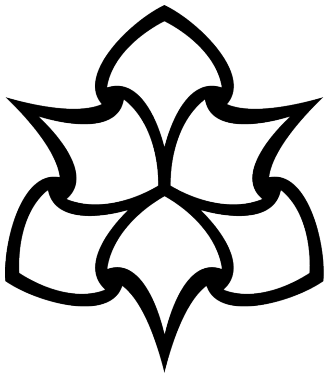

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CONSUMING WILDLIFE – MANAGING DEMAND FOR PRODUCTS IN THE WILDLIFE TRADE

Research Article

Characterizing bird-keeping user-groups on Java reveals distinct behaviours, profiles and potential for change

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Abstract

1. Over 70 million cage-birds are kept across 12 million households on the island of Java, Indonesia, fuelling serious concerns for the health of regional wild bird populations. Understanding the behaviours, preferences and demographic profiles of bird-keepers will guide attempts to reduce demand for wild birds and hence the impact of trade on wild populations and their host ecosystems.
2. We profile three songbird-keeping user-groups based on interviews of nearly one thousand people across Java: *hobbyists*, who own birds primarily as pets; *contestants*, who own birds to enter in singing contests; and *breeders*, who own birds to breed and train for resale or as a pastime.
3. User-groups diverged in their bird-keeping habits and preferences. Hobbyists tended to own small numbers of inexpensive and typically native birds, while contestants and breeders owned larger numbers of often valuable birds. Hobbyists were far less likely to consider origin when buying a bird, owned a larger proportion of both potentially wild-caught and globally threatened birds, but showed no preference for any taxon. By contrast, owning relatively large numbers of lovebirds *Agapornis* spp. and Zebra Doves *Geopelia striata* were key characteristics of contestants, while breeders owned the largest number of birds and species, in particular White-rumped Shamas *Kittacincla malabarica*. Within a 2-year period, user-group membership was fluid, with much transitioning between non-bird ownership and hobbyists, recruitment of non-bird owners to contestants and movement both in and out of the breeder group.
4. Our study provides behavioural change efforts with demographic and geographic profiles to target bird-keepers, who tended to be more affluent and urban and to live in the eastern provinces. Among bird-keepers, hobbyists tended to be middle-aged and lived in the western provinces, contestants were younger urban bird-keepers employed in business and breeders were commoner in the eastern provinces, reflecting the cultural importance of bird-keeping among the Javanese.

5. Efforts to increase the sustainability of bird-keeping in Java should focus on emphasizing the importance of captive-bred birds, in particular to hobbyists, the largest user-group, whose bird-keeping behaviour poses the biggest threat to wild bird populations, whilst also incentivizing legitimate breeding enterprises among contestants and breeders.

KEYWORDS

cage-bird, conservation marketing, consumer demand, sustainable use, wildlife trade

1 | INTRODUCTION

Around 5,000 species of terrestrial birds, mammals, amphibians and reptiles are globally threatened with extinction due to overexploitation in the international wildlife trade, and this number may almost double in the near future (Ribeiro et al., 2019; Scheffers, Oliveira, Lamb, & Edwards, 2019). Bird species are far more widely represented in trade than mammals, and a disproportionate number of avian taxa are threatened by overexploitation (Alves, Lima, & Araújo, 2013; Bush, Baker, & Macdonald, 2014). This is particularly prevalent in Southeast Asia (Coleman et al., 2019; Harris et al., 2017), where intense demand has precipitated an 'Asian Songbird Crisis' (Lee, Chng, & Eaton, 2016; Rentschlar et al., 2018; Sykes, 2017). Halting the extraction of birds from the wild, or at least reducing it to sustainable levels, is thus a global conservation priority (Bezerra, Araújo, & Alves, 2019; Marshall et al., 2020a; Symes, Edwards, Miettinen, Rheindt, & Carrasco, 2018) alongside addressing the problem of habitat loss, which in Asia threatens more bird species than anywhere except Amazonia (BirdLife International, 2020).

The trapping and trading of birds globally is driven principally by demand for pets, but also by the need for nutritional and medicinal resources, symbolic or cultural practices and gambling-related contests (Bezerra et al., 2019; de Oliveira, de Faria Lopes, & Alves, 2018; Jepson, 2010; Harris et al., 2017; Souto et al., 2017). Domestic consumption of birds as pets in two large biodiverse countries, Brazil and Indonesia, may actually be larger than the total international market (Alves et al., 2013; Jepson & Ladle, 2005; Rentschlar et al., 2018). Regulating domestic trade to prevent significant impacts on wild bird populations is, however, problematic, as the size and variety of the networks involved can make enforcement logistically and politically difficult (Alves et al., 2013; Bezerra et al., 2019).

In Indonesia, where at least 26 bird species are globally threatened through overexploitation (BirdLife International, 2020), most of the trade is domestic (Chng, Eaton, Krishnasamy, Shepherd, & Nijman, 2015; Chng, Shepherd, & Eaton, 2018), but demand also drives the importation of birds from other countries in the region (Leupen et al., 2018). The legislation surrounding the trade in wild birds in Indonesia is comprehensive, and the list of protected species, which can only be traded if they are captive-bred, was recently updated to include newly recognized and recently Red-Listed species (Chng et al., 2015; Miller, Gary, ansyah, Sagita, & Adirahmanta, 2019). Even the harvest of unprotected wildlife is, in theory at least, regulated through a quota system set by a governmental body, the Indonesian Institute of Sciences (LIPI). Harvest quotas have, however, only been set for a few species, thereby rendering the capture or trade of any other species illegal (Chng et al., 2015). Nevertheless, the trade and ownership of wild-caught birds is ubiquitous across Indonesia (Chng et al., 2018; Marshall et al., 2020a) and bird traders are often confused about or unaware of the law (Rentschlar et al., 2018) making enforcement both difficult and unpopular (Janssen & Chng, 2018; Miller et al., 2019).

