



A dead letter? Urban conservation, management, and planning strategies from the Mexican urban bird literature

Ian MacGregor-Fors¹ · Miguel A. Gómez-Martínez² · Michelle García-Arroyo¹ · Carlos A. Chávez-Zichinelli³

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Abstract

Urbanization has been identified as one of the major causes of species endangerment. Albeit important efforts by urban ecologists, there are still understudied regions in the globe with an important bias toward bird studies. Fortunately, studies from biodiversity-rich regions are increasingly growing; yet, with few exceptions, most evidence-based suggested urban conservation, management, and planning strategies have remained in the publications. The aim of this study was to draw them from a ‘dead letter’ by compiling all available publications carried out in Mexican grounds that explicitly suggested strategies and/or actions that could influence bird conservation through urban management and/or planning. We identified three main topics of recommendations: (1) greenspace management and planning, (2) study and control of exotic, invasive, and/or nuisance species, and (3) public policies and conservation strategies and plans. It is clear that the recommendations from the reviewed Mexican urban bird literature provide a compelling guide to start bridging the gap between evidence-based knowledge and the materialization of their suggestions on the path toward creating biodiverse and livable cities. We believe that the transference of urban ecology knowledge relies on the willingness of all implied stakeholders, including scientists, urban citizens, and decision makers.

Keywords Biodiversity · Evidence-based policy · Latin America · Literature review · Mexico · Neotropics · Urban ecology

Introduction

Urbanization is the process through which modern housing needs are met by modifying, and even replacing, preexisting systems (Eldredge and Horenstein 2014). Modern economies and globalization processes have led work source concentration toward cities, driving the urban migration pattern and thus the expansion of the urban fringe. The

environmental demands and pressures posed by the more than 4 billion urban citizens is unprecedented (i.e., 4.2 billion for 2018; United Nations 2018), with the resulting ecological footprint extending way beyond city limits (Wigginton et al. 2016). Not surprisingly, several of the major components of global change have been related to urban development (i.e., land-use change, biogeochemical cycle shifts, biological invasions, climate change), setting urbanization as one of the major causes of species endangerment at different temporal and spatial scales, as well as human health and well-being (Czech and Krausman 1997; Czech et al. 2000; Grimm et al. 2008; Maxwell et al. 2016).

Such a worrisome anthropogenic disturbance has drawn the attention of hundreds of ecologists across the globe (Elmqvist et al. 2013); however, our current knowledge on the ecological patterns and related processes that occur in urban centers has important biases, with study objects (i.e., taxonomic group) and sites heading the list. Regarding the study object bias, birds have been the most studied group in urban areas (McKinney 2008). The latter is, among other reasons, due to the fact that they are highly diverse, form complex communities in most urban scenarios, respond to human disturbances, have a well-defined, yet dynamic taxonomy (see supplements to the AOU Checklist of

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✉ Ian MacGregor-Fors
ian.macgregor@inecol.mx; macgregor.ian@gmail.com

¹ Red de Ambiente y Sustentabilidad, Instituto de Ecología, A.C. (INECOL), Carretera antigua a Coatepec 351, El Haya, Xalapa 91073, Veracruz, Mexico

² Instituto de Biotecnología y Ecología Aplicada (INBIOTECA), Universidad Veracruzana, Avenida de las Culturas Veracruzanas 101, Col. Emiliano Zapata, Xalapa 91090, Veracruz, Mexico

³ El Colegio de Puebla, A.C, Puebla, Mexico

North and Middle American Birds; e.g., Chesser et al. 2018), and are relatively easy to survey following standardized methods (with the appropriate field experience; Bibby et al. 1993; Ralph et al. 1993; Blair 1996; Chace and Walsh 2006; Evans et al. 2009; Reis et al. 2012; Escobar-Ibáñez and MacGregor-Fors 2016). Actually, birds are excellent biodiversity indicators (also known as “bioindicators”; Moreno et al. 2007). Regarding the geographic bias, most urban bird studies have been performed in developed countries from temperate regions (Chace and Walsh 2006; Evans et al. 2009; MacGregor-Fors et al. 2009); yet, studies from highly biodiverse regions are complementing the literature (Ortega-Álvarez and MacGregor-Fors 2011a; Ortega-Álvarez and MacGregor-Fors 2011b; MacGregor-Fors and Escobar-Ibáñez 2017; Marzluff 2017).

