European Journal of Wildlife Research (2020) 66: 98
https://doi.org/10.1007/s10344-020-01436-4

ORIGINAL ARTICLE

Thirty years of trade data suggests population declines in a once common songbird in Indonesia

Boyd T. C. Leupen[1] · Lalita Gomez[1,2] · Chris R. Shepherd[1] · K. Anne-Isola Nekaris[2] · Muhammad Ali Imron[3] · Vincent Nijman[2]

Received: 26 March 2020 / Revised: 9 October 2020 / Accepted: 29 October 2020 / Published online: 5 November 2020

Abstract

In Indonesia, the songbird trade is causing serious declines in many native species. Much of this trade is unregulated or illegal but nevertheless occurs openly in physical wildlife markets and online. Here, we report on the trade in a once common songbird, the Sunda laughingthrush (*Garrulax palliatus*), using compiled market data from 365 bird market surveys across a 30-year period. We found a total of 5,281 birds for sale, with the species encountered in roughly two-thirds of the visits. We observed a significant decrease in the number of Sunda laughingthrushes offered over time from ~ 50 birds/survey in the 1990s to ~ 20 birds/survey in the 2000s and < 10 birds/survey in the 2010s, as well as a significant increase in the market price of the species, suggesting declining populations. In line with the countrywide findings, we found a decrease in the number of the species in the bird markets of Medan, but we did not find a similar decrease in Jakarta, suggesting a complex pattern of availability and demand. Nevertheless, this study shows that continued trapping for trade, if left unchecked, poses a significant risk to the species. We conclude that a more proactive stance from the government, including increasing levels of protection and enforcement of existing regulations, community engagement and possibly targeted captive breeding may alleviate the pressure on remaining wild populations. Our study offers a model whereby analysis of wildlife trade over extended periods of time covering vast geographic regions may offer insights that are easily missed when working in a too focused manner on single markets over short periods of time.

Keywords Birds · Songbirds · Indonesia · Wildlife trade regulations · Illegal wildlife trade · Sunda laughingthrush

Introduction

It has been recognised by experts in multiple fields that domestic and international wildlife trade poses serious threats to the conservation of already imperiled species (Karesh et al. 2005; Smith et al. 2009; Harfoot et al. 2018). Nowhere is this more apparent than in Asia, where a multitude of species is being traded openly in huge numbers (Zhang et al. 2008; Nijman 2010; Blair et al. 2017). Songbirds in particular have been negatively impacted, mainly due to large demand in the cage bird trade, to the extent that the status of many species is now at a tipping point (Lee et al. 2016; Sykes 2017; Leupen et al. 2018; Marshall et al. 2019; Nijman et al. 2019). The degree to which this trade is legal, regulated and sustainable differs between the Asian countries. In Singapore, a country that traditionally was very much involved in the songbird trade, the capture of wild birds has largely ceased and many (but not all) songbirds in trade are now derived from captive breeding operations. In Indonesia, where songbird trade is particularly prevalent, the trade in wild as opposed to captive-bred songbirds is omnipresent and does not seem to have diminished in recent years, for example, comparing Chng et al. (2015) with Nash (1993). Despite much of this trade being illegal under the country's various wildlife laws and regulations, the sale of songbirds occurs in the open, in public bird markets and online, negatively affecting the conservation of many native species (Chng et al. 2015; Eaton et al. 2015; Harris et al. 2016; Nijman et al. 2019). A group of songbird species openly traded in Indonesia are

✉ Boyd T. C. Leupen
boyd.leupen@mcrsociety.org

[1] Monitor Conservation Research Society (Monitor), Box 200, Big Lake Ranch, BC V0L 1G0, Canada

[2] Oxford Wildlife Trade Research Group, Department of Social Sciences, Oxford Brookes University, Oxford OX3 0BP, UK

[3] Faculty of Forestry, Universitas Gadjah Mada, Jalan Agro No. 1. Bulaksumur, Yogyakarta 55281, Indonesia

laughingthrushes, which are desired predominantly for their melodious song (Shepherd 2007, 2010; Shepherd et al. 2016). Due to trapping for trade, many laughingthrush species native to Indonesia are now in serious decline (Shepherd 2010; Collar and van Balen 2013; Shepherd et al. 2016).

Among the laughingthrushes negatively affected by Indonesia's songbird trade is the Sunda laughingthrush (*Garrulax palliates*, also known as *Leucodioptron palliatum*) (BirdLife International 2018). This montane and sub-montane forest bird consists of two subspecies, with *G. p. palliatus* occurring in the mountainous areas of the Indonesian island of Sumatra and *G. p. schistochlamys* having a limited and patchy distribution on the island of Borneo, including Indonesian Kalimantan (Brickle et al. 2010; BirdLife International 2018; Collar and Robson 2019). Of the two subspecies, *G. p. palliatus* appears to be more common in trade and could therefore be suffering an immediate decline (BirdLife International 2018). Reports of increasing rarity of the subspecies on Sumatra (Eaton et al. 2015) support this assertion and have contributed to a re-assessment of the Sunda laughingthrush as Near Threatened (from Least Concern) on the IUCN Red List (Birdlife International 2018). The Sunda laughingthrush is currently not included in Indonesia's Regulation of the Minister of Environment and Forestry no. P.106/MENLHK/SETJEN/KUM.1/12/2018, which lists species protected under the country's main wildlife law, the Act of the Republic of Indonesia no. 5 of 1990 concerning conservation of living resources and their ecosystems. However, the capture and trade of the species is regulated by a quota system under Government Regulation no. 8/1999 on wild flora and fauna exploitation and the Decree of the Minister of Forestry no. 447/Kpts-II/2003, which is set annually and includes the number of birds that may be captured, the province or district from where the individuals may be captured, and the purpose of the capture, in this case live for the pet trade.

Sunda laughingthrushes have been observed for sale in Indonesia's wildlife pet markets for decades and often in relatively large numbers (Nash 1993; Shepherd 2010; Chng et al. 2015; Shepherd et al. 2016). Analysis of bird market survey data has proven to be an effective tool to identify overharvested species and determine levels of exploitation (Harris et al. 2015; McNamara et al. 2016). Using data from over three decades, we firstly focused on the Sunda laughingthrush trade at the country level, using all available data gathered during market surveys across more than 30 cities throughout western Indonesia. We then narrowed our focus to two cities, one on the island of Java (Jakarta) and the other on Sumatra (Medan), that have been monitored intermittently by various research teams throughout that same period.

