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Callout analysis in relation to wild birds in a tropical city: implications for urban species management

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Abstract
Urbanisation is changing landscapes at an unprecedented rate, which consequently changes species compositions. We investigate problems faced by urban birds in a neotropical city by analysing the responses made to callouts by the environmental police of Belo Horizonte, Minas Gerais, Brazil from 2002 to 2008. The environment police responded to two types of callouts: solicitation, where a person called to report an issue (n = 560); and reports of hurt or injured birds (n = 399). On average, three callouts per week were made relating to urban birds, with more than half concerning birds of prey. There were significantly more callouts in the wet season, coinciding with peak breeding times for most endemic Brazilian avifauna. We found no effect of caller gender, age or associated socioeconomic factors. Most callouts resulted in birds being forwarded on to Government-managed institute for processing wildlife (n = 584). Only a relatively small number of cases resulted in the birds being released into forested areas within the city (n = 152). Sick birds were sent to veterinary clinics (n = 136) and be released if successfully treated. We suggest how this information could be used to improve urban bird species management in neotropical cities. Our data evidences different guilds to have different relationships with people and birds of prey are less well-understood. The rise in callouts during breeding supports the need for better informed species management, and avoidance of a "one size fits all" approach.

Keywords Birds · Guilds · Human-wildlife conflict · Adaptation · Translocation · Urban wildlife management

Introduction

We have seen an acceleration in growth of urban areas since the second half of the twentieth century, resulting in significant land-use changes and subsequent global losses of biodiversity (Grimm et al. 2008; Elmqvist et al. 2013). This is reflected by both population and species-level declines, in addition to changes in species composition within ecosystems. Generalist species are able to outcompete specialist species that are unable to cope in newly urbanised environments because of their narrow ranges of habitat and resource use (Shochat et al. 2015; Concepcion et al. 2015). In addition to changes in the composition of biological communities, mobility is also thought to play a functional role in urban areas, given species composition is shaped by dispersal and metacommunity dynamics (Leibold et al. 2004; Vellend 2010; Schleicher et al. 2011). Habitat loss and fragmentation is one of the largest threats to wildlife and forces rapid decisions about emigrating (if possible) to better suited habitats or to stay and tolerate the new conditions (McKinney 2002). Highly mobile species, such as birds, are able to rapidly colonise newly available ecological niches and adapt in response to environmental challenges in real-time (Devictor et al. 2007; Shochat et al. 2010).

Belo Horizonte is an urbanised neotropical city that has had much of its natural green areas transformed to anthropogenic structures, with urban sprawl fragmenting the landscape (Isaksson 2018). Changing conditions will have resulted in a local loss of avian species richness, as the new urban landscape favours few functional traits (Pena et al. 2017). However, birds are one of the more common animal taxa that can invade human settlements and, indeed, capitalise on sympatric relationships with humans (Marzluff 2001). For example,

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inhabiting urban cities results in less predation (Diaz et al. 2013), less risk of parasitism (Calegaro-Marques and Amato 2014), higher resource availability (Tryjanowski et al. 2015) and optimal microclimate (Stewart and Oke 2012). The increase in human-wildlife interactions can have positive effects on human wellbeing (Maller et al. 2005; Fuller et al. 2007) but can also result in human-wildlife conflict (Patterson et al. 2003; Casey et al. 2005; Dowle and Dean 2009). This is largely driven by the attitudes of local communities and how they respond to such conflicts (Dickman 2010). In Brazil, most reported cases of human-wildlife conflict concerns felines (Zimmerman et al. 2005; Palmeira et al. 2008). In fact, most studies that investigate such issues largely concern mammals, particularly human-primate interactions in urban areas given their likelihood of holding societal, cultural and religious value (McLennan et al. 2017). There is little reported on the attitudes of local communities in neotropical cities towards birds.

Our objectives in this study were to determine: (1) the nature of callouts reported by the public concerning neotropical birds, (2) investigate any temporal or spatial patterns in callouts that could be related to environmental conditions, (3) examine the demographics and socioeconomics of callers, (4) consider the species' biology, and (5) use this information to better understand human-wildlife interactions and improve wildlife management in the urbanised city of Belo Horizonte.

