Understanding demand for songbirds within Indonesia's captive bird trade

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Abstract

Many South-East Asian bird species are in rapid decline due to offtake for the cage-bird trade, driven largely by consumption in Indonesia and labelled the ‘Asian Songbird Crisis’. The overall aim of this thesis is to identify the scale and scope of demand for songbirds as pets, and identify a portfolio of interventions to reduce the impact of demand on wild populations of songbirds. This will be achieved by quantifying, characterising, and exploring demand for songbirds among Java’s population, through assessing the spatial and temporal patterns of songbird ownership, and profiling the behaviour, preferences and motivations of songbird-keeping consumers. Moreover, I will explore people’s perceptions and attitudes towards bird-keeping and wild birds, and develop a methodology to determine effective behaviour change message content.

Using data from over 3,000 households across Java, it was determined that cage-bird ownership levels were significantly higher in urban areas and the eastern provinces of the island, with a huge number of birds kept across a third of all households. Profiling three songbird-keeping user-groups (Hobbyists, Contestants and Breeders) uncovered that user-groups diverged in their bird-keeping habits and preferences, which influence the impact that they each have on wild bird populations. Exploring public attitudes around bird-keeping in Java revealed convergent and divergent opinions on the environmental importance and impact of keeping birds in households, and the importance of peer pressure and social norms in driving bird-keeping habits. Exploring what campaign messages may be the most persuasive uncovered that messages focussed on the negative impacts of over-exploitation on Indonesia’s wildlife, or on the cultural heritage of bird-keeping, to be the most persuasive. This thesis provides a deep understanding of the demand for songbirds, and the actors involved, which can be used to inform behaviour change efforts and improve the conservation of wild bird populations in Indonesia and beyond.

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1 INTRODUCTION

1.1 BACKGROUND

1.1.1 Wildlife trade and the threat it poses to biodiversity

1.1.1.1 Global wildlife trade

Trade in wildlife, both legal and illegal (Hinsley et al., 2015), is a lucrative industry, generating billions of dollars worldwide and providing livelihoods for a large portion of the world's population (Challender et al., 2014; McNamara et al., 2016; Biggs et al., 2017). The trade in wildlife has been estimated to involve around 18% of all terrestrial bird, mammal, amphibian and squamate reptile species (Scheffers et al., 2019) and many species of plants (Liu et al., 2019) to supply demand for various purposes, notably pets (Alves et al., 2010; Bush et al., 2014), food (Veríssimo et al., 2018; Chausson et al., 2019), medicine (Davis et al., 2016; Theng et al., 2018) and ornaments (Harrison et al., 2016; Harris et al., 2019). However, the trade in wildlife has recently been linked to outbreaks of infectious diseases (Karesh et al., 2005), as well as to large-scale criminal activity (Wyatt et al., 2020). As demand for wildlife and wildlife products continues, many harvested species decline due to extraction pressures on wild populations (Auliya et al., 2016; Benítez-López et al., 2017; Tingley et al., 2017) and consequently many species are threatened with extinction (Ribeiro et al., 2019; Scheffers et al., 2019). As such the role the wildlife trade is playing in the current extinction crisis demands urgent attention (Barnosky et al., 2011; Ceballos et al., 2015; Symes, McGrath, et al., 2018).

1.1.1.2 Asian wildlife trade

Asia is one of the most biodiverse regions in the world, within which South-East Asia is particularly species rich (Myers et al., 2000). The region's biota is also one of the most threatened with extinction (Symes, Edwards, et al., 2018), particularly for certain taxonomic groups such as mammals (Schipper et al., 2008). The regional threats to biodiversity are numerous, and one of the biggest is the trade in wildlife and their products (Nijman, 2010; Hughes, 2017). Much of the trade is international (Symes, McGrath, et al., 2018) but across the region there are also large internal markets for wildlife (Davis et al., 2020). The drivers of the trade are diverse but similar to those operating at the global scale, i.e. typically encompassing use as

food (Drury, 2011), medicine (Davis et al., 2016), ornaments (Collar, 2015; Wyatt et al., 2018), and pets (McMillan et al., 2020). Accordingly, many taxa are threatened across the region including pangolin (Hinsley et al., 2017; Ingram et al., 2018; Theng et al., 2018) with examples of rhino and tiger species locally extirpated from some areas due in part to trapping pressure (Brook et al., 2014; Davis et al., 2020).

1.1.1.3 Trade in birds

Birds are among the most abundant groups of wild animals repeatedly found in both international and domestic trade (Ribeiro et al., 2019), of which around one third of all identified species are traded globally (Harris et al., 2017). Many taxa are involved in the trade including parrots (Pires and Moreto, 2011; Marsden et al., 2016), hornbills (Beastall et al., 2016), and songbirds (Regueira and Bernard, 2012). Across the globe, such is the diversity and abundance of birds that a varied array of uses drive demand, again encompassing food (Bezerra et al., 2019), ornaments (Nijman and Shepherd, 2015b) and pets (Souto et al., 2017). Consequently birds are one of the groups of wild animals most threatened with extinction by trade (Bush et al., 2014).

1.1.2 The Asian Songbird Crisis

1.1.2.1 Overview

Although habitat loss is a common threat for many South-East Asian songbird species (BirdLife, 2020) the wildlife trade threatens South-East Asia's wildlife more than any other region (Coleman et al., 2019), and the cumulative effect on wild bird populations is a major conservation issue (Symes, Edwards, et al., 2018). Indeed, South-East Asia is currently facing such high levels of avian extinction risk that the issue is commonly referred to as the Asian Songbird Crisis (Sykes, 2017; Nijman et al., 2019). This is exemplified by the fact that in 2015 conservationists working in the region organised the first 'Asian Songbird Crisis Summit' (ASCS: Lee, Chng and Eaton, 2016) to address the increasing significance of the issue. The consequences of this crisis for biodiversity and ecosystem services are still largely unknown, but many species commonly found in the trade are frugivorous and therefore seed-dispersers, so that their declines could have pervasive impacts on the long-term vegetative composition on defaunated forests (McConkey and O'Farrill, 2016). There are also concerns that trapping pressure may have altered wild bird behaviour

(Eaton et al., 2015), and there is evidence that mixed-species flocks containing species often targeted by the trade are shifting their composition (Marthy and Farine, 2018).

1.1.2.2 Scale of issue

The trade in Asian songbirds has been on the conservation horizon for the last three decades (Nash, 1993), but only in the past five years has quantitative scientific research on wild bird populations of birds affected by trade emerged (Harris et al., 2015, 2017; Symes, Edwards, et al., 2018). Understandably, a priority of conservationists in the region is assessing the volume of the wildlife trade and identifying where it is occurring (Coleman et al., 2019). A key tool employed by practitioners and researchers to provide such information is the market survey (Chng et al., 2015; Su et al., 2015)—the systematic recording of taxa available for sale in markets in a particular location. These surveys have highlighted the sheer volume of the trade and the diversity of the taxa threatened by trapping pressure (Nijman, Sari, et al., 2017; Chng et al., 2018), with market surveys across Java alone finding over one hundred native Indonesian species for sale (Profauna, 2009; Chng et al., 2015). The results of various market surveys have demonstrated consistently over the last two decades that it is Indonesia which is the biggest source of demand for songbirds across the region (Chng et al., 2015; Leupen et al., 2018).

1.1.3 Approaches to combatting unsustainable trade

1.1.3.1 Top-down approaches

The threat to global biodiversity from the wildlife trade is a major cause for concern among conservationists (Ribeiro et al., 2019; Scheffers et al., 2019). To combat this threat, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was agreed upon in 1973, and brought into effect in 1975 (CITES, 2020). The convention is an international agreement between Parties (nation states) to ensure international trade in CITES-listed species (currently >37,000) of animals and plants is either prohibited altogether or else sustainable, legal and traceable (Harfoot et al., 2018; CITES, 2020). CITES represents the principal mechanism for controlling international wildlife trade, relying on precise and specific regulatory measures such as trade bans and controls based on assessments of species' extinction risk and thorough monitoring (Challender et al., 2015b; Harfoot et al.,

2018). Based on species' assessed extinction risk they are included in one of three appendices: Appendix I includes species threatened with extinction and typically precludes trade; Appendix II includes species of conservation concern in which trade is authorised on the basis of quotas involving export or re-export permits; whereas Appendix III includes species that are protected in at least one country, and while trade is controlled by export and re-export permits, changes to listed species are at each Party's discretion (Nijman and Shepherd, 2015a; CITES, 2020).

CITES represents an international top-down legislative and regulatory approach to reducing pressure on wildlife populations that has had success at driving the national policy of many countries (currently 183 Parties are signatories; CITES, 2020), yet there are questions about its efficacy at solving what has been described as the "wicked" problem—problems that generally lack clear solutions because each is linked to other problems, and the nature and characterization of each cannot be isolated—of trade in wildlife (Rittel and Webber, 1973; Challender and MacMillan, 2014; Thomas-Walters et al., 2020). To begin with, the monitoring processes to assess extinction risk are often impeded by incomplete population data for many CITES-listed species (Challender et al., 2015b). Moreover, CITES regulates the legal international trade in wildlife, but is naturally unable to deal with the widespread illegal trade, which is estimated to be worth US$20 billion annually across the globe involving large swathes of the planet's biodiversity (Challender et al., 2015b; Wyatt et al., 2020). Additionally, there is evidence that the legal international trade in wildlife in some cases may actually facilitate the illegal domestic trade (Daut, Brightsmith, Mendoza, et al., 2015), which has been highlighted as one of the most important conservation issues for some regions (Coleman et al., 2019). Often when species are recommended for Appendix I listing there is little appreciation of the socio-ecological context within which the wildlife in question exists, and there are no requirements to assess the potential consequences of the listing question (Challender et al., 2019). There is evidence that the listing of species can lead to unintended reactions domestically that exacerbate rather than reduce pressure on wildlife, such as elevating prices leading to increased poaching and local extirpations (e.g. black rhinoceros *Diceros bicornis*; Leader-Williams, 2002). Consequently, there are high levels of non-compliance, as

well as a lack of influence, awareness and knowledge, attributed to CITES actors globally (Challender et al., 2015a).

1.1.3.2 Approaches based in social science and consumer research

Almost all significant biodiversity loss is driven by human activities and hence behaviours (Schultz, 2011; Veríssimo, 2019). To arrest this loss, conservation and environmental practitioners are increasingly aware of the need to engage with the drivers of problematic human behaviour (Sandbrook et al., 2013; Bennett et al., 2017). Indeed, much of human subsistence activity such as agriculture and fishing is based on behaviours that directly drive biodiversity declines, threatening wildlife populations in myriad ways including land conversion, pesticide use, and over-extraction (Maxwell et al., 2016). A major driver of biodiversity loss is trapping pressure associated with the exploitation of biodiversity resources for economic or cultural purposes (Symes, Edwards, et al., 2018), of which the unregulated and illegal trade in wildlife is a pervasive and destructive component (Ribeiro et al., 2019). Although a large body of work since the turn of the century has focused on attitudes to conservation issues, only recently has there been a realisation that, in order to reduce the impact of human activity on wildlife, focus also needs to be directed towards the perceptions, attitudes and preferences that lie behind destructive human behaviours, to gain the understanding by which such behaviours, and the motivations behind them, can be changed (St. John et al., 2010).

There is a large and growing body of research that has used a variety of approaches to examine and understand the perceptions of actors affected or involved in particular conservation issues in order to inform more effective management approaches and interventions (Kanagavel et al., 2014; Jefferson et al., 2015; Bennett et al., 2016; White et al., 2017). When focusing on the trade in wildlife it is therefore logical to focus on the various actors involved, typically those who consume or purchase wildlife products. Consequently conservationists have started borrowing from disciplines focused on consumers and their behaviour (Gratwicke et al., 2008; Shairp et al., 2016), including methodologies from social marketing (Drury, 2011; Williams et al., 2018; Lundberg et al., 2020). Understanding the drivers of consumer preferences and their potential impacts on wildlife can reveal important characteristics that can help inform the efforts of conservationists

seeking to reduce trapping pressure on wild populations (Hinsley et al., 2015; Shairp et al., 2016). For example, the power of preferences and cultural factors in affecting the plight of species in the trade is highlighted by the observed Anthropogenic Allee effect (AAE: Courchamp *et al.*, 2006). Across taxa it has been shown that consumers prefer and prize certain wild products on the assessment that they are rare, resulting in a species perceived in such a way becoming scarcer still as the incentives for trappers and traders increase (Hall et al., 2008). Historically conservationists have raised the profile of threatened taxa by highlighting their rarity, but this has, unfortunately, actually been shown in some cases to increase demand for such taxa, thereby increasing trapping pressure and the risk of extinction (Angulo and Courchamp, 2009). Indeed, the importance of conservationists developing a deep understanding of the socio-ecological context of species threatened by trade is paramount to developing effective solutions (Bennett and Dearden, 2014; Daut, Brightsmith and Peterson, 2015).

1.1.3.3 Demand reduction and behaviour change

Regulatory approaches, such as CITES, seek to reduce the impact of consumer behaviour on wildlife population through reducing demand and making consumption more sustainable (e.g. promoting captive-bred alternatives), yet they typically focus solely on the legal trade. In situations where enforcement is ineffective or regulation lacking, which is often the case with trade in wildlife (Cooney and Jepson, 2006; Roe et al., 2020), interventions targeting consumer behaviour offer a potentially valuable avenue to reduce pressure from such behaviour (Rowcliffe et al., 2004; Chausson et al., 2019). Assuming similarities in human behaviour across societal issues, conservationists have looked to other disciplines that seek to understand the drivers of particular habits and to explore pathways to reducing or shifting such behaviours (Kidd, Garrard, et al., 2019). Indeed, approaches combining techniques from social psychology (Abrahamse et al., 2009) and social marketing (Greenfield and Veríssimo, 2019) have shown that positive behavioural change can be produced by targeting relevant consumer behaviours in fields such as public health (Stead et al., 2007; Adams et al., 2012), energy (Issock Issock et al., 2017) and land conservation (Metcalf et al., 2019).

An important part of creating interventions aimed at reducing demand and changing consumer behaviours is the process of segmenting (Razavi and Gharipour, 2018), or breaking down, the public into identifiable groups who differentially impact wildlife (Greenfield and Veríssimo, 2019). By characterising consumers based on their preferences and behaviours, researchers have been able to break homogeneous audiences into identifiable groups to inform and focus demand reduction efforts (Yeo et al., 2017; Williams et al., 2018; Bezerra et al., 2019). Borrowing from such approaches, conservation researchers have used an array of techniques to understand demand for a variety of wildlife products including rhino horn (Truong et al., 2016; Dang Vu and Nielsen, 2018), saiga horn (Theng et al., 2018; Doughty et al., 2019) and orchids (Hinsley et al., 2015). Beyond behaviour and preferences, an understanding of how audiences and stakeholders involved in the wildlife trade can also be broken down or segmented into targetable groups, through demographic (e.g., age, education) and/or psychographic (e.g., attitudes) attributes, also allows researchers and practitioners opportunities to promote pro-conservation behaviour and attitudes using culturally appropriate messages and channels (Veríssimo et al., 2020).

Drawing on a diverse array of disciplines, conservationists have been attempting demand reduction campaigns and interventions for around 50 years (Greenfield and Veríssimo, 2019; Salazar et al., 2019). The number of demand reduction campaigns has increased, particularly in Asia (Veríssimo and Wan, 2019), but there is mixed evidence of their effectiveness in improving the status of the wildlife threatened by demand (Wallen and Daut, 2018; MacFarlane et al., 2020). Unfortunately, the number of demand-reductions campaigns that report on the biological impact of their efforts has been low, likely due to logistical issues surrounding the collection of sufficient data on a large enough spatial scale (Rissman and Smail, 2015; Veríssimo and Wan, 2019). Indeed, the lack of measurable goals in many demand reduction campaigns and the belief that raising awareness of issues will eventually lead to behavioural changes have meant opportunities for evaluation and learning from previous efforts has historically been lacking (Kelly and Barker, 2016; Olmedo et al., 2018). Moreover, beyond biological impact, the ever-adaptable and fluid dynamics of certain markets involving threatened taxa combined with the long-term nature of behaviour change at various

levels act to complicate efforts to measure the effectiveness of demand reduction interventions (Ayling, 2016). In spite of the associated temporal investment, attempts to measure the impact of behaviour change and demand reduction efforts need to gain deep understandings of the target behaviour and the surrounding context to produce robust assessments of effectiveness (Reddy et al., 2017; Veríssimo et al., 2020).

1.1.3.4 Theory of planned behaviour

There are numerous methods by which behaviour change efforts have targeted the 'demand side' of exploitation. In attempting to understand the drivers behind decision-making behaviour, social psychologists have developed theories to model behavioural choices (Kidd, Garrard, et al., 2019), with some suggesting that at least 60 different theories are relevant to understanding and informing behaviour change efforts (Darnton, 2008). One which has proved to be a popular model in circumstances when it is hard to obtain reliable self-reporting on certain behaviours is the Theory of Planned Behaviour (TPB: Ajzen, 1991). The TPB is based on the assumption that an individual's intention to carry out a behaviour frequently predicts that behaviour (Heath and Gifford, 2002). Through the use of quantitative methods to measure agreement with certain statements that focus on positive or negative attitudes towards particular psychographic factors, researchers have demonstrated that attitudes (Gifford and Nilsson, 2014), social and moral norms (Kaiser, 2006; Chen et al., 2009), 'self-efficacy' (personal judgement of one's competence; Janmaimool and Denpaiboon, 2016), and perceived behavioural control (Heath and Gifford, 2002) are some of the most common predictors of individual intention to carry out a wide variety of behaviours (Hargreaves, 2011). The TPB has been used across multiple disciplines and issues, such as recycling (Lizin et al., 2017), transport (Abrahamse et al., 2009) and green product consumption (Paul et al., 2016) to inform behavioural change interventions, with recent examples in initiatives to change environmental behaviours (Green et al., 2019) and the conservation of wildlife (Janmaimool and Denpaiboon, 2016; Amit and Jacobson, 2017; St. John et al., 2018). An example of its use comes from an obesity risk reduction campaign in a public health setting that attempted to increase individuals' self-efficacy in relation to obesity by demonstrating how more regular physical activity can be incorporated into daily routines (Adams et al., 2012). Although there is a lot to be gained from

looking to other disciplines for evidence on how to change behaviours that negatively affect wildlife, biodiversity issues are commonly acutely context-specific or diffuse in nature, making direct links between individual behaviour impacts difficult (Selinske et al., 2018).

1.1.3.5 Effective campaign design: messages and framing

Creating effective campaigns built around key messages that can change behaviour and reduce its impact on wildlife populations is often the overall goal of those who collect evidence through understanding consumer behaviours, attitudes and perceptions (Reddy et al., 2017; Kidd, Garrard, et al., 2019). Previously, conservation efforts have often focused on raising awareness of issues (Olmedo et al., 2018) in order to change behaviours, or emphasizing the shared economic or environmental dividends (Kusmanoff et al., 2016; Reddy et al., 2020). By incorporating aspects of experimental design such as Random Control Trials (RCTs) and Choice Experiments (Stead et al., 2007; Shreedhar and Mourato, 2019; Subroy et al., 2019), research has been able to determine the impact of messages on people's attitudes and behaviours. From such evaluative approaches it has become evident that efforts that focus solely on the economic and environmental benefits of wildlife rarely lead to increases in pro-conservation behaviours or attitudes (Krantz and Monroe, 2016; Reddy et al., 2020).

Despite evidence that focusing solely on raising awareness of issues and society's role in driving environmental and biological declines does not necessarily lead to reduced impact (Olmedo et al., 2018; Green et al., 2019), the importance of understanding the regulation and legality surrounding the use of wildlife means behaviours may not change without active attempts to raise awareness among those involved (Salazar et al., 2019). Indeed, there is evidence that research that examines people's understandings of the impacts of behaviour on biodiversity can inform efforts that seek to both raise awareness and change behaviours (Moss et al., 2017). Raising awareness of conservation issues is not a simple matter however, with evidence that people's trust in sources of information affects the likelihood of them changing their behaviour or attitudes (Krantz and Monroe, 2016). Gaining an understanding of audiences' trust in sources of information and use of particular communication channels has been shown to enable the creation of much

more locally relevant and trustworthy campaigns (Veríssimo et al., 2018; Kidd, Garrard, et al., 2019; Thomas-Walters et al., 2020). As such communication creation and delivery strategy has become a vital component of effective conservation programs and policy development (Jacobson et al., 2006; Mahajan et al., 2019).

The framing and construction of messages that seek to change behaviours are important in achieving the desired response among a target population (Selinske et al., 2018). Despite a long and diverse array of studies exploring framing—the construction of message content to influence individual thoughts—there is no standard list of principles or guides for communicators seeking to use strategic framing to achieve changes in behaviours or attitudes (Kusmanoff, 2017). However, the ability of strategic framing to influence and drive behaviour change has been explored in multiple contexts such as recycling (White et al., 2011), energy consumption (Xu et al., 2018), green commercial consumption behaviour (Grankvist et al., 2004) and climate change mitigation (Spence and Pidgeon, 2010). Indeed, successful media campaigns aimed at increasing vaccination rates (Zimicki et al., 1994) or encouraging people to quit smoking (Tamir et al., 2001) are prime examples of how strategic messaging can be used effectively, demonstrating how other sectors such as public health initiatives commonly incorporate it at the base of their approaches (Stead et al., 2007). However, within conservation there are numerous examples of how framing communications about issues can lead to unintended consequences, including negative attitudes to wildlife (Wilson and Bruskotter, 2009; Douglas and Winkel, 2014), and there is still much discussion about whether to focus on the extrinsic (i.e. appealing to self-interest) or intrinsic (i.e. highlighting intrinsic values) among conservation communicators (Blackmore et al., 2013; Kusmanoff, 2017).

An example of the use of behaviour change interventions in wildlife conservation is the Chi initiative in Vietnam (Offord-Woolley, 2017). TRAFFIC (Trade Records Analysis of Fauna and Flora In Commerce), an international conservation NGO focusing on the wildlife trade, commissioned a social marketing company to carry out market research into the drivers of rhino horn use in Vietnam (Offord-Woolley, 2017). The first stage of the initiative, using social marketing surveys, identified problem users - a distinct demographic, who use rhino horn to impress others by showing off their wealth and status (Offord-Woolley, 2017).

Numerous aspects of the campaign then targeted both the ‘problem’ demographic and specific consumption behaviour in an attempt to reduce demand (Offord-Woolley, 2017). Although it is too soon to evaluate the effectiveness of this strategy, early signs appear promising (Offord-Woolley, 2017).

1.2 STUDY AREA – JAVA, INDONESIA

1.2.1 Importance of Indonesian avian biodiversity

Indonesia is one of the most biodiverse countries in the world, in part due to its archipelagic structure, with multiple areas of particularly high biodiversity (Harrison et al., 2020). For example, the Sundaland biodiversity hotspot, which includes the islands of Sumatra and Borneo (Myers et al., 2000), is home to an estimated 10,000–15,000 species of flowering plants, 44 endemic bird and 37 endemic mammal species (MacKinnon et al., 1997). Indeed, many islands within Indonesia host huge biodiversity with high levels of endemism, excluding presumably many as yet undocumented species in areas unexplored by western scientists (Cannon et al., 2007; Mittermeier, 2014; Brambach et al., 2017; Harrison et al., 2020). This is especially apparent in the diversity of avian taxa distributed across the many thousands of islands that make up Indonesia (Mittermeier, 2014). Unfortunately, in addition to high levels of biodiversity and endemism, Indonesian flora and fauna are also some of the most threatened globally (Myers et al., 2000). Indeed, the avian diversity of Indonesia is second only to that of Brazil in terms of numbers of threatened species (BirdLife International, 2020). The drivers of avian diversity loss in Indonesia are broad, and range from habitat loss, fragmentation and degradation (Hughes, 2017) due to expanding agriculture (Santika et al., 2019) and urbanisation (Firman, 2017), to trapping pressure to supply demand for food (Harris et al., 2017), ivory (Collar, 2015) and the pet trade (Symes, Edwards, et al., 2018).

1.2.2 Cultural and economic importance of bird-keeping

The Indonesian wildlife trade, which also includes amphibians, reptiles (Natusch and Lyons, 2012), and primates (Nijman, Spaan, et al., 2017) is valued at up to US$1 billion annually (Marthy and Farine, 2018), of which the cage-bird trade is estimated to be worth at least US$ 80 million annually (Jepson et al., 2011). Regionally, Indonesia is a source of supply for numerous types of birds (Jepson and Ladle, 2009; Chng et al., 2015; Lee et al., 2016) but in recent years the demand for songbirds has seen large numbers sourced from beyond Indonesia (Leupen et al.,

2018). The importance of the cage-bird trade to the national economy is intrinsically tied to the long history of bird-keeping within Indonesia (Iskandar et al., 2019).

The importance of bird-keeping to Indonesian culture is most evident in the traditional Javanese—the most populous ethnicity within Indonesia—concept of *Kukila*, whereby the five parts of a balanced life for a man constitute: a vehicle, wife, home, Kris (an ornate dagger), and a bird or hobby (Iskandar et al., 2019). The species traditionally kept as part of this custom was Zebra Dove *Geopelia striata*, which was perceived to have special powers conferring protection against magic or evil spirits (Iskandar et al., 2019). Despite its traditional origins, keeping birds is a means by which individuals can demonstrate social status, a prime example of a species sought after to demonstrate status being the Bali Myna *Leucopsar rothschildi*, which is also an example of a species driven to the brink of extinction due to such demand (Jepson, 2016). More recently, however, bird-keeping practices have been influenced by trends across Asia such as the popularity of singing contests, where bird-keepers enter birds to compete based on their song and colour, which has shifted demand to a wider variety of taxa (Jepson and Ladle, 2009; Iskandar et al., 2020). Until the outbreak of avian influenza at the beginning of the 21st century many species sought for the contests were imported from abroad, such as Chinese Hwamei *Garrulax canorus*, yet due to fears of the zoonotic disease, imports dramatically stopped and attention has turned to native species that were suitable substitutes (Jepson, 2008). Bird species targeted by demand for contests have seen dramatic increases in trapping pressure, with demand for Orange-headed Thrush *Geokichla citrina*, historically a common entry in contests, already linked to multiple local extinction events on Java (Jepson, 2008; Eaton et al., 2015). Indeed, it is the political and cultural centre of the Archipelago, Java, which is demonstrably the largest source of demand for songbirds within the country (Jepson and Ladle, 2009; Leupen et al., 2018; Indraswari et al., 2020).

1.2.3 Severity of crisis in Indonesia

At least 26 bird species are globally threatened through over-exploitation in Indonesia (BirdLife International, 2020), and much of the trade is domestic (Chng et al., 2015, 2018), but demand is also driving 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 thorough, and the list of protected species, which can

only be traded if they are captive-bred, was recently updated to include newly recognised and recently red-listed species (Chng et al., 2015; Miller et al., 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) and bird traders are often confused about or unaware of the law (Rentschlar et al., 2018), making enforcement both difficult and unpopular (Janssen and Chng, 2018; Miller et al., 2019). In spite of the national and international protective legislation for particular species there is strong evidence that many endangered species are still commonly for sale in markets across Indonesia (Chng et al., 2015, 2016, 2018). The economic and cultural importance has often been seen as the principal reason why regulation and enforcement have failed to control the activity and thereby reduce impacts on wild bird populations (Jepson et al., 2011; Indraswari et al., 2020). Although efforts have been made to promote and solidify demand for captive-bred alternatives (Jepson et al., 2011), concerns among the breeding community over the protected status of birds reducing financial feasibility (Maizura, 2018) demonstrate the complexity of the issue.

1.3 OUTLINE OF THE THESIS

1.3.1 Thesis aims and objectives

The overall aim of this PhD thesis is to identify the scale and scope of demand for songbirds as pets, and identify a portfolio of candidate interventions to reduce the impact of the cage-bird trade on wild populations of songbirds in Indonesia. This will be achieved by quantifying, characterising, and exploring demand for songbirds among Java's human population.

To achieve this aim, chapters of the thesis have the following objectives:

Chapter 2.	To assess the spatial and temporal patterns of songbird ownership across Java
Chapter 3.	To profile the behaviour, preferences and motivations of songbird-keeping consumers and explore potential for change
Chapter 4.	To explore people's perceptions and attitudes towards bird-keeping and wild birds and profile the reasons for stopping, starting and never owning birds
Chapter 5.	To develop a methodology to determine effective behaviour change message content online
Chapter 6.	Discuss findings and implications for conservation

1.3.2 Chapter outlines

Chapter 2

Spatio-temporal dynamics of consumer demand driving the Asian Songbird Crisis

Overview: The bird-keeping habits of over 3,000 households from 92 urban and rural communities across six provinces on Java, Indonesia, are surveyed, and the prevalence and patterns of bird-keeping compared with those from surveys undertaken a decade ago. Differences in the prevalence of bird-keeping in urban and rural communities across Java are examined to determine what broad-scale demographic factors might influence demand for cage-birds. Numbers of households keeping cage-birds and the numbers of birds owned are extrapolated to assess the volume, composition, and patterns in ownership of species kept across the six provinces of Java.

Chapter 3

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

Overview: Songbird-keeping user-groups on Java are distinguished based on their behaviours and preferences, and the demographic determinants of user-group membership are identified. Three songbird-keeping user-groups are profiled based on interviews of nearly one thousand bird-keepers 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. Differences in bird taxa owned across user-groups and the degree of movement between them over a two-year period are explored. To identify specific threats to wild bird populations, profiles are developed that characterise each group by (a) species typically owned; (b) preferences for wild-caught or captive-bred birds; and (c) number of birds owned and turnover of individual birds.

Chapter 4

Exploring pathways to reduce demand among bird-keepers for songbirds in Java

Overview: The self-reported reasons why some people keep birds and others do not, why those that do sometimes stop, and the role age and other demographic characteristics play in these decisions are explored. Further, public attitudes and perceptions around bird-keeping in Java are examined, alongside the potential psychographic drivers of intention to keep wild-caught as opposed to captive-bred birds. Patterns in the attitudes, beliefs and intentions of bird-keepers and non-bird-keepers in Java are identified that will help guide demand-reduction efforts. A profile of suitable and effective conservation message content is provided and issues that could be the focus of conservation education and awareness-raising initiatives are highlighted.

Chapter 5

Identifying messages to facilitate behaviour change in overconsuming songbird-keeping communities on Java

Overview: Online surveys with a targeted sample of bird-keepers from across Java are used to explore the likelihood of making bird-keeping behaviours more sustainable, and what campaign messages might be the most persuasive. Respondents were shown pairs of messages, based on the results from previous chapters (3 and 4), aimed at changing their consumption habits, and asked to pick which messages they felt carried the most persuasive information or argument. The theme, framing and behaviour promoted in the messages were explored to determine which might best persuade bird-keepers to change their behaviour. Additionally, areas for specific awareness-raising campaigns and the sources of information and media to use to undertake them are examined.

Chapter 6

General conclusions and future directions

Overview: The results from the previous chapters are summarised and situated in a wider context of songbird conservation research. Insights on how to guide the creation of conservation interventions aimed at changing behaviour and reducing demand within the songbird keeping community are highlighted, and the application of this information to conservation efforts is discussed. Specific recommendations for future work are made and directions for future research are discussed.

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2 SPATIO-TEMPORAL DYNAMICS OF CONSUMER DEMAND DRIVING THE ASIAN SONGBIRD CRISIS

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Abstract

Many South-East Asian bird species are in rapid decline due to offtake for the cage-bird trade, a phenomenon driven largely by consumption in Indonesia and labelled the 'Asian Songbird Crisis'. Interventions aimed at reducing this offtake require an understanding of the spatial and temporal dynamics of the trade. We surveyed the bird-keeping habits of over 3,000 households from 92 urban and rural communities across six provinces on Java, Indonesia, and compared prevalence and patterns of bird keeping with those from surveys undertaken a decade ago. We estimate that one-third of Java's 36 million households keep 66–84 million cage-birds. Despite over half of all birds owned being non-native species, predominantly lovebirds (*Agapornis* spp.), the majority of bird-keepers (76%) owned native species. Ownership levels were significantly higher in urban than rural areas, and were particularly high in the eastern provinces of the island. Overall levels of bird ownership have increased over the past decade, and species composition has changed. Notably, lovebirds showed a seven-fold increase in popularity while ownership of genera including groups with globally threatened species such as leafbirds (*Chloropsis* spp.) and white-eyes (*Zosterops* spp.) also rose sharply. The volume of some locally threatened birds estimated to be in ownership (e.g., >3 million White-rumped Shama *Kittacincla malabarica*) cannot have been supplied from Java's forests and research on supply from other islands and Java's growing commercial breeding industry is a priority. Determining temporal and spatial patterns of ownership is a crucial first step towards finding solutions to this persistent, pervasive and adaptive threat to the regional avifauna.

2.1 INTRODUCTION

Trade in wildlife is a multi-billion-dollar international industry increasingly driven by demand in certain countries for wildlife products from an emerging middle class (Drury, 2009; Davis et al., 2016; Veríssimo and Wan, 2019). Birds are a major component of this trade, identified as a threat to over 3,000 wild species, approaching a third of the global avifauna (Butchart, 2008). Impacts of this trade are especially acute in South-East Asia, where more than 1,000 songbird species are removed from the wild for various reasons, a level of extraction that has precipitated an 'Asian Songbird Crisis' (Nijman, 2010; Su et al., 2014; Lee et al., 2016; Harris et al., 2017). Indonesia in particular represents a major regional market for cage-birds (Nash, 1993; Nijman, 2010; Chng et al., 2015), with trade significantly affecting at least 26 globally threatened bird species in Indonesia (BirdLife International, 2020).

