

1 **ACCEPTED BIRD STUDY 8<sup>TH</sup> FEBRUARY 2016**

2

3 **High site fidelity in Northern Wheatears *Oenanthe oenanthe* wintering in Africa**  
4 **revealed through colour marking**

5

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15 **Summary**

16 Wintering Northern Wheatears *Oenanthe oenanthe* in the Sahel region of Northern  
17 Nigeria held small (c. 70 m diameter) distinct territories during the study period, and  
18 territory size did not differ between adult and first winter birds. Evidence suggests  
19 that Wheatears may maintain small territories for a significant duration of the  
20 winter, similar to many other migrants.

21 The decisions migrant birds make during the non-breeding period can carry over to  
22 influence many aspects of their population dynamics (Norris et al., 2004, Newton,  
23 2010, Reudink et al., 2009, Newton, 2006, Pulido, 2007, Sherry and Holmes, 1996,  
24 Baillie and Peach, 1992, Both et al., 2006, Studds et al., 2008). Many migrant species  
25 are site faithful (territorial) during the non-breeding season (King and Hutchinson,  
26 2001, Salewski et al., 2000, Sauvage et al., 1998, Holmes and Sherry, 1992, Marra,  
27 2000, Mcneil, 1982, Cresswell, 2014, Blackburn and Cresswell, 2015, Warkentin and  
28 Hernandez, 1996); a decision which can have substantial consequences for survival  
29 (Monroy-Ojeda et al., 2013), the degree of migratory connectivity (Cresswell, 2014),  
30 how susceptible a species is to the loss or alteration of one or more wintering sites  
31 (Newton, 2010, Sutherland, 1998), gene flow, and the conservation of distinct  
32 populations (Iverson and Esler, 2006). Knowing whether species are site faithful  
33 during winter thus has numerous consequences for the conservation of migrants,  
34 many of which are declining (Warkentin and Hernandez, 1996, Jones and Cresswell,  
35 2010, Vickery et al., 2014, Sherry and Holmes, 1996).

36

37 Here we establish the extent to which the Northern Wheatear *Oenanthe oenanthe*, a  
38 long-distance migrant, is site faithful on its wintering grounds in West Africa, and  
39 give estimates of winter territory size. Although winter territoriality has been  
40 documented for this and other *Oenanthe* species (for example: Panov, 1999, Khoury  
41 et al., 2012, Cornwallis, 1975, Sharland, 1967), the scale of this within-winter site  
42 fidelity has not been explored in detail. Here we use colour ringing to closely track  
43 individually identifiable birds. We also examine age-dependent effects because  
44 aspects of migrant wintering ecology may differ with age (e.g. Marra, 2000).

45 Although population trends vary throughout the Northern Wheatear's range, the  
46 European breeding population (25-49% of the global range) has experienced a  
47 significant moderate decline since 1980 (Birdlife International, 2004).

48

49 The study took place in the winter of 2011 in Katsina state in the Sahel region of  
50 Northern Nigeria, bordering Niger (13°00'56.9"N, 7°07'22.6"E). The study site was a  
51 dry and rocky open area with patches of scrub, *Acacia* trees and bushes, and  
52 boulders, intersected with a dry riverbed (Fig. 1). We captured and colour-ringed 41  
53 Northern Wheatears over an area of approximately 1.3 km<sup>2</sup>, between 15<sup>th</sup>  
54 November and 8<sup>th</sup> December, with the exception of two individuals that were  
55 captured earlier in mid-October during a preliminary visit to the site. Birds were  
56 captured using baited spring traps with conspecific playback and each uniquely  
57 colour-ringed, sexed, aged as adult or first winter (Jenni and Winkler, 2004), and  
58 biometrics recorded (maximum wing chord, tarsus, mass, fat and pectoral muscle  
59 scores). We resighted colour-ringed birds on 17 visits to the site between 3<sup>rd</sup> and 14<sup>th</sup>  
60 December of the same winter. We resighted between dawn (~06:00 h) and 11:00 h,  
61 and/or 16:00 h until dusk (~18:30 h) using binoculars to locate birds (Swarovski SV  
62 8x32) and a spotting scope to read combinations (Zeiss Diascope 65 mm with 25x  
63 eyepiece). Approximately 55 hours in total were dedicated to resighting ringed birds.  
64 The average number of resighting visits made to the site after a bird had been ringed  
65 was 15.7 visits ( $\pm 0.3$ , range = 11 – 17; although note that not every territory was  
66 necessarily visited during a resighting visit). We attempted to locate all birds before  
67 they were disturbed and scored each sighting regarding whether the bird had been  
68 disturbed before being sighted. In the majority of cases, only one resighting location

