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Urban Parrots in Southern South America: Challenges and Opportunities

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Simple Summary: Many species of parrots manage to adapt and survive in cities; nevertheless, the interactions between them and human-made environments are still poorly studied and systematized, especially in the Neotropics. We conducted a survey among specialists and other key informants to complete a comprehensive review of the presence, importance, and main challenges of parrots in cities of different sizes in the Southern Cone of South America. We found that parrots that inhabit cities in the region represent a very important fraction of the total species, with percentages ranging from 67% to 90% of the total number of species cited for each territory evaluated. Seventy-five percent of the species reported are native to the study area, including many endangered species. The rest comes from other regions of South America or other continents. The cities can be important components for the conservation of parrots and other groups of birds, both from the opportunities to promote their public appreciation and from the effective protection of their populations. However, coexistence challenges remain to be resolved.

Abstract: Data on the interactions between the order Psittaciformes and the anthropogenic environment are still insufficient and have not been systematized, especially in the Neotropical region. As a consequence of this coexistence, the volume of accumulated knowledge is probably significantly greater than the formal scientific contributions on the subject. In this survey, information was compiled on the wild parrots inhabiting cities in the Southern Cone of South America, based on surveys with key informants. The results obtained highlighted the presence of a large number of parrot species that form part of the urban avifauna of the region, between 67% and 90% of the total number of species of the order cited for each territory evaluated. The greatest species richness and the number of breeding species were associated with the large cities located in middle and low latitudes. We confirmed breeding within the cities for more than 40% of the species mentioned. Seventy-five percent of the species reported are native to the study area, the rest originating from other regions of South America or other continents. A quarter of the reported species are considered threatened and almost 50% have declining populations. Urban parrots represent a challenge in the search for urban models compatible with biodiversity conservation, and in the designing of innovative conservation strategies that respond to the new challenges posed by a constantly growing human population.

Keywords: anthropogenic environment; neotropics; psittacidae; urban ecology

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1. Introduction

Urbanization is one of the most intense and fastest growing components of the anthropogenic modification of natural environments. Cities are habitats adapted to human needs and their unplanned development has a significant impact on bird diversity. For many species, urbanization represents the permanent loss of suitable environments for their populations, while others that manage to inhabit urban environments must contend with

challenges, such as traffic, pollution, noise, exotic vegetation, and collisions with urban infrastructure [1–4]. Some species even thrive successfully within city limits, to the point of eventually becoming more abundant than in rural settings and even in environments that may be considered natural [5–7].

It has been proposed that urban centers provide an abundant and constant source of food and this would be one of the keys to adaptation. While some bird species feed directly on resources provided by city dwellers [8], others find trophic resources mainly in the vegetation of parks and gardens [9,10]. On the other hand, the relationship with urban predators may not be so clear, as cities could act as refuges that minimize the risk of predation [11,12], but they also include highly efficient and abundant predators, such as domestic cats and rats, which especially attack the nests of some species [13–15].

From this perspective, urban areas provide a habitat with challenges and opportunities for wild birds [16]. Some species populate cities within the areas they historically occupied [17,18], while others, known as "neonatives", expand their geographic range from adjacent, more or less nearby areas, and establish new populations in anthropogenic environments, including cities [19], and finally, some birds are intentionally introduced into urban environments, especially in association with the pet trade. Among the latter are species native to the ecoregion in which the city is located, and others from the same country or even from other continents [20–22]. The balance between "winners" and "losers", including native and introduced birds, determines the eventual importance of cities from the perspective of biodiversity conservation [23]. In addition, the role of urban birds is a direct and immediate link between billions of people and biodiversity, creating an enormous opportunity for environmental awareness and education [24–26].

The order Psittaciformes (parrots and allies) includes 398 species naturally distributed across several continents, mainly covering tropical and subtropical regions of Oceania, South Asia, sub-Saharan Africa, South and Central America and the Caribbean [27], where they occupy diverse ecosystems, from tropical rainforests and temperate forests, to grasslands, savannahs and deserts [28]. They are among the non-passerine bird orders with the highest number of species at risk of extinction [29], particularly in the Neotropics, where 31% of the species in this group are considered threatened [30]. There are different causes contributing to the decline of their populations, including wildlife trade, habitat loss and degradation, and persecution [31–34]. Parrots have managed to adapt and survive in cities, where they often replicate their wild habits. At the same time, their contact with these modified habitats is becoming more intense, more frequent and more widespread [35,36]. Although for [37] this group is underrepresented in anthropogenic environments, this global pattern does not seem to be repeated in the Southern Cone of South America, where the presence of psittacines in cities is frequently cited [5,38–41]. The situation described above results in a scenario of particular interest in this region where the Psittaciformes seem to be both one of the bird groups most affected by human activities and a taxon particularly prone to settle in urban areas.

The benefits and challenges associated with the establishment of native and exotic Psittaciformes in cities have been little studied in this region [42]. Except for a small set of psittacines whose presence in urban environments is perceived as particularly conflicting, such as the monk parakeet *Myiopsitta monachus* [43–47], knowledge about the interactions between psittacines and the anthropogenic environment is still insufficient and has not been systematized, particularly in the Neotropical region. This is despite the fact that urban centers are the everyday territory shared by these birds and the vast majority of those of us who study them. As a consequence of this coexistence, the volume of accumulated knowledge is surely significant, despite the scarcity of formal scientific contributions in this regard. This poses new, nontraditional scenarios in which the continuity of wild populations is defined, the study of which is increasingly necessary.

This study aims to collect information on wild Psittaciformes inhabiting cities of different sizes in the Southern Cone of South America, based on consultations with key informants. In addition, it aims to assess ecological and socio-cultural aspects that help

qualify the role of urban environments as possible components of a conservation strategy for declining species, as well as their role in the introduction of birds potentially detrimental to regional biodiversity.

2. Materials and Methods

2.1. Study Area

This survey covers urban centers in Argentina (Ar), Chile (Ch), Paraguay (Py), and Uruguay (Uy), and the state of Rio Grande do Sul in Brazil (RS). The area studied corresponds to the Southern Cone of South America and extends over some 4,417,454 km^2 between 19°17′40″ S and 59°58′29″ S, and from 75°37′18″ W to 49°42′22″ W, excluding the Antarctic territory. The region is inhabited by more than 70 million people and comprises a remarkable diversity of biomes including the Atlantic forest, pampas, grassland, savannah, desert, scrub, forests, steppe, Chaco, Cerrado and the mountain range [48]. The climates are diverse and range from tropical to subtropical in Paraguay and northern Argentina, arid in the Atacama Desert, cold in southern Patagonia and polar in the higher altitudes of the Andes, with a predominance of temperate climates in most of Argentina, Uruguay, and Rio Grande do Sul. Climate extremes, with floods and droughts caused by excessive or insufficient rainfall, are frequent in much of this territory [49].

2.2. Data Sources

First, a register of potential data providers was compiled, which included ornithologists and other research workers in universities and scientific bodies related to the study of birds, such as birdwatchers, park rangers, authorities, and technicians from protected areas, staff of public environmental and environmental education agencies at the national, provincial/regional/state and municipal levels, authorities and technicians from natural science museums, and administrators of websites dedicated to the dissemination and conservation of wild birds, among others. The survey was designed and distributed using the Google Forms tool. The surveys were written in Spanish for AR, CH, PY and UY, and in Portuguese for RS. Each version included a complete list of native and exotic parrots cited for the corresponding country, or state in the case of RS, and each species was presented with its common and scientific names and an image to facilitate its recognition [50–54]. The list included 27 species for AR, eight for CH, 20 for PY, seven for UY and 18 for RS. The link to the form for each jurisdiction was distributed by email and the *Facebook* social network to 3314 individual and institutional contacts, 1533 in AR, 535 in CH, 417 in PY, 261 in UY and 568 in RS.

Data providers were asked to complete one form per city, including all the wild parrot species known to occur there, and to complete more than one survey if they had information for more than one city. They were asked to include only those species that they considered to be urban residents, and to mention separately those that were occasional or doubtful observations. In addition to the personal details of the information provider, each questionnaire asked about the environments used by each species, the urban and food resources used, the possible breeding events in the urban environment, the nesting substrates used, and the possible relationship between the presence of the species and the pet trade. In addition, there was also a space to include species that might be missing from the original list. The survey contained twenty questions for each species reported in each city. The forms included short answer questions, long answer questions, multiple choice, check boxes and grids with several options (Supplementary Information, S1).

