Illegal Wildlife Trade in Traditional Markets, on Instagram and Facebook: Raptors as a Case Study

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Simple Summary: Wildlife trade, just like other trade, is moving online; this also includes wildlife that cannot be traded legally. To assess the extent to which the illegal wildlife trade has moved online, we focused on the bird trade on the Indonesian islands of Java, Bali and Lombok, where there is widespread access to the Internet and where social media is widely used. We conducted a five-year study (2016–2021) on the raptor trade in traditional bird markets, on Instagram and on Facebook and assessed seizures and successful prosecutions over this period. We found close to 1000 birds of prey for sale (29 species), and evidence of 47 seizures of 131 birds of prey. The five most common birds of prey were similar in all four datasets. Smaller species were more common in the bird markets, whereas the larger ones were more abundantly offered online. In the seizure reports, social media was frequently mentioned, and only five of the seizures led to a successful prosecution. Our study confirms that wildlife trade has indeed shifted from the physical marketplace to online and shows that enforcement is insufficient to curb this illegal trade.

Abstract: Monitoring illegal wildlife trade and how the modus operandi of traders changes over time is of vital importance to mitigate the negative effects this trade can have on wild populations. We focused on the trade of birds of prey in Indonesia (2016–2021) in bird markets (12 markets, 194 visits), on Instagram (19 seller profiles) and on Facebook (11 open groups). We link species prevalence and asking prices to body size, abundance and geographic range. Smaller species were more traded in bird markets and less so online. Abundance in trade is in part linked to their abundance in the wild. Asking prices (mean of USD 87) are positively correlated with size and negatively with their abundance in the wild. Authorities seize birds of prey according to their observed abundance in trade, but only 10% of seizures lead to successful prosecutions. The trade is in violation of national laws and the terms and conditions of the online platforms; the low prosecution rate with minimal fines shows a lack of recognition of the urgency of the threat that trade poses to already imperilled wildlife. The shift of trade from physical bird markets to the online marketplace necessitates a different strategy both for monitoring and enforcement.

Keywords: conservation; illegal wildlife trade; Indonesia; raptors; social media

1. Introduction

The rate at which biodiversity is declining is faster now than at any time in human history; it has been termed the sixth mass extinction [1,2]. Exploitation of wildlife is highlighted as the second greatest threat to global diversity [3]. Wildlife trade is situated at a juxtaposition between economic development, resource use, subsistence and human well-being on the one hand and biodiversity conservation and nature protection on the other [4–8]. It is possible that well-managed wildlife trade can help protect biodiversity, and garner support for its protection [9]. However, at its worst, trade, and especially commercial trade, can lead to once-common species to rapidly be at risk of extinction [10,11], and thus also threaten the livelihood this trade supports [12]. Recognising this, around 90% of all countries and territories [13] have created protected species lists for species that are native to their respective country and for which commercial trade is incompatible with their conservation.

We here focus on birds of prey in Indonesia, a collectively protected group, and how they are traded in the physical wildlife markets and the online marketplace. We also focus on to what extent existing policies regarding their protection are implemented. In Indonesia, all native diurnal birds of prey are included on the country's protected species list [14]. Birds of prey are members of the Order Accipitriformes (including the families Pandionidae, Ospreys and Accipitridae, the hawks, eagles and kites), of which ~75 species are found in Indonesia, and the Order Falconiformes (the family Falconidae, the falcons), of which ~10 species have been recorded in Indonesia [15]. Because of the protected species legislation in Indonesia, birds of prey are not allowed to be killed, sold, bought or kept as pets; any violations are punishable by up to five years imprisonment and/or a fine of USD 6935 (using October 2021 exchange rates). Keeping birds as pets is important in Indonesian culture [16,17], and in most larger cities in Indonesia, at least one bird or animal market (*pasar burung*, *pasar satwa*) is present [18,19]. There are strict regulations in place on what birds can be traded—no wild-caught birds unless they are harvested as part of an allocated quota, no protected species other than for a selected number of songbirds that are captive-bred with the appropriate paperwork, etc.—but these regulations are rarely adhered to [19–23]. For many decades, birds of prey have been commonly seen in bird markets, where they are sold as (novelty) pets [22,24,25]. Almost all these birds are native to Indonesia and were taken from the wild, as there are no commercial captive breeding facilities for birds of prey present in Indonesia.