We expect that, if harvest and capture indeed has a negative impact on the species, (1) the proportion of surveys that record the species should change over time, gradually or abruptly, (2) we will see lower numbers of birds in the markets over time, gradually or abruptly, and if (1) and (2) are true, then we expect that (3) prices, after corrected for inflation, have increased over time, thus reflecting lower availability.

Methods

Study region

Our study area, western Indonesia and the cities of Medan and Jakarta in particular, has changed markedly over the last three decades. In the 1990s, Indonesia was under autocratic rule, with a population of ~ 180 million and an annual population growth rate of almost 2%. At that time, about two-thirds of the population lived in rural areas. For most of the 1990s, the value of the Indonesian Rupiah was at around IDR 2,000 to the USD. At present, Indonesia's population has increased to 264 million, with the current annual population growth rate being just over 1%. The country is now much more urbanized, with 55% of people living in cities. For the last 5 years, the value of the Indonesian Rupiah has stood at around IDR 14,000 to the USD.

Medan is the capital of the province of North Sumatra. In the 1990s, Medan had a population of 1.75 million. At present, the city's population has grown to 2.98 million. The government-recommended minimum wage for the province, corrected for inflation to 2020 values, was USD76.38 per month in 1997. Since then, it has more than doubled, with the minimum wage being USD182.61 in 2020. Of Medan's three active bird markets in the 1990s (Jalan Bintang, Petisah and Sembahe), only Jalan Bintang is still operational today, though there are other small bird shops scattered throughout the city. Surveys in Medan's bird markets were conducted by S. Nash in the 1990s (Nash 1993), C.R. Shepherd in the 1990s and 2000s (Shepherd 2006, 2007, 2010), a team lead by J.B.C. Harris in 2013 and 2014 (Harris et al. 2015), and a team led by T. Bušina from 2015 to 2017 (Bušina et al. 2018). Jakarta is the capital of Indonesia. In the 1990s, the city had a population of 8.26 million, which has increased to 10.57 million in 2020; the Greater Jakarta area's population is approximately double that number. The government-recommended minimum wage for Jakarta Special Capital Region, corrected for inflation to 2020 values, was USD87.25 in 1997 and has almost quadrupled to USD311.77 in 2020. In the 1990s, there were three main bird markets: Barito, Cipinang and Pramuka. At present, the three most important bird markets are Barito, Jatinegara and Pramuka. Surveys here were conducted by different people and teams in the 1990s, including those led by S. Nash (Nash 1993), V. Nijman (Nijman et al. 2009; Nijman and Nekaris 2017; Nijman et al. 2018) and C.R. Shepherd (Shepherd et al. 2016). In more recent years, several research groups have focused on the bird trade in Jakarta, with some

based on one-off surveys (Chng et al. 2015) and others having a more sustained presence (Nijman et al. 2019).

Data collection

We used published and unpublished survey reports to compile Sunda laughingthrush trade records across 39 locations throughout western Indonesia from December 1991 to February 2020 (Table 1). These data were collected by diverse teams of people, many involving one or more co-authors of this paper, working in different settings over these three decades. Work was conducted as part of scientific research programmes with the collaboration of the Indonesian Institute of Sciences (LIPI), or more recently, the Ministry of Research, Technology and Higher Education of the Republic of Indonesia (RISTEK), or as part of a Memorandum of Understanding between Universitas Gadjah Mada and Oxford Brookes University. Some data were collected as part of agreements between the Indonesian Ministry of Forestry and NGOs, including BirdLife, WWF, TRAFFIC and the Leuser Ecosystem Management Agency, or it fell under the remit of local NGOs or Indonesian researchers working on various aspects of natural resource management or biodiversity conservation.

Most of the surveys were carried out on the Indonesian islands of Bali, Java, Kalimantan (Indonesian Borneo) and Sumatra. Besides Jakarta (n = 69 surveys) and Medan (n = 66), five locations were subjected to more than ten surveys: Garut (n = 63), Bandung (n = 24), Tasikmalaya (n = 15) and Cirebon (n = 12), all located in the province of West Java; Surabaya (n = 17) in East Java, and Denpasar on Bali (n = 11). All surveys used similar research methods, recording all birds openly for sale to a species level and, where possible, to a subspecies level. The surveyed bird markets differed in size, ranging from a dozen or so small shops along the side of a street, selling small numbers of birds, to massive four-story bird markets with hundreds of shops offering tens of thousands of birds. For details, we refer to Nijman et al. (2018), which lists all bird markets on the islands of Java, Bali and Lombok, and Chng et al. (2018) and Rentschlar et al. (2018), which provide details on the bird markets in Sumatra and Kalimantan, respectively. Surveyors typically spent several hours in larger markets, visiting each stall or shop to ensure all birds, including Sunda laughingthrushes, were recorded (Shepherd 2006; Chng et al. 2015; Nijman et al. 2017). Prices (in IDR) were collected opportunistically and all prices mentioned here refer to first quotes. As Indonesia's bird markets are open to the public, no undercover techniques were employed.

Many of the bird markets that were surveyed in the 1990s, such as Pramuka in Jakarta, Bratang and Turi in Surabaya and Satria in Denpasar, are still operating in the same location, whereas others have moved to a different location and have changed name, such as Ngasem (now Pasty) in Yogyakarta. Some markets, including Jatinegara in Jakarta, were insignificant in the 1990s but have expanded over time. While for part of our analysis we rely on third-party data, we are confident that we are in a position to give an Indonesia-wide overview of the trade in Sunda laughingthrushes as three of the authors (C.R.S, M.A.I., V.N.) have visited most of the bird markets at least once, and many of them multiple times over the last three decades.

Analysis

For analytical purposes, a survey was defined as a one-off market assessment in one city. Such an assessment may consist of multiple markets within a city. This analysis includes 365 surveys, taken from eleven separate studies. In five instances, different parties, as parts of different studies, conducted separate surveys in one location within the same month. In these cases, only one of the two datasets, i.e. the one that was part of the larger survey with the longest runtime and not necessarily the one that recorded the largest number of Sunda laughingthrushes, were used to avoid duplication. All other data used come from surveys that were carried out at least 1 month apart. Two studies specifically report on turnover of laughingthrushes in Indonesia. Shepherd et al. (2020) reported that for the bird market in Garut in West Java, 90% of the Chestnut-capped laughingthrush (*G. mitratus*) was sold within 7 days and for the Black-capped laughingthrush (*G. chinensis*) 50% were sold within 15 days. Nijman et al. (2020) reported that the rufous-fronted laughingthrush (*G. rufifrons*) in bird markets in western Java were sold on average within 15 days (range 3 to 36 days). As such, duplication of records in our assessment is likely to be minimal. When a study covered multiple months, the midpoints of the research period were selected for analysis.