The urban centers of the different countries and RS were grouped into seven categories according to the number of inhabitants: (1) cities with more than 1,000,000 inhabitants, (2) between 500,000 and 1,000,000 inhabitants, (3) between 100,000 and 500,000 inhabitants, (4) between 50,000 and 100,000 inhabitants, (5) between 10,000 and 50,000 inhabitants, (6) between 5000 and 10,000 inhabitants, and (7) less than 5000 inhabitants (Figure 1). The number of inhabitants for each city was obtained from different sources: [55] for Ar, [56] for Ch, [57] for Py, [58] for Uy, and [59] for RS (Supplementary Information, Table S1).

The information from different localities and neighborhoods in the metropolitan area of Buenos Aires (AMBA) and the Autonomous City of Buenos Aires (CABA) was grouped as corresponding to the same urban nucleus, given their territorial continuity, and the same was done for the responses obtained from the different localities in the metropolitan region of Santiago de Chile. Thereafter, to simplify, we will call large cities, categories 1 and 2, medium-sized cities, categories 3, 4 and 5, and small cities, categories 6 and 7.

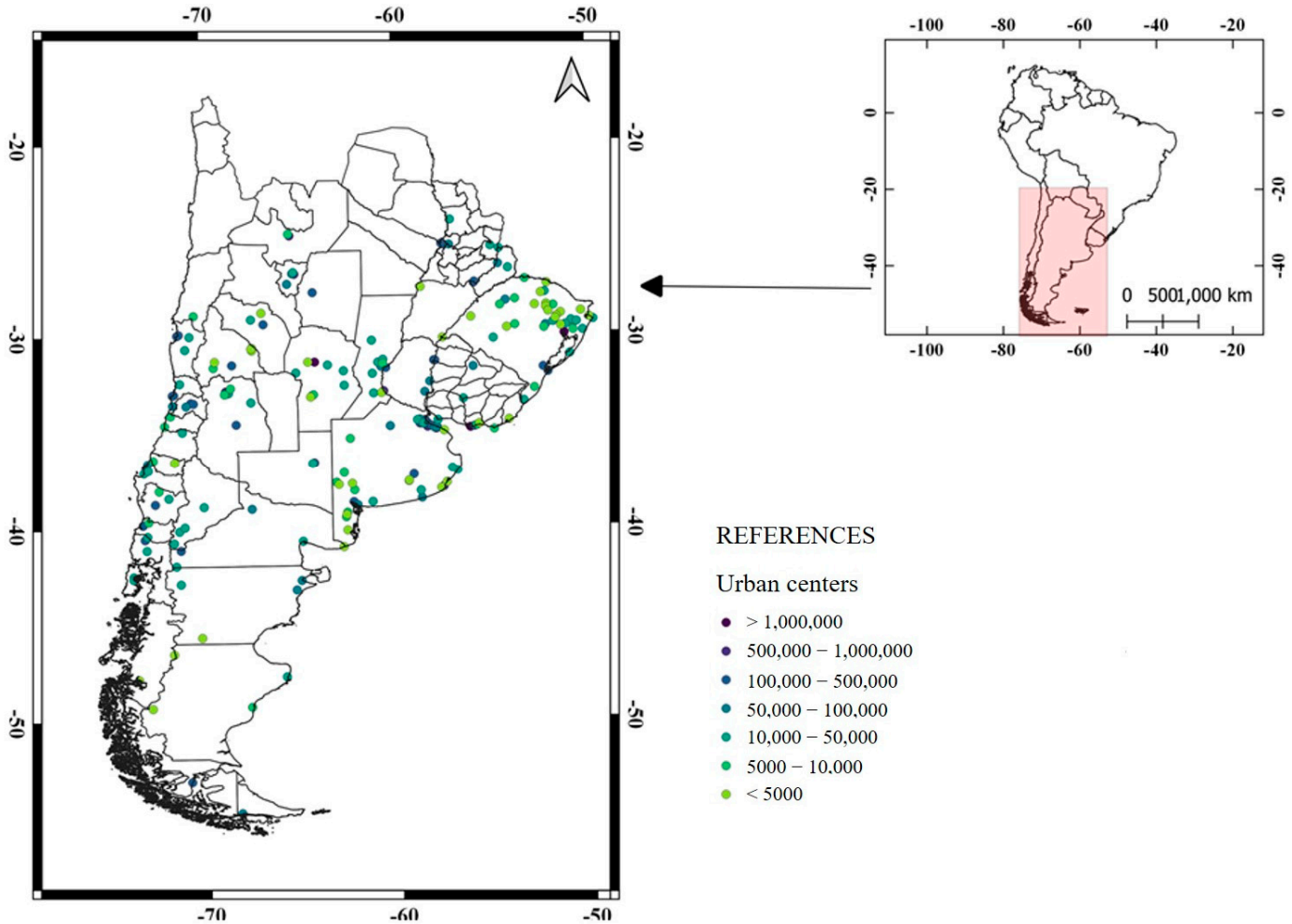


Figure 1. Cities represented in responses to the online survey on the presence of parrots in urban environments in the Southern Cone of South America. The colored dots represent cities in different size ranges according to their number of inhabitants.

2.3. Statistical Analyses

Because the variables follow a Poisson distribution, we used a generalized linear model (GLM, *glm* function from the *lme4* package of R [60]) to assess the possible relationship between parrot species richness and the latitude of each urban center by defining three categories in decimal degrees, and H = −54−−40 (high latitude); M = −40−−30 (middle latitude); and L = −30−−24 (low latitude). GLM was also used to analyze the size of cities (seven categories) and the number of species reported, and the number of reproductive species using the same range of latitudes and categories described above.

The parrot species were classified as native to the study area (Ar-Ch-Py-Uy-RS), as native to another region of South America outside the study area, or as extracontinental. Within the first category, the psittacine species were subdivided into the following: species present in cities within their natural range, species inhabiting urban centers in the study area but outside their natural range, and species whose records were associated with both

situations. The natural range of each species was obtained from the geographical range maps provided by the IUCN. Likewise, most of the species cited were assessed in terms of the conservation category assigned by the [54], except for three particular cases, *Phyrrura molinae* and *Phyrrura frontalis*, in which the [61] was used, and for *Cyanoliseus patagonus bloxami*, in which case the category assigned by Chile was used [62]. *Agapornis* sp. was not included in this analysis as it was only identified to the genus level, while the hybrid *Ara ararauna* x *Ara chloropterus*, or Harlequin Macaw, was excluded as it was not included in the conservation status assessment systems.

Contingency tables [63] were used to assess the possible relationship between the frequency of conflicts associated with the parrots and the size of the cities. Similarly, the association between species and different urban environments was assessed. For this analysis, in the city size categories with more than 50,000 inhabitants, observations of parrots were grouped into urban environments dominated by tall buildings, in suburban environments dominated by houses or low buildings, and in public parks and walkways. For cities with fewer inhabitants and few or no tall buildings, only areas dominated by houses or low buildings and public parks and walkways were considered.

3. Results

The total number of responses received (n = 369) barely exceeded 10% of the surveys distributed to people. A total of 213 responses were received from 196 informants in AR, 59 responses from 54 informants in CH, 18 responses from 18 informants in PY, 28 responses from 27 data providers in UY, and 51 responses from 49 informants in RS. The responses provided information from 187 cities, covering between 29 and 81% of the administrative units in each jurisdiction (provinces in Ar, regions in Ch, departments in the case of Py and Uy, and micro-regions in RS (Table 1). Information was obtained for the full range of city sizes considered (Table 2, Figure 1).

Table 1. Number of responses received, and representativeness of the data provided in the online survey on the presence of parrots in urban environments in the Southern Cone of South America.

Country/State	Informants Consulted	Response Rate (%)	Cities	Provinces/Regions/ Departments Represented (%)
Argentina	1533	12.78	97	78.26
Chile	535	10.09	33	87.5
Paraguay	417	4.31	7	29.41
Uruguay	261	10.34	10	42.10
Rio Grande do Sul	568	8.62	40	62.85

Table 2. Number of responses received to the online survey on the presence of parrots in urban environments, and number of cities represented (in brackets), for urban centers of different size in countries of the Southern Cone of South America.