Initial research explored the underlying behaviours and motivations of bird-keepers from an anthropological or historical perspective, and proposed a market-based way to reduce pressure on wild bird populations (Jepson, 2010; Jepson & Ladle, 2005, 2009; Jepson, Ladle, & Sujatnika, 2011). This entailed substituting captive-bred birds under a certification scheme, promoting singing competitions between captive-bred birds only and establishing ringing courses to help distinguish wild-caught from captive-bred individuals (Jepson & Ladle, 2009). Even so, recent evidence indicates that captive-breeding has not been able to meet the demand for songbirds (Eaton et al., 2015; Harris et al., 2015, 2017).

Interdisciplinary approaches combining techniques from social marketing (Veríssimo, 2019) and social psychology (Fairbrass, Nuno, Bunnefeld, & Milner-Gulland, 2016), in fields such as public health (Stead, Gordon, Angus, & McDermott, 2007), energy (Issock Issock, Mpinganjira, & Duh, 2017) and land conservation (Metcalf, Angle, Phelan, Muth, & Finley, 2019), have shown that positive behavioural change can be produced by targeting relevant consumer behaviours. Identifying and characterizing consumers based on behaviours and preferences has allowed researchers to break seemingly homogeneous audiences into groups on which to target demand reduction efforts (Razavi & Gharipour, 2018; Shairp, Veríssimo, Fraser, Challender, & Macmillan, 2016; Williams, Gale, Hinsley, Gao, & St. John, 2018). Such techniques have helped to understand demand for various wildlife products including orchids (Hinsley, Veríssimo, & Roberts, 2015), rhino horn (Dang Vu & Nielsen, 2018; Truong, Dang, & Hall, 2016) and saiga horn (Doughty et al., 2019), and their potential value for finding ways to reduce demand for Asian songbirds requires urgent exploration.

In this study we seek to distinguish songbird-keeping user-groups on Java based on their behaviours and preferences, and to identify the demographic determinants of user-group membership. We also track differences in bird taxa owned across user-groups and

the degree of movement between user-groups over a 2-year period. Our profiles of user-groups aim to identify specific threats to wild bird populations by characterizing for each group (a) species typically owned; (b) preferences for wild-caught or captive-bred birds and (c) number of birds owned and turnover of individual birds. This exercise may then benefit conservation by segmenting audiences on behaviour and demographics in such a way as to allow demand reduction interventions to be more appropriately and precisely targeted (Hinsley et al., 2015).

2 | METHODS

2.1 | Study design

In 2018 we collected data on bird ownership characteristics during a survey of households on Java, Indonesia, using a stratified sampling technique to capture a spectrum of rural and urban districts within each of the island's six provinces (Marshall et al., 2020a). Within communities and neighbourhoods of selected districts, households were systematically sampled (full details on sampling methodology can be found in Appendix A), and interviews carried out with the most senior member of the household available.

The motivations for bird-keeping in Java include the desire for success in contests, which drives preferences for birds with high-quality songs or colours (Jepson et al., 2011), and the desire for social status, which drives preferences for birds that are normally hard to acquire (Jepson, 2016). However, broad user-groups are primarily described in terms of recreational pursuits (Thomas-Walters et al., 2019). The heterogeneity of the bird-owning community (Jepson et al., 2011) allows us to characterize three potential user-groups: (a) *hobbyists*, who keep birds primarily as pets and rarely engage in competitions or captive-breeding; (b) *contestants*, who keep birds primarily to enter them in singing contests, but may also breed birds; and (c) *breeders*, who breed and/or train birds for resale or as a hobby, but do not regularly enter birds in contests.

To assign bird-keepers to one of the three user-groups, respondents were asked to choose all motivations for keeping birds that were applicable to them: (a) to keep as a hobby, (b) to enter singing contests and (c) to breed or train birds. We also collected data on: species identity, abundance and origin (i.e. captive-bred or wild-caught) of all cage-birds in the household; the consumption behaviour and preferences of bird-keeping respondents (i.e. number and fate of birds owned previously; purchasing habits; time spent tending birds); and socio-economic and demographic profiles at both household and individual levels (see Appendix B for list of survey questions).

To represent household socio-economic status objectively, we used a composite household asset index (HAI: Filmer & Pritchett, 2001). We adopted a checklist of household items and conditions (Schreiner, 2012) and summed the total number of such items to create a score to serve as a proxy for the economic status of the respondent, with higher score indicating greater affluence (Harttgen & Vollmer, 2013). To establish a household occupancy index, we asked respondents how many people lived in their household and how many bedrooms they had, and then calculated the number of people per bedroom. To estimate losses of birds, we calculated the proportion of them owned in 2016 that respondents reported to have subsequently died. As the owning of trafficked wildlife is not illegal under Indonesian legislation (Chng et al., 2018) our questions did not relate to perceived illegal behaviour; thus in common with previous research into songbird-keeping (Burivalova et al., 2017; Krishna et al., 2019) we assumed that respondents provided information about the origins of their birds truthfully.

