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Wildlife trade, captive breeding and the imminent extinction of a songbird

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ABSTRACT

The illegal cage bird trade is increasingly recognised as a major impediment to the survival of a large number of songbirds. Indeed some bird species are now more common in captive private hands than they are in the wild. This includes the black-winged mynas (*Acridotheres melanopterus, A. tricolor* and *A. tertius*), three species of Critically Endangered songbirds endemic to Indonesia. Only 20 years ago these species were not considered globally threatened but high levels of trapping from the wild for the largely domestic cage bird trade has brought all three species to the brink of extinction. It is estimated that less than 500 black-winged mynas remain in the wild. Here we investigate the trade in black-winged mynas, online and in bird markets, and make an assessment of the role captive breeding played in the conservation and management of the species over the period 2009–2018. We found prices peaked in 2014 at ~US$140 (~75% of the monthly minimum wage) per bird and have subsequently gone down to US$85 (now ~33% of the minimum wage), possibly indicating higher supply and lower demand. In 2015–2018 we surveyed seven bird markets in western Java and in 127/145 visits observed 1253 black-winged mynas for sale. Turnover was high, with ~50% of birds sold after one week upon arrival in the market. We estimate that between 1300 and 2300 mynas (retail value ~US$170,000) are sold annually in these seven bird markets. Few birds had closed leg-rings, but were in all likelihood a combination of captive-bred, first-generation captive-born and wild-caught individuals; some appeared to be crossbreeds between the three recognised species. With additional bird markets in Java and Bali and a thriving online trade, we estimate that the number of black-winged mynas in private ownership in Indonesia is in the order of 40,000 birds. Without proper registration and regulation in the trade of captive-bred mynas, even a small amount of wild-caught birds entering this now substantial trade will act as a serious impediment to the conservation of black-winged mynas. With the species already being ecologically extinct, we anticipate that it soon will join the ranks of species like Père David's deer *Elaphurus davidianus* and scimitar-horned oryx *Oryx dammah* that are extinct in the wild but that have captive populations in the tens of thousands. In order to prevent the imminent extinction of black-winged mynas in the wild, we recommend (1) that the Indonesian authorities invest in more effective law enforcement and prosecution of lawbreakers; (2) establishing a multi-stakeholder three species black-winged myna management plan, in which commercial captive breeders participate; and (3) better coordination of reintroduction programmes.

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1. Introduction

Several species have become extinct in the wild but are abundantly present in captivity. Perhaps the most widely known is Père David's deer *Elaphurus davidianus* (Jiang and Harris, 2016). It became extinct in its native China when in 1900 the last individuals of a herd in the Nanyuang Royal Hunting Garden near Beijing were killed (some survived in Beijing Zoo until 1922). By then small captive herds had been established in Europe, and in the decades following, these multiplied so that at present several 1000 of them thrive in captivity. In addition, hybrids between Père David's deer and red deer *Cervus elaphus*, larger than either parent species, are present in herds of several 100s in New Zealand (Tate et al., 1997; Maqbool et al., 2007). On a different continent, the last herds of North Africa's scimitar-horned oryx *Oryx dammah* disappeared in the early 1990s due to overhunting, habitat loss and competition with domestic livestock. The species breeds well in captivity and currently thousands of scimitar-horned oryx are present in various institutions all over the world (Gilbert, 2017). For both Père David's deer and the scimitar-horned oryx managed populations, originating from captive stock, occur in fenced protected areas their respective former range countries (Jiang and Harris, 2016; IUCN SSC Antelope Specialist Group, 2016; Gilbert, 2017; Zheng et al., 2013).

The insatiable demand for cage birds in Indonesia and other parts of Asia has led to what has been termed the Asian Songbird Crisis (Owen et al., 2014; Eaton et al., 2016) and many songbirds may follow the fate of the oryx and deer. While large-scale capturing and trade in songbirds has been ongoing since at least the 1960s, in recent years it has become clear that trade is the major impediment for the survival of many bird species (e.g. Collar et al., 2001; Nijman et al., 2009; Shepherd, 2011; Nijman and Nekaris, 2017; Harris et al., 2015; Eaton et al., 2016; Shepherd et al., 2016a). The trade is most pronounced on the Indonesian island of Java and, to a lesser extent, the neighbouring islands of Bali and Lombok. Here songbirds are openly traded in bird markets (*pasar burung*) or animal markets (*pasar hewan*) that are found in many of the larger cities on these islands (Table 1). Numerous songbirds are ecologically extinct (i.e. due to their absence over large parts of their former range and/or their extremely low abundance where they remain, meaning they no longer play an ecological role). Increasing human populations, with a growing middle class with disposable income, weak governance and rampant corruption, low compliance with bird protection laws and bird trade regulations, and a society where keeping wild, rare and protected birds does not carry a social stigma, hamper effective bird conservation in Indonesia and indeed other parts of Asia.

Collar and Butchart (2014) argued that for their future survival globally, 13 bird species are largely or completely dependent on captive breeding and captive population management. Four of these were Asian birds, including three species from Java and/or Bali, i.e. Javan green magpie *Cissa thalassina*, Bali myna *Leucopsar rothschildi* and black-winged myna *Acridotheres melanopterus*. These birds share their last remaining habitat with an estimated 150 million people (at a density of ~1100 people km^{-2}). We here focus on the black-winged mynas, endemic to the islands of Java, Madura, Bali and Lombok. Also known as black-winged starling (*Sturnus melanopterus*), until recently black-winged starlings were considered to belong to a single species with three clearly defined subspecies, all of which are now considered to be species (*Acridotheres melanopterus*, *A. tricolor* and *A. tertius*), endemic to their respective parts of the islands (del Hoyo et al., 2016). All three species are listed as Critically Endangered by BirdLife (2016a,b,c) because of overharvesting for the pet trade (see below).

Here we report on the largest survey of black-winged mynas in terms of survey effort and geographic coverage to date. Based on repeat visits of bird markets and an online investigation we aimed to establish (a) the magnitude of the trade, i.e. how many birds were present in the bird markets, in what percentage of the surveys did we indeed encounter the species, and how many are traded in Indonesia; (b) what the turnover of black-winged mynas was in these bird markets, i.e. how many were sold (or died while in the market) within a given time period; (c) what the economic value of the trade was, i.e. how much did the birds sell for and what is the monetary gain made by individual traders. We provide information on how trade may affect the three species differently. We discuss the value of captive-bred birds to the conservation of the wild population, provide an overview of legal aspects of the trade in these protected birds and propose an outline for a conservation strategy.

1.1. Legality, protection and the trade in black-winged mynas

Black-winged mynas were added to Indonesia's protected species list in 1979 (Decree by the Ministry of Agriculture, SK Mentan 757/Kpts/Um/12/1979). This was later consolidated into a Government Regulation Number 7 on Protected Animals and Plants (PP 7/1999) where it is listed under the names *Sturnus melanopterus*, Jalak Putih and Kaleng Putih. In July 2018 Indonesia published its new protected species list (P20/MenLHK/SetJen/Kum 1/6/2018) where it includes three species of black-winged myna under their Latin names and newly constructed Indonesian names, based on literal translations of their English names: Jalak Putih - Sayap Hitam (lit: white starling – black wing), Jalak Putih - Punggung Abu (lit: white starling – grey back), and Jalak Putih - Tunggir Abu (lit: white starling – grey rump). The species' [single or plural] inclusion on the protected species list makes it illegal to catch, transport, and trade black-winged mynas or transfer them from one place to another, within or outside Indonesia. Penalties that can be imposed when these laws are broken can total fines of up to IDR 100, 000, 000 (~US$ 7250) and imprisonment for up to five years (sentences are lower if the offences were committed unintentionally).

Despite this formal protection, black-winged mynas have been observed in trade for decades, and as with many legally

Table 1
Bird markets in Java, Bali and Lombok in relation to the (historical) distribution range of three species of black-winged myna. Small markets have typically less than 20 shops, medium markets comprise between 20 and 49 shops and large markets comprise 50 to >200 shops (markets do vary in size, with often more shops open on weekends, and fluctuate somewhat in size over the years, but generally will remain within their respective size classes).* Based on this study; V. Nijman and K.A.I. Nekaris, unpublished data 2012–2018; Chng and Eaton 2015; ProFauna 2009.

