**Supplementary information:** **A range-wide domino effect and resetting of the annual cycle in a migratory songbird**

***Gow et al.***

**Methods**

**Breeding sites and geolocator analysis**

The coordinates for each site and the number of recovered geolocators are as follows:Alaska (Fairbanks; 64.90ºN, -147.70ºW; N = 4), British Columbia (Vancouver; 49.21ºN, -123.18ºW; N = 8), British Columbia (Prince George; 53.85ºN, -123.02ºW, N = 12), Alberta (Beaverhill; 53.40ºN, -112.50ºW, N = 24), Saskatchewan (Saskatoon; 52.17ºN, -106.10ºW; N = 16), Iowa (Ames; 42.11ºN, -93.59ºW; N = 4), Wisconsin (Saukville; 43.40ºN, -88.0ºW; N = 6), North Carolina (Boone; 36.21ºN, -81.67ºW; N = 6); Ontario (Long Point; 42.62ºN, -80.46ºW; N = 25); New York (Ithaca; 42.50ºN, -76.50ºW; N = 5); Quebec (Sherbrooke; 45.55ºN, -72.60ºW; N = 18), and Nova Scotia (Wolfville; 45.10ºN, -64.39ºW; N = 12).

Data from geolocators were analyzed using the BAStag package version 0.1.3 [1] and FLightR package version 0.3.6 [2] in R version 3.2.3 [3] (for details of geolocator data analysis see [4]). FLightR uses a template fit approach that involves using a state-space hidden Markov model to estimate locations probabilistically, reducing the location and movement detection errors associated with geolocator analyses [2, 5].

**Within-subject centering**

Following the guidelines in [6]. We subtracted the mean timing predictor variable for each breeding site from each individual’s timing date. This new predictor variable (the deviation in individual timing from the mean breeding site timing, i.e., timing predictor variables centered around the breeding site mean) were used as a fixed effect expressing the within-breeding site variation (βW). The among-breeding site variation component (βB) was the mean timing for all individuals within a breeding site. We then tested whether these two new fixed effects, within-breeding site or among-breeding site effects were meaningful (had differing slopes). We then tested if βW and βB differed from each other, by including the original fixed effect (timing variable) along side the new βB (leaving out βW). Here, βB now represented the difference between the among- and within-breeding site effects (βB - βW). When the estimate of βB - βW is close to zero, the within-and among effects are the same, thus confirming the original predictor timing variable represents within-individual effects. This also ensures that inferences about the effects of a prior timing event on the future timing event are not erroneously based only on between-individual differences (e.g. βB and βW slopes do not cancel each other out).

**References**

1. Wotherspoon S., Sumner M., Lisovski S. 2013 BAStag: basic data processing for light based geolocation archival tags. (version 0.1-3 ed.

2. Rakhimberdiev E., Winkler D.W., Bridge E.S., Seavy N.E., Sheldon D., Piersma T., Saveliev A. 2015 A hidden Markov model for reconstructing animal paths from solar geolocation loggers using templates for light intensity. *Movement Ecology* **3**, 1–15.

3. R Core Development Team. 2016 R: a language and environment for statistical computing. (3.2.3 ed. Vienna, Austria, R Foundation for Statistic Computing.

4. Knight S.M., Bradley D.W., Clark R.G., Gow E.A., Bélisle M., Berzins L., Blake T., Bridge E.S., Dawson R.D., Dunn P.O., et al. 2018 Constructing and evaluating a continent-wide migratory songbird network across the annual cycle. *Ecological Monographs* ***88***(3), 445–460. (doi:10.1002/ecm.1298).

5. Rakhimberdiev E., Senner N.R., Verhoeven M.A., Winkler D.W., Bouten W., Piersma T. 2016 Comparing interferences of solar geolocation data gainst high-precision GPS data: annual movements of a double-tagged black-tailed godwit. *Journal of Avian Biology* **47**, 589–596. (doi:doi: 10.1111/jav.00891).

6. van de Pol M., Wright J. 2009 A simple method for distinguishing with-versus between subject effects using mixed models. *Animal Behaviour* **77**, 753–758.

