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Research Article

Not in the countryside please! Investigating UK residents' perceptions of an introduced species, the ring-necked parakeet (*Psittacula krameri*)

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Abstract

Wildlife management can generate social conflict when stakeholder perceptions of the target species are not considered. Introduced Ring-necked Parakeets (RNP) are established in the UK and have been added to the 'general licence' of birds that can be killed to prevent serious economic damage. We aimed to better understand perceptions of RNPs on a nationwide scale to inform mitigation actions for potential future conflict over RNP management. We surveyed 3,947 UK residents to understand awareness of, knowledge of and attitudes towards the RNP across the UK.

We found that most respondents (90.2%) were aware of the RNP. Almost half of respondents (45.9%) held negative opinions, particularly against the RNP in rural areas (64.7%), suggesting landscape contexts influence attitudes. Respondent preference for the RNP was low in local neighbourhoods (7.80%) although the species was considered aesthetically pleasing by most (83.0%). Many respondents knew the species' name (54.9%), but underestimated current population numbers in the UK (82.6%) and few knew its full native range (10.0%). We identified respondents' ecological interest, age, education, preference for, awareness of and knowledge of the RNP as significant factors associated with perceptions.

Our findings suggest that the RNP presents a complex socio-environmental challenge, with respondent awareness, knowledge and attitudes each forming an important component of perceptions towards this species. We recommend that wildlife managers utilise our findings and cohesive approach to enhance future RNP perception research in the UK and abroad and towards the success of any proposed management initiatives under the UK general licence.

Key words: Attitudes, awareness, human-wildlife interaction, introduced species, parakeet, social impacts, urban ecology, wildlife management

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Introduction

The societal implications of non-native species (NNS) are less well-researched than their economic and ecological effects (Kapitza et al. 2019). Societal implications refer to how people recognise and perceive NNS in various contexts, from the origins of the NNS in their introduced range to the species' impacts on people's lives (Kapitza et al. 2019). This knowledge gap has been criticised (Gobster 2005; Gozlan et al. 2013;

Abrahams et al. 2019; Kapitza et al. 2019), as their study and incorporation into a NNS management plan can greatly improve the acceptance, support for, implementation and success of that plan with stakeholders (Crowley et al. 2017; Jarić et al. 2020). Social and cultural research can explain why and how people view NNS, which often varies across stakeholders (García-Llorente et al. 2008; Kapitza et al. 2019). Ignoring the societal implications of an NNS can result in conflict over suitable management and hinder successful programmes addressing problems caused by the NNS (Rotherham and Lambert 2011; Crowley et al. 2017, 2019; Shackleton et al. 2019).

The Ring-necked or Rose-ringed Parakeet (*Psittacula krameri*, from hereon RNP) is native to rural woodland, savannah and farmland habitats of sub-Saharan Africa and southern Asia, but has at least 90 established breeding populations across Europe (Pârâu et al. 2016). Outside its native range, the RNP predominantly occurs within urban environments, where warmer microclimates and abundant supplementary food have created suitable conditions for it to survive and thrive (Peck et al. 2014; Pârâu et al. 2016). The current UK population size was recently estimated at 12,000 breeding pairs (Woodward et al. 2020) and was listed by Pârâu et al. (2016) as the largest non-native population across Europe.

The RNP has ecological and socio-economic impacts across mainland Europe (White et al. 2019). Competition for nest sites has had negative and highly-localised declines on cavity occupation by Greater Noctules (*Nyctalus lasiopterus*) in Seville (Spain) and competition for cavity nests (although not definitive impacts) with Nuthatches (*Sitta europea*) in Belgium (Strubbe and Matthysen 2009; Hernández-Brito et al. 2018). The RNP's impacts on agriculture in mainland Europe include minor, local damage to sunflower crops and to fruit trees (White et al. 2019). Other documented effects include noise disturbance from large roosts (Mori et al. 2020), well-being benefits to humans, derived from observing the exotic species (Peck 2014), and its potential as a reservoir of avian pathogens and disease (Menchetti et al. 2016).

Previous studies have found no clear ecological impacts of the RNP on native bird populations in the UK (Newson et al. 2011; Peck et al. 2014; Pringle and Siriwardena 2022), although Peck et al. (2014) found that some native birds increased their vigilance at the cost of their feeding time in the presence of the RNP. Its socio-economic impacts in the UK remain anecdotal (White et al. 2019). While the RNP has been reported to damage UK orchards and vineyards (Menchetti et al. 2016), White et al. (2019) argue that evidence for these agricultural impacts is currently limited and localised. A clear picture of the RNP's impacts in the UK is further complicated by the existence of numerous stories, grey literature, hearsay and beliefs about its impacts (Menchetti et al. 2016; Heald et al. 2019; Hunt and Mitchell 2019).

Despite this ambiguity surrounding the RNP's impact in the UK, it was added to two of the three general licences in 2021 (DEFRA 2020b), which allow people to kill certain species of wild birds. The two defined purposes to kill are "to conserve wild birds and fauna of conservation concern" and "to prevent serious damage to crops, fruit and vegetables"; the species is not under the third licence with the defined purpose "to preserve public health or public safety" (DEFRA 2020a). DEFRA has, to date, not provided any management strategy for the species.

Any assessment of management options for RNPs can benefit from a better understanding of people's perceptions towards the species (Beever et al. 2019; Luna et al. 2019). This is particularly the case because the species presents a unique and complicated scenario, where it is a poorly socially-researched non-native with a

large population that has had few demonstrable invasive effects and yet can be removed locally. Crowley et al. (2019) illustrate how a management plan for the small population of Monk Parakeets (*Myiopsitta monachus*) in the UK stalled following fierce opposition from both animal rights campaigners and local residents with emotional and cultural attachments to the birds. These stakeholders had not been consulted prior to the announcement of the cull and they disagreed with DEFRA's management justification, albeit for varied reasons (Crowley et al. 2019). To date, only one study by Baker (2010) has explored respondent perceptions of the RNP in the UK and this survey was focused solely on Greater London. Baker (2010), Berthier et al. (2017) and Luna et al. (2019) found a high awareness of the RNP in London, Paris and Seville, respectively. Knowledge about the RNP was limited to investigating whether respondents could name the RNP and, in Luna et al. (2019), several respondents were capable of doing so to the family level. Many respondents in different studies appreciated the RNP's aesthetic qualities (Berthier et al. 2017; Luna et al. 2019; Ribeiro et al. 2021), although respondent preference for the RNP varied and attitudes became more negative with increased exposure to the RNP, probably due to increased respondent awareness of the RNP's local impacts (Berthier et al. 2017; Luna et al. 2019; Mori et al. 2020).

While Greater London holds the majority of the UK's RNP population, they are also present in other areas and likely to spread (Holden and Cleeves 2014). This leaves a research gap concerning perceptions of the RNP held by individuals across the UK. These wider perceptions, if known, could be utilised to identify, anticipate and mitigate any possible conflict.

We aimed to improve our understanding of our respondents' perceptions of the RNP to inform mitigation actions for RNP management. We used an online questionnaire that focused on assessing respondents' awareness, knowledge and attitudes towards this species. We employed a national approach to compare and contrast our results with the city-specific findings of Baker (2010) and other RNP perception studies conducted in mainland Europe. We summarise these studies and their detailed findings in the Suppl. material 1: section S1, table S1.1. We expected our respondent sample's awareness of the RNP to be similarly high to London-based Baker (2010) and Luna et al. (2019). We explored attitudes within landscape and species service/disservice contexts as per the conceptual frameworks (Kapitza et al. 2019; Shackleton et al. 2019). We also aimed to identify factors associated with awareness of and attitudes towards the RNP. These included respondents' socio-demographic background, local RNP densities and preference for the RNP and some of these were chosen following the methods and findings of previous RNP perception studies. We hope that, by directly addressing awareness, knowledge and attitudes simultaneously, we can provide the most encompassing research into perceptions of the RNP across Europe to date. Through our findings, we hope to contribute important social and cultural perspectives that inform risk assessment and management of the RNP in the UK and in other areas of its introduced range.

