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Characterizing the habitat requirements of the Common Redstart (*Phoenicurus phoenicurus*) in moderately urbanized areas

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Land-use modifications in central Europe, particularly the sprawl of the urban environments and the intensification of agriculture, have increased since the 1950 and are identified as responsible for the decrease of many bird populations. However, in some cases, moderately urbanized areas can lead to more diversity of birds than perturbed rural areas, and thus can provide an alternative habitat for species such as the Common Redstart (*Phoenicurus phoenicurus)*. In this study, we assigned the importance of a mixed landscape composition for the territory of Common Redstart based on a compositional analysis (MANOVA). Our results indicate that wooded short-cut lawn constitutes the preferred land cover of the Common Redstart, followed by short-cut lawn and private houses which exhibit the same weight in terms of preference. The proportion of the land cover types within the territories were 30.1% ± 12.4%, 18.9% ± 9.0% and 4.4% ± 2.6% (average ± standard deviation), respectively. Finally, based on ecological requirements, we propose that the Common Redstart could represent a flagship species to promote the conservation of biodiversity in moderately urbanized areas of west-central European cities.

1. Introduction

Since the 1950, urban landscape sprawl increased by 80% in European countries (Antrop 2004) and 155% in Switzerland (total urban area increased from 4,000 km^2 to 90,000 km^2, ARE 2009, Hayek *et al.* 2011) replacing other habitats (e.g., farmland, marsh, and forest). Meanwhile, the loss of habitat driven by agricultural intensification in western Europe has been recognized as the major cause in the decline of many bird-species populations in traditional farmlands (Donald *et al.* 2001, Foley *et al.* 2005, Wretenberg *et al.* 2006). It has been reported that 40% of common farmland bird populations disappeared between 1978 and 2002 in Europe, and up to 60% in west-central Europe for the same period (Gregory *et al.* 2005). Recently, cities with moderately urbanized areas with green space have been recognized to support greater species diversity and richness than perturbed rural areas (Blair 1996, Blair & Launer 1997, Palominoa & Carrascal 2006, Sattler *et al.* 2010a, Sattler *et al.* 2010b, Sorace & Gustin 2010). Consequently, moderately urbanized areas in central Europe created by recent land-use modification can potentially offer an attractive habitat for several birds species due to their mixed landscape composition (Pellissier *et al.* 2012), presence of mature trees (Kirby *et al.* 2005) or availability of insects (McIntyre *et al.* 2001).

Consistent with this recent land-use modification, the Common Redstart (*Phoenicurus phoenicurus)*, traditionally found in open areas with sparse vegetation and mature trees (e.g., pastured orchards and open forests lacking ground layer), has been severely affected across Europe (Birdlife 2004, Felix & Felix 2004). The populations of Common Redstart in Switzerland and Germany decreased by 90% and 80%, respectively, until the 1980s, whereupon populations stabilized (Berndt & Winkel 1979, Zbinden *et al.* 2005). Because of this stabilization, the Common Redstart is classified as a species of east Concern according to the UICN red list (BirdLife International 2012). However, compared to historical population levels and because 50%–74% of the global population occurs in Europe (Glutz von Blotzheim & Bauer 1988), the Common Redstart is regarded as a Species of European Conservation Concern (SPEC 2) and is one of the 50 priority bird species identified by the Swiss Species Recovery Program for Birds (Keller *et al.* 2010). Several central-European common bird monitoring schemes estimate that a large proportion (e.g., 17% 9%, see Table S1 in supporting information) of the Common Redstart population is currently located in urban environments. Thus, almost one fifth of the existing populations of Common Redstart in central Europe are potentially situated in urban areas. For this reason, the urban environment can be an alternative habitat for the Common Redstart during land-use modification in central Europe. However, bare ground and sparse vegetation (i.e., the main vegetation types favoured by the Common Redstart for hunting, Martinez *et al.* 2009, Schaub *et al.* 2010) in combination with near food sources (i.e., insects) provided by trees (Smith *et al.* 2006) and dense vegetation (Atkinson *et al.* 2005, Morris 2000) are required to create suitable mixed landscape for the Common Redstart (Fontana *et al.* 2011, Sedlacek *et al.* 2004). The presence of nesting cavities mostly found in roofs of buildings and trees, but also provided by nest boxes in urban environments (Kuranov 2009, Sedlacek & Fuchs 2008), are also critical. For this reason, land-use plans that foster compact urban development, which are promoted by different countries in Europe to mitigate problems of urban sprawl (Commission of the European Communities 1990, Gennaio *et al.* 2009, Pauleit *et al.* 2005, Sandström *et al.* 2006), could considerably degrade the urban habitat for bird species such as the Common Redstart. Most previous studies examining urban bird populations have assessed the importance of biodiversity or richness using large-scale data sets and general land cover with low resolution (Devictor *et al.* 2007, Devictor *et al.* 2008, Evans *et al.* 2009, Jokimäki 1999). However, the importance of mixed landscape was proposed by several authors (Evans *et al.* 2009, Fontana *et al.* 2011) but has never assessed in detail. Additionally, conservation studies on Common Redstart relate to rural areas (Martinez *et al.* 2009, Schaub *et al.* 2010) or forested areas only (Lovaty 2004, Virkkala *et al.* 1994) but never the urban areas.