69 was recorded for each bird per site visit or only if at least 3 hours after a previous  
70 resighting, site visits were separated by at least c. 5 hours, and Wheatears could  
71 cross their territories in seconds; therefore we are confident that resighting locations  
72 are reasonably independent. Locations of ringed individuals were recorded with a  
73 GPS device (Garmin GPSMAP 64). Coordinates were converted to UTM units (Zone  
74 32N) for analyses. Resightings were viewed and edited where necessary in ArcMAP  
75 10.1 (Ersi, 2012) and Garmin BaseCamp software (version 4.2.4; Garmin  
76 International, Inc., Olathe, KS, USA).

77

78 We used an index to illustrate an estimate of territory size instead of the  
79 conventional method of Minimum Convex Polygons (MCP), which requires many  
80 resightings for accurate descriptions of space use and is subject to several biases  
81 (see Hansteen et al., 1997, Börger et al., 2006). For each individual, we averaged the  
82 location of all resightings scored as undisturbed to find the centre of the bird's  
83 territory. We then calculated the distance of each resighting to the territory centre,  
84 and averaged this distance to give the mean distance of each resighting from the  
85 territory centre. This value was then doubled this to give a measure of territory size.  
86 Full methods are described in Blackburn and Cresswell (2015a). Because territory  
87 size estimates calculated from very few resightings were likely to be less accurate,  
88 we then repeated the above for birds only with at least five resightings in an attempt  
89 to reduce the influence of increasing resighting sample size on estimates of territory  
90 size (Börger et al., 2006), whilst still maintaining adequate sample sizes. 15 birds had  
91 at least five independent resightings. Although coordinates recorded with GPS  
92 devices have an error of approximately  $\pm 5$  m (our device gave an accuracy of

93 approximately  $\pm 2 - 3$  m in Nigeria), we assume here that this error was similar  
94 across all recorded points and did not adjust for GPS inaccuracy when calculating our  
95 index of territory size. We used Analysis of Variance (ANOVA) to explore the  
96 influence of age (adult vs. first winter) on territory size, a General Linear Model to  
97 test whether the estimate of territory size was influenced by the number of  
98 resightings for birds resighted at least five times, and Logistic Regression (GLM) to  
99 test whether the probability of resighting a bird was related to the number of  
100 resightings visits made after it was ringed. Analyses were carried out in R version  
101 3.0.1 (R Development Core Team, 2013). Mean values are presented as means  $\pm$  one  
102 standard error in all cases. A statistical significance level of  $p < 0.05$  was chosen to  
103 reject null hypotheses.

104

105 Of the 41 Northern wheatears ringed, 33 were resighted at least once after capture  
106 (mean number of resightings per individual =  $4.6 \pm 0.5$ , range = 1 – 13). The number  
107 of resighting visits made after ringing a bird was the same for birds that we never  
108 resighted compared to those that were resighted (GLM of resighted ( $y/n$ ) ~ number  
109 of resighting visits after ringing:  $\beta = 0.10 \pm 0.18$ ,  $z = 0.5$ ,  $p = 0.60$ ,  $n = 41$ ); therefore  
110 the eight birds that were not resighted after capture may have been transients.  
111 Resighted birds were last seen between 4 and 53 days after capture (mean =  $14.0 \pm$   
112  $2.2$  days). All resighted individuals were observed to hold small, distinct territories  
113 during the entirety of the study (Fig. 1). The two individuals ringed in late October  
114 during the first visit were re-sighted 50 and 53 days later at their exact capture  
115 locations. Mean territory diameter was 73.5 m across all birds resighted at least  
116 twice (the minimum number of locations to calculate a territory size;  $\pm 7.2$  m, range