Prices in IDR were corrected for inflation to 2020 prices using an online inflation calculator and then converted to USD as of February 2020. Each year, Indonesia announces its government-recommended minimum monthly wage for each city and each province. Jakarta generally has the highest recommended minimum monthly wage, after Bekasi, but annual increases in the recommended minimum monthly wage in percentage of the previous year are similar between cities. We used the numbers for Jakarta as an indication of purchasing power (Anonymous 2020).

We used a generalised linear model (GLM) to assess whether the number of Sunda laughingthrushes recorded varied over the period sampled. We fitted the nonlinear effect using a penalized cubic splines function (cs). To account for effort, we included the number of surveys conducted per period as a variable in the model. We also ran a GLM to assess whether the number of surveys with the presence of Sunda laughingthrushes increased with an increase in the effort of

Table 1 Numbers of Sunda laughingthrush *Garrulax palliates* found in bird markets across western Indonesia, gathered from published and unpublished market data for the period from December 1991 to February 2020

Month(s) of survey	Location (city, province)	No. of surveys	No. of positive surveys	Total no. of birds	Mean number of birds	Source
Dec 1991–May 1993	Bandung, W Java	1	33	1600*	42.1	A
	Bogor, W Java	2				
	Jakarta, Java	27				
	Yogyakarta, Java	1				
	Surabaya, E Java	1				
	Palembang, S Sumatra	2				
	Medan, N Sumatra	1				
	Denpasar, Bali	2				
	Makassar, S Sulawesi	1				
Jan–Dec 1997	Medan, N Sumatra	11	11	400	36.4	B
Jan–Dec 1998	Medan, N Sumatra	12	12	425	35.4	B
Jan–Dec 1999	Medan, N Sumatra	12	12	884	73.7	B
Jan–Dec 2000	Medan, N Sumatra	12	12	364	30.3	B
Jan–Dec 2001	Medan, N Sumatra	12	12	260	21.7	B
2005 (unspecified)	Medan, N Sumatra	2	2	18	9.0	C
2007 (unspecified)	Medan, N Sumatra	1	1	6	6	C
Jul 2008	Medan, N Sumatra	2	2	2	1.0	C
Jul 2014	Jakarta, Java	1	1	180	180	D
Jun 2015	Yogyakarta, Java	1	1	34	34.0	E
Jun 2015	Surabaya, E Java	1	1	2	2.0	E
Jun 2015	Malang, E Java	1	1	1	1	E
Jul 2015–Aug 2016	Pontianak, W Kalimantan	3	0	0	0.0	G
Jul 2015–Aug 2016	Pontianak to Sambas, W Kalimantan	3	0	0	0.0	G
Jul 2015–Aug 2016	Pontianak to Kapuas Hulu, W Kalimantan	3	0	0	0.0	G
Jul 2015–Aug 2016	Pontianak to Ketapang, W Kalimantan	3	0	0	0.0	G
Aug 2016	Cirebon, W Java	1	1	20	20	I
Aug–Dec 2016	Garut, W Java	5	2	2	0.4	I
Aug–Dec 2016	Jakarta, Java	3	2	30	10.0	I
Aug–Dec 2016	Tasikmalaya, W Java	2	1	1	0.5	I
Aug 2016–Feb 2017	Banjarmasin, S Kalimantan	1	1	22	22	G
Aug 2016–Feb 2017	Palangkaraya, C Kalimantan	1	na (> 0)	6	6	G
Aug 2016–Feb 2017	Balikpapan, E Kalimantan	1			0	G
Aug 2016–Feb 2017	Samarinda, E Kalimantan	1			0	G
Aug 2016–Feb 2017	Tanjung Selor, N Kalimantan	1			0	G
Sep 2016	Bandung, W Java	1	1	1	1	F
Jan–Dec 2017	Jakarta, Java	18	17	100	5.6	I
Jan–Dec 2017	Cirebon, W Java	5	5	64	12.8	I
Jan–Dec 2017	Garut, W Java	24	2	2	0.1	I
Jan–Dec 2017	Tasikmalaya, W Java	4	4	4	1.0	I
Feb 2017	Jambi, Jambi	1	1	3	3	J
Feb 2017	Medan, N Sumatra	1	1	2	2	J
Feb 2017	Pekanbaru, Riau	1	0	0	0	J
Feb 2017	Palembang, S Sumatra	1	0	0	0	J
Feb–Dec 2017	Bandung, W Java	9	5	21	2.3	I
Mar 2017	Jakarta, Java	2**	2**	12**	6**	H
Mar–Nov 2017	Semarang, C Java	5	2	3	0.6	I
May 2017	Sukabumi, W Java	2	0	0	0.0	H

Table 1 (continued)