We defined cage-birds as we did in Marshall et al. (2020a)—birds (both native to Indonesia and exotic) kept, bought or sold as pets or used in singing contests, including passerines (Passeriformes), pigeons and doves (Columbiformes), owls (Strigiformes), woodpeckers (Piciformes) and cuckoos (Cuculiformes). When birds owned by respondents were actually seen by interviewers (>80% of survey events), they were, in the majority of cases, identified to species level. When birds were not seen, or the interviewer could not recognize them, identification was based on respondent use of market names for the birds, and almost always resulted in their being assigned only to genus level. For example, several species of leafbird *Chloropsis* spp. have one common market name, as do white-eyes *Zosterops* spp. Taxonomy follows del Hoyo and Collar (2014, 2016).

2.2 | Analysis

We profiled the three user-groups based on bird-keeping habits, focusing on the differences in prevalence of behaviours and preferences; where appropriate, differences were tested across groups using Kruskal–Wallis and chi-squared tests. We fitted binary logistic mixed effects regression models (GLMMs) to identify those socio-economic attributes associated with (a) ownership/non-ownership of cage-birds and (b) user-group membership versus non-membership among bird-keepers (explored in three separate models). We excluded responses from households where the principal bird-keepers were not present, except for the initial analysis concerning presence or absence of cage-birds within a household. In all models, community was included as a random factor to account for pseudo-replication across the 92 communities. We used model selection and averaging based on the Akaike information criterion (AIC), creating global models with all potential predictors (Table S1); prior to inclusion continuous variables were standardized and checked for collinearity, and predictors with high variance inflation factors (>1.9) were excluded. The top models were defined as those within ΔAICc < 2 of the model with the lowest AIC value (Grueber, Nakagawa, Laws, & Jamieson, 2011). If no model proved better (i.e. Akaike weight < 0.6) from a top set of candidate models, model-averaging was performed, calculating full (zero) method-averaged parameter estimates and using measures of relative variable importance to determine the strength of a predictor's association with the response variable (Burnham & Anderson, 2002; Grueber et al., 2011).

Random forests, a nonparametric decision-tree-based technique that uses bootstrapped subsets of training data to generate an ensemble of models that are then aggregated into a final model (Breiman, 2001), were used to identify characteristics of user-group membership based on numbers of bird species and individuals and on composition of taxa owned by households in 2018. We used repeated 10-fold cross-validation over a tuning grid of potential values to parameterize the model (i.e. the number of variable splits and trees generated) to achieve the highest predictive accuracy (Kuhn, 2008). The statistical and random forest analyses were carried out using the MuMIn (v1.15.6, Bartoń, 2018), lme4 (Bates, Machler, Bolker, & Walker, 2015), randomForest (Liaw & Wiener, 2002) and caret (v6.0-84, Kuhn, 2008) packages in the R statistical environment (v3.6.1, R Core Team, 2019). We then used the results of the 2018 model to back-predict user-group membership for each household in 2016, based on the number of individuals, species and types of birds owned at that time. This provided an indication of the amount of movement between user-groups between 2016 and 2018.

2.3 | Ethics statement

Research teams gained permission from, and agreed to stipulations set by, the heads of neighbourhood and relevant administrative authorities prior to data collection. Interviewers always received prior informed consent from respondents. Name of interviewer and time and date of survey were recorded before interviews; all data were subsequently anonymized. As the owning of trafficked wildlife is not illegal under Indonesian legislation (Chng et al., 2018) our questions did not relate to perceived illegal behaviour; thus in common with previous research into songbird-keeping (Burivalova et al., 2017; Krishna et al., 2019) we assume that respondents provided information about the origins of their birds truthfully. We obtained ethics approval for our work from the Academic Ethics Committee at Manchester Metropolitan University and the Ethical Review Committee at Chester Zoo. A research permit (427/.A/SIP/FRP/E5/Dit.KI/II/2018) was granted by the Indonesian research authority (RISTEKDIKTI) with Universitas Atma Jaya Yogyakarta as the named partner institution.

3 | RESULTS

3.1 | Household demographic data

With an interview response rate of ~60% (Marshall et al., 2020a), we surveyed 3,040 households from all six provinces of Java. Based on Java's reported 2010 census population of 36,720,166 households, the estimates of bird ownership we present have an associated ± 1.68% margin of error at the 95% confidence level (Newing, 2010). A comparison of the demographic attributes of our sample and the 2010 census data is given in Table S2. Median age (lower quartile–upper quartile) of respondents was 42 (16–91). Most respondents had a high school education (60%), and the largest occupational category was manual labour (35%), yet a large minority were not in formal employment (29%; Table S1). The mean ± *SD* HAI score was 14.8 ± 4.8 (range = 0–34), and the median (lower quartile–upper quartile) number of people per bedroom was 1.7, 1–2. Of households surveyed, 957 (31%) kept birds in 2018; of the remaining 2,083 (69%), 1,603 (77%) had never kept birds, while 161 (8%) kept birds in 2016.

3.2 | Bird-keeping behaviours

Differences in numbers of birds owned, purchasing habits and time spent tending birds per day were most marked between hobbyists and the two other user-groups (contestants and breeders; Table 1). Hobbyists (57% of bird-keepers) tended to keep only small numbers of individuals and species but high proportions of wild-caught birds. Hobbyists were the most likely to receive birds as gifts, although trapping birds themselves or buying them directly from trappers or travelling salesmen was equally prevalent across all user-groups. Contestants and breeders shared many characteristics, but contestants tended to buy more expensive birds and spend more time tending their birds than breeders. Mortality of birds since 2016 was highest in the hobbyist group (proportion of birds that died was 0.22 for hobbyists vs. 0.13 in contestants and 0.15 in breeders), but the difference was not significant. While all user-groups owned threatened species, hobbyists owned a greater proportion of them than the others. Although there were only small differences in preferences concerning the song quality of wild-caught and captive-bred birds, hobbyists were the least likely to express a preference or to take origin into account when purchasing birds (Table 2).