Macintosh HD:Users:elizabethgow:Dropbox:TRES geolocation:Tresmig timing paper:Drafts:Supplement:Sup fig violoin evnets by latitude.pdf

**Supplementary figure 1: Violin plots of the timing of each event in the annual cycle based on latitude.**

The timing of major events throughout the annual cycle of 133 tree swallows (*Tachycineta bicolor*) originating from 12 breeding sites. The shape and length of the violins are based on kernel density estimations of the distribution of the dates of each event by the breeding latitude category within the annual cycle. Each panel represents a different timing event in the annual cycle. The different shades of blue of the violins represent the breeding latitude category. The dot in the middle of the plot is the median value.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Supplementary Table 1: Model averaged estimates ± SE, upper (UCI) and lower (LCI) 85% confidence intervals, and z values from the top supported models (ΔAICc ≤ 4; Supplementary Table 2) from linear mixed models used to explain variation in timing of events throughout the annual cycle of tree swallows (*Tachycineta bicolor*). Breeding site was included as a random effect in all models. Bolded CI values are those that do not overlap zero. Sex was a binary variable with female as the reference. Slope estimates are based on standardized variables. | | | | | |
| Response variable | Predictor variable | Estimate | SE | z-value | LCI | | UCI |
| **(A) Breeding arrival date** | |  |  |  |  | |  |
|  | (Intercept) | 118.60 | 1.47 | 80.19 | **116.48** | | **120.72** |
|  | Breeding latitude | 6.37 | 1.08 | 5.86 | **4.81** | | **7.93** |
|  | Sex | -4.52 | 2.43 | 1.85 | **-7.96** | | **-1.97** |
|  | Non-breeding departure date | 0.93 | 1.08 | 0.86 | -0.03 | | 2.94 |
|  | Non-breeding latitude | 0.26 | 0.79 | 0.33 | -0.99 | | 2.27 |
|  | Non-breeding departure date \* non-breeding latitude | -0.45 | 0.99 | 0.45 | **-3.66** | | **-0.45** |
|  | Breeding latitude\*Non-breeding departure date | -0.02 | 0.43 | 0.04 | -1.89 | | 1.60 |
| **(B) First egg date** |  |  |  |  |  | |  |
|  | (Intercept) | 141.32 | 1.13 | 123.14 | **139.67** | | **142.96** |
|  | Breeding latitude | 3.23 | 1.35 | 2.39 | **1.89** | | **5.02** |
|  | Breeding arrival date | 3.01 | 0.85 | 3.51 | **1.78** | | **4.24** |
|  | Breeding latitude\*breeding arrival date | -0.28 | 0.53 | 0.52 | -1.71 | | 0.15 |
|  | Sex | 0.14 | 0.79 | 0.17 | -1.65 | | 2.80 |
| **(C) Fledge date** |  |  |  |  |  | |  |
|  | (Intercept) | 182.28 | 0.55 | 325.94 | **181.48** | | **183.08** |
|  | First egg date (deploy year) | 3.09 | 0.50 | 6.11 | **2.36** | | **3.81** |
|  | Breeding latitude | 3.77 | 0.43 | 8.75 | **3.15** | | **4.39** |
|  | Sex | 0.33 | 0.62 | 0.53 | -0.21 | | 1.94 |
|  |  |  |  |  |  | |  |
| **(D) Breeding departure date** | |  |  |  |  | |  |
|  | (Intercept) | 192.72 | 0.67 | 283.12 | **191.75** | | **193.70** |
|  | Breeding latitude | -0.63 | 0.52 | 1.19 | -1.39 | | 0.13 |