Species range	Province/District	Market	Human population (x million)	Market size	Black-winged myna recorded*
A. melanopterus	Banten	Serang	0.6	small	no
A. melanopterus	Banten	Tangerang, Cileduk	2.8	small	no
A. melanopterus	DKI Jakarta	Jakarta, Pramuka	10.0	large	yes
A. melanopterus	DKI Jakarta	Jakarta, Jatinegara	10.0	large	yes
A. melanopterus	DKI Jakarta	Jakarta, Barito	10.0	medium	yes
A. melanopterus	W Java	Bogor, T Empang	1.0	medium	no
A. melanopterus	W Java	Bogor, Pasar Bogor	1.0	small	no
A. melanopterus	W Java	Cianjur	0.2	medium	yes
A. melanopterus	W Java	Sukabumi	0.3	small	yes
A. melanopterus	W Java	Bandung, Sukahaji	2.3	large	yes
A. melanopterus	W Java	Bandung, Jl Rajiman	2.3	small	no
A. melanopterus	W Java	Sumedang	0.2	small	no
A. melanopterus	W Java	Purwakarta	0.2	small	yes
A. melanopterus	W Java	Garut, Mawar	0.1	small	yes
A. melanopterus	W Java	Garut, Kerkhof	0.1	small	yes
A. melanopterus	W Java	Cirebon, Plered	0.3	medium	yes
A. melanopterus	W Java	Tasikmalaya, Cikurubuk	0.7	medium	yes
A. melanopterus	W Java	Ciamis, Manis	0.1	medium	no
A. melanopterus	C Java	Sragen	0.1	medium	yes
A. melanopterus	C Java	Purwokerto, Wage	0.2	medium	yes
A. melanopterus	C Java	Pekalongan	0.3	small	no
A. melanopterus	C Java	Kebumen	0.1	small	no
A. melanopterus	C Java	Tegal	0.3	small	no
A. melanopterus	C Java	Purworejo	–	medium	no
A. melanopterus	C Java	Temanggung	–	medium	yes
A. melanopterus	C Java	Semarang, Karimata	1.6	medium	yes
A. melanopterus	C Java	Kudus	0.1	small	no
A. melanopterus	C Java	Jepara	0.1	medium	no
A. melanopterus	C Java	Muntilan, Mekar	–	medium	no
A. melanopterus	C Java	Surakarta, Depok	0.6	large	yes
A. melanopterus	C Java	Ambarawa	0.1	medium	no
A. melanopterus	C Java	Wonosobo	0.1	medium	no
A. melanopterus	C Java	Salatiga	0.2	large	no
A. melanopterus	DI Yogyakarta	Yogyakarta, Pasti	0.4	large	yes
A. melanopterus	E Java	Madiun, Joyo	0.2	medium	no
A. melanopterus	E Java	Ngawi, Mantingan	0.1	medium	no
A. melanopterus	E Java	Kediri, Setono Betek	0.3	small	no
A. melanopterus	E Java	Bojonegoro, B Solo	0.1	small	yes
A. melanopterus	E Java	Jombang, Tunggorono	–	small	no
A. melanopterus	E Java	Surabaya, Bratang	2.8	large	yes
A. melanopterus	E Java	Surabaya, Turi	2.8	medium	yes
A. melanopterus	E Java	Surabaya, Kupang	2.8	large	yes
A. melanopterus	E Java	Malang, Senggol	0.8	large	yes
A. tricolor	E Java	Pasuruan, Kebun Agung	0.2	small	no
A. tricolor	E Java	Lumajang	0.1	medium	no
A. tricolor	E Java	Probolinggo, R Pager	0.2	small	yes
A. tricolor	E Java	Jember, Gebang	0.2	small	yes
A. tricolor	E Java	Situbondo	–	medium	no
A. tricolor	E Java	Bondowoso	–	small	yes
A. tricolor	E Java	Banyuwangi, Pujasera	0.1	small	yes
A. tertius	Bali	Denpasar, Satria	0.6	medium	yes
A. tertius	Bali	Denpasar, Sanglah	0.6	small	yes
A. tertius	Bali	Mengwi, Beringkit	0.1	small	yes
A. tertius	Lombok	Mataram	0.4	medium	yes

Large cities on Java, Bali and Lombok for which we have not information whether or not bird markets are present are Bekasi (2.8 million), Depok (1.6 million) and Cimahi (0.5 milion).

bird market in Jakarta some 300 black-winged mynas were traded each month. More recently, Chng et al. (2015) recorded 773 individuals of 22 legally protected birds openly for sale in three of Jakarta's bird markets, representing 11% of the species and 4% of the number of birds recorded. This report included 13 black-winged mynas. In Indonesia, law enforcement of protected species laws, i.e. confiscation, arrest and prosecution, occurs infrequently and even for the highest profile and most charis

In recent years, large-scale commercial breeding of some of the rarest songbirds has started to influence the Java and Bali bird trade, the interpretation of protected species legislation and the management of threatened species (Jepson and Ladle, 2005; 2009b; Jepson, 2010, 2016; Eaton et al., 2015; Kristianto and Jepson, 2011; Owen et al., 2014). Black-winged mynas are indeed bred by commercial breeders in the Central Javan town of Klaten (Collar et al., 2012; Owen et al., 2014) and in some of the larger cities on Java (see Results) as well as by private individuals throughout Java and Bali.

In June 2013,150 breeders in Klaten were given permission (SK146/iv-K16/KKH/2014) by the Central Javan Head of the Natural Resources Conservation Agency (BKSDA) to breed and sell black-winged mynas, provided they were at least second generation offspring (Anonymous, 2017a). Prior to that ruling many of them were already breeding the species, presumably in direct violation of the law. Following the 2013 decision, any Indonesian citizen can establish a black-winged myna commercial breeding facility, provided that at time of establishment they have two pairs (age is not relevant, so four chicks do qualify) that were legally acquired, the person has a valid ID card and a Letter of Introduction from the head of the village. Fees are Rp500,000 (US$36) per permit which is valid for five years. Following article 71 of Government Regulation No 19 (PP19/Menhut II/2005) facilities that are breeding protected species —thus including those that breed black-winged mynas—have to ensure that 10% of the offspring is returned to the wild. There are no provisions on how these reintroductions are to be executed.

Online traders have started advertising when birds come with SATS-DN certificates to allow birds to be transferred within Indonesia (we noted the first in 2016). These certificates refer to Letters of Domestic [i.e. within Indonesia] Transportation of Wild Plants and Animals. These letter can be issued by the heads of the Natural Resources Conservation Agency (BKSDA) that are present in each province. Requirements are that (1) local dealers of wild plants or animals are licenced by the BKSDA, as indicated above, (2) dealers have demonstrated that they have obtained the stock legally, through harvest or capture permits or earlier issued SATS-DN certificates and (3) they keep track and report to the BKSDA on any changes in stock and offspring. Some online traders now show SATS-DN certificates going back six generations with their ads, but the issue remains how the first traders got permission to obtain legally protected black-winged mynas. As noted by Shepherd et al. (2016a,b), it is likely that some or perhaps most of the breeders are operating outside the legal commercial breeding system and are utilising illegally acquired parent stock.

2. Methods

2.1. Study species and status

Three black-winged myna taxa have traditionally been recognised: the nominate *melanopterus* from Madura and all but the easternmost part of Java (recognisable by the white mantle and white rump, strongly contrasting with the black outer wing), *tricolor* from easternmost Java (grey mantle, white rump) and *tertius* from Bali and Lombok (dark grey mantle, more black on upperwing, grey rump). These differences are not clinal, and del Hoyo et al. (2016) divided them into three species. They retained the name black-winged myna for *A. melanopterus*, and gave the name grey-backed myna to *A. tricolor* and grey-rumped myna to *A. tertius*. BirdLife (2016a,b,c) followed this arrangement for the IUCN Red List Assessment. This three-species arrangement is not universally accepted; for instance a recent book on the birds of Indonesia (Eaton et al., 2016), by no means taxonomically conservative, considered these taxa to comprise one species (but hinted that they might comprise three species).