3.3 | User-group classification

Our user-group classification had an overall accuracy of 84% (Table S3). The most important predictors of user-group membership were (in order of importance): total number of individual birds owned; numbers of lovebirds, White-rumped Shamas and leafbirds owned; and total number of taxa owned (Figure 1). The most notable differences between user-groups were that: (a) hobbyists consistently owned fewer birds than either contestants or breeders, yet owned large numbers of some native taxa (leafbirds and Oriental Magpie-robin); (b) lovebirds were owned in much larger numbers by contestants and breeders; and (c) contestants tended to keep the largest numbers of Zebra Doves. Back-predicting user-group membership based on the above predictors revealed notable dynamism between user-groups in the 2 years 2016 and 2018 (Figure 2; Table S4). Overall, the biggest change between the 2 years was an increase in proportions of hobbyists and contestants, both with relatively large recruitment from non-bird ownership in 2016.

TABLE 1 Characteristics and preferences of the three songbird-keeping user-groups (respondents self-reported membership of these groups). *n* varies according to numbers of disregarded responses for various questions, the lower number of people keeping birds in 2016 and reluctance to answer. *n* was particularly low for losses of birds: hobbyists *n* = 213, contestants *n* = 154 and breeders *n* = 103. Differences in numbers of birds owned and money and time spent on birds were tested using between-group post hoc differences from Kruskal–Wallis, the remainder with χ^2 tests (e.g. H < C indicates hobbyists showed a significantly lower response than contestants)

Ownership characteristics	Hobbyists (*n* = 409–542)	Contestants (*n* = 181–249)	Breeders (*n* = 119–166)	Post hoc differences (significant)
Total birds/species median (LQ–UQ)				
All birds	2 (1–4)/1 (1–2)	5 (3–10)/2 (1–4)	7 (3–13)/2 (1–4)	H < C; H < B; C < B/H < C; H < B
Native birds	2 (1–3)/1 (1–2)	3 (2–6)/2 (1–3)	3 (2–7)/2 (1–3)	H < C; H < B/H < C; H < B
Proportion wild-caught birds[a] owned	0.38	0.19	0.20	C < H; B < H
Proportion threatened birds owned	0.04	0.01	0.02	
Proportion birds died since 2016	0.22	0.13	0.15	
Proportion obtaining birds from:				
Gifts	0.19	0.12	0.14	C < H; B < H
Trapping	0.11	0.08	0.11	
Breeding	0.02	0.25	0.24	H < C; H < B
Proportion purchasing birds:				
All sources	0.70	0.86	0.91	H < C; H < B
Bird markets/shops	0.42	0.46	0.43	
Friends and family	0.35	0.53	0.51	H < C; H < B
Breeders	0.22	0.45	0.42	H < C; H < B
Online	0.12	0.21	0.17	H < C; H < B
Trapper/travelling salesmen	0.11	0.09	0.08	
Money and time spent median (LQ-UQ)				
USD spent on purchase bird	13 (6–21)	36 (18–84)	21 (11–43)	H < C; H < B; B < C
USD spent per week	0.7 (0.4–1.4)	1.4 (0.7–3.6)	1.4 (0.7–3.6)	H < C; H < B; B < C
Hours on birds per week	3 (1–7)	7 (3–11)	4 (2–7)	H < C; H < B; B < C

[a]Wild-caught and potentially wild-caught birds.

TABLE 2 Preferences for captive-bred (CB) or wild-caught (WC) songbirds of songbird-keeping user-groups (respondents self-reported membership of these groups). *n* varies according to numbers of disregarded responses for various questions. Differences between proportions of responses across user-groups were tested with chi-square. Significant differences further explored with post hoc tests are presented: H < C indicates hobbyists showed a lower response to contestants, whereas C > B indicates contestants had a higher response than breeders

	Hobbyists (*n* = 470–542)	Contestants (*n* = 221–249)	Breeders (*n* = 161–166)	Post hoc differences (significant)
Proportion preferring song of:				
Captive-bred	0.58	0.61	0.58	
Wild-caught	0.26	0.31	0.30	
Neither	0.16	0.08	0.11	C < H; B < H
Proportion considering origin of bird important	0.36	0.70	0.57	H < C; H < B
Origin preference				
Captive-bred	0.62	0.50	0.49	
Wild-caught	0.20	0.15	0.22	
Specific location (e.g. Sumatra)	0.19	0.35	0.29	H < C; H < B

3.4 | Socio-economic profiles

Our mixed effect models indicated the importance of seven demographic and geographic variables in characterizing cage-bird ownership, and subsequently user-group membership (Figure 3; full model outputs in Table S5). Compared to those who owned no birds ('non-bird-keepers'), bird-keepers were more likely to live in urban communities and in the eastern provinces. They were also more likely to be employed, and to have attained a high school education, while non-bird-keepers were more likely to have experienced