Among biodiverse regions, the Neotropics shelter the highest number of avian species across the globe (Stotz et al. 1996). Woefully, this region is an example of economic inequality and urbanization meeting biodiversity (MacGregor-Fors and Escobar-Ibáñez 2017). In fact, the most populated countries in the region (i.e., Brazil, Mexico, Colombia, Argentina) have some of the major human agglomerations of the globe (i.e., Mexico City, São Paulo, Buenos Aires, Bogotá; United Nations 2018). Thus, it is not surprising that most urban bird ecology knowledge comes from Brazil, Mexico, and Argentina, respectively (Escobar-Ibáñez and MacGregor-Fors 2017).

As has occurred in other Latin American countries, urban bird studies in Mexico started incipiently in the mid-1980s (Escobar-Ibáñez and MacGregor-Fors 2017). Since then, an important and increasing number of urban bird studies have been performed in a wide variety of cities, ranging from large megalopolis (i.e., Mexico City) and large cities (e.g., Guadalajara, Puebla), to medium- and small-sized ones (e.g., Morelia, Querétaro, Pachuca, Xalapa). Knowledge from small- to medium-sized settlements has not only increased our comprehension of the way in which birds respond to urbanization, but have also provided important knowledge on the strategies and actions that could favor urban bird conservation through urban management and/or planning (Ortega-Álvarez and MacGregor-Fors 2011b; Ortega-Álvarez et al. 2013). Yet, most suggested urban conservation, management and/or planning strategies have remained in the publications, with few exceptions where urban bird ecology knowledge, together with sufficient understanding of urban scenarios and willingness from the implied stakeholders, have derived in concrete actions (e.g., La Carbonera, Querétaro; Pineda-López et al. 2013).

With the aim of avoiding that such highly valuable evidence-based recommendations become a ‘dead letter’, we here compiled all the available explicitly suggested strategies and actions that could positively influence bird conservation through urban management and planning in Mexico.

Considering all the gathered and synthesized information, we underline the importance of bridging the gap between evidence-based knowledge and the materialization of their recommendations on the path toward creating biodiverse and livable cities (McDonnell and MacGregor-Fors 2016).

Methods

We carried out an intensive search of urban bird publications performed within Mexican grounds. To gather as many documents as possible, we searched for publications in several engines from 1985 to May 2019, including the Web of Science (www.webofknowledge.com; available databases through our institutional access, including the Web of Science Core Collection and SciELO Citation Index), and Google Scholar (<http://scholar.google.com>). We used combinations of keywords that included the avian, urban, and geographic area of interest. For instance, for the Web of Science search, we used the following keyword combinations: (“bird” OR “avian”) AND (“urban” OR “city”) AND (“Mexico”). To avoid excluding important information, we additionally searched for publications in targeted journals not indexed in the Web of Science (e.g., *El Canto del Centzontle*), as well as documents published in journals that are currently in the Web of Science but were not considered in any of its databases in the past (e.g., *Acta Zoológica Mexicana*; *Ornitología Neotropical*; *Huiztil*).

After gathering all of the available publications that met the aforementioned criteria, we manually selected those focused on urban birds, excluding thesis and dissertations due to potential duplicity with publications. We afterwards classified the studies by topic, study area, and journal, subsequently selecting those that explicitly suggested conservation, management, and/or planning actions based on empirical knowledge, reason why popular science and outreach publications were also excluded. We used this information to describe the nature of the suggested conservation, management, and/or planning strategies and actions in two ways: (1) a 100 word-cloud (i.e., visual representation of text data where the size of words indicate their frequency; in our case, excluding common words—e.g., pronouns, conjunctions, prepositions—, as well as general and uninformative ones—e.g., urban, city, area, zone, Mexico, site) considering all textual strategies and actions and (2) the synthesis and discussion of the suggested conservation, management, and/or planning strategies and actions.