Month(s) of survey	Location (city, province)	No. of surveys	No. of positive surveys	Total no. of birds	Mean number of birds	Source
May 2017	Surabaya, E Java	1	0	0	0	H
May–Sep 2017	Surakarta, C Java	2	2	3	1.5	I
May–Nov 2017	Denpasar, Bali	4	4	29	7.3	I
Sep 2017	Jakarta, Java	1**	1**	52**	52**	H
Sep–Nov 2017	Sukabumi, W Java	2	1	1	0.5	H
Jan 2018	Cicurung, W Java	1	0	0	0	H
Jan 2018	Sukabumi, W Java	1	0	0	0	H
Jan–Aug 2018	Denpasar, Bali	4	4	61	15.3	I
Jan–Nov 2018	Surakarta, C Java	3	2	3	1.0	I
Jan–Dec 2018	Jakarta, Java	12	11	318	26.5	I
Jan–Dec 2018	Cirebon, W Java	4	4	76	19.0	I
Jan–Dec 2018	Garut, W Java	24	5	5	0.2	I
Jan–Dec 2018	Tasikmalaya, W Java	4	4	13	3.3	I
Feb–Sep 2018	Yogyakarta, Java	5	4	9	1.8	I
Feb–Oct 2018	Semarang, C Java	4	1	1	0.3	I
Feb–Nov 2018	Surabaya, E Java	8	5	16	2.0	I
Mar 2018	Jakarta, Java	1**	1**	250**	250**	H
Mar–Nov 2018	Bandung, W Java	6	3	17	2.8	I
May 2018	Jakarta, Java	1**	1**	94**	94**	H
May 2018	Surabaya, E Java	1**	0**	0**	0**	H
May–Jun 2018	Mataram, Lombok	3	2	5	1.7	I
May–Jun 2018	Banyuwangi, E Java	3	0	0	0.0	I
May–Jun 2018	Bondowoso, E Java	3	0	0	0.0	I
May–Jun 2018	Jember, E Java	1	1	1	1	I
May–Jun 2018	Probolinggo, E Java	3	0	0	0.0	I
Jun 2018	Cicurung, W Java	1	0	0	0	H
Jun 2018	Yogyakarta, Java	1	1	3	3	I
Jun 2018	Temanggung, C Java	1	0	0	0	I
Jun–Oct 2018	Malang, E Java	2	1	2	1.0	I
Jan 2019	Yogyakarta, Java	1	0	0	0	I
Jan 2019	Denpasar, Bali	1	0	0	0	I
Jan–Jun 2019	Tasikmalaya, W Java	2	2	3	1.5	I
Jan–Jun 2019	Garut, W Java	10	2	2	0.2	I
Jan–Jun 2019	Jakarta, Java	6	6	42	7.0	I
Jan–Jun 2019	Bayongbong, W Java	3	3	3	1.0	I
Feb 2019	Cianjur, W Java	1	1	3	3	I
Feb–Jun 2019	Sukabumi, W Java	2	2	2	1.0	I
Mar 2019	Bandung, W Java	3	1	4	1.3	I
Mar 2019	Surakarta, C Java	1	1	1	1	I
Mar–May 2019	Surabaya, E Java	3	3	38	12.7	K
May 2019	Sidoarjo, E Java	1	1	7	7	K
May 2019	Semarang, C Java	1	1	6	6.0	I
Jun 2019	Mataram, Lombok	1	1	1	1.0	K
Jun 2019	Makassar, S Sulawesi	1	1	20	20.0	K
Jun 2019	Cirebon, W Java	1	1	2	2.0	I
Nov 2019	Sukabumi, W Java	1	0	0	0	I
Nov 2019–Feb 2020	Jakarta, Java	2	2	61	30.5	I
Nov 2019–Feb 2020	Bogor, W Java	4	4	6	1.5	I

Table 1 (continued)

Month(s) of survey	Location (city, province)	No. of surveys	No. of positive surveys	Total no. of birds	Mean number of birds	Source
Nov 2019–Feb 2020	Bandung, W Java	4	4	34	8.5	I
Nov 2019–Feb 2020	Tasikmalaya, W Java	3	0	0	0	I
Dec 2019	Depok, W Java	1	0	0	0	I
Dec 2019	Cianjur, W Java	1	1	5	5.0	I
Feb 2020	Surabaya, E Java	1	1	19	19.0	I
Feb 2020	Cirebon, W Java	1	1	2	2.0	I
Total		365	241	5,281		

A = Nash (1993); B = Shepherd (2006); C = Shepherd (2010); D = Chng et al. (2015); E = Chng and Eaton (2016); F = Chng et al. (2016); G = Rentschlar et al. (2018); H = unpublished data; I = Oxford Wildlife Trade Group/Universitas Gadjah Mada/Little Fireface Project 2019–2020 (non-published); J = Chng et al. (2018); K = Monitor (2019) (non-published)

*Approximate number

**Left out of analysis to avoid possible duplication of records acquired during the same period by I

surveys. To detect the difference in the trend of the number of Sunda laughingthrushes recorded between the cities sampled, we ran a GLM with the annual average Sunda laughingthrushes recorded over the years for each city. In addition, to assess how prices of Sunda laughingthrushes changed over time and according to the government-recommended minimum wage for Jakarta, we ran a GLM between the mean price recorded and the years of monitoring and between the proportion represented of the government-recommended minimum wage and the years of monitoring.

We used R 3.6.3 (http://www.R-project.org/) for all statistical analysis. For running all GLMs, we used the R-package gamlss (version 5.1-6) and the gamma distribution or zero-adjusted gamma distribution. A generalised R-square was calculated using the function 'Rsq' of gamlss. We used R-package ggplot2 (version 3.3.0) for plotting the graphs. We accept significance when $p < 0.05$ in a two-tailed test.

Results

Presence

For most of the 1990s, 2000s, and the first half of the 2010s, Sunda laughingthrushes were encountered during each survey in the bird markets of western Indonesia. Nash (1993) recorded them in 87% of his surveys, but he also visited areas in eastern Indonesia, where they do not occur. From 2015

Table 2 Details on the generalised linear and additive models tested

Response variable	Predictor variable	Estimate	Std. Error	*t*	*p*	R^{2a}	$\Delta AIC_{(Null)}$ [b]
Mean of individuals recorded	(Intercept)	177.80	4.424	40.2	< 0.0001*	0.32	9.67
	cs (Time)	− 0.087	0.002	− 39.6	< 0.0001*		
Proportion of positive surveys	(Intercept)	− 0.152	0.075	− 2.0	< 0.05*	0.07	0.66
	Number of surveys	− 0.008	0.004	− 1.7	0.09		
Number of birds recorded in Medan	(Intercept)	369.20	2.953	125.1	< 0.0001*	0.76	− 10.68
	Time	− 0.031	0.001	124.1	< 0.0001*		
Number of birds recorded in Jakarta	(Intercept)	65.844	14.2809	4.611	0.0995	0.04	2.1
	Time	− 0.031	0.007	− 4.3	0.01*		
Asking prices	(Intercept)	212.40	2.080	0.1	< 0.0001*	0.6	7.25
	Time	0.107	0.001	103.8	< 0.0001*		
Price in percentage of Jakarta minimum wage	(Intercept)	− 429.82	638.582	− 0.67	0.522	0.05	1.5
	Time	0.220	0.317	0.7	0.51		

[a] Generalised *R*-square

[b] Difference between the AIC of the model selected and the null model

*$p < 0.05$

onwards, we start to see a decrease, and in 2019, the species was typically recorded in 50% of the surveys. This coincided with an increase in surveying effort, but we did not find a statistically significant relationship between survey effort (number of visits in a given year) and the proportion of surveys that record the species so changes in survey effort would not account for the observed declines.

