Landscape and Urban Planning 178 (2018) 73–81

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Research Paper

Urban core areas are important for species conservation: A European-level analysis of breeding bird species

Jukka Jokimäki[a,*], Suhonen Jukka[b], Kaisanlahti-Jokimäki Marja-Liisa[a]

[a] Arctic Centre, University of Lapland, P.O. Box 122, FI-96101 Rovaniemi, Finland
[b] Section of Ecology, Department of Biology, University of Turku, FI-20014 Turku, Finland

ARTICLE INFO

Keywords:
Birds
Europe
Urbanization
Conservation
Threats
Cavity nesters

ABSTRACT

Natural habitats and species richness have decreased due to the urbanization. The main aim of this study was to determine whether heavily urbanized town centers can also harbor threatened bird species. Twenty-six threatened species nested in the most urbanized areas of European towns. Species-rich areas had a high number of threatened species, indicating that overall species richness could be used as a surrogate for the large number of threatened bird species. Threatened species were more likely to be found in town centers as their distribution range increased. Neither landscape nor plot-level variables explained the species richness of threatened species, which was likely due to the homogeneous habitat structure of urban core zone areas in Europe. The occurrence of *Falco tinnunculus* increased with increases in human density within a built-up area. The occurrence of *Hirundo rustica* and *Muscicapa striata* decreased with increases in the proportion of built-up areas in the surrounding landscape. The occurrence of *Delichon urbica* and *Muscicapa striata* decreased with increases in habitat diversity and the proportion of buildings in the study plot. The most common threatened bird species nested in cavities or buildings. The availability of suitable nesting sites or protection from predators can support the occurrence of cavity nesters in towns. We suggest that modern architecture should account for the breeding habitat needs of cavity-nesting species in building design and that urban green management must consider the occurrence of old trees with cavities or alternatively use nest boxes to support the occurrence of threatened, cavity-nesting bird species.

1. Introduction

Globally, more people currently live in urban areas than in rural areas, and simultaneously, urbanized areas are increasing at a higher rate than urban populations due to urban sprawl (UN, 2014). Therefore, urban nature is important to an increasing number of people, and correspondingly, their views related to conservation are formed in urban environments (Savard, Clergeau, & Mennechez, 2000; Warren & Lepczyk, 2012; Shanahan, Strohbach, Warren, & Fuller, 2014). Therefore, wildlife conservation in urban environments is increasingly important (e.g., Miller & Hobbs, 2002; Dunn, Gavin, Sanchez, & Solomon, 2006; Lepczyk & Warren, 2012; Gil & Brum, 2014). In general, urbanization has been considered to be one of the most important factors responsible for ongoing biodiversity loss and the homogenization of environments (Blair, 1996, 2001; Marzluff, 2001; McKinney, 2002, 2006; Jokimäki & Kaisanlahti-Jokimäki, 2003; Chace & Walsh, 2006; Clergeau, Croci, Jokimäki, Kaisanlahti-Jokimäki, & Dinetti, 2006; Francis & Chadwick, 2013; Ferenc et al., 2014). A recent review indicated that towns have lost substantial amount of biodiversity compared to peri-urban areas (Lepczyk et al., 2017). It is important to know which species can tolerate human-induced disturbance and how to minimize the possible negative effects of urban management on species living in towns to support, or even increase, biodiversity in towns (Blair, 2001; Alvey, 2006; Devictor, Julliard, Couvet, Lee, & Jiguet, 2007; Kark, Iwaniuk, & Banker, 2007; Croci, Butet, & Clergeau, 2008; Rutz, 2008; Jokimäki, Suhonen, Jokimäki-Kaisanlahti, & Carbó-Ramirez, 2016).

Species do not respond to urbanization equally, and the results in different biogeographical areas might differ (Ortega-Álvarez & MacGregor-Fors, 2009; González-Oreja, 2011; Ferenc et al., 2014; Leveau, Jokimäki, & Kaisanlahti-Jokimäki, 2017). McDonald, Kareiva, and Forman (2008) indicated that urbanization is implicated in the listing of approximately 8% of the terrestrial vertebrate species on the IUCN Red List. Aronson et al. (2014) found quite a few threatened and endangered birds in towns around the world. However, an Australian study indicated that cities might be hotspot areas for threatened species, and approximately thirty percent of Australian threatened species were found to occur in towns (Ives et al., 2016). One reason for the

* Corresponding author.
E-mail address: jukka.jokimaki@ulapland.fi (J. Jokimäki).

https://doi.org/10.1016/j.landurbplan.2018.05.020
Received 19 June 2017; Received in revised form 24 January 2018; Accepted 23 May 2018

Table 1
Basic information about the towns included in the study. Study methods: A = Atlas, M = Mapping, and P = Point surveys. Full references are given in ESM 1.