	City Size (Inhabitants) and Country							
Country/State	>1,000,000	500,000–1,000,000	100,000–500,000	50,000–100,000	10,000–50,000	5000–10,000	<5000	Total
Argentina	53 (2)	17 (5)	49 (15)	18 (12)	41 (29)	13 (13)	22 (21)	213 (97)
Chile	16 (1)	0	20 (9)	2 (2)	11 (11)	6 (6)	4 (4)	59 (33)
Paraguay	0	11 (1)	4 (3)	1 (1)	2 (2)	0	0	18 (7)
Uruguay	18 (1)	0	3 (2)	1 (1)	2 (2)	2 (2)	2 (2)	28 (10)
RS	9 (1)	0	4 (2)	3 (3)	11 (11)	9 (8)	15 (15)	51 (40)
Total	69 (5)	35 (8)	91 (40)	31 (25)	70 (57)	30 (29)	43 (42)	369 (206)

3.1. Species Distribution and Richness

The respondents provided information on a total of 35 parrot species observed in urban environments, of which 27 (77.14%) are native to the study area (Ar, Ch, Py, Uy, RS), four (11.43%) correspond to species native to regions of South America outside the study area, and four (11.43%) to species native to other continents. From the 27 species native to

the study area, five (18.52%) correspond to species observed only in cities that overlap with their natural ranges, five (18.52%) to species reported in cities in the study area but outside their historical ranges, and 17 (62.96%) to species found in both situations.

Thirty-five species (87.5%) out of the total of 40 parrots included in the survey for the entire study area were reported in urban environments of different size in one or more of the countries studied. Data for the Argentine Republic indicated a total of 25 psittacine species in urban areas (89.3% of the total number of parrot species known for the country). In Chile, the responses indicated a total of eight urban species (80%), 16 in Paraguay (67%), nine in Uruguay (90%), and 13 in Rio Grande do Sul (68%). *Amazona aestiva* and *M. monachus* were the most widely occurring species, cited in cities in all four countries and in RS (Table 3).

Table 3. Parrot species reported inhabiting urban environments in the Southern Cone of South America (Argentina Ar, Chile Ch, Paraguay Py, Uruguay Uy, and Rio Grande do Sul RS, State in Brazil). The number of responses received for each species is indicated and, in brackets, the total number of cities for which they are mentioned.

Species	Ar	Ch	Py	Uy	RS
Agapornis sp.	5 (3)	1 (1)	0	0	0
Amazona aestiva	38 (17)	1 (1)	15 (5)	4 (3)	15 (8)
Amazona brasiliensis	0	0	0	0	2 (2)
Amazona pretrei	1 (1)	0	0	0	8 (8)
Amazona tucumana	2 (2)	0	0	0	0
Amazona vinacea	1 (1)	0	0	0	2 (2)
Anodorhynchus hyacinthinus	0	0	5 (1)	0	0
Ara ararauna	0	0	5 (2)	0	0
Ara ararauna x Ara chloropterus	0	0	3 (1)	0	0
Ara chloropterus	1 (1)	0	11 (2)	0	0
Ara glaucogularis	0	0	2 (1)	0	0
Aratinga nenday	19 (2)	0	12 (5)	5 (1)	0
Brotogeris chiriri	30 (4)	0	9 (3)	7 (1)	9 (3)
Brotogeris tirica	0	0	0	0	9 (9)
Brotogeris versicolurus	2 (2)	0	1 (1)	0	0
Cyanoliseus patagonus bloxami	0	6 (6)	0	0	0
Cyanoliseus patagonus	71 (39)	0	0	1 (1)	0
Enicognathus ferrugineus	22 (7)	17 (11)	0	0	0
Enicognathus leptorhynchus	0	19 (11)	0	0	0
Eupsittula aurea	1 (1)	0	1 (1)	0	1 (1)
Forpus xanthopterygius	2 (2)	0	7 (4)	0	0
Melopsittacus undulatus	8 (6)	4 (2)	2 (2)	4 (3)	0
Myiopsitta monachus	170 (79)	21 (8)	12 (5)	27 (10)	44 (33)
Nymphicus hollandicus	6 (3)	0	0	0	0
Phyrrura frontalis	15 (3)	0	0	0	10 (8)
Phyrrura molinae	2 (1)	0	0	0	0
Platycercus eximius	0	1 (1)	0	0	0
Pionopsitta pileata	2 (2)	0	0	0	1 (1)
Pionus maximiliani	14 (7)	0	4 (2)	0	7 (7)
Primolius maracana	1 (1)	0	0	0	0
Psilopsiagon aymara	9 (8)	0	0	0	0
Thectocercus acuticaudatus	32 (21)	0	3 (2)	1 (1)	0
Psittacara leucophthalmus	30 (8)	0	3 (2)	1 (1)	1 (1)
Psittacara mitratus	7 (4)	0	0	2 (2)	0
Triclaria malachitacea	0	0	0	0	3 (3)
Total richness for each country	25	8	16	9	13

The three parrot species cited for Argentina that were not reported in urban areas are *Ara militaris*, *Primolius auricollis* and *Psilopsiagon aurifrons*, all native to the north and west of the country, and *Psilopsiagon aurifrons* cited for Chile was not found in the cities surveyed. *Amazona pretrei*, *Amazona vinacea*, *Phyrrhura devillei*, *P. frontalis*, *Pionopsitta pileata*, *Primolius*

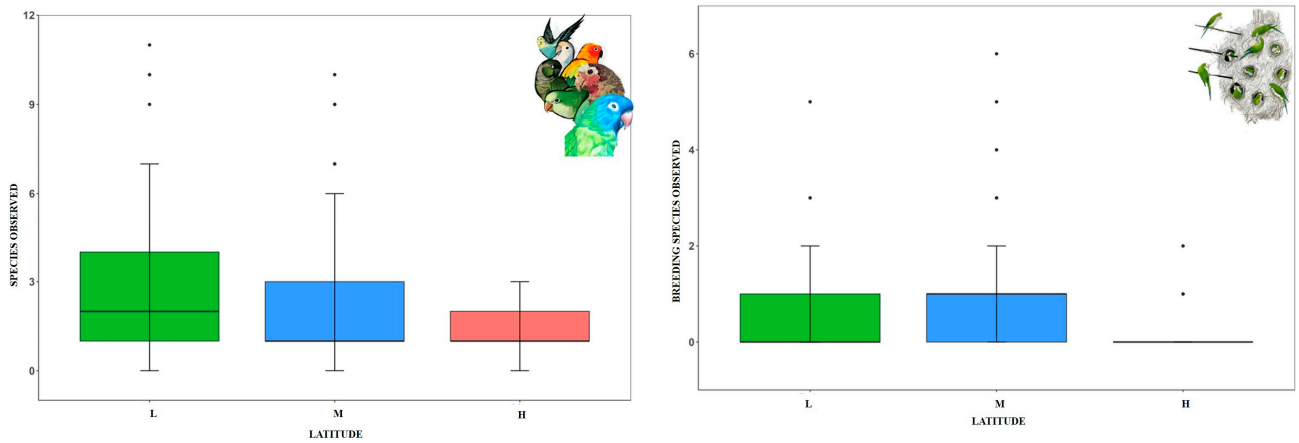
auricollis and *Primolius maracana* cited for Paraguay did not occur in urban environments, while *P. frontalis*, a native species cited for Uruguay, was not reported in urban areas either. Finally, two species cited for the State of Rio Grande do Sul: *Forpus xanthopterygius* and *Primolius maracana* were not observed in cities.

A total of 29 parrot species were reported for the largest cities (categories 1 and 2), 30 species were mentioned for medium-sized cities (categories 3, 4 and 5), and 17 species were reported for the smallest cities (categories 6 and 7). Five species were present in cities across the whole range of sizes. Three species were reported in six of the seven categories defined for the survey, and five in five of the categories. *Ara chloropterus* and *P. molinae* were found only in large cities (four cities in two countries), while *Brotogeris tirica* was only recorded in the smallest cities (nine cities, all in RS; Table 4).

Table 4. Parrot species reported for urban centers of different size in Argentina (Ar), Chile (Ch), Paraguay (Py), Uruguay (Uy) and the State of Rio Grande do Sul in Brazil (RS). Numbers represent the number of cities for which the species is mentioned and, in brackets, the number of countries.