Materials and methods

Study area

The city of Belo Horizonte is occupied by a human population of 2.238 million inhabitants within an area of 330.9 km^2 and is located in the south of Minas Gerais, Brazil (latitudes: 19°46′35″ and 20°03′34″; longitudes: 43°51′27″ and 44°03′47″ (PMBH 2003). It is divided into nine administrative regions, each of which has typical environmental (e.g., percentage of land covered by green areas) and socioeconomic characteristics (e.g., salary levels; Table 1; Teixeira 2009). These fragmented "green areas", which can be either natural habitat or human-cultivated vegetation, are spread throughout the city and 150 of the areas are > 2 ha in size (Teixeira 2009). Due to the nature of fragmented habitats and urbanised areas, there is an increased likelihood of human-bird interactions close to the fragment boundaries. When animals are found in the "green areas" of the city, they are reported and monitored by the Municipal Bureau of Environment and Urban Sanitation as part of the Pró-fauna programme. Brazilian wildlife is ultimately managed by the federal government via the Brazilian Institute of Environment and Renewable Natural Resources (in Portuguese, IBAMA). The Environmental Police responds to callouts made by the citizens and is responsible for the apprehension of wild animals from illegal trafficking, aiding injured animals, and for capturing animals in conflict with the human population (Goulart et al. 2010). The animals involved are either translocated or sent to a wildlife centre.

Study species

According to the IUCN Red List, > 150 Brazilian bird species are globally threatened and 10% are critically endangered (IUCN Red List of Threatened Species 2013). Furthermore, there are Red Lists for individual Brazilian states indicating that a number of species are threatened at regional levels (for examples, see Marques et al. 2002; Mikich and Bérnils 2004; Bressian et al. 2009). This includes Minas Gerais, the state of Belo Horizonte (BIODIVERSITAS 2006).

Table 1 Number of calls (requests or to report an injured bird), number of calls resulting in release of bird back into the wild, the percentage of calls concerning raptors*, percentage of green area, human population density and salary level** in the nine different administrative regions of Belo Horizonte city, Minas Gerais, Brazil

Region	Number of calls	Number of calls: requests	Number of calls: injuries	Number of calls: release	% Green area	% Raptors *	Human density	Salary level **
Northwest	193	95	98	23	2	59.07	8848.70	3.62
Centre-South	152	97	55	33	16	50.66	8018.34	11.35
Pampulha	123	79	44	16	8.5	43.90	3090.75	5.28
West	112	60	52	18	4	55.36	8573.38	4.90
East	90	58	32	18	10	56.67	9109.46	3.82
Northeast	86	51	35	14	6	58.14	6922.28	3.34
Barreiro	79	46	33	6	12	54.43	4893.32	2.04
Venda-Nova	78	43	35	16	3	62.82	8670.58	2.18
North	46	31	15	8	13	32.61	5750.87	2.21
Total	**959**	**560**	**399**	**152**				

*Raptors: including all birds from carnivorous and scavenger guilds; **Expressed as (mean) multiples of minimum salaries

Within our dataset for all callouts recorded between 2002 and 2008 (n = 959), the calls alone reported birds from across 16 different orders and 29 families (Table S1), of which then it becomes more difficult to identify birds to genus and species level. Interestingly, this level of identification seemed to be most absent for orders and families from carnivorous guilds; that is, raptors, and other birds of prey. Of all the birds involved in the callouts where IUCN conservation status information was available (24.8%; n = 234), only two species are considered to be at risk of extinction based on their current demographics: *Cyanocorax caeruleus* from the Corvidae family, and *Penelope jacucaca* from the Cracidae family (listed as near-threatened and vulnerable, respectively). These made up just five of the total calls reported for birds of conservation interest from 2002–2008. All other birds (n = 229) are listed as least-concern and are not a conservation priority. This suggests that only species with initial healthy numbers of individuals were able to respond to urbanisation.

Data collection

The public of Belo Horizonte and its metropolitan area can call out the environmental police to deal with any issue or concern regarding urban wildlife. The police may respond by sending out officers to assess and deal with the situation reported and metadata from the call is recorded using a standardised report form. The decision of action depends on the officer who attends the call out, but generally, injured animals will either go to a rehabilitation centre of veterinary clinic, depending on the severity of injury or illness. Non-injured birds are often relocated to a nearby rural area, as the aim is to release all animals back into the wild. Only birds deemed too debilitated for release back into the wild are placed in government-licensed wildlife centres.

