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ORIGINAL ARTICLE

Investigating people's perceptions of alien parakeets in urban environments

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Abstract

Biological invasions are widely recognised as a significant threat to biodiversity, a driver of global change and a relevant economic problem. Actions to control or eradicate invasive alien species (IAS) can cause great controversy, especially when targeted species are charismatic. Thus, better understanding people's perceptions of invasive species is key for ensuring more effective IAS management. The ring-necked parakeet (*Psittacula krameri*) and the monk parakeet (*Myiopsitta monachus*) are two of the most successful avian invaders worldwide, causing several ecological and socio-economic impacts in recipient regions. We used image-based questionnaires to assess differences in people's perceptions of recently established ring-necked and monk parakeet colonies in an urban environment (Porto, Portugal). Most participants recognised both species and had a positive perception of the parakeets, with respondents' education, gender and age influencing their perception. Potential ecological, economic and social impacts caused by these species do not seem be widely acknowledged yet, likely due to the limited awareness of IAS or the incipiency of their impacts in the area. Our results suggest future actions to manage feral parakeet populations in the area will likely be met with public opposition. While increased public literacy about IAS might help improve risk awareness, complementary tools should be used to promote support for potential interventions. Social assessments are vital to identify, evaluate and address social costs and benefits of IAS. Further research should adopt a multidisciplinary approach to foster communication in IAS management actions, implementing effective and sustainable measures to tackle biological invasions by charismatic vertebrates.

Keywords Invasive alien species · Monk parakeet · Ring-necked parakeet

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Introduction

Biological invasions, defined as the appearance and geographical expansion of species outside their native range, are considered a major threat to natural ecosystems (Ehrenfeld 2010; Simberloff et al. 2013) and a driver of global change (Reid et al. 2005; Ricciardi 2007). Although essential, the management of invasive alien species (IAS) has been increasingly recognised as an emerging social conflict issue, making the inclusion of the human dimension fundamental for successful IAS actions (Crowley et al. 2019).

Given the wide range of detrimental effects and services provided by IAS worldwide (Milanović et al. 2020), perceptions of IAS are diverse and require an interdisciplinary approach for assessing trade-offs and facilitating implementation of management practices (García-Llorente et al. 2008). Kapitza et al. (2019) identified five main categories of influence on IAS perception: ecological conditions, social conditions, values and beliefs, impacts and benefits. Shackleton

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et al. (2019) also provided an overview of factors influencing human perceptions of IAS, including (a) attributes of the individual perceiving the species; (b) characteristics of the species itself; (c) effects of the invasion (including negative and positive impacts, i.e. benefits and costs); (d) socio-cultural context; (e) landscape context; and (f) institutional and policy context. For example, community and cultural attachments to introduced species can develop relatively quickly; in Chicago, monk parakeets (MP) (*Myiopsitta monachus*) introduced during the last 50 years have become to symbolise the resilience and diversity of the city's human inhabitants, and efforts to control these birds have inspired strong opposition (Pruett-Jones et al. 2012).

People's perceptions and responses to IAS management are often overlooked during action planning, triggering bitter disputes and compromising management success (Crowley et al. 2017). An improved understanding of what drives people's perceptions of IAS can thus help anticipate and deal with conflicts of interest, facilitate prioritisation and decision-making, and stimulate effective stakeholder engagement, collaboration and dialogue (Shackleton et al. 2019a). For example, understanding if perceptions change when people are informed or reminded that a given species is alien may establish the extent to which increasing awareness about IAS can effectively alter behaviours and drive support for IAS management.

Birds are among the most successful vertebrate invaders, causing extensive damage to agriculture and natural environments (Hulme 2009; Simberloff et al. 2013; Turbé et al. 2017). Parrots (Psittaciformes), one of the most popular birds traded as pets, are known to successfully become established in new environments as a result of accidental escapes or deliberate releases (Abellán et al. 2017; Cardador et al. 2017; Mori et al. 2020). The ring-necked parakeet (RNP) (*Psittacula krameri*) and the MP (*Myiopsitta monachus*) are particularly widespread outside their native ranges, and known to cause multiple ecological and socioeconomic impacts (e.g. competition with native species, agricultural losses, noise nuisance) (Senar et al. 2016; Hernández-Brito et al. 2018; White et al. 2019). The RNP was first reported in Europe during the late 1960s, and there are currently over 85,000 birds in the continent, especially concentrated in urban areas (Butler 2003; DAISIE 2009; Czajka 2011; Pârâu et al. 2016). The MP is currently the most abundant invasive parrot in Spain and the USA (Muñoz and Real 2006).