Town	Numb. of inhab.	Location N°	Species	Threatened	Study method	References
Alkmaar	94,216	52	20	1	M	Smit et al., 1995, 2005; Baeyens, unpub.
Angers	151,279	47	35	5	P	Clergeau, 2000
Arheim	142,636	51	55	8	M	Schoppers, 1999, 2001; Baeyens, unpub.
Berlin	3,405,469	52	12	1	A	Witt, 2005
Bologna	374,425	44	20	5	A	Bernini et al., 1998
Bonn	314,299	50	14	3	M	Rheinwald, 2005
Bratislava	425,459	48	30	11	M	Weiserbs, unpublished
Brussels	1,067,162	50	36	3	M	Weiserbs & Jacob, 2005; Weiserbs, unpub.
Florence	366,488	43	36	9	A	Dinetti & Romani, 2002
Groningen	181,819	53	9	0	M	Modderman et al., 2001; Baeyens, unpub.
Grosseto	77,057	42	16	3	A	Giovacchini, 2001
Hamburg	1,769,117	53	10	3	M	Mulsow, 2005
Heinola	20,605	61	18	5	M	Vauhkonen, 1999
Helsinki	569,611	60	14	4	A	Pakkala et al., 1998
Jyväskylä	130,735	62	18	3	A	Keski-Suomen lintutieteellinen yhdistys, 2011
Kemi	22,680	65	30	8	A	Rauhala & Suopajärvi, 2002
Lahti	99,419	60	26	5	A	Saikko & Loikkanen, 1999
Leiden	117,530	52	32	4	P	Epe et al., 2005; Baeyens, unpub.
Lisboa	564,447	38	9	1	M	Geraldes & Costa, 2005
Liverno	1,555,986	43	20	6	A	Dinetti, 1994
Lyon	470,000	45	21	6	P	Tatibouet, 1981
Marseille	820,900	43	12	3	P	Marchetti, 1976
Montpellier	251,634	43	25	6	P	Caula, 2007
Nantes	280,600	47	33	7	P	Clergeau, 2000
Napoli	1,046,987	40	22	5	A	Fraissinet, 1995
Oulu	131,786	65	19	4	A	Tynjälä et al., 2004
Paris	9,644,502	48	40	9	A	Pellissier et al., 2012
Pavia	71,486	45	27	6	A	Bernini et al., 1998
Pisa	90,482	43	26	6	A	Dinetti, 1988
Prague	1,212,097	50	12	2	A	Štástný et al., 2005
Rennes	206,229	48	34	5	P	Clergeau et al.,1998; Le Lannic & Collias, 1997
Roma	2,705,603	41	37	7	A	Cignini & Zapparoli, 1996
Rovaniemi	58,943	66	21	5	A	Jokimäki & Kaisanlahti-Jokimäki, 2012
St. Petersburg	4,661,219	59	10	2	M	Khrabryi, 2005
Valéncia	797,654	39	15	6	A	Murgui, 2005
Vienna	1,678,435	48	26	5	M	Holzer & Sziemer, 2005
Warsaw	1,700,536	52	22	5	A	Luniak, 2005
Örebro	95,400	59	16	6	P	Sandström et al., 2006

large number of threatened species found in towns could be that cities are often established in areas of high natural biodiversity (Araújo, 2003; Francis & Chadwick, 2013). Urbanization in Australia is a relatively new phenomenon in a global context; therefore, the results from Europe might be different from those in Australia. In Australia, threatened species can still live in towns for some time due to extinction delay, whereas in Europe, which has a much longer history of urbanization, many threatened species have already disappeared from towns. Due to global urbanization, large-scale analyses are needed to obtain a more general understanding of the role of urbanization in bird species conservation (Marzluff, Bowman, & Donnelly, 2001; Møller, 2009; Evans, Hatchwell, Parnell, & Gaston, 2010; Pautasso et al., 2011; Warren & Lepczyk, 2012; Aronson et al., 2014; Leveau et al., 2017). A small-scale study performed in a restricted area or at few sample sites might contain an inadequate sample of species for analyses and may therefore provide a misleading picture of species occurrence at a global level (Wiens, 1989; Clergeau, Jokimäki, & Snep, 2006; Pellissier, Cohen, Boulay, & Clergeau, 2012).

The role of urban areas in the conservation of threatened species is inadequately understood, and even basic data are lacking from most towns (Niemelä, 1999). We need greater knowledge of threatened breeding bird species richness and occupancy across an entire range of urban environments (Blair, 1996; Fernandéz-Juricic & Jokimäki, 2001; Chace & Walsh, 2006; Kowarik, 2011; Shanahan et al., 2014). Earlier urban ecological studies on threatened birds were mainly conducted in urban green areas, such as parks and woodlots (e.g., Mörtberg & Wallentinus, 2000; Fernandéz-Juricic & Jokimäki, 2001; Donelly & Marzluff, 2004; Fuller, Tratalo, & Gaston, 2009; Aronson et al., 2014; Jokimäki, Kaisanlahti-Jokimäki, & Carbó-Ramirez, 2014; Beninde, Veith, & Hochkirch, 2015; Sorace & Gustin, 2016). However, some studies have also highlighted the important role of the urban matrix (e.g., the whole urban landscape or developed area surrounding the urban parks) for birds (e.g., Tilghman, 1987; Jokimäki, 1999) and mammals (Dickman, 1987).

Given recent findings that urban areas in some regions of the world harbor endangered species, our goal was to examine the occurrence of threatened bird species in the most urbanized parts of European towns. In addressing our goal, we had two prior hypotheses. First, can heavily urbanized town centers also harbor threatened bird species and do species-rich areas harbor also many threatened species? Second, do species richness and the occurrence of individual threatened species depend on landscape and plot-level factors?

2. Materials and methods

2.1. Study selection and data extraction

We used the following criteria in the search for the data: (1) the data had to be collected during the breeding season, (2) the data had to be collected from the urban core area of the town (i.e., central part of the town that is > 50% covered by impervious surface area, containing large buildings, primarily stores, businesses and work places and usually includes the historical center of the town; see definitions in Adams, 2016; and demographia.com), (3) the data had to be collected 1990–2012, (4) the data had to be collected by the standard multiple-visit method (atlas, territory mapping, point counts; Bibby, Burgess, &