While the three species are distinguishable morphologically, and have allopatric distributions, hybridisation between the species does occur, both within and outside their native ranges (Collar et al., 2012). One of 22 black-winged mynas observed in Sukahaji bird market in Bandung in 2016 was judged an *A. melanopterus* x *A. tricolor* hybrid (SC Chng, pers. comm.). Cross-breeding can be done unintentionally (i.e. breeders do not recognise these three forms as separate or, if they do, they do not attach any value to the difference) or, perhaps more likely, intentionally as to create individuals that display certain features —or hybrid vigour— that make them more desirable to their customers.

Identification of the three species, when adult, can be straightforward when observed in the right conditions. Some of the younger birds of *A. tricolor* and *A. tertius* are similar in colouration to *A. melanopterus* (Collar et al., 2012) thus hampering identification. Recognising species differences in the bird markets may be hindered as birds may be kept in cages high up at the front of the shop, thus allowing it only to be seen from the side, or in back of the shop that are normally only dimly-lit. Especially when more than one myna is present in a shop, when surveying it may not be feasible to inspect them all too closely or for too long a period. Likewise close inspection may not be possible in shops that were monitored at high frequencies.

Collar et al. (2001) gave an overview of the changing status of what was then considered one species in the wild, and they mapped 32 locations with records for the period 1980–1999 (11 within the range of *A. melanopterus*, 7 in the range of *A. tricolor* and 14 in the range of *A. tertius*). In the 1980s and 1990s black-winged mynas were regarded as quite common, especially *A. tricolor* and *A. tertius*. Ten years ago the decline on Java was clearly noticeable, and Braasch (2007) reported the numbers of *A. melanopterus* and *A. tricolor* combined to have dropped to a fewer than 100 individuals. Current population numbers in the wild are at best guesstimates, but in most lowland areas where they were formerly observed they are no longer present (see map in Collar et al., 2001). BirdLife (2016a,b,c) gives the following population estimates for individuals in

The IUCN Red List conservation status of black-winged mynas has changed in line with the decline from the countryside from Lower Risk, least concern/near-threatened (1988/1994), Endangered (2000) and Critically Endangered (2010) for what was then considered one species, and since 2016 all three species are listed as Critically Endangered BirdLife (2016a,b,c). Despite trade being one of the major threats to the species, given that it is rarely seen in international trade it has not been listed on any of the appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

2.2. Bird market surveys

We focussed on the open trade in the bird markets of Java and Bali (Fig. 1) with an emphasis on western Java (this comprises the provinces of Banten and West Java and the Special Capital Region of Jakarta). The first author has visited these markets repeatedly since the early-1990s and is familiar with their layout, characteristics and trade dynamics. Data on black-winged mynas from the 1990s and early 2000s is qualitative, and the focus in the bird market surveys was on other, perhaps more high profile, birds and mammals (e.g. Nijman, 2003; Nijman et al., 2009, 2017a,b). Quantitative data were collected in the period 2010 to 2015 but the number of surveys and the number of bird markets visited was limited (see e.g. Shepherd et al., 2016a,b). From September 2015 to July 2018 we increased the survey effort and the number of bird markets included in the survey. Here we focus on seven bird markets in five towns in western Java (Jakarta, Bandung, Cirebon, Garut and Tasikmalaya) that were visited for a total of 145 times during this period (excluding visits that were within one month of each other, or visits where not all stalls or shops were visited). Within the bird markets some distinction is made between these three species by sellers. This appears to be most pronounced between *A. melanopterus* on the one hand (more white, strongly contrasted) and *A. tertius* and *A. tricolor* on the other (darker, with grey, less contrast). All, however, are referred to as white starling : Jalak Putih (Indonesian, used throughout Java, Bali and Lombok), Jalak Bodas (Sundanese, used in western Java), or Jalak Pitoh (Javanese, used in Central and East Java). Over the course of our surveys it became clear that there was stronger support for a three-species arrangement but generally during our bird market surveys we, like the traders, pooled them all as black-winged mynas (s.l.). In the most recent 2018 surveys the three taxa were distinguished if and when possible. It was not possible to retrospectively reassign birds observed in the markets to one of the three species. All bird markets openly display illegally sourced and protected species, including black-winged mynas, and there was no need to use undercover techniques to record the trade.

The two markets in Jakarta were selected as during previous visits (2010–2014) we had observed small numbers of black-winged mynas for sale (Pramuka bird market ~six birds/visit, Barito bird market ~one bird/visit: Shepherd et al., 2016a,b). The others were picked for convenience in terms of logistics (Garut, Tasikmalaya) or because of their relative large size (Bandung, Cirebon). There are at least 54 bird markets on Java, Bali and Lombok, viz. nine large (50 to over 200 stalls or shops), 22 medium (20–49 stalls or shops) and 23 small (less than 20 stall or shops) (Table 1). The distribution of large, medium and small bird markets included in our survey (2: 3: 2) does not differ statistically from the larger sample ($^2 = 0.93$, df = 1, P = 0.33) and we consider our survey representative for the birds traded in bird markets in Java and Bali in general.

2.3. Online trade

In recent years, black-winged mynas started being offered for sale online. As in the brick-and-mortar bird markets, in general, in this virtual market place no distinction is generally made between the three species, and in our searches all were treated as one species. We searched online platforms, Facebook, and traders' websites for adverts or offers of sale and for confiscations of mynas in illegal trade. Searches were conducted using *jalak putih/jalak pito/jalak bodas* in combination with *jual* (Indonesian: root of sale) or *sita* (root of seizure) and *bksda* (a government agencies responsible for seizures). We repeated our online search in English but did not come across any that were offered for sale, nor did we find any seizures reported in English. We also used the new literal translations given in the 2018 protected species list (e.g. *jalak putih punggung abu*) but this did not give any results confirming our finding that these names are not (yet) used in trade. While some traders offer single birds for sale many had multiple birds on offer but it was not possible to establish exactly how many. Furthermore, commercial traders (as opposed to individuals that offer their black-winged myna pet for sale) provided lists of prices of black-winged mynas depending on age and breeding success, but gave no indication if these birds were indeed available. Photographs of black-winged mynas and/or breeding facilities provided evidence that the birds were available but not every individual bird on offer was linked to a photograph. A typical 2017 ad reads [our translation, dollar prices added]:

> *Young, 2–3 months old, can feed themselves, Rp1,600,000* [US$118] *per couple; Immature, 7–8 months, gone through one moult, Rp2,400,000* [US$177] *per couple; Fully formed adults, 1.5 years, 3,600,000* [US$266] *per couple*; *Proven breeders, 3,800,000* [US$280] *per couple.*

From this type of ad, is unclear if this trader has young, immature and adults, as well as proven breeders available or if they only may become available in the near future. It is not possible to establish from the advert how many black-winged mynas are available. As such, our online survey focussed on the asking prices of black-winged mynas, date of posting and the location of the seller, rather than quantities of birds for sale. The online survey was conducted in 2017 and 2018 but we went back to the mid-2000s to find the first ads online.

2.4. Estimating volumes and turnover

We assumed that black-winged mynas observed in the various bird markets are different individuals, i.e. we assume that birds do not move between shops, between markets or between cities. Surveys were at least one month apart (average survey interval was 2 months and 2 days). We expect that all black-winged mynas that were observed in subsequent surveys were different birds; given that we find a high turnover of at least 70% after two weeks (see Results) it is reasonable to assume that indeed after more than two months the mynas have been sold.

In addition to our monthly surveys, Mawar bird market and Kerkhof bird market in Garut were visited at weekly intervals, as this allowed us to get an insight in how frequently new birds arrived and how long individual black-winged mynas remained in the markets. We calculated minimum turnover of black-winged mynas following the methodology described by Nijman and Bergin (2017). It was not possible to calculate turnover when in between the weekly surveys a new consignment of mynas had arrived and the number of mynas in the shops had increased. Using the relationship between turnover and time between surveys we calculated weekly and two-weekly turnovers as the percentage of birds that were present at the beginning of the first week. We used these estimates from both markets to calculate the number of birds that were sold annually in the seven markets combined.

Large increases in the number of black-winged mynas in the shops in Garut between subsequent surveys in a short timespan (i.e. at least a doubling or an increase by > ten individuals within a week) are indicative of vendors having received consignments of mynas. We used these instances to gauge the minimum volumes of these individual consignments.