Species	City Size (Inhabitants) and Country						
	>1,000,000 Ar-Ch-Uy-RS	500,000–1,000,000 Ar-Py	100,000–500,000 Ar-Ch-Py-Uy-RS	50,000–100,000 Ar-Ch-Py-Uy-RS	10,000–50,000 Ar-Ch-Py-Uy-RS	5000–10,000 Ar-Ch-Uy-RS	<5000 Ar-Ch-Uy-RS
Amazona aestiva	5 (4)	5 (2)	6 (3)	4 (3)	5 (2)	4 (3)	5 (2)
Cyanoliseus patagonus	1 (1)	1 (1)	4 (1)	5 (1)	10 (2)	6 (1)	13 (1)
Myiopsitta monachus	5 (4)	5 (2)	21 (5)	14 (4)	34 (4)	22 (3)	29 (3)
Pionus maximiliani	1 (1)	3 (2)	1 (1)	3 (2)	5 (2)	1 (1)	2 (1)
Psittacara acuticaudatus	2 (1)	2 (2)	5 (3)	1 (1)	3 (1)	4 (1)	7 (1)
Enicognathus ferrugineus	1 (1)	0	5 (2)	1 (1)	5 (2)	3 (2)	3 (2)
Phyrrura frontalis	2 (2)	0	1 (1)	2 (1)	3 (2)	1 (1)	2 (1)
Psittacara leucophthalmus	1 (1)	1 (1)	1 (1)	2 (2)	4 (1)	0	1 (1)
Brotogeris chiriri	3 (3)	2 (2)	2 (1)	0	2 (1)	2 (1)	0
Enicognathus leptorhynchus	1 (1)	0	3 (1)	1 (1)	3 (1)	3 (1)	0
Aratinga nenday	2 (2)	1 (1)	3 (2)	1 (1)	1 (1)	0	0
Melopsittacus undulatus	4 (3)	2 (2)	4 (3)	1 (1)	2 (2)	0	0
Amazona pretrei	1 (1)	0	0	3 (1)	2 (2)	1 (1)	2 (1)
Ara chloropterus	1 (1)	1 (1)	1 (1)	0	0	0	0
Phyrrura molinae	1 (1)	0	0	0	0	0	0
Brotogeris tirica	0	0	0	0	1 (1)	4 (1)	4 (1)
Amazona brasiliensis	0	0	0	1 (1)	0	1 (1)	0
Amazona tucumana	0	0	0	1 (1)	1 (1)	0	0
Amazona vinacea	0	0	0	1 (1)	2 (2)	0	0
Anodorhynchus hyacinthinus	0	1 (1)	0	0	0	0	0
Brotogeris versicolurus	1 (1)	0	0	0	0	0	1 (1)
Cyanoliseus patagonus bloxami	1 (1)	0	1 (1)	0	3 (1)	1 (1)	0
Eupsittula aurea	0	1 (1)	0	0	1 (1)	1 (1)	0
Forpus xanthopterygius	0	1 (1)	4 (2)	0	1 (1)	0	0
Pionopsitta pileata	1 (1)	0	0	0	2 (2)	0	0
Primolius maracana	0	0	0	0	1 (1)	0	0
Psilopsiagon aymara	0	1 (1)	1 (1)	0	0	1 (1)	5 (1)
Psittacara mitratus	1 (1)	2 (1)	1 (1)	1 (1)	1 (1)	0	0
Triclaria malachitacea	1 (1)	0	0	1 (1)	1 (1)	0	0
Nymphicus hollandicus	1 (1)	0	1 (1)	1 (1)	0	0	0
Agapornis sp.	1 (1)	0	0	2 (2)	1 (1)	0	0
Ara ararauna	0	1 (1)	1 (1)	0	0	0	0
Platycercus eximius	0	0	1 (1)	0	0	0	0
Ara glaucogularis	0	1 (1)	0	0	0	0	0
Ara chloropterus x *Ara ararauna*	0	1 (1)	0	0	0	0	0
Accumulated richness	22	18	20	19	24	15	12

The number of parrot species for the same city ranged from 0 to 11. The maximum values were found in the middle and low latitudes, where 11 species were found in Asunción and ten species in CABA, Fernando de La Mora and Puerto Iguazú. Statistical differences were found between the latitude of each of the cities and the number of species reported in them. The high latitudes were associated with smaller numbers of species compared to the medium and low latitudes (Figure 2a; $p << 0.01$). The number of parrot species is significantly greater in large cities (1 and 2) than in medium and small cities (3, 4, 5, 6 and 7; Table 5). Significance estimates are described in below.



(**a**) (**b**)

Figure 2. Species richness of parrot species (**a**) and breeding psittacines (**b**) in the three latitudinal ranges defined for the study area: H (54° to 40° S), M (40° to 30° S), and L (30° to 24° S). Each box summarizes the information of the total responses received. Maximum and minimum values and quartiles (first, median, and third) are shown. The black horizontal line inside the box represents the median.

Table 5. Comparison of parrot species richness among cities with different numbers of inhabitants in the Southern Cone of South America.

	City Size (Inhabitants)					
	>1,000,000	**500,000–1,000,000**	**100,000–500,000**	**50,000–100,000**	**10,000–50,000**	**5000–10,000**
500,000–1,000,000	z = 1.813 $p = 0.06976$					
100,000–500,000	z = −4.421 $p = 9.84 \times 10^{-6}$	z = −5.120 $p = 3.06 \times 10^{-7}$				
50,000–100,000	z = −1.520 $p = 0.12846$	z = −2.609 $p = 0.009088$	z = 1.497 $p = 0.135$			
10,000–50,000	z = −4.056 $p = 4.98 \times 10^{-5}$	z = −4.840 $p = 1.3 \times 10^{-6}$	z = 0.112 $p = 0.911$	z = −1.374 $p = 0.16950$		
5000–10,000	z = −2.821 $p = 0.00479$	z = −3.739 $p = 0.000185$	z = 0.219 $p = 0.826$	z = −1.048 $p = 0.29446$	z = 0.130 $p = 0.897$	
<5000	z = −2.824 $p = 0.00475$	z = −3.815 $p = 0.000136$	z = 0.813 $p = 0.416$	z = −1.048 $p = 0.416$	z = 0.688 $p = 0.491$	z = 0.434 $p = 0.665$

3.2. Breeding Species of Parrot

Fifteen parrot species were reported nesting in urban areas: 12 in Ar, two in Ch, five in Py, one in Uy and seven in RS. The surveys highlight *A. aestiva*, *A. nenday*, *B. chiriri*, *C. patagonus* and *M. monachus* among the species with the most observations of nesting events in urban areas. *M. monachus* was the only species reported nesting in urban centers throughout the study area and in the entire size range considered (Supplementary Information, Table S2). The number of species reported breeding per city in the whole region varied between zero and six. The maximum values were found in the middle and low latitudes, where six species were found in CABA and five species in Asunción. Statistical differences were found between the latitude of each of the cities and the number of species reported in them. The high latitudes were associated with smaller numbers of species compared to the medium and low latitudes (Figure 2b; $p < 0.05$). The number of parrot species breeding is significantly greater in big cities (1 and 2) than in medium and small cities (3, 4, 5, 6 and 7; Table 6). Significance estimates are described below.

Table 6. Comparison of parrot breeding species richness among cities with different numbers of inhabitants in the Southern Cone of South America.

	City Size (Inhabitants)					
	>1,000,000	**500,000–1,000,000**	**100,000–500,000**	**50,000–100,000**	**10,000–50,000**	**5000–10,000**
500,000–1,000,000	z= −0.493 p = 0.62233					
100,000–500,000	z = −3.905 $p = 9.43 \times 10^{-5}$	z = −2.436 p = 0.01487				
50,000–100,000	z = −3.033 p = 0.00242	z = −2.394 p = 0.01665	z = −0.783 p = 0.4339			
10,000–50,000	z = −4.491 $p = 7.09 \times 10^{-6}$	z = −3.106 p = 0.00189	z = −0.970 p = 0.3322	z = 0.101 p = 0.91937		
5000–10,000	z = −3.106 p = 0.00190	z = −2.378 p = 0.01739	z = −0.641 p = 0.5212	z = 0.159 p = 0.87398	z = 0.088 p = 0.92981	
<5000	z = −2.398 p = 0.01647	z = −1.482 p = 0.13845	z = 0.840 p = 0.4011	z = 1.309 p = 0.19061	z = 1.653 p = 0.0984	z = 1.212 p = 0.2254

Urban forestations predominated as nesting sites throughout the study area. In addition, the use of structures, such as telephone masts, buildings and electricity pylons, was reported in all the city size categories, and cavities in ravines and man-made slopes in almost all cities (Table 7). *B. chiriri* and *F. xanthopterygius* use abandoned nests of *Furnarius rufus*, and *A. nenday* was reported nesting in nest boxes for *Falco sparverius*. Juveniles of 22 psittacine species were reported in urban areas. Juveniles of *M. monachus* and *C. patagonus* were present throughout the range of city size categories (Supplementary Information, Table S3).

Table 7. Species using nesting substrates in urban areas in the Southern Cone of South America. The number represents the observations reported for each substrate and for each city size range, the number of species reported in each case is indicated in brackets.