Indonesia's most densely populated island, Java, with a population of over 140 million people, is considered the biggest source of demand for cage-birds within the region (Jepson and Ladle, 2005; Eaton et al., 2015). Keeping and breeding songbirds is a common pastime in Indonesia, with deep cultural roots (Jepson and Ladle, 2005). The potential of the trade to affect wild populations is significant: decade-old estimates indicated that across six cities in Java and Bali alone over two million native songbirds were kept as pets, almost a million of which were likely wild-caught (Jepson and Ladle, 2005, 2009). Moreover, in the last three decades keeping birds to enter them in singing contests has become increasingly popular in Indonesia (Jepson, 2008). Market surveys across Java have found over one hundred native Indonesian species for sale (Profauna, 2009; Chng et al., 2015) and revealed that the supply is now being met from Sumatra, Borneo and Peninsular Malaysia (Harris et al., 2017; Rentschlar et al., 2018). Expansion of the already strong bird-breeding industry in Java has previously been recommended to reduce pressure on wild bird populations (Jepson, 2010; Jepson et al., 2011), yet in recent years the breeding industry has lobbied for the removal of nationally protected status from widespread household species such as White-rumped Shama (*Kittacincla malabarica*; Maizura, 2018), highlighting the complexities faced in attempting to address the unsustainable offtake of wild birds. Accordingly, despite efforts from one national singing contest accreditation authority to reduce the number of wild-caught birds in their contests (Jepson et al., 2011), wild populations continue to suffer declines due

largely to trapping pressure (Harris et al., 2017; Marthy and Farine, 2018; BirdLife International, 2020).

Here we seek to examine the extent and species composition of the cage-bird trade and identify patterns of consumption in all six provinces of Java to assess the scale of the threat trade poses to the regional avifauna. Demand for cage-birds is high across urban areas in Indonesia (Jepson and Ladle, 2009), but there has been little research into bird-keeping in rural communities, which are home to around 50% of the human population (Badan Pusat Statistik, 2010). We therefore investigate differences in the prevalence of bird-keeping in urban and rural communities across Java to determine what broad-scale demographic factors might influence demand for cage-birds. We extrapolate the numbers of households keeping cage-birds and the numbers of birds owned to assess the volume, composition, and patterns in ownership of species kept across the six provinces of Java. Finally, we reveal temporal trends in the extent and composition of the trade by comparing our results with those of surveys conducted a decade ago. The results of this study will both highlight the scale of the threat bird-keeping in Java poses to the regional avifauna and form an evidence base to inform and support future interventions aimed at demand reduction as a mechanism to increase the sustainability of songbird-keeping across South-East Asia.

2.2 METHODS

2.2.1 Study design

We define a cage-bird as a bird kept or sold as a pet in either households or markets (Su et al., 2014; Chng et al., 2015). This definition encompasses passerine songbirds and other birds that can be entered in singing contests such as lovebirds (*Agapornis* spp.), various doves (Columbiformes) although not feral pigeons (Jepson and Ladle 2005), owls (Strigiformes) (Nijman and Nekaris, 2017), woodpeckers (Piciformes), and cuckoos (Cuculiformes; Chng et al., 2015). Taxonomy follows del Hoyo and Collar (2014, 2016).

We conducted structured household surveys across six provinces on the island of Java, Indonesia (Banten, Daerah Khusus Ibukota [DKI] Jakarta, West Java, Central Java, Daerah Istimewa Yogyakarta [DIY] and East Java; Figure 2.1). Study locations were chosen using a stratified sampling technique to ensure a

representative sample for each province (Newing, 2010). The nested administrative levels of Indonesia are as follows: 1. Province, 2. Regency, 3. District, 4. Community (either a rural village or an urban community), 5. Neighbourhood. The national Indonesian statistics authority (Badan Pusat Statistik, BPS) uses a composite score across a number of factors to define urban and rural areas based on population density, number of households working in agriculture, and the availability of key infrastructure (Badan Pusat Statistik, 2010); we used the 2010 census data on the number and proportion of people living in BPS-defined rural and urban districts (i.e. administrative level 3). Districts were then ranked by the size of their rural populations to create quartiles for each province along a rurality gradient. Owing to the unavailability of recent data, the population density of urban districts we use (based on 2010 census data) is likely conservative as the values may now be higher due to migration from neighbouring rural communities (UNESCO, 2017), although the broad-scale differences between rural and urban districts will remain relatively constant.

Within each province, two districts were selected randomly from each quartile; within each district two communities were again selected randomly (see Figure 2.A.1.). In each community, a target number of surveys to be completed proportional to the community population size was established (20–40 surveys per community). Communities were divided between teams (2–4 interviewers) by neighbourhoods, which were selected randomly. Research was conducted over two four-month periods between January and October 2018. Over each period research teams, comprising 6–10 trained Indonesian students and the principal investigator, systematically searched assigned neighbourhoods for potential respondents in the first ten homes encountered. Once a neighbourhood had been fully searched or when at least five surveys were completed, another random number was used to find the next neighbourhood within the village until the target number of surveys was met.

Following the Indonesian statistical authority, a ‘household’ was defined as generally a family unit constituting an adult, spouse, and any children below the age of 18 (further examples in BPS, 2010). We aimed to complete surveys with the head of the household (male or female) if present, or else the most senior family member available. The survey was developed in the final quarter of 2017 and finalized after

piloting in early 2018. The questions (see 2.6.2 Appendix B) asked by the interviewers fell into three categories: (1) to collect data for household socio-economic and demographic profiles; (2) to determine whether respondents owned birds and, if so, which species, how many of each, and whether they were captive-bred or wild-caught; and (3) to establish their motivations for bird-keeping. Motivations explored in this paper are (a) to enter birds into singing contests and (b) to breed birds on a relatively small scale commercially or as a hobby. Owned birds were shown, or at least visible, to interviewers on more than 80% of occasions, and were identified to species level. When birds were not seen, identification was made to genus level based on respondents' use of market names for their birds. Although the majority of songbird species are not protected by Indonesian legislation, the capture, transportation and sale of wildlife across provinces without permits are considered illegal offences, the keeping of wildlife is not (Chng et al., 2018). Consequently, our questions do not directly relate to perceived illegal behaviour, and we therefore assumed respondents were answering questions about the origins of their birds truthfully, as in other research on songbird keeping in Indonesia (Jepson and Ladle, 2009; Burivalova et al., 2017).

2.2.2 Ethics statement

Research ethical approval was obtained 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 obtained for Indonesia from the Indonesian research authority (RISTEKDIKTI) with the named research partner institution being Universitas Atma Jaya Yogyakarta. Prior to data collection, teams gained permission from the head of the neighbourhood, and agreed on stipulations laid out by the local higher administrative level (i.e. community, district or regency). Interviewers obtained prior informed consent from household members. Interview rejection rates were high (around 40%), more so in urban than rural areas and for the team's non-Javanese interviewers. Commonest reasons for rejection were lack of time or suspicion of a burglary plot. The time and date of the survey were recorded before data were collected, along with the name of the interviewer; all data were subsequently anonymized.

2.2.3 Data analysis

To investigate the role of rurality in determining the prevalence of bird-keeping across Java, the top two quartiles for rurality were grouped together, as were the bottom two, to create a binary category of rural and urban communities. Mean proportions (± SE) of households surveyed keeping native and non-native birds were calculated for each urban and rural community within each province. The provinces of Java are commonly divided into two halves based on socio-economic differences between populations: the western provinces of Banten, DKI and West Java have a more ethnically mixed population with a relatively small Sundanese majority, while the eastern provinces of DIY, Central and East Java are overwhelmingly ethnically Javanese (Table 2.A.1.;Na'im and Syaputra, 2010). To examine the broad-scale correlates of bird-keeping households, we fitted two Poisson generalised linear models (GLMs), using R statistical software (R Core Team, 2018), with the proportion of households keeping 1. native, and, 2. non-native birds, within communities as the continuous dependent variables in separate models. The predictor variables included in both models were binomial factors: whether the community was classed as rural or urban; and whether the community was in the eastern or western half of the island.

Overall cage-bird ownership and that of individual taxa (e.g. White-rumped Shama) were extrapolated to the whole of Java by calculating (a) the mean proportion (± SE) of households keeping each taxon across communities for each province, and (b) the mean number (± SE) of cage-birds owned per household, and then multiplying (a) by the number of households in each province, and (b) by the estimated number of households keeping those taxa. Taxa were then ranked by the estimated number of birds in households. We summarized the number of individuals of each bird species owned, along with the number of households keeping each species. All data on the number of households were obtained from the 2010 Indonesian Census (Badan Pusat Statistik, 2010). To identify the most common origin for each species, we calculated the proportion of that taxon reported as "wild-caught" or "captive-bred", excluding "unknown", summarized by the origin that represented the majority. A similar method to that above, without extrapolation, was also used to calculate the mean percentages of bird-owning respondents citing breeding and contest-going as motivations, and the prevalence of keeping the

twelve most abundant taxa. Observed species richness and Chao 1 estimation of richness (Souto et al., 2017) were calculated for communities in each province and for urban or rural areas. As the majority of non-native species observed in this study and others (Burivalova et al., 2017) were bred and sourced in captivity, whereas native species found in markets are often sourced from the wild (Chng et al., 2015, 2018) our diversity measures included only species native to Indonesia so as to understand better how bird-keeping affects wild bird populations.

Data on cage-bird ownership and taxa recorded from households in Jepson (2009) were obtained, with the lead author's permission, via Oxford University Research Archive (ORA) to examine changes in the prevalence of bird-keeping and the composition of bird taxa owned between 2007 and 2018. The methods employed to collect data in both studies were broadly comparable, but there were some differences regarding sampling strategy and survey methodology: the data collected in Jepson were only collected in urban locations; and Jepson's survey was 'piggybacked' onto other consumer research (see Jepson and Ladle, 2009). As data collected in 2007 were obtained only from a sample of cities in Java and Bali, we used a subset of our data from the same or adjacent urban communities to make the comparison. For the purposes of this study, only data from Jepson's (2009) random sample were used. We examined the difference in total proportion of songbird ownership levels between 2007 and 2018, and calculated the projected population size of native and non-native songbirds using the same method and same number of households as reported in Jepson (2009). We also compared the percentage of people owning different taxa across the two datasets. In this analysis, to ensure congruency between the taxonomy in our study and Jepson's (2009), we grouped certain species together from our dataset (e.g. tailorbirds *Orthotomus* spp., prinias *Prinia* spp., *Alophoixus* bulbul spp., tits *Parus* spp./Java Sparrows *Lonchura oryzivora*, flycatchers *Cyornis* spp., and laughingthrushes *Garrulax* spp.).

2.3 RESULTS

2.3.1 Prevalence of bird-keeping

Of 3,042 households surveyed in 92 communities across all six provinces (Figure 2.1), 958 (31.5%) kept 5,967 individual birds belonging to 112 species or species groups (55% non-native and 45% native). Of bird-keeping households, 726 (76%) owned at least one native bird, and 545 (56%) owned a non-native bird.

Communities in the eastern provinces of the island (Central Java, DIY, East Java) had significantly higher proportions of households keeping both native (32% vs 15%; $p < 0.001$) and non-native (23% vs 12%; $p = 0.003$) birds than those in the western provinces (Banten, DKI, West Java; Figure 2.1 and Figure 2.A.2. for non-native bird ownership). Urban communities had significantly higher proportions of households keeping both native (25% vs 23%; $p = 0.034$) and especially non-native birds (21% vs 14%; $p < 0.001$) than rural ones (for the full GLM outputs see Table 2.A.2.).

2.3.2 Species composition, total volume and extrapolations of ownership

We estimate that 11,973,000 ± 994,000 (SE) households kept 74,321,000 ± 8,490,000 cage-birds across Java in 2018. This equates to roughly one cage-bird for every two people on the island, or two per household. We estimate that over 30 million lovebirds and around 10 million Island Canaries (*Serinus canaria var. domestica*) were being kept on Java in 2018, but that there were also huge numbers of some native songbirds, including >3 million White-rumped Shamas (*Kittacincla malabarica*) and > 2 million Oriental Magpie-robins (*Copsychus saularis*; Table 2.1). Three species and two genera had higher proportions of individuals reported to be wild-caught than captive-bred, and had estimated ownership levels exceeding one million birds (Table 2.1). Of all (140) species and genera kept, > 12% are listed as threatened or Near Threatened (Appendix C); of taxa with estimated ownership levels exceeding one million birds, Javan Pied Starling (*Gracupica jalla*) is listed as Critically Endangered and two genera (leafbirds *Chloropsis* spp. & white-eyes *Zosterops* spp.) include species listed as threatened or Near Threatened (Table 2.1) on the IUCN (International Union for Conservation of Nature) Red List of Threatened Species (IUCN 2019).

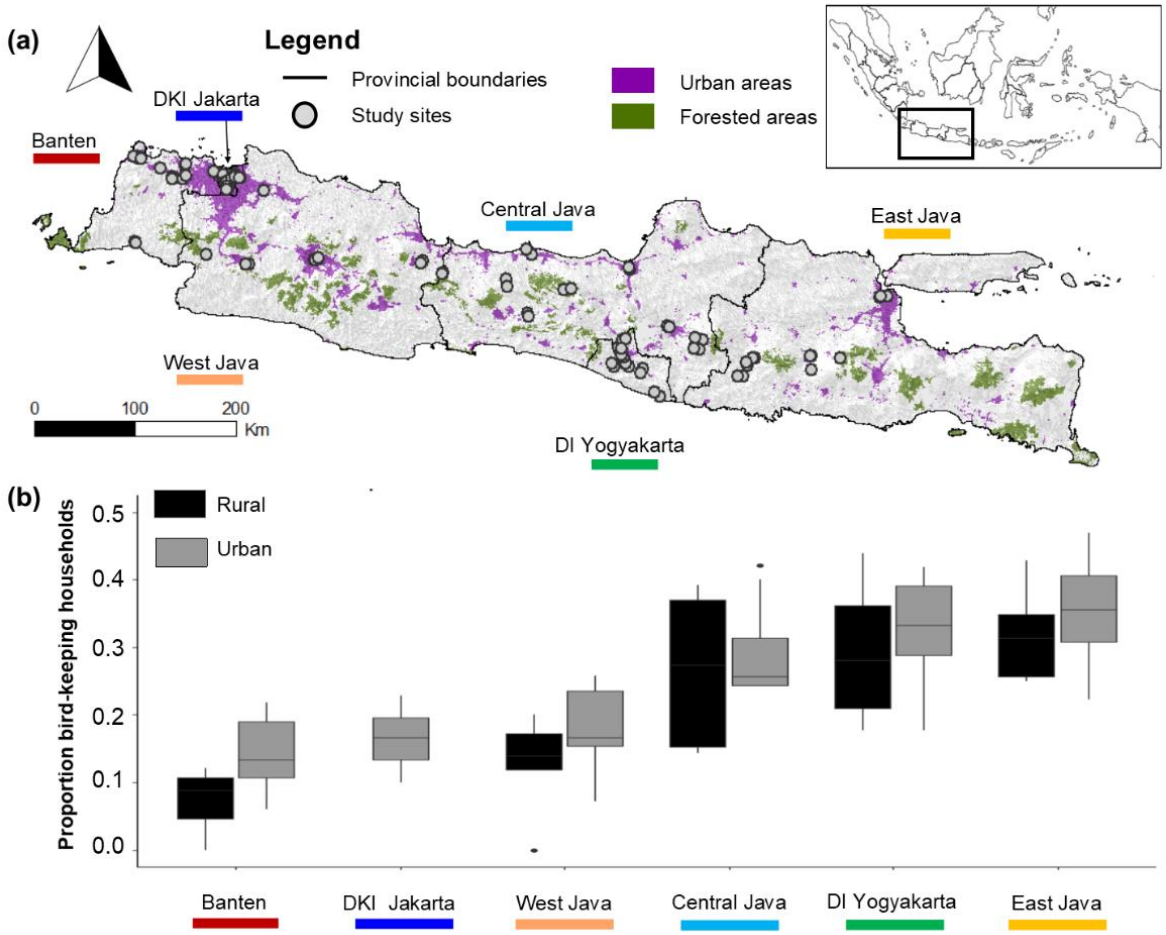

Figure 1. Panel (a) Study sites (communities) across the six provinces where households were surveyed between January and October 2018; highlighted in purple are densely populated areas and in green are areas of native forest. Panel (b) Mean prevalence of households owning at least one native bird species for rural and urban communities across the six provinces of Java.

Table 2.1. The most abundant taxa reportedly owned ranked by the number of birds in households across the six provinces of Java.

Rank	Species: English name	Species: Scientific name	IUCN status[a]	Number of keepers	Number of birds	Primary source[b]	Estimated number of birds in households (SE)
1	Lovebirds	*Agapornis* spp.	-	386	2293	NN	33,479,000 (5,957,000)
2	Island Canary	*Serinus canaria*	-	253	675	NN	9,702,000 (2,467,000)
3	dove spp.	*Streptopelia/Spilopelia/Geopelia* spp.	LC	223	824	CB	8,045,000 (1,272,000)
4	White-rumped Shama	*Kittacincla malabarica*	LC	133	294	CB	3,386,000 (707,000)
5	Budgerigar	*Melopsittacus undulatus*	-	34	209	NN	1,694,000 (788,000)
6	Oriental Magpie-robin	*Copsychus saularis*	LC	116	186	CB	2,457,000 (371,000)
7	white-eyes	*Zosterops* spp.	[c]	83	174	WC	1,859,000 (427,000)
8	Yellow-vented Bulbul	*Pycnonotus goiavier*	LC	120	208	WC	1,644,000 (206,000)
9	leafbirds	*Chloropsis* spp.	[d]	92	123	WC	1,596,000 (211,000)
10	Javan Pied Starling	*Gracupica jalla*	CR	85	125	CB	1,144,000 (143,000)
11	Sooty-headed Bulbul	*Pycnonotus aurigaster*	LC	55	75	WC	1,028,000 (170,000)
12	Long-tailed Shrike	*Lanius schach*	LC	73	81	WC	1,011,000 (54,000)

[a] IUCN status; NT: near threatened; VU: vulnerable; EN: endangered; CR: critically endangered.

[b] Primary source represents that most often reported other than “unknown” for each species; NN: non-native, CB: captive-bred, WC: wild-caught.

[c] White-eye species: *Zosterops palpebrosus* (LC), *Zosterops montanus* (LC), *Zosterops atricapilla* (LC), *Heleia javanica* (LC), *Zosterops flavus* (VU).

[d] Leafbird species: *Chloropsis venusta* (NT), *Chloropsis sonnerati* (VU), *Chloropsis moluccensis* (LC), *Chloropsis cyanopogon* (NT).

2.3.3 Patterns of bird ownership across Java

We found considerable spatial variation across provinces and gradients of rurality in species composition and abundance, overall taxonomic diversity and motivations for keeping birds (Table 2.2). The nine most abundant taxa, including eleven species, were doves (Sunda Collared *Streptopelia bitorquata*, Zebra and Eastern Spotted Dove *Spilopelia chinensis*), White-rumped Shama, Oriental Magpie-robin and white-eyes (*Zosterops* spp.), Yellow-vented Bulbul (*Pycnonotus goiavier*), leafbirds (*Chloropsis* spp.), Javan Pied Starling (*Gracupica jalla*), Sooty-headed Bulbul (*Pycnonotus aurigaster*) and Long-tailed Shrike (*Lanius schach*) (Table 2.2). Captive breeding of birds was more common in the eastern provinces, while ownership associated with singing contests was more common in the western provinces, and lower in rural areas than in urban areas across all provinces. Estimated total species richness of birds kept was highest in Yogyakarta and Jakarta. Jakarta had the highest levels of non-native bird ownership, but the locally threatened White-rumped Shama, a highly prized favourite of singing competitions, was also especially common (Table 2.2).

Table 2.2. Patterns of ownership across Java's provinces, urban and rural communities and overall.

Province	Total bird-keepers (% respondents)		% bird-keepers owning:				Species richness			% bird-keepers owning:								
	n	%	Native birds	Non-native birds	To breed	To enter singing contests	Observed	Expected Chao1 (SE)		dove spp.*	White-rumped Shama	Oriental Magpie-robin	white-eyes**	Yellow-vented Bulbul	Leafbirds***	Javan Pied Starling	Sooty-headed bulbul	Long-tailed Shrike
Banten	77	16.7	67.6	47.9	14.7	29.6	24	31	(6.6)	22.5	13.4	11.6	9.4	0.0	4.1	3.9	3.9	0.9
DKI Jakarta	106	24.3	69.8	68.5	22.5	31.1	37	88	(35.2)	16.9	22.5	14.8	7.5	13.1	12.6	10.6	3.0	2.9
West Java	104	23.2	73.9	50.3	17.3	30.0	29	43	(11.2)	14.3	14.2	12.2	7.3	4.2	4.7	8.3	12.5	1.9
Central Java	212	34.6	79.1	53.8	37.1	21.0	51	53	(2.4)	20.7	12.4	16.9	7.5	17.6	12.2	12.2	7.5	12.3
DI Yogyakarta	232	39.0	82.9	51.0	40.2	19.8	76	99	(12.2)	29.3	12.4	10.7	9.7	20.6	7.3	8.3	4.8	8.0
East Java	227	47.5	75.3	59.7	40.6	29.1	51	66	(10.0)	27.7	13.2	10.0	7.2	6.8	11.1	3.4	3.2	8.4
Urban	602	33.2	73.9	60.1	29.6	30.1	86	102	(8.7)	21.2	15.9	12.6	8.4	12.4	9.1	8.4	4.7	5.3
Rural	356	29.2	77.3	47.6	30.5	20.4	65	93	(15.8)	24.6	12.3	12.9	7.7	8.8	8.6	6.7	6.9	7.5
Overall	958	31.6	75.2	55.3	30.0	26.3	100	127	(13.5)	22.5	14.5	12.7	8.1	11.0	8.9	7.8	5.6	6.2

* Dove species include Sunda Collared *Streptopelia bitorquata*, Zebra and Spotted Doves.

2.3.4 Decadal changes in ownership

Songbird ownership levels have risen markedly over the last decade in each of the five urban areas sampled in both studies (Table 2.3), with songbird ownership from our survey being double or treble (in Surabaya) that reported by Jepson (2009). Accordingly, there has also been a sharp rise in the projected number of songbirds across all locations, most notably in non-native species such as lovebirds, canaries, and Budgerigars (*Melopsittacus undulatus*). The composition of songbird taxa owned has also changed (Figure 2.2): lovebirds have become seven times more prevalent, and white-eyes, Javan Pied Starlings (*Gracupica jalla*) and leafbirds are now far more common. In contrast, Orange-headed Thrush (*Geokichla citrina*), Long-tailed Shrike (*Lanius schach*), and several bulbul species (*Pycnonotus* and *Alophoixus* spp.) have seen dramatic drops in ownership.

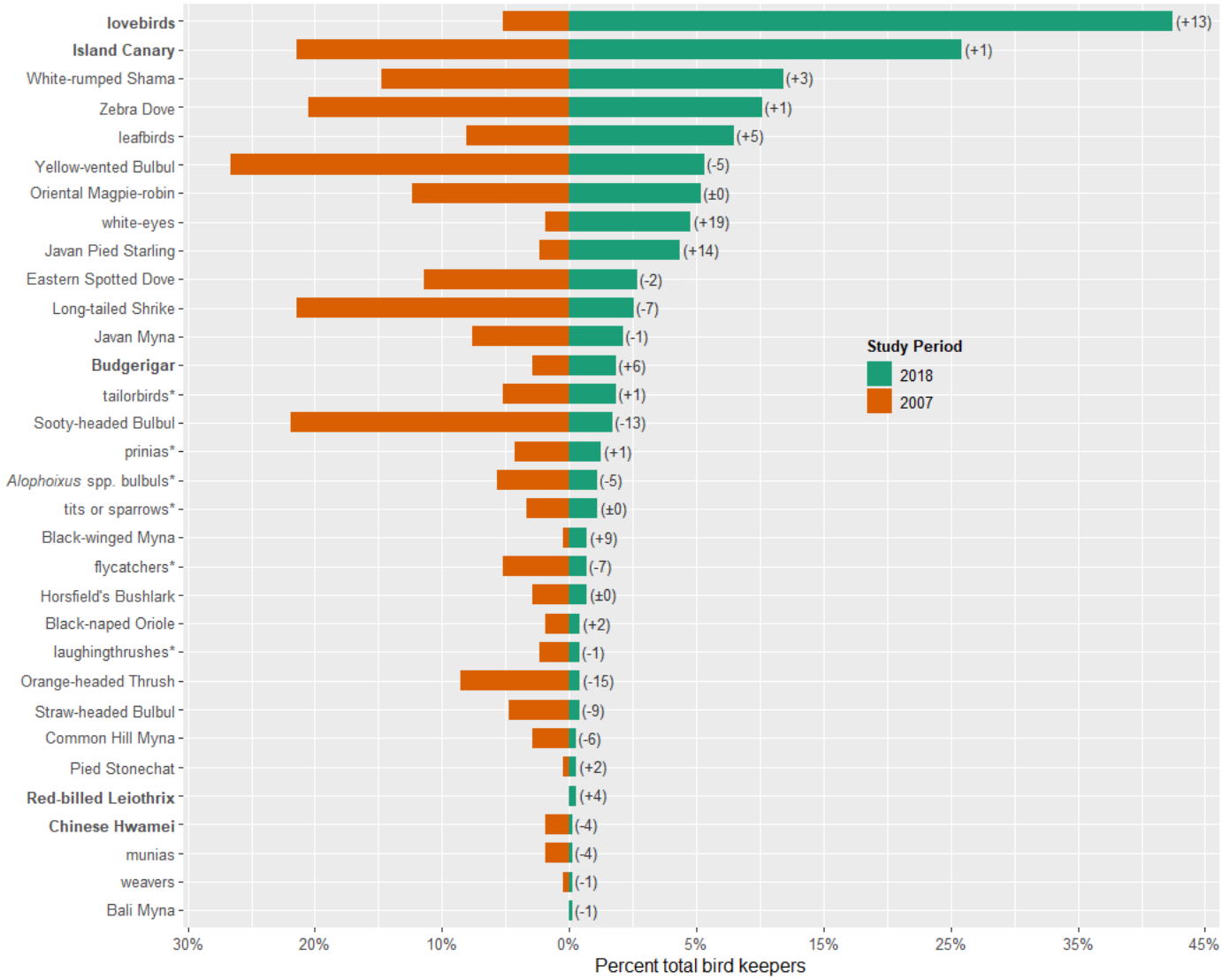

Figure 2. Comparison of species/taxon composition between 2007 and 2018, ranked by percent ownership of species/taxon in 2018. Changes in rank across surveys is shown in brackets beside percentage ownership in 2018. Non-native taxa are highlighted in bold. * indicates species that have been matched despite different taxonomic classification between the two datasets. Scientific names of species are in Appendix C.

Table 2.3. The percentage of n households in each study location that kept songbird species (including lovebirds and canaries) and the projected number of songbirds kept (both native and non-native species) in 2007 and 2018.

City / Province	2007				2018			
	n	Keeping songbirds	Projected number of songbirds		n	Keeping songbirds	Projected number of songbirds	
			native	non-native			native	non-native
Jakarta / DKI	293	8.9	260,812	94,908	371	22.6	124,621	154,573
Bandung / W. Java	299	8.4	90,718	61,495	194	25.8	980,290	2,074,973
Yogyakarta / DIY	300	14.7	34,124	9,177	143	34.3	257,857	705,230
Semarang / C. Java	299	19.1	144,703	61,075	150	35.3	374,494	1,216,178
Surabaya / E. Java	290	20.0	312,974	126,931	125	62.4	912,774	1,899,143
Overall	1481	14.2	843,330	353,586	983	31.9	2,650,036	6,050,098

2.4 DISCUSSION

Investigating the broad-scale patterns of the trade is crucial to understand the impact on species and the ecological services they provide, and to inform interventions to reduce this impact either through demand reduction (Olmedo et al., 2018; Veríssimo and Wan, 2019) or supply management (Jepson and Ladle, 2009; Nijman et al., 2018). This study examined the spatial variability and temporal dynamics of consumer demand in Java both to highlight the scale of the threat it poses to the regional avifauna and as an evidence base that can inform future interventions aimed at increasing the sustainability of songbird-keeping in Java.

We estimate that some 66–83 million cage-birds are now kept in captivity on Java - one bird for every two of the island's human population. While the majority of these birds are captive bred non-native species, the projected number of native songbirds kept in some of Java's largest urban centres has more than trebled over the last decade. Given that less than 12,000 km^2 of Java's forest remains (Prasetyo et al., 2011) and that little of Java's non-forested land remains suitable for many bird species due to both intense land-use management (Higginbottom et al., 2019) and bird-trapping (Ng et al., 2017; Nijman et al., 2018), we suggest that the number of birds held in cages might approach or actually exceed the number of birds left in the wild on the island. The scale of demand for cage-birds has pushed more than a dozen species to the brink of extinction on Java and beyond (BirdLife International, 2020), and many species affected by trade which were once common and widespread, such as Sumatran Laughingthrush (*Garrulax bicolor*) and White-rumped Shama, have now become increasingly difficult to find (Eaton et al., 2015). Even so, despite significant drops in wild bird populations (Harris et al., 2017; Sykes, 2017), bird ownership levels have increased over the past decade.

There was significant variation in multiple bird ownership metrics both across provinces and between urban and rural communities. Overall ownership was higher in Javanese-dominated eastern Java, where both bird-breeding and the keeping of ornamental species such as Yellow-vented Bulbul were much more common. In western Java, bird-keeping was more associated with singing contests, with species such as White-rumped Shama and leafbirds more commonly kept. Even more striking were differences between Java's rural populations and its urban centres. Urban communities were more likely to keep birds, and kept a wider range of

species, perhaps reflecting availability of species from Java and other Indonesian islands in their large markets (Chng et al., 2015) and higher disposable incomes (UNESCO, 2017). They also kept a higher proportion of non-native birds such as lovebirds and canaries, and were much more likely to enter singing contests, which may be associated with the larger proportion of rural populations employed in low-wage labour-intensive work than urban ones. Conservation interventions aimed at demand reduction or other behavioural change will need to start with an appreciation of these differences (Challender et al., 2015a; Olmedo et al., 2018), focusing on the habits of hobby breeders in the eastern half of the island, and the preferences of singing-contest enthusiasts in urban centres in the western half.

A major conservation concern is the decline in ownership of species such as Orange-headed Thrush, Long-tailed Shrike, and some *Pycnonotus* and *Alophoixus* bulbuls. Whether ownership of these taxa has declined more due to a reduction in availability through declines in wild populations, or something more benign like simple trends in what is fashionable, requires investigation. Previous work found an increase in ownership of *Geokichla* thrush species (including Orange-headed Thrush) between 1999 and 2006 (Jepson and Ladle, 2009) due to their popularity in singing contests, and during the same period they appear to have been trapped to local extinction across Java (Jepson, 2008). Regional trends in ownership of some of these taxa open the possibility that availability in the wild may be a key factor in predicting presence in captivity, and that demand shifts to more highly abundant taxa when one source dries up (Eaton et al., 2015). These trends highlight how understanding the popularity of species with individual bird-keepers will be key to predicting which species may be targeted as substitutes in future.

Another major concern is the growth over the last decade in ownership of taxa such as leafbirds and white-eyes, both of which, despite growing fears for wild populations of these taxa (Lee et al., 2016), are yet to become staples of the captive-breeding industry (Nijman et al., 2018). The large numbers of these taxa entering the market reflects the ability of the songbird trade in Java to switch to previously unexploited sources. Recent research on bird-keeping in Sumatra, and Kalimantan demonstrate how leafbirds and white-eyes have become popular outside Java and how wild-caught individuals are often more desirable than captive-bred alternatives (Burivalova et al., 2017; Rentschlar et al., 2018). Notable are within-country regional

trends in consumer demand for cage-birds, for example the large numbers of munias found in markets in Medan to supply merit releases by the large ethnically Chinese population (Chng et al., 2018), or significant levels of trapping (primarily parrots) observed in Maluku to supply local demand for pets (Cottee-Jones et al., 2014; Tamalane et al., 2019). The importance of Java as the biggest regional source of demand however is demonstrated by the large number of birds from higher value species supplied by other islands within Indonesia, notably Sumatra (Bušina et al., 2018) and Kalimantan (Rentschlar et al., 2018).

The huge numbers of White-rumped Shamas in households, a species of great commercial value now virtually extirpated from Javan forests, must be supplied through importation of wild birds from outside of Java (Rentschlar et al., 2018), and commercial breeding (Nijman et al., 2018). We know from seizures that thousands of Shamas arrive in Java from Indonesia's other Sundaic islands, Malaysia and Thailand (Leupen et al., 2018), and the further spread of Java's pervasive demand for songbirds to adjacent areas of Asia must now be regarded as a real and serious danger to wild populations. The degree to which demand for White-rumped Shamas is being or might be met by commercial breeding is unclear, as it is for other species such as Javan Pied Starling, Bali Myna (*Leucopsar rothschildi*), and Oriental Magpie-robin. The numbers of these high-value species kept and reportedly sourced from commercial breeders indicates that the avicultural community in Indonesia has considerable capacity (Jepson et al., 2011). At present, however, legitimate concerns exist that breeding facilities possess the potential to 'launder' wild birds (Eaton et al., 2015; Nijman et al., 2018; Rentschlar et al., 2018) and even that successful commercial breeding may simply stimulate rather than satisfy demand. It is therefore a matter of urgency to establish whether and how commercial captive breeding of popular native or once-native species could be developed and regulated to replace, rather than add to, Java's current consumption of wild-caught birds.