Reports contained the following information (detailed in Goulart et al. 2010): location (with geographic coordinates marked by a global positioning system device), date, gender and age of the person who made the callout (age was divided into four categories for analyses: 1–20, 21–40, 41–60, and > 60 years old), the nature of callouts (e.g., conflict or to deal with an injured animal), the action undertaken by the environment police (e.g., capture of the animals), number and age of animals (adult, juvenile, or infant), the physical condition of the animals as assessed by the environmental police, and if appropriate, where the animals were released (i.e., translocation of the animals; comparing capture and release points coordinates permitted us to calculate the distance of translocation).

Police were able to respond to types of callouts: (1) when asked to intervene when a bird is occupying or nesting in an appropriate place, such as in a place of commerce or residence; (2) when asked to intervene when a bird is observed to be hurt, unwell or suffering. The responses involve either sending the animal to a wildlife centre (CETAS, IBAMA), capturing the animal to translocate it elsewhere, or taking the animal to a veterinary centre for appropriate treatment and care. There are also instances where the bird may have escaped. Data were also obtained from the wildlife centres regarding the confiscated and captured animals, and any animals that may have been brought in by the public during the time period of the data used for this study.

In addition to the callout reports, environmental police officers were also interviewed for further information surrounding their actions, such as how animals were captured and handled, and clarification around the reports, such as a scarcity of information recorded of the age and sex of animals involved in the cases.

Statistical analysis

Data were tested, using the Shapiro–Wilk test to see if they met the requirements for parametric statistics, which they did not, therefore, non-parametric tests were used. Each of the nine administrative regions of Belo Horizonte were considered as discrete sample points as they each have typical environmental and socioeconomic characteristics (PMBH 2003).

Spearman-rank correlations were used to verify correlative relationships between the number of callouts and the size of green area in a city region, bird guild and biological traits, seasonal timings of callouts, human population density in city region and salary level by city region. All data relating to the size of green areas, human population density and salary levels were obtained from the Brazilian Institute of Geography and Statistics (IBGE: http://www.ibge.gov.br/home). We used a Chi-square test/Fisher's exact test to analyse the nature of callouts and caller demographics and a Mann Whitney U-test to compare number of callouts in the wet and dry seasons. All statistical tests were done in MINITAB 15 (alpha = 0.05, bilateral tests).

Results

From January 2002 up to and including October 2008, the environmental police captured 1021 individuals in 959 callouts, which is an average callout rate of 12 times per month and 142 times per year. The proportion of calls across the nine administrative regions of Belo Horizonte are shown (Table 1 and Fig. 1). Of the actions by the environmental police, 97.9% (n = 939 callouts) was related to the capture of individuals (i.e., solicitations), and 41.6% (n = 399) was related to injured animals. Only a relatively small proportion of callouts resulted in release (translocation) of the captured animals (15.8%, n = 152), whereas the majority of caught

