BIRD MIGRANT ASSEMBLAGES IN URBAN AND RURAL AREAS OF CENTRAL ARGENTINA: A REGIONAL-SCALE COMPARISON

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Abstract.– Migrant birds are negatively impacted by urbanization. However, most of the studies about urbanization effects on migrant birds were conducted in the Northern Hemisphere, and studies performed in South America are scarce. This study compares the migrant bird assemblages of urban parks and rural areas of central Argentina. Summer migrant birds were surveyed by standardized point counts in urban parks of six cities. In contrast, rural migrant assemblages were assessed through species lists of the citizen science project eBird in six paired sites. Sample coverage was similar between urban parks and rural areas (0.89 and 0.92, respectively). Migrant species richness was higher in rural than in urban parks. Migrant species composition changed between habitats, and species turnover was the dominant aspect of species dissimilarity. Urban parks had more occurrences of the Glittering-bellied Emerald (*Chlorostilbon lucidus*) and the Tropical Kingbird (*Tyrannus melancholicus*), whereas rural sites had more occurrences of the Vermillion Flycatcher (*Pyrocephalus rubinus*) and the Double-collared Seedeater (*Sporophila caerulescens*). Grasslands present in rural areas may favor the presence of the Vermillion Flycatcher and the Double-collared Seedeater. Therefore, cities are related to significant changes in the migrant bird communities.

Keywords: *avian, agroecosystems, citizen science, green areas, Latin America, urbanization*

Resumen. – ENSAMBLES DE AVES MIGRATORIAS EN ÁREAS URBANAS Y RURALES DEL CENTRO DE ARGENTINA: UNA COMPARACIÓN A ESCALA REGIONAL. Las aves migratorias se ven afectadas negativamente por la urbanización. Sin embargo, la mayoría de los estudios se realizaron en el hemisferio norte y los estudios realizados en Sudamérica son escasos. El objetivo de este estudio es comparar los ensambles de aves migratorias de parques urbanos y áreas rurales del centro de Argentina. Las aves migratorias de verano se muestrearon mediante conteos de puntos estandarizados en parques urbanos de seis ciudades, mientras que las comunidades de aves migratorias rurales se evaluaron a través de listas de especies del proyecto de ciencia ciudadana eBird en seis sitios pareados a las ciudades. La cobertura de muestreo fue similar entre los parques urbanos y las zonas rurales (0.89 y 0.92, respectivamente). La riqueza de especies migratorias fue mayor en los sitios rurales que en los parques urbanos. La composición de especies migratorias cambió entre hábitats, y el recambio de especies fue el aspecto dominante de la disimilitud de especies. Los parques urbanos tuvieron más ocurrencias del Picaflor Común (Chlorostilbon lucidus) y el Surirí Real (Tyrannus melancholicus), mientras que los sitios rurales tuvieron más ocurrencias del Churrinche (Pyrocephalus rubinus) y el Corbatita Común (Sporophila caerulescens). Los pastizales presentes en las zonas rurales pueden favorecer la presencia del Churrinche y el Corbatita Común. Por lo tanto, las ciudades están relacionadas a cambios significativos en las comunidades de aves migradoras.

Palabras clave: *agroecosistemas, América Latina, áreas verdes, aves, ciencia ciudadana, urbanización*

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Urban expansion impacts negatively to bird communities, and especially latitudinal migrant birds, by reducing their diversity and abundance (Park and Lee 2000, Croci et al. 2008, Jokimäki and Kaisanlahti-Jokimäki 2012, Leveau 2021). Bird migrant declines in urban areas has been associated with several factors such as habitat loss and human disturbance in their breeding and wintering areas (Hennings and Edge 2003, MacGregor-Fors et al. 2010), and also with low food availability, and brood parasitism in their breeding areas (Rodewald and Brittingham 2007, Rodewald 2009, Teglhøj 2017). However, among the different habitat types in cities, urban parks may constitute essential habitats for migrant birds during breeding and wintering seasons (Amaya-Espinel and Hostetler 2019, La Sorte et al. 2020, Leveau 2021, Villaseñor and Escobar 2022).

Most of the studies that analyzed the effects of urbanization on migrant birds were conducted in the Northern Hemisphere, where most migrant bird species are associated with forest biomes and generally hunt insects on tree foliage in their breeding grounds (Hennings and Edge 2003, MacGregor-Fors et al.

2010, Zhou and Chu 2012, Zúñiga-Vega et al. 2019). However, the habitat requirements of latitudinal migrants of the Northern Hemisphere can change during their wintering season, using small green areas or wooded sites within suburban areas (Archer et al. 2019).

