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Flying into extinction: Understanding the role of Singapore's international parrot trade in growing domestic demand

SCOTT LI MENG ALOYSIUS, DING LI YONG, JESSICA G. LEE and ANUJ JAIN

Summary

South-East Asia's bird trade is of global conservation concern as it has massively depleted wild populations of many species. Parrots (Order Psittaciformes) are especially vulnerable because they are the most heavily traded group of birds globally under the Convention on International Trade in Endangered Species (CITES) appendices. Singapore's involvement in the global pet bird trade as a transhipment hub is well documented, particularly for parrots. Yet, much less is known about the links between its domestic and international trade. We attempt to quantify this relationship by comparing bird trade data on the CITES database with past market surveys of pet shops, complemented with semi-structured interviews with 30 parrot owners in Singapore. We report a decline in total imports and exports of CITES-listed birds in Singapore from 2005 to 2016, consistent with global trends after the European Union trade ban on wild bird imports. However, parrots continue to make up the majority of total imports; and there was a yearly increase in the percentage of parrot imports out of total imports. In addition, we report a difference in imports and exports of 54,207 CITES I, II and III listed birds into Singapore i.e. birds imported but not re-exported. A substantial proportion of these birds were possibly channelled into the domestic pet trade or used as breeding stock. Interviews with parrot owners confirmed the growing demand and popularity of parrots and particularly of larger species. We conclude that the domestic demand for parrots may have been previously underestimated, and make recommendations to manage Singapore's international and domestic pet bird trade such as implementing a licensing and records system to track the movement of birds.

Introduction

The global wildlife trade is a multibillion-dollar industry, involving the sale and exchange of hundreds of species of animals, plants, and their derivatives (Roe 2008, Wyler and Sheikh 2013, TRAFFIC 2015). While it serves as means of income generation and social mobility for a number of developing communities, the trade is largely exploited for profits by major businesses and illegal syndicates (TRAFFIC 2017). The prevalence and magnitude of the international demand and trade in wildlife has deleterious consequences on wild animal populations, leading to overharvesting and the influx of invasive species and pathogens (TRAFFIC 2008, Hulme 2009, Travis *et al.* 2011, Chin 2012, Olah *et al.* 2016, Parnell 2016, Tingley *et al.* 2017).

Parrot populations are under severe threat from hunting and they rank among the most threatened groups of birds, with 28% of extant species classified as globally threatened (Olah *et al.* 2016). A number of parrot species formerly abundant are now facing extinction (Tella and Hiraldo 2014, Olah *et al.* 2016). Wild populations of African Grey Parrots *Psittacus erithacus*, for instance, have decreased by over 50% in many areas due to overharvesting and habitat destruction

(Dasgupta 2016). The global parrot trade is also implicit in the spread of invasive species (Neo 2015, Cardador *et al.* 2019) and zoonotic diseases (Karesh *et al.* 2005, Kilpatrick *et al.* 2006, Toledo *et al.* 2012).

The South-East Asian region is a well-established trading hub for many parrot species, in terms of its diversity and sheer quantity (Sodhi *et al.* 2004, TRAFFIC 2008, Rosen and Smith 2010, Chng *et al.* 2016). The region's role in the global bird trade is also increasing, following the 2005 European Union (EU) ban on wild-caught bird imports, which redirected trade from the EU to South-East Asia (Figure 1; Reino *et al.* 2017). Furthermore, some countries in the region have inadequate regulations protecting biodiversity, leaving it susceptible to unsustainable exploitation (Lin 2005, Chin 2012).

Singapore is the largest importer of CITES-listed birds in South-East Asia contributing to 18% of imports in the region, followed by Thailand (7%) and Malaysia (7%) (CITES 2018). Its position as a major transhipment centre has been exploited for decades for the international avian trade where birds from Africa and Europe transit through Singapore to be re-exported to East Asia and the Middle East (Chng *et al.* 2015, TRAFFIC 2016). Wild birds are also sourced from