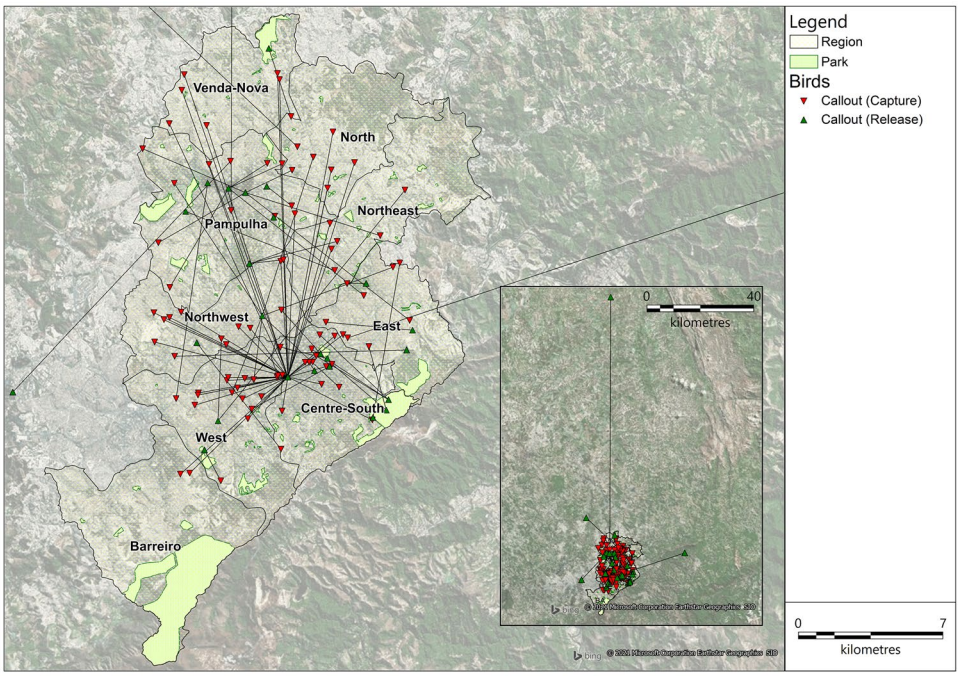

Fig. 1 The location of the nine administrative regions of Belo Horizonte and the distribution of bird callout locations attended by the environmental police between 2002 to 2008

birds were subsequently sent to the IBAMA wildlife processing centre (60.9%, n = 584). However, in some cases, the environmental police sent the caught birds to veterinary clinics (12%, n = 115) and there were only three instances where the bird in question was able to escape during capture. In these instances, the bird was not injured and did not belong to the same guild or occur in the same administrative region. More than half of all callouts specifically concerned birds of prey (including carnivore, raptor and scavenger guilds) (52.6%, n = 515).

The correlation between the size of the green area in administrative regions and the number of callouts was not significant ($r_S = -0.20$, n = 9, $p = 0.61$). The comparison between the number of birds reported in the wet—October to March—and dry seasons—April to September- each year (excluding 2008, which only included data up to the end of September) was significant with more birds reported in the wet season (W = 52.0, df = 10, $p < 0.05$; Fig. 2).

The month in the year significantly influenced the number of birds reported (F = 7.89, df = 11, $P < 0.001$) because

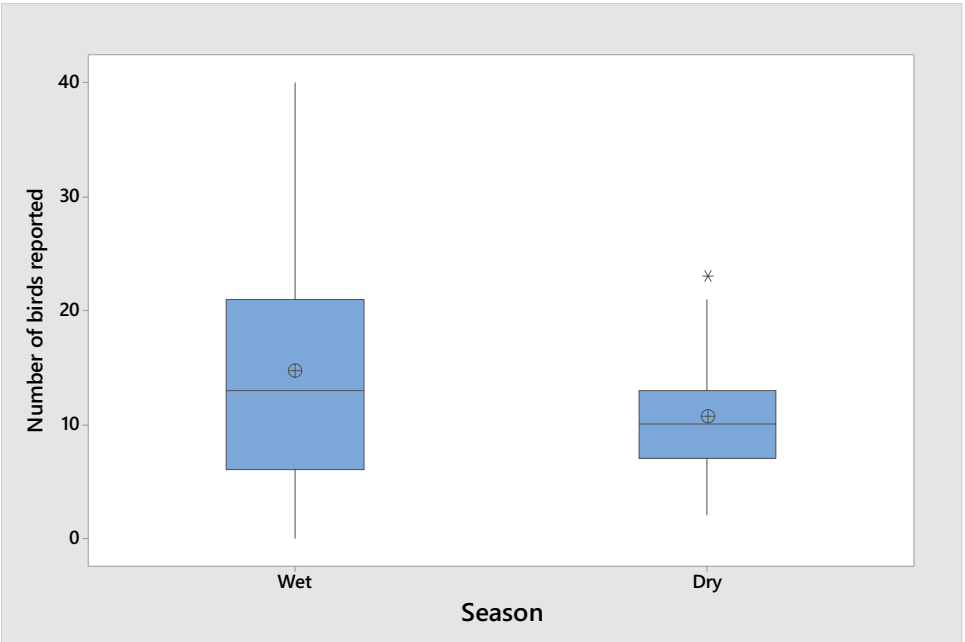

Fig. 2 Mean number of birds reported from 2002–2008 in Wet (October–March) and Dry (April-September) seasons. * denotes a significant difference of $p < 0.05$