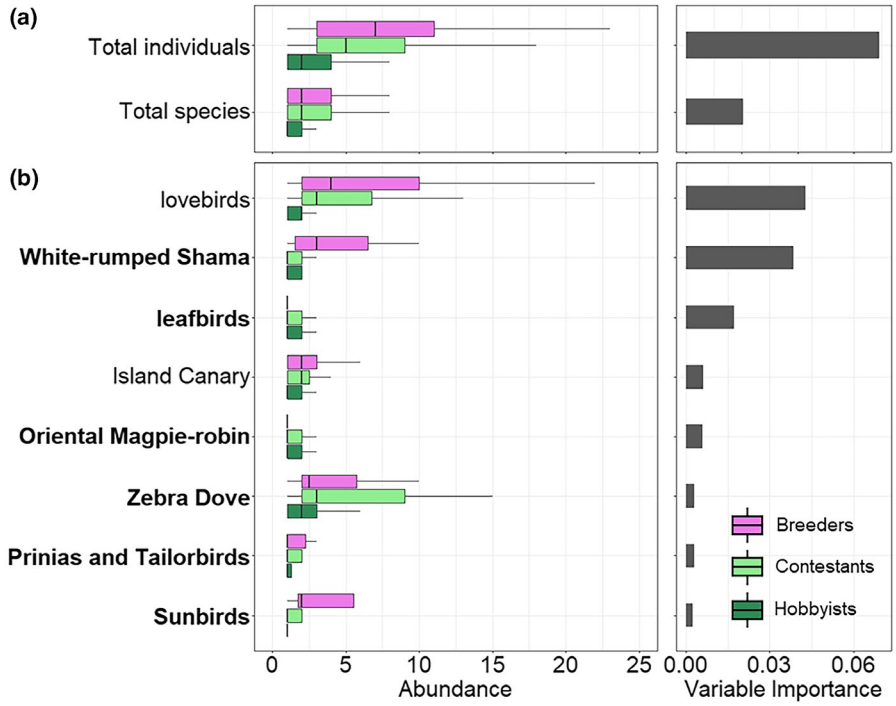

FIGURE 1 Variation in (a) total numbers of birds and species owned and (b) numbers of individual taxa owned across the three user-groups with highest importance (>0.01) in the random forest analysis. Bold indicates native species

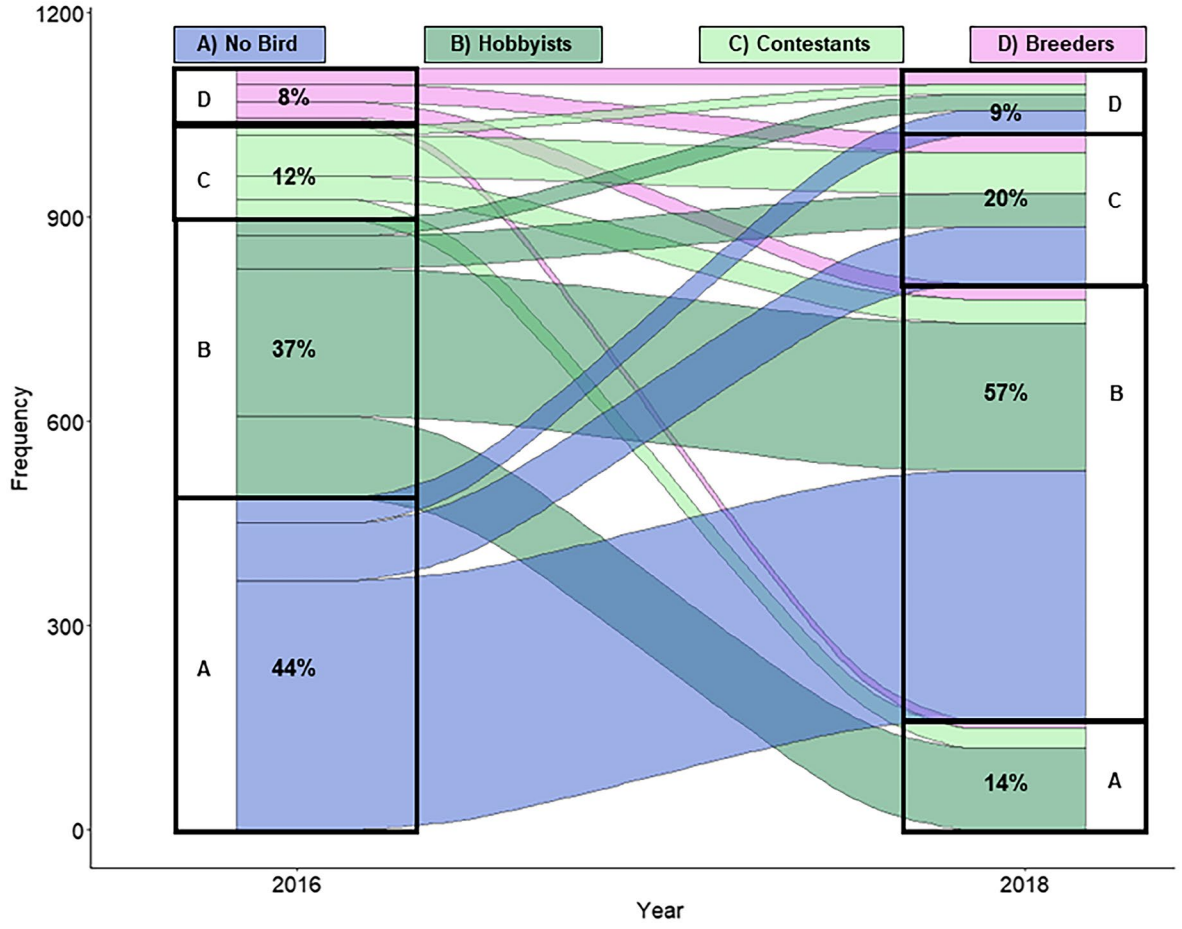

FIGURE 2 Percentages of respondents who kept birds in either 2016 or 2018 and the changes in user-group membership based on the results of the random forest predictions. Respondents who did not own birds in either year (80%) are excluded from this figure to increase interpretability. For example, the number of people keeping birds increased with the majority of non-bird-keepers (A) in 2016 becoming hobbyists (B) in 2018