117 25.2 – 220.0,  $n = 27$ ; Fig. 1). For birds resighted at least five times, mean territory size  
118 was 69.4 m ( $\pm 5.4$  m, range 35.0 – 114.1,  $n = 15$ ). The number of resightings had no  
119 influence on our estimates of territory size for birds resighted at least five times (lm  
120 of territory size~number of resightings:  $p = 0.93$ ,  $F_{1,13} = 0.25$ ,  $n = 15$ ). There was no  
121 difference in territory size between adult and first winter birds (lm of territory  
122 size~age:  $p = 0.97$ ,  $F_{2,23} = 0.03$ ,  $n = 25$ , of which 20 = adult, 5 = first winter).

123

124 By following individually identifiable birds during part of the wintering period, we  
125 show that the Northern Wheatear, a long-distance migrant, is territorial for at least  
126 part of the wintering period. Our study period was relatively short, yet both  
127 wheatears ringed during an earlier visit were resident in the same territories at least  
128 until the end of the study period (50 and 53 days). Furthermore, it was evident that  
129 territories were already established on our arrival in early- to mid-winter. This  
130 suggests that wheatears are territorial for a large part, if not all, of the wintering  
131 period. Individuals responded strongly to playback, and territorial behaviour (singing,  
132 chasing neighbouring birds) was observed throughout the study. Although eight  
133 birds were not resighted after ringing and so may have been transient birds that did  
134 not overwinter in the study area, resightings were not extensive in effort or time,  
135 and we cannot be certain that this was the case. Our findings therefore agree with  
136 other studies documenting strong winter territoriality and site fidelity in several  
137 *Oenanthe* species, including Northern Wheatears (e.g. Panov, 1999, Khoury et al.,  
138 2012, Cornwallis, 1975, but see Smith, 1971); for example for Northern Wheatears  
139 wintering in Egypt and at stopovers during migration (Arizaga et al., 2011), and for  
140 Black-eared Wheatears *Oenanthe hispanica* wintering in Nigeria (Sharland, 1967),

141 but it should be noted than many of these accounts are anecdotal and did not  
142 closely follow individually identifiable birds.

143

144 High site fidelity within winters appears to be common across migrants both in the  
145 Palearctic and Neotropics (for example: Blackburn and Cresswell, 2015, King and  
146 Hutchinson, 2001, Monroy-Ojeda et al., 2013, Wunderle Jr and Latta, 2000, Barg et  
147 al., 2006, Kelsey, 1989, Bates, 1992, Brown et al., 2000, Latta and Faaborg, 2001,  
148 Salewski et al., 2000, Rappole et al., 2003, Moreau, 1969). Likely, winter territoriality  
149 increases survival for these species. Moving during winter or not holding a territory  
150 is often associated with reduced survival (Rappole et al., 1989, Winker, 1998),  
151 whereas being territorial can increase survival probability through familiarity and  
152 predictability of food resources and surroundings (Förschler et al., 2010, Brown and  
153 Long, 2007).

