

# Supporting Information

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## SI Methods

**Comparative Analyses and Phylogeny.** We tested the statistical and evolutionary assumptions of comparative analyses (1) by regressing the absolute standardized contrasts against their standard deviations. To test for effects of problems of heterogeneity in variance, we excluded outliers (contrasts with Studentized residuals >3) in a second series of analyses (2), and repeated analyses with the independent variables expressed in ranks. In neither case did these analyses change any of the main conclusions, and thus we do not report them here.

The composite phylogeny used in the contrast analyses (Fig. S1) was based mainly on Sibley and Ahlquist (3), combined with other sources (4–16). Because information for the composite phylogeny originated from different studies using different molecular and phylogenetic methods, branch lengths were transformed assuming a gradual model of evolution, with branch lengths being proportional to the number of species contained within a clade, as implemented by the CAIC software (17). However, a second set of analyses based on similar branch length produced qualitatively similar results to those reported here (details not shown).

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**Table S1. Statistics for excluded terms in multiple regression models of population trend of migratory birds during 1970–1990, population trend during 1990–2000, and change in mean migration date, 1960–2006**

Variables	<i>F</i>	<i>df</i>	<i>P</i>	Estimate (SE)
Population trend during 1970–1990				
Species-specific values				
Northernmost breeding latitude	3.29	1, 94	.07	−0.058 (0.032)
Change in migration date	2.59	1, 93	.11	−0.902 (0.561)
Population size	1.12	1, 92	.29	0.218 (0.206)
Number of broods	0.34	1, 91	.56	−0.107 (0.184)
Migration distance	0.19	1, 90	.66	−0.134 (0.301)
Sexual dichromatism	0.26	1, 89	.61	−0.138 (0.269)
Independent contrasts				
Change in migration date	1.66	1, 91	.20	−0.779 (0.606)
Population size	2.06	1, 90	.15	0.359 (0.249)
Number of broods	0.34	1, 89	.56	−0.126 (0.214)
Migration distance	0.21	1, 88	.65	−0.168 (0.368)
Sexual dichromatism	0.21	1, 87	.64	0.171 (0.367)
Population trend during 1990–2000				
Species-specific values				
Body mass	2.55	1, 95	.11	0.349 (0.150)
Farmland habitat	1.06	1, 94	.31	−0.380 (0.369)
Northernmost breeding latitude	0.68	1, 93	.41	−0.026 (0.031)
Sexual dichromatism	0.46	1, 92	.50	−0.167 (0.247)
Migration distance	0.35	1, 91	.56	−0.161 (0.273)
Number of broods	0.09	1, 90	.76	−0.058 (0.186)
Population size	0.01	1, 89	.94	0.016 (0.216)
Independent contrasts				
Migration distance	1.14	1, 93	.29	−0.298 (0.278)
Population size	1.51	1, 92	.22	−0.230 (0.187)
Sexual dichromatism	0.22	1, 91	.64	−0.125 (0.267)
Number of broods	0.26	1, 90	.61	−0.094 (0.185)
Northernmost breeding latitude	0.15	1, 89	.70	0.012 (0.030)
Farmland habitat	0.00	1, 88	.95	−0.026 (0.381)
Body mass	0.00	1, 87	.98	−0.011 (0.388)
Change in migration date, 1960–2006				
Species-specific values				
Body mass	2.17	1, 91	.14	−0.043 (0.029)
Northernmost breeding latitude	0.56	1, 90	.46	−0.004 (0.005)
Population size	0.22	1, 89	.64	−0.015 (0.033)
Farmland habitat	0.21	1, 88	.65	0.029 (0.062)
Sexual dichromatism	0.17	1, 87	.68	−0.017 (0.041)
Population trends 1970–1990	0.11	1, 86	.92	0.002 (0.017)
Independent contrasts				
Body mass	1.83	1, 89	.18	−0.087 (0.064)
Farmland habitat	1.07	1, 88	.30	0.061 (0.059)
Northernmost breeding latitude	0.28	1, 87	.06	−0.003 (0.005)
Sexual dichromatism	0.12	1, 86	.73	−0.018 (0.053)
Population trends 1970–1990	0.04	1, 85	.84	0.003 (0.016)
Population size	0.01	1, 84	.93	−0.003 (0.039)

Excluded terms are shown in the order of removal from the model (first to be removed are shown at the bottom).