Nesting Substrates	City Size (Inhabitants)						
	>1,000,000	**500,000–1,000,000**	**100,000–500,000**	**50,000–100,000**	**10,000–50,000**	**5000–10,000**	**<5000**
Urban structures	14 (3)	5 (1)	9 (1)	3 (1)	10 (3)	3 (1)	4 (2)
Trees	122 (7)	23 (4)	46 (6)	15 (4)	50 (6)	22 (3)	31 (6)
Cavities in banks/cliffs	2 (2)	2 (1)	4 (2)	2 (1)	0	4 (1)	5 (1)

3.3. Information on Threats and Population Trends

Of the total number of species reported (35), 16 (47.06%) have a decreasing population trend according to the [61], 12 (35.29%) have stable populations, six (17.65%) have an increasing population trend, and one (*Agapornis* sp.) lacks information on the threat category or population trend. One of the 27 species native to the study area is categorized as Endangered, two as Threatened, four as Vulnerable, 19 as Least Concern and one, *Ara chloropterus* x *Ara ararauna* lacks information. Among the five species originating from other regions of South America and cited in urban environments in the study area, one is Critically Endangered, one Threatened and three are categorized as Least Concern. Three of the four parrot species originating from other continents are classified in their native areas as Least Concern, while no information on the threat category or population trend was obtained for *Agapornis* sp.

Ara glaucolaris, listed as Critically Endangered by the IUCN, was observed in one of the 187 cities reported (Asunción, Paraguay). *A. vinacea*, categorized as Endangered, was reported in three cities (San Pedro, Argentina, Carazinho and Gramado, RS). The three species classified as Near Threatened were observed in 34 cities in AR, CH, PY, UY and RS. The four vulnerable species were reported for 18 cities in AR, CH, PY and RS, and the 25 species categorized as Least Concern for 164 cities in all the jurisdictions considered (Figure 3; Table 8).

Table 8. Species detected in urban areas of Argentina (Ar), Chile (Ch), Paraguay (Py), Uruguay (Uy) and the state of Rio Grande do Sul in Brazil (RS), population trends and categorization according to IUCN (2022). Acronyms indicate native range: SSA (study area, southern South America), OSA (other region in South America) and OC (other continent outside South America). The number indicates the number of cities in which each species was observed in each country/state.

Species	Native Distribution Area	IUCN Category	IUCN Population Tendency	Ar	Ch	Py	Uy	RS	Cities
Ara glaucogularis	OSA	Critically Endangered	Stable			1			1
Amazona vinacea	SSA	Endangered	Decreasing	1				2	3
Amazona aestiva	SSA	Near Threatened	Decreasing	17	1	5	3	8	34
Amazona brasiliensis	OSA	Near Threatened	Increasing					2	2
Primolius maracana	SSA	Near Threatened	Decreasing	1					1
Amazona pretrei	SSA	Vulnerable	Decreasing	1				8	9
Amazona tucumana	SSA	Vulnerable	Decreasing	2					2
Anodorhynchus hyacinthinus	SSA	Vulnerable	Decreasing			1			1
Cyanoliseus patagonus bloxami	SSA	Vulnerable	Increasing		6				6
Ara chloropterus	SSA	Least Concern	Decreasing	1		2			3
Ara ararauna	OSA	Least Concern	Decreasing			2			2
Aratinga nenday	SSA	Least Concern	Increasing	2		5	1		8
Brotogeris chiriri	SSA	Least Concern	Decreasing	4		3	1	3	11
Brotogeris tirica	SSA	Least Concern	Stable					9	9
Brotogeris versicolurus	OSA	Least Concern	Stable	2		1			2
Cyanoliseus patagonus	SSA	Least Concern	Decreasing	39			1		40
Enicognathus ferrugineus	SSA	Least Concern	Stable	7	11				18
Enicognathus leptorhynchus	SSA	Least Concern	Stable		11				11
Eupsittula aurea	SSA	Least Concern	Stable	1		1		1	3
Forpus xanthopterygius	SSA	Least Concern	Stable	2		4			6
Melopsittacus undulatus	OC	Least Concern	Increasing	6	2	2	2		12
Myiopsitta monachus	SSA	Least Concern	Increasing	79	6	5	10	33	133
Nymphicus hollandicus	OC	Least Concern	Stable	3					3
Phyrrura frontalis	SSA	Least Concern	Stable	3				8	11
Phyrrura molinae	SSA	Least Concern	Decreasing	1					1
Pionopsitta pileata	SSA	Least Concern	Decreasing	2				1	3
Pionus maximiliani	SSA	Least Concern	Decreasing	7		2		7	16
Platycercus eximius	OC	Least Concern	Increasing		1				1
Psilopsiagon aymara	SSA	Least Concern	Stable	8					8
Psittacara acuticaudatus	SSA	Least Concern	Decreasing	21		2	1		24
Psittacara leucophthalmus	SSA	Least Concern	Decreasing	7		2	1	1	11
Psittacara mitratus	SSA	Least Concern	Stable	4			2		6
Triclaria malachitacea	SSA	Least Concern	Decreasing					3	3
Agapornis sp.	OC	Data deficient	No data	3	1				4
Ara chloropterus x Ara ararauna	SSA	Data deficient	No data			1			1

Among the five species listed on the forms that were not reported for any of the cities included in the analysis, all native to the study area, *Alipiopsitta xanthops* and *Ara militaris* are classified as Threatened and Vulnerable, respectively, and *Primolius auricollis*, *Psilopsiagon aurifrons* and *Pyrrhura devillei* as Least Concern, all according to IUCN.

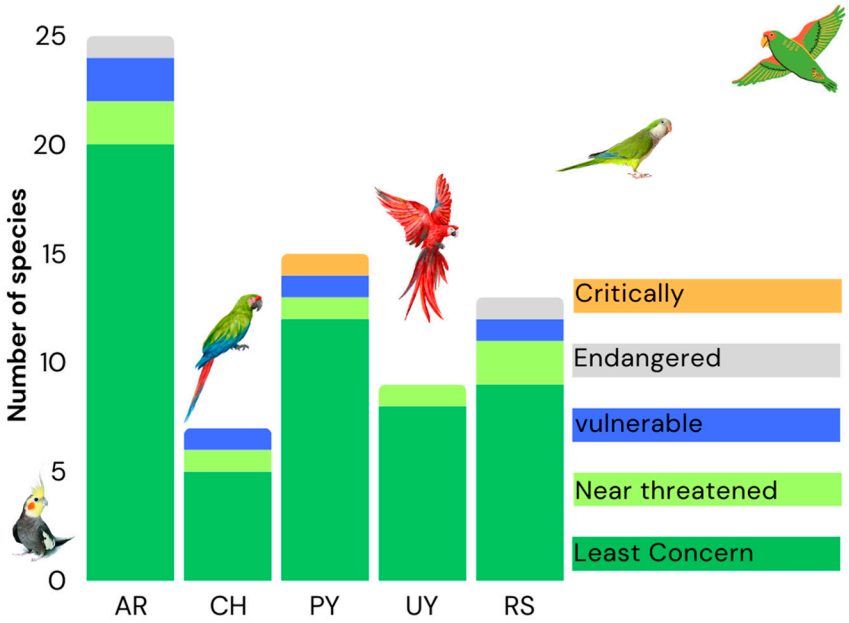


Figure 3. Number of parrot species cited for cities in Argentina (AR), Chile (CH), Paraguay (PY), Uruguay (UY) and the state of Rio Grande do Sul in Brazil (RS) and the conservation status according to IUCN (2022).

3.4. Urban Resources

The observations indicate that 29 of the 35 parrot species assessed make use of public parks and walkways in the cities. Only one of them was found to be exclusively associated with these green spaces, while the rest were also observed in suburban areas and in areas of high population density. Eleven species (41.38%) were associated with suburban environments of medium to low population density, but were lacking in more densely populated areas, and 16 (55.17%) were observed in both suburban environments and areas of high population density dominated by buildings. Finally, only one species (*P. molinae*) was reported to be exclusively associated with the most intensely urbanized sectors (Supplementary Information, Table S4). The association of species with different urban environments varied with the size of the cities (X^2 = 24.9; *gl* = 12; *p* = 0.015; Figure 4).

