



Urban influence on birds at a regional scale: A case study with the avifauna of northern Madrid province

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Received 13 August 2004; received in revised form 8 April 2005; accepted 12 April 2005
Available online 14 July 2005

Abstract

Bird fauna of the Madrid province (Central Spain) was analyzed according to urban development in a landscape mosaic of 700 km². Bird distribution and abundance was studied in urban versus several rural habitats and along a gradient of urban typologies. By means of tree regression analyses we identified the most important habitat structure variables affecting bird species richness and density in urban environments. Bird communities in urban environments were globally less diverse and had higher densities than any natural habitat of the study region. The number of urban-avoider species ($n = 37$) was greater than the number of species favoured by urban habitats ($n = 8$). Current housing developments of extensive crowded terraced-houses, with shortage of gardens, supported the least diverse and dense bird populations. Nevertheless, differences in bird species abundance between urban and natural habitats mitigated in many species when considering the older gardened developments. The plots with the highest species richness (average of 14.5 spp./0.8 ha) were those with 15–28% of building cover, more than 43 medium-sized trees/ha (10–30 cm dbh), and 13–54 small trees/ha (less than 10 cm dbh). Subsequently, future land-use planning should stress the exclusion of urban developments from the most valuable habitats, such as open wooded valley areas devoted to cattle-grazing (mainly ash-groves), and the negative effect of dense, low-gardened housing developments.

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Keywords: Housing development; Urban birds; Species richness; Habitat structure; Landscape mosaics; Tree regression model

1. Introduction

Urban sprawl is one of the most obvious human impacts on nature, leading to perturbation, fragmenta-

tion or total disappearance of native landscapes and wildlife communities. The impressive rate at which current humankind is changing from rural to urban life styles (O'Meara, 1999; Antrop, 2004), makes precise principles on urban ecology especially necessary (Niemelä, 1999; Bowman and Marzluff, 2001; Marzluff et al., 2001). However, urban environments have been poorly studied when compared with other habitats (Marzluff et al., 2001; Chace and Walsh, 2006),

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in spite of interesting characteristics such as their worldwide ubiquity, marked structural heterogeneity, or novel resources provided.

Urban ecologists have primarily focused on birds when testing for urbanization effects on wildlife (e.g., Beissinger and Osborne, 1982; Friesen et al., 1995; Blair, 1996; Germaine et al., 1998; Clergeau et al., 1998; Kluza et al., 2000; Reynaud and Thioulouse, 2000; Green and Baker, 2003; Lim and Sodhi, 2004). Birds are an ecological and taxonomically diversified taxa, widespread and conspicuous, and with a marked sensitivity to environmental changes (Furness et al., 1993). Therefore, urban environments may have a great potential for defining management practices favouring the conservation of birds (Savard et al., 2000; Marzluff and Erwing, 2001). Nevertheless, few studies analyze the effects of urbanization on avian community patterns, with details on precise responses of species to particular features of urban structure (but see Bolger et al., 1997 or Melles et al., 2003). Moreover, urban habitats analyzed are usually located in relatively homogeneous matrices of natural environments, where the finding of clear human impacts of avian communities is easier than in landscape mosaics where urbanizations are widely scattered.

The northern region of the Madrid province (Central Spain) is currently undergoing an intense urban sprawl. Nevertheless, urban habitats were almost negligible before 1960, being limited to isolated cottages and small rural villages within an extensive mosaic of farming stands of low-intensity management (mainly pastures and parklands for cattle-grazing), combined with natural shrublands, oakwoods and pine forests. The formerly small rural areas have undergone an intense urban sprawl, transforming their surrounding natural habitats into built-up environments. This is because of housing demands of 2nd residences closer to natural environments, by people living in the city of Madrid (3.5 million people, 40 km away). As a consequence, the cities in the study region increased urban surface an average 25% between 1992 and 2000 (Comunidad Autónoma de Madrid, 2004). The developments firstly established were predominantly spread single-detached houses, with big gardens that have become mature after 20–40 years. Contrastingly, more recent urban developments mainly consist of tall block buildings or small terraced-houses with no or little areas devoted to gardens. Because these changes from rural

to heavily urbanized model is operating very rapidly, we need to know their effects on native avifauna to develop management actions for the future urban planning of the region. The main goals of this paper are to study the effects of urbanization on the bird community of this region comparing:

- (1) urban versus natural environments, in an extensive landscape mosaic encompassing several habitats markedly different in terms of vegetation and human uses,
- (2) urban typologies in the study region along a gradient ranging from most to least impacting urban development patterns,
- (3) and to analyze habitat preferences of species considering variables describing habitat structure of the urban environment.

2. Material and methods

2.1. Study area and bird census

This study was conducted on the southern slope of the Guadarrama Range (Madrid province, Central Spain), spanning over 700 km² of piedmont and initial mountain ramps (40°35′–40°48′N, 3°45′–4°10′W; 900–1400 m a.s.l.; Fig. 1). This area is located approximately 40 km northwest of Madrid city, with which it is connected by a good network of highways, local roads and railways. The study region has a Mediterranean-continental cold climate, with a mean temperature of 14.5 °C and rainfall of 130 mm during spring time. There is a wide variety of habitats in this area: four main native forests (pinewoods of *Pinus sylvestris*, riparian woods, deciduous oakwoods of *Quercus pyrenaica* and evergreen holm-oakwoods of *Q. rotundifolia*), open wooded habitats of ash (*Fraxinus angustifolia*) and holm-oaks devoted to livestock, several scrublands resulting from forest degradation, artificial pasturelands and urban areas (from small villages to large cities). These habitats are widely scattered in small sized patches due to the land-ownership model in this region and the effects of land-use and environmental factors (e.g., relief, soils, roads and tracks crossing the territory). See Izco (1984) for more details and descriptions of geographic, climatic and botanic characteristics of the study region. New residential

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