



HAL
open science

Stopover ecology of autumn-migrating Bluethroats (*Luscinia svecica*) in a highly anthropogenic river basin

Philippe Fontanilles, Iván de La Hera, Kevin Sourdrille, Florent Lacoste,
Christian Kerbiriou

► To cite this version:

Philippe Fontanilles, Iván de La Hera, Kevin Sourdrille, Florent Lacoste, Christian Kerbiriou. Stopover ecology of autumn-migrating Bluethroats (*Luscinia svecica*) in a highly anthropogenic river basin. *Wilson journal of ornithology*, 2020, 161 (1), pp.89-101. 10.1007/s10336-019-01717-z . hal-03102976

HAL Id: hal-03102976

<https://hal.science/hal-03102976>

Submitted on 7 Jan 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

1 Stopover ecology of Bluethroats in a highly anthropogenic river basin during autumn 2 migration

3 Philippe Fontanilles^{1,*}, Iván de la Hera^{1,2}, Kevin Sourdrille¹, Florent Lacoste¹, Christian Kerbiriou^{3,4}

4
5 ¹ Observatoire d'Intérêt Scientifique Ornithologique (OISO), Cami deth Sailhetou, 65400 Lau Balagnas, France

6 ² School of Biological, Earth and Environmental Sciences, University College Cork, Cork, Ireland.

7 ³ Centre d'Ecologie et des Sciences de la Conservation, UMR7204 MNHN-CNRS-UPMC-Sorbonne Université,
8 55 Rue Buffon, 75005 Paris, France

9 ⁴ Station de Biologie Marine Place de la croix, 29900 Concarneau, France

10
11 Corresponding author, e.mail: fontanilles.oiso@laposte.net

12
13 **Short title:** Stopover ecology of Bluethroats

14 **Key words:** *Luscinia svecica*, home range, body condition, habitat selection, corn crop, diet, trophic resources.

15 16 **Summary**

17 Wetlands are highly productive habitats that are largely used by many avian species as stopover sites during their
18 migrations. However, these habitats are highly threatened by anthropogenic activities, such as land use changes,
19 the introduction of exotic species and global warming. Further understanding on the spatiotemporal use of
20 wetlands and their surrounding areas by migrating birds is essential to predict how these changes might affect
21 avian *en route* ecology. We selected a habitat-generalist passerine of conservation concern, the Bluethroat
22 *Luscinia svecica*, as model of how migratory birds exploit a highly anthropogenic river basin in southwestern
23 France (i.e. Barthes de la Nive) during autumn migration. We captured and radiotracked 29 young Bluethroats in
24 this region to shed light on different aspects of their stopover ecology and behaviour, such as stopover duration,
25 habitat selection and home range size. We also complemented the study with a characterization of Bluethroat
26 diet and arthropod availability in different habitats. Bluethroats positively selected reedbeds (pure or mixed
27 associated with carex), hydrophilous tall grasslands and corn crops. Birds staying more than just one day, 8.4
28 days on average, used preferably corn crops. Home range sizes were on average 5.8 ha (fixed kernels K95) and
29 high occupancy area (K50) was 1.36 ha with large individual variation. Bluethroats stopping over with low body
30 reserves tended to have larger home ranges and used preferentially corn crops, wet or mesotrophic grasslands
31 and rural paths. Reedbeds were typically used as roosting habitat for the majority of birds, being on average 397
32 m apart from their daytime core areas. Short-staying birds tended to show higher body reserves and restricted
33 their activities to a smaller home range (1 ha) in pure and mixed reedbed. The diet of Bluethroats was dominated
34 by ants Hymenoptera Formicidae, Araneidae and Coleoptera that were most abundant in the corn crops. The use
35 of corn crops by migrating Bluethroats during autumn in our study site appears to be a reasonable solution in a
36 highly altered environment. Reducing the use of insecticides in these crops and delaying the harvesting time after
37 mid-October are two measures that could favour Bluethroats and other migratory species while natural wetlands
38 are restored and reedbeds protected from tree encroachment.

39
40 **ACKNOWLEDGEMENTS** – This work was supported by the Conseil Départemental des Pyrénées Atlantiques,
41 Syndicat Nive Maritime, Villefranque and Bayonne councils. We are particularly grateful to F. Esnault, S.
42 Valles, R. Damestoy and R. Dufourcq. We are extremely thankful to L. Delalande, F. Delfour, A. Glad, M.
43 Janczyszyn-Le Goff, T. Sarraude, for their commitment in the collection of the radiotracking data, to L. Julien
44 for invertebrate sampling, and members of OISO association who made this research possible, especially F.
45 Lartigau. National Museum of Natural History authorized the bird-ringing and radio-tracking scheme. The
46 experiments were complied with the current laws of the country in which they were performed. We also thank
47 two anonymous reviewers who gave insightful comments that improved an early version of the manuscript.

48
49 **Author contributions:** All of the authors collected the data, particularly K.S. the habitat map, F.L. and C.K. diet
50 bird and arthropod availability. P.F., I.H. and C.K. analyzed the data, designed the methods and conducted the
51 research. All of the authors took part in the formulation of the questions and hypotheses. P.F. wrote the paper in
52 cooperation with I.H. and C.K.

53 **Conflict of interest:** The authors declare that they have no conflicts of interest.

54 **Ethics statement:** All data and information from external sources used for the analyses and preparation of the
55 manuscript are properly cited. The conclusions are entirely based on our own results. All applicable
56 international, national, and/or institutional guidelines for the care and use of animals were followed.

57 Introduction

58
59 The global conservation of migratory birds not only relies on the protection of their breeding and wintering
60 habitats, but also on the presence of suitable stopover sites along their migratory routes (Hutto 2000, Young
61 2000, Newton 2008). Coastal marshes, estuaries and other types of wetlands are highly productive habitats
62 largely used during migration by waterbirds and other avian species, constituting key conservation areas (Czech
63 and Parsons 2002). Wetland habitats experienced a dramatic reduction and an increased fragmentation during the
64 20th century, mainly as a consequence of the pressure of human activities, such as urbanization and the drainage
65 for agricultural use (von Behren 2007; Whited et al 2000; Czech and Parsons 2002). As a result, wetlands
66 usually remain now embedded in a complex and highly-altered human matrix, where every year migrating birds
67 rest and search for food to undertake their next flight bout.
68

69 The wetland remnants that many birds use as stopover sites are normally small and face some common problems
70 that, in some cases, can be mitigated by human intervention. For example, many wetland managers implement
71 measurements to avoid clogging, which could lead to bush encroachment and the progressive disappearance of
72 marsh vegetation (Clark and Wilson 2001); while the control of invasive and exotic species, that can alter
73 wetland biodiversity and functioning, is also a common practice (Fontanilles et al. 2014; Arizaga et al. 2013).
74 These measurements would increase the quality and carrying capacity of the wetlands, which would be very
75 beneficial for migrating birds (e.g. fuel acquisition; Delingat and Dierschke 2000). Another aspect that has
76 hitherto received little attention is the potential management and planning of the areas surrounding the wetland.
77 These adjacent areas might be intensively used by migrants given the restricted size of wetland patches and the
78 potential high intra and interspecific competition with other migratory and resident individual birds. This
79 situation could be particularly exacerbated during the migration peaks, when large number of individuals can
80 meet together in a single location (Newton, 2004). Such circumstance predicts that many migrants will be forced
81 to expand their home-ranges and use alternative habitats out of the wetland. In this context, identifying which
82 alternative habitats are positively selected by migrating birds during their brief stopovers would be essential to
83 design buffer areas that best meet the requirements for these *en route* migrants. However, our knowledge of the
84 stopover ecology and behaviour of migratory birds is still very limited.
85

