\_Lag0_{dry}$ + $Precip\_Lag1_{wet}$ + $Precip\_Lag2_{dry}$	NA	0.074

Table S5. Bird morphology by age. Models are linear mixed models with species as a random effect fit with restricted maximum likelihood. Significance of age group effect (juvenile) is assessed using the Satterthwaite's method.

	Mass				**Wing**				**Mass:wing**			
Predictors	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*	*Estimates*	*CI*	*Statistic*	*p*
(Intercept)	28.16	22.47 – 33.86	9.70	**<0.001**	75.77	71.16 – 80.39	32.18	**<0.001**	0.33	0.29 – 0.37	14.85	**<0.001**
Juvenile	-0.45	-0.58 – -0.33	-7.06	**<0.001**	-0.59	-0.76 – -0.43	-7.08	**<0.001**	-0.00	-0.01 – -0.00	-5.33	**<0.001**
Random effects												
σ^2	4.36				6.50				0.00			
τ_{00}	649.02 $_{species}$				426.56 $_{species}$				0.04 $_{species}$			
ICC	0.99				0.98				0.99			
n	77 $_{species}$				77 $_{species}$				77 $_{species}$			
Observations	7362				6192				5927			
Marginal R^2 / Conditional R^2	0.000 / 0.993				0.000 / 0.985				0.000 / 0.985			

Table S6. Bird species considered in analysis, their trait assignments, and model-estimated body mass, wing length, and mass:wing ratio. Taxonomy follows South American Checklist Committee ver. 9 Feb 21. Morphological change estimates are from models 1, 7, and 13 (table S4).

Species	Guild	Stratum	Mass (g)				Wing length (mm)				Mass:wing ratio			
			n	1980	2019	Δ (%)	*n*	1980	2019	Δ (%)	*n*	1980	2019	Δ (%)
TROCHILIDAE														
Phaethornis bourcieri	HU	U	115	4.16	3.90	-6.20 ▼	95	55.85	55.05	-1.43	74	0.07	0.07	-5.41
Phaethornis superciliosus	HU	U	149	5.57	5.28	-5.20	131	57.76	55.99	-3.07 ▼	113	0.10	0.10	-4.04
Campylopterus largipennis	HU	M	45	8.85	8.30	-6.30	36	71.89	72.37	0.66	34	0.12	0.12	-6.45
Thalurania furcata	HU	M	116	4.14	3.93	-5.24	87	50.40	50.52	0.24	69	0.08	0.08	-4.94
TROGONIDAE														
Trogon rufus	MF	M	24	51.63	49.53	-4.07	24	109.48	109.80	0.29	20	0.47	0.45	-3.85
MOMOTIDAE														
Momotus momota	MF	M	80	133.00	127.26	-4.31	68	142.42	140.17	-1.58	60	0.93	0.91	-2.05
GALBULIDAE														
Galbula albirostris	MI	M	167	18.03	17.54	-2.70	140	69.06	70.31	1.81 ▲	134	0.26	0.25	-3.86 ▼
BUCCONIDAE														
Bucco capensis	MI	M	22	51.81	49.92	-3.66	22	81.06	82.91	2.28	22	0.64	0.60	-5.94 ▼
Malacoptila fusca	UI	U	115	44.15	42.98	-2.64	95	87.36	88.59	1.40	91	0.51	0.49	-4.70 ▼
THAMNOPHILIDAE														
Frederickena viridis	NGI	NG	59	67.35	66.77	-0.86	56	91.97	92.99	1.11	51	0.73	0.72	-2.18
Thamnophilus murinus	MI	M	100	17.98	17.22	-4.19 ▼	72	59.85	60.82	1.62	70	0.30	0.28	-7.28 ▼
Thamnomanes ardesiacus	UI	U	508	18.42	17.25	-6.36 ▼	395	71.78	72.95	1.62 ▲	382	0.26	0.23	-10.34 ▼
Thamnomanes caesius	MI	M	504	17.71	16.90	-4.61 ▼	373	71.01	71.53	0.73	356	0.26	0.23	-8.24 ▼
Isleria guttata	NGI	NG	105	10.27	10.19	-0.75	71	49.70	51.08	2.77 ▲	64	0.20	0.20	-2.46
Epinecrophylla gutturalis	UI	U	292	8.89	8.36	-5.91 ▼	205	49.47	50.56	2.20 ▲	194	0.18	0.17	-9.84 ▼
Myrmotherula axillaris	UI	U	165	7.81	7.35	-5.82 ▼	120	50.50	50.95	0.88	114	0.16	0.14	-9.49 ▼
Myrmotherula longipennis	UI	U	370	8.51	8.27	-2.86 ▼	317	56.82	57.61	1.39 ▲	299	0.15	0.14	-5.96 ▼
Myrmotherula menetriesii	MI	M	212	8.31	7.93	-4.53 ▼	182	51.27	52.32	2.04 ▲	171	0.16	0.15	-7.93 ▼