**Table S2. Minimal adequate multiple regression models of population trend of migratory birds during 1970–1990, population trend of migratory birds during 1990–2000, and change in mean spring migration date of migratory birds 1960–2006, obtained by step-down removal of nonsignificant predictors (see *Methods*), where the effect of wintering in Africa has been included in initial models instead of migration distance (see *Methods*).**

Variables	<i>F</i>	df	<i>P</i>	Estimate (SE)
Population trend during 1970–1990				
Species-specific values				
Body mass	13.17	1, 94	<.001	0.569 (0.164)
Wintering in Africa	5.11	1, 94	.026	−0.621 (0.275)
Farmland habitat	4.79	1, 94	.031	−0.834 (0.381)
Independent contrasts				
Farmland habitat	7.09	1, 91	.009	−1.087 (0.408)
Northernmost breeding latitude	5.90	1, 91	.017	−0.082 (0.034)
Wintering in Africa	5.29	1, 91	.024	−0.781 (0.339)
Body mass	4.72	1, 91	.033	0.958 (0.441)
Population trend during 1990–2000				
Species-specific values				
Change in migration date	27.19	1, 96	<.001	−2.801 (0.537)
Independent contrasts				
Change in migration date	31.48	1, 94	<.001	−2.656 (0.473)
Change in migration date, 1960–2006				
Species-specific values				
Population trends 1990–2000	22.28	1, 92	<.001	−0.068 (0.014)
Migration distance	11.19	1, 92	.001	0.136 (0.041)
Number of broods	5.52	1, 92	.021	−0.052 (0.022)
Independent contrasts				
Population trends 1990–2000	24.62	1, 90	<.001	−0.078 (0.016)
Wintering in Africa	10.65	1, 90	.002	0.157 (0.048)
Number of broods	5.88	1, 90	.017	−0.070 (0.029)