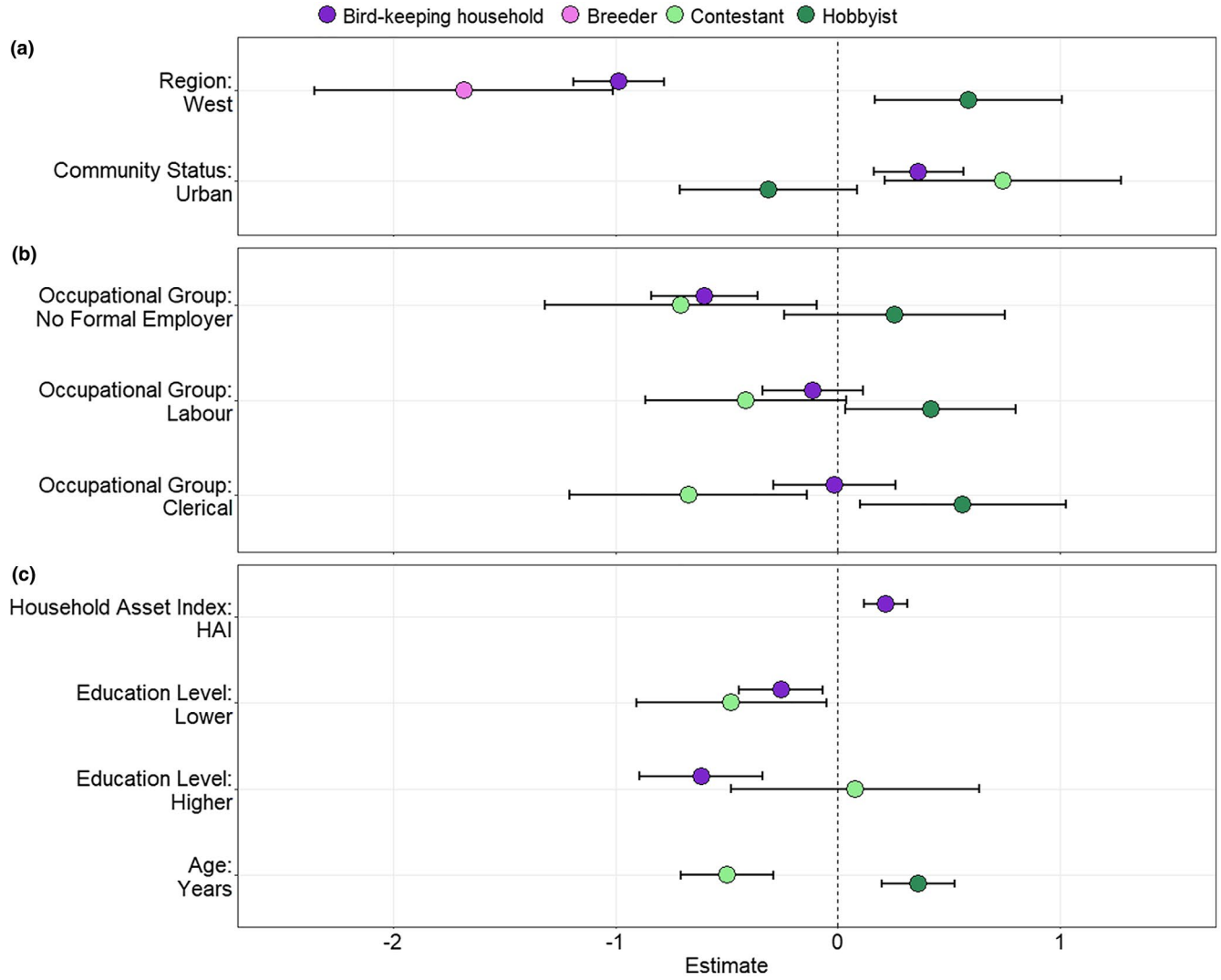

FIGURE 3 Effect sizes (with 95% CIs) of the (a) geographic, (b) occupational and (c) demographic predictor variables with the highest relative variable importance (>0.6) across models predicting bird ownership (against non-bird ownership) and user-group membership (against other bird-keepers)

either a higher or lower level of education (Figure 3). Bird-keeping households tended to have higher asset index scores, and lower occupancy index scores than non-bird-keeping households. Key characteristics of respondents in each user-group were: geographic location (bird-keepers were more likely to be breeders in the eastern provinces and hobbyists in the western provinces; Table S6), occupation (contestants were the most likely to be employed in business); and demography (hobbyists tended to be older than both breeders and contestants, who were the youngest user-group; Figure 3).