In this study, we used image-based questionnaires to gather information on people's perceptions of two alien parakeets, the RNP and the MP, in a recently colonised urban area (Porto, NW coast of Portugal). Humans engage with the environment through a range of experiences, and visual perceptions are key for human connection to ecological phenomena. An image-based approach should thus be useful for understanding people's perceptions of biodiversity (Bayne et al. 2012; Shwartz et al. 2013; Lindemann-Matthies 2016). Adapting a methodology proposed by Luna et al. (2019), we used an image-based survey designed to be appealing, easy to apply and give away minimum information about its purpose.

Our study aimed to (a) assess the degree to which parakeets are considered desirable in surveyed parks; (b) identify the factors (e.g. respondent's sociodemographic aspects, perception of the parakeets' beauty, abundance or worth, knowledge of the parakeets' alien origin); and (c) determine people's desire for the parakeets' presence and overall perception of the parakeets.

Methods

Study area and population

In Portugal, the RNP was first recorded in the wild in 1977, in Pancas (Tagus River estuary, Santarém district), presumably following an escape from captivity (Matias 2010). The largest population is established in Lisbon, where it was first reported in 1999, at the city zoo's free access gardens (Matias 2010). The population was first estimated at a maximum of 208 individuals (2003), and more recent estimates suggest 644 parakeets (Luna et al. 2016), which implies a steady population increase. Porto is Portugal's second biggest city, located in the northern coast, with ca. 2.66 million inhabitants. The metropolitan area of Porto's parks corresponds to 42.4 ha and 22% of the region's total area. The colonisation of Porto area is more recent, as it has only been present for ca. 15 years, with the first confirmed sighting reported in 2008, although observations of isolated individuals occurred since 2002 (Matias 2010). The city's RNP population is composed of approximately 16 individuals, while the MP is estimated at 31 (Carneiro, 2018, unpublished data). Hence, both populations are relatively small, albeit conspicuous, and present the ideal conditions to understand people's perceptions of IAS before infestation.

Based on personal observations and eBird (www.ebird.org) data records, we selected parks and gardens with and without known parakeet presence within the city. We used 11 different parks and gardens scattered throughout the city of Porto to implement our survey (Fig. 1). Given logistic restrictions, all surveys were conducted between October 2016 and March 2018 by the same person (I.C.), in Portuguese.

To explore whether perceptions about parakeets depend on prior familiarity with the birds or their impacts, we surveyed four target groups predefined based on their exposure to the parakeets: (a) visitors of parks where parakeets are present; (b) visitors of parks without parakeets; (c) workers of parks where parakeets are present and (d) recreational fishermen in Passeio Alegre, a garden located on the Douro river bank. This target group was chosen because these fishermen spend long hours fishing close to MPs' nests and we assume might be more