All the species observed in urban areas of the study area use planted trees as roosting sites or perches, mainly species of the genera *Pinus*, *Platanus*, *Peltophorum*, *Populus* and/or *Eucalyptus*. Sixty-two percent also take advantage of buildings and urban structures, among which power lines and other wiring, public lighting poles and roofs of houses and sheds were mentioned as perches, light pole holes as shelter, and antennas as nesting places. Water tanks located on the roofs of houses and low buildings provide water sources for one of the reported species (*C. patagonus*). Seventy-seven percent (27 species) were reported consuming food resources in urban settings, highlighting *M. monachus* consuming food scraps discarded by people, and seeds, fruits, flowers and shoots from parks and gardens in 90 cities across the entire size range and in all the areas surveyed. The consumption of seeds from five conifer species, dates from five palm species, fruits, flowering parts and shoots from 28 trees and shrub species grown in urban areas was reported for all the species. In addition, some contributions pointed out the consumption of cereals dumped on sides of main and rural roads, food scraps discarded by people in parks and squares, and organic waste taken directly from garbage cans (Supplementary Information, Table S5).

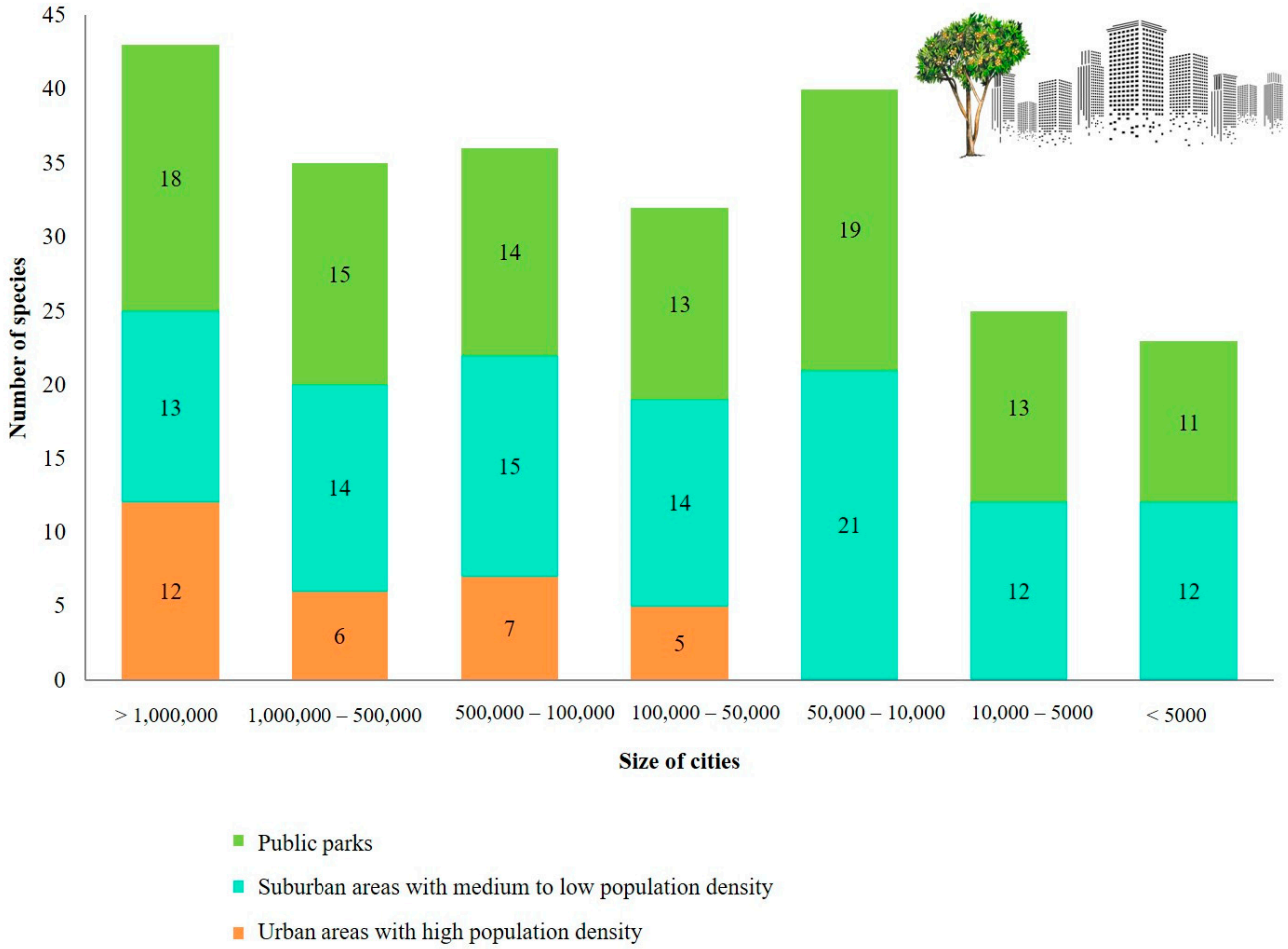


Figure 4. Number of parrot species observed in the different types of city environments in the Southern Cone of South America. Several species use more than one urban environment.

3.5. Conflicts with People

The informants associated the presence of 27 of the species detected in urban environments in the region with the pet trade, which included 18 (69%) for AR, six (75%) for CH, 13 (81%) for PY, four (44%) for UY, and five (38%) for RS (Supplementary Information, Table S6). Specific information was also provided on the presence of solitary specimens found in anthropized environments as a result of releases or escapes that have not yet resulted in the establishment of populations. This is the case of the hybrid *Ara chloropterus* x *Ara ararauna*, or Harlequin Macaw (PY), and five exotic species: *Ara glaucogularis* originating from Bolivia (PY), *Agapornis* sp., originating from Africa (AR and CH), and *Nymphicus hollandicus* (AR), *Platycercus eximius* (CH) and *Melopsitacus undulatus* (AR, CH, PY, UY), originating from Australia.

Of the total of 369 responses, 231 reported conflicting situations between 18 psittacine species and the public. The most frequently cited conflict (41% of observations, 14 species, 82 cities) was complaints about disturbing noises associated with the sounds emitted by the species. This was followed by complaints about fruit consumption (26% of reports, 15 species, 64 cities), complaints about dirt on footpaths, walkways and other public spaces (16% of responses, eight species, 46 cities), complaints associated with perceived health risks (9%, five species, 29 cities) and complaints about power outages (8%, five species, 25 cities; Figure 5).