Numbers

A total of 5,281 Sunda laughingthrushes (both subspecies combined) were recorded across the 11 studies (Table 1). The species was encountered in roughly two-thirds of the surveys (241/365). Four cities that stand out for their high number of Sunda laughingthrushes in trade were Medan (averaging ~ 36 birds/survey), Jakarta (~ 17 birds/survey), Cirebon (~ 14 birds/survey) and Denpasar (~ 10 birds/survey). A fifth city, Banjarmasin in South Kalimantan, was surveyed only once, but a relatively high number of birds ($n = 22$), was recorded. These five cities cover a wide area in western Indonesia, showing that Sunda laughingthrushes are indeed traded in substantial numbers throughout this part of the country.

We found a positive relationship between survey effort and the number of surveys in which the species was recorded (GLM: $R = 0.89$, $R^2 = 0.79$, Est 0.709, Std. Error 0.061, $t = 11.5$, $p < 0.0001$) as well as between survey effort and the number of Sunda laughingthrush recorded per survey (GLM: $R = 0.74$, $R^2 = 0.55$, Est 0.119, Std. Error 0.034, $t = 3.4$, $p = 0.0009$). A statistically significant decline over time is observed when considering the number of recorded Sunda laughingthrushes, controlled by the number of surveys applied (GLM: $R = 0.74$, $R^2 = 0.55$, Est − 0.104, Std. Error 0.002, $t = -66.7$, $p < 0.0001$) (Fig. 1, Table 2). When looking at the cities of Medan and Jakarta specifically, a statistically significant decline over time is observed in Medan (GLM: $R = 0.87$, $R^2 = 0.76$, Est − 0.183, Std. Error 0.001, $t = 124.1$, $p < 0.0001$), but no significant decline is observed in Jakarta (GLM: $R = 0.20$, $R^2 = 0.04$, Est − 0.031, Std. Error 0.007, $t = -4.3$, $p = 0.01$) (Fig. 2, Table 2).

Prices

The asking price of Sunda laughingthrushes has increased significantly over time, even when corrected for inflation (GLM: $R = 0.80$, $R^2 = 0.64$, Est 2.82, Std. Error 0.017, $t = 163.0$, $p < 0.0001$) (Fig. 3, Table 2). In the late 2000s, the asking price was around USD10 to USD15 in today's prices. This has increased to USD35 to USD55 at present. While inflation has been taken into account, in terms of purchasing power as expressed as a percentage of the government-recommended minimum wage for Jakarta, prices have not changed significantly over time (GLM: $R = 0.21$, $R^2 = 0.04$, Est 0.220, Std. Error 0.317, $t = 0.7$, $p = 0.51$). Over the last 14 years, the price of a Sunda laughingthrush has been around 14% of the minimum wage.

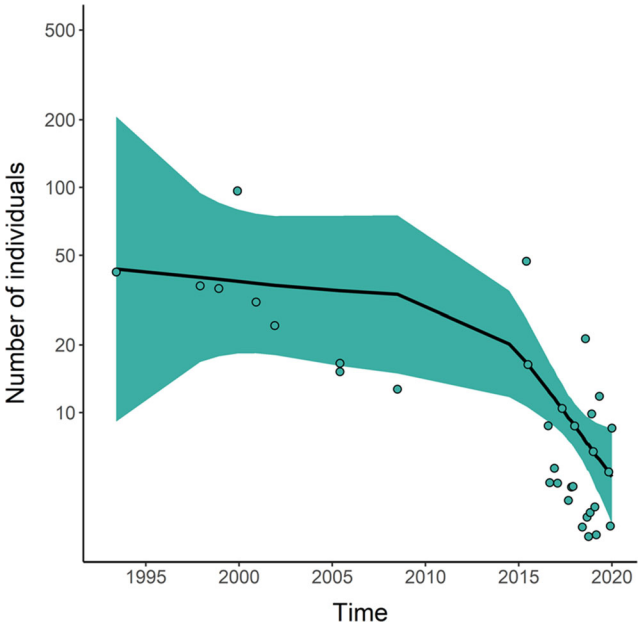

Fig. 1 Numbers of Sunda laughingthrush (*Garrulax palliatus*) found in bird markets across western Indonesia between December 1991 and February 2020

Discussion

We record a significant and ongoing trade in Sunda laughingthrushes in a large number of bird markets throughout western and central Indonesia; in recent years, the numbers have been somewhat lower than in the 1990s, but still are well above the harvest limits set by the Indonesian authorities. Our study is one of only a handful that report the trade in songbirds, or indeed any other animal, over three decades from a large number of bird markets. It also offers a model whereby analysis of wildlife trade over extended periods of time covering vast geographic regions may offer insights that are easily missed when efforts are too focused on single markets over short periods of time. Many of the bird markets included in our survey were visited multiple times in the 1990s, 2000s and 2010s. While our datasets were collected by different teams, at variable time intervals, and differing in their geographical coverage, our study gives the most comprehensive, and in our opinion, representative overview of trade in Sunda laughingthrushes. The proportion of surveys during which we did record the species went down from ~ 90% or more in the 1990s and 2000s to ~ 60% in the 2010s, with no indication of a gradual decline. The number of birds we recorded in the bird markets also declined over this period—it appears from our data that numbers remained relatively stable