86 In this study, we analysed the stopover ecology of migrating Bluethroats *Luscinia svecica* in Barthes de la Nive
87 (France) during autumn migration. Barthes de la Nive is a mosaic of wetlands, riparian woodlands and farmlands
88 located near the Adour River mouth in the Southwestern Atlantic coast of France. The scattered wetlands in this
89 region attract a large diversity of both aquatic and non-aquatic birds during migration periods (Fontanilles et al.
90 2011). The only radiotracking study carried out in this area so far showed that the globally endangered Aquatic
91 Warbler *Acrocephalus paludicola* had a strong preference for reedbeds but, to a lesser extent, it also made use of
92 some farmlands (Fontanilles et al. 2014). This highlights the relevance that the surrounding matrix might have
93 even for a wetland specialist as the Aquatic warbler. Conversely, Bluethroats are migratory birds that can use a
94 large range of habitats, mainly reedbeds and marshlands (Arizaga et al. 2006; Musseau et al. 2017), but also
95 bushlands, woodland and farming habitats (Cramp 1988; Cornulier et al. 1997; Chiron, 2017, Berndt and Hölzl
96 2012), making it an interesting model to study its stopover ecology and habitat selection during migration.
97 Arizaga et al. (2011) radiotracked 20 autumn-migrating Bluethroats in Txingudi (North Spain), a wetland located
98 less than 30km away from Barthes de la Nive. Their results showed a strong selection for reedbeds, low-
99 halophytic vegetation and tidal flats. However, Txingudi is located in a more urbanized environment that
100 probably greatly restricts bird movements, and its proximity to the river mouth allows the presence of habitats
101 that are lacking in Barthes de la Nive (e.g. halophytic vegetation). On the other hand, bird ringing information
102 obtained for both wetlands during autumn migration showed dramatic differences in the number of self-
103 recoveries, which are much more usual in Txingudi than in Barthes de la Nive (Arizaga et al. 2011; Fontanilles
104 unpublished data). These differences could be a consequence of a longer stopover duration of Bluethroats in
105 Txingudi than in Barthes de la Nive, but they could also be caused by the existence of larger home ranges in
106 Barthes de la Nive, something that would be possible in its much less urbanized surrounding. All these aspects
107 suggest a different stopover ecology and behaviour of Bluethroats between both wetlands in spite of their
108 geographic proximity that remains still unexplored.
109

110 In order to better understand the stopover ecology of the Bluethroat in Barthes de la Nive, we performed a
111 radiotracking study during autumn migration that aims to shed light on (1) the stopover duration and the
112 proximate factors that affect it, (2) habitat selection and home range sizes, and (3) we complemented the study
113 with an analysis of Bluethroat diet and the availability of food resources. Although Bluethroats are not globally
114 threatened, some populations have been considered to be under high risk of extinction (Huntley et al. 2007).
115 Consequently, we expect that the spatial information generated in this study could be valuable for the competent
116 authorities to design management practices out of the wetlands patches that could contribute to the conservation
117 of Bluethroats and other birds during their migrations.
118
119
120

121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184

MATERIALS AND METHODS

Study area and vegetation map

Barthes de la Nive (43°27'N; 01°28'W) is a 442-ha mosaic of natural and anthropogenic habitats (Fig. A1), whose remaining wetlands have been maintained safe from complete drainage due to its role in reducing the risk of flooding in Bayonne city. The wetlands are connected to the Adour river by channels, so that its hydrology is influenced by the flow of the river and the tidal regimes. However, its natural influence and ecologic functions in Adour estuary were drastically affected to urbanize the city, to develop port facilities and dykes, which virtually destroyed the original mudflats and intertidal areas. Our study site is now a protected area included in the European Natura 2000 network (FR7200786). The non-urban areas near the river have been widely used for pasture, as hay meadows and other agricultural purposes, being corn plantations the primary crop nowadays. Farming in the region uses a reasonably low quantity of fertilizers and no use of insecticides. Field abandonment and lack of management is increasing gradually bush and tree encroachment, which is changing dramatically the landscape. A vegetation map was obtained from photo-interpretation and field validation for summer 2014 and 2015 (Fig.A1, Table1). This approach showed the relative importance of each habitat in the region (see Table 1).

Bluethroat trapping and body measurements

Mist-netting sessions were performed from mid-August to late September when migrating Bluethroats stopover in this region during their post-breeding migratory period. Note that Bluethroats do not breed in Barthes de la Nive or use it for moulting (Fontanilles et al. 2011). Ringing sessions took place in five different locations across the study area: four wetlands and one corn crop (see details in Supplementary Material Fig. A1, Ap. 3, Table 2). These five sites were reasonably distant each other to reduce potential geographic bias and, according to previous studies (Fontanilles et al. 2011, Fontanilles 2014), they represent the two main habitats (i.e. reedbed, corn crops) where Bluethroats occur during their stopover at Barthes de la Nive.

To maximize the number of captures, we used one male song playback from 30 minutes before dawn (when mist-nets were open) until a tagged bird was released (when mist-nets were furled). By using the tape lures only 30 minutes before sunrise, we reduced the possibilities of forcing the landing of migrating Bluethroats and we expected to capture only birds that decided voluntarily to stop over in our study area (Schaub 1999; Arizaga et al. 2015). During our ringing sessions, we captured 58 Bluethroats (28 in 2014 and 30 in 2015).

Several morphological measurements were taken from each bird in order to obtain a composite index of bird body size (Freeman and Jackson 1990, Tellería et al. 2013, see Supplementary Material). We also recorded body mass (± 0.1 g) and standard scores of fat and muscle (Busse 2000). Body size-corrected measurements of body mass were used to estimate the relative quantity of body reserves carried by each Bluethroat. This was done using linear regression of body mass on body size (see Supplementary Material Ap. 2, Fig. A2), where individuals with more body reserves showed more positive residuals (Salewski et al. 2009).

Radio tracking information

Out of the 58 Bluethroats captured, 29 juveniles were equipped with a radio-transmitter, with a minimum of 4 radiotagged individuals in each of the 5 ringing sites (25 birds were trapped in the reedbeds and 4 in the corn crops; see details in Supplementary Material, Ap. 3, Table A2). Life expectancy of the emitters is typically more than 17 days and the average detection distance is 80-300 meters. We only tagged first-year birds because the study site is mainly used by first-year birds; and because juveniles face their first autumn migration and, consequently, their habitat choice cannot be influenced by previous experience (Piper 2011).