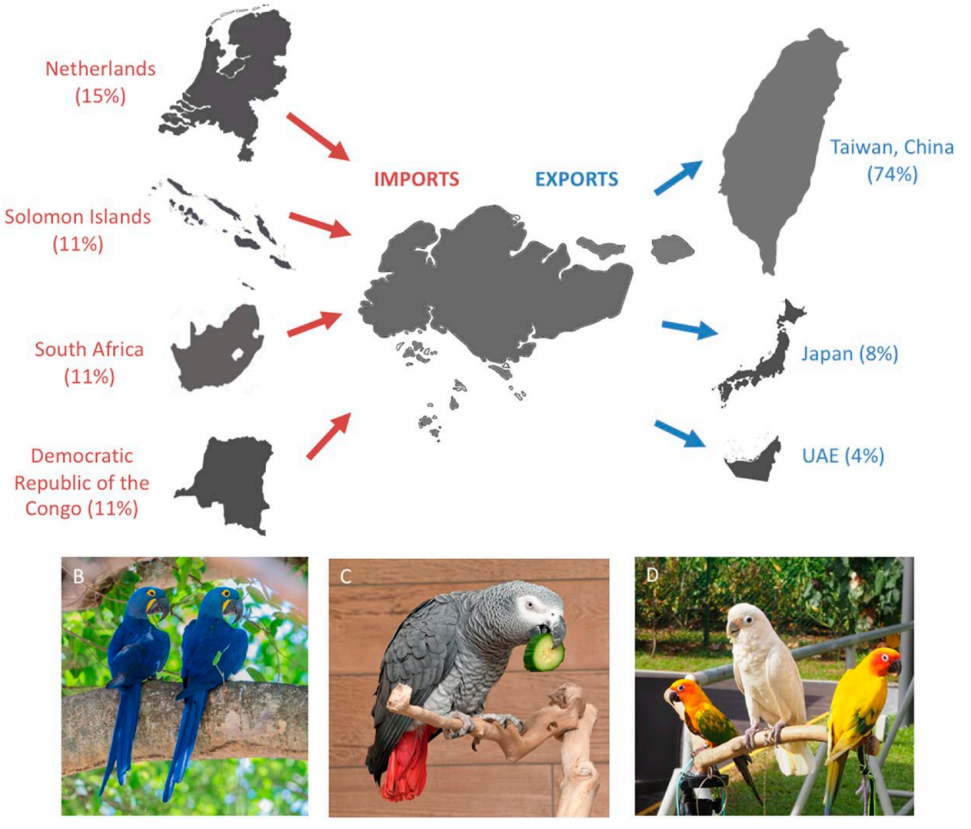

Figure 1. (a) Singapore's top import and export countries/territories for CITES-listed parrots from 2005 to 2016 (see Table S3 for details) (b) Hyacinth Macaw *Anodorhynchus hyacinthinus* (photo credit: Bjorn Olesen) can fetch up to S$40,000 in Singapore, (c) African Grey Parrots *Psittacus erithacus* are popular pets for their ability to mimic human voices (photo credit: Wikipedia Commons) and (d) Tanimbar Corella *Cacatua goffiniana* and Sun Conures *Aratinga solstitialis* on display at a parrot hobbyist group gathering in Singapore.

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various parts of Indonesia and the Philippines to Singapore, to be re-exported globally (Bashari 2015, TRAFFIC 2016). Recent studies reported Singapore's role in the movement of a significant number of CITES-listed birds that were falsely declared as captive-bred out of the Solomon Islands (Shepherd *et al.* 2012) and Australia (Low 2014).

Singapore's domestic bird trade was previously considered too small to explain the difference between the import and export of CITES Appendix I and II listed birds from 2005 to 2014 (Poole and Shepherd 2016). However, recent media reports suggest that Singapore's domestic parrot trade had been previously underestimated. The demand for parrots in Singapore has been growing since 2011 (Chan 2016, Vasko 2014). This includes globally threatened and/or CITES-listed species (Eaton *et al.* 2017).

At present, it is uncertain how Singapore's international import and export of CITES-listed parrots (including native and exotic species) relates to its rising domestic market for these parrots. The latter is often overlooked, as studies tend to focus on Singapore's international wildlife trade. To address these gaps in knowledge, our study aims to assess the trends in the volume and diversity of Singapore's CITES imports and exports of parrots from 2005 to 2016, and how they relate with the domestic sale of parrots in local pet shops, paying close attention to the trade of IUCN (International Union for Conservation of Nature) red-listed and native parrot species. We also support our research with interviews with parrot owners in Singapore.

Methods

Market survey data collection

The key market surveys reviewed in this paper included: Nash (1994), Lee (2006), ACRES (2016) and Eaton *et al.* (2017). Previous reviews such as Chin (2012) and Poole and Shepherd (2016) were also compiled. The articles were acquired from online databases Google Scholar and the Web of Science during a systematic literature search conducted on November 2017. TRAFFIC publications were accessed from the online repository: http://www.traffic.org.

Interviews with parrot owners

Between January and August 2017, we conducted 30 semi-structured interviews with parrot owners, which included two local parrot breeders, a founder of a local parrot hobbyist group and two parrot sitters. The interviews explored the factors that drive the demand for parrots in Singapore by asking the following questions:

1. *Why do you think parrots are increasingly popular as pets in Singapore? If you belong to a parrot hobbyist community, please elaborate how you were introduced and the activities conducted?*
2. *Which factors motivate you to keep parrot(s)?*
3. *What are your main considerations when purchasing a parrot?*

All interviews conformed with the British Sociological Association guidelines. The interviewer explained the objectives and implications of the research in sufficient detail to each interviewee who provided freely given and informed consent for their participation. The interviews were conducted in person or over the phone, one-on-one, in a quiet setting and the interviews were voice recorded using an iPhone (voice memo) after seeking the interviewee's consent.

Participants for the interviews were selected via targeted sampling, a non-probabilistic method of sampling, in which only parrot owners were selected. We contacted friends and acquaintances who kept parrots, and asked if they were willing to be interviewed.

Additional participants for the interviews were acquired via chain referral, which involved snowball sampling and respondent-driven sampling. In snowball sampling, we asked interviewees

if they could provide details of potential participants that may be willing to participate in the study, who we then contacted directly. In respondent-driven sampling, interviewees were asked to let others know of our project and to contact us if interested in participating (Newing 2011).