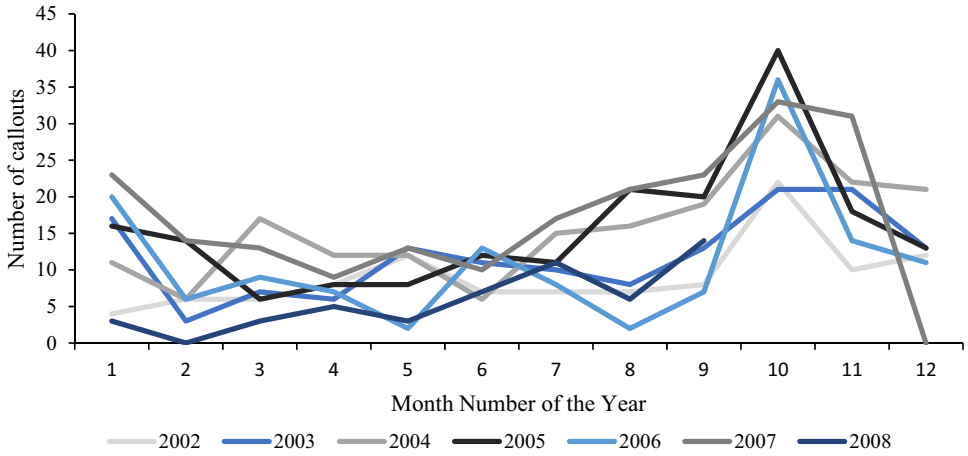

Fig. 3 Number of callouts to deal with avifauna in Belo Horizonte each month, from 2002–2008

of a significant rise in the month of October (W = 21.00, df = 10, $P = 0.005$) which is the start of the breeding season for most local avifauna breed (Fig. 3). Birds of prey (raptors, carnivorous and scavenger birds) were more commonly reported for injuries than other guilds, with almost half of all calls concerning injured birds (49.9%, N = 257). Proportionally, fewer birds of prey caught are passed onto the IBAMA wildlife centre than other guilds, but more are subsequently released back into the wild via translocation (Table 2).

The average caller age was 41.90 ± 1 5.00 years old (± standard deviation), 54% were male and 46% were female. There was a significant difference between the reason for callouts (e.g., hurt animal or problem-causing animal) and gender of the caller ($\chi^2 = 9.926$, df = 1, $p = 0.002$). Men were more likely to report an injured bird. Additionally, there was a significant difference between age groups and reason for callouts ($\chi^2 = 12.135$, df = 3, $p = 0.007$). Callers in year groups "21 – 40" and "41 – 60" were more likely to report a bird, regardless of reason, than callers who were < 21 or > 60 years of age.

There was no significant relationship between human population density within a region and the number of calls made ($r_S = 0.233$, n = 9, $p > 0.05$), but there was a significant positive correlation between the mean salary of people living within a region and the number of calls made ($r_S = 0.767$, n = 9, $p = 0.016$; Fig. 4). Individuals with higher salaries were more likely to report a bird to the environmental police.

The majority of callouts (95.3%, n = 914) involved one individual being captured, whereas a small proportion concerned reports of birds in pairs (3.7%, n = 35) and there was one instance where nine birds (Anatidae) were reported in a single call, which involved the ducks being taken into veterinary care. From all callout reports, the majority concerned adult birds (80.9%, n = 776) and the remaining calls concerned juveniles, as the age of the birds involved was always provided in the report. There were 153 callouts in Belo Horizonte that resulted in the translocation of 153 animals (all single-animal reports) into 67 different local green areas (Fig. 5). Translocation sites ranged in distance from the original callout site (0.08 – 96.93 km) with an average release distance of 6.85 km (± 10.58 km).

Discussion

During the study period, many birds were captured in Belo Horizonte. On average, there were three callouts made each week during the 2002–2008 period. Additionally,

Table 2 Number of callouts for birds based on feeding guilds: birds of prey (all raptors, carnivorous and scavenger species) and all other birds (granivorous, frugivorous, nectivorous, omnivorous and piscivorous species). Percentage of calls being a request or report of an injured bird is given, along with the outcome: animal collection, forwarding the animal to the IBAMA wildlife centre, translocation release and veterinary care

Feeding guild	Number of calls	Call Type		Call outcome*			
		Request	Injury	Collection	IBAMA	Release	Vet
Birds of prey	515	258	257	41	272	109	83
% of total calls		50.10	49.90	7.96	52.82	21.17	16.12
All other	444	302	142	43	312	43	33
% of total calls		68.09	31.91	9.66	70.11	9.66	7.42

