**Supplementary material**

**Supp 1**. Estimation and parameters of sun angles. LD = Loosdrecht, ZM = Zwarte Meer

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Logger ID | location | Start year | SAE | threshold | remarks |
| V3948 004 | LD | 2016 | -3,75 | 500 |  |
| V3948 005 | LD | 2016 | -4,50 | 500 |  |
| V3948 006 | LD | 2016 | -3,00 | 500 |  |
| V3948 003 | LD | 2016 | -0,50 | 500 |  |
| V7408 004 | LD | 2018 | -0,75 | 500 |  |
| V7408 006 | LD | 2018 | 4,25 | 500 |  |
| V7408 009 | ZM | 2018 |  |  | time adjusted , sites manual |
| V7408 010 | ZM | 2018 | -1,50 | 500 |  |
| V7408 012 | ZM | 2018 | -4,00 | 500 |  |
| V7408 014 | ZM | 2018 | -5,50 | 500 |  |
|  |  |  |  |  |  |

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**Supp 2**. Estimates of minimum convex polygon sizes Adehabitat R-package (Calenge 2006) (polygon around LLpoints) of the staging area south of the Sahara between 1 November and 31 January as a relation of the percentage of datapoints included within the polygon. Above 80% of all datapoints the influence of outliers disproportionately adds to the calculated surface of the staging area. With these selected LLpoints we calculated the 80% minimum convex polygon size for each individual with the 80% threshold is visually chosen based on likelihood patterns



**Supp 3.** Estimation of migratory spread (cf Burgess *et al.* 2020), expressed as median distances between all LLpoints in the non-breeding period for two Dutch breeding populations of Great Reed Warbler, between 1 November to 31 January for 10 individuals tagged with light level loggers.