Methods

Survey design

We used the conceptual frameworks presented in Shackleton et al. (2019) and Kapitza et al. (2019) as a structural basis for identifying factors associated with

UK-wide perceptions of the RNP (see Suppl. material 1: section S2). We developed an online questionnaire, comprising both closed and open questions, using the Qualtrics platform (Qualirics 2005). Respondents had to live within the UK and be aged 18 or over. The questionnaire was advertised as a UK bird perception study. This was to attract respondents who may not have responded to a questionnaire only about the RNP and avoided responses being dominated by people with existing strong interests in, or opinions about, the RNP. The survey end-page explained the full intentions of the survey and respondents were clearly presented with the option to withdraw their responses if they so wished.

The questionnaire was piloted for clarity and validity with a sample of 35 individuals. A copy of the final version of the questionnaire and the associated coding/scoring structure is provided in Suppl. material 1: section S3. Approval for this study was granted by the Imperial College Research Ethics Committee (SETREC Reference: 19IC5114). The questionnaire contained four sections, focusing on: 1) socio-demographic information and individual respondent attributes, 2) awareness of the RNP, 3) knowledge about the RNP and 4) attitudes towards the RNP.

The socio-demographic information collected comprised: gender, age, highest level of completed education, first half of postcode of residence and whether they lived in the same residence as when aged 16. The postcode information allowed us to assign a Rural-Urban Classification (RUC) category to each respondent (Office for National Statistics 2019) and to subsequently capture whether a respondent lived in a rural or urban area.

We determined the local RNP density for each respondent by spatially matching data for maximum sightings of the RNP at a 10-km x 10-km square scale, from the Bird Atlas 2007–2011 (Balmer et al. 2013; Gillings et al. 2019), to respondents' postcode prefixes. Bird Atlas 2007–2011 comprises systematic survey data for the entirety of Britain and Ireland and, therefore, represents an accurate and unbiased account of RNP density and distribution. We also collected information on three nature-focused variables for each respondent - nature relatedness; self-assessed bird identification expertise (on a scale of novice [1] to expert [5]); and whether they were a member of wildlife, nature or environmental organisation. These three separate variables can be interpreted as representing respondents' "ecological interest", as respondents who are closely connected to nature, members of wildlife groups and have a greater self-assessed bird identification expertise can be argued as possessing greater interest in ecological systems and organisms. To measure respondents' nature relatedness, an attribute designed to capture how individuals view their relationship with the natural world (Nisbet and Zelenski 2013), we used the 6-item Nature Relatedness scale (NR-6) (Nisbet and Zelenski 2013). Each respondent was asked to rate their level of agreement with each statement on a 5-point Likert scale, from 1-strongly disagree to 5-strongly agree. Based on satisfactory reliability for the scale (Cronbach's alpha = 0.72), we averaged the scores from the six items to derive a single NR-6 measure per individual.

Respondents were asked about their preference for the as-yet unnamed RNP in their local neighbourhood. We presented respondents with a nameless image of the RNP alongside nine other nameless images of UK common birds. We asked respondents to select the four species that they would most like to see in their neighbourhood (defined as the area an individual can cover in a twenty-minute walk around their home). The RNP and another city-dwelling bird, *Columba livia* (Feral Pigeon), were fixed choices for all respondents. The other eight bird options

were randomised from a larger selection of 18 UK birds (see Suppl. material 1: section S4 for list of species and images). Nine of the 18 birds were judged to be colourful and other nine not so as to provide a balance for respondents to choose from and ensure no bias occurred.

To assess respondents' awareness of the RNP, they were presented with an unnamed image of the species and asked, "Do you know this bird?" (options: yes; no; unsure). Respondents were also separately asked "Have you encountered this bird before?" (options: yes [neighbourhood only, elsewhere only, both neighbourhood and elsewhere]; no).

To assess one component of respondents' knowledge of the RNP, we asked them to name the species from the image provided. To score 'correct' [2], the full common or scientific name had to be given (including the synonym Rose-Ringed Parakeet). If only the common genus or family name was correct then it scored 'partly correct' [1] (e.g. parakeet/parrot), otherwise we classified the answer as 'incorrect' [0]. Spelling did not affect classification as long as the name could be determined.

Following these questions, respondents were again presented with an image of the RNP and told its full name. To further assess respondents' knowledge of the size of and provenance of the UK's RNP population, respondents were presented with two multiple-choice questions. Respondents were asked to select the correct: 1) current estimated RNP population size and 2) the continent(s) to which the species is native. Respondents were not shown the correct answers to these questions at this point in the survey. Table 1 summarises how answers to these two questions contributed to a composite "Knowledge" variable alongside respondents' ability to name the bird (see Suppl. material 1: section S3 for how these two questions were displayed to respondents).

Attitudes towards the RNP were measured by asking respondents whether they would like to see the RNP in urban and rural areas of the UK. For both questions, respondents were asked to rate their level of agreement on a 5-point Likert-type scale from 1-strongly disagree to 5-strongly agree. The mid-point score (3) on this scale was "indifferent" and a sixth "I don't know" option was available. We chose to ask these questions given the potential influences of the RNP's urban-centric UK distribution on attitudes and to capture socio-cultural and landscape contexts of respondents' perceptions of the RNP.

Respondents who had encountered the RNP before were given the opportunity to provide any stories or experiences that they may have had with the RNP in an open-text box following the answers they gave to "would you like to see the RNP in rural/urban areas?".

We also presented respondents who had encountered the RNP before with six attitudinal statements, adapted from Belaire et al. (2015). We asked these to better understand respondents' perceptions of the RNP's negative effects and its aesthetic, therapeutic and educational values. These six attitudinal statements were: (1) "They are pleasing to the eye" (aesthetic value), (2) "They make me feel better, physically or mentally" (therapeutic value), (3) "They provide an opportunity for people to learn about nature" (educational value), (4) "They are too noisy" (aesthetic value), (5) "They can be aggressive or intimidating" (stress or fear-inducing effects) and (6) "They make a mess and/or damage my property" (detrimental effects on personal property). The statements' order was randomised for every respondent and responses were scored on a true-Likert scale from 1-strongly disagree to 5-strongly agree (except statements 4–6 which were reverse-scored).

Table 1. Study variables and associated descriptive information (percentage and number of respondents, unless indicated otherwise).

Variable (Shorthand name)	Value range / Levels	% of respondents	N (total n = 3947)
Response variables			
Do you know this bird? (Awareness).	0 = no/unsure	9.8%	388
	1 = yes	90.2%	3559
Would you like to see RNP in urban areas? (Urban)	1 = Definitely not	17.8%	704
	2 = Probably not	28.9%	1140
	3 = Indifferent	18.7%	740
	4 = Probably yes	21.6%	853
	5 = Definitely yes	9.9%	392
	"I don't know" option	3.0%	118
Would you like to see RNP in rural areas? (Rural)	1 = Definitely not	35.4%	1397
	2 = Probably not	29.3%	1157
	3 = Indifferent	12.1%	479
	4 = Probably yes	12.7%	502
	5 = Definitely yes	7.6%	300
	"I don't know" option	2.8%	112
Attitudes toward RNP (Attitude)	Sum of respondents' answers to six attitudinal statements (Belaire et al. 2015). Possible score range = 6–30. 1 = "strongly disagree" through to 5 = "strongly agree".	Mean = 20.0 (SD ± = 4.0)	3217*
Predictor variables			
Member of a nature organisation (Membership)	0 = No	39.2%	1548
	1 = Yes	60.8%	2399
Highest level of completed education (Education)	No education completed (to GCSE level)	1.24%	49
	GCSEs or equivalent	12.0%	472
	A levels or equivalent	18.6%	736
	Undergrad degree or equivalent	32.1%	1266
	Postgrad degree/doctorate/professional qualification or equivalent)	36.1%	1424
Gender	Male	42.1%	1663
	Female	56.9%	2247
	I prefer not to say/Other (please specify)	0.94%	37
Age	18-29	8.08%	319
	30-39	9.48%	374
	40-49	13.9%	547
	50-59	21.6%	854
	60 or older	46.9%	1853
Live in the same city/region as aged 16 (Same residence aged 16)	0 = No	53.7%	2118
	1 = Yes	46.3%	1829
Self-assessed bird identification expertise (Bird Expertise)	1 = novice	5.85%	231
	2	14.1%	555
	3	43.9%	1734
	4	30.0%	1171
	5 = expert	6.49%	256
RNP Density in local area (RNP density)	Count data of RNP individuals sightings from BTO data	Mean = 26.3 (SD ± = 216)	3947
Rural Urban Classification (RUC)	Urban	73.6%	2906
	Rural	26.4%	1041