On the other hand, studies in the Southern Hemisphere are scarce (Conole and Kirkpatrick 2011, Leveau 2013, Amaya-Espinel and Hostetler 2019, de Camargo Barbosa et al. 2020, Villaseñor and Escobar 2022), and migrants of South America that breed in Central Argentina and winter in Northern South America are primarily adapted to open or semi-open habitats and hunt insects on-air and tree foliage in their breeding and non-breeding grounds (Chesser 1994, Stiles 2004, Jahn et al. 2016). Therefore, the role of urban parks in conserving migratory birds can be different between hemispheres. Due to urban parks generally have a semi-open physiognomy, composed of wooded and open lawned areas, summer migrants of South America can be more adapted to these habitats than their North American counterparts.

At the global scale, most studies focused on alpha diversity of migrant birds, such as species richness, along urbanization gradients. However, analyses of migrant species composition along urbanization gradients are scarce. This type of analysis is relevant because, although species richness values can be similar between habitats, species composition can be different (see Parsons et al. 2003, Suarez-Rubio et al. 2011). Moreover, differences in species composition between habitats can be attributed to two components that have seldom been analyzed in migrant birds (Baselga 2010): 1) turnover, which is the replacement of some species by others between habitats; and 2) nestedness, which is the progressive loss of species between habitats.

In central Argentina, during the spring-summer two kind of migrant birds can arrive (Joseph 1997, Table 1): Nearctic-Neotropical Temperate-Tropical (NETT) and South American Temperate-Tropical migrants (SATT). NETT migrants generally breed in the North America and winter in central Argentina, although the Barn Swallow (*Hirundo rustica*) and the Cliff Swallow (*Pretochelidon pyrrhonota*) also breed in the area (Martinez 1983, Salvador et al. 2016). The SATT migrants breed in central Argentina and winter generally in northern South America (Joseph 1997). This study aimed to compare the species composition of summer migrants in urban parks and rural areas of central Argentina. The study was carried out at the regional scale, comparing urban assemblages of six cities versus six paired rural areas. Regional-scale studies about urban bird communities have been scarcely performed (Kark et al. 2007, Croci et al. 2008). Two hypotheses were tested: 1) a significant change in migrant composition between habitats is driven by species nestedness, and 2) a significant change in migrant composition is driven by species turnover.

METHODS

The study was carried out in the Austral Pampas, located in Buenos Aires province, central Argentina (Fig. 1). The landscape is dominated by croplands and livestock grazing with scattered tree plantations. The climate is temperate, with cold winters with a monthly mean value between 7.15 and 8.10 ºC, and warm summers with a monthly mean value between 20.30 and 21.50 ºC (Servicio Meteorológico Nacional). The mean annual precipitation ranges between 901 and 923.6 mm. The altitude of the study area ranges between sea level to 188 masl. The population size of cities ranged between 29 629 and 860 000 inhabitants (Supplementary material, Table S1).

Bird surveys were carried out once in six cities' urban parks and rural areas (Fig. 1), performing a pared comparison of urban and rural sites. The number of parks in each city ranged between 5 and 15, depending on the park availability in each city, and parks were separated from each other by at least 200 m (Supplementary material, Table S1). Park area size ranged between 0.21 and 8.04 ha (mean = 2.19, N = 52) and was distributed along the urban gradient, from the urban center to the city fringe. The habitat of urban parks was generally composed of lawn, shrubs, and trees, and dominated by exotic tree species. Surveys in urban parks were performed by unlimited distance point counts of 5 minutes during the first four hours after dawn. Small parks of less than 2 ha had one point count, whereas larger parks had two or three-point counts separated by 200 m. Surveys were carried out during one visit between October and November 2018 on days without rain or strong winds by LML.

