Chapter 1
Birds from Urban Latin America, Where Economic Inequality and Urbanization Meet Biodiversity

Ian MacGregor-Fors and Juan F. Escobar-Ibáñez

Abstract Following a massive migration toward cities, more than half of the total human population is now urban. Given the unbalanced metabolism of urban systems, urbanization has been recognized to be a major ecological driver with worrisome consequences at different spatial and temporal scales. Such an environmental issue has drawn the attention of ecologists from across the globe since the late 1990s, when urban ecology consolidated as a discipline. Although urban ecology has developed importantly in the last three decades, our comprehension of the effects of urbanization on wildlife communities is heavily biased toward developed countries, most of which are located in temperate regions. Woefully, there is a dearth of knowledge from highly biodiverse areas with increasing urbanization rates and major urban agglomerations. Latin America is not an exception, with most of its population in rapidly growing urban centers. Given that the region concentrates important biodiverse areas in a scenario of considerable economic and social disparity, understanding the effects that urbanization has on wildlife species is of special concern. Even though ecological studies performed in urban Latin America started in the 1970s, urban ecology in the region is still in the process of consolidation, with birds being the most studied group. Several ecological patterns hold in urban Latin America when contrasted with those from other regions; yet, important differences have been identified, making evident the need to understand the response of wildlife species in the region. In this book, we gathered regional experts to set the state-of-the-art of bird studies in urban Latin America. Starting with an updated review, the book transits across topics such as urban bird species richness, composition, abundance, demography, population dynamics, behavior, threats, and conservation, as well as their relationships with 'green' and 'gray' infrastructures. After reviewing the specific topics with information from across the globe, each chapter contrasts the global findings with those from Latin America, identifying knowledge gaps and research needs to suggest future directions. The gathered information sets the

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I. MacGregor-Fors, J.F. Escobar-Ibáñez (eds.), *Avian Ecology in Latin American Cityscapes*, DOI 10.1007/978-3-319-63475-3_1

foundation for the study of birds in urban Latin America, hopefully promoting the consolidation of the field in the region and encouraging future mechanistic studies that untangle the recorded patterns to have the required information to bridge the gap between evidence-based knowledge and practice in urban systems.

Keywords Anthropocene • Avian studies • Ecological footprint • Megadiverse cities • Urban ecology

1.1 Urbanization: Ecological Consequences and Study Paradigms

The human ecological footprint is currently ubiquitous, with increasing disturbance intensity and frequency resulting in unquantifiable effects at different spatial and temporal scales (Bazzaz 1990; Steffen et al. 2005; Maxwell et al. 2016; Venter et al. 2016). Human-related activities have modified ecosystems, directly or indirectly, to such an extent that there are no current ecosystems that can be considered pristine (Vitousek et al. 1997; Steffen et al. 2015). The consequences of human activities are of such magnitude that scientists have recognized the beginning of a new era triggered, among other causes, by the Industrial Revolution: The Anthropocene (Crutzen and Stoermer 2000; Steffen et al. 2011; Waters et al. 2016). Among the most impressive human phenomena of modern history, the wave of migration from nonurban areas (e.g., agricultural settlements, small towns) to urban centers is notable (United Nations 2014, 2015a). Such a massive migration, mainly driven by modern industrial and socioeconomic dynamics, has resulted in an important shift of the total human population, passing from being predominantly nonurban ('rural') to mainly urban (Grimm et al. 2008; United Nations 2015a). As a direct response of the human concentration in cities, their borders are sprawling, and new urban systems are establishing faster than ever, requiring disproportionate amounts of resources to fulfill the modern urban lifestyle (Grimm et al. 2008; Seto et al. 2011). Not surprisingly, the footprint of a city, related to the food, energy, and materials that are imported into the system, often exceeds 200 times its territory (Wigginton et al. 2016).

When an area is urbanized, drastic changes occur at different spatial and temporal scales, including the removal of preexistent vegetation, important shifts in the terrain, redirecting of rivers, filling of water bodies, as well as the addition of artificial structures that result in large extensions of hard, relatively impervious, surfaces (Eldredge and Horenstein 2014). Such drastic changes in the land, most of which are long-lasting, have been related to alarming ecological and human health issues (McKinney 2006; Tzoulas et al. 2007; Seto et al. 2011; McDonnell and MacGregor-Fors 2016). Although the global urban land only represented 3% of the terrestrial surface by 2010 (with only 0.45% covered by impervious surfaces; Liu et al. 2014), the ecological consequences of urbanization and its processes go way beyond their physical limits (Berkowitz et al. 2003). In fact, urbanization has been related to

some of the most alarming components of global change (i.e., land use and land cover transformation, climate change, biological invasions, changes in biogeochemical cycles, biodiversity loss; Grimm et al. 2008) and also identified as one of the major causes of species endangerment (Czech et al. 2000; Marzluff et al. 2001; Seto et al. 2011; Maxwell et al. 2016).