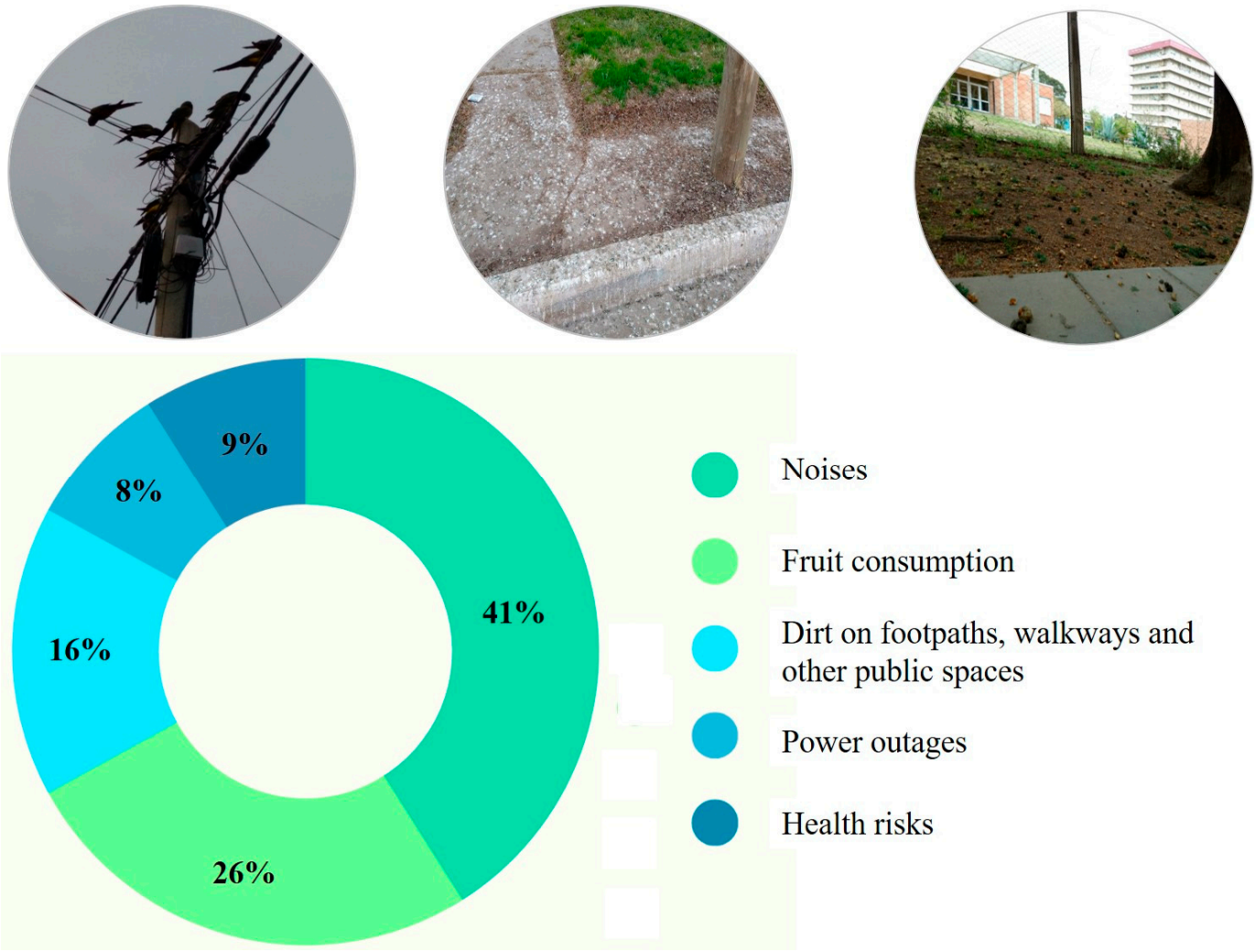


Figure 5. Causes of conflict between urban parrots and human populations in cities in the Southern Cone of South America.

The species with the highest number of reports as problem birds were *M. monachus* and *Cyanoliseus patagonus*. In the first case, 146 of the 274 surveys reporting the presence of this species identified problematic situations in a total of 82 towns across the size range and throughout the study area. The most frequently mentioned conflicts for *M. monachus* were noise and fruit consumption, in that order. For *C. patagonus*, 40 of the 77 surveys reporting its presence in urban environments in AR and CH mentioned problematic situations in a total of 25 cities in all the size ranges below 500,000 inhabitants. The most frequently reported conflicts were noise and power outages associated with the use of power lines as roosting sites. No significant relationship was detected between the frequency of the different types of conflict and the size of the cities for which they were cited ($X^2 = 36.41$; $gl = 24$; $p = 0.7$; Figure 6).

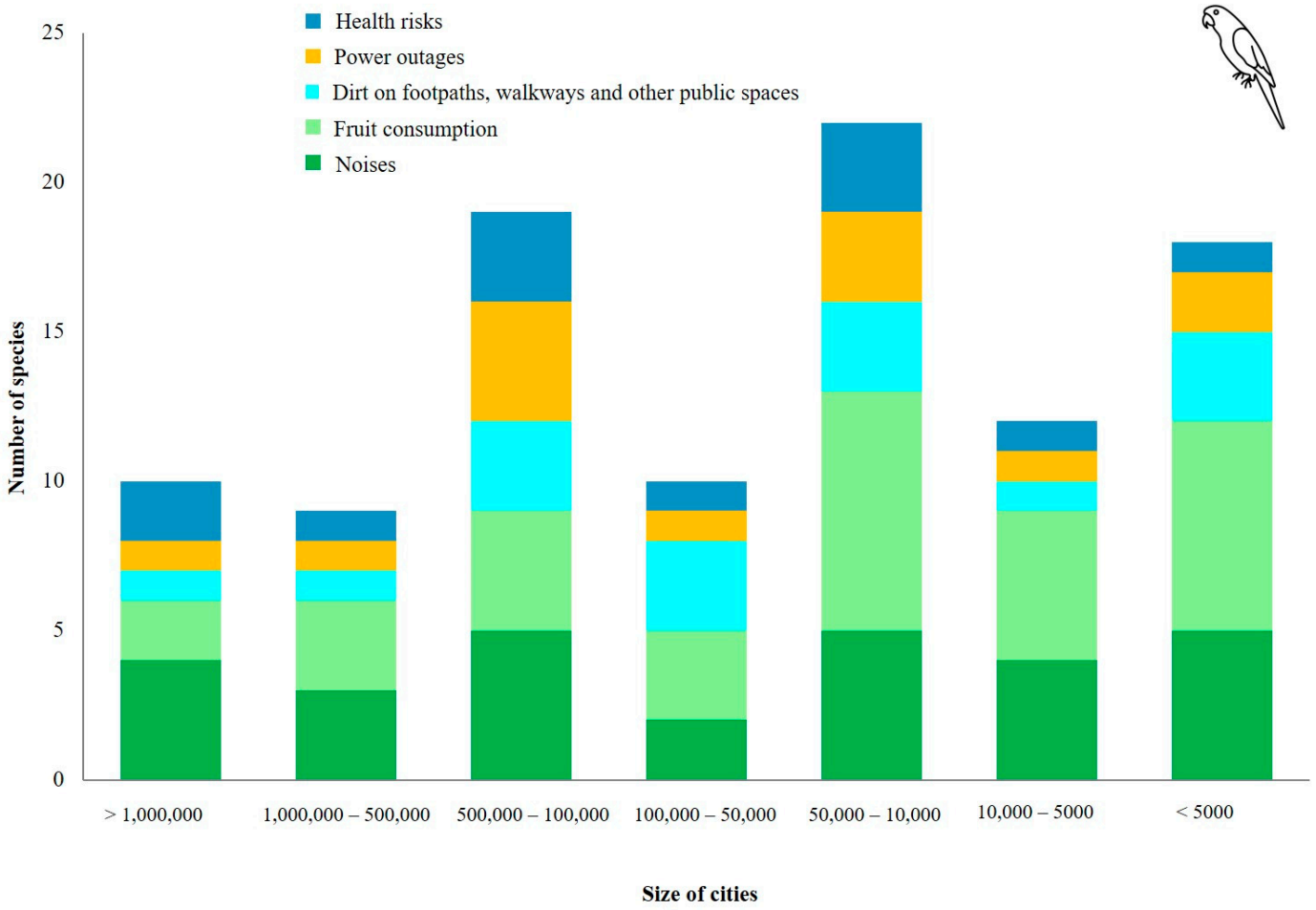


Figure 6. Number of parrot species associated with different types of conflicts in cities with different numbers of inhabitants in the Southern Cone of South America.

4. Discussion

This survey is the first to compile and systematize the knowledge of ornithological professionals and amateurs about the interaction between psittacines and urban environments in the Southern Cone of South America. Although the survey-based methodology presents certain limitations inherent to the subjectivity of the responses and the variability in the experience of the participants, the findings of this work constitute a promising starting point for future research.

The contributions received in this research show that, although the richness of Psittaciformes is greater in the large cities and in the middle and low latitudes defined for the study area, it also covers cities of different size, including small towns in rural areas, in a latitudinal range from 54°48′57.6″ S to 24°05′24.0″ S, and from the Pacific coast to the Atlantic coast, and involves a variety of species. About 70% of the psittacine species known for Paraguay and for the state of Rio Grande do Sul, Brazil, have proven their ability to inhabit urban areas, and these values rise to 90% in the case of Argentina, Chile and Uruguay. These results define a particularly interesting scenario in this region where the Psittaciformes seems to be a taxon especially prone to settle in urban areas.

Seventy-seven percent of the urban parrot species in the Southern Cone of South America are native to the region. These values lead us to wonder about the potential contribution of cities to the conservation of these birds. Can urban environments help sustain populations of threatened species and, at the same time, encourage people to come into contact with this group of birds, promoting their appreciation? In this regard, it is important to note that 25% of the psittacine species in urban habitats reported in this research are included in some category of threat according to the IUCN, and almost 50%

have declining population trends. The success of parrot species in cities of different sizes is largely due to their plasticity in the face of anthropogenic changes and high inter-individual variability in fear of humans [5,64,65], and thus, the potential contribution of cities to the maintenance of parrot populations will depend on the balance between the advantages and challenges posed by the urban environment. In any case, it is essential to recognize that the presence of these species in cities, beyond contributing to the reduction of their chances of population extinction, does not guarantee their ecological functions in natural environments [66].

In addition to the native species that manage to inhabit cities, there are also introduced psittacines from outside the study area. Thus, around 23% of the species observed in urban centers in the Southern Cone are native species from other regions of South America, and/or come from other continents. This situation is mostly attributed to active transport in association with the wildlife trade, and subsequent escapes or voluntary releases [30,67]. In general, captured specimens are transported to large cities because of the greater demand and supply of birds. In this regard, two large cities, CABA in Argentina and Asunción, the capital of Paraguay, showed the highest number of parrot species observed in the wild. Thus, some parrots from South American forests and Chaco woodland have found feeding, roosting and breeding areas in large cities where they are already considered residents of parks and suburban environments [38].