CITES trade data collection

Singapore CITES bird trade data from years 2005 to 2016 were extracted from https://cites.org, which contains import, export and re-export records of CITES Appendix I, II and III-listed bird species, to and from Singapore as reported by CITES Parties to the CITES Secretariat (see Table S1 in the online supplementary material for definitions). Only gross trade output was available i.e. immediate import and export data, without re-export data. CITES data for 2017 were unavailable at the time our study was conducted. The export figures were deducted from import figures (both as reported by Singapore) to quantify the annual difference in the number of birds i.e. imports that were not re-exported from Singapore. Variables for YEAR (2005 to 2016), TERM (Live), SOURCE (ALL Sources) and PURPOSE (Commercial) were kept constant for all searches. "ALL Sources" included— "Captive-bred animals", "Captive-bred/artificially propagated", "Born in captivity", "Confiscations/seizures", "Pre-Convention", "Ranched", "Source unknown", and "Wild".

Our study focuses on the commercial trade of CITES-listed birds. Our dataset differed from Poole and Shepherd's (2016) study in that we included Appendix III birds and all sources including "confiscated", "ranched", "born in captivity" and "unknown". Market survey data were compared with CITES Appendix I, and the IUCN Red List of Threatened Species, extracted from "http://cites.org" and BirdLife International (2017) respectively.

Statistical analyses

The change in the following numerical variables over time was examined over a 12-year period (2005 to 2016): (a) total CITES-listed bird imports, (b) total CITES-listed bird exports, (c) percentage of CITES- listed parrot imports out of total CITES-listed bird imports, (d) percentage of CITES-listed parrot exports out of total CITES-listed bird exports (e) percentage of CITES-listed wild caught bird imports out of total CITES-listed bird imports, and (f) percentage of CITES-listed wild caught parrot imports out of total CITES-listed bird imports. Pearson product-moment correlation was performed on variables "e" and "f", while Spearman rank correlations were performed on variables "a", "b", "c" and "d" which were not normally distributed. The Shapiro-Wilk test was used to assess the normality of the datasets. All statistical analyses were performed using R software (R Core Team 2017).

Results

CITES trade data

Singapore's top 10 CITES-listed bird species by import and export volumes during 2015 and 2016 was composed entirely of parrots, consistent with imports and exports during 2005 to 2014 (with the exception of the Common Hill Myna *Gracula religiosa*), as reported by Poole and Shepherd (2016) (Table S2).

Temporal trends in CITES import and export

Total imports and exports of CITES-listed birds (by volume) in Singapore decreased from 2005 to 2016 (Figure 2a). A strong negative, linear relationship was detected between imports and year of trade from 2005 to 2016 (Spearman's correlation, $n = 12$, $r = -0.76$, $P < 0.05$). Specifically, imports and exports dipped sharply during 2005–2007 and then increased from 2010 to 2012.

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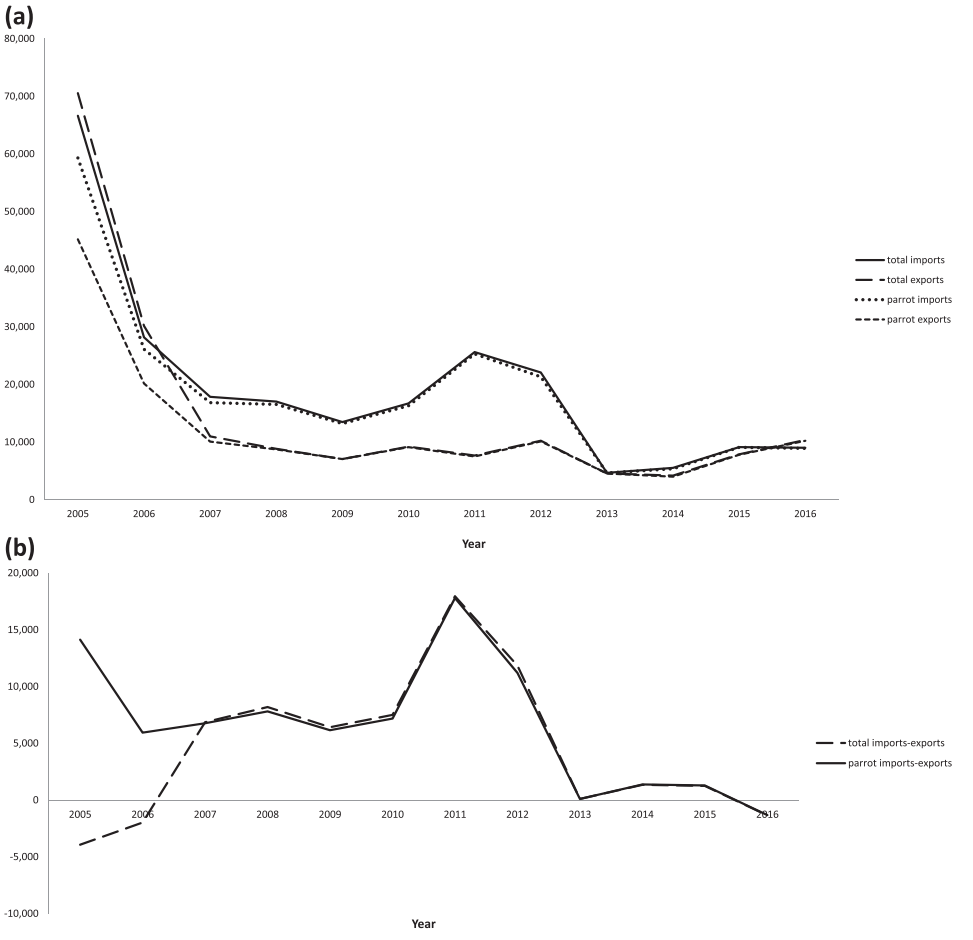

Figure 2. (a) Imports and exports of CITES-listed birds and CITES-listed parrots from 2005 to 2016. (b) Imports minus exports of CITES-listed birds and CITES-listed parrots from 2005 to 2016.

