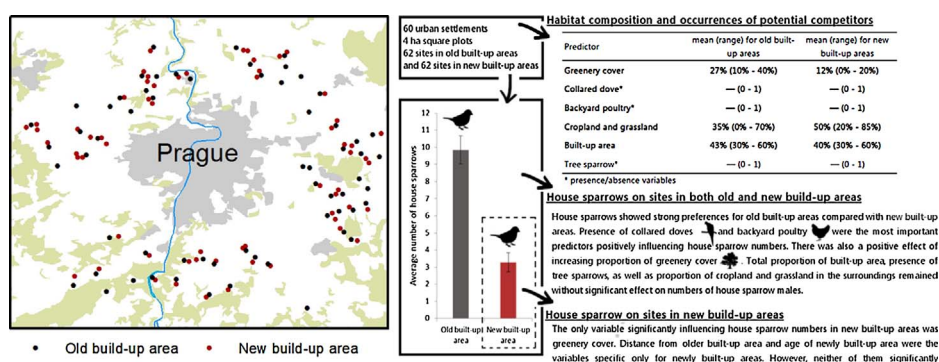


Research Paper

What makes new housing development unsuitable for house sparrows (*Passer domesticus*)?

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GRAPHICAL ABSTRACT



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ABSTRACT

As a species closely associated with people and urban areas, the house sparrow (*Passer domesticus*) was expected to prosper with increased urbanization. Over the past few decades, however, house sparrow populations have decreased in many towns and cities around the world. The most commonly mentioned reasons for these decreases are lack of food, especially invertebrates, and fewer nesting sites and shelters. Given the need to evaluate the role of newly built homes and their effect on sparrow habitat, our overall goal was to evaluate if new housing areas are inhabited with a lower density of house sparrows than old housing areas and, if so, to identify factors responsible for the differences. We carried out observations in 60 small settlements in the greater municipal area of Prague, Czech Republic. Our results indicate house sparrows' high preference for old parts of settlements and unsuitability of newly built-up areas. Backyard poultry's presence and sufficient green space were both important factors related to house sparrow abundances. Specifically, house sparrow abundance was highest in sites with 20% to 30% greenery cover (trees and shrubs) and they exploited sites that had backyard poultry. We found no effect of other granivorous birds acting as competitors. Instead, house sparrow abundance was higher where another granivorous species were present. As a measure to sustain greater biodiversity in modern housing development, we suggest increasing trees and shrubs cover in newly built-up areas to a minimum of 20%.

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1. Introduction

Urban areas are growing rapidly throughout the world, and this trend is expected to continue as urban areas absorb most of the global population growth in the future (United Nations, 2011; Kourtit, Nijkamp, & Reid, 2014). Numerous species have adapted to the proximity of humans (Evans, Chamberlain, Hatchwell, Gregory, & Gaston, 2011; Møller, 2009) and the biodiversity of urban areas has gained more attention with continuous urbanization (Pickett et al., 2011). Further investigation of species' responses to urban environments is important for understanding synurbic populations and their implications for urban biodiversity and management (Francis & Chadwick, 2012). One useful group for understanding urban biodiversity are birds, which are the dominant group of vertebrates in urban areas (Campbell, 2007). Amongst birds, none is more closely associated with man worldwide than the house sparrow (*Passer domesticus*) (Peach, Vincent, Fowler, & Grice, 2008).

In 1963, J.D. Summers-Smith predicted that house sparrow populations would increase with man's global dominance and the increasing amount of built-up land, which is the preferred habitat for the bird. However, four decades later, Summers-Smith was the first to admit how wrong he had been (De Laet & Summers-Smith, 2007). In the last decade numerous studies have reported evidence of a rapid decrease in house sparrow populations in many European towns and cities (Shaw, Chamberlain, & Evans, 2008). For instance, in urban-suburban Britain, with solid long-term observations, the decline appears to have begun in the mid-1980s and continued throughout the 1990s (Robinson, Siriwardena, & Crick, 2005; Summers-Smith, 2003). A similar trend has been reported in India (Singh, Kour, Ahmad, & Sahi, 2013) and over parts of the bird's non-native range in North America (Erskine, 2006) and Australia (Olsen, Weston, Cunningham, & Silcocks, 2003). Although populations are declining in many places, there also are regions with stable or increasing numbers of house sparrows (Shaw et al., 2008).