The great increase in ownership of easy-to-breed non-native species, especially lovebirds, also raises the possibility that higher-volume production of these and other birds could meet indiscriminate demand for cage-birds and song competitors. However, the huge increase in the numbers of non-native birds relative to a still remarkable increase in native birds, suggests that trade in captive-bred non-

native species may simply be supplementing rather than supplanting demand for native songbirds. Again, it is critical to investigate the scale and scope of the industry to determine the commercial viability of expanding businesses sustainably to meet the increasing demand. It is particularly important to explore whether sustainably breeding highly sought-after taxa such as leafbirds and white-eyes, which have thus far proved difficult to breed at commercial scales, could realistically reduce pressure on wild populations. Evidence is also urgently needed, through an intensive profiling of consumer behaviour, preferences, and socio-economic circumstance (Drury, 2009; Offord-Woolley, 2017), to inform a conservation response that can induce a genuine and lasting behavioural change in consumption habits and thereby prevent further exacerbation of the Asian Songbird Crisis.

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2.6 APPENDICES

2.6.1 Appendix A – supporting tables and figures

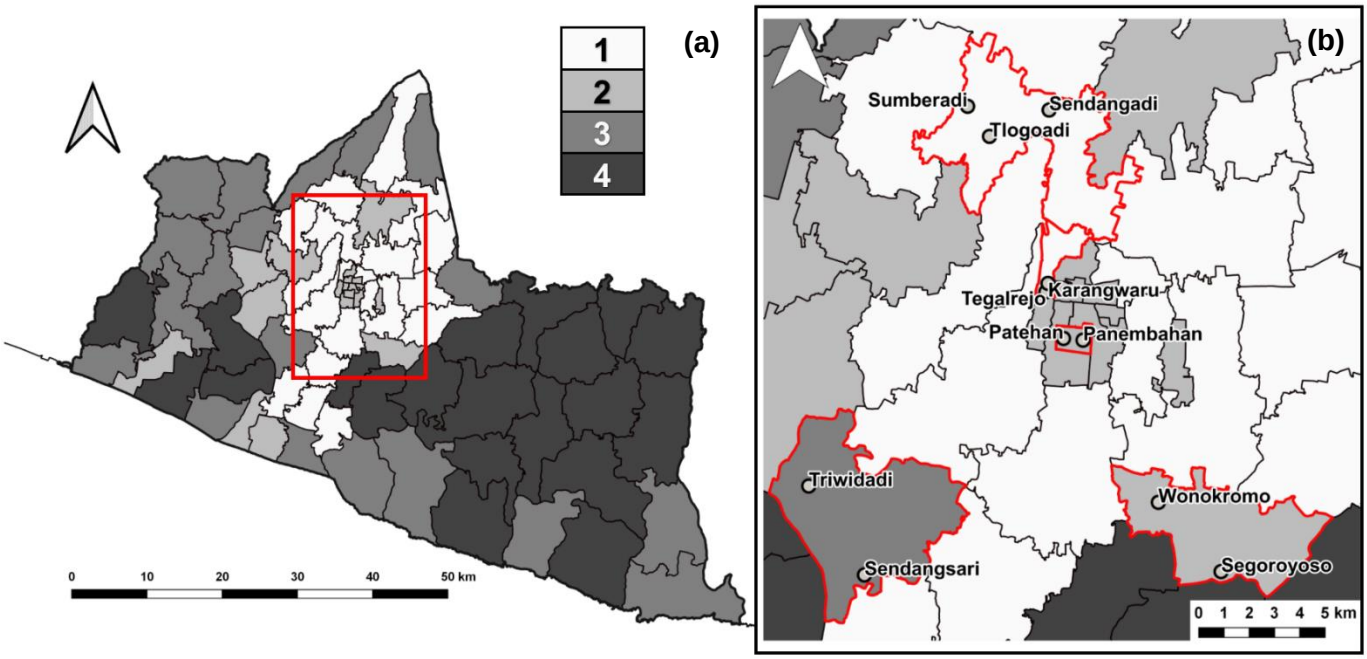

Figure 2.A.1. An example of village selection: A) DI Yogyakarta province showing districts coloured by their placement within the quartiles (1. Very Urban – 4. Very Rural. B) Randomly selected districts (shown in red) with villages (grey dots) assigned numbers and selected by using a random number generator.

Table 2.A.1. Descriptive statistics using our survey data for each province, and rural and urban communities sampled. Provinces in the eastern half of the island, where the population is overwhelmingly 'Javanese' are delineated by a grey line.

Province	Total respondents	Reported ethnicity (%)				Mean age	Mean household asset index	Occupational groups (%)[b]			
		Javanese	Sundanese	Betawi	Other[a]			L	B	C	NFE
Banten	461	44.5	47.1	1.3	7.1	39.7	6.6	28.4	26.5	11.7	33.4
DKI Jakarta	432	30.1	8.3	48.2	13.5	42.1	6.8	24.4	15.7	15.0	44.4
West Java	449	12.5	84.2	1.1	2.2	41.3	6.9	30.5	21.6	10.0	37.9
Central Java	611	98.9	—	—	1.1	42	7.2	39.0	22.6	14.7	23.7
DI Yogyakarta	594	97.9	0.7	0.2	1.2	43.6	7.4	43.3	17.7	16.3	22.7
East Java	478	96.7	—	—	3.4	44.2	7.6	33.1	24.1	15.1	27.8
Rural	1,218	73.4	25.7	—	0.9	42.0	7.1	44.7	16.7	12.2	26.4
Urban	1,807	63.4	17.8	12.2	6.6	42.1	7.1	26.8	24.4	15.2	33.6

[a] For reported ethnicity 'Other' includes: Chinese, Batak, Lampung, Madurese, Balinese.

[b] Occupational categories; L: Labour; B: Business; C: Clerical; NFE: No Formal Employer.

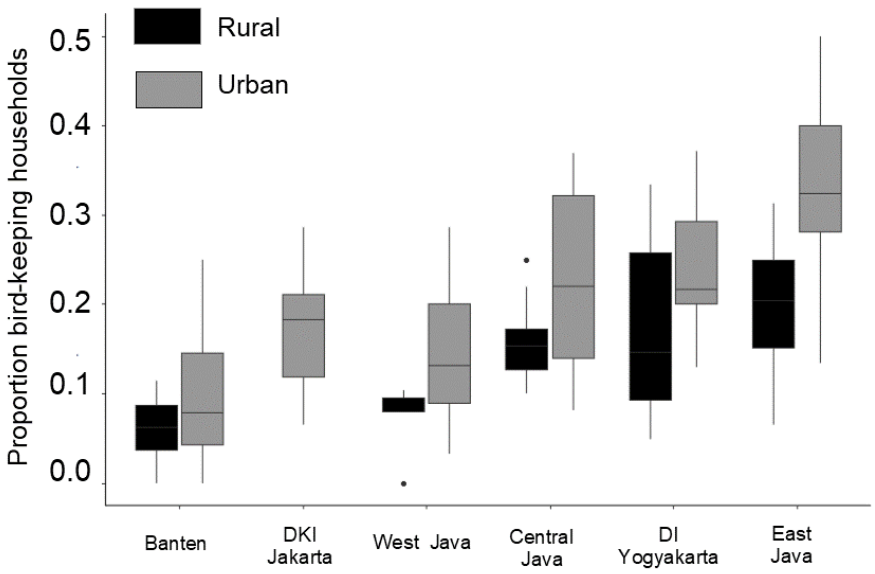

Fig. 2.A.2. Mean prevalence of bird-keeping households that keep at least one non-native bird species for rural and urban villages across the six provinces of Java.

Table 2.A.2. Parameters of the generalized linear models predicting proportion of native and non-native bird-keeping households across the six provinces of Java.

	Effect	Coefficient	SE	t	p-value
Native bird ownership	(Intercept)	0.29	0.016	18.1	<0.001
	Province (Western)	-0.19	0.029	-6.7	<0.001
	Rurality (Urban)	0.05	0.023	2.2	0.034
	Interaction term (Province*Rurality)	0.02	0.037	0.4	0.676
Non-native bird ownership	(Intercept)	0.18	0.020	8.8	<0.001
	Province (Western)	-0.11	0.036	-3.1	0.003
	Rurality (Urban)	0.11	0.028	3.9	<0.001
	Interaction term (Province*Rurality)	-0.03	0.046	-0.7	0.501

2.6.2 Appendix B – survey questions

Section 1 – Socio-economic profile

Q1.1 Where do you live now?

▢ District _____ ▢ Regency _____

Q1.2 What is your ethnicity?

▢ Javanese	o Betawi	▢ Chinese
o Sundanese	▢ Batak	▢ Madurese
	▢ Balinese	▢ Other

Q1.3 What is your religion?

▢ Islam	▢ Buddhism	▢ Protestant
▢ Hinduism	▢ Catholic	▢ Other

Q1.4 How old are you? (in years) _____

Q1.5 What was your last level of education?

▢ No formal education	▢ Baccalaureate / Academy
▢ Did not finish E. School	▢ Bachelor
▢ Elementary School	▢ Postgraduate
▢ Junior High School	▢ Doctorate
▢ High School	▢ Prefer not to say

Q1.6 What is your primary source of income /occupation?

▢ Bird trader / breeder / catcher	▢ Office worker	▢ Housewife
▢ Driver / Transport	▢ Unskilled labourer	▢ Entrepreneur
▢ Farming	▢ Warung worker	▢ Local leader
▢ Selling / Trading	▢ Civil servant	▢ Student
▢ Skilled professional	▢ Unemployed	▢ Retired
	▢ Landlord	▢ Other

Q1.7 How many hours do you work a week?

▢ 0 - 20	▢ 41 - 60
▢ 21 - 40	▢ 61+

Q1.8 Do you have a motorbike, bicycle or car?

▢ Motorbike ▢ Car ▢ Bicycle

Q1.9 What electronics do you have in your house?

▢ M. Phone ▢ Tablet ▢ Computer

Q1.10 Do you have a TV?

▢ Television ▢ Cable TV

Q1.11 What utilities do you have?

▢ Flush toilet ▢ Air conditioner ▢ Fridge/freezer

▢ Concrete floor

▢ Gas cooker ▢ Wood stove

Q1.12 Do you own land and / or property? (other than this one)

▢ Land (fields etc.) ▢ Property (landlord)

Q1.13 How many members are there in your household? _____

Q1.14 How many (bed) rooms do you have in your household? _____

Section 2 – Bird-keeping behaviour

Q2.1 Do you keep any animals at home as pets?

▢ Yes ▢ No ▢ Prefer not to say

Display This Question: If Do you keep any animals at home as pets? = Yes

Q2.2 What types of animal do you keep as pets?

▢ Primate ▢ Reptile ▢ Cat / Dog

▢ Bird ▢ Poultry ▢ Other

▢ Fish ▢ Livestock

Display This Question: If What types of animal do you keep as pets? = Bird

Q2.3 Are / were you the principal bird-keeper/owner in your household?

▢ Yes ▢ No

Q2.4 What birds do you keep?			
	Bird species	Quantity	Source (wild caught / captive bred or unknown)
Bird 1 - 10			

Section 3 – Motivations for bird-keeping

Q3.1 Why do you keep birds? (Choose as many as apply)

- ○ For companionship
- ○ For good luck
- ○ As a hobby
- ○ To protect them from dying in the wild
- ○ To remind me of nature
- ○ To protect myself from danger
- ○ To remind me of my hometown
- ○ To enter singing contests
- ○ To raise my status
- ○ As a symbol of my culture
- ○ To listen to their song
- ○ To admire their beauty
- ○ To breed birds (as a hobby)

2.6.3 Appendix C – species list

Full list of taxa recorded (ranked by number of birds in households), the number of households where the taxa were observed, the number of birds recorded, and the IUCN status where applicable. Taxonomy follows del Hoyo & Collar (2014, 2016).

Rank	English name	Scientific name	Number of keepers	Number of birds	IUCN status
1	Lovebird sp.	*Agapornis* spp.	386	2,293	*
2	Island Canary	*Serinus canaria*	253	675	*
3	Zebra Dove	*Geopelia striata*	155	610	LC
4	White-rumped Shama	*Kittacincla malabarica*	133	294	LC
5	Budgerigar	*Melopsittacus undulatus*	34	209	LC
6	Yellow-vented Bulbul	*Pycnonotus goiavier*	120	208	LC
7	Oriental Magpie-robin	*Copsychus saularis*	116	186	LC
8	White-eye sp.	*Zosterops* spp.	83	174	*
9	Eastern Spotted Dove	*Spilopelia chinensis*	65	169	LC
10	Javan Pied Starling	*Gracupica jalla*	85	125	CR
11	Leafbird sp.	*Chloropsis* spp.	92	123	*
12	Long-tailed Shrike	*Lanius schach*	73	81	LC
13	Sooty-headed Bulbul	*Pycnonotus aurigaster*	55	75	LC
14	Javan Myna	*Acridotheres javanicus*	46	53	VU
15	Common Iora	*Aegithina tiphia*	27	48	LC
16	Tailorbird sp.	*Orthotomus* spp.	33	47	*
17	Sunbird sp.	Nectariniidae spp.	19	43	*
18	Collared Dove sp.	*Streptopelia* spp.	26	41	*
19	Prinia sp.	*Prinia* spp.	19	33	*
20	Black-throated Canary	*Crithagra atrogularis*	7	26	LC
21	Orange-headed Thrush	*Geokichla citrina*	15	25	LC
22	Horsfield's Bushlark	*Mirafra javanica*	11	23	LC
23	Grey-cheeked Bulbul	*Alophoixus tephrogenys*	22	22	LC
24	Myna sp.	Sturnidae spp.	16	19	*
25	Purple-throated Sunbird	*Leptocoma sperata*	13	17	LC
26	Owl sp.	Strigidae spp.	3	15	*
27	Red-billed Leiothrix	*Leiothrix lutea*	3	15	LC
28	White-breasted Woodswallow	*Artamus leucoryn*	4	12	LC
29	Cockatiel	*Nymphicus hollandicus*	1	12	LC
30	Chestnut-capped Thrush	*Geokichla interpres*	4	11	NT
31	Java Sparrow	*Lonchura oryzivora*	2	11	VU
32	Great Tit	*Parus major*	8	10	LC
33	Common Myna	*Acridotheres tristis*	8	9	LC
34	Black-naped Oriole	*Oriolus chinensis*	8	9	LC
35	Tit sp. / Java Sparrow	*Parus* spp. / *Lonchura oryzivora*	8	8	*
36	Unidentified	*NA*	7	8	*
37	Lesser Shortwing	*Brachypteryx leucophris*	6	8	LC
38	White-rumped Seedeater	*Crithagra leucopygia*	3	8	LC
39	Black-winged Myna	*Acridotheres melanopterus*	6	7	CR

40	Common Hill Myna	*Gracula religiosa*	6	7	LC
41	Ashy Tailorbird	*Orthotomus ruficeps*	6	7	LC
42	Thrush sp.	*Geokichla* spp.	5	7	*
43	Olive-backed Sunbird	*Cinnyris jugularis*	5	7	LC
44	Hill Blue-flycatcher	*Cyornis banyumas*	5	7	LC
45	Scarlet-headed Flowerpecker	*Dicaeum trochileum*	5	7	LC
46	Flycatcher sp.	*Ficedula* spp.	6	6	*
47	Straw-headed Bulbul	*Pycnonotus zeylanicus*	6	6	EN
48	Bar-winged Prinia	*Prinia familiaris*	6	6	LC
49	Munia sp.	*Lonchura* spp.	4	6	*
50	Pied Bushchat	*Saxicola caprata*	4	6	LC
51	Brown-throated Sunbird	*Anthreptes malacensis*	5	5	LC
52	Javan Bulbul	*Ixos virescens*	5	5	LC
53	Orange-spotted Bulbul	*Pycnonotus bimaculatus*	4	5	NT
54	Eurasian Tree Sparrow	*Passer montanus*	3	5	LC
55	Chinese Hwamei	*Garrulax canorus*	2	5	LC
56	Weaver sp.	*Ploceus* spp.	4	4	*
57	Quail sp.	*Coturnix* spp.	4	4	*
58	Bulbul or leafbird sp.	Pycnonotidae or *Chloropsis* spp.	3	4	*
59	Plain Prinia	*Prinia inornata*	3	4	LC
60	Sunda Collared-dove	*Streptopelia bitorquata*	3	4	LC
61	Woodpecker sp.	Picidae spp.	2	4	*
62	Common Tailorbird	*Orthotomus sutorius*	3	3	LC
63	Grosbeak Starling	*Scissirostrum dubium*	3	3	LC
64	Laughingthrush sp.	*Garrulax* spp.	2	3	*
65	Mangrove Blue-flycatcher	*Cyornis rufigastra*	2	3	LC
66	Brown Prinia	*Prinia polychroa*	2	3	LC
67	Red Siskin	*Spinus cucullatus*	1	3	EN
68	Parrotfinch sp.	*Erythrura* spp.	1	3	*
69	Drongo sp.	*Dicrurus* spp.	2	2	*
70	Hanging-parrot sp.	*Loriculus* spp.	2	2	*
71	Lorikeet sp.	Psittacidae spp.	2	2	*
72	Purple-backed Starling	*Agropsar sturninus*	2	2	LC
73	Black-crested Bulbul	*Pycnonotus flaviventris*	2	2	LC
74	Chestnut-capped Laughingthrush	*Garrulax mitratus*	2	2	NT
75	Ruby-throated Bulbul	*Pycnonotus dispar*	2	2	VU
76	Clamorous Reed-warbler	*Acrocephalus stentoreus*	1	2	LC
77	Paddyfield Pipit	*Anthus rufulus*	1	2	LC
78	European Goldfinch	*Carduelis carduelis*	1	2	LC
79	Flowerpecker sp.	*Dicaeum* spp.	1	2	*
80	Green Junglefowl	*Gallus varius*	1	2	LC
81	Black-collared Starling	*Gracupica nigricollis*	1	2	LC
82	Brown Honeyeater	*Lichmera indistincta*	1	2	LC
83	Babbler sp.	Timaliidae spp.	1	1	*
84	Cockatoo sp.	*Cacatua* spp.	1	1	*

85	Crow sp.	*Corvus* spp.	1	1	*
86	Emerald Dove sp.	*Chalcophaps* spp.	1	1	*
87	Fantail sp.	*Rhipidura* spp.	1	1	*
88	Prinia or tailorbird sp.	*Prinia* or *Orthomus* spp.	1	1	*
89	Yellow-crested Cockatoo	*Cacatua sulphurea*	1	1	CR
90	Nias Hill Myna	*Gracula robusta*	1	1	CR
91	Bali Myna	*Leucopsar rothschildi*	1	1	CR
92	Sun Parakeet	*Aratinga solstitialis*	1	1	EN
93	Crested Myna	*Acridotheres cristatellus*	1	1	LC
94	Red Avadavat	*Amandava amandava*	1	1	LC
95	Asian Glossy Starling	*Aplonis panayensis*	1	1	LC
96	Mountain Serin	*Chrysocorythus estherae*	1	1	LC
97	Hooded Butcherbird	*Cracticus cassicus*	1	1	LC
98	Racquet-tailed Treepie	*Crypsirina temia*	1	1	LC
99	Western Koel	*Eudynamys scolopaceus*	1	1	LC
100	Oriental Dollarbird	*Eurystomus orientalis*	1	1	LC
101	Black-capped Lory	*Lorius lory*	1	1	LC
102	Horsfield's Babbler	*Malacocincla sepiaria*	1	1	LC
103	Striated Grassbird	*Megalurus palustris*	1	1	LC
104	Helmeted Friarbird	*Philemon buceroides*	1	1	LC
105	Chestnut-capped Babbler	*Timalia pileata*	1	1	LC
106	Barred Buttonquail	*Turnix suscitator*	1	1	LC
107	Common Barn-owl	*Tyto alba*	1	1	LC
108	White-crowned Shama	*Kittacincla (malabarica) stricklandii*	1	1	NR
109	Swallow sp.	Hirundinidae spp.	1	1	*
110	Iora sp.	*Aegithina* spp.	1	1	*
111	Yellow-throated Hanging-parrot	*Loriculus pusillus*	1	1	NT
112	Crested Jay	*Platylophus galericulatus*	1	1	NT

Taxa highlighted in grey are non-native to Indonesia.

* indicates domesticated birds or those identified to genera or family, so IUCN status was not applicable.

○

3 CHARACTERISING BIRD-KEEPING USER-GROUPS ON JAVA REVEALS DISTINCT BEHAVIOURS, PROFILES AND POTENTIAL FOR CHANGE

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Abstract

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. 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. 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 two-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. Our study provides behavioural change efforts with demographic and geographic profiles to target bird-keepers, who tended to be more affluent, urban and live in the eastern provinces. Among bird-keepers, hobbyists tended to be middle-aged and live 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.

3.1 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 (Harris et al., 2016; Coleman et al., 2019), where intense demand has precipitated an 'Asian Songbird Crisis' (Lee, Chng, & Eaton, 2016; Sykes, 2017; Rentschlar et al., 2018). Halting the extraction of birds from the wild, or at least reducing it to sustainable levels, is thus a global conservation priority (Symes et al., 2018; Bezerra, Araújo, & Alves, 2019; Marshall et al., 2020) 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 (Jepson, 2008; Jepson 2010; Harris et al., 2017; Souto et al., 2017; Bezerra et al., 2019; de Oliveira, de Faria Lopes, & Alves, 2018). Domestic consumption of birds as pets in two large biodiverse countries, Brazil and Indonesia, may actually be larger than the total international market (Jepson & Ladle, 2005; Alves et al., 2013; 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 over-exploitation (BirdLife International, 2020), most of the trade is domestic (Chng et al., 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 recognised and recently red-listed species (Chng

et al 2015; Miller et al., 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., 2020) 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 & Ladle, 2005; 2009; Jepson, 2010; Jepson, Ladle and 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 characterising consumers based on behaviours and preferences has allowed researchers to break seemingly homogeneous audiences into groups on which to target demand reduction efforts (Shairp, Veríssimo, Fraser, Challender, & Macmillan, 2016; Razavi & Gharipour, 2018; 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 (Truong, Dang, & Hall, 2016; Dang Vu & Nielsen, 2018) 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 two-year period. Our profiles of user-groups aim to identify specific threats to wild bird populations by characterising 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).

3.2 METHODS

3.2.1 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., 2020). Within communities and neighbourhoods of selected districts, households were systematically sampled (full details on sampling methodology can be found in the 3.6.1 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 characterise 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 3.6.2 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 adapted 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. (2020)—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 recognise 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).

3.2.2 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, creating global models with all potential predictors (Table S1); prior to inclusion continuous variables were standardised 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, 1998; Grueber et al., 2011).

Random forests, a non-parametric 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 composition of taxa owned by households in 2018. We used repeated 10-fold cross-validation over a tuning grid of potential values to parameterise 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, Barton, 2018), 'lme4' (Bates et al., 2015), 'randomForest' (Liaw and Weiner, 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.

3.2.3 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 anonymised. 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 ethical 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.

3.3 RESULTS

3.3.1 Household demographic data

With an interview response rate of ~60% (Marshall et al. 2020), 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 3.C.1. 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 3.C.2). The mean ± SD household asset index 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.

Table 3.1 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* 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	
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

**Wild-caught and potentially wild-caught birds*

3.3.2 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 3.1). 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 prefer either or to take origin into account when purchasing birds (Table 3.2).

Table 3.2 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

3.3.3 User-group classification

Our user-group classification had an overall accuracy of 84% (Table 3.C.3). 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 3.1). The most notable differences between user-groups were that: (1) hobbyists consistently owned fewer birds than either contestants or breeders, yet owned larger numbers of some native taxa (leafbirds and Oriental Magpie-robin); (2) lovebirds were owned in much larger numbers by contestants and breeders; and (3) 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 period 2016–18 (Figure 3.2; Table 3.C.4). Overall, the biggest change between the two periods was an increase in proportions of hobbyists and contestants, both with relatively large recruitment from non-bird ownership in 2016.

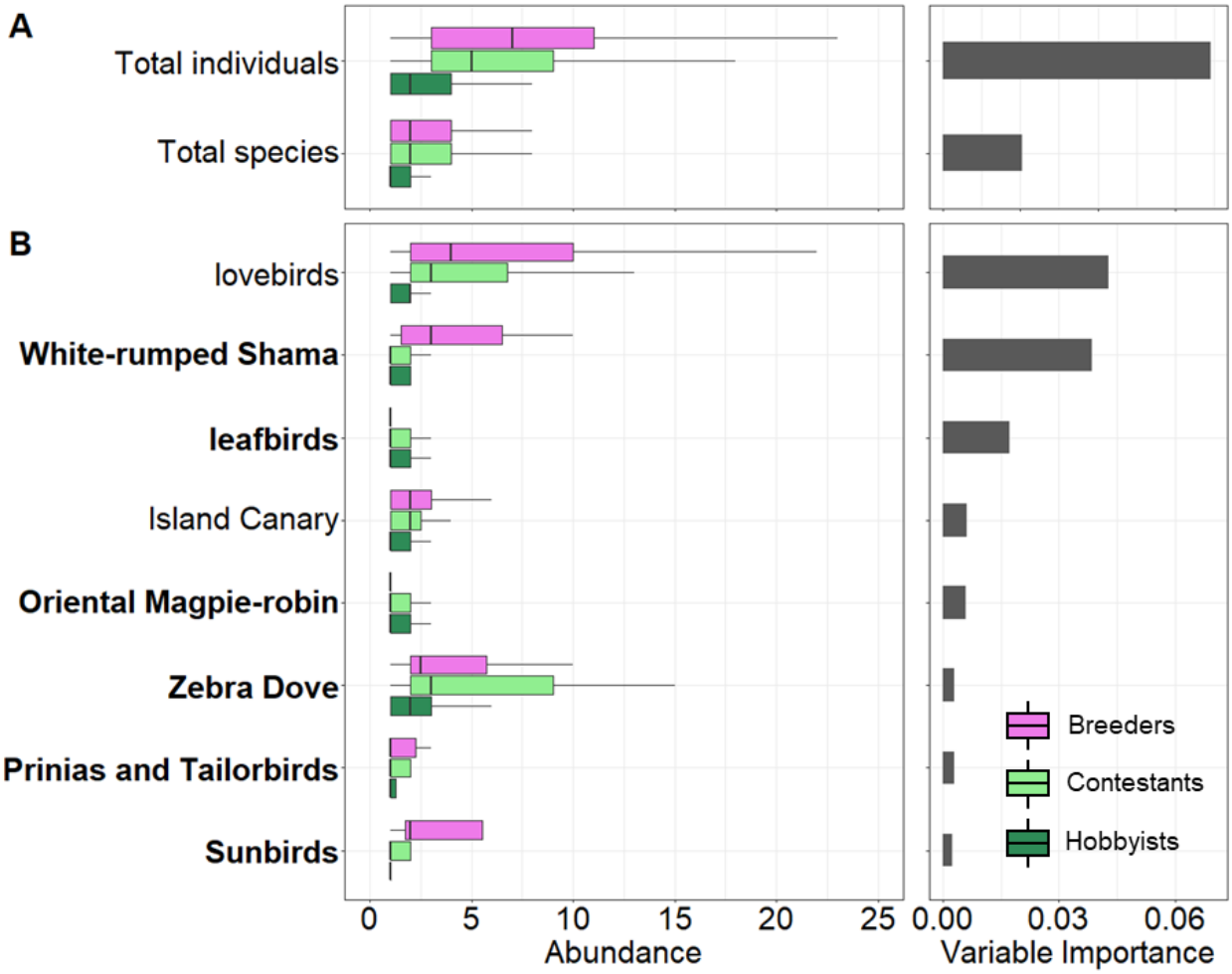

Figure 3.1. Variation in a) total numbers of birds and species owned, and b) numbers of individual taxa owned across the three user-groups with highest importance (> 0.01) in the random forest analysis. **Bold indicates native species.**

3.3.4 Socio-economic profiles

Our mixed effect models indicated the importance of seven demographic and geographic variables in characterising cage-bird ownership, and subsequently user-group membership (Figure 3.3; full model outputs in Table 3.C.5). 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 either a higher or lower level of education (Figure 3.3). 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 3.C.6), 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 3.3).

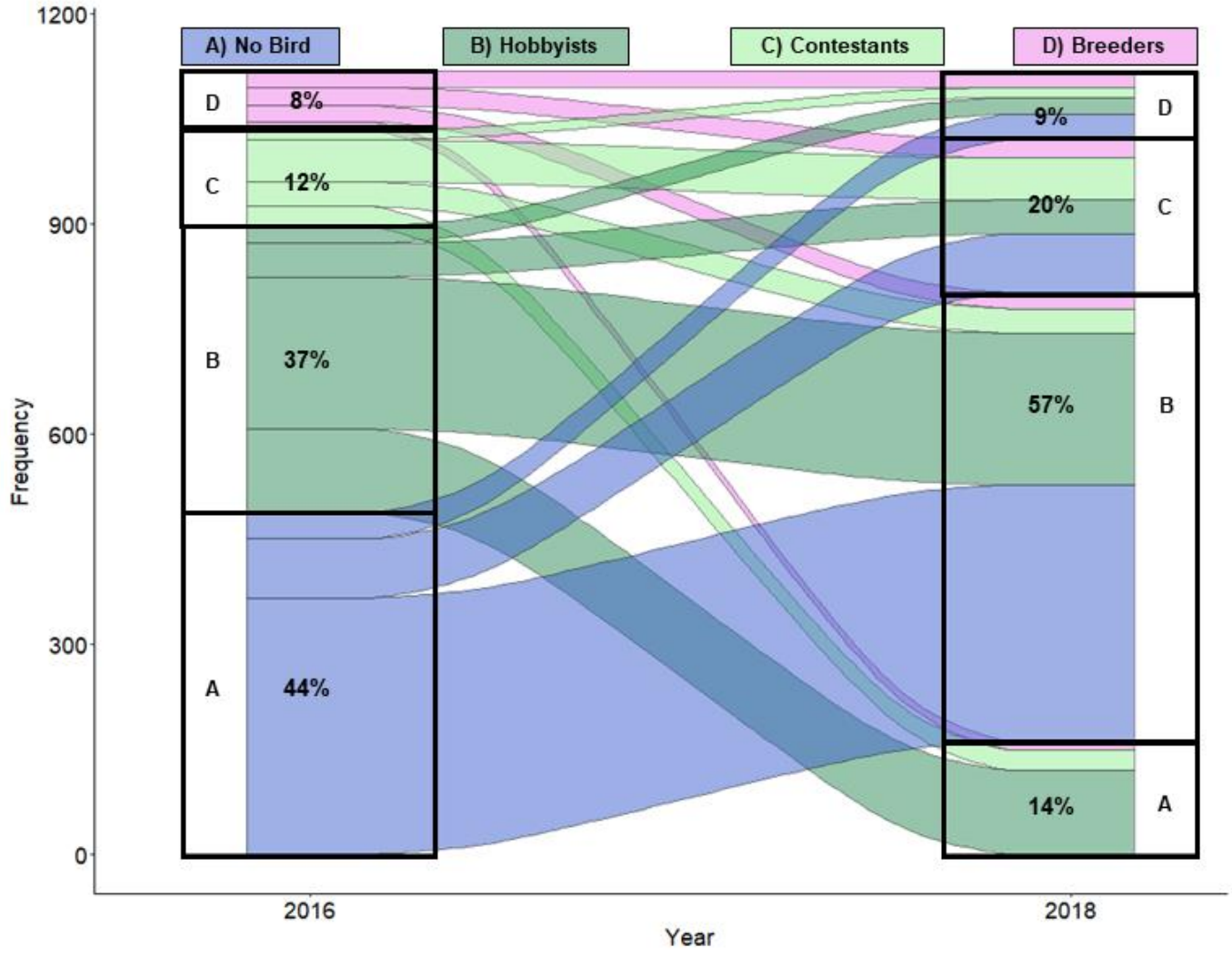

Figure 3.2. Percentages of respondents who kept birds in **either** 2016 or 2018 and the changes in user-group membership based on the results of the random forest predictions. Respondents who did not own birds in **either year** (80%) are excluded from this figure to increase interpretability. For example, the number of people keeping birds has increased with the majority of non bird-keepers (A) in 2016 becoming hobbyists (B) in 2018.