On the day of capture, monitoring of tagged Bluethroats started at least one hour after the bird was released in order to avoid bias linked to potential stress behaviour. For birds that stayed in the area the following days after capture (see below), they were normally monitored 8h per day during, normally, 3-4 days in long-staying individuals. After this period, we checked the presence every day, but the intensity of the radiotracking typically got reduced and depended on other duties associated with the project, particularly, the trapping and monitoring of other individuals (see Supplementary Material Ap.3 for more details).

The positions of the birds were obtained normally by triangulation (3 vectors taken consecutively within less than 10 minutes), but we used bi-angulation in those cases in which landscape barriers (like canals, rivers or dense vegetation) impeded taking more than two informative vectors, or just one vector plus an estimation of the actual distance to the bird when this was observed. We used Sika receivers (Biotrack Ltd) and Yagi antennas to find the birds, and vectors were delimited using a GPS (to determine observer position) and a compass (to obtain magnetic Azimuth). All this information was computerized using the software Cartoexploreur, and we considered the centroid of the triangle determined by the three corresponding vectors as the most likely geographic position of the bird, or the intersections between lines when two vectors were only available. Prior to the start of radiotracking, observers were trained in the study area and the accuracy of the triangulation method was assessed. The average error found in the estimation of the positions of transmitters hidden in the study area was 14.5 ± 1 se m (n=69), which can be considered enough given the purpose of studying main habitat selection.

185

186 **Stopover duration and its determinants**

187 We used the number of days spent by each Bluethroat after being tagged (assessed by the radiotracking survey)
188 as a proxy of stopover duration. This approach is expected to provide a better idea than ringing recaptures on
189 how long Bluethroats stopover in Barthes de la Nive, since ring-recovery data are spatially restricted, have a
190 lower detection probability and strongly depend on a good sampling strategy (Chernetsov 2012). According to
191 the non-Gaussian distribution of stopover durations (see Fig. A3) we performed non parametric tests (Wilcoxon
192 tests, Kruskal-Wallis tests and Spearman correlations) to evaluate which factors (year, sex, site, date of capture,
193 muscle development, fat accumulation and body condition) better correlated with the observed variation in the
194 length of the stay of Bluethroats.

195

196 **Habitat selection**

197 Initially, we tested whether Bluethroat locations were randomly distributed among habitats. We applied the
198 quadrats method (Zaminetti 2005) by defining a grid of K squares 100 x 100 m enveloping all the radio-tracking
199 points. The theoretical distribution $K_{th}(n)$ was obtained following the Poisson's law: $K_{nth} = [K * (D^n / n!)] * \exp(-D)$
200 where n is the number of points per mesh, K(n) the number of stitches having n points, N is the total number of
201 locations and D is the average density of locations by cell that is defined as N divided by K. The existence of
202 significant differences between the two distributions (i.e. K (n) and $K_{th}(n)$) was assessed using a Kolmogorov-
203 Smirnov test.

204 Secondly, for assessing habitat selection, we calculated for each habitat the electivity index of Jacobs (1974) $I_h =$
205 $U - D / (U + D - 2U * D)$ where U is the proportion of locations in habitat h and D the proportion of this habitat in
206 the study area. The index ranges between -1 (strong rejection of a particular habitat) and 1 (strong selection). We
207 used the proportion of locations instead of the proportion of areas in core areas to take into account the edge
208 effects and to be more precise with the actual habitat used. We excluded habitats poorly represented showing
209 less than 5 locations.

210

211 **Home range estimates**

212 The overall home range size of each individual Bluethroat was estimated by the model of 95% kernel (K95;
213 Worton 1989). The K95 approach is usually used in this type of studies, which would allow between study
214 comparisons (Börger *et al.* 2006). Areas of high occupancy were also estimated using the 50% kernel (K50),
215 considered as a good estimator of core areas (Börger *et al.* 2006). We calculated the overall home range with all
216 the locations for each bird and also for each day when there was a minimum of 10 positions. Home range sizes
217 were processed using the Ranges 8v2.10 software (Anatrack Ltd).

218

219 **Home range analysis**

220 We explored whether overall home range size varied in relation to the proportion of habitats contained within it
221 (10 habitat variables, see Table 1), several metrics of heterogeneity (mean patch size, number of habitat or
222 Shanon index perform of patch size distribution) and individual-associated variables (body condition, sex and
223 stopover duration). For that purpose, we performed General Linear Models (GLM) using the home range size
224 (50% kernel and 95% kernel) as a response variable, while habitat cover and individual-associated variables
225 were included as explanatory variables. According to the distribution of home range size (positive long tail
226 distribution), we applied a negative binomial error distribution to the GLM in order to minimize issues related to
227 the over-dispersion ratio in the models (i.e. as close as possible to 1; Zuur *et al.* 2009). Following a multi model
228 inference (Burnham *et al.* 2011; Grueber *et al.* 2011), we generated a set of candidate models containing all
229 possible variable combinations and ranked them by corrected Akaike information criterion (AICc) using the
230 dredge function (R package MuMIn). We only integrated the models complying with the following conditions:
231 (i) models do not include simultaneously correlated covariates ($R^2 > 0.7$) and (ii) models do not include more
232 than three variables to avoid over-parameterization due to the limited data set. Since the simultaneous inclusion
233 of habitat cover and measures of habitat heterogeneity generated important multi-collinearity problems, we
234 decided to perform two separate modelling: one with habitat cover within the home range and individual-
235 associated variables; and a second one, with measures of habitat heterogeneity and individual-associated
236 variables (results of this second modelling are shown in Appendix 5). We restricted this set of models using a
237 cut-off of 2 AICc. The modelling with habitat cover resulted in 4 and 3 top models for 50% Kernel and 95%
238 Kernel, respectively (see Supplementary Material Ap. 5, Table A3). The modelling with measures of habitat
239 heterogeneity resulted in 4 and 2 top models for 50% Kernel and 95% Kernel, respectively (see Supplementary
240 Material Ap. 5).

241 Following the same approach, we explored whether daily home range size (with a minimum of 10 positions)
242 varied in relation to habitat cover within home range, individual-associated variables. According to the
243 hierarchical structure of this data set (radio-tagged individuals survey each day), we treated the variable
244 "individual identity" as a random effect, while considering the other explanatory variables (home range and
245 individual-associated variables) as fixed effects (Zuur *et al.* 2009). Following a multi model inference using
246 General Linear Mixed Models with a negative binomial error distribution, the daily home range analyses resulted
247 in a total of 2 and 3 top models for the 50% and 95% kernel, respectively (see Supplementary Material **Ap. 5,**
248 **Table A**). We also used a secondary method based on PCA analysis detailed in Supplementary Material **Ap. 6.**

249
250
251
252
253
254
255
256
257
258
259

Roosting habitat selection

To provide information on roosting behaviour, we identified the habitats used between sunset and sunrise (roosting locations) and also estimated their distance to the daytime, potential, foraging areas. We identified the habitat of all those locations on the vegetation map. We compared the proportions of roosting locations occurring in each habitat to identify the most used by *a posteriori* Wilcoxon test. For birds flying to a roosting location far away from the area used during daytime hours, we calculated the distance between the centroid of the home range exploited during daytime hours and the core of roosting locations. We then compared the proportions of habitats between these two areas (home range during daytime hours vs. roosting locations core) by *a posteriori* Wilcoxon test.