After another dip in 2013, trade increased slightly during 2014–2016 (Figure 2a). Singapore became a net exporter of birds in 2016 (Figure 2b). Total imports and exports of CITES-listed parrots similarly decreased from 2005 to 2016; however, parrots made up the majority (94.5%) of imports (Table 1), and the percentage of parrot imports out of total imports had increased. A strong positive linear relationship was detected between the percentage of parrot imports out of total imports and year of trade from 2005 to 2016 (Spearman's correlation, $n = 12$, $r = 0.76$, $P < 0.05$).

Singapore as a transit destination for parrots

Singapore's top three import markets for CITES-listed parrots from 2005 to 2016 were the Netherlands (15%), Solomon Islands (11%) and South Africa (11%) and the top three export markets were Taiwan, China (74%), Japan (8%) and the United Arab Emirates (4%) (Figure 1; Table S3).

The import and export percentages for top three markets varied substantially over the years. Imports from the Netherlands varied from zero in 2007 to 47.6% in 2011, imports from the

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Table 1. Number of CITES-listed birds imported or exported by Singapore from 2005 to 2016.

Total imports	235,891
Total exports	181,684
Total imports-exports	54,207
Parrot imports	222,931 (94.5%)*
Parrot exports	144,525 (79.5%)*
Parrot imports-exports	78,406
Total (wild caught) imports	76,263 (32.3%)**
Parrot (wild caught) imports	74,700 (31.7%)***

*Percentage of parrots out of total bird imports/exports.
**Percentage of wild caught bird imports out of total bird imports.
***Percentage of wild caught parrot imports out of total bird imports.

Solomon Islands declined sharply from 2005 to 2009 with no imports since 2010, and imports from South Africa varied from zero in 2005–2006 to 48.9% in 2010. Exports to Taiwan, China varied from 60% in 2006 to 93.5% in 2015, exports to Japan varied from 2.8% in 2009 to 17.9% in 2014 and exports to UAE have been nearly zero since 2009 (Figure 1).

Imports from the Netherlands and South Africa were largely of African and South American origin. Solomon Islands traded mostly regionally sourced parrots including Solomon and New Guinean endemics. The Philippines was the only import market from South-East Asia and contributed to only 2% of total imports.

Exports to Taiwan, China comprised globally sourced parrots of African, Australasian, South-East Asian and South American origin. However, there is no way to verify the actual number of parrot exports to Taiwan, China, since it is not a Party to CITES and does not submit its trade reports. The exporting country, in this case, Singapore, reports Taiwan, China's import figures. South-East Asian countries contributed only 3.8% of Singapore's total parrot exports.

Wild-caught bird trade

The proportion of wild caught bird imports out of total imports increased even though total wild-caught bird imports decreased from 2005 to 2016 (consistent with a decrease in overall trade). A strong positive relationship was detected between the percentage of wild caught bird imports and year of trade from 2005 to 2016 (Pearson's correlation, $n = 12$, r = 0.61, $P < 0.05$). Similarly, a strong positive relationship was detected between the percentage of wild caught parrot imports and year of trade from 2005 to 2016 (Pearson's correlation, $n = 12$, $r = 0.61$, $P < 0.05$). All CITES-listed birds from Singapore were captive bred, as declared by the exporting country (Singapore).

CITES import and export difference

A total of 54,207 (23% of total imports) of CITES Appendix I, II and III listed birds; and 78,406 (35.2% of total parrot imports) of CITES Appendix I, II and III listed parrots were not re-exported for after their arrival into Singapore during 2005 to 2016 (Table 1). However, import-export discrepancies decreased drastically from 2011 to 2016 for both parrots and all birds (Figure 2b), consistent with a decrease in overall trade.

The total import-export difference we report is smaller than that of 85,649 birds reported by Poole and Shepherd (2016). This is possibly due to the difference in methodologies used in that we included in our study: a) CITES Appendix III listed birds for which there were more exports than imports from 2005 to 2016; and b) all sources of birds from CITES database (see section 2.2).

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Review of previous market surveys

There was a huge disparity in survey effort among past market surveys which made it impossible to identify a trend in abundance and/or diversity of parrots traded over time (Table S5). Nash (1993) surveyed pet shops in Singapore over 17 months but only recorded non-CITES listed birds. Lee (2006) and Eaton *et al.*'s (2017) surveys involved a smaller sampling effort – 24 pet shops over six months, and 28 pet shops over four days respectively. ACRES (Animal Concerns Research and Education Society) (2016) monitored wildlife trade advertisements on online platforms in Singapore over three months (June to August 2016).