Hypocnemis cantator	GI	U	283	11.94	11.59	-2.90	▼	197	51.62	52.48	1.67	▲	191	0.24	0.22	-7.98	▼
Percnostola rufifrons	GI	NG	282	28.76	28.26	-1.73		234	70.68	71.79	1.57	▲	220	0.41	0.39	-4.60	▼
Myrmelastes leucostigma	RI	NG	74	24.64	23.13	-6.14	▼	66	65.76	65.79	0.05		59	0.38	0.35	-7.09	▼
Myrmoderus ferrugineus	TI	T	147	24.34	24.21	-0.52		107	61.95	63.85	3.08	▲	104	0.39	0.38	-3.82	▼
Myrmornis torquata	TI	T	101	44.90	42.25	-5.91	▼	77	91.78	92.43	0.71		76	0.49	0.46	-7.14	▼
Pithys albifrons	AF	NG	1160	20.39	19.70	-3.42	▼	874	69.46	70.18	1.04	▲	831	0.30	0.28	-6.38	▼
Gymnopithys rufigula	AF	NG	551	29.26	28.46	-2.74	▼	367	74.04	75.58	2.09	▲	351	0.40	0.37	-7.44	▼
Hylophylax naevius	NGI	NG	43	12.42	12.21	-1.72		28	56.69	57.29	1.07		26	0.22	0.21	-2.75	
Willisornis poecilinotus	NGI	NG	774	16.98	16.21	-4.55	▼	589	63.18	64.03	1.35	▲	566	0.27	0.25	-7.01	▼
CONOPOPHAGIDAE																	
Conopophaga aurita	NGI	NG	66	23.71	22.25	-6.19	▼	52	64.85	66.32	2.27	▲	49	0.37	0.34	-8.89	▼
GRALLARIIDAE																	
Grallaria varia	TI	T	12	124.13	122.32	-1.46		12	113.52	113.67	0.14		11	1.09	1.07	-1.65	
Hylopezus macularius	TI	T	30	42.39	41.65	-1.74		24	83.07	83.48	0.50		22	0.51	0.50	-2.93	
FORMICARIIDAE																	
Formicarius colma	TI	T	248	46.52	45.05	-3.16	▼	219	82.16	83.44	1.55	▲	202	0.57	0.54	-4.42	▼
Formicarius analis	TI	T	98	62.53	61.40	-1.81		100	89.63	90.39	0.85		97	0.70	0.68	-2.59	
FURNARIIDAE																	
Sclerurus obscurior	TI	T	47	25.36	25.07	-1.15		42	78.55	79.44	1.12		41	0.32	0.31	-3.40	
Sclerurus rufigularis	TI	T	150	21.02	20.73	-1.40		124	75.41	75.78	0.50		120	0.28	0.27	-3.53	▼
Sclerurus caudacutus	TI	T	68	39.41	38.82	-1.50		49	90.83	91.91	1.19		46	0.44	0.43	-3.85	▼
Certhiasomus stictolaemus	WO	U	201	16.90	16.35	-3.29		165	77.75	78.91	1.49		159	0.22	0.21	-6.33	▼
Deconychura longicauda	WO	M	57	28.18	27.03	-4.08		48	100.19	100.66	0.47		45	0.28	0.26	-6.79	▼
Dendrocincla merula	AF	NG	271	53.13	52.84	-0.56		203	105.71	105.31	-0.38		186	0.51	0.50	-2.16	
Dendrocincla fuliginosa	AW	U	130	40.82	39.33	-3.67		116	106.43	105.51	-0.86		109	0.39	0.37	-3.88	
Glyphorynchus spirurus	WO	U	924	13.70	13.32	-2.76	▼	762	67.27	68.72	2.15	▲	732	0.21	0.19	-6.28	▼
Dendrocolaptes certhia	AW	M	56	67.73	65.92	-2.68		48	125.39	124.91	-0.38		47	0.55	0.53	-3.29	
Hylexetastes perrotii	AW	M	47	113.37	110.09	-2.89		35	126.86	125.73	-0.89		33	0.91	0.88	-3.61	
Xiphorhynchus pardalotus	WO	M	355	37.83	36.38	-3.84	▼	265	101.23	101.22	-0.01		257	0.38	0.36	-5.77	▼