Increasingly, the wildlife trade, just like other trade, is moving online [26–31]; this also includes wildlife that cannot be traded legally, such as raptors in Indonesia [32,33]. There has been very limited quantitative analysis of the differences and similarities in the online trade in wildlife and the trade in traditional wildlife markets (see [18,28]). We aimed to fill that gap by firstly conducting simultaneous surveys in bird markets and different online platforms for the same group of wildlife (birds of prey) in the same area (western Indonesia) over the same time period. Secondly, we compiled data on seizures of birds of prey, again in the same area and over the same period, to assess if the attention of the enforcement authorities reflects that what is offered for sale.

We predict that:

1. There is no difference in the species composition of birds of prey and their relative numbers that are offered for sale in physical markets and online markets.
2. Species characteristics can explain, at least in part, the relative abundance of birds of prey in trade. Rarity (smaller geographic ranges and/or are assessed to be less common within Indonesia) and size of the bird are negatively correlated with their abundance in trade. Prices reflect rarity and size.
3. Given that all birds of prey are protected under the same legislation, and given that all are readily identifiable as birds of prey, the authorities seize birds of prey relative to their abundance in trade.

2. Materials and Methods

2.1. Data Acquisition

We used four different techniques (traditional market surveys, surveys on Instagram and Facebook, analysis of seizure data) to assess the magnitude and composition of the trade of birds of prey in Java, Bali and Lombok, the epicentre of the Asian Songbird Crisis [34], from January 2016 to October 2021. To make data comparable, we included only data that were available for all to see (sellers, buyers, law enforcement officers, the public), thus excluding trade in back alleys, online trade in closed groups or data that were not publicly available.

2.1.1. Traditional Market Surveys

We conducted market surveys throughout Java, Bali and Lombok; combined, we surveyed at least 40 of the bird markets on these islands, and here we focus on a relatively small number of bird markets that were surveyed intensively over this period (Table 1). These 12 bird markets in 10 cities were surveyed 194 times, with the intervals between visits to individual markets being at least one month (Table 1).

Table 1. Bird markets surveyed between 2016 and 2021 listed from west to east, with the number of surveys that were conducted in each market.

Province	Bird Market, City	Surveys (Years)
Capital District of Jakarta	Pramuka, Jakarta	16 (2016–2020)
Capital District of Jakarta	Jatinegara, Jakarta	15 (2016–2020)
Capital District of Jakarta	Barito, Jakarta	14 (2016–2020)
West Java	Ramayana, Bogor	4 (2017–2020)
West Java	Sukahaji, Bandung	31 (2016–2021)
West Java	Kerkhof, Garut	50 (2016–2021)
West Java	Cikirubuk, Tasikmalaya	22 (2016–2020)
West Java	Plered, Cirebon	17 (2017–2020)
Special District of Yogyakarta	PASTY Yogyakarta	7 (2017–2020)
Central Java	Depok, Surakarta	6 (2017–2020)
Bali	Satria, Denpasar	9 (2017–2021)
Lombok	Sundu, Mataram	3 (2018)

