

Supplementary material

Appendix 1

Figure A1

Longitudinal data from all eight tracks (six individuals) 2012-2014 from the breeding area (grey) in north-western Spain, followed by first stage of autumn migration towards south-eastern Europe (red) showing no longer stops before the staging period in south-eastern Europe (yellow) before the departure across the Sahara Desert (see Fig. 1).

Figure A2

All estimated geographical positions for the six tracked individuals (a total of eight tracks) from breeding areas in north-western Spain to wintering areas in southern Africa and back. Colours represent breeding area (grey) and main stopover sites in south-eastern Europe (autumn: yellow), north-eastern Africa (autumn: brown), non-breeding areas in southern Africa (pink) and north-eastern Africa (spring: dark blue) as well as positions during autumn (red) and spring (blue) migration. Data from three weeks on both sides of equinox has been removed.

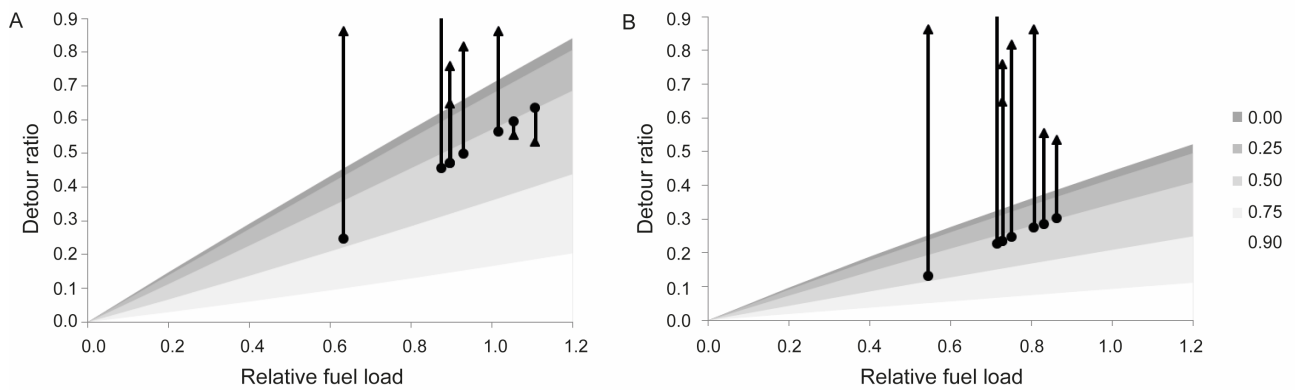


Figure A3

Comparison of the alternative western route with the direct route: maximum detour ratios (the extra distance along detour relative to barrier distance) as a function of relative fuel load required to cross the barrier in a single flight during the autumn (see Fig. 1) based on two flight range equations assuming that fuel load increases both induced and parasite drag (A) and fuel loads only increases induced drag (B) (Pennycuik 1975) with the true relationship presumably being intermediate between these two equations (Alerstam and Hedenström 1998). Grey shading indicates different fractions of the barrier included in the detour assuming that the remaining part of the detour is completed by short flights without fuel transport costs. (Figure is modified from Fig. 6 in Alerstam 2001). The individual detour ratios predicted from theory (triangles) from the alternative western route for each of the six individual red-backed shrikes (total of eight tracks) in relation to calculated relative fuel load is indicated (circles). The black lines show the difference between the theoretically predicted and observed detour ratio given the estimated relative fat loads. The theoretically predicted maximum detour is smaller than the observed detour except two cases (Modified from Alerstam 2001.).

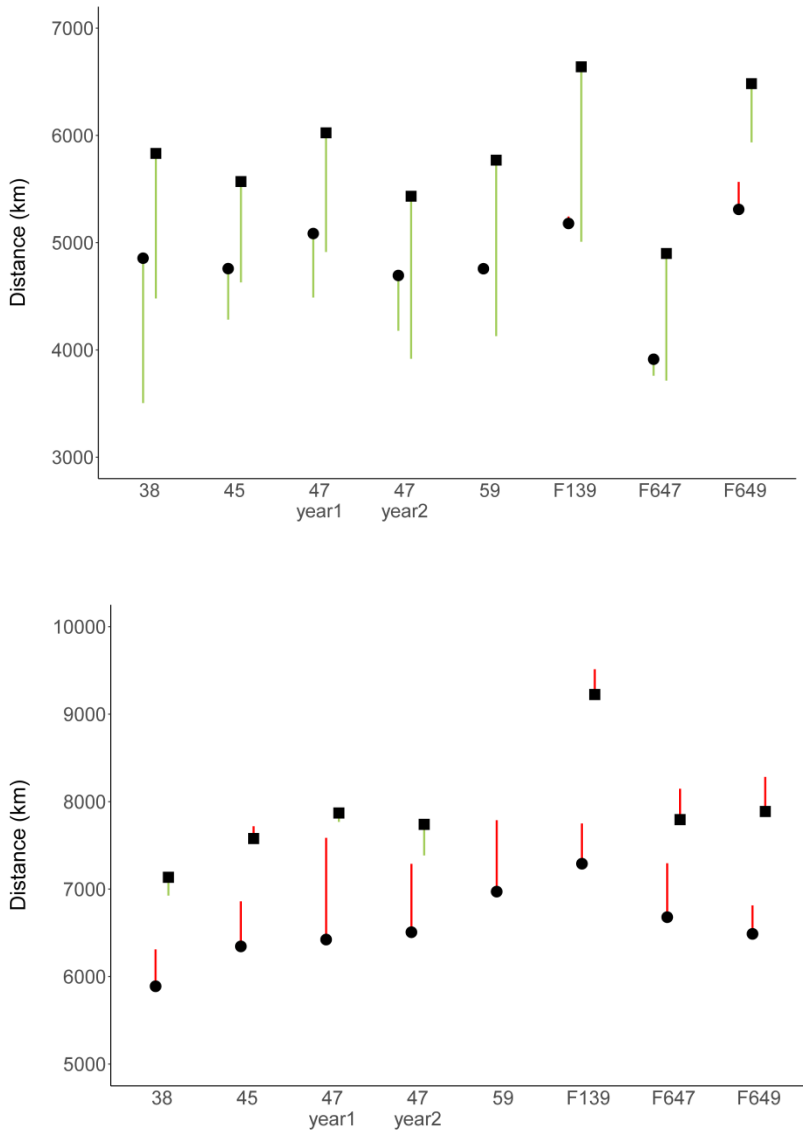


Figure A4

Individual autumn (top) and spring (bottom) migration ground distances along the direct route (black circles) and the observed route (black squares) for all eight different tracks from six individuals (see Fig 1). The air distance (incorporating the effect of wind) along the route is given as the end point of the line from each black circle/square; a tail wind will decrease the ground speed indicated by green line, while head winds are indicated by a red line. All distances were calculated

as great circle distances on an ellipsoid between geographical point locations (R package: Geosphere (Hijmans 2015), function: `distVincentyEllipsoid`). See details in the Methods sections.