

Supplementary material

Online Supplemental Material

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

Appendix 1: Materials and methods

Return rates

From the 50 birds fitted with geolocators in 2012 in the northern population we recaptured 12 (6 males and 6 females) individuals – 11 in 2013 and one in 2014. From the geocator series deployed in this population in 2013 we retrieved 12 (7 males and 5 females) out of the 49 devices. At the southern population 28 (14 males and 14 females) of 69 geocator birds were recaptured in 2014. Birds ringed only with aluminum rings were used as a control group to account for recapture rates. The between-years return rates of the geocator tagged birds from the northern population were 22.0% and 24.5% (control group: 40% and 39%) in 2013 and 2014, respectively. For the southern population the return rate was 40.6% (control group: 45.5%). The differences in the return rates of tagged and control group birds were significant in the northern but not in the southern population (Pearson's χ^2 -test, northern population 2012: $\chi^2 = 6.1$, $p = 0.013$, 2013: $\chi^2 = 4.5$, $p = 0.035$, southern population 2013: $\chi^2 = 0.09$, $p = 0.76$).

Additionally, we observed difference in return rates among early and late breeding individuals, with the latter having lower return rates. This might explain lower return rates in the northern population as proportionally more late breeding birds were tagged. Moreover, the slightly longer migration distance and crossing of an extra barrier (the Baltic Sea) might co-affect the return rates observed in the geocator-tagged flycatchers from the northern population.

22 **Calculating migration routes**

23 We were not able to determine any stopover sites during migration. This was due to (i) irregular
24 shading of the sensor causing large errors in positioning for short stationary periods and (ii)
25 migration close to equinox periods (more pronounced in autumn) when latitude assignments are
26 not possible. Longitude estimations, however, are always possible, because they are derived from
27 midday and midnight times (Hill 1994). Thus, we used total migration time and longitude
28 estimates to describe migration routes, considering continuous movement at a steady pace
29 throughout migration. First, longitude and latitude at the beginning of migration give the start
30 point (e.g. known breeding site for autumn migration) and population specific median longitude
31 and latitude at the end of migration period was set as end point (e.g., respective non-breeding
32 site). Since we assume continuous movement between start and end, a percentage of migration
33 time corresponds to the same percentage of migration distance, e.g. when 25% of total migration
34 time has passed 25% of total migration distance had been covered and thus refers to relative
35 latitude. The longitude readings are derived from geolocator records at each time point (see also
36 Hahn et al. 2014).

37 **Annual variation in breeding time**

38 Although, the majority of the geolocation data for the northern population come from 2012/13,
39 while for the southern population all data are from 2013/14, the data are comparable since the
40 annual variation in the onset of egg-laying is minimal. In 2012 the median first egg-laying date
41 for the northern population was 18 May (n = 114) while in 2013 it was 20 May (n = 118). For the
42 southern population egg-laying date was 5 May (n = 112) in 2012 and 8 May (n = 118) in 2013.

43

44 **References**

45 Hahn, S., Emmenegger, T., Lisovski, S., Amrhein, V., Zehtindjiev, P. and Liechti, F. 2014.

46 Variable detours in long-distance migration across ecological barriers and their relation to

47 habitat availability at ground. - *Ecol. Evol.* 4: 4150–4160.

48 Hill, R. D. 1994. Theory of Geolocation by Light Levels. - In: Le Boeuf, B. J. and Laws, R. M.

49 (eds), *Elephant Seals: Population Ecology, Behavior, and Physiology*. University of

