Eurasian Woodcock samples for isotope analysis from known European breeding sites

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Feather collection

We collected the innermost primary feathers from 135 Woodcock caught by ringers, predated or shot during mid-April to September 2002-2010 at 28 breeding locations across Norway, Sweden, Finland, Estonia, Latvia, Belarus, Russia, Germany, Spain and the UK (see Table S1). We aged birds as adults or first-years according to Ferrand & Gossmann (2009b). Both ages were sampled at 15 of the breeding locations, with just adults or first-years sampled at seven locations each.

Samples were taken from the distal tip of the first primary as this is the first feather to be shed in the annual post-breeding moult by adults and the one most likely to have a stable-isotope ratio representative of the breeding area. Analysis of stable-hydrogen isotopes was undertaken at two laboratories, Iso-Analytical, Cheshire, UK and the National Environmental Isotope Facility Stable Isotope Ecology Laboratory (NEIF-SIEL), East Kilbride, UK. There was a significant 1:1 correlation between feather δ^2H values estimated for the same samples at the two laboratories (r_{18} = 0.87, P<0.001). All values are for non-exchangeable δ^2H expressed in the typical delta notation, in units of per mil (‰).

Calibration of feather and precipitation isotope values using feather samples from known breeding locations

Precipitation δ^2H values (δ^2H_p) at each of the sampling locations were estimated using the online isotopes in precipitation calculator (Bowen *et al.* 2005, http://wateriso.eas.purdue.edu/waterisotopes/pages/data_access/oipc.html). Relationships between feather δ^2H values (δ^2H_f) and mean annual (MAD) and detrended growing season (GSD) δ^2H_p values were examined separately using ANCOVA with bird age as a factor. Growing season δ^2H_p values used for first-year birds were the mean of May and June values for the UK and Spain, June values for Norway and Germany and the mean of June and July values for Sweden, Finland, Russia and the Baltic States. Growing season δ^2H_p values for adult Woodcock were taken as the mean of August and September values for all regions. Relationships for predicting δ^2H_p from δ^2H_f were estimated using reduced major axis regression because both variables were measured on the same scale and both subject to measurement error (Sokal & Rohlf 1981). The correlation between δ^2H_f and MAD was marginally better than the correlation with GSD (Pearson's product moments: 0.49, P < 0.001 and 0.44, P < 0.001, respectively). Thus, subsequent modelling was done using MAD δ^2H_p values.

General linear models (GLM) were used to examine the effect of bird age on the relationship between δ^2H_f and δ^2H_p. Four candidate models were considered to explain the variance in δ^2H_f: (1) an intercept only model, (2) MAD, (3) MAD and age, and (4) MAD, age, and their interaction. The most parsimonious model was selected, based on AIC*c* (Akaike's Information Criterion adjusted for small sample size) and AIC model weights (Burnham & Anderson 2002). The top model (δ^2H_f = MAD + age) received 74% of the support, whilst the second-best model (δ^2H_f = MAD + age + MAD*age) received 26% of the support, and these were separated by 2.08 AIC*c* units. ANOVA was used to further compare the top two models, to determine if the addition of the interaction term provided any improvement upon the less parameterized model. The addition of the interaction term provided no substantive improvement ($F_{1, 132} = 0.07$, $P = 0.78$). The parameter estimates from the less parameterized model were used to calibrate the MAD isoscape into an age-specific δ^2H_f surface (isoscape). The selected model explained 75% of the variance in δ^2H_f, and had a residual standard error of 11.76‰. Calibration equations were derived for adults and first-year birds.

δ^2H_f (adult) = 4.51 (± 6.34 SE) + 0.80 (± 0.08 SE) * MAD

δ^2H_f (first-year) = 4.51 (± 6.34 SE) + 0.80 (± 0.08 SE) * MAD - 28.73 (± 2.15 SE)

Table S1. Locations, sample sizes and mean δ^2H values for adult and first-year Woodcock feathers collected during the breeding season.

				Adult		First-year	
Location	Country	Latitude (°N)	Longitude (°E)	N	Mean ± SD	N	Mean ± SD
1	Russia	58.15	44.42	7	-59.89 ± 3.66	7	-96.51 ± 6.19
2	Russia	58.15	41.62	2	-59.00 ± 0.42		
3	Russia	50.19	39.54	1	-66.56		
4	Russia	55.90	39.20	3	-55.52 ± 5.42	5	-103.95 ± 7.70
5	Russia	57.88	36.53	2	-68.41 ± 2.64	6	-97.29 ± 2.67
6	Russia	56.50	35.67	2	-57.34 ± 2.51	1	-102.02
7	Russia	60.93	34.17			1	-100.52
8	Russia	56.73	34.15	5	-54.30 ± 5.88	3	-89.22 ± 2.53
9	Russia	60.22	31.95	1	-46.12	1	-87.10
10	Belarus	55.45	30.33	4	-59.64 ± 3.53	1	-93.75
11	Russia	61.43	30.15	3	-66.09 ± 1.24	3	-93.33 ± 2.61
12	Russia	60.10	30.08	6	-77.41 ± 16.16	7	-92.26 ± 7.22
13	Belarus	54.82	28.62	8	-74.35 ± 10.31	6	-87.15 ± 6.49
14	Finland	62.64	27.74			3	-94.66 ± 1.57
15	Russia	59.00	28.00	1	-59.52	1	-96.46
16	Belarus	55.51	27.07	13	-64.24 ± 15.96	3	-94.91 ± 1.75
17	Estonia	58.37	26.72			1	-92.37
18	Latvia	57.33	25.62			1	-83.55
19	Belarus	52.80	24.16	3	-48.93 ± 6.41	1	-90.38
20	Sweden	57.93	19.15	1	-59.17		
21	Sweden	60.00	18.00			1	-88.36
22	Sweden	57.73	12.70	1	-43.53		
23	Norway	59.73	9.87			1	-86.90
24	Germany	50.67	8.59			1	-78.76
25	Norfolk	52.70	1.00	1	-11.64		
26	Hampshire	51.20	-1.40	9	-36.77 ± 9.59	2	-46.95 ± 23.61
27	Scotland	57.05	-2.77	2	-55.11 ± 6.10		
28	Spain	43.33	-6.00	4	-29.19 ± 4.22		