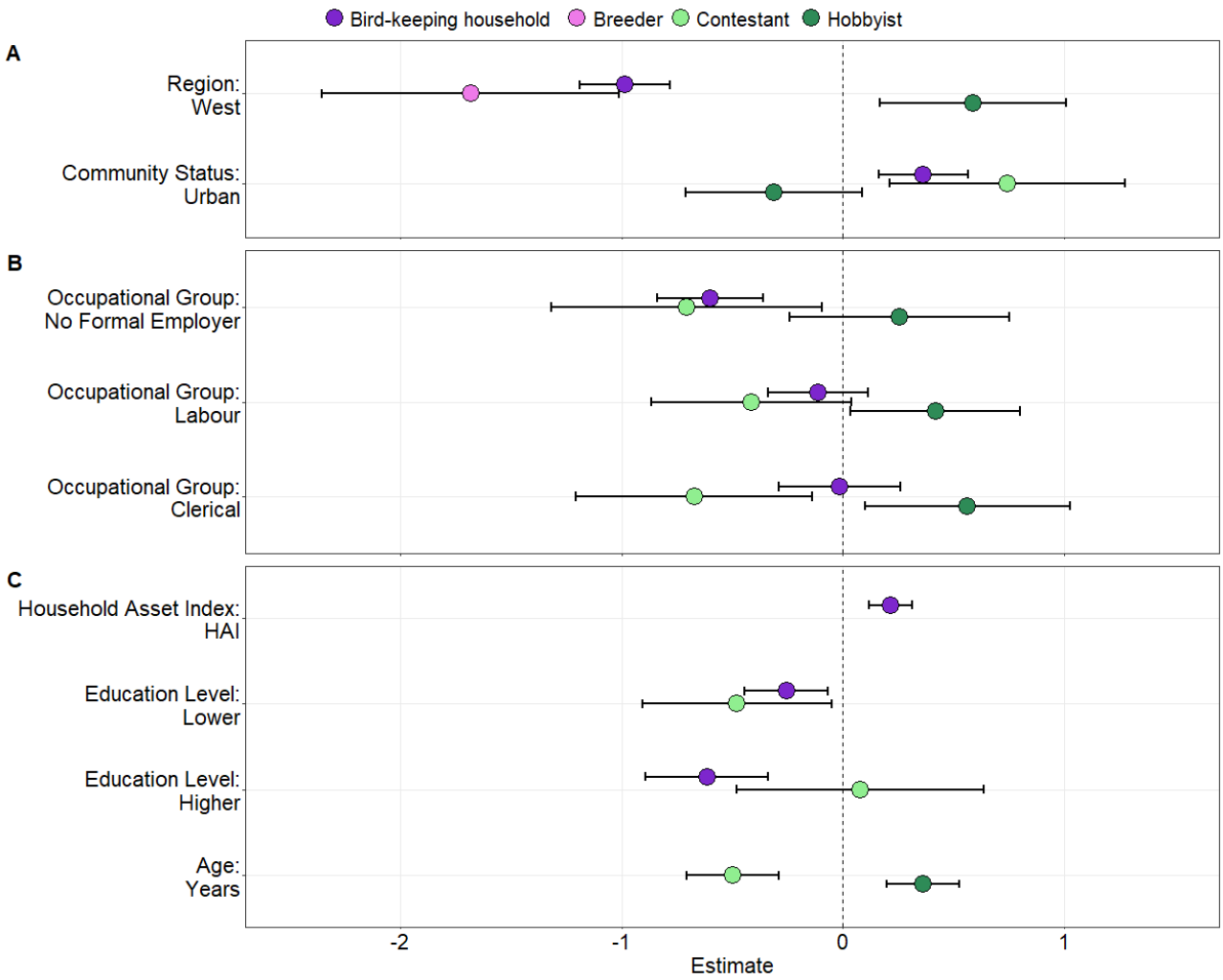

Figure 3.3. Effect sizes (with 95% CIs) of the a) geographic, b) occupational and c) demographic predictor variables with the highest relative variable importance (**> 0.6**) across models predicting bird-ownership (against non-bird ownership) and user-group membership (against other bird-keepers).

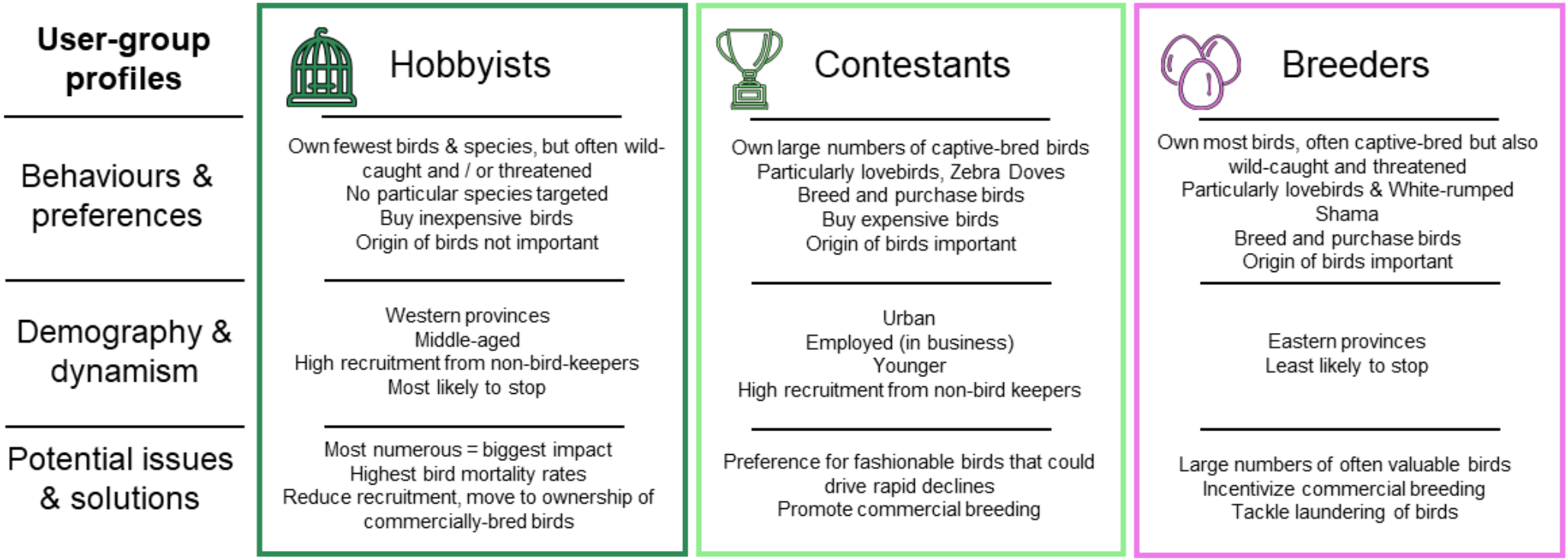

Figure 3.4. Profiles for each user-group based on key behaviours and preferences, demography and dynamism, and the potential issues and solutions to reduce the pressure their behaviours have on wild bird populations.

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 (Figure 3.4), which may represent up to seven million households (Marshall et al., 2020). 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 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.

3.4.1 Informing evidence-based behaviour change

Our study sought to profile songbird-keeping user-groups by characterising 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., 2020). 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., 2020). 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 neutralised by a large increase in the prevalence of often wild-caught native birds (Marshall et al., 2020). Future efforts should focus on the 'demarketing' (Verissimo, 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 (two-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., 2020). 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, increasing the importance placed on the origin of birds, as well as 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 who, as a key consumer demographic in driving national business, suggest 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 (Veríssimo & Wan, 2018, Salazar, Mills, & Veríssimo, 2019). In view of the importance placed on community responsibility and

legislation (Kristianto & Jepson, 2011) conservationists could borrow from such approaches to highlight the social undesirability, illegality, and risks associated with the laundering or trapping of birds.

3.4.2 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., 2020) 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 (BPS 2010) for Java as a whole, there are some differences in a number of attributes (see Table S2 in appendix). 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).

3.4.3 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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3.6 APPENDICES

3.6.1 Appendix A – Detailed account of methodology

We followed the Indonesian Statistics Authority's household typology, where a family unit constitutes an adult, spouse and all children below the age of 16 (further examples in BPS, 2010). Surveys were completed with the head of the household or the most senior family member available. We did not record the respondents' gender, in common with other studies on bird-keeping in Indonesia, as the overwhelming majority of bird-keepers are male (Jepson, Ladle, & Sujatnika, 2011; Burivalova et al., 2017). Bird-keeping households where the principal bird-owner was not present were included, but their absence was recorded and respondents were asked a reduced set of questions which could be directly verified by the interviewer (i.e. species identity and abundance).

The nested administrative levels of Indonesia are: 1. Province, 2. Regency, 3. District, 4. Community, 5. Neighbourhood. To survey households within selected urban or rural districts (administrative level 3; see Marshall et al., 2020 for further information), sampling locations were chosen by assigning and generating random numbers initially to select communities (administrative level 4) and subsequently neighbourhoods (administrative level 5). Research teams (2–4 interviewers) gained permission from, and agreed to stipulations set by, the leaders of neighbourhoods and relevant administrative authorities prior to data collection. Household selection followed Jepson & Ladle (2009): team members flipped a coin to decide whether to sample left or right of the neighbourhood leader's house, and subsequently sampled every second house on the street, turning either right or left (decided by coin-flip) at any junctions, until each member had completed five surveys within the selected neighbourhood. The process of selecting communities and sampling neighbourhoods continued until a predetermined number of surveys (based on the number of urban or rural households present in the population, 90–120) was met for each district, to ensure a representative sample with a 10% error margin at the 95% confidence level (Newing, 2010). Interviewers always received prior informed consent verbally from respondents. Name of interviewer and time and date of survey were recorded before interviews; all data were subsequently anonymised.

3.6.1.1 Literature cited

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3.6.2 Appendix B – Survey Questions

Section 1 – Socio-economic profile

Q1.1 Where do you live now?

- District _____
- Regency _____

Q1.2 What is your ethnicity?

- Javanese
- Sundanese
- Betawi
- Batak
- Balinese
- Chinese
- Madurese
- Other

Q1.3 What is your religion?

- Islam
- Hinduism
- Buddhism
- Catholic
- Protestant
- Other

Q1.4 How old are you? (in years) _____

Q1.5 What was your last level of education?

Original	Recoded for analysis
○ No formal education ○ Did not finish E. School ○ Elementary School ○ Junior High School	Lower
○ High School	High School
○ Baccalaureate / Academy ○ Bachelor ○ Postgraduate ○ Doctorate	Higher
○ Prefer not to say	

Q1.6 What is your primary source of income /occupation?

Original	Recoded for analysis
○ Bird trader / breeder / catcher ○ Selling / Trading ○ Warung worker ○ Entrepreneur	Business
○ Office worker ○ Civil servant ○ Local leader	Clerical
○ Driver / Transport ○ Farming ○ Skilled professional ○ Unskilled labourer	Labour
○ Unemployed ○ Landlord	No Formal Employer

- Housewife
- Student
- Retired
- Other Other

Q1.7 How many hours do you work a week?

- 0 - 20
- 21 - 40
- 41 - 60
- 61+

Q1.8 Do you have a motorbike, bicycle or car?

- Motorbike
- Bicycle
- Car

Q1.9 What electronics do you have in your house?

- M. Phone
- Computer
- Tablet

Q1.10 Do you have a TV?

- Television
- Cable TV

Q1.11 What utilities do you have?

- Flush toilet
- Concrete floor
- Gas cooker
- Wood stove
- Air conditioner
- Fridge/freezer

Q1.12 Do you own land and / or property? (other than this one)

- Land (fields etc.)
- Property (landlord)

Q1.13 How many members are there in your household? _____

Q1.14 How many (bed) rooms do you have in your household? _____

Q1.15 Are you married?

- Yes
- No

Section 2 – Bird-keeping behaviour

Q2.1 Do you keep any animals at home as pets?

- Yes
- No

Prefer not to say

Display This Question: If Do you keep any animals at home as pets? = Yes

Q2.2 What types of animal do you keep as pets?

- Primate
- Poultry
- Bird
- Livestock
- Fish
- Cat / Dog
- Reptile
- Other

Display This Question: If What types of animal do you keep as pets? = Bird

Q2.3 Are / were you the principal bird-keeper/owner in your household?

- Yes
- No

Q2.4 What birds do you keep?

Bird species	Quantity	Source (wild caught / captive bred or unknown)
Bird 1 - 10		

Q2.5 What birds do you keep in 2016?

Bird species	Quantity	Source (wild caught / captive bred or unknown)	How many died?
Bird 1 - 10			

Q2.6 How do you obtain your birds? (Choose as many as apply)

- Receive as gifts
- Trap myself
- Breed myself
- Purchase

Q2.7 Where do you purchase your birds? (Choose as many as apply)

- Bird Markets / Shops
- Friends and Family
- Breeders (Commercial / Hobby breeders)
- Online (inc. Social Media)
- Trapper / Travelling salesmen

Q2.8 Approximately how much did you spend on the last bird you bought? _____

Q2.9 Approximately how much do you spend on (i.e. food) your bird(s) per week?

_____

Q2.10 Approximately how much time (hours) do you spend tending your bird(s) per week?

_____

Q2.11 Which bird has a better quality song?

- Captive-bred
- Wild-caught
- Neither

Q2.12 When buying / obtaining a bird, is the origin important?

- Yes
- No

Q2.13 What do you prefer the origin of your bird to be?

- Captive-bred
- Wild-caught
- From a specific location

Section 3 – Motivations for bird-keeping

Q3.1 Why do you keep birds? (Choose as many as apply)

- To breed birds
- As a hobby
- To enter singing contests

3.6.3 Appendix C – Supplementary Tables

Table 3.C.1 Demographic attributes comparable between study sample and 2010 census data for each province and overall. (% Difference between study sample and census data shown in brackets).

Province		Banten n = 452	DKI n = 411	W. Java n = 434	C. Java n = 588	DIY n = 586	E. Java n = 473	Overall n = 2,944
Level of education (%)	Lower	39.6 (-0.4)	29.2 (-9.4)	44.9 (+2.7)	45.2 (+10.3)	39.9 (-0.4)	41.4 (+2.1)	40.4 (+1.6)
	High School	51.8 (+19.8)	57.9 (+28.1)	43.8 (+14.6)	40.3 (+8.7)	42.2 (+15.3)	45.0 (+13.3)	46.2 (+15.4)
	Higher	8.6 (-19.5)	12.9 (-18.6)	11.3 (-17.3)	14.5 (-19.1)	17.9 (-14.9)	13.5 (-15.6)	13.4 (-17.1)
Occupational group (%)	Business	26.8 (+14.2)	16.3 (-5.3)	22.1 (+9.8)	23.3 (+9.7)	17.7 (+2.3)	24.1 (+12)	21.7 (+8.4)
	Clerical	11.9 (-0.1)	15.6 (-4.4)	10.4 (+0.5)	15.3 (+5.4)	16.6 (+1.1)	15.2 (+4.6)	14.3 (+3.2)
	Labour	28.5 (-2.8)	26.0 (+8.5)	31.6 (-7.0)	40.5 (-2.6)	43.9 (+8.0)	33.2 (-9.2)	34.8 (-3.8)
	No formal employer	32.7 (-11.4)	42.1 (+1.2)	35.9 (-3.3)	20.9 (-12.5)	21.8 (-11.5)	27.5 (-7.5)	29.2 (-7.8)
Number of members in household (%)	1-3	19.9 (-20.7)	24.8 (-22.8)	21.7 (-26.0)	28.2 (-18.7)	31.1 (-24.3)	29.4 (-21.5)	48.1 (-21.9)
	4	27.7(+2.9)	29.7 (+7.9)	30.2 (+5.3)	30.6 (+4.7)	31.7 (+9.2)	28.3 (+3.6)	24.8 (+5.0)
	5	25.2 (+9.0)	22.6 (+8.5)	24.4 (+9.9)	20.6 (+5.5)	21.0 (+8.3)	24.3 (+10.5)	14.5 (+8.3)
	6+	27.2 (+8.8)	22.9 (+6.4)	23.7 (+10.8)	20.6 (+8.6)	16.2 (+6.8)	18.0 (+7.4)	12.6 (+8.5)
Age group (%)	15 - 24	6.0 (-21.5)	10.2 (-14.8)	12.0 (-12.5)	9.5 (-11.7)	6.3 (-15.3)	5.7 (-14.8)	8.2 (-14.6)
	25 - 34	25.9 (-1.7)	19.7 (-9.5)	19.8 (-5.1)	24.7 (+3.2)	22.2 (+2.0)	18.6 (-3.0)	22.0 (-1.6)
	35 - 44	37.6 (+16.1)	31.1 (+10.2)	29.3 (+8.2)	26.7 (+6.4)	25.3 (+5.9)	26.6 (+5.6)	29.1 (+8.2)
	45+	30.5 (+7.1)	38.9 (+14.1)	38.9 (+9.4)	39.1 (+2.0)	46.2 (+7.4)	49.0 (+12.1)	40.8 (+7.9)

Table 3.C.2 Demographic attributes for each province, urban and rural communities and overall. Margin of errors at the 95% confidence level (Newing, 2010) are provided for the estimates of the proportions of bird-keeping households across provinces and overall based on the total number of households observed in the 2010 Indonesian census (Badan Pusat Statistik, 2010).

Province		**Banten** n = 452	**DKI** n = 411	**W. Java** n = 434	**C. Java** n = 588	**DIY** n = 586	**E. Java** n = 473	**Rural** n = 1,190	**Urban** n = 1,754	**Overall** n = 2,944
Bird-keepers (%)		16.4 (±3.4)	24.8 (±4.2)	23.5 (±3.9)	35.2 (±3.9)	38.9 (±3.9)	47.6 (±4.5)	29.5	33.5	31.9 (±1.8)
Level of Education (%)	Lower	39.6	29.2	44.9	45.2	39.9	41.4	49.7	34.1	40.4
	High School	51.8	57.9	43.8	40.3	42.2	45.0	40.9	49.7	46.2
	Higher	8.6	12.9	11.3	14.5	17.9	13.5	9.3	16.2	13.4
Occupational group (%)	Business	26.8	16.3	22.1	23.3	17.7	24.1	16.9	25.0	21.7
	Clerical	11.9	15.6	10.4	15.3	16.6	15.2	12.5	15.6	14.3
	Labour	28.5	26.0	31.6	40.5	43.9	33.2	45.5	27.5	34.8
	No Formal Employer	32.7	42.1	35.9	20.9	21.8	27.5	25.0	31.9	29.2
Household Asset Index	Median	13	13	13	14	14	15	13.0	14.0	14.0
	Range	29	31	29	31	28	33	32.0	32.0	34.0
Household Occupancy Index	Median	2.0	2.3	2.0	1.5	1.5	1.5	1.6	2.5	1.7
	Range	8.3	11.6	9.5	4.7	20.7	8.0	6.7	20.7	20.7
Age	Median	39	41	40	40	42	44	41.0	41.0	41.0
	Range	53	74	68	67	69	64	69.0	75.0	75.0

Table 3.C.3 Error matrix and derived accuracy for the random forest predictions of motivations.

		Reference			**Total**
		Hobbyists	Contestants	Breeders	
Predicted	Hobbyists	527	62	52	**641**
	Contestants	13	184	21	**218**
	Breeders	2	3	93	**98**
	Total	**542**	**249**	**166**	**957**
	User's	0.97	0.74	0.56	
	Producer's	0.82	0.84	0.95	
	Overall	0.84			
	Cohen's Kappa	0.71			

Table 3.C.4 Movement between user groups based on random forest predictions of user group membership.

Group membership in:	2018			
2016	No bird	Hobbyists	Contestants	Breeders
No bird	**1922 (80%)***	366 (15%)	84 (3%)	37 (2%)
Hobbyists	120 (29%)	**217 (53%)**	48 (12%)	24 (6%)
Contestants	29 (21%)	35 (25%)	**60 (43%)**	14 (10%)
Breeders	12 (14%)	23 (27%)	26 (31%)	**23 (27%)**

***In brackets is the % membership in 2016.**

Table 3.C.5 Output from the Generalised Linear Mixed Effect Models with averaged model effect sizes, confidence intervals and relative variable importance for ea response variable.

Predictor		Bird Ownership				Hobbyists				Contestants				Breeders			
		Effect Size (CI)			RVI	Effect Size (CI)			RVI	Effect Size (CI)			RVI	Effect Size (CI)			R
Household Asset Index		0.22	0.12	0.31	**1.00**	-0.07	-0.23	0.09	0.20	0.16	-0.04	0.36	0.55	-0.09	-0.29	0.10	0
Region: West		-0.98	-1.19	-0.78	**1.00**	0.59	0.17	1.01	**1.00**	0.19	-0.34	0.71	0.15	-1.68	-2.36	-1.01	**1**
Community status: Urban		0.36	0.16	0.56	**1.00**	-0.31	-0.71	0.09	0.62	0.74	0.21	1.27	**1.00**	-0.28	-0.74	0.19	0
Educational level	Higher	-0.61	-0.89	-0.34	**1.00**	-0.04	-0.52	0.44	0.45	0.08	-0.48	0.64	0.73	-	-	-	
	Lower	-0.26	-0.44	-0.07	-	0.34	0.00	0.69	-	-0.48	-0.90	-0.05	-	-	-	-	
Occupational Group	Clerical	-0.01	-0.29	0.26	**1.00**	0.56	0.10	1.03	0.79	-0.67	-1.21	-0.14	**1.00**	-	-	-	
	Labour	-0.11	-0.34	0.11	-	0.42	0.03	0.80	-	-0.41	-0.86	0.04	-	-	-	-	
	No formal employer	-0.6	-0.84	-0.36	-	0.26	-0.24	0.75	-	-0.71	-1.32	-0.10	-	-	-	-	
Marital status: Married		0.14	-0.07	0.36	0.47	0.19	-0.25	0.62	0.20	-0.36	-0.84	0.12	0.54	0.17	-0.36	0.71	0
Household Occupancy Index		0.06	-0.03	0.15	0.45	-	-	-	-	-0.09	-0.29	0.10	0.28	0.13	-0.07	0.33	0
Age		0.04	-0.05	0.13	0.27	0.36	0.20	0.52	**1.00**	-0.50	-0.71	-0.29	**1.00**	-	-	-	
Hours worked: >41 per week		-0.08	-0.25	0.09	0.25	0.05	-0.27	0.36	0.04	-0.10	-0.47	0.28	0.07	-	-	-	

Table 3.C.6 Geographic spread of the main types of songbird-keeping user groups (respondents self-reported membership of these groups).

		Hobbyist n = 542	**Contest-goer** n = 249	**Breeders** n = 166
Province	Banten	62.3	33.8	3.9
	DKI	60.4	34.0	5.7
	West Java	66.3	27.9	5.8
	Central Java	58.5	20.3	21.2
	DIY	53.9	18.5	27.6
	East Java	49.6	31.9	18.6
Urban – Rural Status	Rural	59.8	18.1	22.1
	Urban	54.8	30.5	14.6

4 EXPLORING PATHWAYS TO REDUCE DEMAND AMONG BIRD-KEEPERS FOR SONGBIRDS IN JAVA

Abstract

Cage-birds are kept across 12 million households on Java, Indonesia, fuelling deep concerns for the health of wild bird populations. Finding pathways to reduce this demand cannot ignore cultural context and thus requires understanding the various drivers of individual consumption behaviour as well as the attitudes of consumers and potential consumers to bird-keeping and its impacts on wild bird populations. This chapter explores the self-reported reasons why some people keep birds and others do not, why those that do sometimes stop, and the role age and other demographic characteristics play in these decisions. Further, it explores public attitudes and perceptions around bird-keeping in Java, alongside the potential psychographic drivers of intention to keep wild-caught as opposed to captive-bred birds. Few people (<8%) cited health, sanitary or welfare concerns as reasons for not keeping birds, whereas most people started keeping birds to enjoy their beauty or song (28%), or to keep up with peers (23%). Those who own birds primarily as pets (Hobbyists) were most likely to start keeping birds after receiving birds opportunistically, whereas those who own birds to enter singing contests (Contestants) or to breed and train for resale (Breeders) were more likely to be seeking financial returns. Overall, respondents held similar attitudes, but opinions on 1) the environmental importance of birds, 2) how long birds typically live in captivity and 3) whether keeping birds as pets endangers them in the wild, differed between bird-keepers and non-bird-keepers. Older respondents were less concerned that keeping birds endangers them, and few felt birds to be an important part of the environment. Hobbyists were least likely to consider wild bird population health a major concern. A low proportion of respondents admitted an intention to obtain wild-caught birds, but importantly different psychographic predictors were significantly associated with the intention of each user-group. Efforts to dissuade the large pool of potential bird-keepers should focus on the public's concern for the environment in Java and the threat bird-keeping poses to wild populations. The importance of peer pressure among bird-keepers presents an opportunity to promote sustainable bird-keeping among key groups.

4.1 INTRODUCTION

Human behaviour underpins almost all biodiversity loss (Schultz, 2011; Veríssimo, 2019), so to produce effective policies that seek to arrest this loss, conservation and environmental practitioners need to engage with the drivers of problematic human behaviours (Sandbrook et al., 2013; Bennett et al., 2017). The overexploitation of biodiversity for economic or cultural purposes is a highly prevalent driver of biodiversity loss (Symes, Edwards, et al., 2018), of which the illegal and unregulated trade in wildlife and plants is a globally pervasive and destructive component (Ribeiro et al., 2019). In situations where enforcement is ineffective or regulation lacking, which is often the case with trade in wildlife (Cooney and Jepson, 2006; Roe et al., 2020), interventions targeting consumer behaviour offer a potentially valuable avenue to reduce pressure from such behaviour (Rowcliffe et al., 2004; Chausson et al., 2019). By understanding public perceptions of issues, particularly the reasons people reportedly decide to engage or not in a particular behaviour, culturally appropriate interventions can be developed to generate the greatest conservation outcome (Kanagavel et al., 2014; Jefferson et al., 2015). Knowing how audiences (both consumers and potential consumers of wildlife) and stakeholders can be broken down or segmented into targetable groups through demographic (e.g., age, education) and/or psychographic (e.g., attitudes, intentions) attributes allows researchers and practitioners to define messages and select channels and influencers that effectively promote pro-conservation behaviour and attitudes (Veríssimo et al., 2020).

Researchers have used a variety of approaches to examine and understand the drivers of public perceptions in order to inform conservation management (Jefferson et al., 2015; Bennett et al., 2016). Indeed, mixed-method approaches—including the collection of both qualitative and quantitative data—have been demonstrably useful in identifying solutions to particular problems causing biodiversity loss (Angula et al., 2018; Lecuyer et al., 2019; Mellish et al., 2019). Qualitative social research—gathering detailed information about respondents' values, perceptions and experiences (Drury, 2011; Chausson et al., 2019; Lecuyer et al., 2019)—can illuminate the social aspects of behaviours that lead to the over-exploitation of wildlife. Quantitative methods—for example, the use of numeric scales to measure agreement with certain statements that focus on positive or

negative attitudes towards the environment or conservation issues—have been regularly used to inform conservation education and awareness-raising programmes (Moss et al., 2017). In seeking to understand decision-maker behaviour, social psychologists have sought to develop theories to model behavioural choices (Kidd, Garrard, et al., 2019). One, the Theory of Planned Behaviour (TPB: Ajzen, 1991), has proved to be a popular model in circumstances when it is hard to obtain reliable self-reporting on certain behaviours, and is predicated on the assumption that intention to carry out a behaviour typically predicts behaviours (Heath and Gifford, 2002). Researchers have demonstrated that certain psychographic factors, such as attitudes (Gifford and Nilsson, 2014), social and moral norms (Kaiser, 2006; Chen et al., 2009), 'self-efficacy' (personal judgement of one's competence; Janmaimool and Denpaiboon, 2016), and perceived behavioural control (Heath and Gifford, 2002), are often predictors of intention to carry out most behaviours (Hargreaves, 2011). The utility of TPB in informing interventions that seek to make behavioural change has been demonstrated in numerous contexts relating to environmental behaviours (Green et al., 2019), and the conservation of wildlife (Janmaimool and Denpaiboon, 2016; Amit and Jacobson, 2017; St. John et al., 2018). Thus, research combining in-depth qualitative methods exploring public perceptions alongside quantitative methods exploring behavioural intentions should provide practitioners with solid evidence for the formation of effective interventions.

The regulation and enforcement surrounding the illegal domestic cage-bird trade in Indonesia have been ineffective at reducing the impact on wild bird populations (Chng et al., 2015; Indraswari et al., 2020; Marshall et al., 2020b), with the trade threatening many native taxa (Eaton et al., 2015; Birdlife International, 2020), and involving imported birds from neighbouring countries (Leupen et al., 2018). The Indonesian wildlife trade is valued at up to US$1 billion annually (Marthy and Farine, 2018), of which the cage-bird trade is worth at least US$80 million annually (Jepson et al., 2011) and is part of a very long tradition of bird-keeping in Indonesia (Iskandar et al., 2019, 2020). This economic and cultural importance has often been seen as the principal reason why regulation and enforcement have failed to control the activity and thereby reduce impacts on wild bird populations (Jepson et al., 2011; Indraswari et al., 2020). Although efforts have been made to promote

and solidify demand for captive-bred alternatives (Jepson et al., 2011), concerns among the breeding community over the protected status of birds reducing financial feasibility demonstrate the complexity of the issue (Maizura, 2018). Research has so far predominantly focused on the spatiotemporal and demographic aspects of bird-keeping (Indraswari et al., 2020; Marshall et al., 2020b, 2020a), and as yet little attention has been paid to wider public attitudes to the trade and the effect it has on wild bird populations. Understanding the perceptions and attitudes surrounding wildlife products, can be invaluable to researchers seeking to change behaviours in culturally nuanced and sensitive ways (Davis et al., 2016; Davis, Glikman, et al., 2019).

In this chapter I seek to identify patterns in the attitudes, beliefs and intentions of bird-keepers and non-bird-keepers in Java that will help guide demand-reduction efforts. To do this, I provide a profile of suitable and effective conservation messages and pinpoint issues that could be the focus of conservation education and awareness-raising initiatives. Specifically, I explore the reasons and beliefs that underpin decisions to both start keeping birds, as well as to never keep them. These reasons and beliefs are further examined in terms of different age- and user-group membership. I identify differences in attitudes and beliefs, in terms of bird conservation and welfare, between bird-keepers and non-bird-keepers, across age-groups, and across bird-keeping user-groups. Finally, I explore the potential drivers of intentions to keep wild-caught birds among the general human population of Java.

4.2 METHODS

4.2.1 Study design

4.2.1.1 Sampling method

Between January and October 2018, I collected data on attitudes and perceptions towards bird-keeping and the wider environment during a household survey on Java, Indonesia, sampling a spectrum of both rural and urban districts across the island (Marshall et al., 2020a, 2020b). Within districts, communities were selected randomly, while households were sampled systematically. I followed the Indonesian Statistics Authority's household typology, where a family unit constitutes an adult, spouse and all children below the age of 16 (further examples in BPS, 2010). Surveys were completed with the most senior family member available, preferably

the head of the household. Where the principal bird-owner was not present, their absence was recorded, and respondents were asked a reduced set of questions which could be directly verified by the interviewer or were pertaining to their personal opinion.

Prior to data collection, interviewers (2–4 within one team) gained permission from, and agreed to stipulations set by, the relevant administrative authorities (neighbourhood or community leaders). To ensure a representative sample, a predetermined number of surveys (based on the number of urban or rural households present in the population, 90–120) was set for each district (Newing, 2010), which was used as a target for the selection and sampling of neighbourhoods. Prior informed consent was always received verbally from respondents, with all data anonymised after the name of the interviewer and the time and date of survey had been recorded.

4.2.1.2 Survey design

We used a structured household survey divided into demographic characteristic and bird ownership sections (see Marshall et al., 2020a, 2020b for further information) and two further sections using a mixed-methods approach involving the collection of qualitative and quantitative data (Creswell and Clark, 2017; Lecuyer et al., 2018). These additional sections sought a) to gather qualitative data on reasons for not keeping birds, starting to keep birds, and giving up on the hobby, and b) to gather quantitative data on respondents' attitudes and perceptions towards bird-keeping, wild bird populations and the natural environment in general, and their intention to purchase wild-caught birds in the near future. Qualitative questions (i.e. open responses) were evaluated using a grounded theory approach (Olmedo et al., 2018), whereby responses were initially coded, with common categories (e.g., lack of time to tend pets) developed iteratively (Kelly et al., 2019). This approach allows common themes (categories) to emerge from responses without limiting respondents' original answers to a predefined set (Kelly et al., 2019); final categories are then obtained through reviewing, comparing and redefining the common categories regularly.

The quantitative questions focusing on respondent attitudes and intentions used five-point Likert items to measure self-reported levels of agreement with

statements (St. John et al., 2018). Based on previous research in the region (Jepson, 2010), I developed a series of statements focused on the respondents' appreciation of wild birds, bird-keeping and the environment to explore what attitudes were shared across respondents and stakeholder groups (e.g. bird-keeping user-groups, age-groups; see Table 4.1). Additionally, I developed questions based on the TPB to cover various potential predictors (Heath and Gifford, 2002; Klöckner, 2013; St. John et al., 2018) of reported intention to obtain wild-caught birds, including: *Individual Perception*, *Peer perception*, *Social norms*, *Self-efficacy*, *Perceived behavioural control* and *Intention to enact a behaviour* (see Table 4.1). Adopting this mixed-methods approach allowed me to obtain a greater understanding than if I had used only either a qualitative or quantitative approach (Creswell and Clark, 2017; Kelly et al., 2019). The quality and appropriateness of the survey were evaluated through discussions involving social scientists with behaviour change expertise, and piloting and proofing in communities surrounding the local research institution before data collection began. Some aspects were based on previous research in the region (Jepson and Ladle, 2009; Burivalova et al., 2017) known to be effective at eliciting important and useful information. All surveys were conducted in Bahasa Indonesia (the national language), with occasional use of Javanese (regional language) when necessary.

Table 4.1. Attitudinal questions measuring agreement to statements regarding wild birds, bird-keeping and the environment and the psychographic questions based on the Theory of Planned Behaviour. Questions presented here all used five-point Likert items to measure

self-reported levels of agreement with presented statements from ‘strongly agree’ to ‘strongly disagree’.