In order to generate a conservation program for this targeted species, the ecological requirements in urban areas must be well identified. We hypothesize that land cover diversity drives the distribution of the Common Redstart in urban areas. Therefore, we analyzed quantitatively the importance of habitat requirement and availability for the Common Redstart at different geographic scales (GS) with a high resolution land cover (2 m^2) using a compositional analysis methodology (Aebischer *et al.* 1993) based on a long term (10 years) census data set on a moderately urbanized area.

2. Methods

2.1. Study site and monitoring

La Chaux-de-Fonds (47°06' N, 6°47' E; Fig. 1a) is a city of intermediate size for Switzerland (popula-

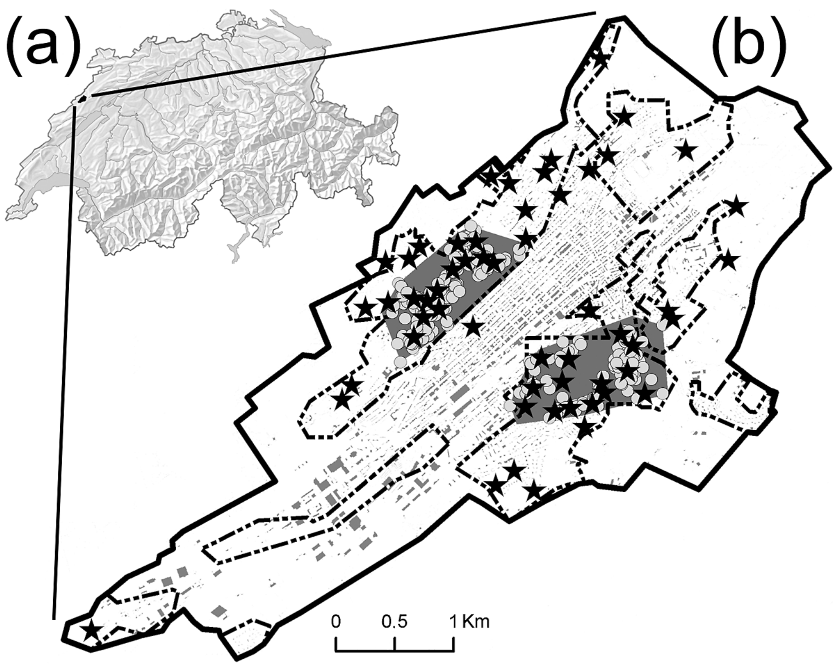

Fig. 1. Geographic location of the study area in Switzerland (a) with a detailed view of the city of La Chaux-de-Fonds (b). The different geographic scale (GS) in our study: The two Minimal Convex Polygon (MCP) of census areas (GS1, 1.5 km^2) and additional 2009 census areas (GS2, 5.4 km^2) are delimitated with grey surface and dashed black lines respectively. Median of each individual territory recorded between 2004 and 2012, (number of territories, *n* = 241) and during 2009 alone (*n* = 56) are represented by the grey points and black star respectively. The entire city (GS3, 14.2 km^2) is delimitated with a solid line. Cartographic data © 2008 by SITN http://sitn.ne.ch.

tion approximately 38,000) located in the Swiss Jura Mountains with an elevation of 1,000 meters above sea level. Three levels of geographic scale (GS) were considered in our study (Fig. 1b).