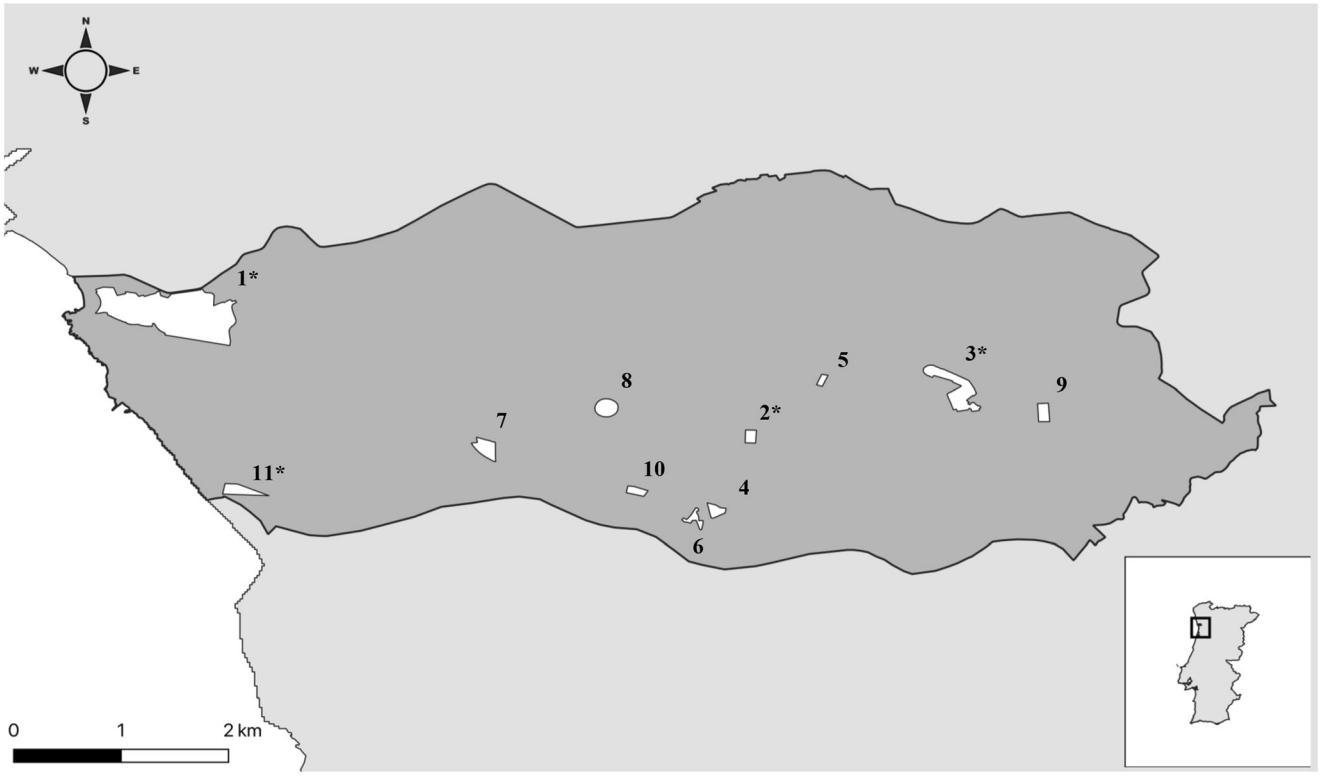

Fig. 1 Map showing the parks and gardens surveyed in our study area (Porto, Portugal — see inset). 1 — Parque da Cidade; 2 — Praça da República; 3 — Parque de S. Roque; 4 — Jardim da Cordoaria; 5 — Jardim do Marquês de Pombal; 6 — Jardim das Virtudes; 7 — Jardim Botânico; 8 — Rotunda da Boavista; 9 — Jardim da Corujeira; 10 — Palácio de Cristal and 11 — Passeio dos Alegres. Asterisks indicate parks and gardens with parakeets: parks with ring-necked parakeets were Parque da Cidade (16–17 individuals) and Parque de S. Roque (2 individuals); parks with monk parakeets were Passeio dos Alegres (31 individuals) and Praça da República (6 individuals)

likely to perceive this species negatively due to noise nuisance.

Potential respondents were approached using street-intercept surveys (Miller et al. 1997). We carried out 50–60 surveys per target group. For park visitors, every third person (residing in Porto and over 16 years old) encountered was invited to take the survey. Due the limited numbers of fishermen and park workers, we administered the survey to all suitable subjects encountered for these groups.

Survey design and implementation

We used questionnaires incorporating a novel visual tool developed and tested by Luna et al. (2019) to assess perceptions of the RNP in Seville (Spain). This questionnaire included a visual (Figure S1, Supplementary material) and a verbal component. Respondents were first asked to choose which species they like to see present in the park, from a plate with images of 20 bird species. Afterwards, they were asked about their perception of the parakeets using a traditional question-based survey, and finally they provided personal data. The questionnaire was pretested using a pilot group composed of ten university students and I.C.'s family members (afterwards excluded from the survey). Their responses helped determine average questionnaire completion time, redefine objectives, broaden the scope of the questions and improve the clarity of the questionnaire.

Survey implementation

Each study participant was presented with an image plate and asked to choose ten birds that they would like to see present in the environment (garden or park) in which that particular survey was being implemented. We expected that if the parakeets were positively perceived, there would be a higher probability of them being chosen. In order to minimise possible biases, we did not talk specifically about the parakeets nor did we answer any question about the specific purpose of the survey or the species shown.

Three questions were then asked to evaluate respondents' awareness about the two focal parakeets, while pointing at its image in the previously shown plate, depending on species' presence at each survey site; they were specifically asked if they were familiar with that particular bird ("Do you know this bird?"), if they knew its name ("Do you know this bird's name?") and if they had seen it in that specific survey site ("Have you seen this bird in this park/garden?"). Fishermen

were only asked about the MP since that is the species present in Passeio Alegre.