2.5. Prices and monetary value of the trade

Prices were obtained by requesting them from traders, by observing black-winged mynas being sold in the bird markets, or by taking them from the online ads. All but one, an online advert from Malaysia, were quoted in Indonesian Rupiah. We did not purchase any birds. When multiple prices were quoted in the online ads only those of adult birds (but not proven breeders or champion singers) were collected.

To put the asking prices into perspective in terms of consumer spending power, we compared mean prices with the annual

were corrected for inflation based on the Consumer Price Index to May 2018 using an online inflation calculator. These inflation corrected prices were then converted to US$ using the OANDA currency exchange database (www.oanda.com) again using the value for May 2018. Using the mean asking price we calculated (a) the annual monetary value of the black-winged myna trade, and, by taking into account the median number of traders that offer black-winged mynas for sale in the different markets, (b) the average monetary value this trade represent for individual traders.

3. Results

3.1. Number of black-winged mynas for sale and turnover

Trade in the 1990s was open and in the larger bird markets, such as Pramuka, typically a dozen or more adult wild-caught black-winged mynas were on offer (cf. Basuni and Setiyani, 1989; Nash, 1993). In the intermediate and smaller markets, the species was often present but in singles or up to half a dozen or so (cf. Nursaid and Astuti, 1996). In the 2000s numbers were decisively smaller, but black-winged mynas continued to be offered for sale in the larger bird markets, albeit in smaller numbers (cf. ProFauna, 2009). In the early 2010s, when the species was already very rare in the wild, they were continued to be offered for sale, sometimes less openly, and the first captive-born black-winged mynas could be seen in the markets (cf. Shepherd et al., 2016b). Black-winged mynas have been recorded in 29/54 bird markets, including 8/9 large (50 + stalls or shops) and 11/22 medium-sized (20–50 stalls or shops) bird markets, throughout their entire distribution range (Table 1).

In western Java in 2015–2018 we observed black-winged mynas during most surveys, and only in Barito bird market (twice during ten visits), Cikurubuk bird market (once in 18 visits), Mawar bird market (eight times during 32 visits) and Kerkhof bird market (seven times during 35 visits) did we not observe the species (Fig. 2). In total we observed 1253 black-winged mynas, with the highest numbers in Sukahaji and Pramuka bird markets (maximums of 53 and 40 mynas, respectively) and the lowest numbers in Barito and Cikurubuk bird markets (maximums of 4 and 7 mynas, respectively) (Table 2). Data from Sukahaji and Pramuka bird markets show that numbers in recent years are considerably higher than what has been recorded in the preceding decade (Fig. 3).

Especially based on surveys conduced in 2018, but to a lesser degree also earlier surveys, about 90% of the black-winged mynas in trade in western Java are *A. melanopterus* (72 out of 80 birds), 6% are *A. tricolor* (5/80) and 4% are *A. tertius* (3/80). A further three mature birds showed the characteristics of both *A. melanopterus* and *A. tricolor* and we judged them to be hybrids. When asked where the black-winged mynas originate from, the most frequent answers from traders in the bird markets were: (1) Java (in western Java this refers to the provinces of Central and East Java), (2) Central Java, and (3)

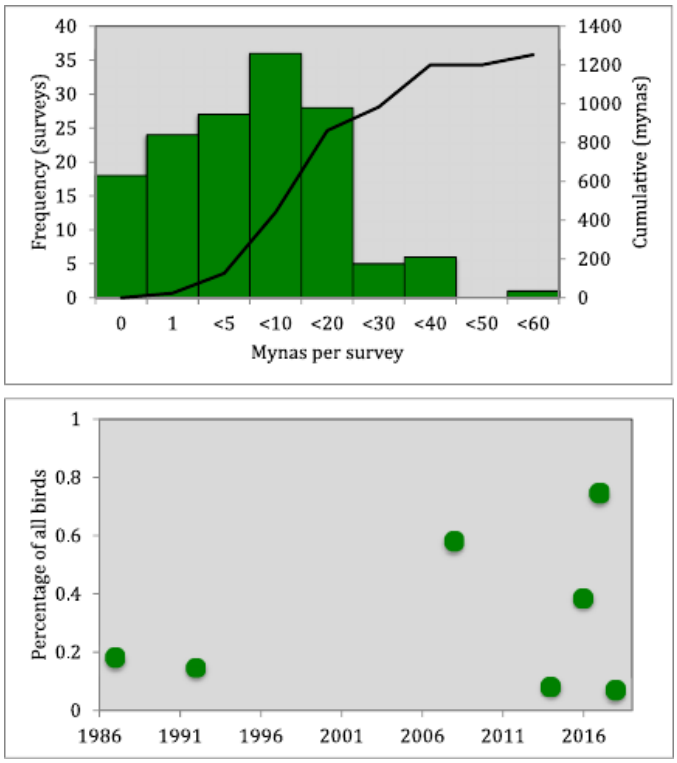

Fig. 2. Trade in black-winged mynas *Acridotheres melanopterus* (s.l.) in western Java. Top: Number of mynas recorded during 145 surveys in west Java in 2015–2018 showing that during most surveys mynas were recorded and mostly 6 to 10 birds at a time. Bottom: Black-winged mynas as a percentage of all birds

Table 2
Number of black-winged mynas (s.l.) observed in seven bird markets in western Java between September 2015 and July 2018.

market	visits	birds	mean number when present	number of traders
Jakarta, Pramuka	12[a]	280	23.3	8
Jakarta, Barito	10	16	2.3	2
Bandung, Sukahaji	25	388	17.6	7
Cirebon, Plered	13	102	8.5	4
Tasikmalaya, Cikurubuk	18	55	3.4	3
Garut, Mawar	32[b]	162	6.7	3
Garut, Kerkhof	35[b]	250	8.9	5
Total	145	1253	9.9	32

[a] Pramuka is Southeast Asia's largest bird market and it takes considerable time to survey it in its entirety; only visits during which all shops were visited are included here.
[b] Includes only surveys at least one month apart.

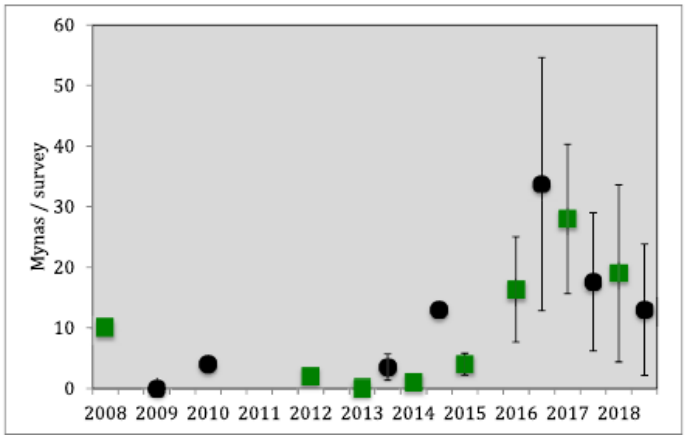

Fig. 3. Change in the mean (±s.d.) number of black-winged mynas *Acridotheres melanopterus* (s.l.) offered for sale in two bird markets in western Java, Indonesia. Green squares: Sugahaji bird market in Bandung; black circles: Pramuka bird market in Jakarta. Sources: this study; ProFauna 2009; Shepherd et al., 2016; Haryoko 2010. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Yogyakarta. Upon further enquiry to breeders their answer became more specific and the town of Klaten was singled out (Klaten is situated in Central Java, thus Java and close to, but outside the Special District of Yogyakarta).

Size of shipments of black-winged mynas coming into the markets averaged 16 birds (based on six consignments) with the largest one comprising 30 birds. Turnover in Mawar bird market was higher than in Kerkhof bird market, and 47% (Kerkhof) to 62% (Mawar) of the birds were sold after one week and 71%–86% were sold after two weeks. We expect mortality rates for black-winged mynas to be low as these high-value birds appeared to be taken well taken care for (unlike cheaper songbirds where it mortalities in the markets is far from negligible) and these turnover figures thus indeed represents birds sold. Informal discussions with traders in bird markets other than the ones in Garut support the observation that black-winged mynas are indeed sold within weeks rather than months after arrival in the markets.