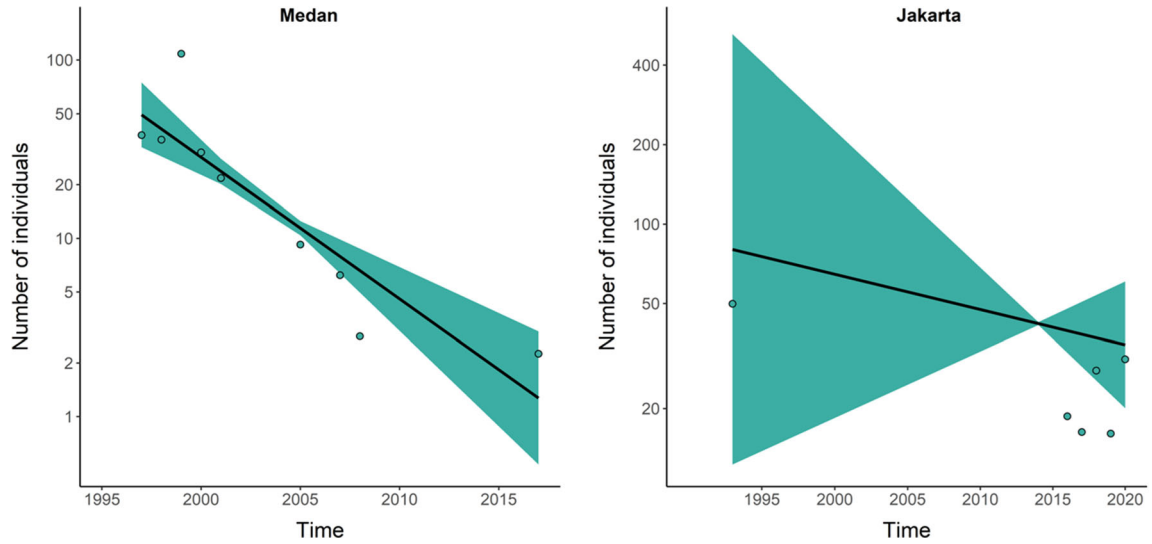

Fig. 2 Numbers of Sunda laughingthrush (*Garrulax palliatus*) found in bird markets in Medan (January 1997–February 2017) and Jakarta (May 1993–February 2020). Only in Medan is the negative trade trend significant

over the period 1991 to 2008, then gradually decreased between 2009 and 2015 and the decline is more steep in the last 5 years (Fig. 1). In line with the countrywide findings, we found a decrease in the number of laughingthrushes in the bird markets of Medan, but we did not find a similar decrease in Jakarta, suggesting a complex pattern of availability and demand. We expected prices to increase, but here the data we have are not incontrovertible. While we did see a clear and significant increase in the asking prices (even after correcting for inflation), this seems to have occurred on the back of a general increase in purchasing power, or at least on the back of a general increase in the minimum wages. As such, in terms of the percentage of one's monthly wage, prices of Sunda laughingthrushes remained more stable. Our findings are largely in agreement, but in various aspects provide more detail, with other studies conducted in Indonesia (Burilova et al. 2017; Bušina et al. 2018; Harris et al. 2015, 2016; Marshall et al. 2019; Nijman et al. 2018; Rentschlar et al. 2018; Shepherd 2006).

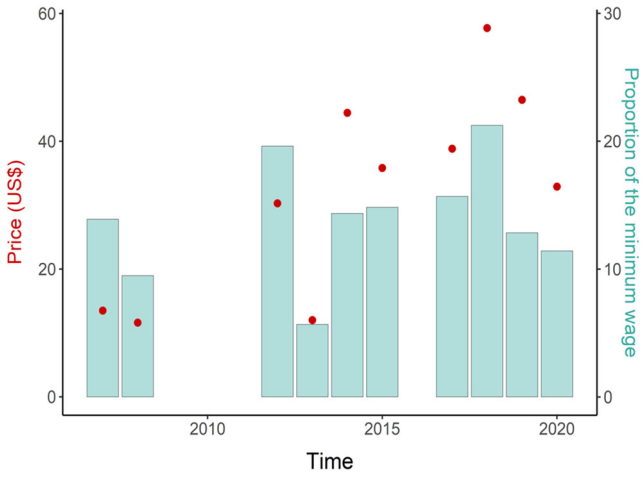

Fig. 3 Asking price of a Sunda laughingthrush (*Garrulax palliatus*) in western Indonesia, in USD, corrected for inflation to 2020 values (circles), and as a percentage of the government-recommended minimum wage for Jakarta (bars)

The reported Sunda laughingthrush trade volumes attest to the species' popularity in the Indonesian songbird trade. An overall decrease in trade numbers was nevertheless observed. Continuing popularity and availability of other laughingthrush species such as the Sumatran laughingthrush (*G. bicolor*) (Shepherd 2013; Bušina et al. 2018) and the rufous-fronted laughingthrush (*G. rufifrons*) (Nijman et al. 2020) further suggest that population declines, rather than a change in consumer behaviour, are the reason behind falling Sunda laughingthrush trade volumes. Fallen trade numbers in Medan's markets correspond with reported wild population declines in Sumatra (BirdLife International 2018), further suggesting decreased availability to be an important factor in the observed lower volumes of Sunda laughingthrushes observed in trade over time. Traders in the bird markets in Jakarta source their birds from a wider geographical range (i.e. Sumatra and Kalimantan, or even the non-Indonesian part of Borneo) and thus any lower availability in one region (e.g. Sumatra) may be offset by switching the sourcing to other regions. The increased scarcity of the species in markets is also reflected by a significant increase in price over time.

Although the explicit distinction between the two subspecies was not made during each of the analysed surveys, available data from surveys in which this distinction was made suggests that the majority of the Sunda laughingthrushes found in trade in Java and Sumatra are *G. p. palliatus* rather than *G. p. schistochlamys*; during four surveys across eight Javan bird markets in 2014 and 2015, Shepherd et al. (2016)

found 215 Sunda laughingthrushes, only two of which were of the *schistochlamys* subspecies. Accessibility may play an important role in the discrepancy between the availability of the two subspecies in markets. The largest confirmed record of *G. p. schistochlamys* in our study involved a total of 20 birds, found in a market in Makassar, Sulawesi in June 2019, which is outside the natural range of this species and may represent a fresh shipment of birds, which would explain the relatively high, concentrated volume.

As no commercial captive breeding records are known to the authors, it is assumed that all individuals observed in trade were sourced from the wild. This assumption is further corroborated by a recent study of consumer attitudes in the Indonesian bird trade where 13 laughingthrushes of at least five species were reportedly kept by interviewees and only one, a Black laughingthrush (*G. lugubris*), was claimed to have been bred in captivity (Burilova et al. 2017). Captive breeding has been suggested as a potential way to ensure the sustainability of Indonesia's songbird trade (Jepson et al. 2011). Although well-regulated captive breeding efforts may indeed contribute to the conservation of songbirds, they could only be effective if customer preferences were to shift towards captive-bred birds (Phelps et al. 2014) and if strict and efficient enforcement structures were put into place to prevent the laundering of wild-caught birds through captive breeding channels. Furthermore, the various species in question would have to be suited for commercial-scale reproduction in captivity (Phelps et al. 2014).