Results

We retrieved a total of 159 publications. Given that we did not have access to 9 of the original documents and 39 that did not

suggest any bird conservation, urban management or planning strategies or actions, we considered a set of 111 publications for further analyses. The set of assessed manuscripts were written in Spanish (~ 57%) and English (~ 42%) (~ 1% in both languages), and published in 35 journals, of which 6 comprised more than 60% of the considered publications: *Huitzil*, *Revista Mexicana de Ornitología* (n = 38), *El Canto del Centzontle* (n = 8), *Acta Zoológica Mexicana* (n = 7), *Landscape and Urban Planning* (n = 7), *Ornitología Neotropical* (n = 6), and *Urban Ecosystems* (n = 5). Of the total set of assessed publications, 61 were focused primarily on ecological topics, 26 were new records and range expansions, 15 bird lists, 7 studied physiological and behavioral responses to urbanization, and 2 focused on conservation matters. Regarding survey sites, publications that required field work were carried out in 62 urban centers of 24 states, with Mexico City, Morelia (Michoacán), Xalapa (Veracruz), Pachuca (Hidalgo), Puebla (Puebla), Querétaro (Querétaro), and Chilpancingo (Guerrero) heading the list (Fig. 1). After excluding common and uninformative words (see Methods for details), the most frequent elements in the 100 wordcloud were ‘species’ (n = 130), ‘green’ (n = 40), ‘management’ (n = 39), ‘conservation’ (n = 34), ‘populations’ (n = 34), ‘environment’ (n = 32), ‘habitat’ (n = 31), ‘community’ (n = 24), and ‘native’ (n = 23) (Fig. 2).

With the aim of classifying the gathered conservation, management and/or planning suggestions, we used three categories to discuss them (as well as other two subtopics), although some are highly interrelated: (1) greenspace management and planning, (2) study and control of exotic, invasive and/or nuisance species, and (3) public policies and conservation

strategies and plans (see Table 1 for details on the frequency of appearance in the set of reviewed publications).

Discussion

Greenspace management and planning

Most studies suggesting strategies and actions targeted their recommendations on greenspace management and planning topics. The latter is not surprising as urban bird diversity often concentrates in such urban areas, which have actually been considered as biodiversity shelters or reservoirs in cities (Malagamba-Rubio et al. 2013; González-García et al. 2014; Hernández-Lara et al. 2017). Many of the reviewed studies recognize the ecological role of urban greenspaces for birds and their importance for the maintenance of urban bird diversity (e.g., Ramírez-Albores 2008; González-Oreja 2011; Monroy-Ojeda et al. 2013; Escobar-Ibáñez and MacGregor-Fors 2016). In general, we identified eight topics related to greenspace management and planning (Table 1), of which three head the list: (1) preserving urban greenspaces (e.g., González-Oreja et al. 2012a; MacGregor-Fors et al. 2018) and waterbodies (Rodríguez-Casanova and Zuria 2018); (2) increasing native vegetation in urban greenspaces (Cupul-Magaña 2000; Ortega-Álvarez and MacGregor-Fors 2009; Carbó-Ramírez and Zuria 2011; Castro-Torreblanca and Blancas Calva 2014), and (3) maintaining well-preserved urban vegetation (e.g., Zuria and Rendón-Hernández 2010; MacGregor-Fors and Schondube 2011; Hernández-Lara et al. 2017). Specific actions were also suggested in the reviewed recommendations, such as creating species-rich urban vegetation

Fig. 1 Map of study sites of the assessed publications that have provided conservation, management, and/or planning strategies and actions in Mexico