Statement	Topic / Variable
Attitudes to:	
There are fewer birds in the wild now than when I was young	Wild birds
People should not disturb wild birds in their natural habitat	
Birds play an important role in the environment / ecosystem	
Birds remind me of my hometown / village	
The state of wild bird populations is not a major concern to me	
Birds live longer in the cages than in the wild	Bird-keeping
Owning caged birds endangers birds in the wild	
The environment in Java is under threat (from pollution and climate change)	The environment
Potential predictors of behaviour:	
Keeping wild-caught birds is acceptable	Individual perception
Friends and family close to you think keeping wild-caught birds is acceptable	Peer perception
Friends and family close to you think you should keep wild-caught birds	Social norms
You are free to obtain wild-caught birds if you want to	Self-efficacy
I am able to access wild-caught birds easily	Perceived behavioural control
The next bird I obtain or ever obtain will be wild-caught	Intention to keep wild-caught birds

4.2.2 Statistical analysis

Demographic attributes and bird-ownership information, including whether any cage-birds were globally threatened according to IUCN (2020), were summarised and examined using descriptive statistics to assess the representativeness of our sample. As is typical of survey-based studies, there were questions that respondents were unable to answer, or to which their answers were uninterpretable, and because of this, sample sizes differed between analyses. After obtaining final categories for the open responses to questions about respondents’ reasons for starting, stopping or never keeping birds, differences in reported responses across different groups (e.g. bird-keepers and non-bird-keepers) were examined using Pearson’s chi-square tests. Although collected and synthesised using qualitative approaches, for final analyses these responses were treated as quantitative data to explore the frequency of themes and categories. Where statistically significant differences were found, post-hoc analyses were conducted to determine which groups contributed significantly to overall trends. For analyses exploring the differences across age-groups, two groupings of ages were used, one for the

respondents' age at interview, and one for the age when they began keeping birds; as respondents had to be over 18 at the time of the interview but could start keeping birds from any age, the distribution of ages in these categories could not follow the same pattern. As in the analyses focusing on reported reasons, I used Pearson's chi-square tests to examine differences across groups in levels of agreement to the attitudinal questions, and post-hoc analyses to determine which groups contributed to overall trends. All statistical analyses were performed in R version 3.6.1 and all figures were created using ggplot2.

I fitted binary logistic mixed-effects regression models (GLMMs) to identify important predictors of intention to obtain wild-caught birds incorporating aspects of the TPB, and age of interviewee at time of survey. I fitted four global models to explore the effects and their significance across different groups regarding bird-ownership status: one for those who had never kept birds, one for those who currently or previously kept birds; one for Hobbyists; and one for Specialists (Contestants and Breeders jointly). In all models, community was included as a random factor to account for the nested nature of data within the 92 communities (Bolker et al., 2009). Prior to inclusion in models, continuous variables were standardised and checked for collinearity, and predictors with high variance inflation factors (>2) excluded (Zuur et al., 2010).

4.3 RESULTS

4.3.1 Description of sample population

Of 3,040 household representatives surveyed, 957 (31%) were keeping birds when interviewed. Of the remaining 2,083, the majority (1,646, 79%) had never kept birds, whereas 437 (21%) had stopped keeping birds before the interview took place (dating as far back as 1980). Of bird-keeping respondents, 56% were Hobbyists, 26% Contestants, and 17% Breeders. Typically, Hobbyists owned the fewest birds (Median, lower quartile–upper quartile; 2, 1–4) whereas Breeders owned the largest numbers (7, 3–13). Hobbyists, however, owned higher numbers of both wild-caught and threatened birds than the other groups, and were the least likely to consider the origin (wild-caught or captive-bred) as important when purchasing birds (for greater detail on user-group characteristics, behaviours and preferences see Chapter 3). Median age (LQ-UQ) of non-bird-keeping and bird-keeping respondents were 41 (32–50) and 41 (33–51) respectively. Compared to non-bird-keepers, bird-keepers

tended to have attained a high school education, and were more likely to have been employed in Business or Clerical work, while non-bird-keepers were more likely to have attained either a higher or lower level of education, and were more likely to be unemployed (for greater detail on the socioeconomic profiles of bird-keepers see Chapter 3).

4.3.2 Primary reasons for never keeping birds

By far the most common reason for not keeping birds was a lack of interest, yet notable proportions of respondents also cited a lack of either skill, knowledge, or patience (22%) and time (19%) to keep birds (Table 4.2). Combined only 7% cited bird welfare or health/hygiene issues as disincentives, and even less (6%) cited lack of money. Proportions of reported reasons differed significantly across age-groups, with younger respondents more likely to cite lack of interest than other reasons, while middle-aged respondents most often cited lack of time as the chief constraint. Bird owners were more likely to own another non-avian pet than non-bird owners (χ^2 = 34.2, df = 1, *n* = 3,040, p <0.01). Respondents who came from households where birds had been kept previously were more likely (43% vs 28%) to keep birds currently than those who did not (χ^2 = 69, df = 1, *n* = 2,864, p <0.001).

4.3.3 Primary reasons to start and stop keeping birds

The most common reasons to start keeping birds were to gain pleasure or entertainment from their song or appearance (28%), to keep up with peers or family members (23%), or simply to have a hobby (21%; Table 4.3). Proportions of reported reasons differed significantly across user-groups, with hobbyists more likely to have started after they obtained their birds opportunistically (as gifts or finding injured birds), and Contestants and Breeders more likely to have started in order to earn money or financial returns from their hobby. Reasons for starting to keep birds also differed significantly between age-groups: those who started as minors (< 16) were more likely to want a hobby and to keep up with peers; young adults (16–25) claimed they had not been able to keep birds before due to financial, temporal or space limitations; adults (25-40) were the only age-group to not state a particular reason; whereas older adults (> 40) obtained birds opportunistically (Table 3).

The most common reasons for ceasing to keep birds were: no longer being able to look after them (38%); giving up when the bird died (24%); having to sell or give away the bird (18%); bird(s) escaping or being stolen (14%); losing interest in the hobby (4%); and feeling sorry for the bird (2%). The majority of bird-keepers gave up within five years of starting, and under-30-year-olds were the most likely to stop within five years ($\chi^2 = 26$, df = 1, $n = 104$, $p < 0.001$).

Table 4.2. Categories of reasons given for not keeping birds. Reasons that were cited by significantly different proportions of age-groups are highlighted in **bold**, with significant differences between groups also highlighted in **bold** and marked with **asterisks***.

Rank	Reason	% Age-groups					Overall (%)
		<30 n=267	**31–40** n=442	**41–50** n=400	**51–60** n=253	**Over 60** n=112	
1	**Lack of interest**	**56***	45	44	40	43	677 (46)
2	**Lack of skill, knowledge or patience**	20	22	18	25	30	317 (22)
3	**Lack of time**	14	19	**26***	20	**9***	281 (19)
4	Lack of money or space	5	7	6	6	8	93 (6)
5	Health or sanitary concerns	2	4	4	4	4	57 (4)
6	Welfare concerns	3	2	3	5	6	49 (3)

Table 4.3. Categories of reasons given for starting to keep birds. Reasons that were cited by significantly different proportions of user- or age-groups are highlighted in **bold**, with significant differences between groups also highlighted in **bold** and marked with **asterisks***.

Rank	Reason	% user-groups			% age starting				Overall (%)
		Hobbyist n=361	Contestant n=220	Breeder n=131	Under 16 n=224	16–25 n=263	26–40 n=306	Over 40 n=147	
1	To enjoy and appreciate bird-song or form	27	22	24	23	27	27	25	386 (28)
2	**To keep up with peers/family**	18	22	23	**30***	17	22	20	318 (23)
3	**To have a hobby**	21	28	24	**31***	20	19	19	293 (21)
4	**Became able to do so [always interested]** [a]	17	15	15	**5***	**22***	13	**8***	141 (10)
5	**Opportunistically obtained [gift/found]**	**13***	1	2	**6***	**5***	11	**20***	139 (10)
6	**To earn money**	1	**9***	**11***	4	5	5	5	58 (4)
7	To add atmosphere	2	2	-	-	3	1	2	18 (1)
8	Impulse purchase	2	1	1	-	2	2	1	12 (1)
9	To protect from danger	1	-	-	-	-	-	1	3 (<1)

[a] *Became able to afford to keep birds or space became available*.

4.3.4 Attitudes towards wild birds, bird-keeping and the environment

Overall, non-bird-keepers and bird-keepers showed similar levels of agreement to the attitudinal statements, appreciating that people should not disturb birds in their natural habitat, enjoying seeing birds in the wild, and judging that there are fewer birds in the wild now than when they were young. However, bird-keepers were more likely than non-bird-keepers to agree with the statements that “birds live longer in cages than in the wild”; and disagree with the statements that “owning caged birds endangers birds in the wild” and “the state of wild bird populations is not a major concern to me” (Figure 4.1A). Similarly, non-bird-keepers and bird-keepers had different levels of agreement in attitudes towards the keeping and acquisition of wild-caught birds (Figure 4.1B). There were few differences in beliefs and attitudes towards bird-keeping across age groups, although younger respondents tended to believe keeping birds endangers them in the wild; and the oldest and youngest respondents were more likely to think that birds are an important part of the environment (Figure 4.1C). Bird-owning user-groups held similar attitudes to wild birds and the keeping of wild-caught birds, but Hobbyists were the most likely to agree that “the state of wild bird populations is not a major concern to me” (Figure 4.1D).

4.3.5 Drivers of intention to keep wild-caught birds

Table 4.4. Percentages of groups that showed intention to obtain a wild-caught bird, with significance levels of psychographic and demographic predictors of said intention. All predictors showed a positive relationship with intention to obtain wild-caught birds; significance levels (P values) are coded as follows: * <0.05; ** <0.01; ***<0.001.

	Non-bird-keepers	Bird-keepers[a]	Hobbyists	Specialists
Intention to obtain wild-caught birds	15.7%	22.7%	22.7%	19.4%
Predictor				
Individual perception	***	***	**	***
Peer perception	**	***	***	-
Social norms	-	**	-	**
Self-efficacy	***	***	***	***
Perceived behavioural control	***	*	-	-
Age	*	-	-	-

[a]*Includes previous and current keepers of birds*

Those who had never owned birds were unsurprisingly the least likely to state they might obtain or purchase a wild-caught bird themselves (15.7%), yet current and previous bird-keepers were only slightly more likely to show intention to obtain a wild-caught bird (22.7%; Table 4). Among user-groups, Breeders were the most likely to admit they might obtain a wild-caught bird (24.6%), followed by Hobbyists (22.7%), whilst Contestants were the least likely (15.6%). In GLMMs predicting intention to purchase wild-caught birds across the different groups (Table 4.4): individual perception, peer perception, self-efficacy, and perceived behavioural control were significantly associated with both non-bird-keepers' and bird-keepers' intention to obtain wild-caught birds; yet increasing age and social norms were significantly associated with only non-bird-keepers' and bird-keepers' intention respectively; individual perception, peer perception and self-efficacy were significantly associated with Hobbyists' intention, whereas personal perception, social norms, and self-efficacy were significantly associated with Specialists' intention (Table 4.4).

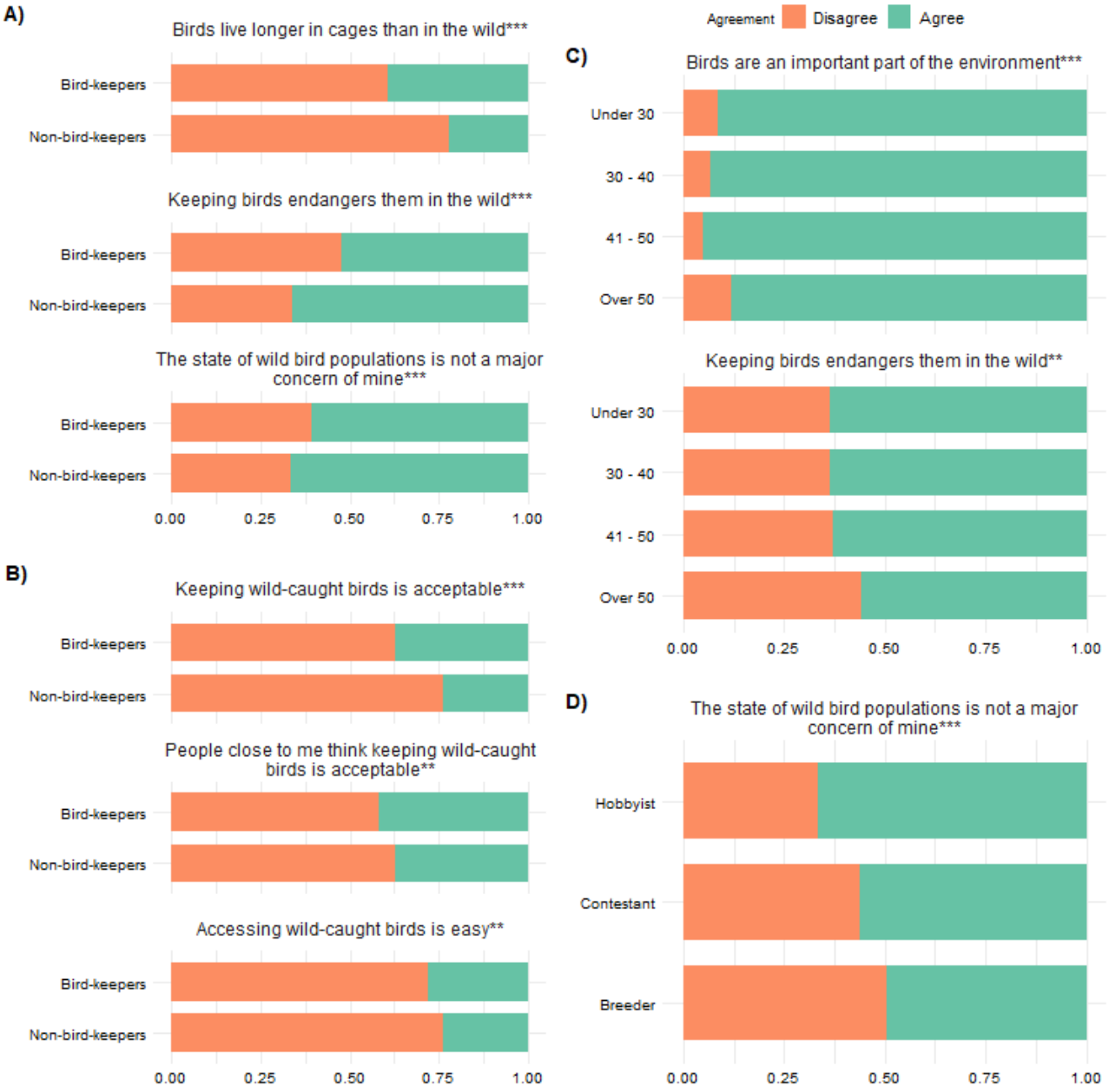

Figure 4.1 Attitudes of non-bird-keepers and bird-keepers towards A) wild birds, and B) the keeping of wild-caught birds; and attitudes of C) age-groups and D) bird-keeping use-groups towards wild birds. Significance at the **5% and ***1% level.

4.4 DISCUSSION

The importance of considering the cultural and social context of consumer behaviour when attempting to find ways to change it is often overlooked, but evidence suggests this information can be crucial in determining success (Olmedo et al., 2018; Veríssimo and Wan, 2019; Dang Vu et al., 2020). This chapter contributes to such efforts by providing an understanding of why people start and stop keeping

birds, or never do so, in addition to how various groups of respondents perceive bird-keeping, the environment and the keeping of wild-caught birds. The results suggest that the typical western concern for the welfare of traded wildlife (Dutton et al., 2011; Challender and MacMillan, 2014) is not shared by non-consumers in Indonesia, as bird welfare was very rarely cited as a reason for not keeping birds. Further, reasons for keeping birds differed across both age- and user-groups, with older people and Hobbyists more likely to obtain them opportunistically, Contestants and Breeders to earn money, and younger people simply to have a hobby, to keep up with peers, or because they became able to. Despite the variety of reasons for starting, stopping or never keeping birds, in general the different groups recognised that wild birds were an important part of the environment, that people should not disturb them in their natural habitat and that wild birds are declining. This general concern for the conservation of birds will be important to explore and build upon in defining interventions seeking to reduce the bird-keeping community's impact on wild bird populations. The information will help guide efforts to reduce demand and change bird-keeping behaviours towards a more sustainable form, as it highlights key points of contention and shared attitudes across heterogeneous stakeholder communities (Jefferson et al., 2015; Bennett et al., 2016). Additionally, this study supports the use of mixed-methods, combining the use of qualitative and quantitative approaches that explore social aspects of conservation issues, to uncover potentially important aspects to be considered in conservation efforts and interventions (Veríssimo et al., 2012; Dang Vu et al., 2020).

Worryingly a proportion of non-bird-keepers cited factors (lack of time or space) constraining their ability to keep birds, suggesting that they may be potential consumers of cage-birds if these factors were removed. Further, the low proportion of respondents citing cost as a barrier to entry into the hobby suggests bird-keeping may be perceived as a low-cost hobby, which would explain its ubiquity across Indonesia (Indraswari et al., 2020). Although not primarily concerned about wild bird populations, non-bird-keepers tended to view bird-keeping as detrimental to those populations and were more likely to view it as unacceptable to keep wild-caught birds. Amplifying the attitudes of non-bird-keepers is thus important if we want to slow recruitment into the bird-keeping community, perhaps playing on the fact that unsustainable bird-keeping threatens wild bird populations, raising awareness that

trapping pressure is having a notable effect on wild populations of species in high demand (Harris et al., 2017), and thereby reducing their efficacy in providing important ecosystem services (Iskandar et al., 2019). This approach may prove particularly successful with the oldest and youngest respondents who agreed that birds are an important part of the environment. Efforts that seek to reduce the recruitment of non-bird-keeping households into the Hobbyist user-group (Marshall et al., 2020a) could focus on reinforcing current beliefs surrounding the impact of bird-keeping on wild populations, and promote more sustainable practices such as the captive-breeding of particular species.

This chapter further reveals that bird-keeping user-groups not only differ in behaviours and preferences (Marshall et al., 2020a), but also in reasons for starting to keep birds and in their attitudes towards birds and the environment. Hobbyists often initially receive their birds opportunistically, commonly as gifts, and worryingly seem the least concerned about wild bird populations. The threat to wild bird populations from such a large group of non-specialists (Marshall et al., 2020a) who may not maintain their hobby long enough to develop the required skill and avicultural techniques to reduce mortality, and in turn consumption, is clear. In other examples of socially driven consumption of wildlife (e.g. wild meat in Vietnam: Shairp et al., 2016) it has been possible to change norms and customs through careful and thorough evidenced-based campaigns, even when behaviours that negatively impact on wild populations are culturally ingrained (Davis, Glikman, et al., 2019; Davis et al., 2020). In the context of songbird keeping in Indonesia, altering the social acceptability of gifting wild-caught birds could be a key tool in slowing recruitment into the Hobbyist user-group, as has been attempted, and in some cases successfully, for the consumption of other wildlife products (e.g. rhino horn use in Vietnam or saiga horn use in Singapore; Dang Vu et al., 2020; Doughty et al., 2019). In contrast, both Contestants and Breeders are more motivated by financial reward, which could also be a proxy for status, as observed in other examples of keeping rare and valuable exotic pets (Aloysius et al., 2020). Contestants tend to be younger, seeing the possibility for quick reward and opportunities for socialising via contests, whereas Breeders tend to be older, potentially starting after moving away from the family household, and no longer constrained by temporal, spatial or financial limitations (Marshall et al., 2020a). The

motivation of these two groups to seek financial reward for their hobby could be an important leverage point in future intervention efforts, perhaps focusing on the profitability of certain breeding practices, or the unsustainable nature of continued illegal behaviour if sanctions were more severe.

Overall there were low proportions of all groups admitting an intention to obtain wild-caught birds in the future. Nevertheless, given the ubiquity of bird-ownership across Java (Marshall et al., 2020b), this number probably represents a concerningly large number of households involved in the procurement of wild-caught birds. Interestingly, Breeders were the most likely to admit the next bird they obtained would be wild-caught, despite their apparent involvement in, and awareness of the importance of, the captive-breeding of songbirds. Additionally, age was a significant predictor of intention for non-bird keepers, with older respondents more likely to admit intent, raising the possibility that younger recruits to the bird-keeping fraternity may be less likely to seek out wild-caught birds, potentially due to higher awareness of legislation. Our results perhaps then mirror other studies where ownership of wild-caught birds was clustered among communities (Burivalova et al., 2017), as the importance of social norms among bird-owners suggests that peer pressure increases intention among particular communities. Further, the fear with such a result is that particular areas where the keeping of wild-caught birds is prevalent may be more resistant to demand-reduction efforts due to strong social norms among a community (Wallen and Daut, 2017; Chausson et al., 2019). Focusing efforts on reinforcing and establishing negative perceptions of obtaining wild-caught birds among younger bird-keepers will thus be vital to increasing the sustainability of the hobby.

By combining qualitative and quantitative approaches this study gives an in-depth profile of the motivations, attitudes and perceptions towards bird-keeping among the human population of Java, Indonesia. Through exploring the cultural context surrounding the consumption behaviour of songbird keepers and their attitudes to wild bird populations this study provides those who wish to change behaviours and reduce demand for songbirds with some key lessons. Many people who do not own birds currently are potential bird-keepers, and efforts will need to establish norms beyond the bird-keeping fraternity to be impactful. Additionally, both demographic and behavioural profiles are associated with differing reasons for

keeping birds and attitudes to the consumption of wild-caught birds and the environment, so conservation programmes and campaigns will need to tailor messages and activities to target particular groups. Our results suggest that a blanket approach will be less efficient in reducing the impact the songbird-keeping community has on wild bird populations, especially considering such a diverse appreciation of both bird-keeping and its impact on the environment. For example, based on the results of this study, recommendations for campaigns could include preventative approaches trying to reduce uptake among non-bird-keepers at a young age, focusing on establishing norms around the acceptability of keeping wild-caught birds. Another option could be to focus on promoting sustainably sourced captive-bred birds as suitable gifts for friends and family as opposed to cheaper wild-caught alternatives. Future research should look into the efficacy and persuasiveness of messages constructed through the understanding presented in this study, and importantly what are the best media and stakeholders to engage with in sharing these messages. Further, the format of these messages should be carefully considered to maximise the engagement of such communities, and thus the impact of future conservation campaigns focused on behaviour change, awareness-raising and education (Chapter 5).

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5 IDENTIFYING MESSAGES TO FACILITATE BEHAVIOUR CHANGE IN OVERCONSUMING SONGBIRD-KEEPING COMMUNITIES ON JAVA

Abstract

There is a pressing need to find effective and impactful campaign messages to change unsustainable consumption behaviour of bird-keepers in Indonesia. This chapter uses online surveys with a targeted sample of bird-keepers from across Java to explore the potential for success in terms of demand reduction and behaviour change among bird-keepers, and what campaign messages may be the most persuasive. Furthermore, it highlights areas for specific awareness-raising campaigns and the sources of information and media to use to undertake them. All participants were shown pairs of messages, based on the results from previous chapters (3 and 4), aimed at changing their consumption habits, and were asked to pick which messages they felt carried the most persuasive information or argument. The framing of the messages and behaviours promoted were explored to determine which might best persuade bird-keepers to change their behaviour. Most bird-keepers perceived keeping wild-caught birds as problematic, and a majority claimed they would attempt to breed birds in the future. Hobbyists were the least likely to consider breeding their own birds, and the most likely to admit they could be persuaded to stop keeping birds. Despite a majority of respondents understanding that both buying and catching wild birds is illegal, a similar majority thought birds in markets are often wild-caught, and that they can be entered into contests. Our results suggest that messages aimed at changing behaviours should focus on the negative impacts of over-exploitation on Indonesia's wildlife and/or cultural heritage, and on the positive aspects of sustainable alternatives rather than the negative aspects of the hobby in general. There was little variation across groups in terms of which messages they found most persuasive, yet both age- and user-groups diverged in most trusted sources of information and media used. Efforts to raise awareness of the detrimental impacts of the trade and change behaviours could maximise results by collaborating with local and religious leaders, and demand reduction campaigns should use divergent communication delivery to target the disparate demographics of bird-keeping groups.

5.1 INTRODUCTION

The overharvesting of wild populations of myriad species is considered one of the biggest drivers of biodiversity loss (Maxwell et al., 2016). Understanding and changing such consumptive behaviours is vital to halt further declines in biodiversity (Schultz, 2011; Kidd, Garrard, et al., 2019), and knowledge of spatio-temporal patterns in wildlife exploitation enables conservationists to pinpoint where interventions are most needed and likely to have greatest effect (Bush et al., 2014; Marshall et al., 2020b). Profiling the motivations and preferences of those who participate in behaviours associated with the over-exploitation of wildlife allows us to focus interventions on specific subsets of behaviour that are potentially the most impactful on wild populations (Thomas-Walters et al., 2019; Marshall et al., 2020a). Exploring the attitudes and intentions of consumers and potential consumers of wildlife further allows us to see how those involved perceive their behaviour and its impact, offering opportunities to generate possible pathways that could reduce their impact on wildlife (see Chapter 4). The next step is to explore the most suitable approaches to changing the unsustainable consumption of wildlife among audiences, such that conservation efforts can objectively demonstrate success (Reddy et al., 2017; Kidd, Bekessy, et al., 2019; Kusmanoff et al., 2020).

Having obtained a detailed understanding of demand, evaluating the effectiveness of message construction is a logical next step (Reddy et al., 2020). In order to determine the impact of messages on people's attitudes, behavioural research has incorporated aspects of experimental design such as Random Control Trials (RCTs) and Choice Experiments (Stead et al., 2007; Hanley et al., 2018; Shreedhar and Mourato, 2019; Subroy et al., 2019). Such approaches allow evaluation of the appropriateness of strategic message framing—the construction of message content to influence individual thoughts (Kusmanoff, 2017)—used to ensure future efforts can build on and improve messaging approaches (Kidd, Garrard, et al., 2019). Previous efforts have often attempted to emphasize shared environmental or economic benefits from the conservation of wildlife (Kusmanoff et al., 2016; Reddy et al., 2020), however, there is evidence that such approaches rarely yield increases in pro-conservation attitudes or behaviours (Krantz and Monroe, 2016; Reddy et al., 2020). Instead, gaining a strong understanding of audiences in order to identify groups to target messages towards can result in more

impactful and effective campaigns (Veríssimo et al., 2018; Kidd, Garrard, et al., 2019; Thomas-Walters et al., 2020).

Based on the assumption that those lacking knowledge of an issue are more likely to modify their behaviour if they learn of its impact, much effort has been directed towards addressing an apparent knowledge deficit, and raising awareness of the impact of people's behaviour on levels of biodiversity (Heberlein, 2013; Wallen and Daut, 2018). There is evidence however, that campaigns focused solely on raising awareness on issues do not necessarily translate into reduced impact (Olmedo et al., 2018; Green et al., 2019). The importance of regulation and legislation surrounding the consumption and exploitation of wildlife suggests efforts seeking to address illegal wildlife trade must address apparent knowledge deficits where possible (Salazar et al., 2019). Examining the ways in which individuals understand how particular behaviours negatively impact biodiversity allows the creation of multi-layered conservation efforts that seek to both raise awareness and change behaviours (Moss et al., 2017). The importance of effective use of media is clear to ensuring that audiences will accept both information and behaviour change campaigns surrounding biodiversity issues (Veríssimo et al., 2020). Indeed, it has been shown that audience's intention to act on messaging is heavily dependent on the trust invested in those communicating the information (Krantz and Monroe, 2016).

To change unsustainable consumption behaviour by bird-keepers in Indonesia and beyond, new solutions and interventions are required that transcend simple regulation and demands for enforcement, by appreciating the socio-ecological context of the issues and engaging constructively with the communities seen as responsible for the problem (Challender et al., 2015a; Larrosa et al., 2016). Typically efforts seeking to reduce the impact of trade on wildlife populations have sought to reduce demand in certain products by highlighting its detrimental impacts or making it undesirable socially (Doughty et al., 2020), referred to as demarketing by social marketing researchers (Veríssimo, 2019). Another common approach is to redirect demand for wildlife products to substitute alternatives that can perform the function of the original desired product (Moorhouse et al., 2020). Here I aim to identify the most persuasive campaign messages to improve the sustainability of songbird keeping behaviour in Java, both in terms of demarketing wild-caught birds

and the redirection of such demand to captive-bred alternatives. Additionally, I seek to devise a methodology that can be replicated in other contexts where songbird species are threatened by overexploitation for the cage-bird trade. Conceptions surrounding the current sustainability of bird-keeping were examined to assess what issues are commonly understood or acknowledged. Finally, the potential mechanisms for communicating awareness-raising efforts and demand reduction campaigns are examined. This chapter has the following specific objectives:

Objective 1 – To explore the potential for success in terms of demand reduction and behaviour change among bird-keepers.

Objective 2 – To determine the persuasiveness of a suite of messages and to explore their construction, in terms of strategic framing and behaviour, to support future behaviour change message generation.

Objective 3 – To explore respondents' knowledge and conceptions regarding the sustainability of the cage-bird trade to uncover what barriers may be inhibiting more sustainable bird-keeping.

Objective 4 – To explore what sources of information and media should be used to disseminate awareness-raising and demand reduction campaigns

5.2 METHODS

5.2.1 Survey design

A questionnaire survey was developed in the first quarter of 2020 based on previous data collected on the attitudes and perceptions of bird-keepers (see Chapter 4), and finalised after piloting in March 2020. The questions (see 5.6.1 Appendix A) fell into four categories those: (1) pertaining to the socio-economic and demographic profiles of respondents; (2) determining whether respondents owned birds and, if so, which user-group they belonged to; (3) assessing which potential messages for demand reduction or redirection campaigns respondents thought were most persuasive and likely to result in a change in consumptive behaviour; and (4) exploring the conceptions and misconceptions of respondents towards bird-keeping. Definitions of bird-keeping user-groups follows those used in Marshall et al., 2020b: *Hobbyists*, who keep birds primarily as pets and infrequently engage in song contests; *Contestants*, who keep birds primarily to enter them in singing contests, but may

occasionally breed birds; and *Breeders*, who breed and/or train birds as a hobby or for resale, but do not often participate in contests.

5.2.1.1 Message generation and comparison

Based on the results of previous work, in particular those concerning attitudes and perceptions of current and potential bird-keepers (Chapter 4), I drafted and framed messages combining multiple aspects: theme (e.g. conservation), frame (e.g. positive or negative), and behaviour (e.g. buy captive-bred or do not buy wild-caught birds). This led to the creation of 20 statements, combining theme and frame, which were then further combined with a behaviour to create a total of 40 messages (see Table 5.1). These messages were then presented to the respondent, who was asked which they thought would be more persuasive to their friends and family. The subject of these questions were friends and family to avoid potential bias in responses regarding respondents' own potentially illegal behaviour (Nuno and St. John, 2014; Davis, Crudge, et al., 2019). To reduce the number of comparisons each respondent was asked to make, the messages were divided into two sets, such that half the statements were combined with each behaviour in each set. This enabled the respondent to make only 10 comparisons as opposed to 20. Through using survey software randomisation functions, I was able to ensure that each set was shown an equal number of times, to minimise sampling bias.

5.2.1.2 Sources of information

A further set of responses from the previous survey (carried out in 2018, see Chapters 2-4) was included in this chapter to explore trusted sources of information and commonly used media vehicles.

5.2.2 Survey sampling

To promote the online survey, I created a Facebook page (www.Facebook.com) for my study and used a combination of *posts* and paid *adverts* to recruit participants. Adverts were created using Facebook's 'Ad manager' function (Facebook, 2016) to recruit participants. Facebook allows basic targeting based on the age, gender, and location information provided on an individual's Facebook profile page (Akers and Gordon, 2018). As our main demographic of interest were men who kept or showed interest in keeping birds as pets, I used Facebook targeting to direct our survey

towards men aged 18 and over from all six provinces of Java. I refined 75% of my targeting effort towards those who either listed birds as an interest or whom Facebook had recognised as an interest from their profile (Kapp et al., 2013). To ensure the study was transparent, I created a video (https://bit.ly/3mJbOGA) in which I explained in Indonesian the goals of the research and asked viewers to participate in the study through clicking a link provided and completing our survey. This post was then promoted using Facebook's 'Boost' function to reach our target demographic, operating in a similar way to the adverts.

After an initial pilot period (27/04/20–14/05/20) to determine the best approach, adverts and 'Boosted' posts were run continuously in the six weeks 15/05/20–28/06/20. Throughout this period adverts were closely monitored and adjusted if necessary to maximise the number of Facebook users reached (Kapp et al., 2013; Akers and Gordon, 2018). Once a respondent clicked on an advert they were redirected to the survey, which was hosted on Qualtrics (www.qualtrics.com).

Table 5.1.
Framework used to generate messages to be compared by respondents in the online survey using the following question: “Which of these messages do you think would be more persuasive for your friends or family?”.