The census was conducted between 2003 and 2012 (Droz & Laesser 2009, Laesser & Droz 2010, Laesser *et al.* 2011) in two areas with the highest Common Redstart density based on a previous survey (Laesser 2007). Then GS1 (1.5 km^2; Fig. 1b) was drawn as a minimum convex polygon (MCP) encompassing all Common Redstart observations during this census. Censuses were conducted one hour before sunrise to maximize the detection of singing Common Redstarts (Thomas *et al.* 2002). The entire GS1 area was covered in 1.8 ± 0.2 hours (average ± SD). The geospatial location of each bird sighting was recorded, and territories were defined based on territory mapping methods (Bibby *et al.* 2000). During the first three years of monitoring, the two census areas were visited weekly (Saturday) from April to June (eight censuses). During this period, a territory was defined when at least one singing Redstart was observed three times in the same site. These censuses (Laesser 2004) helped to define the breeding schedule of the Common Redstart population. Since 2006, the monitoring has continued with four censuses (week number 17, 19, 21 and 22) encompassing 90% of the territories found during the first three years (Perrenoud 2008). Based on these censuses, and according to European and Swiss year trends (PECBMS 2012, Zbinden *et al.* 2005), the Common Redstart population in La Chaux-de-Fonds is considered to be stable in GS1 during the study period (2003–2012) with fluctuations of 24.3 ± 5.8 (average ± SD) territories by year.

Based on habitat preferences and a previous survey (Laesser 2007), the GS2 (5.4 km^2; Fig. 1b) was defined as the area we expected to find Redstarts and had a similar habitat compared to

Table 1. The 21 land cover categories described in our geographic scale (GS). Categories have been classified into eight types of land cover for the compositional analysis. The grouped land cover types 1 represent the vegetated surface and the last three (6) the constructed surface.

Land cover categories	Description	Grouped land cover types
(1) Vegetable gardens, (2) bare ground, (3) manure stockpiles, (4) rock, (5) non-asphalted roads, (6) hippodromes, (7) construction sites	–	(1) Bare ground
(8) Pastures, (9) grasslands with regular reaping, (10) private gardens	–	(2) Short-cut lawns
(11) Wooded pasture, (12) wooded garden, (13) public parks	–	(3) Wooded short-cut lawn
(14) Forests, (15) hedgerows with dense vegetation	Connected canopy	(4) Wood
(16) Meadows, (17) fallow fields	Dense/tall meadows (mostly intensive)	(5) Dense vegetation
(18) Sidewalks, (19) roads, (20) patio	–	(6) Asphalted surfaces
(21) Buildings	≤ 10 m high	(7) Private house
(21) Buildings	> 10 m high	(8) Tenement

GS1. During 2009, a census was carried out covering the GS2. This census showed that in 2009, the GS1 covered 48% of GS2 population (number of territories in GS2 = 56, Droz & Laesser 2009, Laesser & Droz 2010). The GS3 level constitutes the entire city (14.2 km^2) which were used to give an overview landscape of the entire city of La Chaux-de-Fonds and was not used for further analysis.

To consider all territories with the same weight for the further analysis, the median northing and easting (alternatively, latitude and longitude) of all observations comprising a territory was considered the median point of that territory. Next, the territory areas were defined by a circular buffer with a 100 m radius around this median. Based on this designation, territories were similar in size (31,400 m^2) to those described in the literature for urban areas (Sedlacek *et al.* 2004) and included 95% of our field observations. Finally, for further analysis, we created a non-overlapping buffer territory, one for each year, using the Thiesen polygons function to separate the overlap of the original buffer proportionally. Areas of the non-overlapping buffer were calculated and the normality of the area distribution evaluated with a quantile–quantile plot.

Additionally, we visited GS1 and GS2 between May and June each year (0–20 visits per year) to look for nests, measure their elevation by laser telemeter (BOSCH DLE 50) and record the type of nest site (i.e., house, tree or nestbox). However, because few nests compare to male territorial males were found (28.8% ± 7.8% of nests found per year ± SD) and because the nest locations were not distributed homogenously in space throughout GS1, we do not consider these data in habitat analysis. Moreover, we supposed that the limiting factor for pair mating is more related to lower female:male ratios (Donald 2007) than to the habitat in GS1 and GS2.