Assuming these turnovers to be representative for all seven bird markets then we calculated 1711–2257 black-winged mynas sold per year based on the one-week turnover rates and a slightly lower number of 1292–1565 birds per year based on the two-weeks turnover data.

3.2. Online trade

In total we found 66 adverts with details on prices and date of posting. The first online ads we were able to locate date from May 2010, when traders in Jakarta and Surabaya offered black-winged mynas for sale, and in 2011 we found five adverts, again from Jakarta. In 2012 to 2014, we found on average nine online ads, including ones from Cirebon, Yogyakarta, Surakarta and Bogor. In the most recent years, we found on average about six ads per year, with in August 2016 the first online trader specifically mentioning that the mynas were traded with valid SATS-DN (Letters of Domestic Transportation of Wild Plants and Animals) certificates.

3.3. Monetary value

We obtained 89 independent asking prices for black-winged mynas offered for sale (Fig. 4). Prices seemed to have peaked in 2014 when the mean (inflation correct) price was around US$140, but in 2018 prices were down to around US$85 (similar

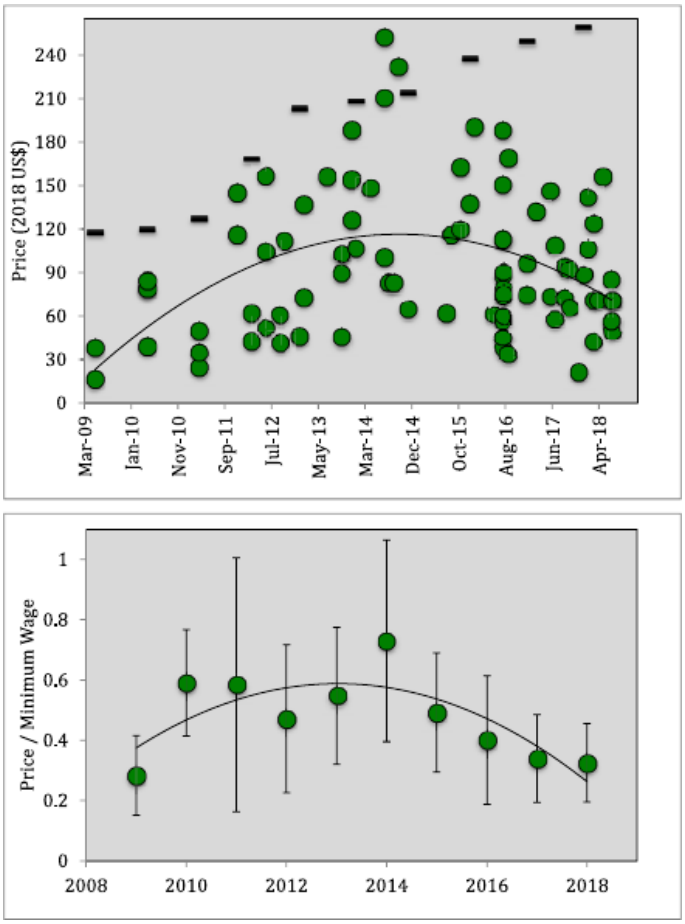

Fig. 4. Trade dynamics and monetary value of black-winged mynas *Acridotheres melanopterus* (s.l.) in Java, Indonesia; all prices are corrected for inflation and are expressed in 2018 US$ prices. Top: Asking prices between 2009 and 2018 (n = 89) showing large variations and prices peaking in 2014. The relationship is best described by a second order polynomial function, explaining some 17% of the observed variation in prices. Dashes are the annual government-set minimum wage for Jakarta. Bottom: the mean (±s.d.) asking price expressed as proportion of that year's government-set minimum wage for Jakarta showing a polynomial relationship peaking in 2013–2014.

comparatively low (33% of the monthly recommended minimum wage) whereas in 2014 they were unusually high (73%), and indeed some asking prices exceeded a month's minimum salary (Fig. 4).

Mean (inflation corrected) asking prices in Jakarta (US$ 110, n = 15) were slightly higher than in Yogyakarta (US$ 104, n = 5) and Bogor (US$98, n = 5) and these were slightly higher than in Bandung (US$ 79, n = 11). The mean price irrespective of location in the period we conducted our market surveys (i.e. 2015–2018), again corrected for inflation, was US$87 (s d. US$39). The overall value of this trade in these seven markets in terms of sales, totals US$173,000 (68% confidence interval, US$82,000–284,000) per year.

With on average 32 traders selling black-winged mynas in these seven bird markets, the monetary value of these birds based on asking prices amounts to ~ US$7400 per year per trader. The differences between bird markets are large, with for instance traders in Cikurubuk bird market in Tasikmalaya making on average around US$4000 per year and traders in Sukahaji bird market in Bandung over US$13,500. Within these bird markets not all traders sell equal amounts, and hence some have a substantially higher turnover than this.

4. Discussion

4.1. Volumes, turnover and estimates of the total captive population

Based on one of the largest datasets available to date, we established that in recent years the trade in black-winged mynas in western Java is open, omnipresent, significant in terms of numbers (especially when taking into account the estimates of the remaining wild populations) and it has the potential to be a significant impediment to the conservation, or recovery, of these Critically Endangered birds in the wild. In the seven birds markets we monitored over recent years we estimate that between 1300 and 2300 black-winged mynas are sold annually. We encountered black-winged mynas in nearly all our surveys (i.e. 127/145 surveys), a change from 2009 when ProFauna (2009) recorded them in 3/70 surveys and from 2013 to

when compared to other birds in the bird markets, they are now affordable for a large proportion of Indonesian society. While in individual bird markets the number of black-winged mynas may have increased over time (see Fig. 3), as a proportion of all wild-caught birds on offer in these markets no clear increase is noticeable (Fig. 2).

While in trade, and especially the online trade, few make the distinction between the three species of black-winged mynas, our observation and those of others may give an indication what proportion of the trade comprises each of the three species. Thus, Shepherd et al. (2016a,b) reported 18/21 black-winged mynas recorded in three bird markets in Jakarta to be *A. melanopterus* and the remaining three were *A. tertius*. In Sukahaji bird market in Bandung in 2016, 18/22 were *A. melanopterus,* three were *A. tricolor*, and one was an *A. melanopterus* x *A. tricolor* hybrid (SC Chng, pers. comm.). Surveys of bird markets in Central and East Java by Chng and Eaton (2015), within the range of *A. melanopterus* but close to the range of *A. tricolor* and *A. tertius*, recorded one *A. melanopterus,* five *A. tricolor* and one *A. tertius.* Combined with our observations this then suggests that around 84% of black-winged mynas in trade are *A. melanopterus* (109/129), 10% are *A. tricolor* (13/129) and 5% are *A. tertius* (7/129). Some of the younger birds of *A. tricolor* and *A. tertius* are similar in colouration to *A. melanopterus* (Collar et al., 2012) and this may potentially somewhat skew the observed preponderance of the latter species. Which species is traded where may differ somewhat between bird markets, and given that 43/54 bird markets on Java, Bali and Lombok are situated within the natural range of *A. melanopterus* (Table 1) this species may have been traditionally most affected. An unknown proportion of the trade comprises hybrids, but the four purported hybrids observed in trade does not allow for further extrapolation.

Assuming the seven bird markets we monitored are representative for the trade in the other 47 bird markets, we estimate that the total number of black-winged mynas sold in the bird markets is in the order of 10,000 (based on a low turnover of 47% sold after one week in the bird market) to 15,000 (based on a higher turnover of 62%) birds a year. This estimate does not take into account the online trade. Given that several commercial breeders offer black-winged mynas online, this may significantly add to this total. Even if when kept as cage birds, black-winged mynas stay alive for just two or three years, the total number of individuals in captivity on Java and Bali must be measured in the tens of thousands (30,000 mynas requires one in every 3000 households to have one pair). These estimates are in line from what can be inferred from data presented by Jepson and Ladle (2009a). Based on a household survey conducted in six cities in Java and Bali they estimated that 12,921 (95% CI, 9084—17,888) black-winged mynas were kept as cage birds. The people in these six cities represent around 30% of the total urban population on Java and Bali, suggesting that the total number of black-winged mynas kept as pets reaches 30,000 to 50,000 birds. If observations in the bird markets are representative for what species of black-winged myna is kept in captivity (no distinction was made between the three species in the household survey by Jepson and Ladle, 2009a), and taking 40,000 as a ballpark figure for the overall number in captivity, then ~34,000 A. *melanopterus*, ~4000 A. *tricolor* and ~2000 A. *tertius* are kept in private hands in Indonesia.