Table S3. Complete dataset used in analyses

Species	Trend in migration date	Population trend 1970–1990	Population trend 1990–2000	No. of broods	Natal dispersal	Farmland breeding habitat	Habitat specialization	Thermal maximum	Migration distance	Wintering in Africa	Winter habitat	Northern-most breeding latitude	Sexual dichromatism	Brain mass (g)	Body mass (g)	European breeding population
																(pairs × 10 <sup>5</sup> )
<i>Accipiter nisus</i>	-0.032	3	1	1	15.6	0	-	-	12.79	0	1	70.00	1	2.92	204.0	3.95
<i>Acrocephalus palustris</i>	-0.157	0	0	1	-	0	-	-	66.84	1	3	63.93	0	0.52	12.0	50.00
<i>Acrocephalus schoenobaenus</i>	-0.060	0	0	2	40.4	0	-	-	62.10	1	3	70.63	0	-	11.9	59.00
<i>Acrocephalus scirpaceus</i>	-0.116	0	0	1	47.0	0	-	-	44.60	1	3	64.64	0	0.58	11.8	38.50
<i>Alauda arvensis</i>	-0.291	-3	-1	4	5.5	1	1.32	20.08	13.01	0	2	71.16	0	0.97	36.4	600.00
<i>Anas acuta</i>	-0.099	-3	-2	1	-	0	-	-	26.72	1	4	70.63	1	-	917.0	3.40
<i>Anas platyrhynchos</i>	-0.461	0	-1	1	19.9	0	-	-	8.12	0	3	71.09	1	5.82	1119.0	42.00
<i>Anser anser</i>	0.136	3	3	1	-	0	-	-	12.28	0	3	71.11	0	11.91	3464.5	1.55
<i>Anthus pratensis</i>	-0.346	0	-1	3	0.9	0	0.69	16.97	15.64	0	2	71.17	0	0.36	19.2	115.00
<i>Anthus (spinoletta) petrosus</i>	-0.312	0	-1	2	-	0	-	-	21.27	0	3	75.00	0	0.58	21.5	15.20
<i>Anthus trivialis</i>	-0.130	0	-1	3	-	0	0.46	19.55	47.07	1	1	70.50	0	0.68	23.4	345.00
<i>Apus apus</i>	-0.049	0	-1	1	36.8	0	-	-	59.39	1	5	70.00	0	0.69	39.6	119.50
<i>Arenaria interpres</i>	-0.050	0	0	1	-	0	-	-	63.88	1	4	83.33	1	-	107.5	0.58
<i>Aythya fuligula</i>	-0.056	0	-2	1	-	0	-	-	17.08	0	3	70.16	1	4.36	656.5	8.05
<i>Bucephala clangula</i>	-0.154	2	1	1	-	0	-	-	9.66	0	3	70.31	1	-	840.3	5.40
<i>Calidris temminckii</i>	0.034	0	0	1	-	0	-	-	43.12	1	3	71.25	0	-	26.1	2.53
<i>Carduelis cannabina</i>	0.116	0	-2	3	4.4	0	0.63	20.54	4.11	0	2	66.00	1	0.67	18.9	190.00
<i>Carduelis carduelis</i>	-0.368	0	1	3	11.1	0	0.56	20.59	1.16	0	2	63.57	1	0.59	15.6	205.00
<i>Carduelis chloris</i>	-0.286	0	0	2	4.2	0	0.52	20.51	1.34	0	5	70.31	1	0.89	27.6	230.00
<i>Carduelis flammea</i>	-0.178	0	-	2	22.7	0	-	-	9.46	0	2	76.00	1	0.59	13.1	139.00
<i>Carduelis spinus</i>	-0.253	0	-	2	-	0	-	-	6.83	0	1	70.00	1	0.56	13.8	140.00
<i>Carpodacus erythrinus</i>	0.238	0	0	1	-	0	-	-	24.22	0	1	67.67	1	-	23.4	45.50
<i>Cephus grylle</i>	0.006	-2	0	1	-	0	-	-	0.70	0	4	81.75	0	-	394.5	2.15
<i>Charadrius hiaticula</i>	-0.193	0	-1	3	-	0	-	-	2.56	0	4	83.33	0	-	63.2	1.70
<i>Clangula hyemalis</i>	-0.440	0	0	1	-	0	-	-	15.78	0	4	82.22	1	-	722.5	7.20