Market volume and diversity

The majority of birds sold in Singapore's pet shops were songbirds: 69.5% (Lee 2006) and 98.3% (Eaton *et al.* 2017). However, parrots made up 49% (84 of 172 species; Lee 2006) and 40% (44 of 209 species; Eaton *et al.* 2017) of bird species recorded. The most common parrots sold included the Budgerigar *Melopsittacus undulatus*, Cockatiel *Nymphicus hollandicus*, and Monk Parakeet *Myiopsitta monachus*, all of which are not CITES-listed (Table S7). The majority of the parrots (67.9 % and 78.8 %) recorded by Lee (2006) and Eaton *et al.* (2017) in market surveys respectively, were CITES-listed. A significant proportion (273 out of 655; 41.7%) of wildlife trade advertisements identified on online platforms also involved CITES-listed birds (ACRES 2016).

Further, parrots comprised a substantial proportion (44.4%) of threatened birds recorded in pet shops (see Table 2) including the Yellow-crested Cockatoo *Cacatua sulphurea* and African Grey Parrot that have possibly been wild caught and trafficked into the country (AVA 2002, WWF 2016, CNA 2015).

Seven (30.4%) CITES-listed threatened parrot species were recorded in market surveys but not in Singapore's CITES import or export database (Table 2). Conversely, the majority (80.5%, 33 species) of threatened bird species recorded in the CITES database were not documented in market surveys. These birds could have been re-exported out of Singapore for the international trade.

Interviews with parrot owners

A detailed description of the interview results and analysis will be covered in a separate study. Here, we present results that explore the changing ownership trends in Singapore and how it relates to the country's international trade of parrots. Interviewees were numbered from 1 to 30 based on the date of the interview. Selected quotes, each labelled with the interviewee's assigned number are listed in Figure S2.

Interviews with parrot owners in Singapore revealed that pet shops[1] and hobbyist groups in Singapore function as key platforms that influence the public to keep parrots, and sometimes on impulse[2]. Parrot hobbyist group events such as the free-flying of parrots in the open are especially effective at attracting interest from passers-by[3]. These groups also leverage social media to draw attention[4] and recruit members.[5] Hobbyist group members agreed that the number of hobbyist groups and membership within these groups have increased over the past five years[6] (A. J. pers. comm.).

A local breeder whom we interviewed said that although the majority of parrots sold consist of the smaller, non-CITES listed parrots such as budgies and cockatiels (also see Lee 2006, Eaton *et al.* 2017), the demand for larger parrots has also increased. Interviewees also shared that some parrot owners keep smaller parrots to gain handling experience before progressing to larger parrots.[7] The breeder confirmed the growing anecdotal evidence which suggests that macaw sales have increased by 50% in Singapore from 2001 to 2016, including threatened species such as the globally 'Vulnerable' Hyacinth Macaw *Anodorhynchus hyacinthinus* (Chan 2016). Further, some owners purchase additional parrots to keep their first parrot company.[8]

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Table 2. List of IUCN threatened birds recorded at pet shops in Singapore by previous researchers. The list is compared with CITES trade data to identify birds that were imported but did not show up in market surveys and vice versa.

Common Name,	Species	CITES appendix	CITES Import*	CITES Export*	Nash, 1993**	Lee, 2006	Eaton et al., 2017
IUCN CRITICALLY ENDANGERED							
Bali Myna,	*Leucopsar rothschildi*	**I**	+				
Edward's Pheasant,	*Lophura edwardsi*	**I**	+				
Javan Green Magpie,	*Cissa thalassina*				**X**		
Silvery Pigeon,	*Columba argentina*				**X**		
Swift Parrot,	***Lathamus discolor***	**II**	+	+			
Yellow-crested Cockatoo,	***Cacatua sulphurea***	**I**		**X**		**X**	**X**
IUCN ENDANGERED							
African Grey Parrot,	***Psittacus erithacus***	**I**	**X**	**X**		**X**	**X**
Chattering Lory,	***Lorius garrulus***	**II**				**#**	
Egyptian Vulture,	*Neophron percnopterus*	**II**	+				
El Oro Parakeet,	***Pyrrhura orcesi***	**II**				**#**	
Golden Parakeet,	***Guaruba guarouba***	**I**				**#**	
Green Peafowl,	*Pavo muticus*	**II**	+	+			
Green Racquet-tail,	*Prioniturus luconensis*	**II**	+				
Green-tighed Parrot,	***Pionites leucogaster***	**II**	+	+			
Grey-crowned Crane,	*Balearica regulorum*	**II**	+	+			
Lilac-crowned Amazon,	***Amazona finschi***	**I**	**X**				**X**
Pruple-naped Lory,	***Lorius domicella***	**II**		+			

Table 2. Continued.