4 | DISCUSSION

The clearest and most significant threat to wild bird populations from bird-keeping is the consumption behaviour of Java's most abundant user-group, hobbyists, which may represent up to seven million households (Marshall et al., 2020a). The high volume of birds owned by this group, including the largest proportion of potentially wild-caught and threatened birds, is acquired primarily through convenience and availability, with little importance placed on origin or song quality (Burivalova et al., 2017). Furthermore, mortality of cage-birds was highest among hobbyists, and the sheer numbers of hobbyists keeping wild-caught birds across Java means that there is likely to be a huge throughflow of birds into the market (Eaton et al., 2015). Conversely, the prevalence (Marshall et al., 2020a) and abundance of highly sought-after taxa (e.g. White-rumped Shama, Oriental Magpie-robin, leafbirds) kept by contestants suggests that an anthropogenic Allee effect (Courchamp et al., 2006) is at work, drawing some species into an extinction vortex through their ever-increasing rarity in the wild, market value and status-giving properties (Eaton et al., 2015; Krishna et al., 2019). Although breeders show similar behaviours and preferences to contestants, they also favour profitable taxa (lovebirds, canaries *Serinus* spp., doves) that can be easily bred and resold for a much-elevated price. Indeed, the capacity for

contestants and especially breeders to produce their own birds may offer a counter to trapping pressures on wild populations (Nijman, Langgeng, Birot, Imron, & Nekaris, 2018). Nevertheless, an unknown but potentially significant proportion of birds held by bird-keepers in Java may come from low-intensity recreational trapping in the wild. Moreover, the large numbers of birds kept, predictably high mortality of wild-caught birds during capture, transportation and marketing (Indraswari et al., 2020) and low survival of many sensitive species in captivity, combine to suggest that the drain on wild populations is likely to be high.

4.1 | Informing evidence-based behaviour change

Our study sought to profile songbird-keeping user-groups by characterizing and identifying the behaviours that should underpin conservation efforts to increase the sustainability of bird-keeping. In combination with previous studies, we are closer to understanding the temporal dynamics of demand for songbirds and the implications these pose for future conservation efforts (Jepson & Ladle, 2009; Marshall et al., 2020a). Bird-keeping has increased in prevalence in urban centres in Java, and the abundance of captive-bred exotic birds, such as lovebirds and canaries, has grown dramatically (Marshall et al., 2020a). Tracking changes in behaviours, and in particular those that have the largest impact on wildlife populations, is vital to determining the success of conservation interventions (Veríssimo & Wan, 2018). This study contributes to the body of evidence on Indonesian songbird-keeping practices by expanding the detail of how user-groups differentially effect bird populations, establishing a baseline against which interventions aimed at reducing the impact on wild birds can be measured (Reddy et al., 2017). Previous efforts to increase the availability and popularity of captive-bred alternatives (Jepson & Ladle, 2009) have unfortunately been neutralized by a large increase in the prevalence of often wild-caught native birds (Marshall et al., 2020a). Future efforts should focus on the 'demarketing' (Veríssimo, Vieira, Monteiro, Hancock, & Nuno, 2020) of wild-caught birds in addition to redirecting demand (Moorhouse, Coals, D'Cruze, & Macdonald, 2020) towards captive-bred birds among all user-groups, but hobbyists in particular. Given that effective behaviour change usually requires considerable time (Greenfield & Veríssimo, 2019), movement between user-groups even over a very short (2-year) period could reduce the chances of targeted interventions having a lasting effect on their behaviours and preferences. On the other hand, this dynamism may reflect a responsiveness and flexibility among the population towards adopting more sustainable bird-keeping behaviours. Demand reduction campaigns certainly need to operate on this latter assumption.

A key intervention to reduce demand for wildlife products is the dissemination of information and targeting of campaigns (Veríssimo, Challender, & Nijman, 2012). The bird-keeping community in Java could represent as many as 12 million households (Marshall et al., 2020a). By breaking down this vast audience into user-groups the possibility arises of tailoring and targeting messages for their maximum impact. Interestingly, bird-keepers tended to have moderate levels of education, with our result suggesting that there may be at least two separate non-bird-keeping groups based on educational attainment, those who have not achieved a high school education and those who have achieved higher levels of education. Slightly more affluent, hobbyist bird-keepers are typically middle-aged and from the western provinces, so increasing the importance placed on the origin of birds, as well as on the quality and longevity of captive-bred individuals (Burivalova et al., 2017), may help stem the large inflow of wild-caught birds into hobbyist households. Aspects of bird-keeping have moved away from traditional practices (Jepson & Ladle, 2009) as evidenced by the younger, urban profile of contestants which, as a key consumer demographic in driving national business, suggests competitive bird-keeping will remain an important aspect of the Indonesian economy (Naafs, 2018). Consequently, the choice and source of taxa for competitive bird-keeping among Java's young urban men must be key targets in any campaign to achieve sustainability in the bird trade. Breeders, however, appeared to be the least likely to stop bird-keeping in the short term, more often becoming contestants and less often hobbyists. It may be that, as the most invested group, breeders frequently change the species they keep, both influencing and reacting to market trends; if so, they may be receptive to conservation programmes promoting the captive-breeding of threatened species.

The greater financial and temporal investments made by contestants and breeders in their birds, which acquire both status-earning and resale value, may help explain why bird origin was more important for them than for hobbyists. There is huge potential profit and status in breeding and training birds (Jepson et al., 2011), and initiatives could stress the value to be placed on origin (equivalent to 'pedigree'). Contestants and breeders both stressed the importance of sourcing birds from particular locations, and promoting a strong cultural attachment to place (Kristianto & Jepson, 2011) could provide another means of increasing the sustainability of bird-keeping. The prestige already attributed to birds and their breeders from regions renowned for their breeding capacity (i.e. Klaten in Central Java; Shepherd, Nijman, Krishnasamy, Eaton, & Chng, 2016) could be harnessed to encourage others to focus on breeding non-threatened native taxa sustainably. Unfortunately, however, a legal sustainable supply of wildlife may provide cover for the laundering of wild-sourced animals and their products (e.g. Nijman & Shepherd, 2015). This issue has caused major debate among conservationists, reflecting that surrounding the trade in ivory and rhino horn (Bennett, 2015; Collins, Cox, & Pamment, 2017; Harris, Gore, & Mills, 2019). Nevertheless, successful conservation marketing campaigns and environmental education can shift social norms and increase compliance with local legislation (Salazar, Mills, & Veríssimo, 2019; Veríssimo & Wan, 2018). In view of the importance placed on community responsibility and legislation (Kristianto & Jepson, 2011) conservationists could borrow from such approaches to highlight