	Frame	Positive		Negative	
Theme	Conservation	Sustainable captive-bred birds do not affect wild-bird populations		Wild songbird populations are threatened due to over-extraction for trade	
	Cultural	Many young people prefer captive-bred birds over wild-caught ones		Bird-keeping is old fashioned	
	Ease of training	Captive-bred birds are easier to train		Wild-caught birds can be harder to train	
	Economic value	Some people say keeping birds is expensive and a lot of hassle		Many bird-keepers think captive-bred birds are a good investment	
	Health/Cleanliness	Captive-bred birds are less likely to have wild diseases		Some people think birds are dirty and unhealthy	
	Legality	It is perfectly legal to keep captive-bred birds		It is illegal to keep wild-caught birds	
	Patriotism	Breeding birds demonstrates Indonesian capacity at animal husbandry		Over-exploitation of birds threatens future of bird-keeping in Indonesia	
	Personal vs. social good	Most people enjoy seeing birds in the wild, not in cages		Most people think there are fewer birds in the wild now than before	
	Social norm/perception	Many of bird-keepers prefer captive-bred birds to wild-caught		Most people think keeping wild-caught birds is not a good thing	
	Bird condition	Captive-bred birds are easy to look after, they rarely die or escape		Wild-caught birds die or are in bad condition whilst in transit	
Behaviour		Buy captive-bred birds	Do not buy wild-caught birds	Buy captive-bred birds	Do not buy wild-caught birds

5.2.3 Data analysis

Demographic attributes and bird-ownership information were summarised and examined using descriptive statistics to assess the sample representativeness. Online samples were compared with the sample of bird-keepers collected during the face-to-face survey in 2018 (Chapters 2-4). Proportions of reported responses (to all questions the except message comparison section) were calculated and differences examined using Pearson's chi-square tests. Where statistically significant differences were found, post-hoc analyses were conducted to determine which groups contributed significantly to overall trends.

In order to understand which messages respondents found most persuasive, the total frequency with which messages were chosen as the more persuasive (of the two presented together) was used to determine which messages won the most contests. These were then ranked by the proportion of the total number of comparisons carried out. The same process was repeated on two subsets based on the behavioural component of the message: a) Buy captive-bred birds and b) Do not buy wild-caught birds (see Table 5.1). This was carried out to determine whether the theme or frame of a statement would be more successful when combined with a different behaviour. Similarly, to explore whether bird-keeping user-groups or age-groups showed different rankings of messages, the rank of each message for each user-group and age-group was determined. Differences in rank were calculated to determine increases or decreases in success across groups. All statistical analyses were performed in R version 3.6.1 (R Core Team, 2018).

5.3 RESULTS

5.3.1 Study sample

Over the data collection period (15/05/20–28/06/20), the adverts and boosted posts reached a total of 5.6M Indonesians on Facebook, resulting in a total of 92K (1.6%) different people clicking on the link to the survey. Of these, 1.9K proceeded past the introductory page, 1.7K provided information on presence or absence of birds, 1056 completed the message comparison section and 980 provided full socio-demographic data.

Of those respondents who provided demographic information (n = 980), only 2% came from outside of Java, with proportionally representative samples from

each of the six provinces of Java (see Table 5.B.1). The key demographic attributes of the sample were: largest age-group between 26–35 (n = 384, 39%); the majority had attained a high school education (n = 440, 47%) or higher (n = 422, 45%); and the most common occupational category was labour (n = 295, 31%) or business (n = 273, 28%), with 52 respondents (5%) employed in the trade of birds in some form (i.e. bird traders, professional breeders, contest organisers; Table 5.B.1). Overall 89% of respondents were bird-keepers, with each user-group represented in our sample at similar levels (~21-23%; see Table 5.B.1). Bird-keeping profiles of user-groups in this sample are provided in the Appendix (Tables 5.C.1 – 5.C.4).

5.3.1.1 Representativeness of the sample

Comparing the study sample of bird-keepers collected online in 2020 to that collected in previous work (Chapters 2–4), the online sample of bird-keepers tended to be younger (30% more 18–45 year olds), educated to a high school level (32% more), with 20% less Hobbyists, 6% more Contestants and 14% more Breeders (Table 5.B.2). The differences in the results suggest that the online sample was better at obtaining data on specialist bird-keepers (higher proportion of Contestants and Breeders), and worse at collecting data on Hobbyists of an older generation, which would be in agreement with previous results (Chapter 3).

5.3.2 Likelihood of changing behaviours

Slightly more than half (58%) of respondents (n = 680) admitted to thinking that the keeping of wild-caught birds is problematic, roughly a third (35%) responding ‘maybe’ and less than one in ten (7%) stating that it was not. The Indonesian government was most often cited (44%) as the party responsible for resolving this issue, followed by traders (16%), bird-keepers (15%), all parties (10%) and communities where birds are trapped (8%). The majority (88%) of bird-keeping respondents stated that they would breed birds at some point in the future (n = 590), with Contestants more likely to do so than Hobbyists. A majority (55%) of bird-keepers reported that they could probably be persuaded to stop keeping birds (Yes - 29%, Maybe – 26%), with the other 45% of bird-keepers reporting that they could not be persuaded to stop. Across user-groups, Hobbyists were the most likely to report they could be persuaded to stop compared to both Contestants and Breeders (41% vs 25/21% respectively).

Table 5.2. Most persuasive messages ranked by the total number of times respondents chose each statement. The theme of the message and frame (positive or negative) are presented alongside the percentage of times each message won when presented with each behavioural tagline (e.g. "*Wild songbird populations are threatened due to over-extraction for trade*" was chosen as the most persuasive message when paired with "*Buy captive-bred birds*" more often than when paired with "*Do not buy wild-caught birds*"). Statements which showed over 5% difference in success between behaviours are highlighted in **bold**. Differences in the rankings of messages between the overall ranking and across groups are presented using ↓ to represent a lower ranking for the group in question and ↑ to represent a higher ranking, with the number representing the difference in positions (e.g. "*Wild songbird populations are threatened due to over-extraction for trade*" was ranked one place lower for non-bird-keepers [NBK] than overall).

Statement	Theme	Frame	Buy Captive-bred	Do not Buy Wild-caught	Overall		Differences across groups			
					%	Rank	H	C	B	NBK
Wild songbird populations are threatened due to over-extraction for trade	Conservation	–	77	75	76	1	-	-	-	↓1
Over-exploitation of birds threatens the future of bird-keeping in Indonesia	Patriotism	–	**70**	**76**	73	2	-	-	-	↑1
Captive-bred birds are easier to train	Ease of training	+	69	67	68	3	-	-	-	↓1
Captive-bred birds are easy to look after, they rarely die or escape	Bird condition	+	67	66	67	4	-	-	-	↓2
Many bird-keepers think captive-bred birds are a good investment	Economic value	+	61	58	60	5	↓2	-	↓1	↓2
Most people think there are fewer birds in the wild now than before	Personal vs. social good	–	**55**	**64**	59	6	↑1	↓1	↓1	↓6
Many bird-keepers prefer captive-bred birds to wild-caught	Social perception	+	57	57	57	7	↓2	↓1	↑2	↑2
Breeding birds demonstrates Indonesian capacity at animal husbandry	Patriotism	+	53	54	54	8	↓6	↑2	-	↑5
Wild-caught birds can be harder to train	Ease of training	–	55	52	53	9	↑3	-	-	↑1
It is perfectly legal to keep captive-bred birds	Legality	+	52	51	52	10	↑2	↓1	-	↓5
Wild-caught birds die or are in bad condition whilst in transit	Bird condition	–	52	49	51	11	↑1	↑1	-	↓2
Most people think keeping wild-caught birds is not a good thing	Social perception	–	50	46	48	12	↓1	-	-	↑1
Many young people prefer captive-bred birds over wild-caught ones	Cultural	+	**51**	**45**	48	13	↓2	↓1	-	↑4
Sustainable captive-bred birds do not affect wild-bird populations	Conservation	+	44	49	47	14	↑3	↑1	-	-
Most people enjoy seeing birds in the wild, not in cages	Personal vs. social good	+	46	45	45	15	↑3	-	-	↑5
It is illegal to keep wild-caught birds	Legality	–	37	40	38	16	-	↓1	-	-
Captive-bred birds are less likely to have wild diseases	Health / Cleanliness	+	33	33	33	17	-	↑1	-	↓1
Some people say keeping birds is expensive and a lot of hassle	Economic value	–	26	27	27	18	-	-	-	↓1
Bird-keeping is old fashioned	Cultural	–	28	24	26	19	-	-	-	↑2
Some people think birds are dirty and unhealthy	Health / Cleanliness	–	**16**	**22**	19	20	-	-	-	-

5.3.3 Optimal message for changing behaviours

A total of 1,061 respondents completed the persuasive message comparison section to obtain a total of 10,610 comparisons. The breakdown by group was as follows: 321 (30%) Hobbyists, 307 (29%) Breeders, 305 (29%) Contestants, and 98 (9%) non-bird-keepers. The *statement* that won the most comparisons was “Wild songbird populations are threatened due to over-extraction for trade” followed closely by “Over-exploitation of birds threatens the future of bird-keeping in Indonesia” (Table 5.2). The behaviour promoted in each message appeared to affect the chances of a message being picked, for example, “Most people think there are fewer birds in the wild now than before” won more often with the tag-line “Do not buy wild-caught birds” than “Buy captive-bred birds”. Although there appeared to be no pattern in terms of which *theme* proved more popular, both messages for *Cultural* and *Health / Cleanliness* were in the bottom ten and five respectively in terms of popularity. Similarly, the frame of the message did not appear to determine its perceived persuasiveness. Instead the combination of theme and frame, and to some extent behaviour, appeared important in determining the perceived persuasiveness of messages. There were no notable differences across user-groups, yet there were differences between the perceived persuasiveness of messages between bird-keepers and non-bird-keepers, with the impact of over-exploitation of birds on bird-keeping proving the most persuasive, and the similarly themed message on breeding birds as important cultural heritage, proving far more popular for non-bird-keepers. Similarly, across age-groups there was only one notable difference in the top five ranked messages, with the older group of respondents (over 46 years old) ranking the “Over-exploitation of birds threatens the future of bird-keeping in Indonesia” as the most persuasive message.

5.3.4 Barriers to changing behaviours

5.3.4.1 Awareness and misconceptions

In terms of potential barriers to changing bird-keeping behaviours, respondents largely agreed on which statements were true. However, the statement that captive-bred birds sing better than wild-caught birds proved to divide opinion the most (Table 5.3). Across user-groups, Breeders were the most likely to state captive-bred birds had better songs, and the least likely to state that wild-caught birds are permitted to

enter into singing contests. Non-bird-keepers were the least likely to be aware that captive-bred birds can be identified by rings on their legs, and more likely to think that birds in markets were captive-bred as opposed to wild-caught.

5.3.4.2 Trusted and commonly used sources of information

Overall the most trusted sources of information were religious leaders (35%), local leaders (26%), peers (16%) and scientists/experts (11%; Table 5.4). In terms of commonly used media, radio and TV (42%), local meetings, and social media and the internet (both 24%) appeared the most prevalent. There was important variation in trusted sources of information across both different bird-keeping and age groups: Non-bird-keepers were the most likely to cite religious leaders as their most trusted sources of information, and most likely to cite radio and TV as a source of information. Hobbyists were the least likely to use social media and the internet for information, and the most likely to use printed media. Contestants were the least likely to use radio and TV for information, and most likely to use social media and the internet. Breeders were the most likely to cite local leaders as their most trusted sources. Respondents under 30 years old were the most likely to cite peers and scientists/experts. Additionally, they were most likely to cite social media and the internet as preferred sources. Respondents aged between 31–40 years old were the second most likely to use social media and the internet, whereas those aged 41–50 years old were highly likely to use social media and the internet. Respondents aged 51–60 years old were the most likely to cite religious leaders, and least likely to cite peers and scientists / experts. Additionally, they were the most likely to use radio and TV and local meetings, whereas respondents aged over 60 years old were the most likely to use local meetings for information and printed media.

Table 5.3.
Awareness and perceptions of the wild-caught and captive-bred birds in the cage-bird trade.

	% believing statement true					
Statement	**Breeders**	**Contestants**	**Hobbyists**	**Non-bird-keepers**	**Overall**	**n**
Buying wild-caught birds is legal	28	31	29	27	28	1,103
Captive-bred birds have a better song than wild caught birds	65	54	57	51	59	1,216
Captive-bred birds can be identified by rings on their legs	91	91	86	77	89	923
It is legal to capture birds from the wild	27	23	25	30	26	1,249
The majority of birds for sale in markets are captive bred	32	33	30	43	34	1,214
The majority of birds for sale in markets are wild caught	71	69	77	63	71	1,221
Wild-caught birds are cheaper than captive bred birds	84	85	86	76	84	1,315
Wild-caught birds are permitted to enter singing contests	64	76	74	66	69	1,203

Table 5.4. Trusted sources of information and most commonly used media to gather information. Sources and media that were cited by significantly different proportions of user- and age-groups are highlighted in bold, with significant differences between groups also highlighted in bold and marked with asterisks*.

		% non-bird-keepers	% user-groups			% age-groups					% Overall
			Hobbyist	Contestant	Breeder	< 30	31–40	41–50	51–60	Over 60	
Most trusted sources	**Religious leaders**	**37**	34	30	27	**25**	34	38	**41**	42	35
	Local leaders	24	27	25	**35**	21	26	26	27	28	26
	Peers	15	16	22	19	**24**	17	14	**12**	13	16
	Scientists/Experts	11	10	11	9	**17**	11	9	**7**	8	11
	Themselves	6	6	4	4	4	5	7	6	4	6
	Teachers	6	6	8	4	8	6	5	6	3	6
	Politicians	1	1	0	1	1	1	0	1	0	1
Most commonly used media	**Radio/TV**	**43**	42	**36**	37	**38**	40	42	**47**	47	42
	Local meetings	24	25	21	25	**16**	23	26	**29**	**30**	24
	Social media/Internet	24	**20**	**32**	27	**36**	**28**	**21**	**12**	**8**	24
	Newspapers/Magazines/Books	**10**	**13**	12	11	10	**9**	11	11	**15**	11

5.4 DISCUSSION

Through a novel experimental methodology, I was able to determine which two behaviour change messages were considered the most persuasive. Both of the most persuasive messages had negative frames, focusing on the impact of the trade on either Indonesian wildlife or cultural heritage. Although the two most persuasive messages could be ready for use by conservation efforts, the results also highlight how the framing of messages plays an important role in their potential effectiveness (Miller et al., 2018; Kusmanoff et al., 2020). Messages that focused on the positive aspects of keeping captive-bred birds were consistently popular among respondents, while those that focused on the negative aspects of bird-keeping in general were consistently unpopular. These results suggest that messages aimed at changing behaviours should focus on the negative impacts of overexploitation for the trade on Indonesian wildlife or cultural heritage, as well as the positive aspects of sustainable alternatives, but not on the negative aspects of the hobby in general. The lack of variation in perceived persuasiveness across bird-keeping user- and age-groups—particularly in the top and bottom five messages—suggests these aspects of the messages can be used to target bird-keepers as a single homogeneous audience, shifting the targeted behaviour where necessary (Thomas-Walters et al., 2020). Indeed, in line with other research (Moorhouse et al., 2020), the results of this online survey suggest that redirection of demand for wild-caught birds towards captive-bred birds may be a viable option. Simultaneously demarketing wild-caught birds may provide a way to reducing the impact of Hobbyist consumption behaviour (Veríssimo et al., 2020), considering that they were the most likely to admit that they could be persuaded to stop keeping birds.

The overexploitation of wild-caught birds to supply the cage-bird trade is a global conservation issue (Daut, Brightsmith, Mendoza, et al., 2015; Symes, McGrath, et al., 2018; Ribeiro et al., 2019), and my results suggest that many people in Java appreciate the severity of the issue, with more than 90% of respondents admitting that the keeping of wild-caught birds is problematic. In spite of this apparent consensus regarding the trade, in accordance with other research there were still worryingly low levels of awareness on the regulation and legality of the hobby (Miller et al., 2019). In my study, around a third of respondents were unaware that buying wild-caught birds is illegal, or that capturing of birds from the wild is also

prohibited, despite domestic legislation regarding the sale and capture of birds at the national level (Chng et al., 2015). The low levels of awareness surrounding this issue is concerning, as evidence suggests that even at relatively low levels of prevalence, shared perceptions can become ingrained within certain populations (Veríssimo et al., 2020). Despite concerns that respondents would be affected by social desirability bias (Davis, Crudge, et al., 2019), many thought that the majority of the birds in markets were wild-caught and cheaper than captive-bred alternatives. Consequently, in addition to redirecting demand and demarketing wild-caught birds, efforts need to address their availability in the markets (Chng et al., 2015). Furthermore, mirroring face-to-face survey results (Chapter 3) there was a large minority who considered the song of wild-caught birds better and most respondents believed wild-caught birds could be entered into singing contests.

Previous studies have proposed that conservation efforts should involve market-based approaches to the issue, working with the song contest community to promote captive-bred only events (Jepson and Ladle, 2009), but evidently the dialogue needs to be reopened with these communities about the continued use of illegally sourced birds in contests. The price of captive-bred birds may be a barrier to larger uptake among the less specialised bird-keepers who represent the majority (Marshall et al., 2020a), yet many bird-keepers showed an interest in breeding their own birds, particularly among Contestants, which could offer an alternative source if managed to sufficient capacity. Importantly, a large minority of respondents believed that the Indonesian government was responsible for managing the problem of over-exploitation of wild-caught birds. Although the manner in which government should manage the issue was not discussed in the study, this result suggests that bird-keepers would welcome state intervention to make the trade more sustainable. Perhaps removing barriers to ownership of captive-bred birds through subsidising local facilities would be a first step.

As this research was targeted specifically on a particular demographic (male bird-keepers from across Java) there are caveats to the representativeness of the sample obtained. It was therefore necessary to assess how the data collected in this chapter (online via targeted Facebook sampling) compared to the data collected during previous work (face-to-face household surveys; Chapters 2–4) in terms of demographic differences that will affect the ability to generalise from this data. The

approach used in the first part of this thesis sought to obtain a representative sample of the population of Java, whereas the online survey sought to obtain a representative sample of bird-keepers, which may go some way to explain the divergences between the two samples of bird-keepers. As highlighted in previous work (Chapter 3), not all bird-keepers obtain birds online, yet use of social media, including Facebook, is widespread and popular in Indonesia (Sujarwoto et al., 2019). Further, previous work struggled to obtain data on particular demographics (higher-income neighbourhoods), and the data collected here appears to have been more successful at capturing a broader selection of bird-keepers (but a reduced selection of Indonesians in general). Future work should look into carrying out both online and face-to-face surveys in parallel to assess the differences between the two more accurately (Szolnoki and Hoffmann, 2013). In spite of these caveats, the sample collected is still representative of a vast number of bird-keepers who are active online, and the insights obtained could be more useful to demand reduction and behaviour change campaigns online, rather than via more traditional media (Roberge, 2014; Moorhouse et al., 2017; Doughty et al., 2020).

Finally, one of the aims was to inform behaviour change and demand reduction campaigns. The impact of communication delivery on changing attitudes and behaviour has been demonstrated across disciplines (Krantz and Monroe, 2016; Thomas-Walters et al., 2020), thus despite my results showing little variation in the perceived persuasiveness of messages across groups, differences were apparent in the trusted sources and media used by respondents. As such, campaigns should focus on the negative impacts that overexploitation of birds has on both the cultural heritage of bird-keeping and breeding in Java, and the wild bird populations within Indonesia, but they should employ different media for each target audience. Campaigns focusing on demarketing wild-caught birds targeted at Hobbyists should focus on the western provinces of Java (Marshall et al., 2020a), working with religious leaders and engaging communities using the traditional media sources of television, radio and local meetings. For Contestants, campaigns should focus on urban areas and younger audiences (Marshall et al., 2020a), with an aim to increase the purchasing and breeding of captive-bred birds, and should highlight the illegality of wild-caught birds in contests, working with the contest communities and employing social media based communications. For Breeders in the eastern

provinces of Java (Marshall et al., 2020a), campaigns should focus on demarketing wild-caught birds and increasing their breeding output, engaging with local leaders and the traditional media sources. To be effective, these efforts will require sufficient funding (Thomas-Walters et al., 2020) and thorough continued evaluation to ensure success is demonstrable (Burgess et al., 2018; Olmedo et al., 2018). The work of this and previous chapters (Marshall et al., 2020a, 2020b) provides conservationists with the targeted baseline data required to measure the future success of behaviour change efforts (Reddy et al., 2017).

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5.6 APPENDICES

5.6.1 Appendix A – Online Survey Questions

1 Where do you live?

o	Banten	o	Jawa Barat	o	DIY
o	DKI Jakarta	o	Jawa Tengah	o	Jawa Timur

2 Where do you live (cont.)?

o Regency _____

o District _____

3 How old are you?

o	18 - 25	o	36 - 45	o	55+
o	26 - 35	o	46 - 55		

4 What's your occupation?

o	Bird trader / breeder / catcher	o	Farming
o	Selling / Trading	o	Skilled professional
o	Warung worker	o	Unskilled labourer
o	Entrepreneur	o	Unemployed
o	Office worker	o	Landlord
o	Civil servant	o	Housewife
o	Local leader	o	Student
o	Driver / Transport	o	Retired

5 What is your highest level of education?

o	No formal education	o	Baccalaureate / Academy
o	Did not finish E. School	o	Bachelor
o	Elementary School	o	Postgraduate
o	Junior High School	o	Doctorate
o	High School	o	Prefer not to say

6 Do you keep birds? (excluding Domestic Pigeons)

o	Yes	o	No

7 What types of birds do you keep? (Answer as many as apply)

- ▢ Lovebirds or Canaries - Exotic birds
- ▢ White-rumped Shama
- ▢ Oriental Magpie-robin
- ▢ Leafbirds
- ▢ Zebra Doves
- ▢ Prinias or Tailorbirds
- ▢ Sunbirds
- ▢ Bulbuls
- ▢ Laughingthrushes
- ▢ Long-tailed Shrikes
- ▢ White-eyes
- ▢ Other _____

8 How many birds do you have in total?

- o 1
- o 2 - 3
- o 4 - 6
- o 6+

9 How long have you kept birds continuously? (without stopping)

- o Less than a year
- o Between 1 - 2 years
- o Between 2 - 5 years
- o Between 5 - 10 years
- o More than 10 years

10 Select the statements you consider to be true.

- ▢ CB birds can be identified by rings on their legs
- ▢ Buying WC birds is illegal
- ▢ The majority of birds for sale in markets are captive-bred
- ▢ The majority of birds for sale in markets are wild-caught
- ▢ Wild-caught birds cannot be entered into some singing contests

11 What types of birds do you own? Wild-caught, Captive-bred or do not know?

- o Only CB birds
- o CB and WC birds
- o Only WC birds
- o Do not know

12 What percentage of your bird-keeping friends own wild-caught birds?

- o 0% - None
- o 1 - 25% - a quarter
- o 25 - 50% - up to half
- o 50 - 75% - around 3 quarters

o 75 - 100% - most of them

13 How often do you buy birds?

o Once a month or more (1)

o Once every 2 - 3 months (2)

o Once every 4 - 6 months (3)

o Once every 6 - 12 months (4)

14 Which of the following best describes you?

o Hobbyist – keep birds as hobby, do not breed birds or enter contests (often)

o Contestant – keep birds to enter contests, occasionally breed birds

o Breeder – keep birds as a hobby but also to sell and trade

o None of the above

Message Persuasiveness Comparison Section (see Table 5.1)

25 Which of these would you buy for yourself?

o Wild-caught bird

o Captive-bred bird

o Any bird (origin not important)

o None of the above

26 Which of these would you buy as gift for someone?

o Yellow-vented Bulbul o Leafbird

o Lovebird o Canary

27 How likely do you think it is that you will start breeding your own birds?

o Definitely will

o Probably will

o May or may not

o Probably will not

o Definitely will not

28 Why not? (Choose as many as apply)

- ▢ Too expensive
- ▢ Too much effort
- ▢ Do not have the space
- ▢ Other reason _____
- ▢ Not interested

29 How likely do you think it is that you could be persuaded to stop keeping birds?

- o Definitely
- o Probably
- o May or may not
- o Probably not
- o Definitely not

30 Whom do you consider your most trusted source of information?

- o Religious leaders
- o Local leaders
- o Peers
- o Scientists
- o Politicians
- o Other _____
- o Teachers

31 What media do you use for information?

- ▢ Social media
- ▢ Newspapers / Magazines
- ▢ Radio / TV
- ▢ Local meetings
- ▢ Other _____

32 We are interested to hear what you think about the bird-keeping and the sustainability of the trade surrounding bird-keeping. Would you be able to spend another couple of minutes talking to us about this issue?

- o Yes
- o No

33 Do you think keeping wild-caught birds is problematic?

- o Yes
- o Maybe
- o No
- o Do not know

34 Why not?_____

35 Who do you think is responsible for this issue?

- o The government
- o Bird-keepers
- o Villages where people trap birds
- o Traders
- o Other (please specify) _____

36 What do you think is the solution to this issue?_____

5.6.2 Appendix B - Demographic characteristics

Table 5.B.1. Demographic characteristics of study sample

	Province	Banten	DKI	West Java	Central Java	DIY	East Java	Outside Java	Overall n	Overall %
Overall responses	n	62	76	239	244	108	228	23	980	-
	% total sample	6	8	24	25	11	23	2		
Regencies sampled	n	8	5	27	35	5	36	21	137	-
	% sampled	100	83	100	100	100	95	5		
Bird-keeping group (%)	No Bird	10	9	9	7	9	8	22	191	11
	Hobbyist	32	33	30	31	29	28	43	387	23
	Contestant	23	25	30	30	34	27	22	366	22
	Breeder	31	26	30	31	25	33	13	356	21
Age group (%)	18 - 25	2	9	15	21	17	17	22	159	16
	26 - 35	53	39	34	39	44	38	57	384	39
	36 - 45	19	36	33	29	28	31	9	291	30
	46 - 55	18	14	13	9	8	11	9	110	11
	55+	8	1	3	2	4	3	4	32	3
Educational level (%)	Higher	47	41	43	43	43	49	43	422	45
	High School	52	51	44	45	52	45	43	440	47
	Lower	2	8	13	12	5	5	14	84	9
Occupational group (%)	Bird trade	2	4	4	6	8	6	0	52	5
	Business	18	32	28	29	26	32	22	273	28
	Clerical	25	15	23	21	19	25	39	214	22
	Labour	39	32	34	30	33	25	26	295	31
	No formal employer	15	13	8	12	11	10	9	103	11
	Other	2	4	2	3	3	1	4	22	2

Table 5.B.2. Demographic characteristics of bird-keepers in the study sample, compared with those from the 2018 random household survey. Differences between percentages (or n) of respondent characteristics between 2018 and 2020 are presented in brackets (e.g. in the current study there are 20% less Hobbyists than in the 2018 sample).

		Banten		DKI		West Java		Central Java		DIY		East Java		Overall n		Overall %	
User-group (%)	Hobbyist	38	(-18)	39	(-22)	34	(-33)	33	(-23)	33	(-21)	32	(-16)	387	(-66)	35	(-20)
	Contestant	26	(-13)	30	(-3)	33	(+5)	32	(+11)	38	(+19)	30	(-4)	366	(+145)	33	(+6)
	Breeder	36	(+31)	31	(+25)	33	(+27)	34	(+11)	29	(+2)	38	(+20)	356	(+210)	32	(+14)
Age group (%)	18 - 25	0	(-4)	10	(+1)	14	(+5)	21	(+13)	18	(+10)	17	(+11)	141	(+78)	16	(+8)
	26 - 35	57	(+22)	42	(+16)	34	(+16)	41	(+18)	46	(+26)	37	(+20)	361	(+186)	40	(+19)
	36 - 45	20	(-13)	35	(+6)	36	(-1)	29	(0)	26	(+7)	32	(+7)	271	(+52)	30	(+3)
	46 - 55	16	(-5)	13	(-1)	13	(-8)	8	(-15)	7	(-24)	11	(-14)	95	(-104)	11	(-13)
	55+	7	(0)	0	(-21)	4	(-12)	1	(-15)	3	(-19)	3	(-24)	24	(-140)	3	(-17)
Educational level (%)	Higher	43	(-24)	40	(-25)	44	(+3)	43	(-5)	39	(-8)	51	(-2)	385	(-34)	45	(-7)
	High School	56	(+43)	51	(+34)	43	(+34)	45	(+31)	56	(+37)	43	(+32)	402	(+286)	47	(+32)
	Lower	2	(-19)	9	(-9)	13	(-37)	12	(-26)	5	(-30)	6	(-30)	78	(-207)	9	(-26)
Occupational group (%)	Business	20	(-19)	36	(+12)	34	(+2)	37	(7)	35	(+11)	41	(+7)	304	(+60)	35	(+5)
	Clerical	26	(+9)	15	(-12)	25	(+17)	21	(1)	19	(-1)	25	(+5)	198	(+39)	23	(+4)
	Labour	43	(+4)	35	(+9)	33	(-19)	31	(-14)	36	(-11)	25	(-9)	272	(-65)	32	(-9)
	No formal employer	11	(+6)	14	(-9)	8	(0)	11	(+6)	11	(+2)	9	(-3)	86	(+6)	10	(0)

5.6.3 Appendix C - User-group bird-keeping profiles

The most prevalent birds owned were exotic (primarily lovebirds, canaries and cockatiels), Hobbyists were the most likely to own bulbuls, Contestants the most likely to own shamas, and Breeders Exotic birds (Table 5.C.1). Only around one third of bird-keepers owned three birds or fewer, with Hobbyists most likely to own the fewest birds, and Breeders most likely to own over ten birds (Table 5.C.2). Over half of bird-keepers bought birds once or twice a year, Hobbyists being the most likely to buy birds less often, and Breeders the most likely to buy birds very regularly (Table 5.C.2). More than half of bird-keepers owned at least one wild-caught bird, with Hobbyists the least likely to own solely captive-bred birds, and the most likely to not know the origin of their birds (Table 5.C.2). Similarly, over half of all respondents reported that less than half of their bird-keeping friends and acquaintances kept wild-caught birds, with Contestants the most likely to report that more than half kept wild-caught birds, and non-bird-keepers the most likely to report less than half.

Table 5.C.1 Top 20 owned species across user-groups and overall

Rank	Taxa	% User-groups				Overall
		Hobbyist	Contestant	Breeder	Unknown*	%
1	Exotic Birds	60.5	70	73.5	61	66.3
2	White rumped Shama	29.1	54.1	40.5	41.9	41.1
3	Leafbird sp	20	31.7	19.9	23.5	23.7
4	Oriental Magpie robin	24.2	27.7	21.1	20.3	23.4
5	Small native birds	22.1	23.2	26.8	15.5	22.1
6	White eye sp	16.4	11.5	17.1	11.6	14.3
7	Zebra Dove	15.8	7.8	15.7	11.3	12.8
8	Bulbuls (*Pyconotus* & *Alophoixus* spp)	17.9	7.8	12.3	10.3	12.3
9	Sunbird sp	6.8	9.2	7.1	4.2	6.9
10	Long tailed Shrike	5.2	5.9	4	4.2	4.8
11	Laughingthrush sp	4.2	1.4	2	3.5	2.8
12	Java Pied Starling	3.6	1.4	2.8	1.3	2.4
13	Orange headed Thrush	2.6	2	2.3	1.3	2.1
14	Horsfield's Bushlark	1.6	1.7	2.6	1	1.7
15	Flycatcher sp	2.3	1.4	2	1	1.7
16	Yellow vented Bulbul	2.6	0.3	1.7	1.6	1.6
17	Chestnut capped Thrush	1	1.7	2.3	1	1.5
18	Medium sized native birds	2.1	0.6	0.9	0.6	1.1
19	Collared Dove	1.3	0.3	0.9	0.3	0.7
20	Spotted Dove	0.5	0	1.1	0.6	0.6
21	Black winged Myna	1	0	0.9	0	0.5
22	Straw headed Bulbul	0.5	0	1.1	0	0.4
23	Raptors	0.5	0	0.6	0.3	0.4
24	Pied Bushchat	0.8	0.3	0	0.3	0.4

Table 5.C.2. Bird-keeping characteristics of various user-groups

		User-group				No Bird	Overall	
		Hobbyist	Contestant	Breeder	Unknown*		n	%
Number of birds owned (%)	One to three	54	26	16	45	-	496	35
	Four to six	24	26	20	23	-	325	23
	Seven to nine	14	15	13	10	-	184	13
	Over ten	9	32	51	23	-	398	28
Frequency of buying birds (%)	X Twelve+ a year	13	16	21	16	-	191	17
	X Two to six a year	28	38	29	16	-	361	31
	Once or twice a year	58	46	50	69	-	601	52
Origin of birds owned (%)	Only CB birds	34	44	48	46	-	506	42
	At least one WC bird	58	54	50	40	-	638	53
	Do not know	8	2	2	14	-	58	5
Amount of bird-keeping that friends own WC birds (%)	Less than half	52	49	52	62	65	656	52
	Half	24	22	22	18	15	270	22
	More than half	25	29	26	20	20	325	26

6 GENERAL CONCLUSIONS AND FUTURE DIRECTIONS

6.1 INTRODUCTION

The overall aim of this PhD thesis was to quantify, characterise, and explore demand for songbirds in Java to inform a portfolio of potential interventions that could reduce the impact the cage-bird trade has on wild populations of songbirds in Indonesia and beyond. The first objective was to assess the spatial and temporal patterns of songbird ownership across Java. The second objective was to profile the behaviour, preferences and motivations of songbird-keeping consumers, and explore potential for change. The third objective was to explore people's perceptions and attitudes towards bird-keeping and wild birds, and profile the reasons for stopping, starting and never owning birds. The final objective was to develop a methodology to determine effective behaviour change message content.