All of the above has led to great concern in the scientific community, with ecologists consolidating urban ecology as a discipline after the urban development explosion of the 1990s (McDonnell 2011). Since the foundation of urban ecology, it has been well recognized that cities are comprised of three major spheres: physical, ecological, and social (Alberti et al. 2003; Berkowitz et al. 2003; Nilon et al. 2011). Since the 1990s, a vision of urban ecological studies as generators of information to have a direct impact on human well-being through the maintenance of ecological processes within cities was established (Niemelä 1999). Yet, most studies have been framed following two approaches: ecology 'in' and 'of' the city (Pickett et al. 1999). Briefly, the ecology 'in' the city paradigm focuses on biologically oriented studies performed in urban systems to assess ecological questions, while the ecology 'of' the city paradigm broadens the scope to include the complexity of urban systems, considering all three major spheres and their interactions (Pickett et al. 2011). Most recently, Pickett et al. (2016) highlighted an emerging paradigm, ecology 'for' the city, that encourages ecologists to collaborate with specialists from other disciplines, as well as all implied urban stakeholders to promote livable, sustainable, and healthier cities through environmental integrity, social equity, and economic viability.

1.2 Latin America, a Complex Scenario for Biodiversity

In Latin America, economic inequity, urbanization, and biodiversity converge (Santandreu et al. 2002). The region experiences important urban growth, housing more than 500 million urbanites (United Nations 2015b). A considerable proportion of the Latin American population is concentrated in urban centers (80%), four of which are among the 28 'megacities' (agglomerations with >10 million inhabitants) recognized by the United Nations (2014) (i.e., Mexico City, Mexico: 20.8 million; São Paulo, Brazil: 20.8 million; Buenos Aires, Argentina: 15.0 million; Rio de Janeiro, Brazil: 12.8 million), and another four among the 72 urban centers with >5 million inhabitants (i.e., Lima, Peru: 9.7 million; Bogota, Colombia: 9.5 million, Santiago, Chile: 6.5 million; Belo Horizonte, Brazil: 5.7 million). It is forecast that the population of these eight cities will have a ~15% average growth by 2030. Moreover, two Mexican cities are predicted to be included among the 100 most populated cities of the world by 2030: Guadalajara (5.8 million) and Monterrey (5.5 million; United Nations 2015b; Fig. 1.1).

Together with the overcrowding of cities and the rapid urbanization occurring in Latin America, the region is marked by extreme inequities (Pauchard and Barbosa

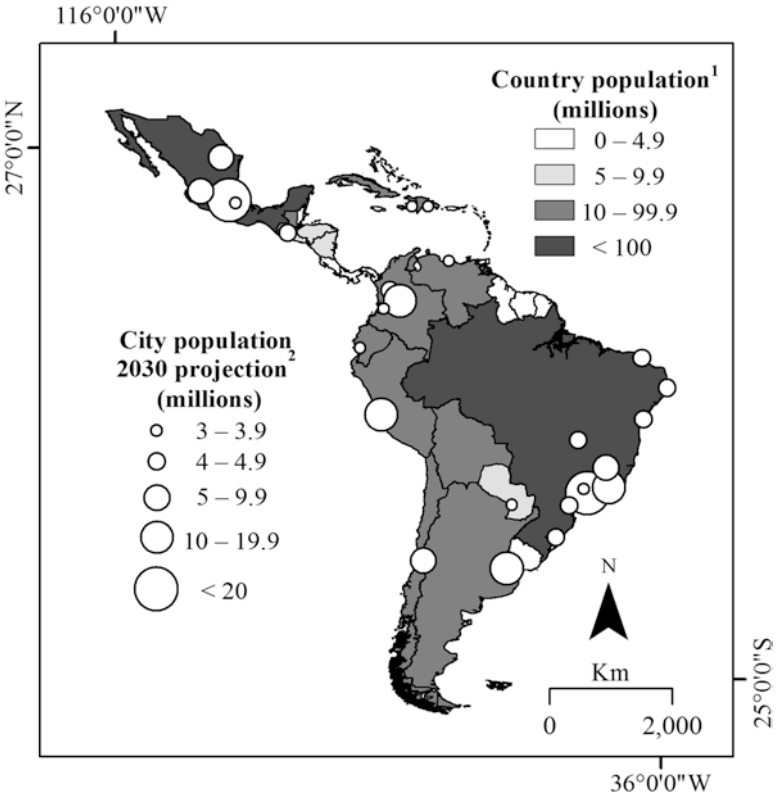

Fig. 1.1 Human population in urban Latin America highlighting [1]2014 values for countries and [2]2030 projections for cities with >3 million inhabitants