Only two of the seven native laughingthrush species (Sumatran laughingthrush and rufous-fronted laughingthrush) are currently protected under Indonesia's wildlife laws. But trade does not only affect legally protected songbirds (Nijman et al. 2019). As mentioned, the harvesting of Sunda laughingthrushes is nevertheless regulated through a quota system under Government Regulation no. 8/1999 on wild flora and fauna exploitation and the Decree of the Minister of Forestry no. 447/Kpts-II/2003. We were only able to obtain harvest quotas for Sunda laughingthrushes for 14 years. For 11 of these 14 years (1987 to 1993, 2008, 2010, 2015 and 2016), the quotas for Sunda laughingthrush were set at zero, effectively prohibiting the capture of wild birds. Despite this, large quantities of Sunda laughingthrushes were found illegally for sale in the markets during most of those years. For 2018 and 2019, the harvest quota was set at 150 (for Jambi province on Sumatra exclusively), yet the numbers we observed in 2018 were three times that. In 2020, the quota was increased to 450 (250 for Jambi province and 200 for West Sumatra), notwithstanding reported population declines on Sumatra (BirdLife International 2018). Additionally, although no export quota for the species were set for any of the 14 years, two Sunda laughingthrushes were found for sale at the biannual Zwolle Bird Market in Zwolle, the Netherlands (now AviMarkt Europe) on 23 February 2019 (B. Leupen, pers. obs.), which indicates illegal origins. International trade is not indicated on the species' IUCN Red List assessment but appears to occur to at least some extent.

The apparent unhindered exceedance of allotted harvest quotas, in combination with overall declining Sunda laughingthrush trade volumes as well as price increases, suggests that at least several populations of the species, and particularly on Sumatra, are threatened by trade, and as such, the following recommendations are made:

- The Government of Indonesia is urged to provide full protection for the Sunda laughingthrush, which would prohibit all capture and commercial trade in wild-caught individuals of the species. While at present there is no indication that international trade in Sunda laughingthrushes is significant, it may be prudent to properly investigate the levels of international trade, and if this is deemed substantial and a potential impediment to the conservation of the species, additional regulation through CITES may be warranted.
- Greater focus and resources should be directed to community engagement within the range of the Sunda laughingthrush to educate trappers and wildlife traders on the illegality and unsustainability of the trade and the consequent impact on livelihoods. Empowering local communities in finding solutions to prevent species decline has been suggested as an effective tool in combatting the illegal wildlife trade (Hubschle and Shearing 2018; Roe and Booker 2019).
- The feasibility of captive breeding efforts for the species should be explored by experts in this field. The success of such efforts highly depends on a myriad of factors, including economic viability and effective regulation to prevent the laundering of wild-caught species, and evidence that commercial breeding will in fact remove pressure from wild populations (Phelps et al. 2014).
- The Government of Indonesia is strongly encouraged to take strong actions against individuals trapping, selling or keeping illegally sourced songbirds such as the Sunda laughingthrush, and to close markets or shops that continue to sell species in violation of the Indonesian Law. Increased regulations, systematic monitoring and management requirements may be viewed as increasing burdens on the Indonesian Government, but this can be achieved not only through an increase in funding but also by strengthened institutions, improved capacity and greater collaboration.

Acknowledgements Many thanks to Jonathan Beilby for his contributions to this paper, to Thais Morcatty for statistical assistance, to Loretta Shepherd for useful comments and edits, and to the editor and two reviewers for constructive comments and suggestions for improvement.
Funding We thank Fondation Segré (BL, CRS, LG), Cleveland Zoological Society and Cleveland Metroparks Zoo, People's Trust for Endangered Species and Columbus Zoo (KAIN, VN) for funding this work. BL, CRS and LG's work on this paper was funded by Fondation

Segré. KAIN and VN's work on this paper was funded by Cleveland Zoological Society and Cleveland Metroparks Zoo, People's Trust for Endangered Species, and Columbus Zoo. MAI received no additional funding for his work on this paper.

Data availability The datasets that were generated and/or analysed during the current study can be obtained from the corresponding author on request.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interests.

Code availability Not applicable.

References

Anonymous (2020) Upah minimum provinsi DKI Jakarta 2015-2020. Statistik Sektorial Provinsi DKI Jakarta. Jakarta, Indonesia

BirdLife International (2018) *Garrulax palliatus*. The IUCN Red List of Threatened Species 2018. https://doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22715589A131801551.en. Accessed 15 March 2020

Blair ME, Le MD, Sethi G, Thach HM, Nguyen VT, Amato G, Birchette M, Sterling EJ (2017) The importance of an interdisciplinary research approach to inform wildlife trade management in Southeast Asia. BioScience 67:995–1003

Brickle NW, Eaton JA, Rheindt FE (2010) A rapid bird survey of the Menyapa mountains, East Kalimantan, Indonesia. Forktail 26:31–41

Burilova Z, Lee TM, Hua F, Lee JSH, Prawiradilaga DM, Wilcove DS (2017) Understanding consumer preferences and demography in order to reduce the domestic trade in wild-caught birds. Biol Conserv 209:423–431

Bušina T, Pasaribu N, Kouba M (2018) Ongoing illicit trade of Sumatran Laughingthrush *Garrulax bicolor*: one-year market monitoring in Medan, North Sumatra. Kukila 21:27–34

Chng SCL, Eaton JA (2016) In the market for extinction: Eastern and Central Java. TRAFFIC Southeast Asia, Petaling Jaya

Chng SCL, Eaton JA, Krishnasamy K, Shepherd CR, Nijman V (2015) In the market for extinction: an inventory of Jakarta's bird markets. TRAFFIC, Petaling Jaya Selangor

Chng SCL, Guciano M, Eaton JA (2016) In the market for extinction: Sukahaji, Bandung, Java, Indonesia. BirdingAsia 26:22–28

Chng SCL, Shepherd CR, Eaton JA (2018) In the market for extinction: birds for sale in selected outlets in Sumatra. TRAFFIC Bull 30:15–22

Collar NJ, Robson C (2019) Sunda Laughingthrush (*Garrulax palliatus*). In: del Hoyo J, Elliott A, Sargatal J, Christie DA, de Juana E (eds) Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona https://www.hbw.com/node/59604. Accessed 1 March 2020