After the image-based component of the study, we also asked respondents about their perception of the parakeets using a traditional question-based survey based on the companion animal bonding scale (Poresky et al. 1988), modified by Luna et al. (2019) (Table S1, Supplementary material). This scoring was used to explore whether a respondent's selection of a specific parakeet was associated with the attribution of positive adjectives to that species, and which characteristics explained people's perception of the parakeets.

Finally, we asked brief socio-demographic questions (gender, year of birth, size of the city where they lived before the age of 16, size of the city where they currently live and education level) to characterise potential differences among subjects and explore how those might be associated to people's perceptions of parakeets.

Data analysis

Factors affecting parakeet selection

First, we tested if parakeet selection differed significantly across target groups, using a Krustal-Wallis test. Afterwards, to explore which variables determined the selection of the parakeets during the visual survey, we used generalised linear models (GLM), fitted with a binomial error and a logistic link function. The selection of the focal parakeet was used as the dependent variable, and target group, presence of the "non-native" tag, socio-demographic aspects, familiarity/sightings of the species and the plates used were set as predictors. Before proceeding with the modelling process, we checked whether there was collinearity between predictors, by computing the variance inflation factor. Since none of our variables showed high values (VIF>5), we considered all variables in the subsequent analyses (Lin 2012).

We used function "dredge" from the R package MuMIn (Bartoń 2014), followed by function "model.avg" to obtain the averaged coefficients, weighted by the AICc of each model. Finally, we used the function "confint" to obtain the respective confidence intervals. All these analyses were conducted separately for the selection of the RNP and MP.

Factors affecting people's perceptions of parakeets

To determine which factors influence respondents' overall perception about parakeets, we repeated the same procedure as above (dredge and model averaging) with the same set of predictor variables as before (in the full model) but using people's overall perception of the parakeets as response variable. Overall perception was quantified by the sum of the 11 scores given to the adjective list provided during the second part of the survey, depicting a gradient from a highly negative (11) to a highly positive (77) perception of the species.

We then analysed in more detail how each component of the overall perception was influenced by the same set of predictors. To do so, we summarised the results of the second part of the survey (i.e. the scores people gave to parakeets' characteristics) with a principal component analysis (PCA) using R function "prcomp". We then conducted the same model averaging procedure as before, using the most important principal components' scores as dependent variables, instead of the overall ordinal perception.

Finally, to test if visual parakeet selection was associated with the respondent's perception of the species, we performed a Pearson correlation test between parakeet selection and the PCA scores of the first two axes. All these analyses were performed separately for the selection of the RNP parakeet and the MP.

We used the program R (R Core Team 2017) for all statistical analysis, and packages "VIF", "MuMIn" and "Splines" (Lin 2012; Bartoń 2014; Wang and Yan 2018).

Results

Survey respondents

We completed a total of 223 surveys, with a non-response rate of 10%. Regarding target groups, we conducted (a) 50 surveys with workers of parks with parakeets; (b) 60 surveys with visitors of parks with parakeets; (c) 60 surveys with visitors of parks without parakeets and (d) 53 surveys with recreational fishermen in Passeio Alegre. The modal respondent was male, 40 to 50 years old, grew up and lived either in cities smaller than Porto, or in Porto, and had a high school diploma (Table 1).

Parakeet selection

When people were asked to visually choose ten out of 20 species they desired to see represented in the site, 46% (n = 102) of the respondents chose both parakeets, 33% (n = 73) chose one parakeet and only 22% (n = 48) chose neither species of parakeet. Parakeet selection was similar across surveyed groups ($H(3) = 3$; p-value=0.392) (Fig. 2a).