2.2. Land cover proportion

A GS3 shape file containing 21 land cover categories was refined from cartographic data provide by SITN – © 2008 (http://sitn.ne.ch) and grouped into eight land cover types described in Table 1. The grouped land cover types were used for further habitat analysis. For this purpose, a manual digitizing scale of 1:1,000 was performed on GS3 (Fig. S1) using ArcGIS® 9.3 (ESRI, Redlands, California, USA) based on orthophoto images (Swisstopo

© 2008) and additional observations of GS3. A strong effort was made to separate the land cover regarding short-cut lawn, which represents a necessary land cover for the hunting area of the Common Redstart (Martinez *et al.* 2009). The two land cover types, which were both short-cut lawns (Table 1, land cover type 2 & 3), represent the group of land cover influenced by regular grass-cutting principally by lawnmower or in some cases by animal grazing (mainly cows). Regarding the grass coverage, two types of wooded land cover (Table 1, land cover type 3 & 4) were defined as "wooded short-cut lawn" and "wood". "Wooded short-cut lawn" contained wooded pasture, gardens, and public parks and had trees that well-spaced without connected canopies. Conversely, "wood" included forests and hedgerows and had dense understory vegetation and had trees with well-connected canopies.

Our nest records suggest a preference for nesting in small buildings (6.5 m ± 3.7 SD, number of nests = 46) and therefore we hypothesize that high buildings create an ecological barrier for Common Redstart movement. For these two reasons, we categorized two classes of buildings where a building lower or equal to 10 m was considered a private house and a building higher than 10 m was considered a tenement. We calculated the height of each building, with a resolution of 2 m, based on the difference between the digital terrain model (DTM) and the digital surface model (DSM).

2.3. Habitat analysis

The proportion of land cover was analyzed using compositional analysis (Aebischer *et al.* 1993) with the software package "adehabitatHR" for R (Calenge 2006, R Core Team 2013). This method used a multivariate analysis of variance (MANOVA) to relate the spatially used and available proportion of land cover at different geographic scales (GS) to understand the ecological requirements of the Common Redstart. Although developed for telemetry, this method has also been used in habitat analysis with only visual observations (Cummins & O'Halloran 2002, Lavers *et al.* 2005, Martinez *et al.* 2009).

The proportion of used land covers was extracted for each year for the eight non-overlapping buffers territories from the GS3 land cover shape file (Fig. S1). The proportion of land covers within the territories was expected to be independent of the year and the GS. To test this hypothesis, we compared the non-normal distribution of each proportion of land cover between each year and between each GS with a Kruskal–Wallis rank sum test (KW-test). The 2003 data set shows an unexplained variation in terms of land cover (KW-test, $P < 0.001$), and was consequently not incorporated in the habitat analysis. The available land cover proportion for GS1 and GS2 analysis was extracted from GS3 on the entire area covered by the respective GS. Finally, to process compositional analysis, the frequencies equal to zero were replaced by 0.01, and 1,000 random repetitions were used, as recommended by Aebischer (1993). We used the indices of habitat preferences, proposed by others (Holt *et al.* 2010, Cummins *et al.* 2002), to synthetically represent the compositional analysis. The indices of habitat preferences were generated for GS1 and GS2 analysis by summing the log of the used to available land cover ratio for each ranked land cover type.

3. Results

3.1. Land cover proportion

The wooded short-cut lawn was the most widespread land cover type within our study, but was

Table 2. Available land cover (in percent) for GS1 (1.5 km^2), GS2 (5.4 km^2) and GS3 (14.2 km^2).

Area	Bare ground	Short-cut lawns	Wooded short-cut lawn	Wood	Dense vegetation	Asphalted surfaces	Private house	Tenement
GS1	6.2	9.8	39.9	7.3	1.4	26.1	3.8	5.5
GS2	1.3	12.0	10.6	13.1	42.4	15.7	1.7	3.2
GS3	1.9	13.4	11.0	9.6	29.9	23.6	2.3	8.3

less represented in GS2 and GS3 compared to GS1 (Table 2). On the other hand, GS1 has a low extent of dense vegetation compared to GS3, which is again 1.4 times less than for GS2. Moreover, GS1 is similar to the GS3 in terms of constructed surface (GS1: 34.8%; GS3: 34.2%) and is relatively higher than GS2 (20.6%).