Collar NJ, van Balen S (2013) Notes for the conservation of the rufous-fronted laughingthrush *Garrulax rufifrons*. Forktail 29:15–18

Eaton JA, Shepherd CR, Rheindt FE, Harris JBC, van Balen S, Wilcove DS, Collar NJ (2015) Trade-driven extinctions and near-extinctions of avian taxa in Sundaic Indonesia. Forktail 31:1–12

Harfoot M, Glaser SA, Tittensor DP, Britten GL, McLardy C, Malsch K, Burgess ND (2018) Unveiling the patterns and trends in 40 years of global trade in CITES-listed wildlife. Biol Conserv 223:47–57

Harris JBC, Green JMH, Prawiradilaga DM, Giam X, Giyanto, Hikmatullah D, Putra CA, Wilcove DS (2015) Using market data and expert opinion to identify overexploited species in the wild bird trade. Biol Conserv 187:51–60

Harris JBC, Tingley MW, Hua F, Yong DL, Adeney JM, Lee TM, Marthy W, Prawiradilaga DM, Sekercioglu CH, Suyadi, Winarni N, Wilcove DS (2016) Measuring the impact of the pet trade on Indonesian birds. Conserv Biol 31:394–405

Hubschle A, Shearing C (2018) Ending wildlife trafficking: local communities as change agents. The Global Initiative Against Transnational Organised Crime, Switzerland

Jepson P, Ladle RJ, Sujatnika (2011) Assessing market-based conservation governance approaches: a socio-economic profile of Indonesian markets for wild birds. Oryx 45:482–491

Karesh WB, Cook RA, Bennett EL, Newcomb J (2005) Wildlife trade and global disease emergence. Emerg Infect Dis 11:1000–1002

Lee JGH, Chng SCL, Eaton JA (eds) (2016) Conservation strategy for Southeast Asian songbirds in trade: recommendations from the first Asian Songbird Trade Crisis Summit 2015 held in Jurong Bird Park, Singapore, 27–29 September 2015. Wildlife Reserves Singapore/ TRAFFIC Southeast Asia

Leupen BT, Krishnasamy K, Shepherd CR, Chng SC, Bergin D, Eaton J, Yukin DA, Hue SKP, Miller A, Nekaris KAI, Nijman V, Sabaan S, Imron MA (2018) Trade in white-rumped shamas *Kittacincla malabarica* demands strong national and international responses. Forktail 34:1–8

Marshall H, Collar NJ, Lees AC, Moss A, Yuda P, Marsden SJ (2019) Spatio-temporal dynamics of consumer demand driving the Asian songbird crisis. Biol Conserv 241:108237

McNamara J, Rowcliffe M, Cowlishaw G, Alexander JS, Ntiamoa-Baidu Y, Brenya A, Milner-Gulland EJ (2016) Characterising wildlife trade market supply-demand dynamics. PLoS One 11:a0162972

Nash SV (1993) Sold for a song: the trade in Southeast Asian non-CITES birds. TRAFFIC Southeast Asia, Petaling Jaya

Nijman V (2010) An overview of international wildlife trade from Southeast Asia. Biodivers Conserv 19:1101–1114

Nijman V, Nekaris KAI (2017) The Harry Potter effect: the rise in trade of owls as pets in Java and Bali, Indonesia. Glob Ecol Conserv 11:84–94

Nijman V, Shepherd CR, van Balen S (2009) Declaration of the Javan hawk eagle *Spizaetus bartelsi* as Indonesia's National Rare Animal impedes conservation of the species. Oryx 43:122–128

Nijman V, Sari SL, Siriwat P, Sigaud M, Nekaris KAI (2017) Observation of four critically endangered songbirds in the markets of Java suggest domestic trade as a major impediment to their conservation. BirdingAsia 27:20–25

Nijman V, Langgeng A, Birot H, Imron MA, Nekaris KAI (2018) Wildlife trade, captive breeding and the imminent extinction of a songbird. Glob Ecol Conserv 15:e00425

Nijman V, Nekaris KAI, Imron MA (2019) Asian songbird crisis also affects unprotected species. Oryx 53:13–16

Nijman V, Ardiansyah A, Hendrik R, Imron MA, Nekaris KAI (2020) The trade in rufous-fronted laughingthrush *Garrulax rufifrons* in Java. Indonesia, Forktail (in press)

Phelps J, Carrasco LR, Webb EL (2014) A framework for assessing supply-side wildlife conservation. Conserv Biol 28:244–257

Rentschlar KA, Miller AE, Lauck SL, Rodiansyah, Bobby M, Muflihati K (2018) A silent morning: the songbird trade in Kalimantan, Indonesia. Trop Conserv Sci 11:1940082917753909

Roe D, Booker F (2019) Engaging local communities in tackling illegal wildlife trade: a synthesis of approaches and lessons for best practice. Conserv Sci Pract 1:e26

Shepherd CR (2006) The bird trade in Medan, North Sumatra: an overview. BirdingAsia 5:16–24

Shepherd CR (2007) Trade in the black-and-white laughingthrush *Garrulax bicolor* and white-crested laughingthrush *G. leucolophus* in Indonesia. BirdingAsia 8:49–52

Shepherd CR (2010) Observations on trade in laughingthrushes (*Garrulax* spp.) in North Sumatra, Indonesia. Bird Conserv Intern 21:86–91

Shepherd CR (2013) Protection urgently needed for the endemic Sumatran laughingthrush. TRAFFIC Bull 25:53–54

Shepherd CR, Eaton JA, Chng SCL (2016) Nothing to laugh about – the ongoing illegal trade in laughingthrushes (*Garrulax* species) in the bird markets of Java, Indonesia. Bird Conserv Intern 26:524–530

Shepherd CR, Leupen BTC, Siriwat P, Nijman V (2020) International wildlife trade, avian influenza, organised crime and the effectiveness of CITES: the Chinese Hwamei as a case study. Global Ecol Conserv 23:e01185

Smith KF, Behrens M, Schloegel LM, Marano N, Burgiel S, Daszak P (2009) Reducing the risks of the wildlife trade. Science 324:594–595

Sykes B (2017) The elephant in the room: addressing the Asian songbird crisis. BirdingAsia 27:35–41

Zhang L, Hua N, Sun S (2008) Wildlife trade, consumption and conservation awareness in southwest China. Biodivers Conserv 17:1493–1516