This chapter summarises the key results from the thesis, and evaluates how the findings can inform potential behaviour change interventions. This chapter also highlights how future research could build on this body of work, and identifies priorities for future studies. Finally, I provide suggestions for behaviour change interventions and pathways to reducing the impact keeping songbirds as pets has on wild populations.

6.2 SUMMARY OF KEY CHAPTER RESULTS

Chapter 2: *Spatio-temporal dynamics of consumer demand driving the Asian Songbird Crisis*

By examining differences in the prevalence of bird-keeping in urban and rural communities, I was able to determine what broad-scale demographic factors influenced demand for cage-birds, and assess the scale and scope of demand across Java. Ownership levels were significantly higher in urban than rural areas, and were particularly high in the eastern provinces of the island. Further, I estimated that one-third of Java's households keep a huge number of cage-birds, and, through comparisons with data from household surveys undertaken over a decade ago, I found that overall levels of bird ownership have increased. The majority of birds currently kept are non-native species, predominantly lovebirds (*Agapornis* spp.), which have also shown a seven-fold increase in popularity since previous work.

Given that much of Java's remaining suitable habitat for songbirds is no longer viable for a range of reasons, this suggests that the number of birds held in cages might approach or exceed the number of birds left in the wild on the island. Ownership of native taxa is still high, and some genera, including groups with globally threatened species, saw sharp increases in ownership over the last decade. The huge increase in the numbers of non-native birds relative to a still remarkable increase in native birds suggests that trade in captive-bred non-native species may simply be supplementing rather than supplanting demand for native songbirds. A clear next step was to go deeper than broad-scale understandings, and begin profiling consumer behaviour, preferences, and the socio-economic circumstance of bird-keepers, to obtain a finer scale data set on songbird demand.

Chapter 3: *Characterising bird-keeping user-groups on Java reveals distinct behaviours, profiles and potential for change*

By profiling three songbird-keeping user-groups (Hobbyists, Contestants and Breeders), I uncovered that user-groups diverged in their bird-keeping habits and preferences. User-group membership also appeared fluid over a two-year period, 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 by bird-keepers. My findings are useful at informing behavioural change efforts with demographic and geographic profiles to target bird-keepers, who tended to live in the eastern provinces and be more affluent and urban than non-bird-keepers. The findings of this chapter suggest that bird-keeping behaviour and preferences may influence the impact that different bird-keepers have on wild bird populations, and that measures to reduce these impacts should treat each group differently. It was then logical to move towards understanding how these groups differed in their attitudes to the environment and their hobby, to understand pathways to communicating and delivering behavioural change.

Chapter 4: *Exploring pathways to reduce demand among bird-keepers for songbirds in Java*

Through exploring the self-reported reasons people keep birds, I found that most people started keeping birds to enjoy their beauty or song, or to keep up with peers, whereas few people cited health, sanitary or welfare concerns as reasons for not

keeping birds. Examining differences across user-groups revealed that Hobbyists were most likely to start keeping birds after receiving birds opportunistically, whereas Contestants and Breeders were more likely to be seeking financial returns. By exploring public attitudes and perceptions around bird-keeping in Java, I found that respondents across groups held similar views, but opinions on the environmental importance of birds, how long birds typically live in captivity, and whether keeping birds as pets endangers them in the wild, differed between bird-keepers and non-bird-keepers. Overall, there were low proportions of all groups admitting an intention to obtain wild-caught birds in the future. Nevertheless, given the ubiquity of bird-ownership across Java, this number probably represents a concerningly large number of households involved in the procurement of wild-caught birds. My findings suggest the importance of peer pressure and social norms among bird-keepers could provide both an opportunity and a barrier to addressing the threat bird-keeping has on wild bird populations. Based on these understandings, the next step was to create, explore and identify messages that would be able to either reduce demand and change consumption behaviours.

Chapter 5: *Identifying messages to facilitate behaviour change in overconsuming songbird-keeping communities on Java*

Using online surveys with a targeted sample of bird-keepers, I uncovered that bird-keepers perceived keeping wild-caught birds as problematic. Subsequently, a majority of respondents claimed they would attempt to breed birds in the future, with Hobbyists the least likely to do so, but the most likely to admit they could be persuaded to stop keeping birds. Further, by utilising a novel methodology to explore what campaign messages may be the most persuasive, I uncovered that messages focussed on the negative impacts of over-exploitation on Indonesia's wildlife or cultural heritage of bird-keeping were the most persuasive. Additionally, messages framed to emphasise the positive aspects of sustainable alternatives were considered more persuasive than those that highlighted the negative aspects of the hobby in general (e.g. welfare issues, health concerns, old-fashioned hobby). Furthermore, my results highlight issues that could become the focus for specific awareness-raising campaigns. My results also revealed another potential barrier to more sustainable bird-keeping: that captive-bred birds are more expensive than wild-caught birds, which may be inhibiting increased uptake. Efforts to increase the

sustainability of the trade could maximise results by collaborating with local and religious leaders, and demand reduction campaigns should use divergent communication delivery to target the wide-variety of bird-keeping demographics.

6.3 LIMITATIONS AND OPPORTUNITIES FOR FUTURE RESEARCH

Whilst this thesis has uncovered important insights on demand for songbirds as pets in Java, and how using this information can inform conservation management approaches, there are some limitations to this research that could be improved upon in future studies.

Data for chapters two to four were collected during two field seasons across 2018, through face-to-face household surveys. The data were collected by the author and a team of Indonesian volunteers and students using questionnaire surveys carried out in Bahasa Indonesia, the national language of Indonesia. In spite of our best efforts, some responses were difficult to verify due to a reliance on self-reported responses, which introduces some doubt on the reliability of the data (Thomas et al., 2014; Nilsson et al., 2019). For example, when asking bird-keepers about the source of their birds (wild-caught or captive-bred), there is currently no definitive method to verify this information. Additionally, many respondents did not know the sources of their bird, stating they bought their birds in the market. Whether respondents were being deceptive and/or affected by social desirability bias (Nuno and St. John, 2014; Davis et al., 2019) was also possible, although the abundance of seemingly wild-caught birds in markets (Chapter 5), and the fact that owning wild-caught birds is not illegal (Chng et al., 2015), may nullify these issues. Two other similar limitations were also acknowledged: 1) there was some variability in the local names used for birds across Java; and 2) we did not verify whether the local names given for previously owned birds (Chapter 3) were accurate. These limitations could have resulted in some of the calculations for certain species being inaccurate. To rectify this uncertainty in future research, interviewers could bring photo cards or utilise a mobile phone application with images for each species and commonly used market names, as has been done in other strands of research where species identification can be affected by a local diversity of names (Bezerra et al., 2019). Recording of such information (variability of local names) would prove particularly

useful for future research and conservation efforts. If the results and approach of this thesis are to be carried out in the future to perform longitudinal research, efforts should be made to improve the reliability of the responses.

The approach used in Chapter 2 to extrapolate the numbers of birds kept in households was robust, yet through the use of sophisticated statistical methods, the estimation approach could be improved (Chao et al., 2014). However, the estimations given, and the associated confidence intervals are still worthwhile and give insight into the scale and scope of bird-keeping in Java. Additionally, the representativeness of the sample collected was examined in Chapter 3, and despite some caveats appeared to have been successful at capturing a broad sample of households. If future research is to use the results of this thesis as a baseline to measure the impact and effectiveness of interventions (Reddy et al., 2017; Sung and Fong, 2018), efforts should be made to provide detailed information regarding the generation of estimations, sampling approach, and any reproducibility issues. One limitation apparent in both my data collection, and seemingly that of Jepson (2009), is that collecting data on higher status households (Jepson and Ladle, 2009), who may be able to afford species prized for their rarity or cost, such as Javan Green Magpie (*Cissa thalassina*) or Bali Myna (*Leucopsar rothschildi*; Jepson, 2016). For example, the sampling methodology I used was far better at collecting data in middle- or lower-income neighbourhoods, as higher-income neighbourhoods in Indonesia are often gated and/or privately secured. Further, gated and private communities are not under the same administrative boundaries and jurisdiction as other neighbourhoods, and as such would require further bureaucracy to gain access. Due to the limited timeframe associated with PhD data collection, it was not possible to include such areas on a large scale. Future studies could account for this earlier in the planning process or seek alternative data collection strategies for such hard to reach communities (Faugier and Sargeant, 1997; Baltar and Brunet, 2012).

The fourth chapter of this thesis looked at the perceptions and attitudes of bird-keepers towards wild-caught birds and the impact their hobby has on wild populations. Following on from previous research (Paul et al., 2016; Amit and Jacobson, 2017; Miller, 2017; St. John et al., 2018) that supports the use of behavioural psychology approaches to explore the drivers of intention to carry out

behaviours, I used the Theory of Planned Behaviour (TPB Ajzen, 1991) to inform the creation of a set of questions surrounding obtaining f wild-caught birds. Although my results are informative and have provided insight into the psychographic factors behind such intention, a more rigorous approach to question design could have proved more reliable. Often in research employing TPB, researchers use multiple questions to measure each factor (e.g. social norms; Kaiser, 2006; Abrahamse et al., 2009; St. John et al., 2018), yet in my study I chose to only use one question for each factor to reduce survey time and increase the number of responses. Future studies that choose to use TPB should use multiple questions to measure each psychographic factor, as this will improve the reliability of the measures (Hogberg et al., 2015).

The final analysis chapter (Chapter 5) was originally intended to be carried out both face-to-face and online, to allow an assessment of the reliability of each method at collecting data on this topic. The global public health crisis caused by Covid-19 meant that face-to-face data collection had to be cancelled and I had to return to the UK. Unfortunately, this meant that an assessment on the reliability of the two methodological approaches was not possible. Future studies should seek to incorporate both online and face-to-face elements to allow an examination of their reliability, both in terms of response rates and sampling bias. I only used one website to facilitate online data collection (Facebook), yet there is evidence that other websites (e.g. Google) may also prove to be useful at providing data collection for studies interested in the consumption of wildlife or their products (Doughty et al., 2020). Future studies could incorporate a number of different online sampling approaches to assess which proves the most robust for songbird-keeping communities (Doughty et al., 2020).

6.3.1 Priorities for future research

This thesis sought to further knowledge on the various facets of demand for songbirds as pets within Java, and achieved the objective of identifying the scale and scope of such demand. Much effort is made to survey markets to assess demand (Nijman et al., 2013; Su et al., 2014; Chng et al., 2015; Daut et al., 2015), and this thesis supplements and enriches such research by adding detail about consumption (which birds end up in households) of bird-owning households. A synthesis of both data streams to explore whether there is accordance among

households and markets would be extremely useful for those seeking to monitor the flow of trade. In addition to these data sets, there is already work exploring the utility of seizure data to map networks of the trade in birds (Indraswari et al., 2020), and others exploring the online trade (Iqbal, 2015). Future research could attempt to link up these data sets to allow analyses of how inter-related physical, online and peer-to-peer markets are, and most importantly enable, the measurement of intervention impact on both temporal and spatial scales. For example, a case study could focus in on one region, province, or city for a set period of time, monitor what birds are available in markets, (both physical and online), assess what birds are in households (through targeted face-to-face and online surveys), and work in unison with governmental bodies and local NGOs to carry out random inspections in ports (land, air and sea) identified to be at high risk of bird smuggling (Indraswari et al., 2020). Such an approach would enable an assessment of the flow of birds through ports, markets and households, and through targeted interventions based in Random Control Trial (RCT) methodology (Stead et al., 2007; Yom-Tov et al., 2018), measure which interventions work best at a local scale. Approaches based on applying mark-recapture and other prevalence estimating methods (Lebreton et al., 1992; Bernard et al., 2010; Thomas et al., 2010) on a combined data set from these various aspects of the trade could provide rigorous and robust measures of the throughflow of birds.

Similarly, the importance of bird-keeping user-group membership in influencing differential impact on wild bird populations implies further research on the dynamics of these groups will enable even more specific interventions that target key areas and audiences. The suitability of machine learning approaches at categorising and classifying consumers based on birds kept was demonstrated in this thesis (Chapter 3), but with more reliable data on behaviours and preferences, such approaches could be vastly more powerful (Al-Jarrah et al., 2015; Obermeyer and Emanuel, 2016). Similar to many Asian countries, social media use is particularly prevalent in Indonesia (Nijman and Nekaris, 2017; Sujarwoto et al., 2019), and the singing contest community is highly active online (Karokaro, 2020), which is supported by the results in this thesis (Chapters 4 & 5). Much advertising and promotion of singing contests are facilitated by social media, representing an opportunity for novel approaches combining web-scraping–the automated collection

of data from websites (Batrinca and Treleaven, 2015)–and machine learning to assess the prevalence of singing contests across spatial and temporal scales. Further, such an approach could assess the popularity of species for contests, in terms of the number of contests in which they are present, and whether there is any geographic variation in species present. With such data it would be possible to measure whether interventions targeting contests in certain regions were successful and their consequences, for example whether the prohibition of wild-caught birds in certain administrative areas shifts the species composition or simply substitutes the same species but sourced alternatively.

Another major area of research that requires investigation is the sustainability of the captive-bred supply of birds in Java. This thesis explored the prevalence of species in households (Chapter 2), the preferences of bird-keepers regarding the source of birds owned (Chapter 3), and how much they knew or were concerned about the illegality of the cage-bird trade (Chapters 4 & 5). Yet, the suitability of particular species to more sustainable sourcing was not explored. Within the songbird conservation community, much attention has focussed on the speed at which species with particular qualities or attributes are substituted like-for-like when supply cannot meet demand (Eaton et al., 2015; Bergin et al., 2018), but little focus has yet been given to the suitability of species for captive-breeding. There is evidence that the unreliability of reported sources enables the laundering of birds and animals (Nijman and Shepherd, 2015b, 2015a; Janssen and Chng, 2018), and my findings that captive-bred birds are typically more expensive than wild-caught ones would support this, as there is an apparent financial incentive for traders to deceive consumers (Tensen, 2016). Without investigations into the financial reality of captive-breeding and the suitability of species to such endeavours, those seeking to promote the 'sustainable' substitution of captive-bred birds will be basing much on faith. Future research could work with breeders and traders to explore the economic aspects to breeding and trading captive-bred birds, and explore what aspects determine species' suitability for captive-breeding. Further, an important avenue yet to be explored is how the longevity of birds in households affects the impact of the trade on wild songbird populations. Collection of data on the longevity of birds in households, how often these birds are replaced, and the manner in which they do so, would enable analyses similar to those used to assess long term

population viability (Boyce, 1992; Beissinger and Westphal, 1998). This could incorporate data from market, household and online surveys to assess the likelihood of trade driving extinctions of species. Such analyses would also be invaluable to informing conservation management strategies to maximise the breeding capacity of Indonesia in line with those species most at risk from trade. Indeed, as much focus has already been placed on markets, households and the online trade, conservation researchers and practitioners should now aim to engage with the supply side of the trade, to create lasting and effective solutions (Challender et al., 2015b, 2015a).

6.4 APPLICATIONS TO CONSERVATION AND FUTURE DIRECTIONS

Beyond research interest, this thesis provides a deep understanding of demand for songbirds and the actors involved, which can inform behaviour change and demand reduction efforts in multiple ways. Firstly, I have identified areas where bird-keeping is most prevalent in Java, and where demand has increased over a decade, providing geographic focal points for interventions. Secondly, going beyond geographic targets, this thesis provides opportunities to home in on particular demographic groups whose consumption behaviours have the greatest impact on wild bird populations, by identifying those who are most likely to be a member of a particular user-group. Thirdly, through gaining an understanding of why bird-keepers started their hobby, what they think of it, and what drives their intention to own wild-caught birds, this thesis identified potential points of agreement or disagreement to focus discussions and engagement with both bird-keepers and non-bird-keepers alike. Finally, this thesis combined these findings to create and find messages and framing considered to be persuasive, which can form the basis of future demand reduction and behaviour change campaigns. Thus, these findings provide comprehensive profiles to target groups of consumers (and to a lesser extent non-consumers) and their behaviours, which represents a toolkit for those seeking to improve the sustainability of the hobby. The output from this thesis will not solve the Asian Songbird Crisis, but substantially contributes to current efforts by providing a much-needed further data set on demand for songbirds, which was previously lacking. Future efforts will need measures of efficacy and effectiveness,

and this thesis provides a baseline data set with which to measure such interventions.

Next steps would be to fund intervention delivery, and to collaborate with both Indonesian based NGOs seeking to reduce impact and governmental counterparts tasked with regulating trade and monitoring wildlife. Through collaboration with organisations on the ground in Indonesia and beyond to other countries where demand for songbirds or wildlife as pets is high, we could achieve positive conservation outcomes. Previous efforts to improve the sustainability of the trade in songbirds may have failed to measure their impact, but it is imperative this does not happen again. Through combining the expertise and knowledge of conservationists (e.g. the IUCN Asian Songbird Specialist group), and including the participation of Indonesian conservation groups (e.g. BirdPacker; https://www.birdpacker.com/), campaigns could use the toolkit presented in this thesis and apply it to specific regions or locations to test its efficacy at reducing demand and changing consumption behaviours. The most pressing focus of such campaigns could be the consumption behaviour of Hobbyists bird-keepers, who do not appear as engaged in the online community to the same extent as the specialist user-groups. The campaign could focus on both raising awareness of the impact of the trade, but also redirecting demand towards more sustainable captive-bred alternatives, both of which are demonstratively persuasive as evidenced in Chapter 5. These campaigns would need to engage traditional media (local radio, TV, posters etc.) and perhaps focus on targeting high-risk areas of Java identified in Chapter 2. Prior to, and after such campaigns, surveys (both online and face-to-face) sampling the scale of demand for a region should be carried out to allow effective impact assessment of the interventions. The potential interventions that could be developed from the results and findings of this thesis are numerous, and the next steps will be to continue collaborating with the organisations and individuals who made this work possible, to create a number of campaigns that have demonstrable success at reducing the impact of the songbird trade on wild bird populations.

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Spatio-temporal dynamics of consumer demand driving the Asian Songbird Crisis

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ABSTRACT

Many South-East Asian bird species are in rapid decline due to offtake for the cage-bird trade, a phenomenon driven largely by consumption in Indonesia and labelled the 'Asian Songbird Crisis'. Interventions aimed at reducing this offtake require an understanding of the spatial and temporal dynamics of the trade. We surveyed the bird-keeping habits of over 3000 households from 92 urban and rural communities across six provinces on Java, Indonesia, and compared prevalence and patterns of bird-keeping with those from surveys undertaken a decade ago. We estimate that one-third of Java's 36 million households keep 66–84 million cage-birds. Despite over half of all birds owned being non-native species, predominantly lovebirds (*Agapornis* spp.), the majority of bird-keepers (76%) owned native species. Ownership levels were significantly higher in urban than rural areas, and were particularly high in the eastern provinces of the island. Overall levels of bird ownership have increased over the past decade, and species composition has changed. Notably, lovebirds showed a seven-fold increase in popularity while ownership of genera including groups with globally threatened species such as leafbirds (*Chloropsis* spp.) and white-eyes (*Zosterops* spp.) also rose sharply. The volume of some locally threatened birds estimated to be in ownership (e.g., > 3 million White-rumped Shama *Kittacincla malabarica*) cannot have been supplied from Java's forests and research on supply from other islands and Java's growing commercial breeding industry is a priority. Determining temporal and spatial patterns of ownership is a crucial first step towards finding solutions to this persistent, pervasive and adaptive threat to the regional avifauna.

1. Introduction

Trade in wildlife is a multi-billion-dollar international industry increasingly driven by demand in certain countries for wildlife products from an emerging middle class (Drury, 2009; Davis et al., 2016; Veríssimo and Wan, 2018). Birds are a major component of this trade, identified as a threat to over 3000 wild species, approaching a third of the global avifauna (Butchart, 2008). Impacts of this trade are especially acute in South-East Asia, where > 1000 species of wild birds are traded for various reasons, a level of extraction that has precipitated an 'Asian Songbird Crisis' (Nijman, 2010; Su et al., 2014; Lee et al., 2016; Harris et al., 2017). Indonesia in particular represents a major regional market for cage-birds (Nash, 1993; Nijman, 2010; Chng et al., 2015), with trade significantly affecting at least 26 globally threatened bird species in Indonesia (BirdLife International, 2019).

Indonesia's most densely populated island, Java, with a population of over 140 million people, is considered the biggest source of demand for cage-birds within the region (Jepson and Ladle, 2005; Eaton et al., 2015). Keeping and breeding songbirds is a common pastime in Indonesia, with deep cultural roots (Jepson and Ladle, 2005). The potential of the trade to affect wild populations is significant: decade-old estimates indicated that across six cities in Java and Bali alone over two million native songbirds were kept as pets, almost a million of which were likely wild-caught (Jepson and Ladle, 2005, 2009). Moreover, in the last three decades keeping birds to enter them in singing contests has become increasingly popular in Indonesia (Jepson, 2008). Market

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surveys across Java have found over one hundred native Indonesian species for sale (Profauna, 2009; Chng et al., 2015) and revealed that the supply is now being met from Sumatra, Borneo and Peninsular Malaysia (Harris et al., 2017; Rentschlar et al., 2018). Expansion of the already strong bird-breeding industry in Java has previously been recommended to reduce pressure on wild bird populations (Jepson, 2010; Jepson et al., 2011), yet in recent years the breeding industry has lobbied for the removal of nationally protected status from widespread household species such as White-rumped Shama (*Kittacincla malabarica*) (ASEAN Post, 2018), highlighting the complexities faced in attempting to address the unsustainable offtake of wild birds. Accordingly, despite efforts from one national singing contest accreditation authority to reduce the number of wild-caught birds in their contests (Jepson et al., 2011), wild populations continue to suffer declines due largely to trapping pressure (Harris et al., 2017; Marthy and Farine, 2018; BirdLife International, 2019).

Here we seek to examine the extent and species composition of the cage-bird trade and identify patterns of consumption in all six provinces of Java to assess the scale of the threat trade poses to the regional avifauna. Demand for cage-birds is high across urban areas in Indonesia (Jepson and Ladle, 2009), but there has been little research into bird-keeping in rural communities, which are home to around 50% of the human population (Badan Pusat Statistik, 2010). We therefore investigate differences in the prevalence of bird-keeping in urban and rural communities across Java to determine what broad-scale demographic factors might influence demand for cage-birds. We extrapolate the numbers of households keeping cage-birds and the numbers of birds owned to assess the volume, composition, and patterns in ownership of species kept across the six provinces of Java. Finally, we reveal temporal trends in the extent and composition of the trade by comparing our results with those of surveys conducted a decade ago. The results of this study will both highlight the scale of the threat bird-keeping in Java poses to the regional avifauna and form an evidence base to inform and support future interventions aimed at demand reduction as a mechanism to increase the sustainability of songbird-keeping across South-East Asia.

2. Methods

2.1. Study design

We define a cage-bird as a bird kept or sold as a pet in either households or markets (Su et al., 2014; Chng et al., 2015). This definition encompasses passerine songbirds and other birds that can be entered in singing contests such as lovebirds (*Agapornis* spp.), various doves (Columbiformes) although not feral pigeons (Jepson and Ladle, 2005), owls (Strigiformes) (Nijman and Nekaris, 2017), woodpeckers (Piciformes), and cuckoos (Cuculiformes) (Chng et al., 2015). Taxonomy follows del Hoyo and Collar (2014) and del Hoyo and Collar (2016).

We conducted structured household surveys across six provinces on the island of Java, Indonesia (Banten, Daerah Khusus Ibukota [DKI] Jakarta, West Java, Central Java, Daerah Istimewa Yogyakarta [DIY] and East Java; Fig. 1). Study locations were chosen using a stratified sampling technique to ensure a representative sample for each province (Newing, 2010). The nested administrative levels of Indonesia are as follows: 1. Province, 2. Regency, 3. District, 4. Community (either a rural village or an urban community), 5. Neighbourhood. The national Indonesian statistics authority (Badan Pusat Statistik, BPS) uses a composite score across a number of factors to define urban and rural areas based on population density, number of households working in agriculture, and the availability of key infrastructure (Badan Pusat Statistik, 2010); we used the 2010 census data on the number and proportion of people living in BPS-defined rural and urban districts (i.e. administrative level 3). Districts were then ranked by the size of their rural populations to create quartiles for each province along a rurality gradient. Owing to the unavailability of recent data, the population density of urban districts we use (based on 2010 census data) is likely conservative as the values may now be higher due to migration from neighbouring rural communities (UNESCO, 2017), although the broad-scale differences between rural and urban districts will remain relatively constant.

Within each province, two districts were selected randomly from each quartile; within each district two communities were again selected randomly (see Fig. A.1.). In each community, a target number of surveys to be completed proportional to the population size was established (20–40 surveys per community). Communities were divided between teams (2–4 interviewers) by neighbourhoods, which were selected randomly. Research was conducted over two four-month periods between January and October 2018. Over each period research teams, comprising 6–10 trained Indonesian students and the principal investigator (HM), systematically searched assigned neighbourhoods for potential respondents in the first ten homes encountered. Once a neighbourhood had been fully searched or when at least five surveys were completed, another random number was used to find the next neighbourhood within the community until the target number of surveys was met.

Following the Indonesian statistical authority, a 'household' was defined as generally a family unit constituting an adult, spouse, and any children below the age of 18 (further examples in BPS, 2010). We aimed to complete surveys with the head of the household (male or female) if present, or else the most senior family member available. The survey was developed in the final quarter of 2017 and finalized after piloting in early 2018. The questions (see Appendix B) asked by the interviewers fell into three categories: (1) to collect data for household socio-economic and demographic profiles; (2) to determine whether respondents owned birds and, if so, which species, how many of each, and whether they were captive-bred or wild-caught; and (3) to establish their motivations for bird-keeping. Motivations explored in this paper are (a) to enter birds into singing contests and (b) to breed birds on a relatively small scale commercially or as a hobby. Owned birds were shown, or at least visible, to interviewers on > 80% of occasions, and were identified to species level. When birds were not seen, identification was made to genus level based on respondents' use of market names for their birds. Although the majority of songbird species are not protected by Indonesian legislation, the capture, transportation and sale of wildlife across provinces without permits are considered illegal offences, while the keeping of wildlife is not (Chng et al., 2018). Consequently, our questions do not directly relate to perceived illegal behaviour, and we therefore assumed respondents were answering questions about the origins of their birds truthfully, as in other research on songbird keeping in Indonesia (Jepson and Ladle, 2009; Burivalova et al., 2017)

2.2. Ethics statement

Research ethical approval was obtained 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 obtained for Indonesia from the Indonesian research authority (RISTEKDIKTI) with the named research partner institution being Universitas Atma Jaya Yogyakarta. Prior to data collection, teams gained permission from the head of the neighbourhood, and agreed on stipulations laid out by the local higher administrative level (i.e. community, district or regency). Interviewers obtained prior informed consent from household members. Interview rejection rates were high (around 40%), more so in urban than rural areas and for the team's non-Javanese interviewers. Commonest reasons for rejection were lack of time or suspicion of a burglary plot. The time and date of the survey were recorded before data were collected, along with the name of interviewer; all data were subsequently anonymized.

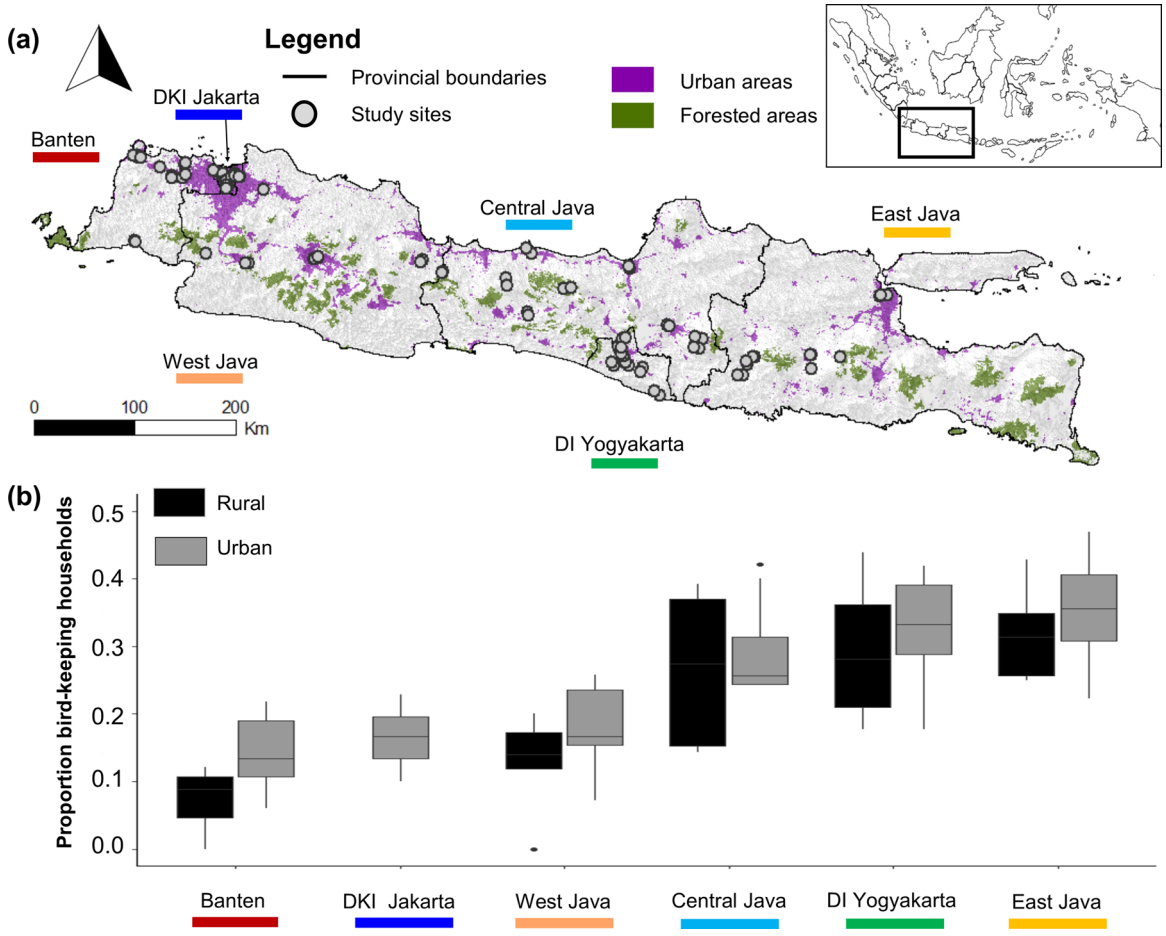

Fig. 1. Panel a: Study sites (communities) across the six provinces where households were surveyed between January and October 2018; highlighted in purple are densely populated areas and in green are areas of native forest. Panel b: Mean prevalence of households owning at least one native bird species for rural and urban communities across the six provinces of Java. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

2.3. Data analysis

To investigate the role of rurality in determining the prevalence of bird-keeping across Java, the top two quartiles for rurality were grouped together, as were the bottom two, to create a binary category of rural and urban communities. Mean proportions (± SE) of surveyed households keeping native and non-native birds were calculated for each urban and rural community within each province. The provinces of Java are commonly divided into two halves based on socio-economic differences between populations: the western provinces of Banten, DKI and West Java have a more ethnically mixed population with a relatively small Sundanese majority, while the eastern provinces of DIY, Central and East Java are overwhelmingly ethnically Javanese (Table A.1.; Na'im and Syaputra, 2010). To examine the broad-scale correlates of bird-keeping households, we fitted two Poisson generalized linear models (GLMs), using R statistical software (R Core Team, 2018), with the proportion of households keeping 1. native, and, 2. non-native birds, within communities as the continuous dependent variables in separate models. The predictor variables included in both models were binomial factors: whether the community was classed as rural or urban; and whether the community was in the eastern or western half of the island.

Overall cage-bird ownership and that of individual taxa (e.g. White-rumped Shama) were extrapolated to the whole of Java by calculating (a) the mean proportion (± SE) of households keeping each taxon across communities for each province, and (b) the mean number (± SE) of cage-birds owned per household, and then multiplying (a) by the number of households in each province, and (b) by the estimated number of households keeping those taxa. Taxa were then ranked by the estimated number of birds in households. We summarized the number of individuals of each bird species owned, along with the number of households keeping each species. All data on the number of households were obtained from the 2010 Indonesian Census (Badan Pusat Statistik, 2010). To identify the most common origin for each species, we calculated the proportion of that taxon reported as 'wild-caught' or 'captive-bred', excluding "unknown", summarized by the origin that represented the majority. A similar method to that above, without extrapolation, was also used to calculate the mean percentages of bird-owning respondents citing breeding and contest-going as motivations, and the prevalence of keeping the twelve most abundant taxa. Observed species richness and Chao 1 estimation of richness (Souto et al., 2017) were calculated for communities in each province and for urban or rural areas. As the majority of non-native species observed in this study and others (Burivalova et al., 2017) were bred and sourced in captivity, whereas native species found in markets are often sourced from the wild (Chng et al., 2015, 2018), our diversity measures included only species native to Indonesia so as to understand better how bird-keeping affects wild bird populations.