The first record of house sparrow decline comes from the beginning of the 20th century. At that time, automobiles had replaced horse-drawn transport and caused a decrease in seed, a food resource from horse feeding and indigestible remains (Summers-Smith, 2005). Lack of food is still one of the causes of the birds' decline most often cited (Murgui & Macias, 2010; Peach et al., 2008; Singh et al., 2013). The main reason, however, is not a lack of seeds (De Coster, De Laet, Vangestel, Adriaensen, & Lens, 2015) but rather a decrease in invertebrate abundance (Peach et al., 2008). Although, adult house sparrows have mostly a plant diet (Cramp & Simmons, 1994), invertebrates comprise an important part of their diet during the breeding season and are necessary for feeding nestlings. Shortage of these invertebrates may cause a reduction in clutch size (Peach, Sheehan, & Kirby, 2014) and higher chick mortality (Peach et al., 2008; Seress et al., 2012). For instance, Peach et al. (2015) found large positive impact on the abundance of recently fledged birds, but only a small positive impact, limited mainly to small colonies, on the overall abundance of territorial males. Lack of invertebrates may be linked with the presence of fewer vegetated areas in modern municipalities. For example, Turrini & Knop (2015) found a link between arthropod diversity and abundance and sufficiency of vegetated space in urban areas. Availability of invertebrates also could be negatively affected by the use of pesticides or planting of exotic species which are typical for modern gardening. House sparrows collect invertebrates from deciduous woody vegetation, trees, and grassland rather than from evergreen or ornamental shrubs (Vincent, 2006).

House sparrows are very flexible in using a variety of structures as nesting sites (Summers-Smith, 2009). However, modern buildings may have changed the availability of nesting sites. New housing technologies using different materials offer fewer holes and cracks (Shaw et al., 2008; Singh et al., 2013), whereas old crumbling buildings with holes under roofs, cracks in siding, and unkempt surroundings offer more

shelters and nesting sites. In addition, a shortage of potential nesting sites and shelters increases predation risk. Domestic cats (*Felis catus*) and sparrowhawks (*Accipiter nisus*) are the most cited predators of house sparrows in urban areas (De Coster et al., 2015; Summers-Smith, 2003). For example, domestic cats have been estimated to kill yearly as many as 27 million birds in the UK between 1 April and 31 August (Woods, McDonald, & Harris, 2003).

Much has been written about the causes of house sparrow decline and many of the aforementioned studies refer to the coincidence of several factors that are mostly associated with fewer nesting sites, shelters, and invertebrates. Furthermore, Shaw et al. (2008) had suggested that the house sparrow population in many cities is more abundant in areas with low socioeconomic status as compared to more affluent areas. Moreover, Wotton, Field, Langston and Gibbons (2002) revealed that houses built before 1919 are important as a source of nesting sites. Thus, it is possible that changes in all of these important factors might be explained by complex changes in housing development even on a smaller scale within particular human settlements. However, there have been no studies to date that have included the aging process of new housing areas as a factor which may influence their suitability for house sparrows. Measuring the abundance of house sparrows in newly built-up areas of different ages can point to possible trends in house sparrow populations in the future.

Given the need to evaluate the role of newly built homes and their effect on sparrow habitat, our overall goal was to evaluate if new housing areas are inhabited with a lower density of house sparrows than old housing areas and, if so, to identify factors responsible for the differences. To address this goal we sought to answer the following questions: 1) Is there any difference in house sparrow numbers between old and new housing areas? 2) Do total amount of trees and shrubs (hereinafter termed greenery cover), extent of built-up area, presence of backyard poultry and potential avian competitors affect house sparrow numbers in residential housing areas? 3) Are newly built-up areas more suitable for house sparrows as they get older or/and in relation to distance to older built-up areas?

2. Methods

2.1. Research area

The Czech Republic provides a suitable model country with a clear separation between old and modern housing developments due to rapid change from a centrally planned to a market economy with significant economic growth after the Velvet Revolution in 1989. The political and economic changes initiated the start of suburban growth (Ouředníček, 2007). Whereas old parts of settlements had been established prior to 1940 and their area almost has not changed, a major suburbanization process began after 1989 and new parts of settlements have grown up rapidly. These specific conditions of urban development allow us to compare modern housing with older-style housing on a local scale. With the improved economic situation and mobility, many people have moved from cities to neighboring villages. Thus, housing development has gone through a dramatic change as new residential areas have grown up around original settlements to occupy agricultural fields and grasslands. Original built-up areas also have undergone transformations. Renovation of old buildings is slower than constructing new buildings on a green field.

2.2. Study sites

This study was carried out at 124 sites in 60 small, moderately developed urban settlements (Francis & Chadwick, 2012) located within 25 km from the center of Prague, the capital city of the Czech Republic (Fig. 1). The entire area has undergone significant urban-suburban housing development. New parts of settlements (hereinafter termed new built-up areas) are characterized as uniform housing

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