Variable (Shorthand name)	Value range / Levels	% of respondents	N (total n = 3947)
RNP Knowledge (Knowledge: each knowledge level is the sum of respondents' answers to RNP identification [0, 1, 2], RNP population size [0, 1] and RNP native range [0, 1, 2])	0-1 = Low	25.8%	1020
	2-3 = Intermediate	58.1%	2295
	4-5 = High	16.0%	632
Nature Relatedness (NR-6)	Mean of six answers to NR-6 scale. Possible score range = 1–5. 1 = low nature relatedness; 5 = high nature relatedness	Mean = 4.44 (SD ± = 0.54)	3947
Preference for RNP in local area (RNP preference)	0 = RNP not selected from provided images	92.2%	3639
	1 = RNP selected from provided images	7.80%	308
Preference for Feral Pigeon in local area (FP preference)	0 = FP not selected from provided images	94.7%	3737
	1 = FP selected from provided images	5.30%	210
Specific respondent knowledge and RNP encounter variables			
Respondent knowledge of RNP name	0 = incorrect/no answer	2.46%	97
	1 = genus/family level	42.6%	1682
	2 = species level	54.9%	2168
Respondent knowledge of RNP population	0 = incorrect	82.6%	3261
	1 = correct	17.4%	686
Respondent knowledge of RNP native range	0 = incorrect	45.8%	1808
	1 = partially correct	44.2%	1746
	2 = fully correct	9.96%	393
Encountered RNP in the wild	0 = no	18.5%	730
	1 = yes	81.5%	3217

*Only 3,217 respondents for this variable as it was only presented to respondents who had encountered the RNP before in the wild.

Based on satisfactory reliability for the sum of these six questions (Cronbach's alpha = 0.81), we summed the scores from the six items to derive a single "attitudinal" variable (minimum possible score of 6 and maximum possible score of 30).

Finally, after submitting their own answers for the six attitudinal statements, respondents were shown the correct answers to the knowledge questions alongside some information on the RNP's ecology and behaviour in the UK.

Survey dissemination

We followed a non-probability sampling approach, incorporating both snowball and convenience sampling techniques (Bryman 2016), to enable us to collect a large number of responses in a time- and cost-effective manner. The survey was open from 1 April 2019 to 30 June 2019.

We contacted > 100 institutions and organisations – wildlife and non-wildlife related. We invited them to distribute the questionnaire to their members/followers, for example, via email, newsletter and social media (institutions that helped are listed in Suppl. material 1: section S5). Project accounts were also created for distributing the questionnaire (Twitter, Instagram and Facebook). The survey was accessible to anyone with an internet connection and a computer, tablet or mobile phone. Generalisations made in this study apply only to the respondents and not to the whole UK population.

Data analyses

All raw data from the questionnaire responses were checked for duplications and errors prior to analysis and anomalies and incomplete answers were removed. We

removed 42 of the 3,989 complete responses because positive verification that the respondent lived in the UK could not be achieved. We reclassified respondent education, gender, age and RNP knowledge (Table 1) to ensure that: 1) either there were enough data points in each level of the aforementioned categorical predictor to then help improve our model reliability or 2) that the re-categorised predictor better reflected actual known socio-demographic trends. Please see Suppl. material 1: section S6 for further details on the reclassified categories.

To assess associations between predictors and respondents' answers to whether or not they would like to see the RNP in rural/urban areas, we built two separate Proportional Odds Logistic Regression (POLR) models using the MASS package in R (Venables and Ripley 2002). We refer to these models as "urban" and "rural". "I don't know" answers were omitted for the "rural" (2.84%) and "urban" (2.99%) models. We also built two Generalised Linear Models (GLMs) to assess associations between predictors and respondents' awareness of the RNP and their attitudes through their responses to the amalgamated score from the six statements from Belaire et al. (2015) (i.e. an "attitudinal" model). The first GLM was fitted with a binomial distribution with respondent awareness as the respondent variable (i.e. "awareness" model). The second GLM was fitted with a Gaussian distribution and identity link with the composite attitudinal variable as the response variable (i.e. "attitudinal" model). We fitted all four models with the predictors listed in Table 1 bar two predictors. First, we did not include respondents' knowledge of the RNP as a predictor of respondent awareness because one needs to be aware of something to have knowledge about it in the first place. Second, we did not include whether respondents' had previously encountered the RNP before as a predictor in any of the models because it was a similar predictor to respondents' awareness of the bird.

We checked for collinearity between model predictors in our models using the vif() function from the "car" package in R (Fox and Weisberg 2019). No predictors were removed from any of the four models, as all $GVIF^{(1/(2*df))}$ values were lower than 2.5 as per Santos et al. (Santos et al. 2018).

We conducted a series of model validation steps testing the assumption of Proportional Odds (PO) for our POLR models, goodness of fit using POLR-specific indices alongside standard GLM diagnostic tests and detecting trends in spatial autocorrelation (SAC) for all models. Both POLR models met the PO assumption after graphically inspecting for violation of the PO assumption (Fox and Weisberg 2019). We used the Pulkstenis-Robinson, Lipsitz and Hosmer-Lemeshow goodness-of-fit tests (Fagerland and Hosmer 2016) to conclude that our POLR models are a good fit (Suppl. material 1: section S7). We also ran goodness-of-fit tests on our GLM models (Suppl. material 1: section S7). We found no significant SAC in all models after using correlograms (Rhodes et al. 2009). We applied the dredge() function to our models in R (Kamil Bartoń 2020). We then sifted a 95% confidence set from each list of models produced by dredge() and averaged the list of models using the model.avg() function. We focused on the coefficients produced via the zero-averaging method (i.e. "full averages") as this method is superior to the natural averaging method for identifying which predictors have the strongest effect on the response variable (Grueber et al. 2011).

Finally, a single coder (A.P-B) analysed free-text responses using NVivo (QSR International Pty Ltd. 2018). All responses were coded through an inductive, iterative process of close reading, labelling responses in relation to thematic categories and then refining the groupings by sentiment (i.e. "negative", "mixed", "positive", "unsure", "neutral" and "[reviewer] could not tell"). This inductive approach was

standardised by having the lead author randomly sample and code up to 200 different text answers on three separate occasions before conducting the final labelling process (see Suppl. material 1: section S8) (Van Atteveldt et al. 2021). Word frequency analysis was also used to derive the descriptive words participants most associated with RNPs. Text was cleaned to remove stop words (e.g. 'and', 'the'), punctuation and numbers and inflected forms of each word were grouped so that they could be analysed as a single item (e.g. 'big', 'bigger', 'biggest').