*This table does not include all outcomes: there are also escapes and deaths

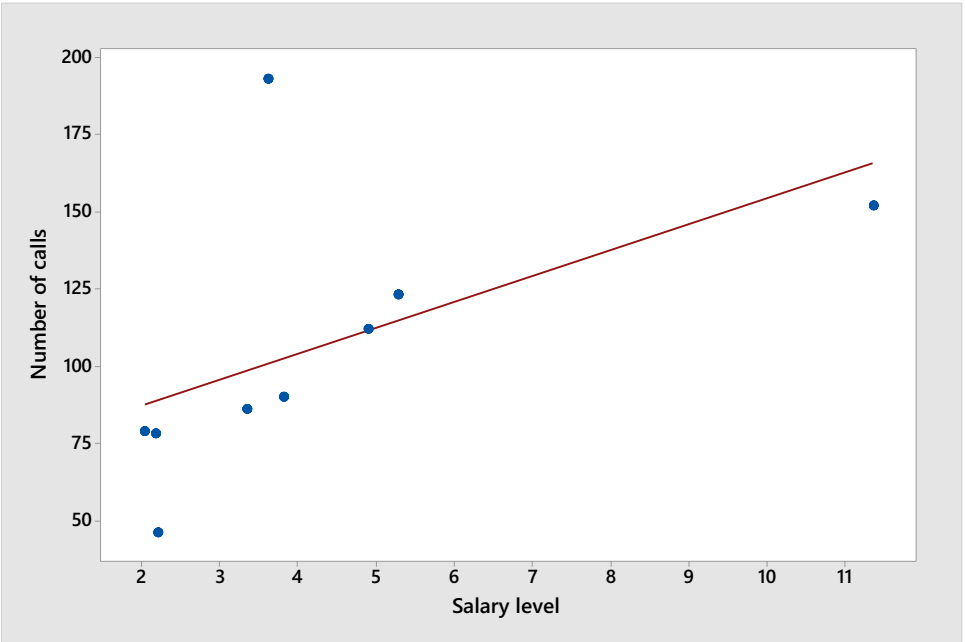

Fig. 4 Mean number of calls to the environmental police made about birds in the city of Belo Horizonte, Brazil from 2002–2008 and caller salaries expressed as (mean) multiples of minimum salaries

birds were the most popularly reported group of "problem" animals, in that the caller was reporting the animal with intent for a callout and intervention. For example, a previous study looked at all calls in the region in 2011 and found that 91.5% of 7426 calls were birds, with only 7% and 1.5% for reptiles and mammals, respectively (Freitas et al. 2015). This demonstrates the scale of the problem and the need for management of urban birds, among other wildlife, in neotropical cities.

Rapid environmental change, driven by anthropogenic activities, is resulting in an unprecedented loss of wildlife (e.g. Ceballos et al. 2015). This is most severe in tropical regions where species richness is highest and both human populations and deforestation rates are increasing. Brazil has one of the richest avifauna in the world with almost 1700 species of birds (IUCN Red List of Threatened Species 2013), of which > 10% are endemic, making Brazil an important country for conservation investment (Sick 1997). Knowledge about the animals being handled is a vital tool for wild species conservation as it facilitates improvement of environmental education and enforcement actions. By implementing a program involving animal