Several of the authors (S.v.B., J.A.E., C.R.S., M.A.I., V.N.) have visited these bird markets repeatedly since the late 1970s to early 1990s onwards. As such, we are familiar with their layout, characteristics and trade dynamics, allowing us to include a representative sample. Bird markets are open to the public and are open all days of the week from early morning to early evening. Traders offer a wide range of wild bird species for sale, including native species that are legally protected, native species that can be traded in limited numbers and non-native species that were imported into the country or that were bred in captivity. In the larger bird markets, birds of prey are typically displayed in the back or in specific sections, but in the smaller bird markets, they are displayed among other birds. The surveyors visited each individual stall or shop and recorded the species and the number of individuals for sale, including birds of prey when present. A survey could last from around two hours for some of the smallest bird markets (e.g., Kerkhof in Garut) to a full day for the largest (e.g., Pramuka in Jakarta). We did not purchase any birds or other wildlife. COVID-19 had only a limited impact on our studies; most bird markets remained open, but travel restrictions and regional lockdowns meant we surveyed fewer cities in 2021.

2.1.2. Instagram Surveys

In practice, a large part of the online trade of birds of prey in Indonesia is very similar to that of the trade in an open, public space. It is in the best interest of the online vendors to ensure that as many potential customers as possible can see and buy what is offered. The online trade of birds of prey occurs in the open. The Instagram accounts can be viewed by

conducting a simple Google search. We used a series of hashtags to identify commercial sellers of exotic pets in Indonesia, including elang, exotic pet, bird of prey, alap-alap (elang meaning eagle and alap-alap meaning falcon in Bahasa Indonesia). Once a seller, often a pet shop, was identified, we checked for additional Instagram accounts. For analysis, we only include sellers that were based in Java, Bali or Lombok. Instagram profiles were often active for less than the duration of study period; if a profile was shut down but emerged later under the same or a slightly different name, it was included as one profile (see Nijman et al. [35] for details). This amounted to a total of 19 Instagram profiles.

We used a manual approach in our online trade survey to record, filter, classify and assess legal and illegal trade. We did not interact with any participants or access any personal profile pages and only collected information that was publicly displayed. Data were anonymised after cross-checking for duplicates, and no information after the monitoring session can be attributed to one person. Duplicates were identified by matching images, text and the account uploads. We took a conservative approach to removing duplicates, erring towards reducing duplicates rather than increasing detection.

2.1.3. Facebook Survey

We searched for open Facebook groups that were based in Indonesia and that offered birds of prey for sale. As with the Instagram accounts, these were found through a straightforward Google search, using the word *elang* or *alap-alap* in combination with *jual* (sale). These included groups with names such as "Selling and Buying of Eagles and Falcons" (*Jual Beli Elang dan Alap-alap*), followed by a geographic location (province, town, etc.). The Facebook groups were classified as "open" or "public" and had their privacy settings set at a level where it was not necessary to join a group to see posts and comments. For analysis, we only include Facebook groups that were based in Java, Bali or Lombok (acknowledging that sellers may actually be based elsewhere in Indonesia). This totalled eleven Facebook groups.

2.1.4. Seizures and Prosecution

We searched for online reports of raptors being seized by the Indonesian authorities in Java, Bali and Lombok. These included local newspaper articles, blogs, press releases from NGOs, the police or the forestry department and legal documents. All searches were conducted in Indonesian using the keywords *elang* or *alap* in combination with *bksda* (the agency that is responsible for most seizures), *sita* (root for seizure), *dihukum* (punished) and/or *vonis* (verdict). In Indonesia, when faced with a possible seizure of protected species, owners may have the option to voluntarily hand over their animals; these are then logged as "donations" and no legal action will be taken. We excluded all cases of donations. For every seizure, we extracted information on the eagles (numbers, species), the reason of the seizure (here grouped as "trade in a protected species", "possession of a protected species" or both) and mentions of social media to advertise or publicise the possession or availability of the eagle. If a seizure was reported but no information was included on a successful prosecution, we searched for follow-up reports using specifics (date, name of suspects, location, etc.). If data on prosecution were found, we noted the outcome of the final sentencing. Sentencing can include time in prison, a monetary fine or both. Monetary fines can be replaced by additional prison time specified by the judge (often one or two additional months), but we report the initial final outcome. In Indonesia, the names of suspects are frequently reported in full.