Migrant species of rural areas were obtained through species lists available in eBird (ebird.org). Only terrestrial ecosystems, such as forests, grasslands, or semi-open areas, were considered, whereas

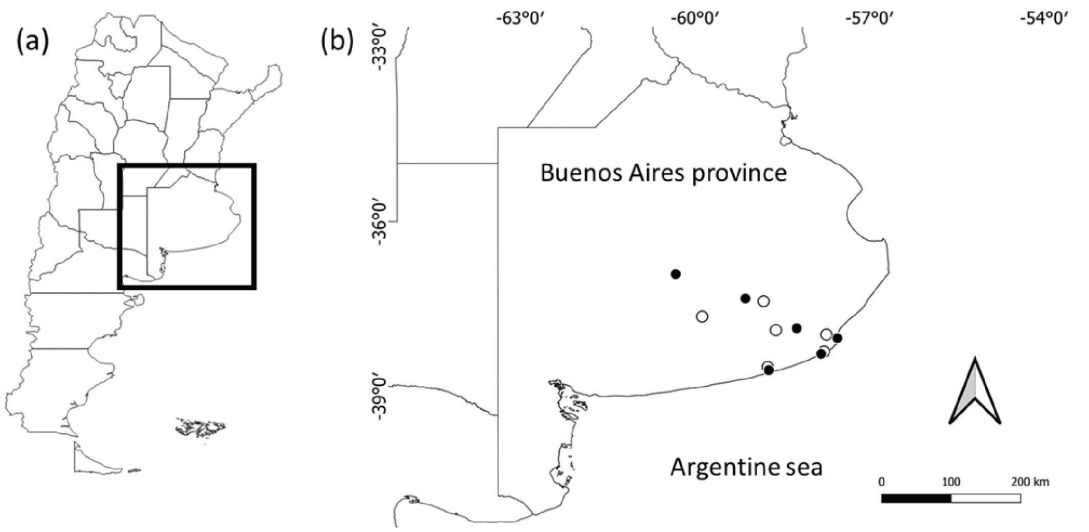

Figure 1. Location of the Buenos Aires province in Argentina (a), and location of the cities (black dots) and rural sites (white dots) in the Buenos Aires Province.

species associated with aquatic ecosystems were discarded. A total of six species lists with presence/absence data were obtained from at least 1 km of each city border, and a maximum distance of 87 km. Most of the lists were located in rural areas composed of crops, cattle grazing, and scattered tree plantations, whereas one list was found in an exurban area with low house densities (6-25 homes/ km^2, Hansen et al. 2005). When possible, species lists made during October and November 2018 were used. However, due to the scarcity of data, lists made during October-December of 2015, 2017, and 2019 were also used. From available lists on eBird, only those with the highest species richness were used. Sampling effort in each list ranged from 1 to 3 hours, with birds being recorded during the first four hours after dawn or during the last four hours before sunset in a traveling mode (Supplementary material, Table S2).

Statistical analysis

The total species richness for urban parks and rural areas was calculated. Due to differences in sampling effort between urban parks and rural areas, the sample coverage of each habitat was calculated using the online software iNEXT (chao.shinyapps.io/iNEXTOnline/). Sample coverage varies between 0 and 1, and it is the proportion of the total number of individuals that belong to the species detected in the sample. Incidence-based curves were calculated using the presence of species in each of the six cities and rural sites through 999 iterations. Then, the sample coverage of each habitat with their 95% confidence intervals (CI) was obtained.

Differences in species composition between habitats were analyzed using a matrix of species presence/absence in cities and rural sites. A presence-based dissimilarity was calculated between sites using the Bray-Curtis index, which varies between 0 (all species shared) and 1 (total dissimilarity). Then, significant differences in species composition between habitats were analyzed with the adonis test in vegan package of R (Oksanen et al. 2017, R Core Team 2017). In addition, a non-metric multidimensional scaling was performed to ordinate the sites and species, using the function metaMDS in vegan (Oksanen et al. 2017). Finally, to calculate the contribution of species turnover and nestedness to the total dissimilarity between sites, the Sørensen index was partitioned using the function beta.multi of the betapart package (Baselga et al. 2018). The Sørensen index of dissimilarity also varies between 0 and 1.

RESULTS

A total of 15 migrant bird species were recorded in urban and rural areas, of which the Fork-tailed Flycatcher (*Tyrannus savana*) and the Barn Swallow (*Hirundo rustica*) were the most common species (Table 1). The Barn Swallow and the Cliff Swallow (*Petrochelidon pyrrhonota*) were Neartic migrants that breed in North America and winter in central Argentina, although some populations of these species also breed in central Argentina (Martinez 1983, Idoeta et al. 2011, Salvador et al. 2016). The rest of species were South American Temperate-Tropical migrants (Joseph 1997).