Results

A total of 3,947 respondents completed the questionnaire (Table 1), with skews towards: older individuals, individuals with higher self-assessed bird expertise, individuals who perceive themselves as more connected to nature and individuals who are well-educated. Just under half (42.5%) of our respondents lived in postcodes located within the South-East of England, although this region was not purposefully targeted (Fig. 1). Our sample is an approximately geographically representative sample of the UK population as 32.7% of the UK population live in South East England (Office for National Statistics 2019). Table 2 compares our sample's demographics with the demographics recorded in the 2011 UK-wide census conducted by the Office of National Statistics (Office for National Statistics 2011).

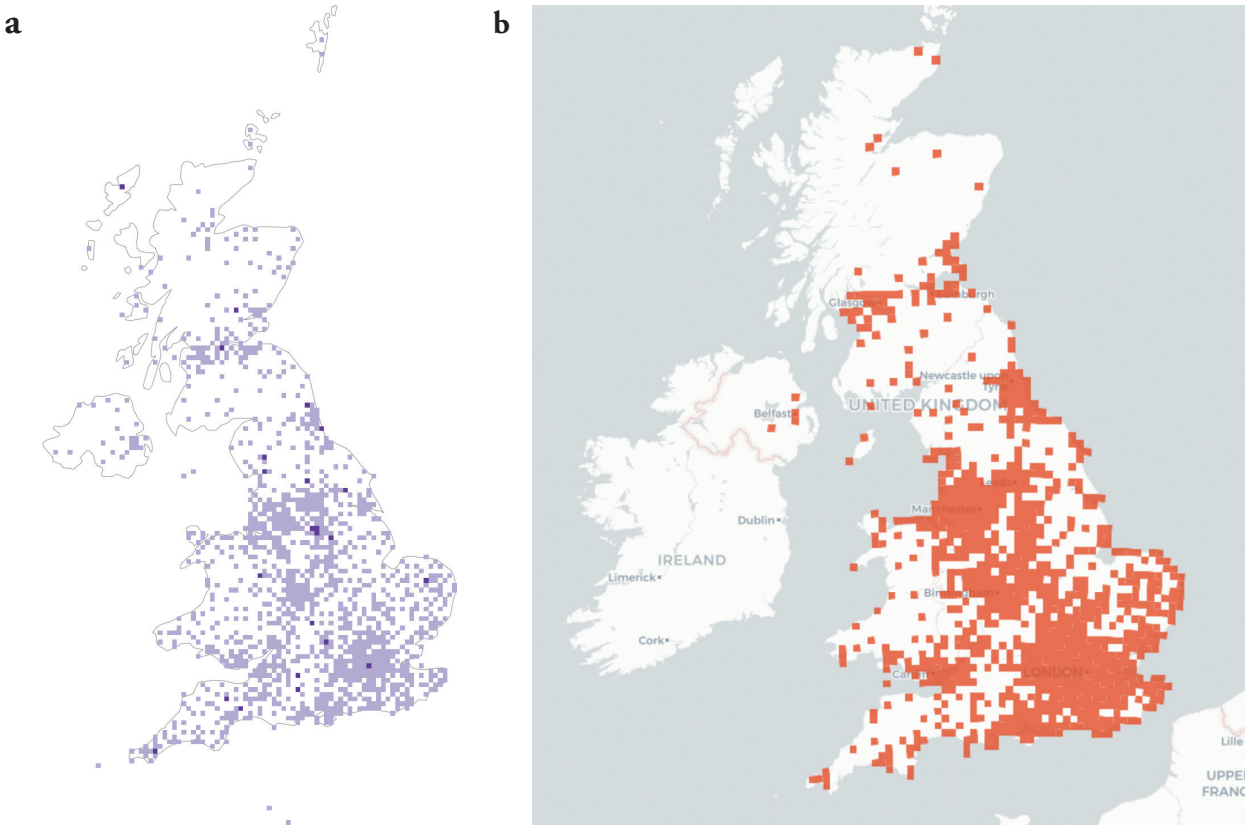

Figure 1. Map of respondents' geographical distribution at a 10 km × 10 km square scale. Location was derived by calculating coordinates from their postcode prefix by using a Google Maps API Key retrieved in 2019 (Google 2019), converting them to Easting and Northings and mapping them on to a base BNG layer from the public repository on www.naturalearthdata.com. Darker purple squares indicate 10 km × 10 km grid squares with > 1 respondents. Note that the Channel Islands and Shetland Islands (which contained two respondents each) are omitted due to space constraints **b** RNP distribution in the UK at a 10 km × 10 km square scale, from the NBN Atlas Partnership (2021).

Table 2. Comparison of the demographics of the sample in this study with those recorded in the 2011 UK-wide census conducted by the Office of National Statistics.

Variable	Level	Our sample	ONS 2011 Census (UK)
Respondent age[a]	18-29	8.08%	16.2%[b]
	30-59	45.0%	40.0%[b]
	60+	46.9%	22.5%[b]
Respondent gender	Male	42.1%	49.1%
	Female	56.9%	50.9%
	Other	0.94%	Unable to find
Highest level of education completed[a]	No schooling completed to GCSE level	1.24%	23.2%
	Up to 6th Form or equivalent	30.6%	44.7%
	Graduate and beyond (or equivalent)	68.2%	32.2%
Respondent RUC[c]	Urban	73.6%	80.5%
	Rural	26.4%	19.5%

[a]Concatenated since the ONS Census records age and education brackets differ slightly. [b]As a percentage of the total UK population (e.g. including individuals under 18 years old). [c]Combined from ONS 2011 Census data for England & Wales (Office for National Statistics 2011) and Northern Ireland (Northern Ireland Statistics & Research agency 2015) and 2011-12 Rural-Urban Classification (RUC) data for Scotland (National Records Scotland 2011).

Most respondents were aware of the RNP and claimed they recognised the RNP from the picture provided (90.2%, Table 1). Just over half of all respondents reported to have encountered the RNP outside of their neighbourhood (56.4%), followed by 22.5% in their neighbourhood or elsewhere and 2.2% in their neighbourhood only. A total of 18.6% of respondents had never seen a RNP before in the wild. We found a significant association between this breakdown in encountering the RNP before and respondents' RUC category (X^2 = 13.1, df = 1, $p < 0.001$), with a higher frequency of urban respondents having seen an RNP in their neighbourhood and elsewhere compared to rural respondents.

The proportions of respondents who correctly estimated numbers of RNPs in the UK ("more than > 21,000") and knew their native range at the continental level (both "Africa" and "Asia") were 17.4% and 10.0%, respectively. The majority of respondents (54.9%) were able to provide the full species name of the RNP as opposed to the 42.6% of respondents who could name the RNP to the family level and the 2.46% who were unable to correctly name the RNP.

Overall, respondents tended to be more averse to seeing the RNPs in rural than urban areas (Table 1, X^2 = 4431, df = 16, $p < 0.001$). The majority of respondents selected (strongly) agree for the three positively framed attitudinal statements about the RNP. However, negatively framed attitudinal statements were dominated by neutral responses (Fig. 2).

Nearly all respondents (94.3%) who had encountered a RNP before provided free-text opinions concerning the species. The sentiment breakdown of responses was 45.9% negative, 27.1% mixed, 16.1% positive, 7.3% unsure, 2.6% neutral and, for 0.9%, we could not discern the sentiment. Table 3 shows the different topics mentioned by respondents with example quotes (see Suppl. material 1: sections S8, S9 for more detail).