Diet of Bluethroat

To try to elucidate why birds tend to select specific habitats, we analysed their diet and the invertebrate availability. We collected 105 faecal samples during ringing operations for all sites in 2015 (n=52) and 2014 (n=30) and only in Urdains in 2012 (n=23). All remains identified in faeces were used to estimate the minimum number of prey items and the occurrence of each taxonomic group within each sample. While some bias in diet analyses was possible because small or soft-bodied preys are less easily detected, strong correlation has been found between prey remains in droppings and the actual composition of the diet (Davies 1977a, 1977b). We also assessed prey biomass using predictive models based on the relationship between body length and mass of terrestrial arthropods (Hodar 1996; see Supplementary Material **Ap. 7** for additional details). We explored which factors influenced the prey abundance, testing explicitly the effects of age (young vs adult birds), sex and day using a Generalized Linear Model (GLM) with a Poisson error distribution. P-values were corrected for over-dispersion. Only taxa representing more than 2% of the prey abundance were considered

Invertebrate availability between habitats

We estimated the variation in the abundance of (near) ground invertebrates (the main feeding substrate of Bluethroats) between the two main habitats occupied by Bluethroats (corn crops and reedbeds). Given the large extension of the study area, we decided to focus our invertebrate sampling on three of the five trapping areas: the corn crop area, and Villefranque and Urdains reedbeds (**Fig. A1**). The corn crops in the other bank of the Nive River had similar plantation and exploitation, so we assumed them to have a similar invertebrate availability. We used 3 standardized coloured (yellow, white, blue) bowl traps and a pitfall glass per station (for a total of 12 stations, 6 in the corn crops, 3 in each reedbed). All stations were sampled simultaneously at 3 temporal stages in August 2015. Traps were deployed for four days. For more details, see Supplementary Material **Ap. 8**. For subsequent analyses, we pooled together the data of the three bowl traps of each station. We focused the analyses on those taxa whose remains had been found in faeces of trapped Bluethroats. We compared invertebrate availability, abundance and biomass between the two reedbeds and the corn crop using General Linear Models with a Poisson error distribution.

Unless specified, mean values are given \pm se (standard error).

RESULTS

Stopover duration and body condition effect

Tagged Bluethroats stayed 5 days (± 1 se; range 1-20) on average upon capture in Barthes de la Nive, but showing a clearly non-Gaussian distribution where up to 13 individuals left the study area the next night after being captured (**Fig. A3**). The remaining 16 Bluethroats stayed on average 8.4 ± 1.3 days (see **Table A1, Fig. A3**). Observed variation in stopover duration did not differ significantly between years ($W=91$, $p=0.536$), sites (Kruskal-Wallis $H(3, 29) = 1.11$, $p=0.774$), sex ($W=133$, $p=0.189$), date of capture (r Spearman = -0.11, $t_{27} = -0.59$, $p=0.558$) or muscle development (r Spearman = -0.17, $t_{27} = -0.92$, $p=0.365$). The fat score was significantly associated with stopover duration (r Spearman = -0.40, $t_{27} = -2.24$, $p=0.034$). However, the individual trait that better explained stopover duration was the quantity of body reserves, which was estimated from the residuals of body mass on body size (effects of body size on body mass: $\beta=0.888$, $F_{1,27}=100.9$, $p < 0.001$). Thus, Bluethroats with relatively more body reserves for a given body size left the Nive basin earlier on average (r Spearman = -0.59, $t_{27} = -3.78$, $p < 0.001$; **Fig. 1**) than birds with relatively less body reserves. Additionally, we analysed whether stopover duration differed between habitats used. Irrespective of where they were trapped, birds that used corn crops during their stay remained significantly ($W=23$, $p < 0.001$) longer ($10 \text{ days} \pm 1.1 \text{ se}$, $n=10$) in the area than those not using this habitat type ($2.7 \text{ days} \pm 0.6 \text{ se}$, $n=19$; see **Fig. 2**).

Habitats selection

The 29 radiotracked juvenile Bluethroats provided 1718 positions during their stay in our study site. Bluethroat locations were not randomly distributed among habitats. Their distributions differed significantly from the theoretical null distributions (Kolmogorov-Smirnov test $D = 0.896$, $p < 0.0001$). The main habitats used by all birds were corn crops and reedbeds, either pure or mixed (**Fig. 3**). The distribution differed between birds staying one day, which preferred pure reedbed ($W=55.5$, $p=0.034$), and the rest, which positively selected the

313 corn crops ($W=162$, $p=0.013$). The birds stopping over for just one day made use of less habitat types (2.2 ± 0.3
314 [1-4] habitats) than birds staying longer (4.7 ± 0.5 [2-10]; $W=180.5$, $p<0.001$). However, during the first day of
315 stay, there were no differences between them in the preferred habitat and number of them (tests Wilcoxon, $p>$
316 0.05 , **Fig.A4**). Regarding the available habitats (**Fig. 4**), Bluethroats strongly positively selected pure and mixed
317 reedbeds, corn crops and hydrophilous tall grasslands. They moderately selected paths, wooded reedbeds and
318 mesophic grasslands, while they avoided water, railways, ferns, wet grasslands, houses, woodlands and hay
319 meadows.

320

321 **Home range analysis**

322 The average number of locations per individual was 59.2 ± 9 (22.5 ± 1.6 for birds staying one day, and 89 ± 12
323 for birds staying longer). The average overall K95 home range was 5.8 ± 1.8 ha with a large variation between
324 individuals (standard deviation 9.9, range 0.016-46.5). The core area (i.e. K50) was on average 1.36 ± 0.35 ha
325 (standard deviation 1.87, range 0.004-7.6). K95 areas were larger in birds staying more than one day (9.72 ± 3
326 ha) than in birds stopping over just one day (1.07 ± 0.46 ha; $W = 23$, $p< 0.001$). Similar results were obtained for
327 the K50 core area: 0.28 ± 0.12 ha for long-staying birds, and 2.24 ± 0.53 ha for birds staying only 1 day ($W = 18$,
328 $p< 0.001$).

329 Bluethroats with greater overall home range included more wet grassland, woodland and mesophilic grassland
330 within their range, and also exhibited longer stopover duration. On the other hand, Bluethroats with smaller
331 overall home range exhibited larger quantities of body reserves and occupied areas with a higher proportion of
332 reedbed (Table 2). Analyses performed for daily home ranges highlighted that Bluethroats with greater home
333 range included more hay grasslands, open water, and woodlands; while Bluethroat with smaller daily home
334 range occupied areas with a higher proportion of crop fields, natural paths and pure reedbeds (**Table 2**). In
335 addition, analyses performed with measures of habitat heterogeneity, showed that Bluethroats with greater
336 overall home range exhibited a more diversified home range (Appendix 5). According to AICc, measures of
337 habitat heterogeneity performed better than habitat cover variables for K95, while the opposite was true for K50
338 (Appendix 5).