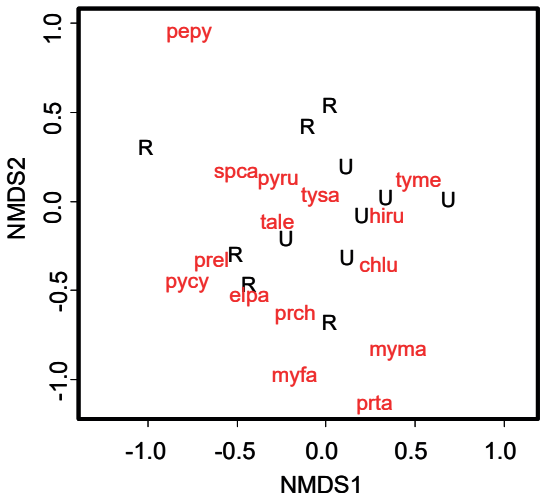

Figure 2. Non-metric multidimensional scaling (Stress = 0.08) showing the ordination of urban (U) and rural (R) sites and species in Buenos Aires province, Argentina. Species names: chlu: Glittering-bellied Emerald (*Chlorostilbon lucidus*), elpa: Small-billed Elaenia (*Elaenia parvirostris*), hiru: Barn Swallow (*Hirundo rustica*), myfa: Bran-colored Flycatcher (*Myiophobus fasciatus*), myma: Northern Streaked Flycatcher (*Myiodinastes maculatus*), pepy: Cliff Swallow (*Petrochelidon pyrrhonota*), prch: Grey-Breasted Martin (*Progne chalybea*), prel: Southern Martin (*Progne elegans*), prta: Brown-chested Martin (*Progne tapera*), pycy: Blue-and-white Swallow (*Pygochelidon cyanoleuca*), pyru: Vermillion Flycatcher (*Pyrocephalus rubinus*), tale: White-rumped Swallow (*Tachycineta leucorrhoa*), tyme: Tropical Kingbird (*Tyrannus melancholicus*), spca: Double-collared Seedeater (*Sporophila caerulescens*).

Migrant species richness was higher in rural than in urban parks (15 versus 10 species, Table 1). Sample coverage was slightly higher in rural (0.92, CI=0.84-1.00) than in urban parks (0.89, CI = 0.80, 0.97). On the other hand, species composition changed between habitats (Table 2), and the partition of the Sørensen dissimilarity index showed that the component of turnover was higher than the component of nestedness (0.59 versus 0.16). The occurrence of the Glittering-bellied Emerald (*Chlorostilbon lucidus*), the Tropical Kingbird (*Tyrannus melancholicus*) was associated to urban parks (Fig. 2), whereas the occurrence of the Vermillion Flycatcher (*Pyrocephalus rubinus*) and the Double-collared Seedeater (*Sporophila caerulescens*) was associated to rural areas.

DISCUSSION

The results obtained showed that, at the regional scale the species richness of migrant birds was lower in urban parks than in rural areas. In addition, the species composition changed between habitats, showing a dominant pattern of species turnover between urban and rural habitats.

The lower migrant species richness in urban parks than in rural areas obtained in this study agree with several studies conducted in the Northern Hemisphere (Butler 2003, Hennings and Edge 2003, Stratford and Robinson 2005, Mason et al. 2007, Loss et al. 2009, Minor and Urban 2010, MacGregor-Fors et al. 2010, Jokimäki and Kaisanlahti-Jokimäki 2012). Several factors such as different vegetation structure and the scarcity of food resources may influence the lower species richness of migrant birds in urban areas (Stratford and Robinson 2005, Teglhøj 2017). In addition, the urban heat island phenomenon may induce and advance green vegetation growth and insect abundance along the year (Leveau 2018), causing a mismatch of resources availability and migrant arrivals to urban areas (Tryjanowski et al. 2013). This mismatch between resources availability and migrant arrivals could affect them negatively.

The composition of migrant species differed between urban parks and rural areas. Urban parks had more occurrences of the Glittering-bellied Emerald, the Tropical Kingbird. The Glittering-bellied Emerald could be favored in urban areas due to the diversity of flowering plants and its plasticity to nest in trees and man-made structures (Povedano and Maugeri 2020). On the other hand, the Tropical Kingbird usually hunt on aerial insects from the canopy, and its plasticity for foraging and use of nesting trees probably allows them to inhabit urban parks (Martins-Oliveira et al. 2012, Daros et al. 2018). Moreover, the higher tree cover in urban areas than in rural areas (Leveau 2013) provide to the Tropical Kingbird of places for foraging and nesting. Some species, such as the Vermillion Flycatcher and the Double-collared Seedeater were more common in rural areas. The Vermillion Flycatcher is an aerial forager of insects, which have a more specialized nesting behavior than the Tropical Kingbird. Unlike the Tropical Kingbird, the Vermillion Flycatcher uses lichen and moss to construct their nest (Narosky and Salvador 1998), and these materials could be in low availability in urban areas due to they are associated to old trees. The Vermillion Flycatchers nest at a lower height than more urban Fork-tailed Flycatcher (Mezquida 2002, Rebollo et al. 2020), and this could be related to more nest predation in the Vermillion Flycatcher. In addition, the Vermillion Flycatcher hunts aerial insects near the ground over natural herbaceous vegetation (Fitzpatrick 1980). This type of vegetation is scarce in urban parks due to vegetation is heavily managed and dominated by exotic lawn. Lawn has a lower insect abundance than unmanaged vegetation (Unterweger et al. 2017), and this could affect negatively the occurrence of the Vermillion Flycatcher in urban parks.