|  | Fledge date | 5.45 | 0.46 | 11.70 | **4.78** | | **6.12** |
|  | Sex | -1.24 | 0.85 | 1.45 | **-2.51** | | **-0.58** |
|  | Breeding latitude\*fledge date | -0.94 | 0.30 | 3.07 | **-1.38** | | **-0.50** |
|  |  |  |  |  |  | |  |
| **(E) Arrival at first stopover** | |  |  |  |  | |  |
|  | (Intercept) | 194.21 | 0.37 | 518.90 | **193.67** | | **194.75** |
|  | Breeding latitude | -1.43 | 0.38 | 3.69 | **-1.99** | | **-0.88** |
|  | Distance breeding to stopover | 3.38 | 0.36 | 9.29 | **2.86** | | **3.90** |
|  | Breeding departure date | 5.93 | 0.34 | 17.25 | **5.44** | | **6.43** |
|  | Breeding latitude\* breeding departure date | -0.44 | 0.36 | 1.22 | **-1.01** | | **-0.17** |
|  | Sex | 0.38 | 0.52 | 0.73 | **0.04** | | **1.48** |
|  | Distance breeding to stopover\*breeding departure date | -0.02 | 0.25 | 0.06 | -0.68 | | 0.58 |
|  |  |  |  |  |  | |  |
| **(F) Stopover departure** | |  |  |  |  | |  |
|  | (Intercept) | 269.81 | 4.51 | 59.28 | **263.28** | | **276.34** |
|  | Stopover latitude | -16.32 | 3.59 | 4.51 | **-21.52** | | **-11.13** |
|  | Stopover arrival date | 11.10 | 2.94 | 3.74 | **6.84** | | **15.36** |
|  | stopover latitude\*stopover arrival | 8.09 | 2.95 | 2.71 | **3.81** | | **12.37** |
|  | Sex | -0.26 | 2.08 | 0.12 | -7.78 | | 5.23 |
|  | Breeding latitude | -0.22 | 1.93 | 0.11 | -7.18 | | 4.98 |
|  |  |  |  |  |  | |  |
| **(G) Non-breeding arrival date** | |  |  |  |  | |  |
|  | (Intercept) | 306.79 | 2.16 | 140.76 | **303.66** | | **309.91** |
|  | Distance stopover to non-breeding | 6.70 | 1.72 | 3.85 | **4.20** | | **9.20** |
|  | Stopover departure date | 3.32 | 1.61 | 2.04 | **0.98** | | **5.65** |
|  | Sex | 10.04 | 3.10 | 3.20 | **5.54** | | **14.54** |
|  | Distance \* stopover departure date | -5.53 | 1.59 | 3.45 | **-7.83** | | **-3.23** |
|  | Breeding latitude | -0.51 | 1.24 | 0.41 | -4.13 | | 0.93 |
|  |  |  |  |  |  | |  |
| **(H) Non-breeding departure date** | |  |  |  |  | |  |
|  | (Intercept) | 85.37 | 3.88 | 21.76 | **79.75** | | **91.00** |
|  | Non-breeding latitude | 7.50 | 1.77 | 4.20 | **4.94** | | **10.06** |
|  | Sex | -14.35 | 3.50 | 4.06 | **-19.42** | | **-9.29** |
|  | Breeding latitude | 0.18 | 1.47 | 0.12 | -3.67 | | 5.44 |
|  | Non-breeding arrival | -0.03 | 0.79 | 0.04 | -2.74 | | 2.40 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Supplementary table 2. Summary of predictor variables used in models to explain timing of events in the annual cycle in tree swallows (*Tachycineta bicolor*)(A-H). Interactions between two predictor variables are denoted by the superscript \*, if there was more than one interaction in the model, then the second interaction is indicated by the subscript ^. Breeding arrival dates are from the recapture year and first egg dates are from the year of geolocator deployment. | | | | | | | | | | | | | | |
|  | Predictor variables | | | | | | | | | | | | | |