Common Name,	Species	CITES appendix	CITES Import*	CITES Export*	Nash, 1993**	Lee, 2006	Eaton et al., 2017
Saker Falcon,	*Falco cherrug*	II		+			
Straw-headed Bulbul,	*Pycnonotus zeylanicus*	II			#		
Sun Parakeet,	***Aratinga solstitialis***	II	X	X			X
Visayan Hornbill,	*Penelopides panini*	II	+				
White Cockatoo,	***Cacatua alba***	II	+	+			
White-winged Duck,	*Asarcornis scutulata*	I	+				
Yellow Cardinal,	*Gubernatrix cristata*	II	+				
Yellow-headed Parrot,	***Amazona oratrix***	I				#	
IUCN VULNERABLE							
Black-cheeked Lovebird,	***Agapornis nigrigenis***	II	+				
Black-crowned Crane,	*Balearica pavonina*	II	+				
Black-necked Crane,	*Grus nigricollis*	II	+				
Black-winged Lory,	***Eos cyanogenia***	II				#	
Blue-eyed Cockatoo,	***Cacatua ophthalmica***	I	X	X			X
Cabot's Tragopan,	*Tragopan caboti*	I	+				
Channel-billed Toucan,	*Ramphastos vitellinus*	II	+	+			
Chattering Lory,	***Lorius garrulus***	II	+	+			
Crimon-bellied Parakeet,	***Pyrrhura perlata***	II	+	+			
Greater Green Leaf-bird,	*Chloropsis sonnerati*				X		X
Hispaniolan Amazon,	***Amazona ventralis***	II	+				
Hyacinth Macaw,	***Anodorhynchus hyacinthinus***	II	+				

Table 2. Continued.

Common Name,	Species	CITES appendix	CITES Import*	CITES Export*	Nash, 1993**	Lee, 2006	Eaton et al., 2017
Java Sparrow	*Lonchura oryzivora*	II	X				X
Javan White-eye,	*Zosterops flavus*						X
Malayan Peacock-pheasant,	*Polyplectron malacense*	II		+			
Nene,	*Branta sandvicensis*	II	+				
Pesquet's Parrot,	***Psittrichas fulgidus***	I	+	+			
Reeves's Pheasant,	*Syrmaticus reevesii*						X
Salmon-crested Cockatoo,	***Cacatua moluccensis***	I		X			X
Secretary Bird,	*Sagittarius serpentarius*	II	+				
Shoebill,	*Balaeniceps rex*	II	+				
Southern cassowary,	*Casuarius casuarius*				X		
Southern-crowned Pigeon,	*Goura scheepmakeri*	II		+			
Sumatran Leafbird,	*Chloropsis media*						X
Wattled Crane,	*Bugeranus carunculatus*	II	+				
Western-crowned Pigeon,	*Goura cristata*	II		+			
White-faced Patridge,	*Arborophila orientalis*				X		
White-throated Toucan,	*Ramphastos tucanus*	II	+	+			
Yellow-billed Amazon,	***Amazona collaria***	II	+	+			
Yellow-naped Amazon.	***Amazona auropalliata***	I	X			X	X
Yellow-shouldred Amazon,	***Amazona barbadensis***	I					#

Parrots in **BOLD;**
Species recorded in market surveys labelled **X;**
CITES-listed birds traded but not recorded in market surveys labelled **+;**
Birds recorded in market surveys but not in CITES trade data labelled **#;**
*From 2005 to 2016;
**Only Non-CITES birds.

Local breeders also state that parrots are the most expensive birds sold in Singapore, with their price ranging from SGD $200–$40,000 (USD $150–$30,000; Table S6). This is consistent with anecdotal records that suggest the Hyacinth Macaw was the most expensive bird, priced between SGD$35,000 (USD $26,170) and SGD $40,000 (USD $30,000) in 2014 (Vasko 2014, Chan 2016).

Discussion

Decline in CITES imports and exports

The decline in Singapore's CITES-listed bird trade since 2005 is consistent with the global drop in trade volume following the EU imposed ban on wild-caught birds (Reino *et al.* 2017). Regional declines in South-East Asia were also attributed to the avian flu outbreak, which led to more stringent regulations on veterinary conditions and limited trade to bird-flu-free zones (Anonymous 2005, Lee 2006, AVA 2015, Zannia 2017). Since 2015, the Agri-food and Veterinary Authority (AVA), Singapore's CITES management and scientific authority) had also increased surveillance efforts and exerted stricter control over CITES permits to regulate trade (S. A. pers. comms. with owner of commercial bird breeding farm in Singapore). For instance, the AVA pledged to stamp out the illegal wildlife trade (CNA 2015) and destroyed 7.9 tonnes of elephant ivory publicly to reiterate the government's zero tolerance towards wildlife trafficking (PHYS 2016).

Increasing domestic demand for parrots

Our interview results confirm a growing domestic demand for parrots and an increase in parrot hobbyist group membership in Singapore as also reported by anecdotal media reports (Chan 2016, Vasko 2014, Woo, 2018), e.g. one media reported that pet shop owners in the country have found a consistent (estimated 10%) increase in parrot sales every year from 2011 to 2013 (Vasko 2014). The yearly increase in the percentage of CITES-listed parrot imports out of total CITES-listed bird imports from 2005 to 2016 also supports this assertion.

The increasing popularity of parrots among pet owners in Singapore may reflect a broader demand for parrots in the South-East Asian pet trade and perhaps globally, with detriment to wild parrot populations. Globally, parrots remain the most traded group among CITES-listed birds. Although other taxa (e.g. passerines) have declined substantially since the 2005 EU trade ban, the trade of parrots has since recovered to almost 60% of their pre-ban levels by 2011 (Reino *et al.* 2017). The South-East Asian and New Guinean parrot trade constitute a significantly greater proportion of global parrot trade as compared to pre-EU trade ban levels (Reino *et al.* 2017).