Territory size calculated from the non-overlapping buffer showed an average (± SD) of 23,200 ± 6,200 m^2 (Fig. S2 A & B), which includes 80% ± 12% of our field observations per year. No significant difference between the proportion of land cover within the territories between 2004 and 2012 as well as between GS1 and GS2 were found ($P > 0.1$; Table S2**).** The Common Redstart territories of GS1 and GS2 mainly consisted of wooded short-cut lawn (30.1% ± 12.4%), followed by asphalt surface (24.8% ± 8.4%) and short-cut lawn (18.9% ± 9.0%). The asphalt surfaces are probably not used by the Common Redstart but constitute a widely distributed land cover in GS3 (Fig. S1). Some bare ground land cover (i.e., garden) were probably attractive for the Common Redstart but were poorly represented in the territories (1.8% ± 2.3%) because the available bare ground were relatively poor in both GS (Table 2). Wood was relatively well represented in the territories (12% ± 14%) but was more irregularly distributed between the territories compare to the other land cover (Fig. S2 A). Further investigation of the raw data show that this land cover is mostly represented on the edge of the territory. Available proportions of dense vegetation found in GS2 (42.4%) relative to the one used inside territories (2.0% ± 4.9%) indicate that this land cover is only marginally represented in Common Redstart territories. The proportion of tenement and private houses are not similar (5.5% ± 4.0% and 4.4% ± 2.6%, KW-test: $\chi^2 = 7.80$, $P = 0.005$) within the territories, which suggests that the height of the buildings play a significant role in habitat selection.

3.2. Habitat analysis

The compositional analysis for GS1 shows all selected land cover types range at random ($\Lambda = 0.119 \pm 0.060$, $\chi^2 = 1.01$, df = 7, $P < 0.001$ or $P = 0.01$ by randomization). The compositional analysis rank

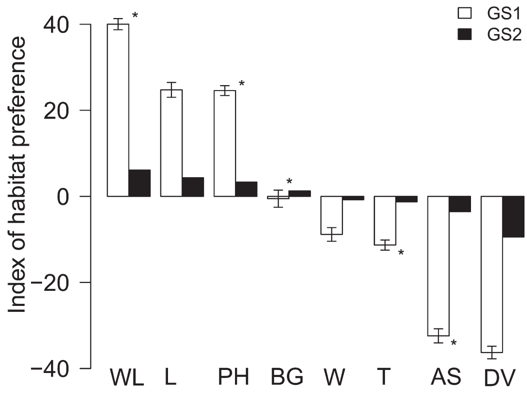

Fig. 2. Index of habitat preferences generated from the compositional analysis on the census area GS1 from 2004–2012 (n = 241) and GS2 for 2009 (n = 56). A high positive index indicates a more favorable land cover type and negative values unfavorable land cover type. Average indices between years and error bars are reported for the GS1 analysis. Significant levels (* $p < 0.05$) reported for the GS1 analysis indicate whether a statistical difference existed between the pairwise comparison of higher-ranked (left) and adjacent lower-ranked (right) land cover types. The types of land cover type are described in Table 1: WL, wooded short-cut lawn; L, short-cut lawn; BG: Bare ground; W, wood; DV, Dense vegetation; AS, asphalted surfaces; T, Tenement; PH, private house.

between the years (Table S3) was relatively consistent. For this reason, the average and standard deviation between years of the compositional analysis result was used to calculate the index of habitat preference(Fig. 2). This was advantageous because we could identify where habitat preferences were different between land cover types (Fig. 2). The index of habitat preference followed the order from higher to lower ($P < 0.05$, no difference in habitat preference is indicated by "="): wooded short-cut lawn > short-cut lawn = private house > bare ground > wood = tenement > asphalt surface > dense vegetation. The compositional analysis on GS2 were consistent with GS1 ($\Lambda = 0.266$, $\chi^2 = 0.86$, df = 7, $P < 0.001$ or $P = 0.01$ by randomization) and showed the same index of habitat preference: wooded short-cut lawn > short-cut lawn > private house > bare ground > wood > tenement > asphalt surface > dense vegetation.

Similarities in the index of habitat preference between GS1 and GS2 confirm the habitat preference of the Common Redstart at larger scales. The

Table 3. Comparison of the four land cover categories (percent ± SD) for Common Redstart territories given in the literature. For each study, the percentage of territories for which sparse vegetation reached the value calculated by Schaub *et al.* (2010) are given in brackets.