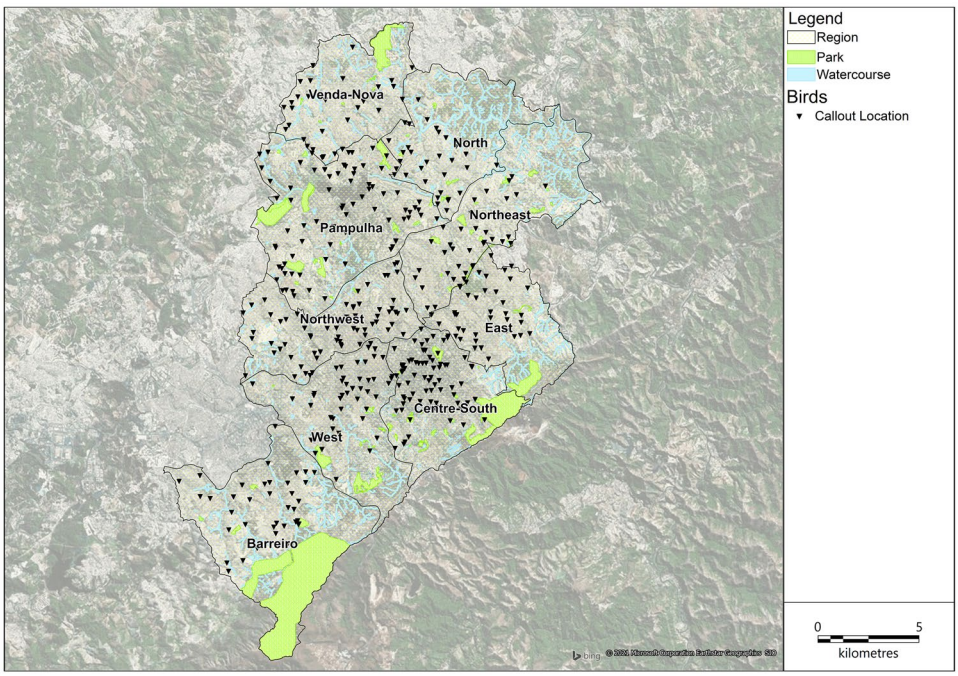

Fig. 5 The location of the nine administrative regions of Belo Horizonte, the distribution of bird callout locations attended by the environmental police between 2002 to 2008 and the resulting translocation-release location

rescue, rehabilitation and release (e.g., Griffith and Higgins 2012), there is an indirect contribution to conservation through increasing awareness, particularly through public education (e.g., Guy et al. 2014; Millineaux 2014). In this study, almost half of all callouts were reports of injuries (44%), where a small proportion of those birds caught by the environmental police were taken into veterinary care and the majority of birds were taken to the IBAMA wildlife centre. IBAMA also have veterinary staff, but largely focus on rehabilitation and receive birds apprehended from illegal trafficking or found to be in conflict with the human population (Goulart et al. 2010). Given birds make up a relatively small percentage of the total animals seized from illegal trafficking (< 1%, Fuccio et al. 2003), it would suggest that most birds reported – aside from injuries – is due to being perceived to be a "nuisance". Only a small proportion of the callouts resulted in a translocation and the translocation sites ranged considerably in distance from the location the bird was originally caught, although on average the release distance was only 6.85 km. Research shows that dispersal distance correlates with home range size in bird species (Bowman 2003) and for some species, this distance would fall within its home range but for others, it may not and will result in an animal losing its territory.

More than half of all callouts were for birds of prey (carnivore, raptor and scavenger guilds) and yet these reports were the least complete for data availability, often lacking information regarding species identification, sex and age of the bird(s). This is especially true for raptors, which make up 45% of callouts grouped under 'birds of prey', as none of the raptor callouts included species information about the bird(s) at genus level and only 54% of callouts had species information at family level and these were all Accipitridae. It appears there is a gap in local knowledge about these animals. Furthermore, the knowledge of the responders to such calls is also limited and the call response is determined based on the information provided by the caller. Each rescued individual is an opportunity to collect data about population biology, behaviour and other aspects of the species' biology. Therefore, it is important to ensure this information is recorded, especially for groups of birds which may be reported more frequently and have negative relationships with the public. This can contribute to an overall better understanding of local avifauna, anthropogenic impacts on wildlife and species conservation (Pyke and Szabo 2018).

Caller profile appeared to be significant, with men more likely to report a bird than women. In contrast, a previous study found that women appeared to have a greater interest in birds then men, though there was no significant difference in knowledge about local species (Hummel et al. 2015). Caller age was also significant, with callers ages more likely to fall within the "21–40" and "41–60" categories, in addition to callers being likely to have higher salaries. This may be related to the "luxury effect" in that higher socioeconomic status correlates with higher biodiversity, and this has been recognised in the distribution of birds (Leong et al. 2018). Interestingly, a study by Hummel et al. (2015) found there was a more positive relationship between humans and birds in lesser economically developed countries. This would support the idea that perhaps these attributes could be linked to personality traits such as confidence, boldness and assertion; but they could also be associated with likelihood to own more land, property or other man-made buildings that birds may inhabit and thus give a reason to call the environmental police to take action.