339 A second analytical method based on PCA analysis gave similar results (see Supplementary Material **Ap. 6**).

340

341 **Roosting habitat selection**

342 We identified the overnight habitat in 26 Bluethroats. Pure reedbed was the main roosting habitat, with 44.2% of
343 the nights (**Fig. 5**). Mixed or wooded reedbeds were also well-represented within the roosting habitats,
344 representing 17.5% and 16.8 %, respectively. So, reedbeds (pure, mixed and wood reedbed) were the preferred
345 habitats for roosting ($80.1 \pm 8\%$ of nights) in 23 birds that stayed for at least one night. Corn crops were also used
346 by 5 birds but less frequently than reedbeds: $13.1 \pm 6\%$ of nights.

347 83% of birds spending the night in reedbeds (pure, mixed and wood reedbed) occupied the same reedbed during
348 the day. This took place in $59 \pm 9\%$ of the nights (**Fig. 6**). This particularly concerned the 13 Bluethroats which
349 stopped for one day. Individuals staying for at least 2 days showed relatively predictable movements and
350 selected repeatedly the same areas during the night. 27% of the birds (7) spent overnight in a reedbed (Urdains or
351 Villefranque) and normally moved during the day to a corn crop. This was noticed for $12.5 \pm 5\%$ of the nights.
352 We calculated the distance between roosting core areas and daytime foraging core areas. Birds flew on average
353 397 ± 33 m to reach its roosting location ($n=10$, range 80- 692 m). Five birds also used corn crops to stay during
354 the night after using it also during the daytime (19 nights).

355

356 **Diet analyses and available invertebrates within habitats**

357 We analysed Bluethroat diet and invertebrate availability to explore foraging preferences. We obtained 105
358 faecal samples: 84 faecal samples from first year birds and 21 from adults, 55 from males and 47 from females.
359 A total of 431 prey items were identified, 4.1 ± 0.8 on average per dropping. We found 14 orders of invertebrates
360 (2.2 ± 0.3 on average per sample). The diet of Bluethroats was dominated by ants Hymenoptera Formicidae,
361 representing 45.5 % of preys and occurring in 54% of the samples (**Table 3**). Araneidae was the second most
362 abundant group (20.4%) with a similar occurrence to ants (53%); and Coleoptera was the third most common
363 group (10.2% of all preys and 31% of the samples). These two last taxa were the main contributors to the
364 consumed biomass, representing 64.7 % and 14.9%, respectively. We did not detect any significant effects of
365 Bluethroat age and sex on prey abundance. We did also observe that Cicadellidae was less consumed over time
366 (**Table 3**).

367 Corn crops hosted significantly more invertebrates and biomass than reedbeds for Coleoptera, Diptera and
368 Araneida in pitfalls, and for Cicadellidae in bowls (**Table 4**). Corn crops also had higher availability of not-
369 Formicidae Hymenoptera than Urdains in bowls, but less than Villefranque. Finally, Formicidae was more
370 abundant in Urdains than in the other two sites.

371

372

373

DISCUSSION

Variation in stopover duration and home range size

Bluethroats showed large individual variation in their stopover duration and home range size in Barthes de la Nive. Observed mean values differed from those obtained by Arizaga et al. (2013). Thus, stopover duration was shorter and home range larger in Barthes de la Nive (mean stopover duration of 5 days and mean home range size of 5.8 ha) than in Txingudi (9.6 days and 2 ha, respectively). Differences in stopover duration between these two sites were mediated by the fact that 45% of the radiotracked Bluethroats in Barthes de la Nive apparently departed the following night after capture, a circumstance that never took place in Txingudi (Fig. A3). If these short-staying individuals were excluded from the calculations, the stopover duration in Barthes de la Nive (i.e. 8.4 days) would conform better to the values obtained in Txingudi. After the signal of a bird disappeared from the place it was last detected, we carefully explored the whole study area by car the following day in its search, and sporadically the following days. This makes us very confident that the stopover duration estimates obtained in Barthes de la Nive are reliable. Likewise, the fact that only one of the 29 radiotracked Bluethroats stayed longer than the life-expectancy of the transmitter would not alter these between-site differences or the general conclusions of our study (see below). Actually supporting the longer stopover duration of Bluethroats in Txingudi, it was slightly higher (3 out of 20) the number of Bluethroats whose stay reached the expected functional life of the transmitters in this wetland than in Barthes de la Nive.

It could be argued that the higher number of short-staying Bluethroats in Barthes de la Nive was caused by the use of playbacks during the trapping sessions, which were not implemented in Txingudi. However, current evidence would not support this hypothesis, since the use of playbacks typically attracts Bluethroats with lower body reserves (Arizaga et al. 2015) and, as our results show, birds with less fuel loads would tend to have longer stopover durations (Alerstam and Lindström 1990; Salewski and Schaub 2007). This bias of playback use on the body reserve loads of autumn migrating Bluethroats was consistent in the three wetlands (on the Bay of Biscay, Gironde, Txingudi, Urdaibai) analysed by Arizaga et al. (2015) that are geographically close to Barthes de la Nive. If Bluethroats do show transient vs. non-transient divergent behaviours during migration as have been described for other migratory species (Rappole and Warner 1976), playbacks might have also biased stopover duration estimates if they do preferentially attract transient individuals. Again, the results obtained by Arizaga et al. (2015) do not support this possibility, since playbacks do not seem to affect the number of Bluethroat recaptures, and this would be an expected outcome if playbacks promoted the capture of more transient individuals that will have less recapture prospects. Likewise and contrary to what would be expected for their transient condition, these short-staying individuals did not move as much as would be expected after being trapped in Barthes de la Nive, and their first-day home range did not differ significantly from that observed for long-staying conspecifics.

). Additionally, overall home ranges are nearly twice to three times larger in Barthes de la Nive than in Txingudi (Arizaga et al. 2013). Musseau et al. (2017) also found home ranges of similar size to Arizaga et al. (2013) in moulting Bluethroats. These contrasting differences between Txingudi and Barthes de la Nive are very likely mediated by the strong differences in the degree of urbanization and habitat composition that seem to have profound consequences in the stopover behaviour of Bluethroats between two relatively close locations.

Habitat and roosting site selection

Migrating Bluethroats in Barthes de la Nive strongly selected reedbeds (pure and mixed) and other hydrophilic natural grasslands, which concurs with the favourite habitat that Arizaga et al. (2013) and Musseau et al. (2017) found for migrating and moulting conspecifics, respectively. Much less known was the preference of migrating Bluethroats for corn crops, although one study had detected this species in this crop type during migration (Gottschalk & Cover 2016) and some populations of Bluethroats seem to thrive and even breed successfully in some agricultural fields, such as oilseed rape crops (Cornulier et al. 1997; Berndt and Hölzl 2012, Chiron 2017). We did not find the preference of Bluethroats for tidal mudflats or low-halophytic vegetation described in other studies (Arizaga et al. 2013; Godet et al. 2015; Musseau et al 2017), but the representation of these habitats in Barthes de la Nive is relatively limited, which could explain this lack of use.