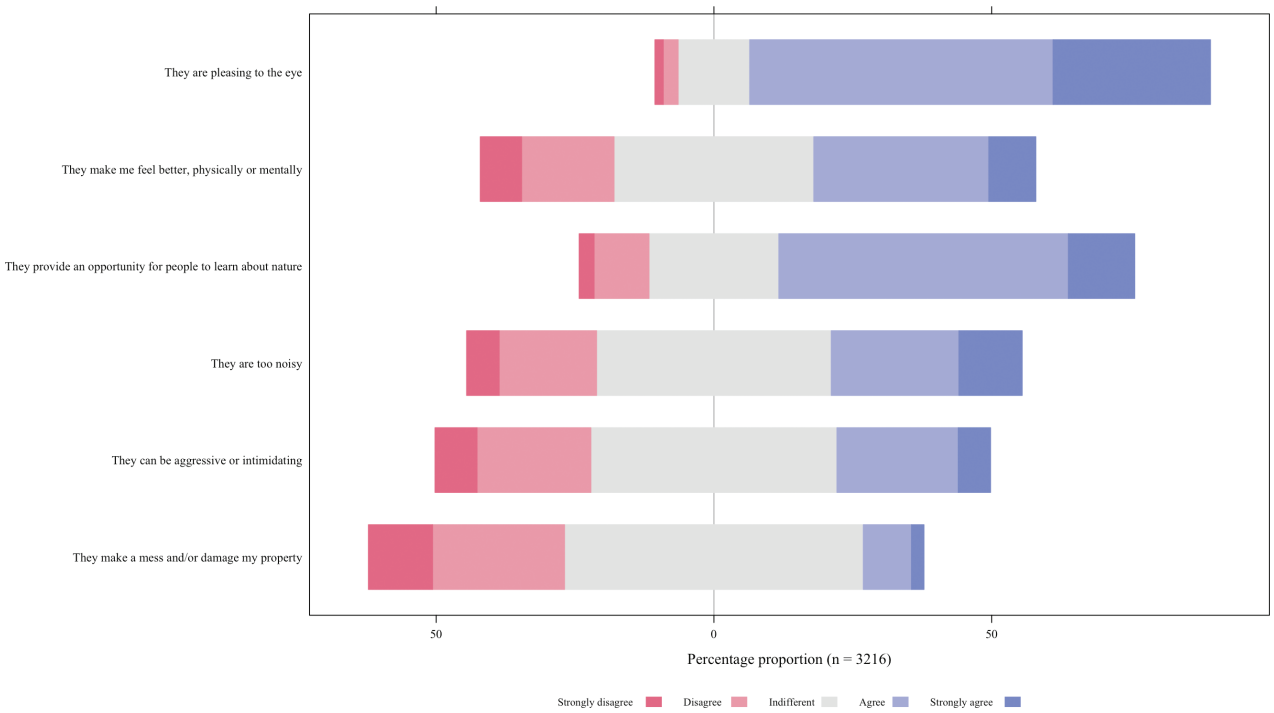

Figure 2. Respondents' answers as a percentage proportion to the six attitudinal statements from Belaire et al (2015). The statements are recontextualised for the RNP and utilised to inform the composite *Attitude* response variable.

Table 3. Topics that respondents mentioned in their open-text answer. The following are provided: a topic description, sample size (n), a graph illustrating respondents' different sentiments towards the RNP within that topic and an example quote. The graph illustrates the % proportion of different sentiments across the specific topic responses that were negative (blue), positive (green), mixed (yellow), neutral (orange), unsure (purple) and can't tell (black). Topics are ordered by sample size and only topics with n > 50 are shown. All topics (n > 0) can be viewed in Suppl. material 1: section S9. More detail on each topic and their sub-topics can be found in Suppl. material 1: section S8.

Topic		Example Quotes
Non-native status of the RNP (n = 2006)		'as this bird is not native to this country I'm not sure what effect it would have on our resident bird populations. I know they are becoming more common in the southeast and visiting bird tables.'
RNP as a bird that add pressure on UK wildlife (n = 1282)		'Very colourful and interesting to see - seen in Thames Ditton & near Hampton Court. However, may cause problems with local bird population. Are rural birds more vulnerable?'
Respondents mentions RNP noise (n = 453)		'A pain in the backside - so intrusively noisy and not a native bird'
Respondent experience with RNP (negative, positive or otherwise) (n = 403)		'I love seeing them in St James' Park when I go to London. I love hearing them in the trees. I am sure I have heard one mimicking a 'Hello' ..maybe wishful thinking !!'
RNP impact on UK ecosystems and local species is unknown (n = 319)		'an introduced bird with as yet unknown [effects] on native populations'
Damage that RNPs cause (n = 301)		'15 years ago, I lived in an area where Rose-ringed parakeets were endemic. They are pretty and spectacular birds, but very noisy. They travel around in large flocks, swooping down into gardens and monopolising bird feeders - I think the largest number we had in our garden at one time was 25. ***They also ruined the crop on my apple tree by picking young, unripe apples in their claws, removing a strip of peel using their beak, tasting the exposed flesh with their tongues and then dropping the apples on the ground. They didn't seem to learn to try elsewhere when they found that the apples were still unripe: they just kept on picking, tasting and dropping.***'

Topic		Example Quotes
Spread of the RNP in the UK (n = 282)		'Depends on their impact to other species and habitat but if adverse I would rather they stay contained to areas they have established in only'
RNP will affect rural areas (n = 270)		'A very colourful bird I love to see when in London for work but am concerned by the impact it would have on other wildlife in rural areas'
How RNP should be controlled in the UK (n = 261)		'I still think of this as an alien introduced bird not native. ***However I wouldn't actively support eradication***'
The legal context and protection that surround the RNP in the UK (n = 258)		'Evidence I have seen regarding ecological impact of this bird seems inconclusive. ***For the moment it should be given the same level of protection as other species***'
How many RNPs there are in the UK (n = 174)		'All wild birds in UK are protected by law. ***Having seen them in Europe in urban areas they appear to breed in large numbers adding to noise and pollution and, like feral pigeons, should be managed to maintain smaller populations***.'
Release of the RNP in the UK (n = 153)		'I am unsure if these are all due to escaped pets so they're not native to the UK?'
RNP as a competitor at birdfeeders in the UK (n = 101)		'A lovely bird to see flying around ***but totally dominates garden bird feeder and wrecks any soft fruit bushes/trees for fruit in the Autumn.*** A rather unwanted pest [species]. Also good at continually harrying any sparrowhawks so tend not to see them much now.'
RNP brightens urban areas (n = 97)		'A bird that would lend beautiful colour to sometimes drab urban sprawl.'
All biological life is precious and shouldn't be mercilessly killed (n = 94)		'***All bird life should be protected including introduced species***. Although not common in Gloucestershire, occasionally escapees are seen.'
RNP is a part of urban areas in the UK (n = 93)		'I associate this bird with London, and as I am not a fan of cities, I think this means I have a slightly negative perception of this species, plus it's introduced, of course.'
Comparing the RNP to other non-native species in the UK (n = 87)		'It's a non-native species and as such could endanger native species. They don't occur where I live but I guess it's just a question of time! ***I predict that like Canada Geese and Grey Squirrels, they will become a serious nuisance species.***'
RNP has no impact on UK ecosystems and local species (n = 78)		'It's a naturalised species in the UK, ***but as far as I'm aware it isn't considered invasive and is not putting other species under stress due to competition***. This being the case, I don't have any particular preconceptions about what its range 'should' be.'
RNP adds diversity to current UK wildlife (n = 74)		'***Add[s] colour, bird song (?) and interest to urban areas. Probably more adapted to urban areas, especially gardens and parks where food and shelter can be found.*** Not sure about rural colonisation, could they adapt when many of our native birds are struggling and from a purist point of view prefer to see native species in the wild. '
Acceptance of RNP is in the UK despite not being a native species (n = 67)		'As time passes, ring necked parakeet will be another part of our diverse ecology ***we should just enjoy their noisy boisterous presence***.'
RNP as a pest (n = 54)		'The bird is a total pest. It does not belong in the UK and creates problems wherever it turns up. It also displaces resident species from their rightful nest sites'
Respondents prefer local (native) species compared to the RNP (n = 51)		'***Because I prefer to see indigenous species***. I am concerned about the effect that non-native species have on the native flora and fauna. Unnatural competition for food and nesting sites.'
RNP can be used to raise awareness of nature in the UK (n = 50)		'Non-native spp, now naturalised. They possibly displace other hole nesting spp such as starling. They are noisy. ***They are good for introducing non birders to start noticing nature***'

[a]The entire quote is supplied and unhighlighted if the whole quote is pertinent to the topic, otherwise the sections of the quote pertinent to the topic are highlighted in ***bold italic***.