Campylorhamphus procurvoides	WO	M	31	34.73	33.92	-2.33		27	94.20	95.22	1.09		23	0.38	0.36	-5.32	▼
Xenops minutus	MI	M	144	12.27	11.95	-2.62		110	64.30	64.88	0.91		103	0.19	0.18	-5.15	▼
Philydor erythrocercum	MI	M	85	23.70	23.60	-0.43		67	83.26	85.47	2.66		62	0.29	0.28	-3.14	
Philydor pyrrhodes	UI	U	28	29.69	28.92	-2.58		18	82.24	83.94	2.07		16	0.36	0.35	-3.33	
Clibanornis rubiginosus	NGI	NG	81	36.79	35.85	-2.56		57	80.77	80.48	-0.36		56	0.46	0.45	-2.41	
Automolus ochrolaemus	UI	U	35	34.49	33.15	-3.91	▼	31	85.53	86.19	0.76		28	0.40	0.38	-6.44	▼
Automolus infuscatus	UI	U	240	31.84	30.77	-3.35	▼	182	85.25	86.05	0.93		174	0.38	0.36	-5.57	▼
Synallaxis rutilans	NGI	NG	30	16.71	16.50	-1.29		23	55.35	56.35	1.80		22	0.30	0.30	-1.97	
PIPRIDAE																	
Corapipo gutturalis	MF	M	188	8.20	7.68	-6.34	▼	177	54.33	54.62	0.54		170	0.15	0.14	-9.09	▼
Lepidothrix serena	UF	U	258	10.80	10.07	-6.83	▼	203	53.09	54.13	1.95	▲	201	0.21	0.19	-9.71	▼
Pseudopipra pipra	UF	U	969	12.01	11.48	-4.35	▼	797	62.12	62.62	0.80	▲	774	0.20	0.18	-8.08	▼
Ceratopipra erythrocephala	MF	M	91	12.03	11.56	-3.96	▼	76	55.33	55.99	1.20		76	0.22	0.21	-5.91	▼
COTINGIDAE																	
Lipaugus vociferans	MF	M	23	71.87	67.98	-5.42		21	118.43	118.83	0.33		20	0.62	0.57	-8.19	▼
TITYRIDAE																	
Schiffornis olivacea	UF	U	241	34.56	32.47	-6.03	▼	173	89.66	91.00	1.49	▲	164	0.39	0.36	-9.44	▼
ONYCHORHYNCHIDAE																	
Onychorhynchus coronatus	UI	U	47	14.69	14.02	-4.58		33	75.92	75.51	-0.55		32	0.20	0.18	-6.12	
Terenotriccus erythrurus	MI	M	64	6.83	6.55	-4.16		49	48.20	49.97	3.66	▲	46	0.14	0.13	-9.03	▼
Myiobius barbatus	MI	M	293	10.60	10.13	-4.43	▼	217	61.24	62.84	2.62	▲	204	0.18	0.16	-8.57	▼
TYRANNIDAE																	
Platyrinchus saturatus	NGI	NG	155	10.58	9.95	-5.92	▼	120	56.90	57.16	0.44		117	0.19	0.17	-9.47	▼
Platyrinchus coronatus	UI	U	219	8.75	8.29	-5.32	▼	175	53.08	53.11	0.05		165	0.17	0.15	-8.33	▼
Platyrinchus platyrhynchos	UI	U	22	12.19	11.51	-5.60	▼	18	61.84	62.60	1.21		18	0.20	0.18	-10.40	▼
Corythopis torquatus	NGI	NG	170	14.75	14.55	-1.38		112	63.62	63.58	-0.06		109	0.24	0.23	-4.64	▼
Mionectes macconnelli	MF	M	647	12.48	11.83	-5.19	▼	500	62.97	63.10	0.21		483	0.20	0.19	-7.92	▼
Rhynchocyclus olivaceus	MI	M	47	19.38	19.12	-1.33		39	69.80	70.40	0.87		37	0.29	0.27	-6.51	▼
Attila spadiceus	MI	M	26	33.27	31.75	-4.58		27	81.48	81.36	-0.15		26	0.41	0.39	-6.04	▼