During our online survey we came across one advertisement from Malaysia (Perak, posted in 2011), and Shepherd et al. (2016a,b) reported one pair for sale in Thailand (Bangkok, in 2010), but overall we agree with Collar et al. (2012) that the vast majority of captive black-winged mynas are held in Indonesia. As such there may not be a real need for it to be included on any of the appendices of CITES (Shepherd et al., 2016a,b; Phelps et al., 2010). While at least seven zoos on Java have black-winged mynas in their collections, there does not appear to be a coordinated management plan, and most of the mynas are in private hands.

Fraudulent trade can illustrate the changing status of the black-winged myna and how it is traded. In May 1994, in Pramuka bird market, a Bali myna, then and now listed as Critically Endangered, was offered for sale, but upon closer inspection this bird turned out to be a black-winged myna (*A. melanopterus*) that had its yellow eye-patches coloured blue (V. Nijman and R. Sözer, pers. observ.). In June 2015 adds showed up on Facebook of a black-winged myna that upon closer inspection turned out to be a Javan myna *Acridotheres javanicus* that had large parts of its body bleached or dyed (Fig. 1). With Javan mynas getting rarer due to the songbird trade, it is interesting to see what replacement birds will be used in the future for this species.

4.2. Legality of the trade and enforcement by the government

Given the openness of the trade in black-winged mynas it is sometimes easy to forget that large parts of this trade is illegal, and the trade goes against the intentions of Indonesia's protected species legislation and the country's regulations concerning the trade in captive-bred birds. As noted in earlier publications (Shepherd et al., 2016a,b; Nijman et al., 2017), only a small proportion of the black-winged mynas in trade have closed leg-rings. Therefore it is impossible to establish if any of these birds are indeed captive-bred (we are confident many of them are, certainly if the estimates of the remaining wild populations are correct, but there is no way to be certain). In the bird markets we have not seen any certificates openly displayed, nor have we seen traders passing on any certificates to buyers. This lack of procedure suggests that at least a proportion of the black-winged mynas in these markets could be derived from the wild and we can have little confidence that breeders do not add wild-caught individuals to their stock if the opportunity arises (cf. Shepherd et al., 2016a,b).

The Bali myna is another Critically Endangered species that is rare in the wild but that is now bred in significant numbers on Java and Bali (Jepson, 2016). Bali mynas are protected in Indonesia and the trade in captive-bred birds is governed by a similar set of rules to those that are in place for black-winged mynas. Bali mynas are offered for sale openly in the bird markets

most, if not all, of the Bali mynas we observed had closed leg-rings, and when asked traders would often indicate that they are being sold with certificates and legal paperwork.

With poor regulation in place, commercial captive breeding of black-winged mynas is unlikely to remove pressure from remaining wild populations. Enforcement efforts to prohibit the poaching and trade of the birds are absent, erratic, or inefficient, and as long as the profit margins outweigh the risks for catching and selling black-winged mynas trade will continue (Shepherd et al., 2016a,b). That commercial captive breeding of black-winged mynas does not seem to remove the demand for illegally sourced birds is furthermore illustrated by the recent theft of 149 A. *melanopterus* and two *A. tertius* from the Cikananga Conservation Breeding Centre in West Java (Tritto and Sözer, 2014; Shepherd et al., 2016b). Prices in the bird markets and online have peaked in 2014 and in terms of spending power are as low as they have ever been. These reduced prices suggest lowered demand, higher supply or a combination of both. More black-winged mynas are offered openly for sale in at least some of the bird markets in recent years than in the past, suggesting a higher supply. We have no data on whether or not the demand for black-winged mynas has changed over time.

A limited number of confiscations made in recent years suggest that at least a part of the trade in black-winged mynas is indeed still considered illegal by the Indonesian authorities (Table 3). Traders in Garut selling black-winged mynas were reprimanded but did not receive a fine or sentence as, according to the confiscating agency they were not aware that the birds were protected (Zulumar 2013). The trader from Surabaya was arrested when offering black-winged mynas for sale online; while the birds were obtained from a commercial breeding facility in Klaten this, according to the authorities, still did not allow the birds to be sold (Anonymous, 2017b). No information is available whether or not the trader was successfully prosecuted. The black-winged mynas offered for sale in Gianyar all had closed leg-rings; the birds were seized with the authorities citing that the species was not allowed to be traded. No arrests were made (Anonymous, 2018). Banyuwangi is in the distribution range of *A. tricolor* and Gianyar is within the range of *A. tertius*; photographs released with the press releases of the confiscations indicate that in both cases indicate that (some of) the birds were *A. melanopterus*. In the four most recent cases the arresting organisation (BKSDA) indicated that all the seized birds would be, or already had been, released back into the wild. Two of these releases concerned *A. melanopterus* that were released within the natural distribution range of *A. tricolor* (i.e. the easternmost part of Java) and *A. tertius* (i.e. Bali).

4.3. Introgression and the conservation value of captive stock

It appears from our study that while legislators in Indonesia and conservationists globally now follow the three species arrangement, this is not universally followed by breeders, traders and, presumably consumers, on Java and Bali. All three species are traded in bird markets within each other respective geographic ranges, with for instance *A. melanopterus* observed in trade in Bali and in easternmost Java (Anonymous, 2018; Fanani, 2018) and all three species are traded in the bird markets of Bandung and Jakarta. At least four individuals in the bird markets were deemed to be hybrids. Importantly, both in the bird markets and in photographs on traders' online platforms, additional individuals were encountered that could be either *A. melanopterus* or *A. tricolor*, or hybrids This discrepancy could be due to our inability to identify especially younger individuals from these two species or it may indicate the breeders create crossbreeds between the two, or even three, species.

While we do not think that the wild phenotypes of black-winged mynas will disappear entirely in the foreseeable future, it is likely that different types (paler, darker, more or less white) will emerge soon, most likely facilitated by cross-breeding. The creation of different types is seen in another Javan endemic, the Java sparrow *Lonchura oryzivora*. Here breeders on Java, through selective breeding, have mostly eradicated the wild phenotype and with the majority of Java sparrows in trade are now considerably paler (up to completely white) in colour.

Facilities that breed black-winged mynas are obliged to reintroduce 10% of their birds back into the wild. Our research shows that thousands of black-winged mynas are bred in captivity each year and this may mean that, theoretically, hundreds

Table 3
Seizures of 33 black-winged mynas *Acridotheres melanopterus* (s.l.) on Java and Bali, Indonesia. All seizures were made by different branches of the Natural Resources Conservation Agency (BKSDA) apart from the one in Surabaya where the Police made the arrest. Sources: Zulumar (2013), Anonymous (2015, 2017b, 2018), Haryanto (2016), Fanani (2018).

Date	Location	Number seized	Other protected animals seized	Trader arrested	Trader prosecuted	Mynas released
v 2013	Kerkhof bird market, Garut	2	1 crested serpent-eagle *Spilornis cheela*, 1 blue-streaked lory *Eos reticulata*, 3 porcupines	No	No	Unknown
ix 2015	PASTI bird market, Yogyakarta	2	2 Sunda leopard cats *Prionailurus javanensis*	No	No	Unknown
x 2016	Barito bird market, Jakarta	2	1 cockatoo, 2 lorys, 1 Bali myna *Leucopsar rothschildi*, 2 Javan slow loris *Nycticebus javanicus*	No	No	Yes, near Cisarua
iii 2017	Online trader, Surabaya	13	No	Yes	Not known	Yes, near Malang
ii 2018	Klungkung bird market, Gianyar	13	No	No	No	Yes, on Bali, location

of birds are being released in different parts of Java, Bali, Lombok and Madura, without proper habitat assessments, health checks, genetic screening, post-release monitoring, or indeed taking into consideration which of the three species are being released where. While perhaps well intended by lawmakers, this provision to reintroduce 10% has the potential to create more harm than it does good (although few breeders may indeed follow the stipulations in Article 71). Large numbers of individuals of all three species are available in captivity for future reintroductions. Owners including zoos, commercial breeders or private individuals may be willing to give support for any future reintroduction programmes (finances, logistics, land, and animals). Considerable efforts, however, are needed to ensure that only the right individuals are released and that these releases are part of a coordinated plan.