<i>Columba oenas</i>	-0.954	3	2	4	10.4	0	0.68	19.24	3.45	0	1	65.00	0	2.27	314.5	6.25
<i>Columba palumbus</i>	-0.360	0	1	3	10.7	1	0.19	20.26	2.03	0	1	67.33	0	2.38	494.5	130.00
<i>Corvus corone</i>	-0.215	3	0	1	9.9	0	0.32	20.46	5.71	0	2	71.17	0	8.14	544.5	120.00
<i>Corvus monedula</i>	-0.816	0	0	1	8.6	0	0.55	20.40	0.29	0	2	66.36	0	4.69	249.0	101.00
<i>Cuculus canorus</i>	0.266	0	-1	1	-	0	0.27	20.46	49.38	1	1	70.47	0	2.24	120.5	64.00
<i>Cygnus cygnus</i>	-0.474	3	3	1	-	0	-	-	9.29	0	3	70.00	0	-	11375.0	0.19
<i>Cygnus olor</i>	-0.325	2	3	1	34.3	0	-	-	1.08	0	3	62.41	1	-	10750.0	1.03
<i>Delichon urbica</i>	0.026	0	-2	2	10.4	0	0.89	20.55	44.25	1	5	70.33	0	0.59	19.5	169.50
<i>Emberiza citrinella</i>	-0.205	0	-1	3	8.4	1	0.54	19.35	4.72	0	2	70.44	1	0.82	26.8	245.00
<i>Emberiza hortulana</i>	0.063	-3	-1	1	-	1	-	-	36.48	1	2	67.50	1	-	20.6	106.00
<i>Emberiza schoeniclus</i>	-0.249	0	-1	2	5.4	0	-	-	10.52	0	3	71.18	1	0.68	18.8	68.00
<i>Erethacus rubecula</i>	-0.302	0	1	3	6.0	0	0.25	20.42	5.00	0	5	70.00	0	0.66	16.4	630.00
<i>Ficedula hypoleuca</i>	-0.118	0	-1	1	20.6	0	-	-	43.00	1	1	70.67	1	0.45	14.3	160.00
<i>Fringilla coelebs</i>	-0.140	0	0	2	3.6	0	0.51	20.57	5.54	0	2	71.25	1	0.77	24.2	1850.00
<i>Fringilla montifringilla</i>	-0.156	0	0	2	-	0	-	-	13.75	0	1	71.25	1	0.78	22.6	175.00
<i>Gallinago gallinago</i>	0.009	0	-2	1	-	0	-	-	7.05	0	3	71.25	0	1.35	106.5	14.15
<i>Gavia arctica</i>	0.251	-3	-3	1	-	0	-	-	10.57	0	4	73.28	0	-	2804.5	0.72
<i>Haematopus ostralegus</i>	-0.033	3	-2	1	-	0	-	-	21.39	0	4	71.25	0	-	531.0	3.75
<i>Hippolais icterina</i>	-0.033	0	-1	1	-	0	-	-	71.34	1	2	70.00	0	0.54	13.3	53.00
<i>Hirundo rustica</i>	-0.174	-2	-1	3	14.1	1	0.88	20.52	42.34	1	5	70.38	1	0.58	19.1	260.00
<i>Jynx torquilla</i>	0.141	-2	-2	3	-	0	-	-	35.20	1	5	69.50	0	-	37.3	9.40
<i>Lanius collurio</i>	-0.010	-2	-1	1	-	1	0.67	20.20	64.72	1	2	66.33	1	1.00	30.7	96.50
<i>Larus argentatus</i>	-0.502	3	2	1	-	0	-	-	22.14	0	4	71.25	0	6.43	895.0	15.25
<i>Larus fuscus</i>	-0.333	3	3	1	28.2	0	-	-	34.34	1	4	71.25	0	-	817.5	3.25
<i>Larus marinus</i>	-0.492	0	3	1	-	0	-	-	7.28	0	4	79.31	0	-	1599.5	1.45
<i>Larus ridibundus</i>	0.129	3	-2	1	47.0	0	-	-	23.50	0	4	68.00	0	2.88	280.5	18.50
<i>Limosa lapponica</i>	-0.018	0	0	1	-	0	-	-	59.92	1	4	70.31	0	-	301.0	0.04
<i>Luscinia luscinia</i>	-0.084	0	0	1	-	0	-	-	63.10	1	1	65.00	0	-	25.0	53.00
<i>Luscinia svecica</i>	-0.045	0	0	2	-	0	-	-	25.50	1	3	71.17	1	-	18.2	61.50
<i>Melanitta fusca</i>	0.028	0	-2	1	-	0	-	-	2.55	0	4	70.63	1	-	1587.5	0.93