2013). Such disparities are of both social and economic nature, with more than 120 million urbanites living in poverty, largely as a result of employment deficits and economic informality. However, the urban scenario is not consistent throughout the region, with economic inequality being both higher and lower when compared to national calculations (e.g., higher Gini index values – measures of wealth distribution, for Guadalajara; Managua, Nicaragua; São Paulo; and lower values in Bogota, Santiago, Mexico City; ONU-Habitat 2012). Inequity is also translated to the ecological sphere of Latin American cities, with an uneven distribution of greenspaces, often concentrated in high-income areas (Barbosa et al. 2007; Reyes and Figueroa 2010).

This scenario of human agglomeration and social and economic inequities meets megadiversity in the region. Latin America, with seven out of 25 global biodiversity hotspots (Cincotta et al. 2000) and six out of 17 megadiverse countries (i.e., Brazil, Colombia, Ecuador, Mexico, Peru, and Venezuela; Mittermeier et al. 1997), holds an important proportion of the global terrestrial ecoregions (Olson and Dinerstein

2002), which are critical for global biodiversity conservation (Mittermeier et al. 2011). Regarding birds, one of the best studied wildlife groups due to their potential as bioindicators (Moreno et al. 2007), most of their diversity and endemicity are concentrated in Latin America (Stotz et al. 1996; Mittermeier et al. 2011; Hedblom and Murgui 2017). Such complexity makes Latin America a focal region for understanding human disturbances and their effects on biodiversity to have a solid foundation to establish evidence-based decision-making.

1.3 Bird Responses to Urbanization

Together with plants, birds are the most studied wildlife group by urban ecologists (McKinney 2008). Such bias occurs for several reasons, of which the following head the list: (i) birds are diverse (Jetz et al. 2012; Navarro-Sigüenza et al. 2014); (ii) form complex communities within urban systems (Blair 1996; Tratalos et al. 2007); (iii) are relatively easy to survey (Ralph et al. 1996); and (iv) respond to modifications in their habitats (Marzluff et al. 2001; Chace and Walsh 2006; Aronson et al. 2014). Since the 1940s, with Pitelka's (1942) report of the birds of a resort village in the California North Coast (United States), urban bird studies have populated the scientific literature, rising importantly after the late 1990s, and reaching a peak in 2012.

With the publication of the iconic book of urban bird studies edited by John M. Marzluff et al. (2001), urban ornithologists have identified several patterns (reviewed by Chace and Walsh 2006 and Evans et al. 2009). For example, bird species richness tends to decrease with urbanization (although it sometimes peaks at intermediate levels of urbanization intensity; Lepczyk et al. 2008), and total bird abundance tends to increase with urbanization, due to the large numbers of a few abundant generalist, often exotic and/or invasive, species. Most recently, Marzluff (2016) reviewed urban bird publications since 2006, recognizing that although some mechanistic processes related to well-studied patterns are being assessed in developed countries (e.g., demographic responses to urbanization), there still exists an important bias toward pattern studies in developing regions, such as Latin America.

Urban bird studies from Latin America have been reviewed in the past, both regionally and nationally (i.e., Colombia; Delgado-V and Correa-H 2013). González-Urrutia (2009) performed a first regional review, focusing on 72 studies, and concluded that urban bird ecology in Latin America was still incipient. In 2011, Ortega-Álvarez and MacGregor-Fors (2011a) performed an in-depth review of 84 studies, starting with Fonaroff's (1974) publication of the urban birds of Port of Spain, Trinidad and Tobago. Recognizing that some general patterns seem to hold in Latin America when contrasted with studies from developed temperate countries, Ortega-Álvarez and MacGregor-Fors (2011a, b) pointed out some differences that had been recorded in the region (e.g., higher species richness recorded in urban Latin America when contrasted with other regions; no evidence of intermediate urbanization

scenarios under which avian species richness peak; the important presence of insectivore species in cities across Latin America). Such differences highlight the need to better understand the response of birds to urbanization in a rapidly urbanizing region to add to the global comprehension of this complex phenomenon.