Human-wildlife conflict is on the rise with the increase of the human population, occupation of wilderness and the consequent need to monetise natural resources. Therefore, there are more frequent confrontations between wildlife and people which is of increasing conservation concern (Treves et al. 2009). Predators are a particular problem, including birds of prey, because they damage livestock and fisheries and can jeopardise human safety (Peterson et al. 2010). It can also simply be because a species has responded well to the habitat alterations and so, consequently, has increased in frequency (for example, the Great Kiskadee – *Pitangus sulphuratus*). However, urbanisation can also negatively impact bird species inhabiting Brazilian natural ecosystems if they are not able to tolerate the new environmental settings and consequently face local or complete extinction in the wild (for example, the Razor-bulled Curassow – *Mitu* – and Glaucous Macaw – *Anodorhynchus glaucus*) (Marini and Garcia 2005). Generalist species appear to fare better in the face of environmental change because they are able to acclimatise within the broad spectrum of habitat parameters to which they have adapted (Van Tienderen 1991). Conversely, specialist species are likely to be unable to cope with environmental changes if their ecological niche is too narrow and resources fundamental to their fitness are depleted or cease to exist. Caracaras were one of the most frequently reported group of birds in this study, which is unsurprising given their generalist feeding habits and varied foraging tactics (Sick 1997; Travaini et al. 2001). Their wider trophic roles have undoubtedly contributed to their ability to thrive in urbanised areas (Sazima 2007).

Given birds can expand and persist in urban cities, we can better understand the processes of adaptation to urban-living in wildlife by investigating the effects on key aspects of avian biology such as life-history strategies, health and survival, but also on breeding performance and behaviour. We found that there were significantly more callouts during the wet season (October to March), which is the main breeding season for most Brazilian avifauna. The rise in callouts

in October could coincide with the fact that birds inhabiting urban areas nest in a wide variety of locations (Reynolds et al. 2019). Birds invest significant time and energy into building and maintaining nests (Hansell 2000). A meta-analysis shows that the detection of birds' nests by predators declines with increasing urbanisation (Vincze et al. 2017). Therefore, it is likely birds will choose more urbanised areas, like Belo Horizonte, if it means there is an increased chance of offspring survival. In addition to nest-building and incubation, birds will also exhibit other conflictive behaviours during the breeding season. Seasonal patterns in territorial behaviour are common in many species due to the selective advantage they provide for an individual to secure mates during the breeding season. Therefore, the rise in callouts during the breeding season is unsurprising.

Birds are most vulnerable during the breeding season (Perrins 1970). Therefore, if there are more callouts during this period which involves human intervention and physically disturbing, catching and in most instances, moving a bird from the call location; it could have disastrous consequences from a conservation standpoint. In many countries, there is legislation in place that makes it an offence to intentionally kill, injure or take any wild bird, including taking or destroying its eggs or nest, or damaging a nest while it is in use of being built (for example, the Wildlife and Countryside Act 1981 in the UK: https://www.legislation.gov.uk/ukpga/1981/69/). Furthermore, a number of endemic and/or species of conservation interest will have additional protection in place during the nesting season (for example, Schedule 1 status in the UK: https://www.legislation.gov.uk/uksi/2017/1012). This study evidences the potential negative impact such interventions may have on bird populations in Belo Horizonte and why such protection and careful species management during the breeding season is needed.

Overall, from this study we can make a series of recommendations about the practical management of birds within a neotropical urbanised city: (1) better data collection is needed by the environmental police, particularly for more commonly reported guilds; (2) better understanding is needed of avifaunal biology in order to make more informed decisions with regards to release locations and to better manage birds during the breeding season at a time when they are most vulnerable and in need of protection; and (3) the public need to be better educated about how to interact with urban birds and be better informed on wildlife protection laws. Through these recommendations, we expect to see an improvement in urban species management in neotropical cities, which would facilitate positive interactions between humans and wildlife within an urbanised environment.

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Authors' contributions All authors contributed to the idea, design and analysis for the study. CPT collected the data, DLH wrote the manuscript and RJY provided the funding.

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Availability of data and material All research data supporting this publication are directly available within this publication and stored in a repository at the University of Salford.

Declarations

Ethics approval At the time the data were collected for this study, there were no ethical review processes required in Brazil for this type of research.

Consent to participate/for publication Not applicable.

Conflicts of interest The authors have no conflicts of interest to declare that are relevant to the content of this article.

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