Numerous examples have been published where the wrong species or hybrids have been used in translocations and reintroductions. Among these are ungulates and red-legged partridge (*Alectoris rufa*) in Italy (Randi, 2005; Baratti et al., 2005), lesser white-fronted geese (*Anser erythropus*) and grey partridge (*Perdix perdix*) in Scandinavia (Ruokonen et al., 2000; Nijman et al., 2010; Liukkonen, 2006), black wildebeest (*Connochaetes gnou*) and blue wildebeest (*C. taurinus*) in South Africa (Benjamin-Fink and Reilly, 2017), and slow lorises (*Nycticebus* spp) in Indonesia (Nekaris and Starr, 2015). Such practises can cause ecological and taxonomic havoc. The Indonesian authorities now recognise the existence of three species of black-winged myna in their protected species legislation. Therefore they must put measures in place to prevent the release of hybrids between these three species or of the release of captive-bred mynas outside their native range (e.g. *A. melanopterus* on Bali or Lombok).

Currently black-winged mynas, including crossbreeds, are more abundant in captivity than they are in the wild. Given the very small numbers left in the wild, and the ongoing pressure on these populations from the trade, it is not inconceivable that in the near future none will be left in the wild. The estimates of the remaining wild population and the number we estimate in captivity contrast strongest for *A. melanopterus* (20 in the wild vs 34,000 in captivity) and least for *A. tertius* (some 200 in the wild vs 2000 in captivity). With certainly *A. melanopterus* already being ecologically extinct (very small remaining population and present in only two out of 40 historically known sites: Collar et al., 2001), and the others close to ecological extinction, and with breeders continuingly producing mynas, we anticipate that all three soon will join the ranks of species like Père David's deer and scimitar-horned oryx that are extinct in the wild but that have captive populations in the tens of thousands. For both the deer and the oryx reintroduction plans are place, and managed populations are present in fenced off areas in China (oryx), Tunesia, Morocco and Chad (deer) (Jiang and Harris, 2016; IUCN SSC Antelope Specialist Group, 2016). Over time, with a concerted effort from all parties involved, the same may become feasable for the black-winged mynas.

4.4. Recommendations

Based on our study we make a number of recommendations; focussing on (1) more effective monitoring, law enforcement and prosecution of lawbreakers, (2) The establishment of a multi-stakeholder black-winged myna management plan, and (3) coordinated reintroduction programmes.

As noted elsewhere (Nijman et al., 2017a,b), and what is clear from the above *ad hoc* seizures (Table 3), the monitoring of Javan bird markets and online platforms by the Indonesian authorities has been sporadic and a more systematic approach is needed to ensure that wild-caught black-winged mynas do not enter the trade. It is imperative that regulations that are in place, including those concerning the sale of captive-bred birds, are better enforced. Breeders, buyers and sellers found in violation of the law, especially where it concerns the world's most threatened species such as the black-winged mynas, should be prosecuted to the full extent of the law. Thus far there is no evidence that anyone has ever been prosecuted for illegally trading or owning black-winged mynas. Given that this trade occurs in the open, daily, at predictable places (i.e. in the bird markets) more must be expected from the Indonesian authorities (municipal, provincial and national) to take urgent action in those places where the trade is most prevalent. More extensive and more systematic monitoring of the online trade in black-winged mynas, ensuring these traders follow existing regulations, is equally needed.

Within the current political and socioeconomic situation in Indonesia, conservationists and the general Indonesia public alike cannot rely solely on the Indonesian conservation authorities to prevent the imminent extinction of the three species of black-winged myna in the wild. A dedicated, well-financed and fully mandated body comprising of authorities (including the BKSDA), local governments, international and local NGOs, commercial breeders and international donors, needs to be established. One of the first task of this body is to initiate the establishment of a black-winged myna management plan, dealing both with the conservation of the last remaining wild mynas and the large number of birds in captivity. First proposed by Collar et al. (2001), this programme is long overdue. With the cooperation of the bird keepers' community, commercial breeders and many Indonesian (bird) conservation groups, there should be ample opportunities, and funds, to improved and more effective conservation.

It is inevitable that captive breeding and reintroduction will have to play a vital role in the future of black-winged mynas in the wild. At present it is unclear if any of the commercial breeders follow the stipulation of Article 71 that requires them to return 10% of the offspring to the wild, but if they do it does not appear to be part of a coordinated reintroduction programme. The same is true for the release of black-winged mynas into the wild following confiscations (Table 3) or the release of 40 mynas by the Minister of Forestry around International Environment Day 2016 on the grounds of the Taman Safari Zoo in

(Tritto, 2014). It is imperative that any future releases, be it by the authorities following confiscations, or by zoos or commercial breeders of captive-bred birds, need to be done as part of structured conservation programmes.