Tabla 1. List of species observed in urban parks and rural sites of Buenos Aires province, Argentina. Numbers are total species occurrences in cities (N =6) and rural sites (N = 6). NETT: Nearctic-Neotropical Temperate-Tropical migrant; SATT: South American Tropical-Temperate migrants (Joseph 1997).

Common name	Scientific name	Migrant type	Urban	Rural
Glittering-bellied Emerald	*Chlorostilbon lucidus*	SATT	5	3
Small-billed Elaenia	*Elaenia parvirostris*	SATT	1	1
Bran-colored Flycatcher	*Myiophobus fasciatus*	SATT	0	2
Vermillion Flycatcher	*Pyrocephalus rubinus*	SATT	1	4
Tropical Kingbird	*Tyrannus melancholicus*	SATT	6	3
Fork-tailed Flycatcher	*Tyrannus savana*	SATT	5	6
Northern Streaked Flycatcher	*Myiodinastes maculatus*	SATT	1	1
Blue-and-white Swallow	*Pygochelidon cyanoleuca*	SATT	0	1
Brown-chested Martin	*Progne tapera*	SATT	0	1
Southern Martin	*Progne elegans*	SATT	1	4
Grey-Breasted Martin	*Progne chalybea*	SATT	2	3
Barn Swallow	*Hirundo rustica*	NETT	6	5
Cliff Swallow	*Petrochelidon pyrrhonota*	NETT	0	2
White-rumped Swallow	*Tachycineta leucorrhoa*	SATT	4	3
Double-collared Seedeater	*Sporophila caerulescens*	SATT	0	3

The Double-collared Seedeater is a granivorous species that nest at low height and place its nest in herbaceous vegetation (de la Peña 2019). As said previously, this type of vegetation is scarce in urban parks. On the other hand, due to the Double-collared Seedeater is a ground nesting species, could be negatively affected by nest predation in urban parks (Jokimäki and Huhta 2000).

Vacant lands are a type of urban habitat that contains non-managed herbaceous vegetation, which could help the conservation of the Vermilion Flycatcher and the Double-collared Seedeater in cities. For example, Villaseñor et al. (2020) found that vacant lands in Santiago de Chile harbored several grassland birds, such as the Grassland-yellow Finch (*Sicalis luteola*) and the Correndera Pipit (*Anthus correndera*), which were absent or scarce in urban parks.

Differences in methodology of bird surveys between urban parks and rural sites could influence the results obtained. For example, the point count may detect less migrant species than the transect survey (travelling method) of eBrid counts (DeGraaf et al. 1991). However, a recent study found that the survey-method did not affect the detection of migrant species (Leveau 2021). On the other hand, eBird counts proved to be successful detecting most of the regular summer migrants in the study area (Narosky and Di Giacomo 1993, López-Lanús 2020). Of a total of 18 species of summer migrants recorded in southern Buenos Aires province, only the Swainson´s Hawk (*Buteo swainsoni*), the Dark-billed Cuckoo (*Coccyzus melacoryphus*) and the Sand Martin (*Riparia riparia*), which are scarce summer visitors in the study area, were not detected in the eBird lists used in this study.

Table 2. Results of the Adonis test showing differences in migrant species composition between urban parks and rural sites in Buenos Aires province, Argentina. Df: degrees of freedom.

	Df	F	R^2	P
Habitat	1	3.478	0.258	0.013
Residuals	10		0.742	
Total	11		1.000	

Due to differences in methodology and sampling effort between habitats, more research is needed to analyze the effects of urbanization on migrant bird assemblages in central Argentina. The continuing support to citizen science projects such as eBird may promote increasing data availability for both urban and rural areas, thus favoring new research projects about migrant assemblages and urbanization.

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