Data on cage-bird ownership and taxa recorded from households in Jepson and Ladle (2009) were obtained via Oxford University Research Archive (ORA) to examine changes in the prevalence of bird-keeping and the composition of bird taxa owned between 2007 and 2018. The methods employed to collect data in both studies were broadly comparable, but there were some differences regarding sampling strategy

and survey methodology: the data collected in 2007 were restricted to urban locations; and their survey was 'piggybacked' onto other consumer research (see Jepson and Ladle, 2009). As data collected in 2007 were obtained only from a sample of cities in Java and Bali, we used a subset of our data from the same or adjacent urban communities to make the comparison. For the purposes of this study, only data from Jepson and Ladle's (2009) random sample were used. We examined the difference in total proportion of songbird ownership levels between 2007 and 2018, and calculated the projected population size of native and non-native songbirds using the same method and same number of households as reported in Jepson and Ladle (2009). We also compared the percentage of people owning different taxa across the two datasets. In this analysis, to ensure congruency between the taxonomy in both studies, we grouped certain species together from our dataset (e.g. tailorbirds *Orthotomus* spp., prinias *Prinia* spp., *Alophoixus* bulbul spp., tits *Parus* spp./Java Sparrow *Lonchura oryzivora*, flycatchers *Cyornis* spp., and laughingthrushes *Garrulax* spp.).

3. Results

3.1. Prevalence of bird-keeping

Of 3042 households surveyed in 92 communities across all six provinces (Fig. 1), 958 (31.5%) kept 5967 individual birds belonging to 112 species or species groups (55% non-native and 45% native). Of bird-keeping households, 726 (76%) owned at least one native bird, and 545 (56%) owned a non-native bird. Communities in the eastern provinces of the island (Central Java, DIY, East Java) had significantly higher proportions of households keeping both native (32% vs 15%; $p < 0.001$) and non-native (23% vs 12%; $p = 0.003$) birds than those in the western provinces (Banten, DKI, West Java; Fig. 1 and Fig. A.2. for non-native bird ownership). Urban communities had significantly higher proportions of households keeping both native (25% vs 23%; $p = 0.034$) and especially non-native birds (21% vs 14%; $p < 0.001$) than rural ones (for the full GLM outputs see Table A.2.).

3.2. Species composition, total volume and extrapolations of ownership

We estimate that 11,973,000 ± 994,000 (SE) households kept 74,321,000 ± 8,490,000 cage-birds across Java in 2018. This equates to roughly one cage-bird for every two people on the island, or two per household. We estimate that over 30 million lovebirds and around 10 million Island Canaries (*Serinus canaria* var. *domestica*) were being kept on Java in 2018, but that there were also huge numbers of some native songbirds, including > 3 million White-rumped Shamas (*Kittacincla malabarica*) and > 2 million Oriental Magpie-robins (*Copsychus saularis*; Table 1). Three species and two genera had higher proportions of individuals reported to be wild-caught than captive-bred, and had estimated ownership levels exceeding one million birds (Table 1). Of all (112) species and genera kept, > 12% are listed as threatened or Near Threatened (Appendix C); of taxa with estimated ownership levels exceeding one million birds, Javan Pied Starling (*Gracupica jalla*) is listed as Critically Endangered and two genera (leafbirds *Chloropsis* spp. & white-eyes *Zosterops* spp.) include species listed as threatened or Near Threatened (Table 1) on the IUCN (International Union for Conservation of Nature) Red List of Threatened Species (IUCN, 2019).

3.3. Patterns of bird ownership across Java

We found considerable spatial variation across provinces and gradients of rurality in species composition and abundance, overall taxonomic diversity and motivations for keeping birds (Table 2). The nine most abundant taxa, including eleven species, were doves (Sunda Collared *Streptopelia bitorquata*, Zebra and Eastern Spotted Dove *Spilopelia chinensis*), White-rumped Shama, Oriental Magpie-robin, white-eyes, Yellow-vented Bulbul (*Pycnonotus goiavier*), leafbirds, Javan Pied

Table 1
The most abundant taxa reportedly owned ranked by the number of birds in households across the six provinces of Java.

Rank	Species: English name	Species: Scientific name	IUCN status[a]	Number of keepers	Number of birds	Primary source[b]	Estimated number of birds in households (SE)
1	Lovebirds	*Agapornis* spp.	–	386	2293	NN[c]	33,479,000 (5,957,000)
2	Island Canary	*Serinus canaria*	–	253	675	NN[d]	9,702,000 (2,467,000)
3	Dove spp.	*Streptopelia / Spilopelia / Geopelia* spp.	LC	223	824	CB	8,045,000 (1,272,000)
4	White-rumped Shama	*Kittacincla malabarica*	LC	133	294	CB	3,386,000 (707,000)
5	Budgerigar	*Melopsittacus undulatus*	–	34	209	NN	1,694,000 (788,000)
6	Oriental Magpie-robin	*Copsychus saularis*	LC	116	186	CB	2,457,000 (371,000)
7	White-eyes	*Zosterops* spp.	–c	83	174	WC	1,859,000 (427,000)
8	Yellow-vented Bulbul	*Pycnonotus goiavier*	LC	120	208	WC	1,644,000 (206,000)
9	Leafbirds	*Chloropsis* spp.	–d	92	123	WC	1,596,000 (211,000)
10	Javan Pied Starling	*Gracupica jalla*	CR	85	125	CB	1,144,000 (143,000)
11	Sooty-headed Bulbul	*Pycnonotus aurigaster*	LC	55	75	WC	1,028,000 (170,000)
12	Long-tailed Shrike	*Lanius schach*	LC	73	81	WC	1,011,000 (54,000)

[a] IUCN status; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; CR: Critically Endangered.
[b] Primary source represents that most often reported other than 'unknown' for each species; NN: non-native, CB: captive-bred, WC: wild-caught.
[c] White-eye species: *Zosterops palpebrosus* (LC), *Zosterops montanus* (LC), *Zosterops atricapilla* (LC), *Heleia javanica* (LC), *Zosterops flavus* (VU).
[d] Leafbird species: *Chloropsis venusta* (NT), *Chloropsis sonnerati* (VU), *Chloropsis moluccensis* (LC), *Chloropsis cyanopogon* (NT).

Table 2
Patterns of ownership across Java's provinces, urban and rural communities, and overall.

Province / Urban Status	Total bird-keepers (% respondents)		% bird-keepers owning:				Species richness		% bird-keepers owning:								
	n	%	Native birds	Non-native birds	To breed	To enter singing contests	Observed	Expected Chao1 (SE)	Dove spp.[a]	White-rumped Shama	Oriental Magpie-robin	White-eyes[b]	Yellow-vented Bulbul	Leafbirds[c]	Javan Pied Starling	Sooty-headed Bulbul	Long-tailed Shrike
Banten	77	16.7	67.6	47.9	14.7	29.6	24	31 (6.6)	22.5	13.4	11.6	9.4	0.0	4.1	3.9	3.9	0.9
DKI Jakarta	106	24.3	69.8	68.5	22.5	31.1	37	88 (35.2)	16.9	22.5	14.8	7.5	13.1	12.6	10.6	3.0	2.9
West Java	104	23.2	73.9	50.3	17.3	30.0	29	43 (11.2)	14.3	14.2	12.2	7.3	4.2	4.7	8.3	12.5	1.9
Central Java	212	34.6	79.1	53.8	37.1	21.0	51	53 (2.4)	20.7	12.4	16.9	7.5	17.6	12.2	12.2	7.5	12.3
DI Yogyakarta	232	39.0	82.9	51.0	40.2	19.8	76	99 (12.2)	29.3	12.4	10.7	9.7	20.6	7.3	8.3	4.8	8.0
East Java	227	47.5	75.3	59.7	40.6	29.1	51	66 (10.0)	27.7	13.2	10.0	7.2	6.8	11.1	3.4	3.2	8.4
Urban	602	33.2	73.9	60.1	29.6	30.1	86	102 (8.7)	21.2	15.9	12.6	8.4	12.4	9.1	8.4	4.7	5.3
Rural	356	29.2	77.3	47.6	30.5	20.4	65	93 (15.8)	24.6	12.3	12.9	7.7	8.8	8.6	6.7	6.9	7.5
Overall	958	31.6	75.2	55.3	30.0	26.3	100	127 (13.5)	22.5	14.5	12.7	8.1	11.0	8.9	7.8	5.6	6.2

[a] Dove species include Sunda Collared *Streptopelia bitorquata*, Zebra and Spotted Doves.
[b] White-eye species include *Zosterops palpebrosus, Z. montanus, Z. atricapilla, Z. flavus, Heleia javanica*.
[c] Leafbird species include *Chloropsis venusta, C. sonnerati, C. moluccensis, C. cyanopogon*.

Starling, Sooty-headed Bulbul (*Pycnonotus aurigaster*) and Long-tailed Shrike (*Lanius schach*) (Table 2). Captive breeding of birds was more common in the eastern provinces, while ownership associated with singing contests was more common in the western provinces, and lower in rural areas than in urban areas across all provinces. Estimated total species richness of birds kept was highest in Yogyakarta and Jakarta. Jakarta had the highest levels of non-native bird ownership, but the locally threatened White-rumped Shama, a highly prized favourite of singing competitions, was also especially common (Table 2).

3.4. Decadal changes in ownership

Songbird ownership levels have risen markedly over the last decade in each of the five urban areas sampled in both studies (Table 3), with songbird ownership from our survey being double or treble (in Surabaya) that reported by Jepson and Ladle (2009). Accordingly, there has also been a sharp rise in the projected number of songbirds across all locations, most notably in non-native species such as lovebirds, canaries, and Budgerigars (*Melopsittacus undulatus*). The composition of songbird taxa owned has also changed (Fig. 2): lovebirds have become seven times more prevalent, and white-eyes, Javan Pied Starlings and leafbirds are now far more common. In contrast, Orange-headed Thrush (*Geokichla citrina*), Long-tailed Shrike, and several bulbul species (*Pycnonotus* and *Alophoixus* spp.) have seen dramatic drops in ownership.

4. Discussion

Investigating the broad-scale patterns of the trade is crucial to understand the impact on species and the ecological services they provide, and to inform interventions to reduce this impact either through demand reduction (Olmedo et al., 2018; Veríssimo and Wan, 2018) or supply management (Jepson and Ladle, 2009; Nijman et al., 2018). This study examined the spatial variability and temporal dynamics of consumer demand in Java both to highlight the scale of the threat it poses to the regional avifauna and as an evidence base that can inform future interventions aimed at increasing the sustainability of songbird-keeping in Java.

We estimate that some 66–83 million cage-birds are now kept in captivity on Java—one bird for every two of the island's human population. While the majority of these birds are captive-bred non-native species, the projected number of native songbirds kept in some of Java's largest urban centres has more than trebled over the last decade. Given that < 12,000 km^2 of Java's forest remains (Prasetyo et al., 2011) and that little of Java's non-forested land remains suitable for many bird species due to both intense land-use management (Higginbottom et al., 2019) and bird-trapping (Ng et al., 2017; Nijman et al., 2018), we suggest that the number of birds held in cages might approach or actually exceed the number of birds left in the wild on the island. The scale of demand for cage-birds has pushed more than a dozen species to the brink of extinction on Java and beyond (BirdLife International, 2019), and many species affected by trade which were once common and widespread, such as Java Sparrow and White-rumped Shama, have now become increasingly difficult to find (Eaton et al., 2015). Even so, despite significant drops in wild bird populations (Harris et al., 2017; Sykes, 2017), bird ownership levels have increased over the past decade.

There was significant variation in multiple bird ownership metrics both across provinces and between urban and rural communities. Overall ownership was higher in Javanese-dominated eastern Java, where both bird-breeding and the keeping of ornamental species such as Yellow-vented Bulbul were much more common. In western Java, bird-keeping was more associated with singing contests, with taxa such as White-rumped Shama and leafbirds more commonly kept. Even more striking were differences between Java's rural populations and its urban centres. Urban communities were more likely to keep birds, and kept a

Table 3
The percentage of households in each study location that kept songbird species (including lovebirds and canaries) and the projected number of songbirds kept (both native and non-native species) in 2007 and 2018.

City/province	2007				2018			
	n	% Keeping songbirds	Projected number of songbirds		n	% Keeping songbirds	Projected number of songbirds	
			Native	Non-native			Native	Non-native
Jakarta / DKI	293	8.9	260,812	94,908	371	22.6	124,621	154,573
Bandung / W. Java	299	8.4	90,718	61,495	194	25.8	980,290	2,074,973
Yogyakarta / DIY	300	14.7	34,124	9177	143	34.3	257,857	705,230
Semarang / C. Java	299	19.1	144,703	61,075	150	35.3	374,494	1,216,178
Surabaya / E. Java	290	20.0	312,974	126,931	125	62.4	912,774	1,899,143
Overall	1481	14.2	843,330	353,586	983	31.9	2,650,036	6,050,098

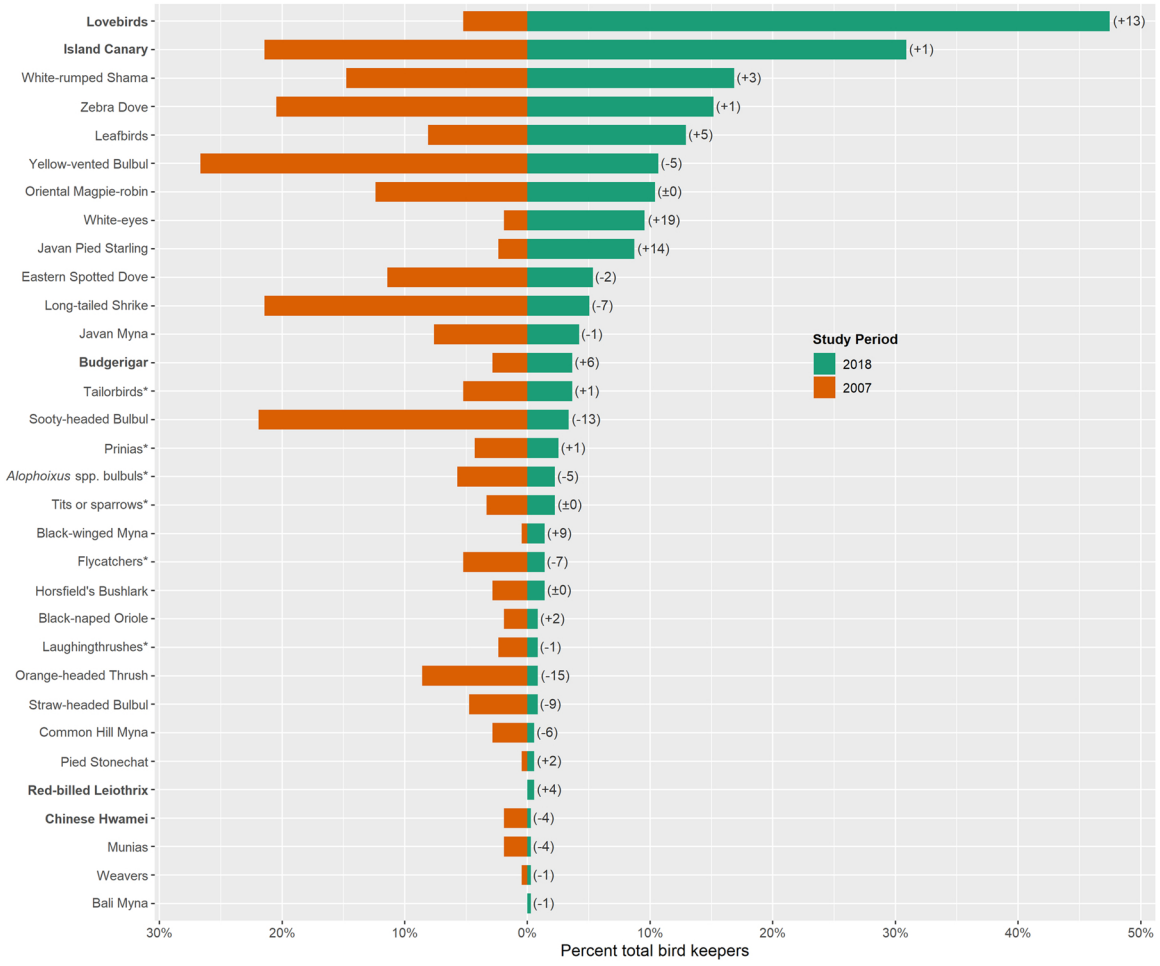

Fig. 2. Comparison of species/taxon composition between 2007 and 2018, ranked by percent ownership of species/taxon in 2018. Changes in rank across surveys is shown in brackets beside percentage ownership in 2018. Non-native taxa are highlighted in bold. * indicates species that have been matched despite different taxonomic classification between the two datasets. Scientific names of species are in Appendix C.

wider range of species, perhaps reflecting availability of species from Java and other Indonesian islands in their large markets (Chng et al., 2015) and higher disposable incomes (UNESCO, 2017). They also kept a higher proportion of non-native birds such as lovebirds and canaries, and were much more likely to enter singing contests, which may be associated with the larger proportion of rural populations employed in low-wage labour-intensive work than urban ones. Conservation interventions aimed at demand reduction or other behavioural change will need to start with an appreciation of these differences (Challender et al., 2014; Olmedo et al., 2018), focusing on the habits of hobby breeders in the eastern half of the island, and the preferences of singing-contest enthusiasts in urban centres in the western half.

A major conservation concern is the decline in ownership of species such as Orange-headed Thrush, Long-tailed Shrike, and some *Pycnonotus* and *Alophoixus* bulbuls. Whether ownership of these taxa has dropped more due to a reduction in availability through declines in wild populations, or something more benign like simple trends in what is fashionable, requires investigation. Previous work found an increase in ownership of *Geokichla* thrush species (including Orange-headed Thrush) between 1999 and 2006 (Jepson and Ladle, 2009) due to their popularity in singing contests, and during the same period they appear to have been trapped to local extinction across Java (Jepson, 2008). Regional trends in ownership of some of these taxa raise the possibility that availability in the wild may be a key factor in predicting presence

in captivity, and that demand shifts to more highly abundant taxa when one source dries up (Eaton et al., 2015). These trends highlight how understanding the popularity of species with individual bird-keepers will be key to predicting which species may be targeted as substitutes in future.

Another major concern is the growth over the last decade in ownership of taxa such as leafbirds and white-eyes, both of which, despite growing fears for wild populations of these taxa (Lee et al., 2016), are yet to become staples of the captive-breeding industry (Nijman et al., 2018). The large numbers of these taxa entering the market reflects the ability of the songbird trade in Java to switch to previously unexploited sources. Recent research on bird-keeping in Sumatra and Kalimantan demonstrates how leafbirds and white-eyes have become popular outside Java and how wild-caught individuals are often more desirable than captive-bred alternatives (Burivalova et al., 2017; Rentschlar et al., 2018). Notable are within-country regional trends in consumer demand for cage-birds, for example the large numbers of munias found in markets in Medan to supply merit releases by the large ethnically Chinese population (Chng et al., 2018), or significant levels of trapping (primarily parrots) observed in Maluku to supply local demand for pets (Cottee-Jones et al., 2014; Tamalane et al., 2019). The importance of Java as the biggest regional source of demand however is demonstrated by the large number of birds from higher-value species supplied by other islands within Indonesia, notably Sumatra (Bušina et al., 2018) and Kalimantan (Rentschlar et al., 2018).

The huge numbers of White-rumped Shamas in households, a species of great commercial value now virtually extirpated from Javan forests, must be supplied through importation of wild birds from outside of Java (Rentschlar et al., 2018), and commercial breeding (Nijman et al., 2018). We know from seizures that thousands of shamas arrive in Java from Indonesia's other Sundaic islands, Malaysia and Thailand (Leupen et al., 2018), and the further spread of Java's pervasive demand for songbirds to adjacent areas of Asia must now be regarded as a real and serious danger to wild populations. The degree to which demand for White-rumped Shamas is being or might be met by commercial breeding is unclear, as it is for other species such as Javan Pied Starling, Bali Myna (*Leucopsar rothschildi*), and Oriental Magpie-robin. The numbers of these high-value species kept and reportedly sourced from commercial breeders indicates that the avicultural community in Indonesia has considerable capacity (Jepson et al., 2011). At present, however, legitimate concerns exist that breeding facilities possess the potential to 'launder' wild birds (Eaton et al., 2015; Rentschlar et al., 2018; Nijman et al., 2018) and even that successful commercial breeding may simply stimulate rather than satisfy demand. It is therefore a matter of urgency to establish whether and how commercial captive breeding of popular native or once-native species could be developed and regulated to replace, rather than add to, Java's current consumption of wild-caught birds.

The great increase in ownership of easy-to-breed non-native species, especially lovebirds, also raises the possibility that higher-volume production of these and other birds could meet indiscriminate demand for cage-birds and song competitors. However, the huge increase in the numbers of non-native birds relative to a still remarkable increase in native birds, suggests that trade in captive-bred non-native species may simply be supplementing rather than supplanting demand for native songbirds. Again, it is critical to investigate the scale and scope of the industry to determine the commercial viability of expanding businesses sustainably to meet the increasing demand. It is particularly important to explore whether sustainably breeding highly sought-after taxa such as leafbirds and white-eyes, which have thus far proved difficult to breed at commercial scales, could realistically reduce pressure on wild populations. Evidence is also urgently needed, through an intensive profiling of consumer behaviour, preferences, and socio-economic circumstance (Drury, 2009; Offord-Woolley, 2017), to inform a conservation response that can induce a genuine and lasting behavioural change in consumption habits and thereby prevent further exacerbation of the Asian Songbird Crisis.

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Appendices. Supplementary data

Supporting material can be found in three appendices: Appendix A - supporting tables and figures; Appendix B – survey questions; Appendix C - full list of bird taxa reportedly owned. Supplementary data to this article can be found online at https://doi.org/10.1016/j.biocon.2019.108237.

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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

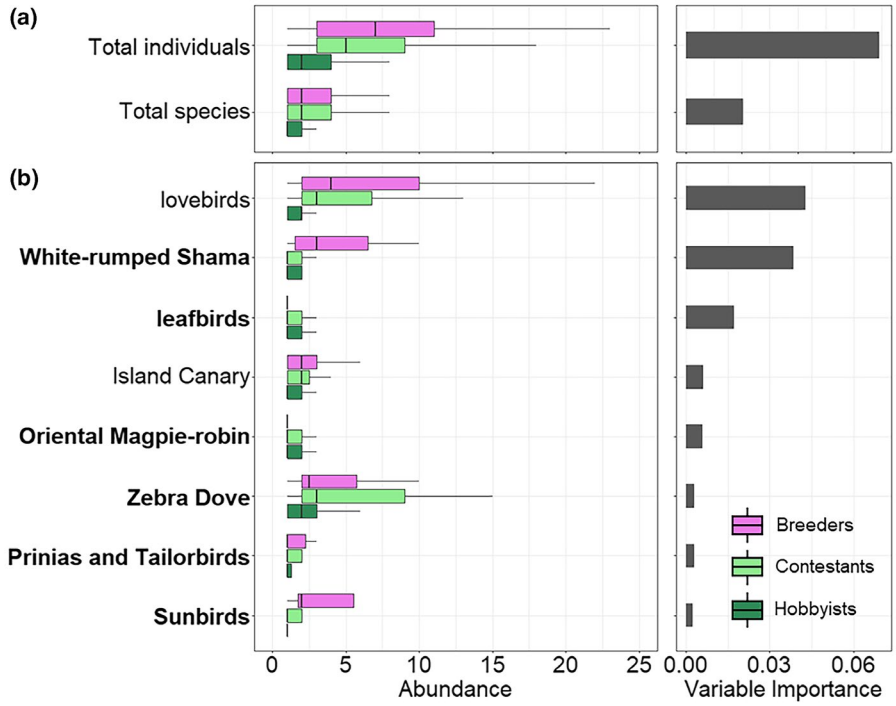

FIGURE 1 Variation in (a) total numbers of birds and species owned and (b) numbers of individual taxa owned across the three user-groups with highest importance (>0.01) in the random forest analysis. Bold indicates native species

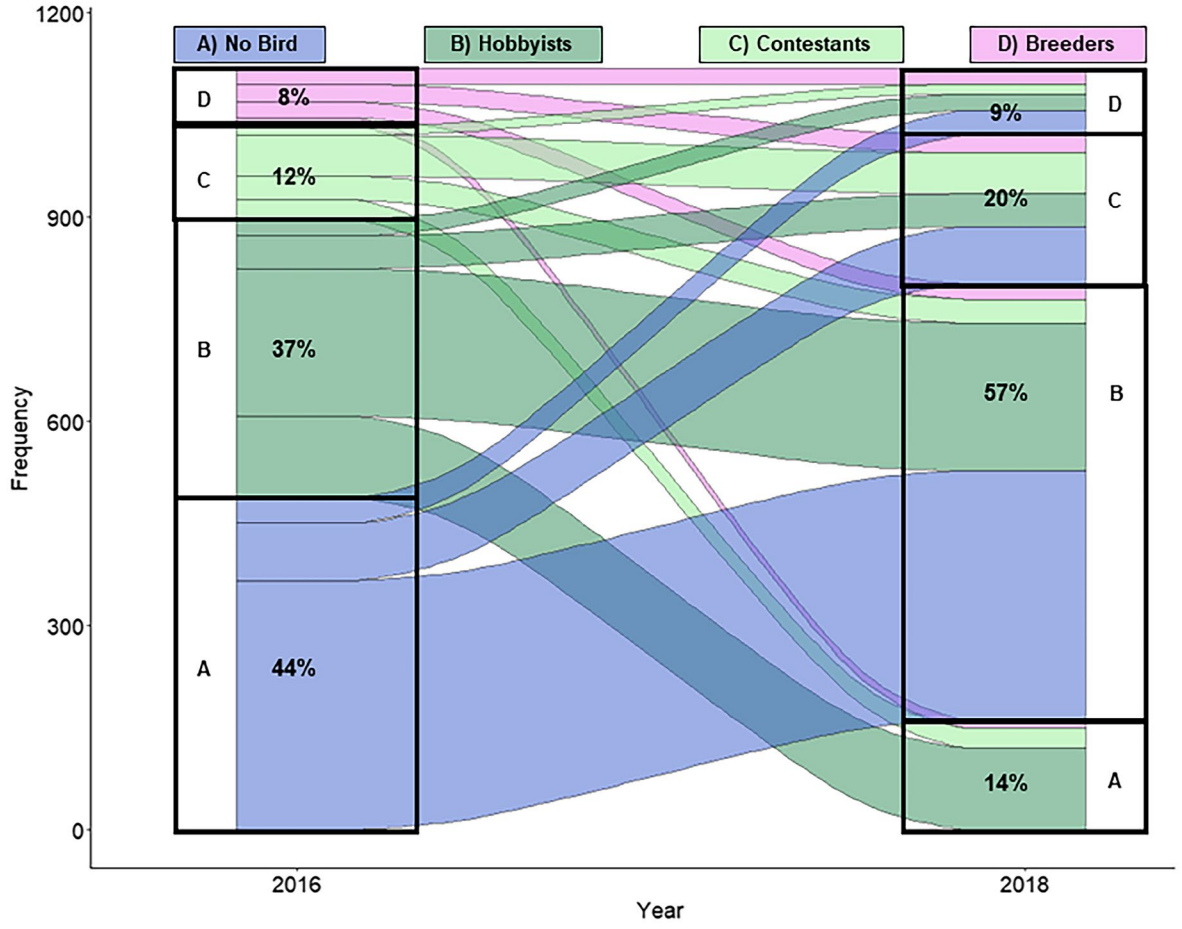

FIGURE 2 Percentages of respondents who kept birds in either 2016 or 2018 and the changes in user-group membership based on the results of the random forest predictions. Respondents who did not own birds in either year (80%) are excluded from this figure to increase interpretability. For example, the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

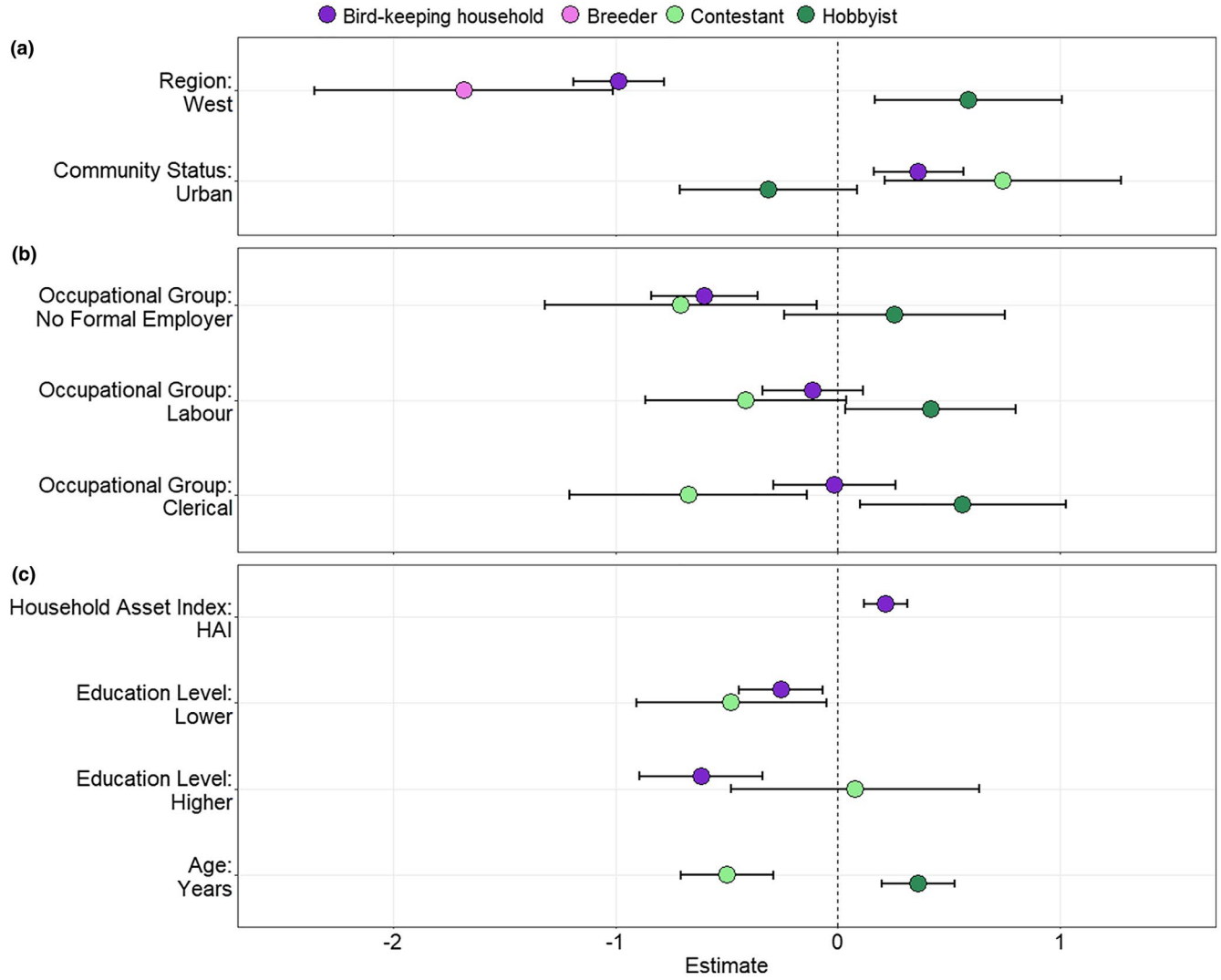

FIGURE 3 Effect sizes (with 95% CIs) of the (a) geographic, (b) occupational and (c) demographic predictor variables with the highest relative variable importance (>0.6) across models predicting bird ownership (against non-bird ownership) and user-group membership (against other bird-keepers)

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

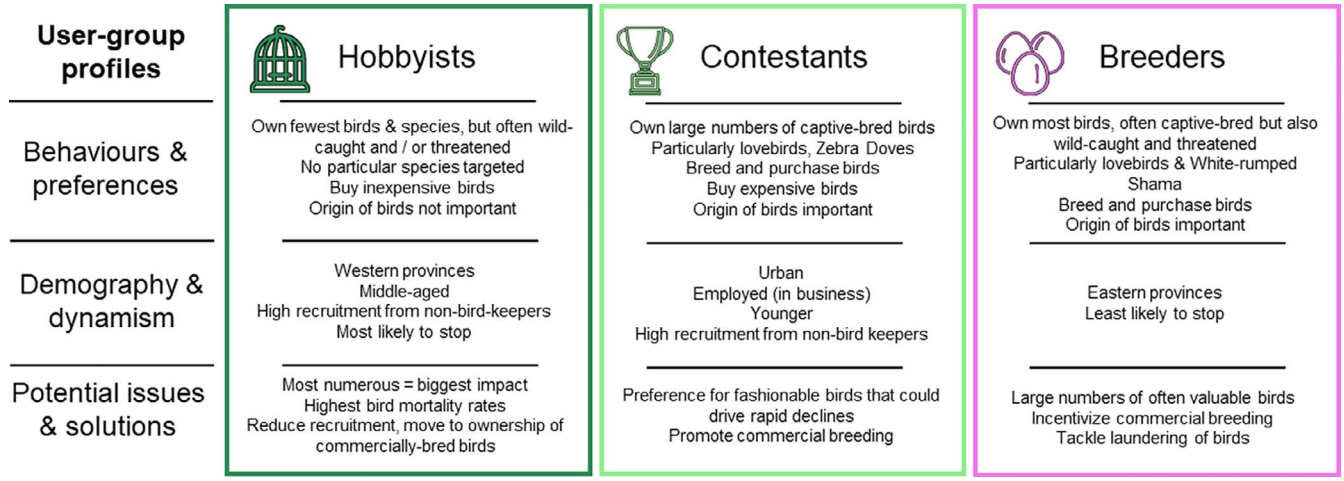

FIGURE 4 Profiles for each user-group based on key behaviours and preferences, demography and dynamism, and the potential issues and solutions to reduce the pressure their behaviours place on wild bird populations

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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