Regarding reported sightings (responses to question "Have you seen this species?", pointing at the species' image), the MP was seen more often (88%) than the RNP (12%), and recreational fishermen reported more sightings (83%) than other survey groups (Fig. 2b). Regarding familiarity with parakeets (responses to the question "Do you know this species?", pointing at the species' image), approximately 60% of surveyed respondents stated they knew the MP, and ca. 50% said they knew the RNP. From the four target groups, workers

Table 1 Summary of key demographic characteristics of the study participants (*N*=223). Categories with no registered counts were omitted (e.g. residence in cities larger than Porto)

Characteristics	Level	Count	Percentage
Gender	Male	142	63.68
	Female	81	36.32
Age group	< 20	20	8.97
	20–30	33	14.80
	30–40	37	16.59
	40–50	41	18.39
	50–60	45	20.18
	60–70	33	14.80
	> 70	14	6.28
Place of residence until 16 years old	City smaller than Porto	122	54.71
	Porto	101	45.29
Current place of residence	City smaller than Porto	119	53.36
	Porto	104	46.64
Education level	High school	73	32.74
	Bachelor degree	41	18.39
	Master degree and above	13	5.83

of parks with parakeets were the most aware of both parakeets' existence (62% knew either species), while 88% of recreational fishermen surveyed stated they were familiar with the MP (Fig. 2c). When questioned whether they knew the parakeets' name, all respondents mentioned names commonly associated with the Psittacidae family, namely "parakeet" or "parrot" (Fig. S1, Supplementary material). Only in the case of the ring-necked parakeet, four people gave the exact name of the species.

Regarding the RNP, respondents' decade of birth (years of birth were grouped into decade of birth) was the main predictor of parakeet selection, as respondents born during the 1960s and 1970s (now 60 to 41 years old) were less likely to select this species (Fig. 3). On the other hand, selection of the MP appears to be mainly explained by the region where the respondents lived before age 16. People who grew up in cities smaller than Porto tended to select the MP more often than those who grew up in Porto (Fig. 3).

Respondents' perceptions of the exotic parakeets

Ring-necked parakeet

Regarding people's overall perception (sum of the 11 scores given to the adjectives provided during the second part of the survey, depicting a gradient from a highly negative (11) to a highly positive (77) perception of the species) of the RNP, our results suggest perceptions of this parakeet were best explained by respondents' education level and gender. Specifically, people with lower education and men had a more positive perception of this species (Fig. 3).

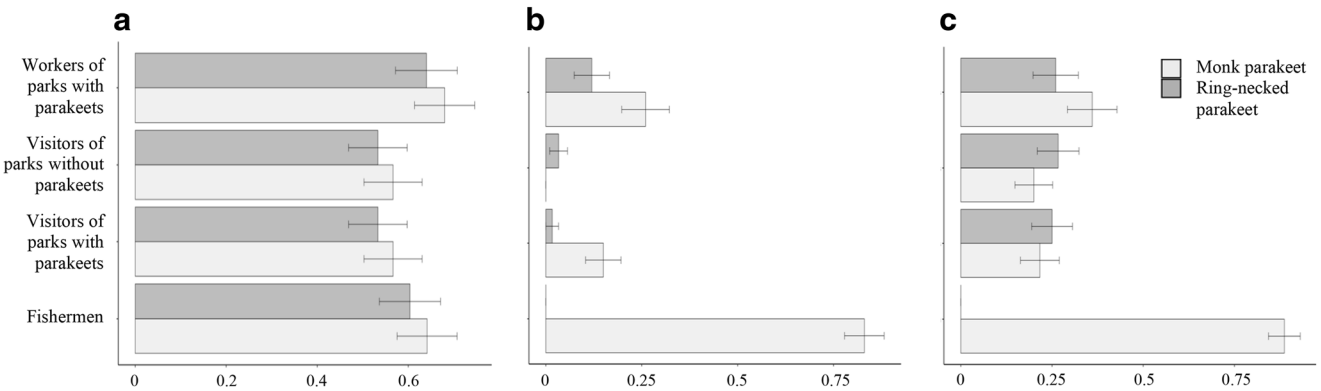

Fig. 2 Prevalence of parakeet species selection across surveyed groups (a); and prevalence for respondent's reported familiarity and sightings of the exotic parakeets (b, c). Sightings (b) assessed by asking respondents if they have ever seen either species in the surveyed park, and familiarity (c) with the parakeets was assessed by asking respondents whether they knew the species. *N* (visitors of parks with parakeets)=60; *N* (visitors of parks without parakeets)=60; *N* (workers of parks with parakeets)=50; *N* (recreational fishermen)=53