| Response Variables | breeding arrival date | first egg date | fledge date | breeding departure date | first stopover arrival date | stopover departure date | non-breeding arrival date | non-breeding departure date | breeding latitude | stopover latitude | non-breeding latitude | distance breeding to stopover | distance stopover to non-breeding | sex |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| (A) breeding arrival date |  |  |  |  |  |  |  | X\* | X^ |  | X\*^ |  |  | X |
| (B) first egg date | X\* |  |  |  |  |  |  |  | X\* |  |  |  |  | X |
| (C) fledge date |  | X\* |  |  |  |  |  |  | X\* |  |  |  |  | X |
| (D) breeding departure date |  |  | X\* |  |  |  |  |  | X |  |  |  |  | X |
| (E) first stopover arrival date |  |  |  | X\*^ |  |  |  |  | X^ |  |  | X\* |  | X |
| (F) stopover departure date |  |  |  |  | X\* |  |  |  | X | X\* |  |  |  | X |
| (G) non-breeding arrival date |  |  |  |  |  | X\* |  |  | X |  |  |  | X\* | X |
| (H) non-breeding departure date |  |  |  |  |  |  | X |  | X\* |  | X\* |  |  | X |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Supplementary Table 3. Individual variable support within each model, number of estimable parameters (*k*), log likelihood values, AICc values, ∆AICc values and model weight from each model from the LMMs used to explain variation in the timing of events throughout the annual cycle of tree swallows (*Tachycineta bicolor*) (A-H). Breeding site was included as a random effect in all models. The short forms of the variables within models are: BL = breeding latitude; NBL = non-breeding latitude; NBDD= non-breeding departure date; BA = breeding arrival date; DFE = first egg date; FD = fledge date; BDD = breeding departure date; dBS = distance between breeding and stopover sites; SL = stopover latitude; SA = stopover arrival; dSNB = distance between stopover and non-breeding sites; SDD= stopover departure date; NBA = non-breeding arrival date. | | | | | | | |
| **Response variable** | **Predictor variables** | **(Intercept)** | ***k*** | **logLik** | **AICc** | **∆AICc** | **weight** |
|  |  |  |  |  |  |  |  |
| (A) Breeding arrival date |  |  |  |  |  |  |  |
|  | BL+sex | 118.88 | 5 | -472.40 | 955.31 | 0.00 | 0.22 |
|  | BL+NBDD+sex | 118.47 | 6 | -471.41 | 955.53 | 0.22 | 0.20 |
|  | BL+NBL+sex+NBL\*NBd | 119.07 | 8 | -469.63 | 956.50 | 1.19 | 0.12 |
|  | BL+NBL+sex | 119.06 | 6 | -472.05 | 956.81 | 1.50 | 0.10 |
|  | BL+NBDD+NBL+sex | 118.61 | 7 | -471.31 | 957.58 | 2.28 | 0.07 |
|  | BL+NBDD+sex+BL\*NBDD | 118.52 | 7 | -471.38 | 957.73 | 2.42 | 0.07 |
|  | BL+NBDD | 116.47 | 5 | -473.87 | 958.25 | 2.94 | 0.05 |
|  | BL+NBDD+NBL+sex+BL\*NBDD+NBL\*NBDD | 119.03 | 9 | -469.45 | 958.46 | 3.15 | 0.05 |
|  | BL+NBDD+NBL+NBDD\*NBL | 116.95 | 7 | -472.17 | 959.31 | 4.00 | 0.03 |
|  | BL+NBDD+NBL+sex+BL\*NBDD | 118.63 | 8 | -471.30 | 959.85 | 4.54 | 0.02 |
|  | BL+NBDD+NBL | 116.47 | 6 | -473.82 | 960.36 | 5.05 | 0.02 |
|  | BL | 116.47 | 4 | -476.02 | 960.38 | 5.07 | 0.02 |
|  | BL+NBDD | 116.46 | 6 | -473.87 | 960.45 | 5.14 | 0.02 |
|  | BL+NBDD+NBL+BL\*NBd+NBL\*NBDD | 116.96 | 8 | -471.87 | 960.98 | 5.67 | 0.01 |