Table 4. Model-averaged estimates derived from the 95% confidence model set for our four models. These models are of awareness of and attitudes toward RNPs and whether or not respondents would like to see the RNP in rural/urban areas. Significant levels within predictors are highlighted in bold and italics. See Suppl. material 1: section S10 for details on the models' 95% confidence model sets and more detailed tables for each model.

Variable	Level*	Awareness		Attitudinal		Rural		Urban	
Intercept (GLM)	(Intercept)	Estimate (SE)	Importance	Estimate (SE)	Importance	Estimate (SE)	Importance	Estimate (SE)	Importance
		-1.30 (0.52)	*na*	***15.35 (0.90)***	*na*	*na*	*na*	*na*	*na*
Intercept (POLR)	Definitely not|Probably not	*na*		*na*		***-1.89 (0.36)***	*na*	***-1.33 (0.34)***	*na*
	Probably not|Indifferent					-0.5 (0.36)		0.16 (0.34)	
	Indifferent|Probably yes					0.25 (0.36)		***1.06 (0.34)***	
	Probably yes|Definitely yes					***1.60 (0.36)***		***2.75 (0.34)***	
Age	30-39	0.15 (0.21)	1.00	-0.2 (0.32)	1.00	0.06 (0.13)	0.82	-0.10 (0.14)	0.99
	40-49	***0.56 (0.21)***		***-0.58 (0.29)***		0.29 (0.18)		0.09 (0.13)	
	50-59	***0.65 (0.2)***		***-0.99 (0.28)***		0.20 (0.15)		0.02 (0.12)	
	60 or older	***0.62 (0.18)***		***-2.02 (0.26)***		0.11 (0.12)		-0.02 (0.11)	
Self-assessed bird expertise	Expertise Level 2	***0.58 (0.18)***	1.00	0.00 (0.05)	0.02	***-0.43 (0.16)***	0.99	-0.02 (0.07)	0.09
	Expertise Level 3	***1.29 (0.18)***		0.01 (0.06)		***-0.52 (0.15)***		-0.01 (0.05)	
	Expertise Level 4	***2.05 (0.23)***		0.01 (0.06)		***-0.51 (0.16)***		-0.01 (0.06)	
	Expertise Level 5	***3.19 (0.61)***		0.01 (0.08)		***-0.61 (0.2)***		-0.03 (0.10)	
Gender	Male	0.07 (0.11)	0.69	-0.21 (0.15)	0.90	-0.01 (0.04)	0.39	-0.10 (0.06)	0.99
	Other	1.22 (1.18)		-1.48 (0.81)		-0.22 (0.35)		***-0.95 (0.33)***	
Knowledge of RNP	Mid Knowledge Level	*na*		0.01 (0.08)	0.20	***-0.30 (0.08)***	1.00	-0.15 (0.09)	0.88
	High Knowledge Level			0.05 (0.14)		***-0.27 (0.10)***		-0.25 (0.13)	
Membership	Yes	***0.74 (0.12)***	1.00	0.02 (0.09)	0.28	***-0.24 (0.07)***	1.00	***-0.23 (0.07)***	1.00
Education	GCSEs or eq.	-0.04 (0.22)	0.07	***1.34 (0.67)***	1.00	0.10 (0.28)	1.00	-0.01 (0.14)	0.26
	A Levels or eq.	-0.04 (0.22)		***1.41 (0.66)***		-0.14 (0.28)		-0.03 (0.15)	
	Graduate or eq.	-0.03 (0.19)		***1.81 (0.65)***		-0.47 (0.28)		-0.08 (0.18)	
	Post-graduate	-0.03 (0.19)		***2.06 (0.65)***		-0.50 (0.28)		-0.05 (0.16)	
Awareness of RNP	Aware of RNP	*na*		-0.08 (0.2)	0.34	***-0.62 (0.11)***	1.00	-0.17 (0.13)	0.75
RNP Density	RNP Density in Respondent's Area	0.00 (0.00)	0.59	-0.00 (0.00)	0.76	-0.00 (0.00)	0.46	0.05 (0.00)	0.36
NR-6 Mean	Respondent NR-6 Score	***0.25 (0.11)***	0.94	***0.90 (0.13)***	1.00	0.01 (0.04)	0.30	***0.17 (0.06)***	0.97
Preference for RNP	Preference for RNP	0.36 (0.24)	0.82	***4.15 (0.25)***	1.00	***2.39 (0.12)***	1.00	***2.59 (0.12)***	1.00
RUC	Urban	***0.47 (0.13)***	1.00	-0.02 (0.09)	0.28	***0.21 (0.07)***	0.99	0.00 (0.04)	0.26
Same residence aged 16	Yes	-0.06 (0.1)	0.43	0.00 (0.07)	0.26	0.02 (0.04)	0.33	-0.01 (0.04)	0.31

*Reference levels for the categorical variables was as follows: Age = 18-29, Self-assessed bird expertise = Expertise Level 1, Gender = Female, RNP Knowledge = Low Knowledge Level, Membership = No, Education = No schooling completed, Awareness of RNP = Not Aware of RNP, Preference for RNP = No Preference for RNP, RUC = Rural, Same residence aged 16 = No.

The top ten adjectives in all the text responses were "native", "invasive", "noisy", "rural", "urban", "introduced", "nesting", "indigenous", "local" and "protected" (max n = 2214). "Native", "invasive", "noisy", "introduced" and "indigenous" were all used to describe the RNP negatively. "Native" was used to refer to either the RNP's introduced status, its effect on native species or sometimes both in the same response. "Indigenous" was used to refer to the RNP's introduced status in 42.7% (n = 199) of the responses and 57.3% (n = 199) of the time it was used to refer to the species' impacts on native wildlife. Respondents expressed concerns about the impacts of the RNP on "nesting" and "local" UK species, as well as stating a preference for the latter. Respondents expressed an aversion to the effects the RNP might have in "rural" areas and conversely did not mind the RNP much – or thought it added value – to "urban" areas. "Protected" was used to describe the protection status of the RNP in the UK.

Respondent awareness was positively associated with membership of a wildlife group, greater self-assessed bird expertise, living in urban areas and nature-relatedness (Table 4). Respondents aged 40 and above were more likely to be aware of the RNP than respondents aged 18–29. Positive responses to the attitudinal statements were associated with nature relatedness, higher levels of education and a preference for the RNP in the local neighbourhood (Table 4). The responses to the attitudinal statements of respondents aged 40 or older were more negative than respondents aged 18–29. Support for the RNP in rural areas was positively associated with having a preference for the RNP in the local neighbourhood and living in an urban area (Table 4). Support for the RNP in rural areas was negatively associated with respondent awareness, self-assessed bird expertise, RNP knowledge and membership of wildlife groups. Support for the RNP in urban areas was positively associated with nature-relatedness and a preference for the RNP in the local neighbourhood (Table 4). Support for the RNP in urban areas was negatively associated with membership of a wildlife group. Respondents choosing "Other" for Gender were more likely to be against the RNP in urban areas compared to "Female" respondents.