2.2. Data Preparation and Analysis

We assume that birds of prey offered for sale in one bird market are different individuals from the ones offered in other bird markets, i.e., we do not anticipate that individual birds of prey move between bird markets. We also assume that individual birds of prey that were offered for sale on one particular Facebook page are not also offered for sale on another Facebook page; given that the Facebook pages were often linked to individual

cities or regions, we think this is a reasonable assumption. The few significant traders who posted on multiple Facebook pages were easily detected and their posts were included only once. Likewise, we assume that birds of prey offered by different sellers on Instagram represent different individuals (for details, see [35]).

Birds of prey observed in the bird markets were identified on the spot by the surveyor. All species included in the Facebook and Instagram posts were identified by V.N. By and large, the species names that accompanied the posts were correct, i.e., sellers know what they offer for sale. Once, a Blyth's Hawk-eagle *Nisaetus alboniger* was offered for sale as a Javan Hawk-eagle *N. bartelsi*, and this may have been deliberate to increase saleability. Birds that were too young to be identified to the species level (often downy chicks) or cases where the photographs did not allow identification were excluded. Species names in the text and accompanying photographs in seizure reports did not always correspond, e.g., eagles originating from Java were labelled as Javan hawk-eagles, young Brahminy Kites *Haliastur indus* were identified as Black Kites *Milvus migrans* and once, a Rufous-bellied Eagle *Lophotriorchis kienerii* and dark morphs of the Changeable Hawk-eagle *N. cirrhatus* were misidentified as Black Eagles *Ictinaetus malaiensis* (and once, the other way around). Given that most reports were accompanied by photographs, we were able to ensure correct identification.

Asking prices were collected in the bird markets (these were first quotes, and these would have lowered after bargaining or when more than one bird was purchased at a time, something we did not engage in) and were recorded when included with the online listings. All were given in Indonesian Rupiah, and these were corrected for inflation to 2021, and then converted to USD.

For each species, we collected information on their global conservation status (Least Concern, Near-Threatened and Endangered) and the species' range of occurrence (in millions km^2), both taken from the IUCN Red List website, along with the wing length (in mm) and mean clutch size (number of eggs) [15,36,37]. We also assessed the commonness of each of these species in the wild on the islands of Java, Bali and Lombok, as well as Sumatra (as one of the main sources of birds that are offered for sale on Java [38,39]. This was performed independently by V.N., S.v.B. and J.A.E., who have all conducted bird (and specifically raptor) surveys on these islands over the past few decades. Scores ranged from 1 (very rare) to 5 (very common) and 0 (not present) and were summed to arrive at a combined score. The lowest score (0) was given when all three surveyors agreed that the species did not occur in Indonesia, and the highest score (15) was given when all three agreed that the species was very common. There was a high level of agreement between the assessors (Pearson's R ranged between 0.779 to 0.873, $p < 0.00001$), justifying pooling the data.

Many of the online conversations were in Bahasa Indonesia, with some use of regional languages (Bahasa Jawa, Bahasa Sunda) and slang. All the translations are ours.

2.3. Statistical Analysis

We performed three generalised linear models (GLM) to assess whether the number of individuals sold in street markets (model 1), on Facebook (model 2) and on Instagram (model 3) are influenced by asking price (inflation corrected to 2021), body size (wing length), clutch size, range of occurrence, abundance in the wild (score from 0 to 5) and conservation status.

To assess whether seized animals and the price per species are influenced by all the variables mentioned above, and by the average number of traded individuals, we performed a GLM for the seizures (model 4) and a generalised additive model (GAM) for the price (model 5).