|  | BL+ NBL | 116.47 | 5 | -476.01 | 962.53 | 7.22 | 0.01 |
|  | BL+NBDD+NBL+BL\*NBDD | 116.47 | 7 | -473.82 | 962.60 | 7.29 | 0.01 |
|  | sex | 118.49 | 4 | -481.22 | 970.78 | 15.47 | 0.00 |
|  | NBDD+sex | 118.42 | 5 | -481.11 | 972.73 | 17.42 | 0.00 |
|  | NBL+sex | 118.53 | 5 | -481.21 | 972.92 | 17.61 | 0.00 |
|  | NBDD+NBL+sex | 118.42 | 6 | -481.11 | 974.94 | 19.63 | 0.00 |
|  | NULL | 116.38 | 3 | -484.47 | 975.13 | 19.82 | 0.00 |
|  | NBDD+NBL+sex+NBd\*NBL | 118.68 | 7 | -480.45 | 975.85 | 20.54 | 0.00 |
|  | NBd | 116.44 | 4 | -483.86 | 976.06 | 20.75 | 0.00 |
|  | NBL | 116.38 | 4 | -484.29 | 976.91 | 21.60 | 0.00 |
|  | NBDD+NBL | 116.46 | 5 | -483.41 | 977.33 | 22.02 | 0.00 |
|  | NBDD+NBL+NB\*NBL | 116.79 | 6 | -482.69 | 978.10 | 22.79 | 0.00 |
|  |  |  |  |  |  |  |  |
| (B) First egg date |  |  |  |  |  |  |  |
|  | BL+BA | 141.21 | 5 | -370.66 | 751.91 | 0.00 | 0.41 |
|  | BL+BA+BL\*BA | 141.68 | 6 | -370.02 | 752.86 | 0.95 | 0.26 |
|  | BL+BA+sex | 140.94 | 6 | -370.57 | 753.98 | 2.06 | 0.15 |
|  | BL+BA+sex+BL\*BA | 141.48 | 7 | -369.98 | 755.08 | 3.16 | 0.09 |
|  | BA | 141.17 | 4 | -373.65 | 755.68 | 3.77 | 0.06 |
|  | BA\*sex | 140.70 | 5 | -373.35 | 757.29 | 5.38 | 0.03 |
|  | BL | 141.38 | 4 | -376.46 | 761.32 | 9.40 | 0.00 |
|  | BL+sex | 141.65 | 5 | -376.38 | 763.36 | 11.44 | 0.00 |
|  | NULL | 141.09 | 3 | -383.82 | 773.86 | 21.95 | 0.00 |
|  | sex | 141.19 | 4 | -383.80 | 776.00 | 24.08 | 0.00 |
|  |  |  |  |  |  |  |  |
| (C) Fledge date |  |  |  |  |  |  |  |
|  | BL+DFE | 182.42 | 5 | -297.69 | 605.96 | 0.00 | 0.61 |
|  | BL+DFE+sex | 182.06 | 6 | -297.04 | 606.90 | 0.93 | 0.39 |
|  | DFE+sex | 181.88 | 5 | -307.08 | 624.74 | 18.78 | 0.00 |
|  | DFE | 182.36 | 4 | -308.25 | 624.89 | 18.93 | 0.00 |
|  | BL+sex | 181.56 | 5 | -325.35 | 661.27 | 55.31 | 0.00 |
|  | BL | 182.15 | 4 | -326.50 | 661.38 | 55.41 | 0.00 |
|  | sex | 181.18 | 4 | -333.58 | 675.55 | 69.58 | 0.00 |
|  | NULL | 181.77 | 3 | -334.80 | 675.83 | 69.87 | 0.00 |
|  |  |  |  |  |  |  |  |
| (D) Breeding departure date |  |  |  |  |  |  |  |
|  | BL+FD+sex+BL\*FD | 192.87 | 7 | -235.98 | 487.27 | 0.00 | 0.76 |
|  | BL+FD+BL\*FD | 192.12 | 6 | -238.57 | 490.11 | 2.84 | 0.18 |
|  | BL+FD+sex | 191.98 | 6 | -240.83 | 494.65 | 7.37 | 0.02 |
|  | FD+sex | 192.01 | 5 | -242.27 | 495.23 | 7.95 | 0.01 |
|  | BL+FD | 191.59 | 5 | -242.41 | 495.51 | 8.24 | 0.01 |
|  | FD | 191.39 | 4 | -244.57 | 497.60 | 10.33 | 0.00 |
|  | BL | 191.15 | 4 | -288.90 | 586.25 | 98.98 | 0.00 |
|  | BL+sex | 191.21 | 5 | -288.89 | 588.46 | 101.19 | 0.00 |
|  | NULL | 190.43 | 3 | -291.69 | 589.64 | 102.37 | 0.00 |
|  | sex | 190.48 | 4 | -291.68 | 591.81 | 104.54 | 0.00 |
|  |  |  |  |  |  |  |  |
| (E) Arrival at first stopover |  |  |  |  |  |  |  |
|  | BL+dBS+BDD+BL\*BDD | 194.43 | 7 | -279.59 | 574.21 | 0.00 | 0.29 |
|  | BL+dBS+BDD+sex+BL\*BDD | 194.08 | 8 | -278.52 | 574.36 | 0.16 | 0.26 |
|  | BL+dBS+BDD+BL\*BDD+dBS\*BDD | 194.46 | 8 | -279.44 | 576.20 | 2.00 | 0.11 |