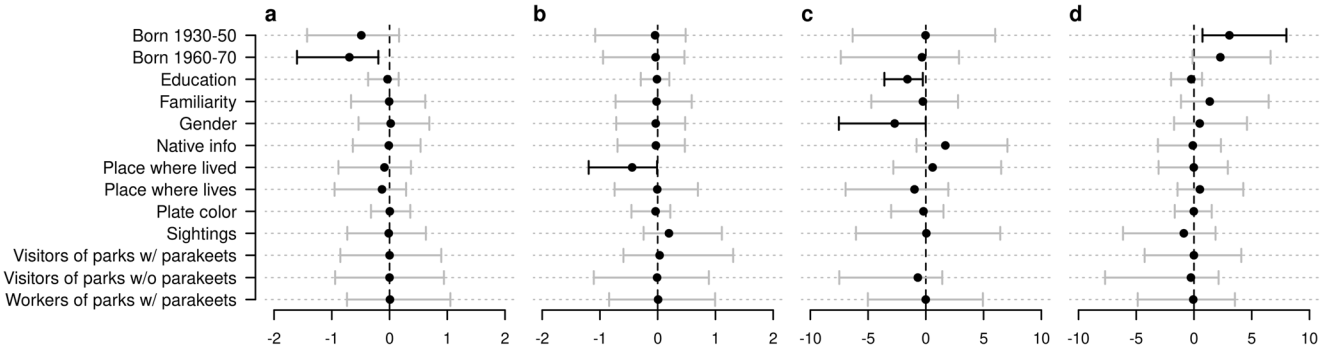

Fig. 3 Averaged model coefficient estimates and confidence intervals for ring-necked (**a**, **c**) and monk parakeet (**b**, **d**) selection and overall perception (sum of the 11 scores given to the adjectives in Table S1). Significant coefficients represented in black. Reference level for gender is male, for plate colour is "bright", for education is "high school" and for place where lives/lived is "cities smaller than Porto"

Model averaging conducted using the Friendliness axis (scores of PC1) as a function of social predictors showed that people with lower education gave higher friendliness scores to this species (Table S2 and Fig. S3, Supplementary material).

Monk parakeet

Our results show that people's overall perception of the MP is mostly influenced by respondents' age (Fig. 3), as older people tend to have a positive perception of this species. Model averaging conducted with the PCA scores of the "Dullness + Friendly" axis showed that park visitors consider it noisy while workers of parks with parakeets and younger people consider it colourful, friendly and good (Table S3 and Fig. S5, Supplementary material). Model averaging conducted with the PCA scores of the "Abundance" axis suggest people living in Porto or older people tend to have more negative perceptions of the MP (Table S3 and Fig. S6, Supplementary material).

RNP visual selection was moderately related to respondents' scores in aspects that formed the "Friendliness axis" (r = 0.35; N=83; p-value = 0.0012), as people who had a positive perception about the species' friendliness were more prone to selecting it.

Discussion

This study underpins the importance of people's perceptions of IAS in the most important metro area of NW Iberia, providing a better understanding of people's perceptions of recently established alien parakeet populations in urban environments, as well as its determinants. People's perceptions of IAS can be highly context specific, varying substantially between different individuals, groups, areas (e.g. countries and landscapes) and over time (Kapitza et al. 2019; Shackleton et al. 2019a), with species charisma affecting all stages of the invasion process (Jarić et al. 2020).

We expected that, if people perceived parakeets positively, they would be often selected as a desired species. Indeed, parakeets were a very popular choice, with almost 80% of the respondents choosing at least one of the two parakeets. Parrots are intelligent, visually attractive, easily tamed and able to mimic the human voice; these traits have made them extremely popular pet birds and the most traded bird taxa globally (Tella and Hiraldo 2014; Mori et al. 2017). Even though the percentage of deviance explained by the models was low, we found that respondents born in the 1960s and 1970s were less likely to choose a parakeet. Fitzgerald et al. (2007) also found that older people are more reluctant to choose an alien species to be part of their environment.

People's familiarity with the target species proved to be quite high, with over half of the respondents stating they knew the parakeets. However, there was a considerable difference between the two species, as respondents were mostly familiar with the MP, especially target groups with increased exposure to the birds. Likewise, there was a very noticeable difference between the two species regarding sighting reports, with the MP seen almost five times as often as the RNP. Although both species are rare in the city, MPs are slightly more abundant in the study area, compared to RNP. Furthermore, RNP are not easily observed, as they often perch high up in trees and do not build conspicuous nests (Senar et al. 2012). In contrast, MPs often feed on the ground and build conspicuous and large stick nests (Forshaw 2010).