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References

Anonymous, 2015. BKSDA Yogyakarta Sita 30 Satwa Dilindungi. 108 Jakarta, 25 Sept 2015.
Anonymous, 2017a. Peraturan Perijinan Penangkaran Jalak Putih and Bali. https://kicaumaniajuara.blogspot.com/2017/05/peraturan-perijinan-penangkaran-jalak-putih-dan-bali.html.
Anonymous, 2017b. Penjual yang tawarkan 13 Jalak Putih ini ditangkap, begini imbauan polisi kepada pencinta burung. Tribun Jateng, 15 March 2017.
Anonymous, 2018. Lakukan Patroli, Petugas BKSDA Bali Selamatkan Jalak Putih. KSDAE, 8 February 2018.
Baratti, M., Ammannati, M., Magnelli, C., Dessì-Fulgheri, F., 2005. Introgression of chukar genes into a reintroduced red-legged partridge (*Alectoris rufa*) population in central Italy. Anim. Genet. 36, 29–35.
Basuni, S., Setiyani, G., 1989. Studi perdagangan burung di pasar Pramuka, Jakarta dan teknik penangkapan burung di alam. Media Konservasi 2, 9–18.
Bempah, R.T., 2016. Puluhan burung Jalak Putih dilepasliarkan di Taman Safari. Kompas, 12 June 2016.
Benjamin-Fink, N., Reilly, B.K., 2017. Conservation implications of wildlife translocations: the state's ability to act as conservation units for wildebeest populations in South Africa. Global Ecol Conserv 12, 46–58.
BirdLife International, 2016a. *Acridotheres tertius*. IUCN Red List of Threatened Species 2016: e.T103871084A104347549. Downloaded on. https://doi.org/10.2305/IUCN.UK.2016-3.RLTS.T103871084A104347549.en. (Accessed 21 July 2018).
BirdLife International, 2016b. *Acridotheres tricolor*. IUCN Red List of Threatened Species 2016: e.T103870973A104348050. Downloaded on. https://doi.org/10.2305/IUCN.UK.2016-3.RLTS.T103870973A104348050.en. (Accessed 21 July 2018).
BirdLife International, 2016c. *Acridotheres melanopterus*. IUCN Red List of Threatened Species 2016: e.T103870843A94266716. Downloaded on. https://doi.org/10.2305/IUCN.UK.2016-3.RLTS.T103870843A94266716.en. (Accessed 21 July 2018).
Braasch, T., 2007. Hoffnung für den Schwarzflügelstar. ZGAP Mittl. 23, 6–7.
Chng, S.C., Eaton, J.A., 2015. In the market for Extinction: Central and East Java. TRAFFIC, Petaling Jaya.
Chng, S., Eaton, J.A., Krishnasamy, K., Shepherd, C.R., Nijman, V., 2015. In the Market for Extinction: an Inventory of Jakarta's Bird Markets. TRAFFIC, Petaling Jaya.
Chng, S.C., Guciano, M., Eaton, J.A., 2016. In the market for extinction: Sukahaji, Bandung, Java, Indonesia. Bird. Asia 26, 22–28.
Collar, N.J., Butchart, S.H.M., 2014. Conservation breeding and avian diversity: chances and challenges. Int. Zoo Yearbk. 48, 7–28.
Collar, N.J., Andreev, A.V., Chan, S., Crosby, M.J., Subramanya, S., Tobias, J.A., 2001. Threatened Birds of Asia: the BirdLife International Red Data Book. BirdLife, Cambridge.
Collar, N.J., Gardner, L., Jeggo, D.F., Marcordes, B., Owen, A., Pagel, T., Pes, T., Vaidl, A., Wilkinson, R., Wirth, R., 2012. Conservation breeding and the most threatened birds in Asia. Bird. Asia 18, 50–57.
del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A., de Juana, E., 2016. Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona.
Eaton, J.A., Shepherd, C.R., Rheindt, F.E., Harris, J.B.C., van Balen, S., Wilcove, D.S., Collar, N.J., 2015. Trade-driven extinctions and near-extinctions of avian taxa in Sundaic Indonesia. Forktail 31, 1–12.
Eaton, J.A., van Balen, B., Brickle, N.W., Rheindt, F.E., 2016. Birds of the Indonesian Archipelago. Lynx, Barcelona.
Fanani, A., 2018. Tiga hewan dilindungi di Banyuwangi diamankan BKSDA Jatim. Detik News, 9 May 2018.
Gilbert, T., 2017. International Studbook for the Scimitar-horned oryx Oryx Dammah, twelfth ed. Marwell Wildlife, Winchester.
Harris, J.B.C., Green, J.M., Prawiradilaga, D.M., Giam, X., Hikmatullah, D., Putra, C.A., Wilcove, D.S., 2015. Using market data and expert opinion to identify overexploited species in the wild bird trade. Biol. Conserv. 187, 51–60.
Haryanto, R., 2016. Polisi Ungkap Kasus Perdagangan Satwa Ilegal. Detik News, 5 October 2016.
Haryoko, T., 2010. Komposisi jenis dan jumlah burung liar yang perdagangkan di Jawa Barat. Berita Biol. 10, 385–391.
IUCN SSC Antelope Specialist Group, 2016. *Oryx dammah*. IUCN Red List of Threatened Species 2016: e.T15568A50191470. Downloaded on 9 June 2018.
Jepson, P., 2010. Towards an Indonesian bird conservation ethos: reflections from a study of bird-keeping in the cities of Java and Bali. In: Tilman, S., Gosler, A. (Eds.), Ethno-ornithology: Birds, Indigenous Peoples, Culture and Society. Earthscan, London, pp. 313–330.
Jepson, P., 2016. Saving a species threatened by trade: a network study of Bali starling *Leucopsar rothschildi* conservation. Oryx 50, 480–488.
Jepson, P., Ladle, R.J., 2005. Bird-keeping in Indonesia: conservation impacts and the potential for substitution-based conservation responses. Oryx 39, 442–448.
Jepson, P., Ladle, R.J., 2009a. Governing bird-keeping in Java and Bali: evidence from a household survey. Oryx 43, 364–374.
Jepson, P., Ladle, R.J., 2009b. Developing new policy instruments to regulate consumption of wild birds: sociodemographic characteristics of bird-keeping in Java and Bali. Oryx 43, 1205–1212.
Jiang, Z., Harris, R.B., 2016. *Elaphurus davidianus*. The IUCN Red List of Threatened Species 2016: e.T7121A22159785. Downloaded on 9 June 2018.
Kristianto, I., Jepson, P., 2011. Harvesting orange-headed thrush *Zoothera citrina* chicks in Bali, Indonesia: magnitude, practices and sustainability. Oryx 45, 492–499.
Liukkonen, T., 2006. Finnish native grey partridge (*Perdix perdix*) population differs clearly in mitochondrial DNA from the farm stock used for releases. Ann. Zool. Fenn. 43, 271–279.
Maqbool, N.J., Tate, M.L., Dodds, K.G., Anderson, R.M., McEwan, K.M., Mathias, H.C., McEwan, J.C., Hall, R.J., 2007. A QTL study of growth and body shape in the inter-species hybrid of Père David's deer (*Elaphurus davidianus*) and red deer (*Cervus elaphus*). Anim. Genet. 38, 270–276.
Nash, S., 1993. Sold for a Song: the Trade in Southeast Asian Non-CITES Birds. TRAFFIC International, Cambridge.
Nekaris, K.A.I., Starr, C.R., 2015. Conservation and ecology of the neglected slow loris: priorities and prospects. Endanger. Species Res. 28, 87–95.
Nijman, V., 2003. Distribution, habitat use and conservation of the endemic chestnut-bellied hill-partridge (*Arborophila javanica*) in fragmented forests of Java, Indonesia. Emu 103, 133–140.
Nijman, V., 2017. Orangutan trade, confiscations, and lack of prosecutions in Indonesia. Am. J. Primatol. 79, e22652.
Nijman, V., Bergin, D., 2017. Trade in spur-thighed tortoises *Testudo graeca* in Morocco: volumes, value and variation between markets. Amphibia-Reptilia 38, 275–287.

Nijman, V., Sari, S.L., Siriwat, P., Sigaud, M., Nekaris, K.A.I., 2017a. Observation of four Critically Endangered songbirds in the markets of Java suggest domestic trade as a major impediment to their conservation. Bird Asia 27, 20–25.
Nijman, V., Shepherd, C.R., 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., Spaan, D., Rode-Margono, E.J., Nekaris, K.A.I., 2017b. Changes in the primate trade in Indonesian wildlife markets over a 25-year period: fewer apes and langurs, more macaques and slow lorises. Am. J. Primatol. 79 (11), e22517.
Nursaid, R., Astuti, M., 1996. Survey perdagangan burung di pasar Malang (januari-juli 1996). KSBK, Malang.
Owen, A., Wilkinson, R., Sözer, R., 2014. In situ conservation breeding and the role of zoological institutions and private breeders in the recovery of highly endangered Indonesian passerine birds. Int. Zoo Yearbk. 48, 199–211.
Phelps, J., Webb, E.L., Bickford, D., Nijman, V., Sodhi, N.S., 2010. Boosting CITES. Science 330, 1752–1753.
ProFauna, 2009. Wildlife Trade Surveys on the Bird Market in Java. ProFauna, Malang.
Randi, E., 2005. Management of wild ungulate populations in Italy: captive-breeding, hybridisation and genetic consequences of translocations. Vet. Res. Commun. 29, 71–75.
Ruokonen, M., Kvist, L., Tegelström, H., Lumme, J., 2000. Goose hybrids, captive breeding and restocking of the Fennoscandian populations of the Lesser White-fronted goose (*Anser erythropus*). Conserv. Genet. 1, 277–283.
Shepherd, C.R., 2011. Observations on trade in laughingthrushes (*Garrulax* spp.) in North Sumatra, Indonesia. Bird. Conserv. Int. 21, 86–91.
Shepherd, C.R., Eaton, J.A., Chng, S.C., 2016a. Nothing to laugh about—the ongoing illegal trade in laughingthrushes (*Garrulax* species) in the bird markets of Java, Indonesia. Bird. Conserv. Int. 26, 524–530.
Shepherd, C.R., Nijman, V., Krishnasamy, K., Eaton, J.A., Chng, S.C., 2016b. Illegal trade pushing the Critically Endangered black-winged myna *Acridotheres melanopterus* towards imminent extinction. Bird. Conserv. Int. 26, 147–153.
Tate, M.L., Goosen, G.J., Patene, H., Pearse, A.J., McEwan, K.M., Fennessy, P.F., 1997. Genetic analysis of Père David's × red deer interspecies hybrids. J. Hered. 88, 361–365.
Tritto, A., 2014. Reintroduction of the black-winged starling *Sturnus melanopterus* in west Java, Indonesia. IZN 61, 85–87.
Tritto, A., Sözer, R., 2014. Bird thieves in Java show that Indonesian wildlife crime knows no boundaries. J Indonesian Nat Hist 2, 11–12.
Zheng, W., Beauchamp, G., Jiang, X., Li, Z., Yang, Q., 2013. Determinants of vigilance in a reintroduced population of Pere David's deer. Current Zool 59, 265–270.
Zulumar, S., 2013. Badan Konservasi Garut Sita 14 Satwa. Tempo. (Accessed 13 May 2013).