The increase in the domestic demand for parrots in Singapore is of concern because there is evidence that globally threatened species such as the Yellow-crested Cockatoo are in trade, which have been possibly wild caught and trafficked into the country. In addition, a substantial proportion of wildlife trade in Singapore takes place online with almost no regulations in place (ACRES 2016, Mahmud 2017). The scale of the online trade may have been previously underestimated with the potential of contributing to a significant proportion of Singapore's total wildlife trade.

Parrot importing and exporting countries

CITES-listed parrot imports to Singapore originated from diversified sources from the Netherlands and South Africa which trade in a variety of parrot species, to the Solomon Islands, Democratic Republic of the Congo and Guyana which export mostly regional species. The large volume of parrot imports from the Solomon Islands is particularly worrying because it involves

restricted-range species such as the Solomons Cockatoo *Cacatua ducorpsii*. However, trade with the Solomon Islands has reduced sharply since 2006 when the Solomon Islands Government imposed a ban on wildlife exports to give time to develop protection acts (Shepherd *et al.* 2012). Singapore also imported parrots from the broader New Guinea region, which has a history of poorly regulating CITES permits and exceeding CITES trade quotas (Shepherd *et al.* 2012).

Singapore's CITES-listed parrot exports, in contrast, were far less diverse, and were directed to developed markets in Asia (Taiwan, China, Japan, UAE and Hong Kong) and Europe (Netherlands, Denmark and Spain). Given that Taiwan, China contributed to nearly 75% of Singapore's parrot exports, bilateral agreements on sustainable sourcing of parrots should be developed.

Singapore's trade with South-East Asian countries was insignificant. This is despite the fact that there is domestic and international demand for South-East Asian parrot species. Our interviews with parrot owners confirmed the popularity of South-East Asian parrots such as the Yellow-crested Cockatoo and Chattering Lory *Lorius garrulus* in Singapore. Similarly, South-East Asian parrots are popular pets in Indonesia (Bashari 2015) and Philippines (Tabaranza and Lepiten-Tabao 2001). The CITES data suggests that Singapore imports a number of captive-bred South-East Asian parrot species from Europe and South Africa. This may be because breeders in Europe and South Africa have access to better facilities and expertise for captive-breeding of parrots compared to breeders in the region. This is laudable as a move to promote sustainably sourced parrot species in trade.

CITES import and export difference

We suggest that the difference in imports and exports could be due to permitting issues and time lag in exports. Following Poole and Shepherd's (2016) study, the AVA clarified that reporting before 2016 was based on permits issued, which did not reflect actual trade figures. AVA has since provided actual trade figures (Neo 2016). Indeed, we noticed that Singapore updated its 2005–2016 CITES import and export numbers in 2017 (S. A. pers. obs.). However, the updated numbers still reflect a large difference (54,207 birds) in imports and exports. Poole and Shepherd (2016) suggested that a large number of birds could be housed in local captive-breeding farms in Singapore for re-export.

In response to Poole and Shepherd's (2016) study, AVA further clarified that birds may not be re-exported within the same year that they were imported into the country due to time-lag in exports i.e. they could have remained in Singapore for a few years before re-export (Lim and Tan 2016). However, it is unlikely that tens of thousands of birds can be kept for years before they are re-exported because of high mortality rates and lack of space in land-scarce Singapore. Import-export difference could increase further if the trade in non-CITES birds is also considered (Poole and Shepherd 2016).

We hypothesize that a large proportion of the CITES-listed birds that were not re-exported were directed into Singapore's domestic bird market, which was previously underestimated. Parrots that were not re-exported (78,406 individuals or 35.2%) constitute a significant proportion of total CITES listed parrot imports, including species native to and/or naturalised in Singapore. This observation corroborates with anecdotal reports of the rising domestic demand of parrots in Singapore. It also highlights the need for better documentation of the rising domestic demand.

Limitations of CITES-trade and market survey data

Birds recorded as imported in CITES datasets and not documented in market surveys may be re-exported to other countries or housed in captive breeding or exporting facilities. These birds could have also been sold in Singapore but were overlooked in market surveys because they were not displayed publicly. Conversely, it is possible that bird species and numbers documented in

market surveys but not in CITES datasets may refer to captive-bred individuals from local breeding facilities and/or birds imported prior to 2005 but housed in breeding farms or pet shops (J.G.H.L. unpubl. data). It is also possible that these birds were illegally trafficked into the country (Poole and Shepherd 2016).

Finally, there is missing data from non-CITES party states, and potential inconsistency in species identification by CITES regulatory bodies. CITES permits are generally issued on the basis of declarations, which involve the attachment of photographs of the species in trade. In certain cases, enforcement authorities may lack the capacity to identify species accurately, especially similar-looking species or subspecies or parrots with colour mutations and hybrids. The latter adds another layer of complication on the identification of already cryptic, similar-looking species/subspecies (J.G.H.L. unpubl. data). The technical capacity of Singapore's CITES authority is expected to greatly improve with the National Parks Board replacing AVA as the CITES authority of Singapore from April 2019 (Wong 2018) – a move that has been praised by the conservation community.