1.4 Avian Studies in Urban Latin America

In this book, we have gathered regional urban bird experts who, refereed by internationally renowned peers, have set the state-of-the-art of urban bird studies in Latin America, contrasted the main retrieved findings with those from other regions across the globe, identified knowledge gaps, and suggested future research needs and directions for each specific topic. This sets the foundation for study of birds in urban Latin America and sheds light on the upcoming steps, hopefully promoting the consolidation of the field in the region. The latter will be possible with the migration toward mechanistic studies that untangle the recorded patterns, and thus generate the required ecological information needed to bridge the gap between evidence-based knowledge and practice in urban systems.

In Chap. 2, Escobar-Ibáñez and MacGregor-Fors set the current status of urban bird studies in Latin America by compiling all available research published since the regional 2011 review (Ortega-Álvarez and MacGregor-Fors 2011a). Focusing their updated review on ecological studies, species lists, and new records, Escobar-Ibáñez and MacGregor-Fors identify several conceptual limitations and spatiotemporal biases that need to be considered with the aim of consolidating the discipline in the region. In Chap. 3, MacGregor-Fors and García-Arroyo focus on bird species richness and composition shifts related to urbanization. Although bird species richness and composition general patterns hold in Latin American cities when compared with the rest of the literature, MacGregor-Fors and García-Arroyo highlight the important number of species that can be recorded within Latin American cities, as well as differences in species composition, mainly assessed using trophic categories. In Chap. 4, Leveau and Zuria review urban avian abundance, demography, and population dynamics, and their urban-related drivers. Based on the response of bird species to urbanization, Leveau and Zuria conclude that, in agreement with studies from other regions, exotic, invasive, and/or generalist species tend to have large populations in urban Latin America, while specialists tend to have low numbers or be absent in urban centers. In Chap. 5, Faggi and Caula focus on the two main infrastructures that make up urban centers: the one comprised by vegetation ('green' infrastructure), and that including man-made structures ('gray' infrastructure). Using this pragmatic framework, Faggi and Caula's synthesis reflects the tight relationship between specific man-made structure and many urban-related bird species, while identifying several 'green' traits that tend to relate with more complex and diverse urban avian communities. In Chap. 6, González-Lagos and Quesada examine the behavioral responses of birds to urbanization. Their analysis focuses on the

ethological adjustments to habitat loss and fragmentation, as well as resource availability, pollution (namely noise and artificial night lighting), species interactions, and tolerance to human activities. In Chap. 7, Santiago-Alarcon and Delgado-V summarize the global and regional information regarding urban threats for birds. Covering several major topics (i.e., cat predation, collisions with building structures and vehicles, parasitism), Santiago-Alarcon and Delgado-V identify the crucial need to focus on the effect that urban threats have on Latin American birds due to a concerning lack of studies of most of the evaluated topics. In Chap. 8, Piratelli et al. recognize the general dearth of studies focused on urban bird conservation, with Latin America not being an exception. Although there is evidence in nonpublished and/or confidential technical reports, there is a crucial need to approach the conservation of urban biodiversity through the use of charismatic and informative groups such as birds, where building bird-friendly environments can translate in higher ecological quality, livable, and sustainable cities.

Finally, in Chap. 9, MacGregor-Fors et al. wrap up the book underlining the main findings and conclusions, identifying general knowledge gaps and future research directions. This final chapter pinpoints issues that require urgent attention to enrich future urban bird ecology studies in Latin America, specifically: (i) to consolidate our comprehension of the ecological patterns and related mechanistic processes to understand the response of birds to urbanization, from genes to landscapes; (ii) to standardize the definition of 'urban' and urbanization intensity (including urban–nonurban gradients), as well as urban land uses; (iii) to address the role of the diverse array of spatial (e.g., city size, location) and site-specific variables (e.g., vegetation cover, plant diversity, urbanization intensity), which characterize Latin American cities, on the response of birds to urbanization; (iv) to reevaluate the experimental design and analytical frameworks used for urban bird studies, such as the use of citywide surveys and the inclusion of the physical and social spheres in the interpretation of the studied ecological patterns and processes; and (v) to reexamine several conceptual and analytical approaches in the assessment of biotic homogenization related to urbanization.

Acknowledgments The authors are deeply thankful to Mark Goddard and Rafael Rueda Hernández for their valuable comments and suggestions that improved the clarity of this chapter, and Michelle García-Arroyo for her support in drawing Fig. 1.1. JFE-I acknowledges the scholarship and financial support provided by the National Council of Science and Technology (CONACYT 366146), as well as the Graduate School of the Instituto de Ecología, A.C. (INECOL).

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