Our results showed that home-range size is smaller when birds occupied reedbeds (for overall home ranges) and corn crops (for daily home ranges). A potential explanation for this result is that these habitats might offer more trophic resources, which would prevent birds from moving long distances in search for food (Bibby and Green 1980; Chernetsov et al. 2004). Another complementary hypothesis for the higher occurrence of Bluethroats in these two habitat is that, given their dense structure, they could also provide a suitable shelter, not only for roosting during the night but also to rest during daytime between migration flight bouts. The use of reedbeds as roosting habitat has been described before in Bluethroats (Eybert et al. 2004; Harmange et al. 2016) and our study confirmed this preference and suggested that corn crops might occasionally play a similar role. In contrast, long-staying Bluethroats seem to expand their home range probably because they are in high demand of food for

437 refueling and, perhaps, because of the competition with conspecifics and other species (Chernetsov and Titov
438 2001; Fransson et al. 2008).

439 If home-range size is considered a proxy of habitat quality, inland reedbeds could be interpreted as a refuge or a
440 more optimal habitat than corn crops, which might represent the most-commonly available substitution habitat
441 (Godet et al. 2018), where birds needing to refuel would move due to competition and the limited availability of
442 reedbeds.

443 In our site, Bluethroats encounter also some potentially unsuitable habitats such as woodlands, open water,
444 mowngrasslands and infrastructures (house, road, railway) that would explain why they had to fly away a
445 relatively long distance from their preferred roosts (Harmange et al. 2016), expanding their home range size.
446 Similar patterns have been shown in Briere for breeding Bluethroats (Godet et al. 2015).

447
448 We did not detect any difference between males and females in home range size, flight distance or stopover
449 duration. Typically, small-sized, young and female Bluethroats are subordinated to large, adult and male
450 conspecifics, respectively (Lindström et al. 1990, Moore et al. 2003). Our results suggest that Barthes de la Nive
451 was occupied, not under an ideal despotic distribution, but under an ideal free distribution, where home range
452 size would be determined by its habitat composition.

453 **Diet of birds and invertebrate availability**

455 The diet description in our study site fitted well with the trophic characterization made in other Bluethroat
456 studies (Allano et al. 1998; Orłowski *et al.* 2014; Musseau et al. 2017). In decreasing order of importance, our
457 study showed the relevance of Hymenoptera Formicidae (40.6% of prey; 8.7% of biomass), Diptera (resp. 14%
458 and 6.5%), Coleoptera (13.7%, 40%) and Araneae (9.4%, 22.5%). Bluethroats typically forage on the ground
459 (Orłowski et al. 2014, Allano et al. 1998, Cramp 1988) where Formicidae are particularly abundant. As in other
460 agricultural farms (Cornouiller et al. 1997), corn crops showed a very high insect abundance and biomass, which
461 could explain why Bluethroats positively selected this habitat. Again and as a consequence of the relative
462 scarcity of intertidal habitats, arthropods such as Malacostraca Amphipoda, were absent from the diet of
463 Bluethroat in Barthes de la Nive, although they have been found in other studies (Musseau et al. 2017; Allano et
464 al. 1998).

465 466 **Habitat management implications**

468 Our study confirmed the importance of wetlands and their associated reedbeds in Barthes de la Nive for
469 migrating Bluethroats, as it was also shown for other bird species stopping over in the region (Fontanilles et al.
470 2014). This reaffirms the need to conserve and potentially expand these valuable habitats, whose largest
471 remnants in Southwestern France persist in the Nive/Adour river basin, and are mainly threatened by clogging
472 and bush encroachment, particularly by invasive exotic tree species (i.e. *Acer negundo*, *Baccharis halimifolia*).
473 So, tree expansion must be controlled in reedbeds to maintain an open wetland.

474 Likewise, our results unexpectedly revealed a positive selection of corn crops by Bluethroats. The tall and dense
475 arrangement of corn plants resemble the habitat structure of reedbeds. However, corn crops do not seem to
476 constitute an ecological trap but a substitution habitat, (Godet et al 2018) an human-induced opportunity for
477 migrating birds. Anyway, further research would be required to further understand this selection process and
478 whether it also takes place in other sites. Our preliminary results suggest that corn crops would provide plenty of
479 food resources and a suitable shelter for birds stopping over in Barthes de la Nive. Our study using the
480 Bluethroat as model species raises the question of how other bird species respond to the presence of corn crops
481 during their stopovers. The corn crops of Barthes de la Nive are used by a large group of migratory species
482 (Fontanilles not published), so that measures to maintain or increase the suitability of this common crop for birds
483 around the limited wetland remnants should be encouraged. Among them, promoting organic farming and
484 postponing the harvesting time after mid-October, when most insectivorous migrants are in or near their southern
485 wintering quarters, would be relatively easy to implement and might have immediate payoff (Dänhardt et al.
486 2010).

487
488
489
490
491
492

493 **REFERENCES**

494

495 Alerstam T, Lindström C (1990). Optimal bird migration: the relative importance of time, energy and safety. In:
496 Gwinner E (eds). Bird migration: the physiology and ecophysiology. Springer-Verlag Heidelberg, Berlin, pp.
497 331–351

498

499 Allano L, Bonnet P, Constant P, Eybert M (1988). Premières données sur le régime alimentaire des jeunes
500 gorgebleues (*Luscinia svecica namnetum*, Mayaud) au nid dans un marais salant exploité (Guérande, Loire-
501 Atlantique). C. R. Acad. Sci. Paris 306 : 369–374

502

503 Arizaga J, Alonso D, Campos F, Unamuno JM, Monteagudo A, Fernandez G, Carregal XM, Barba E (2006). Do
504 subspecies of bluethroat *Luscinia svecica* show a geographic segregation during the autumn migration period in
505 Spain? *Ardeola* 53: 285–291

506

507 Arizaga J, Barba E, Alonso D, Vilches A (2010). Stopover of Bluethroats (*Luscinia svecica cyaneacula*) in
508 northern Iberia during the autumn migration period. *Ardeola* 57: 69–85

509

510 Arizaga J, Mendiburu A, Alonso D, Cuadrado JF., Jauregi JI, Sánchez JM (2011). A comparison of stopover
511 behavior of two subspecies of the Bluethroat (*Luscinia svecica*) in Northern Iberia during the autumn migration
512 period. *Ardeola* 58: 251–265

513

514 Arizaga J, Andueza M, Tamayo I (2013). Spatial behaviour and habitat use of first-year Bluethroats *Luscinia*
515 *svecica* stopping over at coastal marshes during the autumn migration period. *Acta Ornithologica* 48: 17-25

516

517 Arizaga J, Musseau R, Laso M, Esparza X, Unamuno E, Azkona A & Fontanilles P (2015). Biases associated
518 with the use of a playback in stopover ecology studies in small passerine birds. *Bird study* 62, Issue 2: 280-284