Vegetated surface							
Sparse vegetation	Wood	Dense vegetation	Constructed surface	*n*	Landscape	Locality	Reference
28.0 ± 17.8 (10)	17.1 ± 8.9	53.8 ± 19.0	11.2 ± 11.1	39	Rural	Heidelberg (D)	Braun 2009*
45.4 ± 25.9 (31)	1.9 ± 3.9	45.3 ± 30.3	7.4 ± 10.2	58	Rural	Basel (CH)	Martinez *et al.* 2009
50.7 ± 24.0 (20)	23.0 ± 4.5	2.1 ± 4.9	34.8 ± 15.2	241	Urban		This study
62.1 ± 12.8 (22)	53.6 ± 17.0	9.4 ± 13.4	6.4 ± 5.6	41	Urban	Breznice (CZ)	Sedlacek *et al.* 2008
34.4 ± 16.5 (0)	26.1 ± 6.2	27.0 ± 9.3	38.6 ± 8.8	3	Urban	Zürich (CH)	Fontana *et al.* 2011
43.4 ± 11.3 (0)	27.0 ± 7.2	27.8 ± 5.4	28.7 ± 12.5	4	Urban	Lucern (CH)	Fontana *et al.* 2011
29.2 ± 0.1 (0)	11.2 ± 0.1	25.1 ± 0.1	45.7 ± 0.1	24	Urban	Lugano (CH)	Fontana *et al.* 2011

The four habitat categories follow Martinez (2009) combined some grouped land cover types according to the Table 1: I) Sparse vegetation: (1), (2), (3); II) Wood: recalculated as percent of canopy cover based on aerial photo. Excepted Martinez data which take in account the coverage by the tree diameter. In the case of percent canopy the sparse vegetation can be also considered for the same surface than tree; III) Dense vegetation: (5); IV) Constructed surface: (6), (7), (8). * Estimation based on the Google earth image for the same period than the studies (2008). All calculation were based on the raw data form the given reference, additional data for 2010–2011 was taking in account for the Basel locality (Martinez *et al.* 2009). *n* = number of territories.

calculated percentage between the index of habitat preference of the short-cut lawn and the rest of preferred land cover (positive index, 72.5%), mainly wooded (44.8%) demonstrate the high importance of this type of land cover for the Common Redstart territory. However, the available proportion of all land cover unused by the Common Redstart in GS1 and GS2 was still important for each year (Table S4) suggesting that the most attractive land cover shown by the compositional analysis is not adequate to explain the distribution of the species alone. Moreover, we observed in GS1 that 62% of all nests were situated in private houses, compared to 32% in nest boxes and 5% in tree cavities (number of nests = 74). This confirms the importance of the 2nd or 3rd ranked private houses from the compositional analysis, which supports the idea that mixed landscape composition is more important than a high availability of the most preferred land cover.

4. Discussion

4.1. Habitat requirements and availability

Our results confirm the importance of sparse vegetation (defined as the sum of bare ground, wooded and unwooded short-cut lawn, Table 1) present in both GS as an ecological requirement for Common Redstart territories for hunting and food availability (Martinez *et al.* 2009, Sedlacek *et al.* 2004). Therefore, the sparse vegetation within territories reaches the optimal value calculated by Schaub (2010; 60% with Bayesian model) for 20% of our territories. This percentage of optimal territories with sparse vegetation is likely high compared to other urban study sites, but is similar to values observed in rural areas (Table 3). The sparse vegetation available for the Common Redstart is probably favored in our study area, which is only moderately urbanized, compared to other cities which have more constructed surfaces (defined as the sum of asphalted surfaces and buildings; GS1: 35% VS 49%, average between Zurich, Lucern and Lugano; Fontana *et al.* 2011).