Recommendations

Previous market surveys in Singapore merely provided snapshots of species volume and diversity at any given time that also fail to capture turnover of birds (e.g. Eaton *et al.* 2017), making it challenging for direct comparison with annual CITES datasets. Given the severity of the bird trade on wild bird populations (Harris *et al.* 2015), we recommend the implementation of a systematic and long-term monitoring effort of key pet shops, captive-breeding farms and exporting facilities in Singapore, to document the temporal turnover of species volume and diversity and ideally as a collaborative effort between CITES authorities, other government agencies and independent parties e.g. universities and non-government organisations.

Moreover, regulatory bodies in Singapore should consider implementing a licensing and records system, such as in Australia (DBCA 2013), to track the movement of birds through local captive-breeding farms, exporting facilities and pet shops. The trade in African Grey Parrots in particular should be monitored in domestic markets to assess if its uplisting to CITES Appendix I status in October 2016 (CITES 2016, Dale 2016) had any impact on subsequent trade. Authorities involved in the enforcement of CITES could be better trained in species identification to detect cryptic and similar-looking species/subspecies. A consultative panel comprising of technical authorities from universities, zoological institutions and conservation NGOs could be established to support species identification and taxonomic issues.

The wildlife trade also contributes to the spread of zoonotic diseases (Karesh *et al.* 2005) and parrots are susceptible to a range of pathogens, a number of which need to be carefully managed in captivity due to their high transmission rates, mostly developing no symptoms despite harbouring and/or shedding the pathogen and high mortalities (J. L. pers. comm. with Neo P.). Birds in trade are often kept in overcrowded and poor conditions, and these factors along with poor disease management play a role in exacerbating the spread of pathogens and diseases (Karesh *et al.* 2007). Outbreaks of avian disease not only impact the avicultural industry, but also on native bird populations, livestock and humans such as in the case of *Chlamydia psittaci*, which causes psittacosis in humans (Karesh *et al.* 2007, Vanrompay *et al.* 1995). Current disease control measures are mostly restricted to disease-causing pathogens with implications to livestock or human health. As such, there is a need for more extensive measures such as comprehensive disease testing and the implementation of proper biosecurity protocols and mandatory screening programs in pet shops and veterinary clinics (J.G.H.L. unpubl. data).

The scale of the online bird trade and its contribution to CITES trade has also been previously underestimated in Singapore (Iqbal *et al.* 2015), and there are currently no regulations governing wildlife trade online (Mahmud 2017). However, the CITES authority in Singapore has conducted monitoring efforts on platforms such as "Gumtree", "Locanto", and "Facebook", where a large

proportion of CITES-listed birds are known to be traded (ACRES 2016); and informed users about laws prohibiting the sale of illegal wildlife in Singapore (Mahmud, 2017). Studies in future could assess the efficacy of these monitoring efforts.

Finally, unsustainable trade can be averted with a change in consumer behaviour (WWF 2012, Neo 2016). Regulatory bodies should encourage pet shops to display the IUCN conservation status and source of parrots sold, to inform customers before they make a purchase. This could be done in collaboration with existing measures such as the "You Buy They Die" campaign by TRAFFIC and Wildlife Reserves Singapore that advocates against the purchase of threatened bird species (TRAFFIC 2015). A combination of improved trade monitoring, capacity development and responsible consumer behaviour is necessary to manage the trade of parrots, and the broader conservation of wild parrot populations.

Supplementary Material

To view supplementary material for this article, please visit https://doi.org/10.1017/S0959270919000182

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Author contributions

AJ conceived and designed the study. SA conducted the literature review and compiled the datasets. All the authors contributed to the analysis and writing of the manuscript.

Notes

1 "My friend brought me to a pet shop and I ended up buying two cockatiels." (17)
"When I went to the pet shop I had no intention to buy the parrot but the longer I was there, I knew I would come out buying something." (16)

2 "I went to the bird shop to buy bird food, I actually had zero intention of getting a bird but then saw one at a bird shop and it looked so cute." (22)
People in the parrot community use the word "poison". They play up the positive aspects of the birds and not the negatives, like the cost" (18)

3 "When parrot owners meet non-parrot owners during events, the non-parrot owners will get to see the parrots start getting interested in keeping parrots." (20)
"Birds, can fly and come back, the thrill of that got people interested, they think it is very cool" (22)

4 "Through social media many are introduced and made aware of a parrot's capability and how cute, adorable, and intelligent they are" (24)

5 "There is greater awareness on parrots because of the facebook group created, more parrots owners can get together, it is like a community." (20)

6 "There is greater awareness on parrots because of the Facebook group created, more parrot owners can get together, it is like a community." (20)

7 "Some people start off with small parrots, to train their ability to care for parrots then upgrade to bigger parrots" (26).

8 "I wanted to find a male companion for my female bird" (20)
"To have only one bird is quite sad so I got a second one, to accompany my first one" (22)

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SCOTT LI MENG ALOYSIUS*
Department of Biological Sciences, National University of Singapore, Singapore.

DING LI YONG
Nature Society (Singapore), 510 Geylang Road, Singapore.

JESSICA G. LEE
Wildlife Reserves Singapore, Singapore.

ANUJ JAIN
BirdLife International (Asia), #01-16/17, 354 Tanglin Road, Singapore.

**Author for correspondence; e-mail: scott.aloysius@u.nus.edu*

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