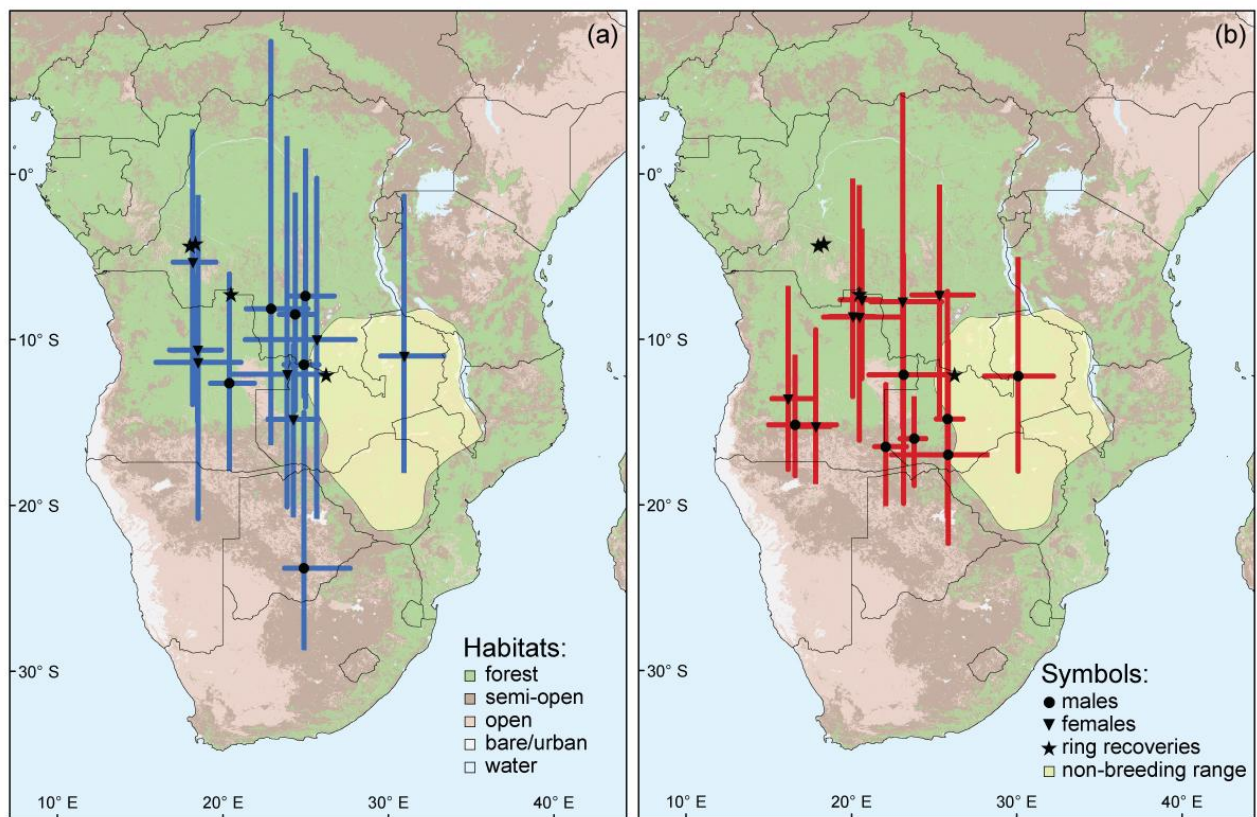
50 California Press, pp. 227–236.

51

52 **Appendix 2: Supplementary figures and tables**

53

54 **Fig. A1.** Non-breeding residency sites of individually tracked Collared Flycatchers from the
55 southern breeding population in the Czech Republic (a, n = 13) and the northern breeding
56 population in Sweden (b, n = 14) depicted as median positions (● – males, ▼ – females) and
57 interquartile ranges (lines). Stars represent sub-Saharan ring recoveries of Collared Flycatchers
58 according to EURING database. The currently estimated non-breeding range is outlined in
59 yellow (BirdLife International and NatureServe 2011). The base map shows terrestrial habitats of
60 reclassified land cover data from GLC2000 database, European Commission Joint Research
61 Centre (available at <http://bioval.jrc.ec.europa.eu/products/glc2000/glc2000.php>).



64 **Table A1.** Results of Levene’s test of variation between and within (between consecutive events)
65 populations in timing of key stages in the annual cycle, including breeding (Breeding I),
66 departure from the breeding site (BS departure), Sahara crossing in autumn (Sahara autumn),
67 arrival at the non-breeding site (Non-BS arrival), departure from the non-breeding site (Non-BS
68 departure), Sahara crossing in spring (Sahara spring), arrival at the breeding site (BS arrival), and
69 breeding the following year (Breeding II), of Collared Flycatchers. Significant values are
70 highlighted in bold font.

Stage	Between populations		Between events – southern population (Czech Republic)		Between events – northern population (Sweden)	
	F	p-value	F	p-value	F	p-value
Breeding I	1.794	0.183				
BS departure	0.238	0.629	0.001	0.970	1.029	0.314
Sahara autumn	1.981	0.171	0.688	0.415	0.003	0.959
Non-BS arrival	0.373	0.546	0.092	0.764	2.687	0.112
Non-BS departure	0.930	0.346	2.781	0.109	0.119	0.733
Sahara spring	3.518	0.076	12.111	0.003	0.453	0.508
BS arrival	14.297	0.002	2.015	0.174	1.368	0.258
Breeding II	0.001	0.981	1.100	0.303	4.454	0.046

71