We demonstrated that the presence of sparse vegetation combined with tall scattered trees, used as song perches (Mathevon *et al.* 2005), constitutes the limiting land cover conditions suitable for the Common Redstart. Even for landscapes where wood was important (Table 3), increases in tree density did not limit Common Redstart occurrence, despite being strongly suggested by several authors (Fontana *et al.* 2011, Järvinen 1986, Sedlacek *et al.* 2004, Taylor & Summers 2009, Titeux *et al.* 2004). However, large areas of wooded habitat is likely to be unattractive for the Common Redstart in our GS, although not clearly rejected as edges of forest regularly constitute part of territories. It is possible that the dense vegetation in wooded areas limits the access of ground food resources for Common Redstarts (Krystofkova *et al.* 2006, Taylor & Summers 2009). The observed preference for buildings as nest sites in our census areas concurs with that reported for the Spotted Flycatcher (*Muscicapa striata*; Kirby *et al.* 2005) where the authors suggested a preference due to lower predation in buildings than trees.

Our results suggest that an optimal mixed landscape between short vegetation, scattered trees and constructed surfaces (mainly small buildings) determine the presence of Common Redstart in a moderate urban landscape. Therefore, GS1 was principally constructed during the 1960 and represents mixed mature garden habitat, which could contribute to the attractiveness of the habitat of the Common Redstart. Consistent with this hypothesis, we also observed a decreased presence of the Common Redstart where one of the main land covers strongly dominates (Fontana *et al.* 2011, Pellissier *et al.* 2012). Indeed, a previous study using a large-scale multivariate analysis showed that 21% of the Common Redstart distributions can be explained by land cover, such as the degree of urbanization, the amount and composition of forested and open areas (Titeux *et al.* 2004).

4.2. Implications for conservation

Based on our study and previous knowledge, we address two types of recommendations for urban policy. Firstly, we recommend conserving the mixed land cover percentage that are indicative of urban Common Redstart territories (Table 3) as much as possible. For this reason, land use plans that foster compact urban development, which are often promoted by different countries in Europe to mitigate problems of urban sprawl (Commission of the European Communities 1990, Gennaio *et al.* 2009, Pauleit *et al.* 2005, Sandström *et al.* 2006), are likely to be a problem for the species when the area of sparse vegetation decreases.

Secondly, we recommend promoting suitable habitat for the Common Redstart by increasing the tree content where sparse vegetation requirement was already sufficient. We base this recommendation on our analysis, which suggests that the limiting land cover in GS3 was proportion of tree cover. However, an optimal tree cover could not be determined from our analysis. For this reason, we agree with Fontana (2012) and suggest that increasing tree until 46% canopy coverage (equal proportions of deciduous and coniferous species) should increase both species richness and diversity. This management is consistent with previous recommendations for increasing bird biodiversity in cities (Clergeau *et al.* 2001, Evans *et al.* 2009, Palominoa & Carrascal 2006, Sandström *et al.* 2006).

Additionally, we propose using the Common Redstart as a flagship species to promote garden biodiversity in moderately urbanized areas. We justify this choice because the Common Redstart has multiple ecological requirements, which include several important aspects of urban biodiversity (such as the promotion of ground insect species and requirement for trees). Furthermore, the Common Redstart is easily recognizable to the general public and could be used to publicize wider biodiversity (Home *et al.* 2009). Moreover, landscapes favored by the Common Redstart are recognized as living quarters representing a high quality of life for the human population (Fuller *et al.* 2007, Home *et al.* 2010). Finally, using the Common Redstart as a flagship species would need to be balanced with other biodiversity conservation plans and must be prioritized in areas with optimal sparse vegetation (50.7%) in order to expect an effective increase in Common Redstart populations.

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Leppälinnun elinympäristövaatimukset urbaaneilla alueilla

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Tässä tutkimuksessa arvioimme sekalaisen maiseman koostumuksen merkityksen leppälinnun reviirillä. Tuloksemme mukaan leppälintu suosii lyhyeksi leikattua nurmea jossa on puita. Toiseksi suosituimmat maakäyttötyypit ovat muu lyhyeksi leikattu nurmi sekä omakotitalot. Nämä kaksi ovat suurin piirtein yhtä suosittuja. Mainittujen maakäyttötyyppien osuudet (keskiarvo ± keskihajonta) leppälintureviirien sisällä ovat 30.1 ± 12.4 % (nurmi puineen), 18.9 ± 9.0 % (muu nurmi) ja 4.4 ± 2.6 % (omakotitalot). Perustuen lajin ekologisiin vaatimuksiin, esitämme että leppälintu voisi toimia lippulaivalajina edistettäessä luonnon monimuotoisuuden suojelua kohtalaisen urbaaneilla alueilla Länsi- ja Keski-Euroopan kaupungeissa.

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