Species	Trend in migration date	Popu-lation trend 1970–1990	Popu-lation trend 1990–2000	No. of broods	Natal dispersal	Farmland breeding habitat	Habitat speciali-zation	Thermal maximum	Migration distance	Wintering in Africa	Winter habitat	Northern-most breeding latitude	Sexual dichro-matism	Brain mass (g)	Body mass (g)	European breeding population
																(pairs × 10 <sup>5</sup> )
<i>Melanitta nigra</i>	-0.532	0	0	1	-	0	-	-	16.10	0	4	74.53	1	-	1306.5	1.15
<i>Mergus merganser</i>	-0.130	2	-1	1	-	0	-	-	4.89	0	3	71.25	1	-	1641.5	0.61
<i>Mergus serrator</i>	-0.208	0	-1	1	-	0	-	-	11.05	0	4	73.20	1	-	1090.5	0.97
<i>Motacilla alba</i>	-0.075	0	0	3	16.1	0	0.47	20.24	18.12	0	2	71.17	1	0.58	20.8	195.00
<i>Motacilla flava</i>	-0.014	0	-1	2	12.5	1	-	-	40.98	1	2	70.67	1	0.47	17.4	109.50
<i>Muscicapa striata</i>	-0.056	-2	-1	2	12.8	0	-	-	64.40	1	1	70.50	0	0.53	15.5	180.00
<i>Numenius arquata</i>	0.023	-	-2	1	-	0	-	-	44.67	0	4	70.63	0	3.68	725.0	2.90
<i>Oenanthe oenanthe</i>	0.021	0	-2	2	18.9	0	-	-	38.17	1	2	71.17	1	0.72	24.0	88.00
<i>Parus caeruleus</i>	-0.069	0	0	2	5.3	0	0.44	20.57	0.00	0	1	67.33	1	0.65	11.8	320.00
<i>Parus major</i>	-0.252	0	0	2	5.3	0	0.36	20.47	0.00	0	1	70.67	1	0.85	18.5	685.00
<i>Phalacrocorax carbo</i>	-0.313	3	3	1	-	0	-	-	2.63	0	3	71.27	0	-	2254.0	3.40
<i>Philomachus pugnax</i>	0.019	0	-2	1	-	0	-	-	52.20	1	3	71.25	1	-	140.5	3.55
<i>Phoenicurus ochruros</i>	-0.377	0	1	3	-	0	0.89	19.93	15.83	0	5	60.36	1	0.61	16.0	64.00
<i>Phoenicurus phoenicurus</i>	-0.068	-3	0	2	12.2	0	0.78	19.70	33.93	1	1	70.50	1	0.54	15.9	114.00
<i>Phylloscopus collybita</i>	-0.180	0	0	2	-	0	0.41	19.87	22.55	0	1	70.29	0	0.38	7.7	454.45
<i>Phylloscopus sibilatrix</i>	0.272	0	-2	2	20.0	0	2.09	18.92	52.74	1	1	68.33	0	-	9.1	180.00
<i>Phylloscopus trochilus</i>	-0.048	0	-1	2	20.8	0	0.65	17.70	68.09	1	1	71.18	0	0.31	9.3	780.00
<i>Plectrophenax nivalis</i>	-0.722	0	0	2	-	0	-	-	20.49	0	2	83.00	1	-	37.4	11.90
<i>Podiceps cristatus</i>	-0.098	3	-2	2	-	0	-	-	4.40	0	4	66.00	0	-	875.0	3.75
<i>Podiceps grisegena</i>	-0.060	0	-1	2	-	0	-	-	7.87	0	4	67.67	0	-	829.8	0.44
<i>Prunella modularis</i>	-0.153	0	0	3	2.1	0	0.38	19.05	9.23	0	2	70.67	0	0.71	19.0	190.00
<i>Pyrrhula pyrrhula</i>	-0.303	0	0	3	4.6	0	0.71	18.87	0.00	0	1	70.31	1	0.89	31.0	106.50
<i>Regulus regulus</i>	-0.156	0	0	2	-	0	1.09	18.86	0.00	0	1	70.29	1	0.38	5.8	270.00
<i>Saxicola rubetra</i>	0.015	0	-1	2	0.5	1	0.79	19.44	34.84	1	2	70.00	1	0.67	16.6	77.00
<i>Scolopax rusticola</i>	-0.176	-	-2	1	-	0	-	-	14.32	0	1	70.16	1	2.47	309.5	42.00
<i>Somateria mollissima</i>	-0.030	3	1	1	-	0	-	-	3.34	0	4	80.83	1	7.92	2066.5	10.20