519

520

521 Barg JJ, Jones J, Robertson RJ (2005). Describing breeding territories of migratory passerines: suggestions for
522 sampling, choice of estimator, and delineation of core areas. *Journal of Animal Ecology* 74:139- 149

523

524 Berndt AM, Hölzel N (2012). Energy crops as a new bird habitat utilization of oilseed rape fields by the rare
525 Bluethroat (*Luscinia svecica*). *Biodiversity Conservation* 21: 527-541

526

527 Bibby CJ, Green RE (1980). Foraging behaviour of migrant pied flycatchers, *Ficedula hypoleuca*, on temporary
528 territories. *J. Anim. Ecol.* 49: 507–521

529

530 Börger L, Francon N, De Michele G, Gantz A, Meschi F, Manica A, Lovari S Coulson (T) 2006. Effects of
531 sampling regime on the mean and variance of home range size estimates. *Journal of Animal Ecology* 75: 1393–
532 1405

533

534 Both C, Bouwhuis S, Lessells CM Visser ME (2006). Climate change and population declines in a long-distance
535 migratory bird. *Nature*, 441: 81-83

536

537 Burnham KP, Anderson DR, Huyvaert KP (2011). AIC model selection and multimodel inference in behavioral
538 ecology: some background, observations, and comparisons. *Behavioural Ecology and Sociobiology*, 65, 23-35

539

540 Busse P (2000). Bird Station Manuel. SE European Bird Migration Network, Gdansk

541

542 Chernetsov N (2012). Passerines migration: stopovers and Flight. Ed. Springer

543

544 Chernetsov N, Manukyan A (2000). Foraging strategy of the Sedge Warbler (*Acrocephalus schoenobaenus*) on
545 migration. *Vogelwarte* 40: 189–197

546

547 Chernetsov N, Titov NV (2001). Movement patterns of European reed warblers *Acrocephalus scirpaceus* and
548 sedge warblers *A. schoenobaenus* before and during autumn migration. *Ardea* 89: 509–515

549

550 Chernetsov N, Mukhin A, Ktitorov P (2004). Contrasting spatial behaviour of two long-distance passerine
551 migrants at spring stopovers. *Avian Ecol. Behav.* 12: 53–61

552

553 Chiron D, (2017). Range extension of the Bluethroat *Luscinia svecica namnetum* towards intensive farming
554 habitats in Central western France. *Alauda* 85 (2): 81-91

555

556 Church JA, White NJ (2011). Sea-level rise from the late 19th to the early 21st century. *Surveys in Geophysics*
557 32: 585–602
558

559 Clark DL, Wilson MV (2001). Fire, mowing, and hand-removal of woody species in restoring a native wetland
560 prairie in the Willamette valley of Oregon. *Wetlands* 21(1) :135-144
561

562 Cornulier Th, Bernard R, De, Arroyo B, Bretagnolle V (1997). Extension géographique et écologique de la
563 Gorgebleue à miroir *Luscinia svecica* dans le Centre-Ouest de la France. *Alauda* 65 (1): 1-6
564

565 Cramp S (1988). *The Birds of the Western Palearctic*. Oxford: Oxford University Press. Vol. 5.
566

567 Czech HA, Parsons CK (2002). Agricultural Wetlands and Waterbirds: A Review Author(s): Waterbirds: The
568 International Journal of Waterbird Biology. Special Publication 2: Managing Wetlands for Waterbirds:
569 Integrated Approaches 25:56-65
570

571 Dänhardt J, Green M, Lindström Å, Rundlöf M, Smith HG (2010). Farmland as stopover habitat for migrating
572 birds effects of organic farming and landscape structure. *Oikos* 119: 1114–1125.
573

574 Davies NB 1977a. Prey selection and the search strategy of the Spotted Flycatcher *Muscicapa striata*, a field
575 study on optimal foraging. *Animal Behaviour* 25: 1016-1033
576

577 Davies NB (1977b). Prey selection and social behaviour in wagtails (Aves: Motacillidae). *Journal of Animal*
578 *Ecology* 46: 37-57
579

580 De la Hera I, Fontanilles P, Delalande L, Glad A, and Sarraude T (2017). Attraction of other species by
581 bluethroat *Luscinia svecica* song playback during autumn migration: an experimental test using bird-ringing
582 data. *Ardeola* 64(1): 91-99
583

584 Delingat J, Dierschke V (2000). Habitat utilization by Northern Wheatears (*Oenanthe oenanthe*) stopping over
585 on an offshore island during migration. *Vogelwarte* 40: 271–278
586

587 Devictor V, Julliard R, Clavel J, et al. (2008). Functional biotic homogenization of bird communities in disturbed
588 landscapes. *Glob. Ecol. Biogeogr.* 17: 252–261.
589

590 Ellegren H (1990) Autumn migration speed in Scandinavian bluethroats *Luscinia s. svecica*. *Ring Migration*,
591 11, 121-131
592

593 Eybert MC, Bonnet P, Geslin T, Questiau S (2004). *La Gorgebleue*. Belin, 71 p
594

595 Fontanilles P, Laval B, Diribarne M (2014). Sélection des habitats et occupation spatiale du Phragmite
596 aquatique *Acrocephalus paludicola* sur une halte migratoire du sud-ouest de la France, mise en place d'une
597 gestion intégrée. *Alauda* 82(4): 343-351
598

599 Fontanilles P (2014). Migration et régime alimentaire de la Gorgebleue à miroir dans les Barthes de l'Adour,
600 Actes du séminaire "Conservation des espèces et gestion des zones humides", Bayonne, 31 janvier 2014.
601

602 Fontanilles P, Chanchus B, Chauby X, De Franceschi C, Dufresne L, Fourcade J.M, Lapios J.M, Lartigau F,
603 Legay P, Thouy P, Tillo S, Urbina-Tobias P, Short R & Williams H (2012). Bilan du baguage des passereaux
604 migrants et nicheurs sur les barthes de la Nive (Pyrénées-Atlantiques) en 2011. *Le Casseur d'os*, 12 : 80-84
605

606 Fransson T., Barboutis C., Mellroth R., Akriotis T (2008). When and where to refuel before crossing the Sahara
607 desert extended stopover and migratory fuelling in first-year garden warblers *Sylvia borin*. *J. Avian Biol.* 39:
608 133–138
609

610 Freeman S, Jackson WM (1990). Univariate metrics are not adequate to measure avian body size. *Auk* 107 : 69-
611 74
612

613 Geslin T, Lefeuvre J.C. Le Pajolec Y, Questiau S, Eybert MC (2002). Salt exploitation and landscape structure in
614 a breeding population of the threatened bluethroat (*Luscinia svecica*) in salt-pans in western France. *Biological*
615 *Conservation*. 107: 283–289
616

617
618 Godet L, Marquet M, Eybert MC, Gregoire E, Monnet S, Fournier J (2015). Bluethroats *Luscinia svecica*
619 *namnetum* offset landscape constraints by expanding their home range. *J Ornithol* 156 :591–600