Discussion

Social perceptions of non-native species are important to consider when managing populations of these non-native species (Kapitza et al. 2019). If the RNP is to be managed under the general licence in the UK, mitigation actions might be required to pre-empt conflict and controversy over its management. We successfully collected a comprehensive sample of UK respondents' awareness of, knowledge of and attitudes towards the RNP that could help inform such mitigation. Awareness was similarly high (90.2%) to studies by London-based Baker (2010) and Seville-based Luna et al. (2019), implying that it is a well-known bird within our sample, which is further supported by the ability of many respondents to name it (54.9%). Knowledge of the RNP influenced respondent attitudes towards the RNP in rural areas, indicating that it is a new and potentially important driver to include in future RNP perception studies.

Attitudes towards the RNP were more complex. A large proportion of respondents (45.9%) held a negative opinion of the RNP and only very few respondents (7.80%) indicated a preference for the RNP in their local neighbourhood. However, the majority of respondents agreed that the RNP had pleasant aesthetics (83.0%). Attitudes towards the RNP in rural areas were also more negative (64.7%) than those in urban areas (46.7%), suggesting a rural-urban split in perceptions.

Respondents also mention a variety of topics in their text answers, with the species' non-native status and ecological impacts being the most mentioned. The text answers also suggest that there may be greater acceptability for RNP management in areas with high RNP population densities and measurable impacts to ecosystems and agricultural areas. The inclusion of RNPs on the general licence does allow for this localised control, though, interestingly, is not permitted for socio-economic nuisance. We also found that younger respondents were more tolerant of RNP presence than older respondents, potentially indicating that RNP tolerance is increasing over time, which could lead to lower support for management in future. This may be counteracted, however, by the extent of spread and perceived impacts, which could equally rise with time if the RNP population continues to expand.

Respondent awareness of the RNP

The increase in respondent awareness in our study compared to Baker's (71%) (2010) could be due to the 10 year gap between studies, providing people in the UK with more opportunities to encounter and familiarise themselves with the species. However, it is worth noting that Baker (2010) calculated respondents' awareness using a differently worded question to our survey: "Did you know that there is a population of Rose-ringed Parakeets in London? [Yes/No]". It is unsurprising that ecological interest and an urban provenance drive greater awareness of the RNP: respondents with a greater ecological interest are more likely to have encountered or be aware of UK fauna which includes the RNP, whilst respondents from urban areas are simply more likely to have encountered the urban-centric species.

Our findings further suggest that levels of respondent awareness of the RNP are notably high when compared with birds and IAS more generally. Cox and Gaston (2015), for example, found that people living in urban areas are largely unaware of the avifauna that is around them, while Rodríguez-Rey et al. (2022) found the UK public's awareness of IAS to be low. Such a high awareness of the RNP could suggest that there are many individuals who know what the RNP is and hold an opinion of the species, although this needs to be further tested beyond our respondent sample. Should these opinions be varied, as we found, difficulties for consensus on management could ensue and would require careful consideration to avoid escalation of conflict.

Respondent knowledge about the RNP

The fact that respondent knowledge drove some of the attitudes highlights the importance of this new variable in RNP perception research and that it should be explored when considering mitigation actions ahead of RNP management. High respondent awareness of, a high respondent encounter rate with the species and a nature-orientated respondent sample could explain why numerous respondents knew the RNP's name. We propose that future perception studies explore these hypotheses to understand what drives respondent knowledge of the RNP itself to better understand this variable. We also suggest investigating knowledge about the RNP's actual and/or perceived impacts on agriculture and wildlife and whether this knowledge affects attitudes in a similar manner to how our knowledge variable influenced attitudes towards the RNP in rural areas.

Many respondents did not know the RNP's population size in the UK, but this is likely to represent the fact that absolute population sizes are an abstract concept

without reference points, rather than a genuine lack of knowledge *per se*. We recommend investigating if knowledge about the RNP's numbers in relative terms, for example, 'a few', 'many' could reveal a clearer pattern of individuals' perceived RNP abundance; this is known to influence perceptions (Van Der Wal et al. 2015) and could be utilised to provide insights about density-dependent effects on perceptions of the RNP in the UK.

Respondent attitudes towards the RNP in urban areas

Respondents' support for the RNP in urban areas amongst younger generations indicates that RNPs could be increasingly accepted as part of these urban ecosystems, suggesting potential evidence of shifting baseline syndrome (Soga and Gaston 2018). This is despite people maybe not 'liking' them, particularly as implied by the large number of "negative" opinions we identified. Respondents' support for the RNP in urban areas could also be because the RNPs are colourful birds with an attractive aesthetic that beautify areas perceived as otherwise drab and wildlife-depleted, as some respondents (n = 97) suggested in their text answers. The idea that the RNP acts as a colourful relief for urban environments is further supported by the large number of respondents who agreed to the attitudinal statements describing the RNP's aesthetic and educational services, namely that the RNP "*provides an opportunity to learn about nature*" and is "*pleasing to the eye*". Indeed, Berthier et al. (2017) found that the RNP has the "attraction of the aesthetic of the diverse" in Paris (France) and it could be that a similar factor is influencing respondents' acceptance of the RNP in urban areas of the UK. The influence of landscape on attitudes is important for wildlife managers to consider, especially if enacting RNP controls on a localised scale where landscape types are more likely to be defined and attitudes, therefore, more likely to be contained to those areas.

Respondent attitudes towards the RNP in rural areas

Respondents marked aversion to the RNP's presence in rural areas could be because rural areas might not be considered as ecological 'sacrifice zones' in the same way cities often are (correctly or not) (De Souza 2021; Sanz and Rodríguez-Labajos 2023). Consequently, respondents view rural areas as worthy of protection from parakeet expansion. This is supported by the respondents' text answers that repeatedly stated concerns for rural areas (n = 270) and concerns of the RNP's effects on UK natural ecosystems. Furthermore, respondents viewed the RNP's noise and 'damaging behaviour' as unfit for UK rural areas, possibly partly driven by how respondents could view the UK countryside as a highly regarded socio-cultural ideal (Bunce 2005) that should be protected from potentially disruptive non-native species.

Respondents' text answers detailing their presumptions of the RNP's supposed negative ecological implications on UK wildlife (n = 1282) and the damage they cause (n = 301) could also explain these attitudes against the RNP in rural areas, even though current research shows the RNP to have negligible ecological effects in the UK (Newson et al. 2011; Peck 2014, Peck et al. 2014; Pringle and Siriwardena 2022). It is not unprecedented that numerous respondents held factually incorrect perceptions of the RNP's ecological implications in the UK and that these supposed impacts influenced these respondents' attitudes towards the RNP. Berthier et al. (2017) also found that some Parisian respondents viewed the RNP negatively due to their per-

ception that the RNP had serious ecological and social (noise and damage) impacts, despite there being no current evidence of negative ecological implications driven by the species in Paris (France) (White et al. 2019). Berthier et al. (2017) found that this perception of the RNP was caused by these respondents living in areas with, or experiencing, the RNP in high numbers and we, therefore, recommend that managers do not ignore how RNP population density, interactions with or experience of the RNP can shape perceptions that can inform the feasibility of management.

The role of dissonance in explaining attitudes towards the RNP in rural and urban areas

Our observed difference in perceptions of the RNP at a landscape level could be due to prevailing positive and negative manifestations of dissonance by respondents who have experienced the species in urban and rural landscapes, respectively. Crowley et al. (2019) described "dissonance" as the surprise of encountering an organism out of a (expected) place and it can play a key role in perceptions towards and the perceived charisma of parakeets. Dissonance might manifest itself negatively, as shown by our respondents who have experienced the RNP and found it to be a "noisy, non-native bird [that] shouldn't be here", or positively, as shown by our respondents who have experienced the RNP and happily expressed how encountering RNPs in urban areas "adds to the magic [of London's Parks]". Manifestations of dissonance amongst individuals may either lead to support for or unpleasant clashes in reaction to potential RNP control programmes and we suggest that managers anticipate this accordingly. One possible avenue to mitigate this is to further engage with members of the public to understand their reactions to RNP management in different and discretely defined landscapes and ecosystems, for example, a city park vs. countryside river valley.