For the relationship between the prices and the range of occurrence, we tested the fit of non-linear effects with a penalised cubic splines function (cs). Prior to the GLM and GAM, we tested for multicollinearity among the variables, and no collinearity was found. We tested models with all possible combinations among the recorded variables,

from the simplest model (only one predictor variable) to the most complex model (all predictor variables). We selected the family of distribution and the final model based on the Akaike Information Criteria (AIC) for the generalised models. We considered models with satisfactory support all models with ΔAIC values less than 2 in relation to the model with the lowest AIC (best-ranked model) [40].

To test the difference in the wing length between types of market (street market, Instagram and Facebook), we used a one-way ANOVA (analysis of variance) and Tukey's test as the post-hoc test. Normality (Shapiro–Wilk test) and equality of variances (Levene's test) were guaranteed prior to the ANOVA test. Statistical analyses were run using R 3.6.3 [40] We used the R-packages GGally for testing multicollinearity and gamlss for running the GLM/GAM [40], and stats for ANOVA and Tukey's test. We considered the results as significant when $p < 0.05$.

3. Results

3.1. Species Composition in Physical Markets and Online

We found 924 individuals of 29 species for sale, i.e., 71 individuals of 11 species in the bird markets, 254 individuals of 19 species on Instagram and 599 individuals of 22 species on Facebook. Twenty-five species are classified by the IUCN Red List as Least Concerned, three as Near-Threatened (Rufous bellied Eagle, Gurney's Eagle *Aquilla gurneyi* and Grey-headed Fish-eagle *Icthyophaga ichthyaetus*) and only one as Endangered (Javan Hawk-eagle). Most species occur on Java, Bali and Lombok, but some occur in other parts of Indonesia (e.g., Sulawesi Hawk-eagle *N. lanceolatus*) or only outside Indonesia (e.g., Mountain Hawk-eagle *N. nipalensis*) (Table 2). There were few resident species found in Java, Bali or Lombok that were not recorded during our survey, with the exceptions of the Flores Hawk-eagle *N. flores* found on Lombok and islands to the east of Lombok, and Oriental Hobby *Falco severus* and Osprey *Pandion haliaetus*.

Table 2. Birds of prey offered for sale in physical markets, on Facebook and on Instagram in Java, Bali and Lombok, Indonesia, and the number of each species that were seized, during the period 2016–2021. Abundance is a score based on field observations by three of the authors, and this ranges from 0 (not present) to 15 (all three observers agree it is very common). n.a. = not available. Price is mean price.

Species Name	Abundance	Price (USD)	Bird Markets	Instagram	Facebook	Seized
Black-winged Kite *Elanus caeruleus*	9	27.0	32	55	246	32
Crested Honey-buzzard *Pernis ptilorhynchus*	6	45.0	0	3	0	0
Bat Hawk *Macheiramphus alcinus*	4	n.a.	0	1	0	0
Jerdon's Baza *Aviceda jerdoni*	3	n.a.	0	0	1	0
Black Baza *A. leuphotes*	9	29.5	0	0	2	0
Crested Serpent eagle *Spilornis cheela*	12	38.8	6	22	38	11
Changeable Hawk-eagle *Nisaetus cirrhatus*	8	70.7	5	42	80	19
Javan Hawk-eagle *N. bartelsi*	4	100.5	0	17	12	7
Blyth's Hawk-eagle *N. alboniger*	6	106.0	0	1	1	0
Sulawesi Hawk-eagle *N. lanceolatus*	0	n.a.	0	0	2	0
Mountain Hawk-eagle *N. nipalensis*	0	250.0	0	1	0	0
Rufous-bellied eagle *Lophotriorchis kienerii*	5	71.5	0	1	0	0
Black Eagle *Ictinaetus malaiensis*	10	129.5	2	10	10	6
Golden Eagle *Aquila chrysaetos*	0	n.a.	0	0	1	0
Bonelli's Eagle *A. fasciata*	0	n.a.	0	0	1	0
Gurney's Eagle *A. gurneyi*	0	n.a.	0	4	0	0
Grey-headed Fish-eagle *Icthyophaga ichthyaetus*	5	118.5	0	1	2	0