620
621 Godet L, Harmange C, Marquet M, Joyeux E, Fournier J (2018). Differences in home-range sizes of a bird
622 species in its original, refuge and substitution habitats: challenges to conservation in anthropogenic habitats.
623 *Biodiversity and Conservation* 27:719–732
624
625 Gottschalk TK & Cover L (2016) Migratory and visiting birds in a maize field near Giessen, Germany in
626 summer and autumn. *Vogelwarte* 54(1):1-14
627
628 Grueber CE, Nakagawa S, Laws RJ, Jamieson IG (2011). Multimodel inference in ecology and evolution:
629 challenges and solutions. *Journal of Evolutionary Biology* 24: 699–711
630
631 Harris S, Cresswell WJ, Forde PG, Trehwella WJ, Woollard T, Wray S (1990). Home-range analysis using
632 radio-tracking data - a review of problems and techniques particularly as applied to the study of mammals.
633 *Mammal Review* 2 : 97-123
634
635 Harmange C, Godet L, Marquet M, Dietrich J, Monnet S, Grégoire E, Eybert MC, Fournier J
636 (2016). [Unexpected movements of male Bluethroats *Luscinia svecica namnetum* during the breeding period]
637 Déplacements inattendus chez des mâles de Gorgebleue à miroir blanc *Luscinia svecica namnetum* en période de
638 nidification. *Alauda* 84 (3): 195-202
639
640 Hóðar JA (1996). The use of regression equation for estimations of arthropod biomass in ecological studies. *Acta*
641 *Oecologica* 17 (5): 421-433
642
643 Hutto (RL (2000). On the importance of en route periods to the conservation of migratory landbirds. *Studies in*
644 *Avian Biology*, 20: 109-114
645
646 Jacobs J (1974). – Quantitative measurement of food selection: a modification of the forage ratio and Ivlevs’
647 selectivity index. *Oecologia* 14: 413-417
648
649 Lindström C, Hasselquist D, Bensch S, Grahn M (1990). Asymmetric contests over resources for survival and
650 migration. A field experiment with Bluethroats. *Animal Behaviour* 40: 453–461
651
652 Millennium Ecosystem Assessment (MA) (2005). Ecosystems and human well-being: Wetlands and Water
653 synthesis. Washington, DC: World Resources Institute
654
655 Mohr CO (1947). Table of equivalent populations of North American small mammals. *American Midland*
656 *Naturalist* 37: 223-249
657
658 Moore (FR), Mabey S, Woodrey M (2003). Priority access to food in migratory birds: age, sex and motivational
659 asymmetries. In: Berthold P, Gwinner E, Sonnenschein E (eds). *Avian migration*. Springer-Verlag Heidelberg,
660 Berlin, pp. 281–291
661
662 Musseau R, Herrmann V, Kerbiriou C, Bénard S, Herault T, Kerbiriou E, Jiguet F (2014). Ecology of Aquatic
663 Warblers *Acrocephalus paludicola* in a fall stopover area on the Atlantic coast of France. *Acta Ornithologica* 49:
664 93-105
665
666 Musseau R, Beslic S, Kerbiriou C (2017). Importance of intertidal wetlands for the French coastal endemic
667 Bluethroat (*Cyanecula svecica namnetum*) and conservation implications in the context of global changes.
668 *Ardeola* 64: 325-345
669
670 Musseau R, Boutault L, Beslic S (2018). Rapid losses of intertidal salt marshes due to global change in the
671 Gironde estuary and conservation implications for marshland passerines. *Journal of Coastal Conservation*
672 22(2): 443-451
673
674 Newton I (2008). *The migration ecology of birds*. Academic Press, London. Peris S. J., Mendes
675
676 Newton I (2004). Population limitation in migrants. *Ibis* 146: 197–226
677
678 Orłowski G, Rusiecki S, Karg J (2014). Partial dietary segregation between adult and nestling Bluethroats
679 *Luscinia svecica*. *Acta Ornithol.* 49: 107–118
680
681 Pickering M, Wells N, Horsburgh K, Green J (2012). The impact of future sea-level rise on the European shelf
682 tides. *Cont. Shelf Res.* 35: 1–15
683

684 Piper WH (2011). Making habitat selection more “familiar”: a review. *Behavioural Ecology and Sociobiology*,
685 65: 1329-1351
686
687 Poulin B, Lefebvre G, Mauchamp A (2002). Habitat requirements of passerines and reedbed management in
688 southern France. *Biol. Conserv.* 107: 315–325
689
690 Provost P, Kerbirou K, Jiguet F (2010). Foraging range and habitat use by Aquatic Warblers *Acrocephalus*
691 *paludicola* during a fall migration stopover. *Acta Ornithologica* 45: 173–180
692
693 Rappole JH, Warner DW (1976). Relationships between behavior, physiology and weather in avian transients at
694 a migration stopover site. *Oecologia* 26:193-212
695
696 Saino N, Ambrosini R, Rubolini D, Harden-berg JV, Provenzale A, Huppopp K, Huppopp O, Lehikoinen A,
697 Lehikoinen E, Rainio K, Romano M, Sokolov L (2011). Climate warming, ecological mismatch at arrival and
698 population decline in migratory birds. *Proceedings of the Royal Society*, 278: 835-842
699
700 Salewski V, Kéry M, Herremans M, Liechti F, Jenni L (2009). Estimating fat and protein fuel from fat and
701 muscle scores in passerines. *Ibis* 151: 640–653
702
703 Salewski V, Schaub M (2007). Stopover duration of Palearctic passerine migrants in the Western Sahara;
704 independent of fat stores? *Ibis* 149 : 223–236
705
706 Schaub M, Schwilch R & Jenni L (1999). Does tape-luring of migrating Eurasian Reed-Warblers increase
707 number of recruits or capture probability? *Auk* 116: 1047–1053
708
709 Tellería JL, de la Hera I, Pérez-Tris J (2013). Morphological variation as a tool for monitoring bird populations:
710 a review. *Ardeola* 60: 191-224
711
712 Tucker GM, Heath M (2004). *Birds in Europe: Population Estimates, Trends and Conservation Status*. BirdLife
713 International. Cambridge
714
715 von Behren Christa R (2007). Impact of agriculture and urban development on the community structure of
716 wetland birds in East Central Minnesota. Honors Projects. Paper 5
717
718 Whited D, Galatowitscha S, Testerb JR, Schikb K, Lehtinenb R, Husvethc J (2000). The importance of local and
719 regional factors in predicting effective conservation Planning strategies for wetland bird communities in
720 agricultural and urban landscapes. *Landscape and Urban Planning* 49: 49-65
721
722 Yong W, Finch DM, Moore FR, Kelly JF (1998). Stopover ecology and habitat use of migratory Wilson's
723 Warblers. *Auk* 115: 829–842
724
725 Worton BJ (1989). Kernel methods for estimating the utilisation distribution in home range studies. *Ecology*, 70
726 : 164-168
727
728 Zanimetti JM (2005). – *Statistique spatiale*. Ed Lavoisier
729
730 Zuur AF, Ieno EN, Walker N, Saveliev AA, Smith GM (2009). *Mixed Effects Models and Extensions in*
731 *Ecology with R. Statistics for Biology and Health*. Springer, New York, USA
732