Similarly, the high richness of parrots reported in medium-sized urban centers such as San Pedro and Puerto Iguazú (Argentina) can simply be attributed to the rich biodiversity that characterizes the ecoregion, while for Fernando de la Mora (Paraguay) it can be explained by its proximity to the cities of Asunción and San Lorenzo, both known for their fairs and markets for the illegal trade of native and exotic wild parrots [68]. Two unusual observations of *Ara glaucogularis*, a species endemic to Bolivia and listed as Critically Endangered by the IUCN (2022), were also recorded in Asunción. Although it was not possible to verify the accuracy of these reports, their presence could be explained by escapes from illegal trade, as one form of wildlife trade in the country involves larger psittacines, usually individuals of the genus Ara, whose capture is complicated by the scarcity of individuals in the wild habitat [68]. The same is true for *Agapornis* sp., native to Africa, and *Nymphicus hollandicus*, *Platycercus eximius* and *Melopsitacus undulatus*, native to Australia. Only the latter had been previously reported in urban areas in the region [69–71]. In none of these four cases is there evidence of successful establishment in cities in the study area, where their survival seems to be limited to captive specimens in aviaries, exhibition centers and wildlife rehabilitation centers [72,73]; even so, they deserve attention considering the chances of possible escapes and the eventual establishment of spontaneous populations. An example of such a situation is the Rose-ringed Parakeet (*Psitacula krameri*) that is bred and commercially traded as a pet in the study area but whose presence outside captivity had not been detected at the time of our survey. However, sightings of individuals were subsequently reported in Argentine cities [74]. In this case, the history of the species as an invasive in much of Europe [75–77], should be taken as a warning sign to prevent potential ecological impacts [78].

In other cases, it is less easy to decide to what extent the species have been able to spontaneously expand their ranges, favored by modifications and changes in land use, and how the wildlife trade has contributed to this expansion [79]. This is the case of *Amazona aestiva* and *Myiopsitta monachus*, that are distributed in areas of anthropogenic influence in different parts of the world [64,79]. The former, whose distribution in South America includes northern and eastern Brazil, northern Argentina and southern Paraguay [80], was already considered a resident species in the metropolitan region of Buenos Aires city, Argentina [38], which coincides with the reports obtained in this survey, which also cites the presence of a communal roost established in an urban park. The role of cities as centers of trade and the release of exotic psittacines could represent an opposing factor to the contributions of urban environments to conservation, depending on the ability of these birds to expand into the surrounding natural or semi-natural environments. This problem,

which has been extensively studied globally [64,65,81–83], could be in an initial phase in our study area, where population nuclei of exotic urban psittacines do not yet seem to have conspicuously expanded outside these environments. Beyond that, it should be considered as a latent danger, based on potential expansion, and as a current threat due to the eventual co-introduction of pathogens [84,85].

Regarding the use of urban environments by parrots, significant associations of species with parks and public walkways were detected across the size range of the urban centers studied, even considering that these are spaces that have a minority areal representation in the urban environment. Green spaces have been mentioned as key sites for this group of birds as they provide food resources throughout the year [30,38,44,86].

Among the trophic resources that urban centers provide for the species included in this analysis, a great variety of fruits, seeds, flowers and pollen of different species cultivated in green areas were highlighted, as well as native vegetation surrounding the cities. Part of the success of Psittaciformes in cities is associated with a generalist diet that allows them to vary their diet according to the seasonal availability of the resource [44,87–89]. Our reports also indicate that some parrot species have adapted to new foraging opportunities, such as household waste. In this regard, some research has documented the emergence of a set of behaviors acquired through social learning in response to human-generated resources, specifically the opening of bins by kea parrots in New Zealand, and by cockatoos in Sydney [90–92].

On the other hand, parrot breeding activity was mainly associated with large cities and the mid and low latitude range defined for the study area. The 42% of the species reported in the surveys found favorable nesting sites in urban centers in the Southern Cone of South America, highlighting the importance of cavities in trees in public groves, most of which include exotic species. Reports of *Psittacara leucophtalmus*, *Pionus maximiliani* and *Phyrrura frontalis* nesting in trees in urban parks are consistent with those reported by [39]. Likewise, nesting attempts of *Amazona aestiva* in tree cavities and the presence of juveniles of this species reported in cities in Argentina were previously observed by [38]. Tree cavities are becoming a particularly scarce resource in natural environments due to the removal of old trees and so urban trees could offer an alternative to the scarce availability of nesting substrates for many species of the Psittacidae. However, these interactions are much more complex, and some studies highlight the importance of increasing research on the availability of cavities in urban environments, the specific preferences of each species, and information on the reproductive success of parrots in these environments [93,94].

Nesting reports of *Myiopsitta monachus* were frequently associated with groves and urban structures, such as antennas, constructions, buildings, towers, light poles, transformers, public lighting poles, water tanks, and windmills. Some of these substrates have also been mentioned by different authors [95–99] and possible strategies have been exposed in the event of possible damage caused by the location of the nests in structures used for supplying electricity in different cities [100,101]. Moreover, the nesting substrates reported for *Cyanoliseus patagonus* were cavities in rural, urban and semi-urban ravines and cliffs, mostly in quarries formed by the extraction of sediments and substrates for construction, generally located in the vicinity of the urban area, in addition to records of nesting in holes in the walls of buildings [102–104]. Unlike most parrots, which depend on pre-existing cavities for nesting and are thus limited in their breeding by the availability of nest holes, *Myiopsitta monachus* builds platform nests from sticks, while *Cyanoliseus patagonus* excavates its own cavities in cliff faces. These reproductive behaviors make these two species particularly well-suited for establishing themselves in urban environments.

The presence of parrots in urban areas involves both positive and negative interactions with humans [42,65]. In some cases, the adaptation of some wild psittacines to urban environments has led to problems of coexistence with urban dwellers. One of the most frequently reported cases involves *Myiopsitta monachus*, a bird native to South America that has been traded as a pet in different parts of the world, particularly during the 1980s. Through escapes and releases, the species has managed to successfully establish itself in

new territories and is now considered an invasive, alien species with negative ecological and economic effects in different parts of the world [95,105,106]. Our survey is linked to different conflicts in the study area, including complaints about fruit consumption and damage to human infrastructure, such as cables, telecommunications towers and electricity pylons, due to the establishment of its communal nests [97,107,108]. In Chile, the species was released in 1972 as a result of trade [109] and according to our results it has become established in at least 133 urban centers of between more than 1,000,000 and less than 5000 inhabitants. It has also been suggested that its advance might be favored by the availability of exotic trees planted in urban groves that serve as support for the construction of its nests [97].

Another of the conflicting cases reported by respondents is that of *C. patagonus*. The Burrowing Parrot is distributed in Argentina, Chile [110,111] and occasionally Uruguay [112]. In this regard, it is interesting to note its presence in a suburban environment of Colonia del Sacramento (Uruguay), where an informant observed a solitary specimen, possibly escaped from captivity, roosting next to a group of *M. monachus* for about two months during the winter of 2018. The Burrowing Parrot is an endangered species in Argentina, whose population has declined due to causes, such as the pet trade, habitat loss and degradation, as well as historical persecution for being declared an agricultural pest [102]. Despite this, in recent years, there has been an apparent seasonal increase in its abundance in urban areas of Argentina and growing conflicts with city dwellers due to the arrival of flocks at urban roosts [113]. The survey results point to damage to overhead wires, frequent power outages, noise nuisance complaints and dirt due to excrement.

The results obtained highlight the presence of a large number of Psittaciformes species associated with the urban avifauna of the Southern Cone of South America and the importance of expanding local and regional studies to understand the behavior, biology, and positive and negative interactions established between psittacines and these environments. This information can be generated by combining citizen science records, as in this case, together with field observations by ornithologists, taking advantage of the abundance and constancy of the presence of these birds in cities [114]. At the same time, the importance of maintaining objective estimates of their abundance in urban and natural environments becomes evident, as the concentration of these species in anthropized environments could lead to false conclusions about their population trends [113].

Therefore, urban parrots represent a challenge for the search for sustainable urban models that make it possible to maintain biologically rich cities and to design innovative conservation strategies that respond to the new challenges posed by an ever-growing human population, including the consideration of areas traditionally little, or not, taken into account, such as the cities. Any strategy that focuses on the management of urban Psittaciformes species should take account of at least three main points: first, the role of the cities in sustaining viable populations of vulnerable species; second, their role as points of contact and awareness between these birds and the majority of the human population in the region; and third, the eventual risk associated with the introduction of birds and their pathogens, and their impacts within and outside the urban environment.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/birds5040051/s1.

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