We expected different target groups — defined a priori by their level of exposure to the parakeets — to have distinctive perceptions about the parakeets, as has been shown in other studies (García-Llorente et al. 2008; Luna et al. 2019). However, our results showed no significant differences in target groups' parakeet selection or overall perception. In fact, both visitors from parks with and without parakeets gave low scores to bird colourfulness and friendliness, which may also reflect the possibility that many visitors might go to both types of park, hence attenuating eventual differences. Perhaps not even groups accustomed with

the birds' presence — recreational fishermen and workers of parks with parakeets — personally feel the consequences of their presence. It is possible that, even though these groups already experience some of the impacts of this species' presence, such as the loud and constant noise, they still appreciate the presence of such charismatic species in urban gardens and parks (Avery et al. 2006). However, in the future, this perception could change if the parakeets' populations grow larger, and more negative impacts emerge (Luna et al. 2019).

We found that overall respondents have a very positive perception of both parakeets. This seems to be particularly true for the RNP, which may again be explained by the species' lower abundance and conspicuousness in the city, when compared with the MP. Various studies support the idea that public perceptions of different animal species are based on peoples' emotional connections with those species, with animals regarded as pets being perceived more positively (Fox 1990; Fitzgerald et al. 2007). As MPs are seen more often, people may perceive them as a feral bird, while the rarer RNP might still be mostly regarded as a pet. Gender also seems to be an important factor, with men having a more positive perception of the RNP. Men and women often have fundamentally different values and perceptions of wildlife management or ecological issues (Lauber et al. 2001; Dougherty et al. 2003), but this trend was not apparent in our study.

Understanding perceptions helps anticipate potential conflicts in the management of particular IAS, especially those with both positive and negative attributes and effects (Shackleton et al. 2019a), such as parakeets. Conflicts can arise over control techniques particularly regarding animal welfare, and knowing local perceptions can help mitigate these conflicts (Olszańska et al. 2016; Crowley et al. 2019; Villatoro et al. 2019) and enable the development of programmes to engage and inform stakeholders (Novoa et al. 2018; Shackleton et al. 2019b). In our study, most people disregarded the "Non-Native" tag when choosing the species they would like to see present in the area. This could be due to respondents being unfamiliar with the term "non-native" or their unawareness of the consequences that IAS may have in recipient environments (McKinney 2006; Fraser 2001; van Ham et al. 2013), requiring further research.

Our results raise two major concerns: first, respondent's positive perception of parakeets means that future actions to control or eradicate the populations of feral parakeets will likely be met with public opposition, compromising its effectiveness (Bremner and Park 2007). Second, people appear to have limited knowledge or concerns about the ecological, economic and social impacts that the presence of a potential invasive bird, such as the parakeet, may have in urban parks and gardens (García-Llorente et al. 2008; White et al. 2019), which may lead to additional intentional releases of alien birds, thus worsening an already growing problem. Due to our focus on a single case-study, further research is required, including comparisons across case studies. While the survey tool developed by Luna et al. (2019) adapted in our study would have to be further tested (e.g. regarding its reliability, inclusion of additional explanatory variables and measurement error), similar assessments should be considered as part of IAS management, identifying locally relevant strategies and target groups. Nevertheless, our results confirm the vital role that social assessments may have in identifying, evaluating and addressing the social costs and benefits of IAS (Crowley et al. 2017).

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10344-021-01487-1.

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Author's contribution Inês Carneiro, Pim Edelaar, Álvaro Luna and Luís Reino contributed to study conception and design. Data collection and analysis were performed by Inês Carneiro and Miguel Porto. The first draft of the manuscript was written by Inês Carneiro with contributions from Luís Reino. Following versions were written by Joana Ribeiro with contributions from Ana Nuno and Luís Reino. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Availability of data and material To be made available upon approval.

Code availability To be made available upon approval.

Declarations

Ethics approval Ethical clearance for our research work was not required by the University of Porto (where Inês Carneiro was based when conducting this research, as part of her MSc project), as respondents' identification was not collected (i.e. no names or addresses written down). Nevertheless, our research adopted international best practices and adhered to the guidelines by the British Sociological Association Statement

of Ethical Practice (2017). In particular, when approached for participation, survey respondents were informed that participation was voluntary and anonymous; withdrawal was possible at any time; individual details would not be disclosed or identifiable and information collected would be used for research purposes only.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication Not applicable

Conflict of interest The authors declare no competing interests.

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