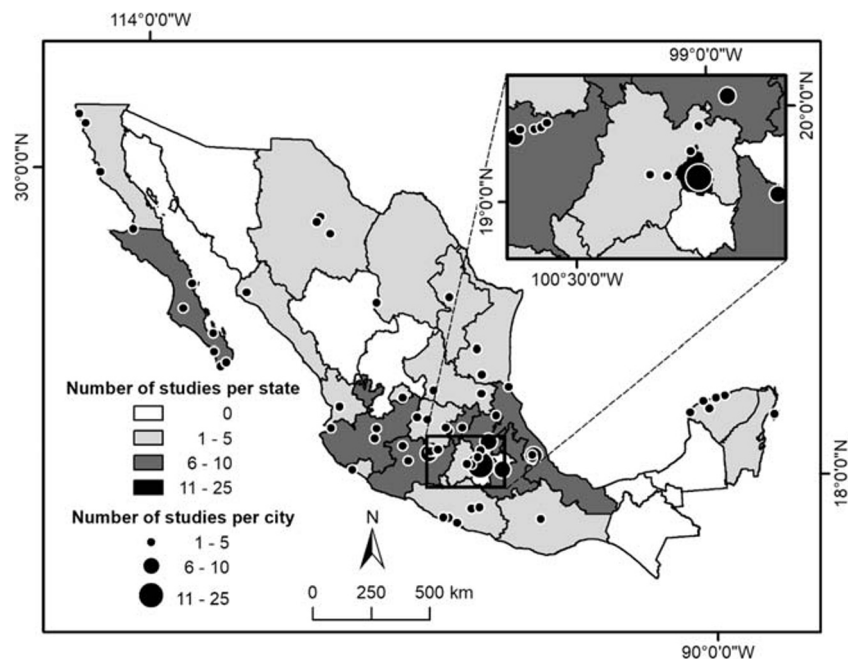


Fig. 2 Word-cloud of the textual suggested conservation, management, and planning strategies and actions provided in the assessed publications performed within Mexican grounds



Table 1 General topics of the suggested strategies and actions for bird conservation, as well as urban management and planning retrieved from the Mexican literature

Topic / Suggested strategies and actions	Frequency ^a
Greenspace management and planning	
Preserving urban greenspaces and waterbodies	9
Increasing native vegetation in urban greenspaces	8
Warranting well-preserved urban vegetation	7
Increasing the number of urban greenspaces	6
Creating species-rich urban vegetation assemblages	5
Increasing vegetation cover within urban greenspaces	3
Distributing urban greenspaces to buffer the border effects of urbanization	2
Creating multi-use urban greenspaces	1
Study and control of exotic, invasive, and nuisance species	
Monitoring exotic bird species	19
Studying exotic species related diseases	5
Banning exotic birds as pets	4
Controlling the effect of pets (mainly cats and dogs) on native urban birds	4
Preventing exotic bird species reproduction	3
Controlling the effects of nuisance bird species on urban infrastructure	3
Controlling the trade of exotic species	2
Public policies and conservation strategies and plans	
Including evidence-based ecological knowledge to urban development plans	16
Developing and implementing environmental education plans	7
Mitigating air, acoustic, and light pollution	6
Urban wildlife conservation and management plans	5
Creating vegetation corridors	4
Creating and implementing urban greenspace management plans and policies	3
Others	
Supporting basic urban bird ecology knowledge throughout cities	13
Increase in the use of public and free-access urban bird databases	3

^a Given that single publications have suggested several recommendations, values in this column indicate the number of times the topic was mentioned in the 111 reviewed publications

assemblages (e.g., Cupul-Magaña 2000; Ortega-Álvarez and MacGregor-Fors 2009; Carbó-Ramírez and Zuria 2011), increasing the number of urban greenspaces (e.g., MacGregor-Fors 2008; Monroy-Ojeda et al. 2013; González-Oreja 2017), increasing vegetation cover within urban greenspaces (Mellink and de la Riva 2005; MacGregor-Fors 2008; López-Flores et al. 2009; Almazán-Núñez and Hinterholzer-Rodríguez 2010), creating multi-use urban greenspaces, not only with recreational purposes but also taking into account biological conservation (Cupul-Magaña 1996), and considering urban greenspaces as buffers of the extent of urbanization in large cities (MacGregor-Fors 2010; MacGregor-Fors and Ortega-Álvarez 2011).