|  | BL+dBS+BDD+sex+BL\*BDD+dBS\*BDD | 194.11 | 9 | -278.44 | 576.55 | 2.34 | 0.09 |
|  | BL+dBS+BDD+sex+dBS+BDD | 193.89 | 8 | -279.76 | 576.85 | 2.64 | 0.08 |
|  | BL+dBS+BDD+sex | 193.80 | 7 | -281.05 | 577.12 | 2.91 | 0.07 |
|  | BL+dBS+BDD+dBS+BDD | 194.27 | 7 | -281.18 | 577.38 | 3.18 | 0.06 |
|  | BL+dBS+BDD | 194.19 | 6 | -282.54 | 577.83 | 3.62 | 0.05 |
|  | dBS+BDD+dBS\*BDD | 194.25 | 6 | -285.57 | 583.90 | 9.69 | 0.00 |
|  | dBS+BDD+sex+dBS\*BDD | 193.96 | 7 | -284.70 | 584.42 | 10.21 | 0.00 |
|  | dBS+BDD | 194.12 | 5 | -287.25 | 585.03 | 10.83 | 0.00 |
|  | dBS+BDD+sex | 193.85 | 6 | -286.54 | 585.83 | 11.62 | 0.00 |
|  | BL+BDD | 194.14 | 5 | -300.00 | 610.53 | 36.32 | 0.00 |
|  | BDD | 194.09 | 4 | -301.12 | 610.59 | 36.39 | 0.00 |
|  | BL+BDD+BL\*BDD | 194.43 | 6 | -299.13 | 611.02 | 36.81 | 0.00 |
|  | BDD+sex | 193.81 | 5 | -300.37 | 611.28 | 37.08 | 0.00 |
|  | BL+BDD+sex | 193.87 | 6 | -299.35 | 611.46 | 37.25 | 0.00 |
|  | BL+BDD+sex+BL\*BDD | 194.16 | 7 | -298.43 | 611.88 | 37.68 | 0.00 |
|  | dBS | 193.26 | 4 | -374.70 | 757.75 | 183.54 | 0.00 |
|  | BL+dBS | 193.41 | 5 | -374.06 | 758.67 | 184.46 | 0.00 |
|  | dBS+sex | 192.97 | 5 | -374.46 | 759.46 | 185.25 | 0.00 |
|  | BL+dBS+sex | 193.13 | 6 | -373.85 | 760.46 | 186.26 | 0.00 |
|  | BL | 193.59 | 4 | -376.49 | 761.34 | 187.14 | 0.00 |
|  | BL+sex | 193.33 | 5 | -376.32 | 763.17 | 188.97 | 0.00 |
|  | NULL | 193.22 | 3 | -380.10 | 766.42 | 192.21 | 0.00 |
|  | sex | 192.97 | 4 | -379.93 | 768.22 | 194.01 | 0.00 |
|  |  |  |  |  |  |  |  |
| (F) Stopover departure |  |  |  |  |  |  |  |
|  | SL+SA+SL\*SA | 269.72 | 6 | -580.13 | 1172.98 | 0.00 | 0.51 |
|  | SL+SA+sex+SL\*SA | 270.22 | 7 | -580.09 | 1175.14 | 2.16 | 0.17 |
|  | BL+SL+SA+SL\*SA | 269.68 | 7 | -580.10 | 1175.16 | 2.18 | 0.17 |
|  | BL+SL+SA+sex+SL\*SA | 270.17 | 8 | -580.07 | 1177.36 | 4.39 | 0.06 |
|  | SL+SA | 268.83 | 5 | -583.82 | 1178.13 | 5.16 | 0.04 |
|  | SL+SA+sex | 270.25 | 6 | -583.53 | 1179.76 | 6.79 | 0.02 |
|  | BL+SL+SA | 268.76 | 6 | -583.72 | 1180.15 | 7.17 | 0.01 |
|  | BL+SL+SA+sex | 270.16 | 7 | -583.44 | 1181.84 | 8.86 | 0.01 |
|  | SL | 268.10 | 4 | -587.45 | 1183.24 | 10.26 | 0.00 |
|  | BL+SL | 268.29 | 5 | -587.18 | 1184.87 | 11.89 | 0.00 |
|  | SL+sex | 268.98 | 5 | -587.34 | 1185.18 | 12.20 | 0.00 |
|  | BL+SL+sex | 269.31 | 6 | -587.04 | 1186.78 | 13.80 | 0.00 |
|  | BL+SA | 269.45 | 5 | -589.42 | 1189.34 | 16.36 | 0.00 |
|  | SA | 269.92 | 4 | -590.98 | 1190.29 | 17.31 | 0.00 |
|  | BL+SA+sex | 270.88 | 6 | -589.16 | 1191.02 | 18.05 | 0.00 |
|  | SA+sex | 271.47 | 5 | -590.66 | 1191.83 | 18.85 | 0.00 |
|  | NULL | 269.26 | 3 | -596.34 | 1198.88 | 25.91 | 0.00 |
|  | sex | 270.10 | 4 | -596.26 | 1200.85 | 27.87 | 0.00 |
|  | BL | 269.14 | 4 | -596.27 | 1200.86 | 27.89 | 0.00 |
|  | BL+sex | 269.93 | 5 | -596.19 | 1202.89 | 29.91 | 0.00 |
|  |  |  |  |  |  |  |  |
| (G) Non-breeding arrival date |  |  |  |  |  |  |  |
|  | dSNB+SDD+sex+dSNB\*SDD | 306.84 | 7 | -516.11 | 1047.21 | 0.00 | 0.65 |
|  | BL+dSNB+SDD+sex+dSNB\*SDD | 306.67 | 8 | -515.73 | 1048.73 | 1.52 | 0.31 |