<i>Sterna hirundo</i>	0.622	0	0	1	-	0	-	-	52.75	1	4	71.25	0	-	125.0	4.20
<i>Sturnus vulgaris</i>	0.085	0	-2	2	9.5	1	0.40	19.96	2.63	0	2	71.25	1	1.70	80.5	395.00
<i>Sylvia atricapilla</i>	-0.167	0	1	2	41.2	0	0.32	20.49	19.63	0	1	70.10	1	0.67	18.9	370.00
<i>Sylvia borin</i>	0.016	0	0	2	-	0	0.34	19.39	63.25	1	1	70.31	0	0.62	19.0	240.00
<i>Sylvia communis</i>	-0.102	0	1	2	14.4	1	0.54	20.35	53.05	1	2	69.33	1	0.56	14.5	195.00
<i>Sylvia curruca</i>	-0.119	0	0	2	32.3	0	0.51	19.71	27.79	1	2	69.67	0	0.53	12.4	63.00
<i>Tadorna tadorna</i>	-0.118	2	0	1	-	0	-	-	9.35	0	4	66.17	1	4.74	1152.0	0.54
<i>Tringa glareola</i>	0.000	-2	0	1	-	0	-	-	62.89	1	3	70.78	0	-	67.5	7.75
<i>Tringa hypoleucos</i>	0.134	0	-2	1	-	0	-	-	44.39	1	3	71.25	0	-	47.8	11.60
<i>Tringa nebularia</i>	-0.194	0	0	1	-	0	-	-	49.16	1	3	70.31	0	-	173.5	1.18
<i>Tringa totanus</i>	-0.024	-2	-2	1	-	0	-	-	35.28	1	3	71.09	0	1.42	112.0	4.45
<i>Troglodytes troglodytes</i>	-0.228	0	1	2	8.9	0	0.41	20.40	1.34	0	1	69.33	0	0.50	8.9	315.00
<i>Turdus iliacus</i>	-0.208	0	0	2	-	0	-	-	10.77	0	1	71.17	0	1.45	62.8	185.00
<i>Turdus merula</i>	-0.314	0	1	4	3.3	0	0.21	20.52	3.98	0	5	71.17	1	1.92	95.8	610.00
<i>Turdus philomelos</i>	-0.192	0	0	4	7.0	0	0.40	19.69	14.65	0	1	70.33	0	1.59	70.5	280.00
<i>Turdus pilaris</i>	-0.050	0	0	2	-	1	-	-	10.77	0	2	71.17	0	1.85	92.1	190.00
<i>Turdus torquatus</i>	-0.061	0	0	2	-	0	-	-	14.13	0	2	71.17	1	1.87	117.0	4.90
<i>Turdus viscivorus</i>	-0.415	0	0	3	8.3	0	0.44	20.09	4.36	0	2	69.00	0	2.21	117.8	52.00
<i>Vanellus vanellus</i>	-0.061	0	-3	1	-	1	-	-	12.08	0	2	70.16	1	2.16	218.5	22.50

Information on trend in mean migration date (days/year) (see *Methods*), breeding population trend [large decline (-3), moderate decline (-2), small decline (-1), stable (0), small increase (+1), moderate increase (+2) to large increase (+3); scores were not given for species classified as "fluctuating" [see (18)], number of broods, natal dispersal, farmland breeding habitat [0 = no; 1 = yes; from code 7, "agricultural and grassland habitats," in appendix 4 of BirdLife International (18)], habitat specialization, thermal maximum, migration distance (° latitude), wintering in Africa (0 = no; 1 = yes), main wintering habitat (1 = woodland, forest, or wooded savannah; 2 = farmland and grassland, dry savannah, grassland, or other dry open habitats; 3 = wetlands and inland waters; 4 = sea and coastal areas; 5 = all terrestrial habitats), northernmost breeding latitude, brain mass (g), body mass (g), and size of the European breeding population size (pairs × 10<sup>5</sup>). See *Methods* for details and data sources.