Undoubtedly, vegetation cover with high plant species richness can provide a diverse array of conditions that could enhance habitat conditions for birds, even in highly urbanized conditions (Jáuregui and Heres 2008; Carbó-Ramírez and Zuria 2011; Rodríguez-Casanova and Zuria 2018). As pointed out by several studies from across the globe (Gavareski 1976; Jokimäki 1999; Donnelly and Marzluff 2004; Strohbach et al. 2013), greenspace size in Mexico has been identified as a driver of urban bird diversity, with studies suggesting that larger urban greenspaces promote more complex conditions and interactions with other wildlife groups (e.g., MacGregor-Fors et al. 2008; Maya-Elizarrarás 2011; Ortega-Álvarez and MacGregor-Fors 2011b; Monroy-Ojeda et al. 2013; MacGregor-Fors et al. 2018). Closely related to the next main topic, some of the reviewed publications agree that native-dominated urban greenspaces could increase the diversity of native avifauna, and mitigate the impact of exotic, often nuisance, species (e.g., Martínez-Morales et al. 2010; Plasencia-Vázquez and Escalona-Segura 2012; Castro-Torreblanca and Blancas Calva 2014; Cuevas and Íñiguez-Dávalos 2017).

Study and control of exotic, invasive, and/or nuisance species

The set of reviewed studies pinpoints several specific issues and actions that could increase our knowledge, and in the best of cases, mitigate the negative effects of nuisance species on native urban avifaunas, as follows: monitoring exotic bird species (Almazán-Núñez et al. 2015; Maya-Elizarrarás 2018; Romero-Figueroa et al. 2017; Zuria et al. 2017), studying diseases related with exotic species (e.g., Chablé-Santos et al. 2012; Gómez Aíza and Zuria 2012; Blancas-Calva et al. 2014; Tinajero and Rodríguez-Estrella 2014), banning exotic bird species as pets (e.g., Guerrero-Cárdenas et al. 2012; Almazán-Núñez et al. 2015; Salgado-Miranda et al. 2016), controlling the effect of pets (mainly cats and dogs) on native urban birds (Zuria and Rendón-Hernández 2010; MacGregor-Fors and Schondube 2011), preventing exotic bird reproduction (e.g., Ortega-Álvarez and MacGregor-Fors 2011a; Ramírez-Albores 2012; Almazán-Núñez et al. 2015; Sierra-Morales and Almazán-Núñez 2017; Salgado-Miranda

et al. 2016), regulating the effect of nuisance bird species on urban infrastructure (Gómez Aíza and Zuria 2012), and controlling the trade of exotic species (e.g., Almazán-Núñez et al. 2015; Ramírez-Albores and Chapa-Vargas 2015; MacGregor-Fors et al. 2011b; Salgado-Miranda et al. 2016; González-Herrera et al. 2018).

Although there is still much research needed to understand the effects that exotic and/or invasive species can have on native avifaunas, we agree with most studies suggesting to adopt the precautionary principle (although see González-Oreja et al. 2018). Accordingly, as suggested by many of the studies cited above, it would be advisable to closely follow invasive colonies and/or populations to define active management programs and control nuisance species when evidence-based knowledge indicates it to be necessary (Almazán-Núñez et al. 2015; Ramírez-Cruz et al. 2019). Finally, one of the most frequent topics we identified regarding nuisance species was diseases; yet, studies fail to provide strategies to implement their recommendations (Chablé-Santos et al. 2012; Gómez-Aíza and Zuria 2010; Blancas-Calva et al. 2014). Thus, it is imperative that evidence-based and straight-forward strategies are provided by specialists in order to mitigate the important effects that nuisance species can have on wildlife species and human health.

Public policies and conservation strategies and plans

Studies that provide suggestions for conservation often state that in order to establish suitable public policies or realistic plans for wildlife within Mexican cities, we first need to generate basic information to have baselines as starting points (e.g., studying urban wildlife diversity in target cities; Almazán-Núñez and Hinterholzer-Rodríguez 2010; Charre et al. 2013; MacGregor-Fors et al. 2016; Jiménez-Guevara et al. 2018). Authors also agree on the pressing need of having high-quality ecological information to set the foundations of the evidence-based knowledge needed to create proper urban development plans that account for the maintenance of bird diversity, together with all of the additional and all related ecological, health, and human well-being benefits in these artificial environments (Almazán-Núñez and Hinterholzer-Rodríguez 2010; MacGregor-Fors 2005; Escobar-Ibáñez and MacGregor-Fors 2016). In general, the protection of their habitats has been identified as fundamental to preserve and enrich avian diversity in urban Mexico (Arizmendi et al. 1994; Santiago-Pérez 2010; Carbó-Ramírez and Zuria 2011; Hernández-Lara et al. 2017). Studies have used the corridor framework to propose habitat connectivity for birds in Mexican cities, which could play a fundamental role on their conservation (Arizmendi et al. 1994; Carbó-Ramírez and Zuria 2011; MacGregor-Fors et al. 2018). Promoting large and well connected urban greenspaces could prevent the local extirpation of bird populations, such as that

of the Chestnut-capped Brushfinch (*Arremon brunneinucha*; Hernández-Lara et al. 2017).