Respondent answers to the attitudinal statements

Our results for the attitudinal statements were similar to the findings of Belaire et al. (2015), which more broadly studied urban residents' perceptions of multiple bird species in the United States. Their respondents valued birds' aesthetics, educational and therapeutic services highly, whilst they tended to ignore or only classify species' annoyances and associated disservices as minor (apart from certain exception species). Respondents might similarly value the RNP's aesthetics and cultural services highly, either objectively or sentimentally, which is unsurprising given the RNP possesses traits of great aesthetic attraction: a bright green plumage and an ornamental tail (Lišková et al. 2015; Santangeli et al. 2023).

However, the mismatch between our sample's negative opinions towards the RNP and a high appreciation of the bird's aesthetic qualities suggests that respondents' views of the RNP's aesthetic services are complex and warrant further investigation. As suggested by Crowley et al. (2019), it could be that that parakeet aesthetic charisma depends on their proximity and numbers and appreciation of the RNP's aesthetics possibly only occurs if the species is experienced in 'the right place' – i.e. urban areas (as discussed earlier) or in its native range - and in the 'right quantity'. Wildlife managers might encounter affection for the RNP in these different contexts and we emphasise that the RNP's aesthetic, as well as educational and therapeutic qualities, should be fully considered before any control measures are conducted. Interestingly, Kueffer and Kull (2017) suggest that reducing

a NNS/IAS's aesthetics to a 'service' can be limiting and we recommend exploring the deeper psychological and social processes that influence the RNP's perceived aesthetics to better understand its implications for management.

Respondent preference for the RNP

The actual selection rate for the RNP by respondents was much lower than the expected random selection rate of the RNP being selected 40% of the time on average. This is similar to Luna et al. (2019), who found that the majority of their sample did not choose the parakeet (34.8%) and that their respondents' selection rate for the RNP was also below the expected random selection rate (50%). Similar results were obtained in Paris (France), where the RNP was only placed in 8% of the gardens people designed using a computer programme, ranking 29th out of 32 species proposed (Shwartz et al. 2013).

The species low popularity in our sample could be due to respondents unwilling to disregard the "non-native" attribute of the RNP due to a higher level of ecological and associated knowledge about the RNP's potential impacts. Ribeiro et al. (2021) did find that preferences for the RNP were high and that respondents disregarded the "non-native" tag attributed to the RNP possibly due to a lack of ecological knowledge about the RNP's impacts. Differences between our sample's and the RNP preference of Ribeiro et al. (2021) could be due to density-dependent effects, since the RNP population in the study site of Ribeiro et al. (2021) is drastically smaller (Porto, 16 individuals). Alternatively, our sample's low RNP preference could be a manifestation of respondents actually 'liking' the RNP, but not in 'the right place' i.e. the UK and again highlights that geographical contexts play a role in perceptions of the RNP.

RNP density as a predictor of respondent attitudes

Studies by Berthier et al. (2017), Luna et al. (2019), Ribeiro et al. (2021) and Mori et al. (2020) all found that attitudes towards the RNP became more negative when respondents lived in areas with, or experienced, the RNP in high numbers. However, we did not find a significant relationship between RNP local density and respondents' attitudes or answers to the "Rural/Urban" questions. Our finding could differ from previous studies due to potential limitations of the RNP density dataset, namely its time lag and spatial accuracy. The utilisation of an RNP population metric on a more granular spatial level or that was measured at the same point in time as the questionnaire could have yielded a result similar to previous studies. Further, Mori et al. (2020) found that RNP noise level, used as proxies for RNP density, significantly affects negative attitudes towards the species. In combination, these results suggest that perceptions of RNP abundance, or nuisance behaviour, may be a more important influence on attitudes than actual bird numbers.

Another reason could also be that our respondents were surveyed at a different geographical scale (national) compared to these previous studies, which sampled specific city populations. The UK RNP population dwarfs the RNP populations in cities studied by Berthier et al. (2017), Luna et al. (2019), Ribeiro et al. (2021) and Mori et al. (2020), as well as the populations of RNP in those cities' countries (Pârâu et al. 2016) (see Suppl. material 1: table S1.1). We do not know the implications of these differences on our findings. Nevertheless, we still recommend

exploring the relationship between respondent interaction levels with the RNP, either through proxies or direct density measurements, and respondent perceptions to highlight implications for management. For example, Monk Parakeet numbers can influence their own aesthetic charisma (Crowley et al. 2019), which, in turn, plays an important role in influencing perceptions of NNS/IAS (Shackleton et al. 2019; Jarić et al. 2020).

Sample biases and skews

It should be noted that the prevalence of negative opinions held towards the RNP in our sample could be a result of our demographic skew towards older, more nature-orientated individuals with greater ecological knowledge. These individuals may be more ecologically aware as they are more likely to be members of wildlife groups (Oxley et al. 2016; Waliczek et al. 2017) and, therefore, are more likely to know about the impacts of non-native species. Such individuals may be more likely to be predisposed towards possessing a greater awareness and/or holding negative views of non-native species, based on the precautionary principle and/or a general aversion to non-native species. Indeed, Bremner and Park (2007) and Oxley et al. (2016) found that older individuals and those who were part of wildlife organisations were more likely to support control measures towards NNS. Additionally, 42.5% of our respondents came from the SE of England which is where the majority of the RNP population is concentrated in the UK. Whilst we did not find a relationship between RNP population density and perceptions in our study, it should not be discounted as a potential underlying factor as to the prevalence of negative sentiment in our sample. Furthermore, our respondent sample was mostly composed of more educated individuals compared to the UK population average, which might increase the likelihood of our respondents being informed about UK nature, the RNP and its potentially deleterious effects. Finally, we acknowledge that our survey was advertised as a survey on perceptions of UK garden birds and that this could have attracted respondents who are already interested in nature and ornithology and consequently are possibly more likely to be aware and know about the RNP already. All together, these sample skews need to be considered when examining the high number of concerns about the RNP's ecology in the UK and negative attitudes towards the RNP.

Conclusion

Our findings indicate that the RNP presents a complex socio-environmental challenge, with respondent awareness, knowledge and attitudes each forming an important component of respondent perceptions. These results suggest that localised RNP management under the two general licence conditions could encounter some support amongst nature-orientated individuals or in rural areas, although this should be further researched in the UK prior to any control action. This is because there always is potential for social conflict in reaction to any proposed RNP management no matter how localised control is, as seen with the Monk Parakeets in the UK (Crowley et al. 2019). Therefore, we advocate for the continued study and incorporation of social and cultural perceptions of the RNP into mitigation actions that purposely anticipate heated controversies around potential UK control of the species.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

As stated in the methods, approval for this study was granted by the Imperial College Research Ethics Committee (SETREC Reference: 19IC5114). We thank the ICREC once more for their assistance. There are no ethical conflicts or further statements to make for this research article.

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Author contributions

Alessandro Pirzio-Biroli conceived the research idea, which was developed with support from all co-authors, particularly Rachel L. White and Julia Schroeder as thesis supervisors. Alessandro Pirzio-Biroli led the design of the study, including the online survey, which was reviewed by all co-authors. Alessandro Pirzio-Biroli led the development of the methodology and refinement of the research questions, which was supported by all co-authors. Alessandro Pirzio-Biroli distributed the survey, collected responses and conducted the data analysis including the model building and sentiment analysis. All co-authors contributed to the data analysis and the interpretation of the results. Alessandro Pirzio-Biroli led the writing of the manuscript. All co-authors contributed critically to the drafts and gave final approval for publication.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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Supplementary material 1

Supplementary sections

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Data type: zip

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