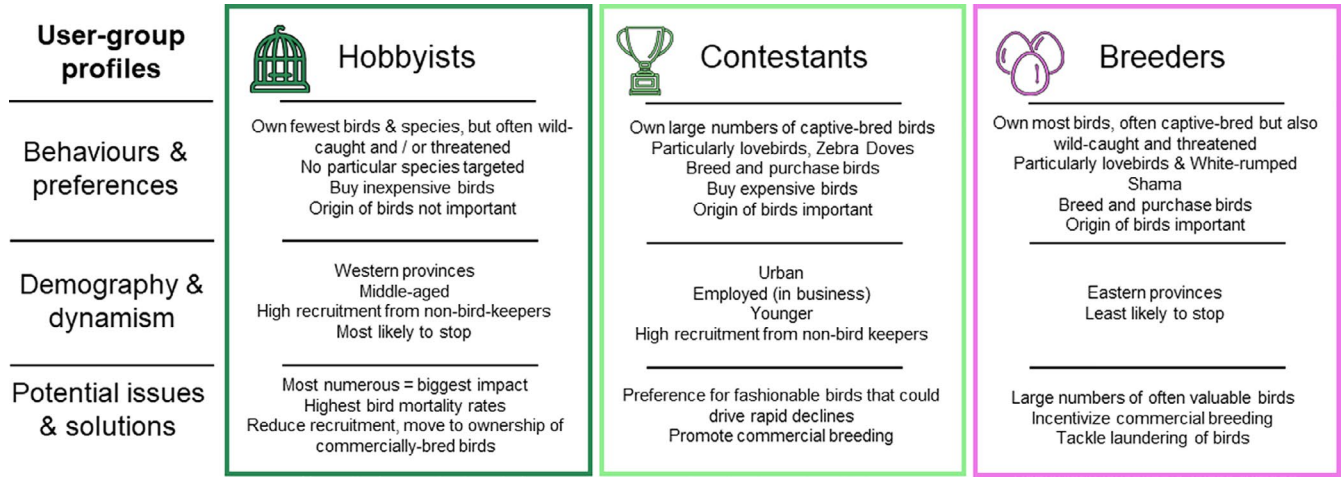

FIGURE 4 Profiles for each user-group based on key behaviours and preferences, demography and dynamism, and the potential issues and solutions to reduce the pressure their behaviours place on wild bird populations

the social undesirability, illegality and risks associated with the laundering or trapping of birds.

4.2 | Limitations and caveats

We sought to obtain as representative a sample as possible of households across urban and rural districts from all six provinces of Java by combining a stratified sampling approach to district selection (Marshall et al., 2020a) with the systematic sampling of households within selected districts. When comparing the demographic profile of our study sample with available data from the 2010 Indonesian Census (Badan Pusat Statistik, 2010) for Java as a whole, there are some differences in a number of attributes (see Table S2 in Appendix B). Overall, our sample under-represented those aged 15–24 (14% less than the census), those who have achieved a degree or higher educational attainment (17% less) and those who live in smaller households (21% less), and over-represented those who have achieved high school education (15% more; Table S2). These differences suggest our approach had some of the limitations of previous research (Jepson & Ladle, 2009). For example, there are difficulties in obtaining access and research permissions from certain gated communities that typically occur in more affluent urban areas. The potential bias the omission of such communities creates may be accentuated by their importance in driving trends in the consumption of rarer highly prized species among portions of the bird-keeping community (Jepson, 2016). Future work should address this issue, potentially using online survey techniques to reach such 'high end' consumers (Baltar & Brunet, 2012; Bornstein, Jager, & Putnick, 2013).

4.3 | Conclusions

Although conservationists may justly view bird-keeping as inherently detrimental to wild bird populations (Sykes, 2017), within Indonesia the trade in birds is seen as far too economically important and culturally ingrained to be halted completely (Jepson, 2016). Moreover, despite the accumulating evidence of rolling local and even global extinctions (Eaton et al., 2015), the long tradition of breeding native species (such as Zebra Dove) means that commercial breeding is repeatedly identified as a viable solution to the extraction of wild birds (Nijman et al., 2018). Further research is required to define audiences more precisely, explore the attitudes and perceptions of bird-keepers and frame content aimed at changing specific behaviours (Kidd et al., 2019), but our current breakdown into three user-groups offers an opportunity to begin programmes targeting each group.

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CONFLICT OF INTEREST

Nothing to declare.

AUTHORS' CONTRIBUTIONS

S.J.M. and H.M. conceived the ideas with all authors designing the methodology together; P.Y. facilitated data collection and H.M. collected and analysed the data; H.M. and S.J.M. led the writing of the

manuscript. All authors contributed critically to the drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

Due to the personal nature of the demographic information collected for this study, fully anonymized data are available from the Dryad Digital Repository: https://doi.org/10.5061/dryad.msbcc2fvz (Marshall et al., 2020b).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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