Not only connectivity among greenspaces has been identified as crucial for bird density promotion and conservation in urban Mexico, but also their nature, in which environmentally heterogeneous ones with high vegetation cover could provide high-quality habitats for the avifauna they shelter (e.g., median-strips, residential gardens, parks, cemeteries, urban preserves; Arizmendi et al. 1994; Gómez-Aíza and Zuria 2010; Carbó-Ramírez and Zuria 2011). Management plans have also been recommended to include urban-related pollution sources (e.g., noise, artificial light at night) as potentially detrimental for urban dwelling birds (Bermudez-Cuamatzin et al. 2009; Bermudez-Cuamatzin et al. 2010; MacGregor-Fors et al. 2011a; González-Oreja et al. 2012b; Nava-Díaz et al. 2015). Some studies have pinpointed the potential beneficial effects of environmental education as a tool that can help transferring evidence-based knowledge to urban citizens, pushing forward the implementation of conservation measures in urban Mexico (Arizmendi et al. 1994; Guerrero-Cárdenas et al. 2012; Molina et al. 2012; Rodríguez-Ruíz et al. 2017; González-Carrasco 2017).

In general, authors agree in the urgency of having high-quality ecological information to set the foundations of the evidence-based knowledge needed to create proper urban development plans that account for the maintenance of bird diversity (Almazán-Núñez and Hinterholzer-Rodríguez 2010; MacGregor-Fors 2005; Escobar-Ibáñez and MacGregor-Fors 2016). In this sense, urban greenspaces represent key components for bird conservation. Studies suggest to increase the number of greenspaces in areas where cities are expanding, as well as improving their quality, focused not only on recreational, but also with conservation purposes (e.g., Cupul-Magaña 1996; Almazán-Núñez and Hinterholzer-Rodríguez 2010; Carbó-Ramírez and Zuria 2011; MacGregor-Fors and Ortega-Álvarez 2011; MacGregor-Fors and Schondube 2011; Puga-Caballero et al. 2014).

There are two additional topics that are of great relevance (see ‘Others’ in Table 1). On the one hand, funding and supporting urban ecology studies in Mexico, as well as in other understudied regions, is crucial if we aim to understand the ecological sphere of these complex socio-ecosystems (Berkowitz et al. 2003; Pickett et al. 2016). Actually, the reviewed publications highlight the need to increase the number of studies that allow the proper assessment of the effects of anthropogenic disturbances, such as urbanization, on wildlife groups (e.g., Rodríguez-Estrella 2007). On the other hand, three of the reviewed studies suggest a precise action to increase urban-ecology knowledge, mainly through citizen-science, using public and free-access avian databases such as *aVerAves* (e.g., Mexican eBird, <https://ebird.org/averaves/home>; Aguilar-Gómez et al. 2015; Heredia et al. 2015; González-Carrasco 2017).

Undoubtedly, the gathered, discussed, and synthesized strategies and actions are of high value. Yet, we believe that their potential, if materialized, is boundless, especially because they include actions that could rapidly impact the ecological quality of cities. We are convinced that translating urban bird ecology knowledge to action relies on the willingness of the implied stakeholders, including scientists, urban citizens, and decision makers (MacGregor-Fors 2015). In this sense, bridging the gap toward resilient, biodiversity-rich, and livable cities has its foundations on evidence-based scientific knowledge, requiring important joint efforts with other disciplines, sharing agendas and speaking the same language (McDonnell et al. 2016; McDonnell and MacGregor-Fors 2016). Thus, with the aim of adding our grain of sand toward avoiding that the assessed conservation, management and/or planning actions turn into a ‘dead letter’, we have included an additional document (Appendix 1) that gathers all of them in both English and Spanish, which could aid decision makers in favoring bird conservation in urban Mexico.

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