|  | dSNB+SDD+dSNB\*SDD | 310.37 | 6 | -520.64 | 1054.02 | 6.81 | 0.02 |
|  | BL+dSNB+SDD+dSNB\*SDD | 310.34 | 7 | -520.63 | 1056.24 | 9.03 | 0.01 |
|  | dSNB+SDD+sex | 308.02 | 6 | -521.82 | 1056.38 | 9.17 | 0.01 |
|  | BL+dSNB+SDD+sex | 307.97 | 7 | -521.74 | 1058.47 | 11.26 | 0.00 |
|  | dSNB+sex | 307.96 | 5 | -524.65 | 1059.82 | 12.62 | 0.00 |
|  | BL+dSNB+sex | 307.87 | 6 | -524.63 | 1061.99 | 14.78 | 0.00 |
|  | dSNB+SDD | 311.28 | 5 | -525.98 | 1062.47 | 15.26 | 0.00 |
|  | dSNB | 311.29 | 4 | -528.15 | 1064.63 | 17.43 | 0.00 |
|  | BL+dSNB+SDD | 311.30 | 6 | -525.97 | 1064.67 | 17.47 | 0.00 |
|  | BL+dSNB | 311.33 | 5 | -528.14 | 1066.79 | 19.58 | 0.00 |
|  | SDD+sex | 307.67 | 5 | -530.17 | 1070.85 | 23.65 | 0.00 |
|  | sex | 307.81 | 4 | -531.26 | 1070.85 | 23.65 | 0.00 |
|  | BL+SDD+sex | 308.10 | 6 | -529.62 | 1071.98 | 24.77 | 0.00 |
|  | BL+sex | 308.23 | 5 | -530.74 | 1071.99 | 24.79 | 0.00 |
|  | NULL | 310.51 | 3 | -533.22 | 1072.64 | 25.43 | 0.00 |
|  | SDD | 310.38 | 4 | -532.17 | 1072.69 | 25.48 | 0.00 |
|  | BL | 310.95 | 4 | -532.66 | 1073.67 | 26.46 | 0.00 |
|  | BL+SDD | 310.82 | 5 | -531.60 | 1073.71 | 26.50 | 0.00 |
|  |  |  |  |  |  |  |  |
| (H) Non-breeding departure date |  |  |  |  |  |  |  |
|  | NBL+sex | 85.35 | 5 | -526.52 | 1063.55 | 0.00 | 0.51 |
|  | BL+NBL+sex | 85.49 | 6 | -526.48 | 1065.69 | 2.13 | 0.17 |
|  | NBA+NBL+sex | 85.30 | 6 | -526.51 | 1065.76 | 2.20 | 0.17 |
|  | BL+NBL+sex+BL\*NBL | 85.91 | 7 | -526.30 | 1067.59 | 4.04 | 0.07 |
|  | NBA+BL+NBL+sex | 85.44 | 7 | -526.47 | 1067.93 | 4.38 | 0.06 |
|  | NBA+BL+NBL+sex | 85.84 | 8 | -526.30 | 1069.86 | 6.31 | 0.02 |
|  | NBL | 79.64 | 4 | -534.51 | 1077.36 | 13.81 | 0.00 |
|  | sex | 83.89 | 4 | -535.04 | 1078.42 | 14.87 | 0.00 |
|  | NBA+NBL | 79.41 | 5 | -534.04 | 1078.59 | 15.04 | 0.00 |
|  | NBA+sex | 83.35 | 5 | -534.43 | 1079.37 | 15.82 | 0.00 |
|  | BL+NBL | 79.56 | 5 | -534.48 | 1079.47 | 15.92 | 0.00 |
|  | BL+sex | 83.65 | 5 | -534.88 | 1080.28 | 16.72 | 0.00 |
|  | NBA+BL+NBL | 79.34 | 6 | -534.01 | 1080.76 | 17.21 | 0.00 |
|  | BL+NBL+BL\*NBL | 80.17 | 6 | -534.21 | 1081.15 | 17.60 | 0.00 |
|  | NBA+BL+sex | 83.16 | 6 | -534.31 | 1081.34 | 17.79 | 0.00 |
|  | NBA+BL+NBL+BL\*NBL | 79.98 | 7 | -533.70 | 1082.39 | 18.83 | 0.00 |
|  | NBA | 79.39 | 4 | -537.84 | 1084.02 | 20.47 | 0.00 |
|  | NULL | 79.76 | 3 | -538.98 | 1084.16 | 20.61 | 0.00 |
|  | BL | 79.51 | 4 | -538.69 | 1085.73 | 22.18 | 0.00 |
|  | NBA+BL | 79.19 | 5 | -537.63 | 1085.78 | 22.22 | 0.00 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Supplementary Table 4. The effects of a previous timing event on the future timing event. The LME estimates ±SE, and the lower and upper 95% confidence intervals (LCI, UCI) are shown. Confidence intervals that span zero indicate a non-meaningful result. The main effect of the previous timing event is decomposed into its within- and between -population (breeding site) components for each timing event. | | | | |