Rhytipterna simplex	MI	M	24	34.44	32.29	-6.22	▼	25	95.33	95.39	0.07		24	0.37	0.34	-7.40	▼
VIREONIDAE																	
Tunchiornis ochraceiceps	UI	U	225	10.32	9.63	-6.67	▼	172	56.52	56.17	-0.62		163	0.19	0.17	-8.60	▼
TROGLODYTIDAE																	
Microcerculus bambla	NGI	NG	72	16.72	16.11	-3.65		53	54.59	55.70	2.04		48	0.31	0.29	-7.07	▼
Cyphorhinus arada	TI	T	172	20.34	19.22	-5.50	▼	122	58.87	60.30	2.43	▲	109	0.35	0.31	-10.29	▼
POLIOPTILIDAE																	
Microbates collaris	NGI	NG	272	10.84	10.48	-3.26	▼	200	49.53	50.43	1.81	▲	190	0.22	0.21	-7.62	▼
TURDIDAE																	
Turdus albicollis	UF	U	335	50.05	46.61	-6.87	▼	234	102.09	102.80	0.69		226	0.50	0.45	-9.68	▼
PARULIDAE																	
Myiothlypis rivularis	RI	NG	21	13.31	12.34	-7.30		21	61.70	60.97	-1.18		18	0.22	0.20	-8.68	
CARDINALIDAE																	
Cyanoloxia rothschildii	UF	U	61	25.75	24.58	-4.55		49	75.49	77.96	3.27		47	0.34	0.32	-7.87	▼
THRAUPIDAE																	
Tachyphonus surinamus	MF	M	174	20.69	19.84	-4.11	▼	141	79.54	78.51	-1.30		139	0.27	0.25	-5.26	▼
Lanio fulvus	MI	M	29	25.88	25.37	-1.97		21	89.66	88.47	-1.33		21	0.30	0.29	-5.00	

Guild: AW=ant-woodcreeper, AF=army-ant follower, GI=gap insectivore, HU=hummingbird, MF=midstory frugivore, MI=midstory insectivore, NGI=near-ground insectivore, RI=riparian insectivore, TI=terrestrial insectivore, UF=understory frugivore, UI=understory insectivore, WO=woodcreeper

Stratum: M=midstory, U=understory, NG=near-ground, T=terrestrial

▼=decreasing with 95% credible intervals entirely negative, ▲=increasing with 95% credible intervals entirely positive