154

155 Measures of territory size are scarce for Wheatears, but our findings are similar to  
156 winter territory sizes documented for Finsch's wheatears *Oenanthe finschii* (Khoury  
157 et al., 2012). Territory size did not differ between first winter and adult birds and the  
158 location of first winter territories was not distinct from that of adults (see Fig. 1), and  
159 there appears to be no spatial segregation according to age, unlike some Neotropical  
160 examples (e.g. Marra and Holmes, 2001, Stutchbury, 1994). However, the number of  
161 first winter birds in our sample is small, our measure of territory size is relatively  
162 crude and based on small sample sizes for each individual and we do not measure  
163 territory quality. Nonetheless, territory size, location and quality does not differ  
164 according to age and sex for Whinchats, a similar Palearctic migrant (Blackburn and



165 Cresswell, 2015). This suggests that – like Whinchats – Northern Wheatears probably  
166 do not exhibit strong dominance hierarchies according to age on the wintering  
167 grounds, in contrast to several Neotropical species which do (e.g. Stutchbury, 1994,  
168 Marra, 2000). Further work is required to confirm whether the absence of age or  
169 dominance effects on territoriality is the general case for Palearctic wintering  
170 passerines.

171

172 In summary, we accurately document high within-winter site fidelity in a long-  
173 distance Palearctic migrant and suggest that Northern Wheatears maintain  
174 territories throughout the wintering period. More detailed knowledge of winter  
175 residency and whether individuals are capable of relocating under changing  
176 conditions is essential for the effective conservation of migrants given the increasing  
177 anthropogenic-driven decline across wintering habitats (Vickery et al., 2014).

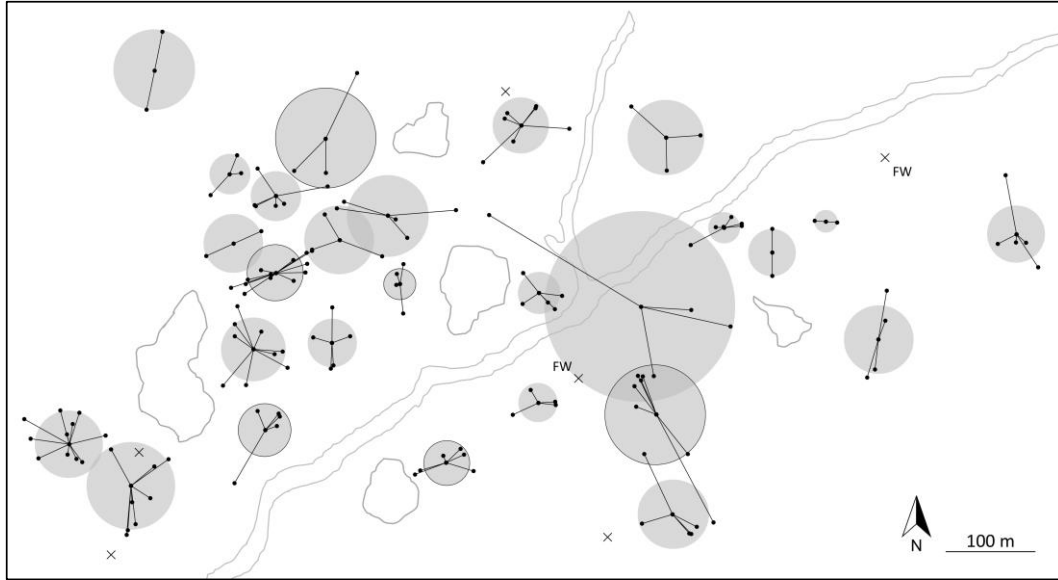
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183 This is paper number (XX – *number to be added in proof stage*) from the AP Leventis  
184 ornithological Research Institute. This study complies with the current ethic  
185 regulations of Nigeria and the A.P. Leventis Ornithological Research Institute.

186 Fig. 1. Individual territories of 33 Northern Wheatears wintering in northern Nigeria.  
187 Each point represents an undisturbed resighting, connected to the mean location of  
188 all resightings for that individual. The grey shaded circles illustrate the territory size  
189 for each individual resighted at least twice ( $n = 27$  birds). Black crosses show the  
190 location of birds resighting only once following capture ( $n = 6$  birds). Territories  
191 outlined in black and crosses with 'FW' show the territories of first winter birds.  
192 Shapes with grey outlines show the location of rocky outcrops and a dry riverbed.  
193 This figure shows that Wheatears held small, distinct territories throughout the  
194 duration of the resighting period.

195 Fig. 1

196



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