|  |  | estimate±SE | LCI | UCI |
| Breeding arrival date | |  |  |  |
|  | Non-breeding departure date | 0.059±0.054 | -0.047 | 0.16 |
|  | within-population | -0.052±0.06 | -0.16 | 0.06 |
|  | between-population | 0.13±0.18 | -0.25 | 0.52 |
|  | βB - βW | 0.079±0.19 | -0.31 | 0.48 |
|  |  |  |  |  |
| First egg date | |  |  |  |
|  | Breeding arrival date | **0.29±0.06** | **0.17** | **0.40** |
|  | within-population | 0.098±0.06 | -0.03 | 0.22 |
|  | between-population | **0.42±0.16** | **0.08** | **0.76** |
|  | βB - βW | 0.18±0.17 | -0.18 | 0.53 |
|  |  |  |  |  |
| Fledge date | |  |  |  |
|  | First egg date | **0.5±0.06** | **0.38** | **0.63** |
|  | within-population | **-0.45±0.063** | **-0.57** | **-0.32** |
|  | between-population | **0.88±0.13** | **0.62** | **1.15** |
|  | βB - βW | **0.43±0.14** | **0.14** | **0.73** |
|  |  |  |  |  |
| Breeding departure date | |  |  |  |
|  | Fledge date | **0.79±0.06** | **0.68** | **0.92** |
|  | within-population | **-0.79±0.07** | **-0.94** | **-0.64** |
|  | between-population | **0.81±0.1** | **0.61** | **1.03** |
|  | βB - βW | 0.02±0.12 | -0.22 | 0.28 |
|  |  |  |  |  |
| First stopover arrival date | |  |  |  |
|  | Breeding departure date | **0.97±0.06** | **0.87** | **1.08** |
|  | within-population | **-0.96±0.06** | **-1.07** | **-0.84** |
|  | between-population | **1.07±0.13** | **0.79** | **1.34** |
|  | βB - βW | 0.11±0.14 | -0.18 | 0.41 |
|  |  |  |  |  |
| First stopover departure date | |  |  |  |
|  | First stopover arrival date | **1.22±0.37** | **0.50** | **1.95** |
|  | within-population | **-1.34±0.43** | **-2.19** | **-0.48** |
|  | between-population | **0.95±0.68** | **-0.48** | **2.35** |
|  | βB - βW | -0.39±0.81 | -2.03 | 1.23 |
|  |  |  |  |  |
| Non-breeding arrival date | |  |  |  |
|  | First stopover departure date | 0.091±0.63 | -0.03 | 0.22 |
|  | within-population | -0.1±0.66 | -0.2304889 | 0.03 |
|  | between-population | -0.004±0.21 | -0.45 | 0.45 |
|  | βB - βW | -0.1±0.22 | -0.56 | 0.36 |
|  |  |  |  |  |
| Non-breeding depature date | |  |  |  |
|  | Non-breeding arrival date | -0.14±0.09 | -0.33 | 0.04 |
|  | within-population | 0.14±0.1 | -0.06 | 0.33 |
|  | between-population | -0.2±0.33 | -0.91 | 0.49 |
|  | βB - βW | -0.07±0.35 | -0.80 | 0.65 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Supplementary Table 5. Coefficients from a random intercept mixed model demonstrating how first egg date influences fledge date within each breeding site. Random effect was first egg date | breeding site. | | | | | |
| Breeding site | | Intercept | | First egg date | |
| Ames | | 58.27 | | -0.49 | |
| Beaverhill | | 58.69 | | -0.56 | |
| Boone | | 57.59 | | -0.41 | |
| Fairbanks | | 64.57 | | -1.38 | |
| Ithaca | | 57.00 | | -0.32 | |
| Long Point | | 55.36 | | -0.09 | |
| Prince George | | 60.76 | | -0.85 | |
| Saskatoon | | 58.35 | | -0.51 | |
| Saukville | | 60.67 | | -0.84 | |
| Sherbrooke | | 61.20 | | -0.91 | |
| Vancouver | | 61.06 | | -0.89 | |
| Wolfville | | 59.90 | | -0.73 | |