Table 2. *Cont.*

Species Name	Abundance	Price (USD)	Bird Markets	Instagram	Facebook	Seized
White-bellied Fish-eagle *I. leucogaster*	10	196.5	0	25	15	10
Black Kite *Milvus migrans*	3	66.7	0	0	9	3
Brahminy Kite *Haliastur indus*	9	52.3	1	25	53	32
Grey-faced Buzzard *Butastur indicus*	7	n.a.	1	0	0	0
Rufous-winged Buzzard *B. liventer*	3	184.7	0	2	0	0
Chinese Goshawk *Accipiter soloensis*	13	13.0	7	0	22	0
Japanese Sparrowhawk *A. gularis*	13	11.0	10	0	3	2
Besra *A. virgatus*	4	35.0	2	2	7	0
Crested Goshawk *A. trivirgatus*	10	39.6	0	27	45	3
Black-thighed Falconet *Microhierax fringillarius*	7	27.7	1	0	4	0
Indonesian Kestrel *Falco moluccensis*	11	36.3	4	6	39	3
Peregrine Falcon *F. peregrinus*	8	259.0	0	9	6	3

The five species that were most commonly offered for sale were very similar between the online platforms and the physical bird markets, with black-winged kites being the most common and changeable hawk-eagles also making the top five three times (Table 3). In the bird markets, two small migrants, the Japanese Sparrowhawk *Accipiter gularis* and the Chinese Goshawk *A. soloensis*, were relatively commonly offered for sale. The White-bellied Fish-eagle *Icthyophaga leucogaster* was commonly offered for sale on Instagram.

Table 3. The five most commonly observed eagles offered for sale in bird markets, on Instagram and on Facebook in Java, Bali or Lombok, Indonesia, in the period 2014–2021. For Latin names, see Table 1.

Bird Markets	Instagram	Facebook	Seizures
Black-winged Kite (32)	Black-winged Kite (55)	Black-winged Kite (246)	Black-winged Kite (28)
Japanese Sparrowhawk (10)	Changeable Hawk-eagle (42)	Changeable Hawk-eagle (80)	Brahminy Kite (32)
Chinese Goshawk (7)	Crested Goshawk (27)	Brahminy Kite (53)	Changeable Hawk-eagle (19)
Crested Serpent-eagle (6)	Brahminy Kite (25)	Crested Goshawk (45)	Crested Serpent-eagle (11)
Changeable Hawk-eagle (5)	White-bellied Fish-eagle (25)	Crested Serpent-eagle (38)	White-bellied Fish-eagle (10)

3.2. Species Characteristics and Abundance in Trade

On average, the smallest birds of prey were offered in the bird markets (mean wing length: 279.14 ± 85.36 mm), followed by those for sale on Facebook (320.44 ± 85.84 mm), and the largest ones were available on Instagram (366.60 ± 100.55 mm). The difference between the mean size of birds offered for sale are different among the market types (ANOVA F = 9.721, df = 921, p = 0.001), and all of them were different from each other (Tukey: Market–Instagram: t = 4.3, $p < 0.05$; Instagram–Facebook: t = 2.5, $p < 0.05$; Facebook–Market: t = 3.1, $p < 0.05$).

When focusing on the physical bird markets, the number of birds we recorded for sale was negatively correlated with size (wing length), and positively with their range of occurrence and their abundance in western Indonesia (Figure 1a–d; Table 4). Clutch size and the remaining variables were not retained in the best model.

The number offered for sale on Facebook was positively correlated with the species' range of occurrence and negatively with the asking price (Figure 1e–g; Table 4). The number of birds of prey offered for sale on Instagram was positively correlated with their abundance in western Indonesia (Figure 1h; Table 4). The other variables were not correlated with the numbers we observed for sale online.
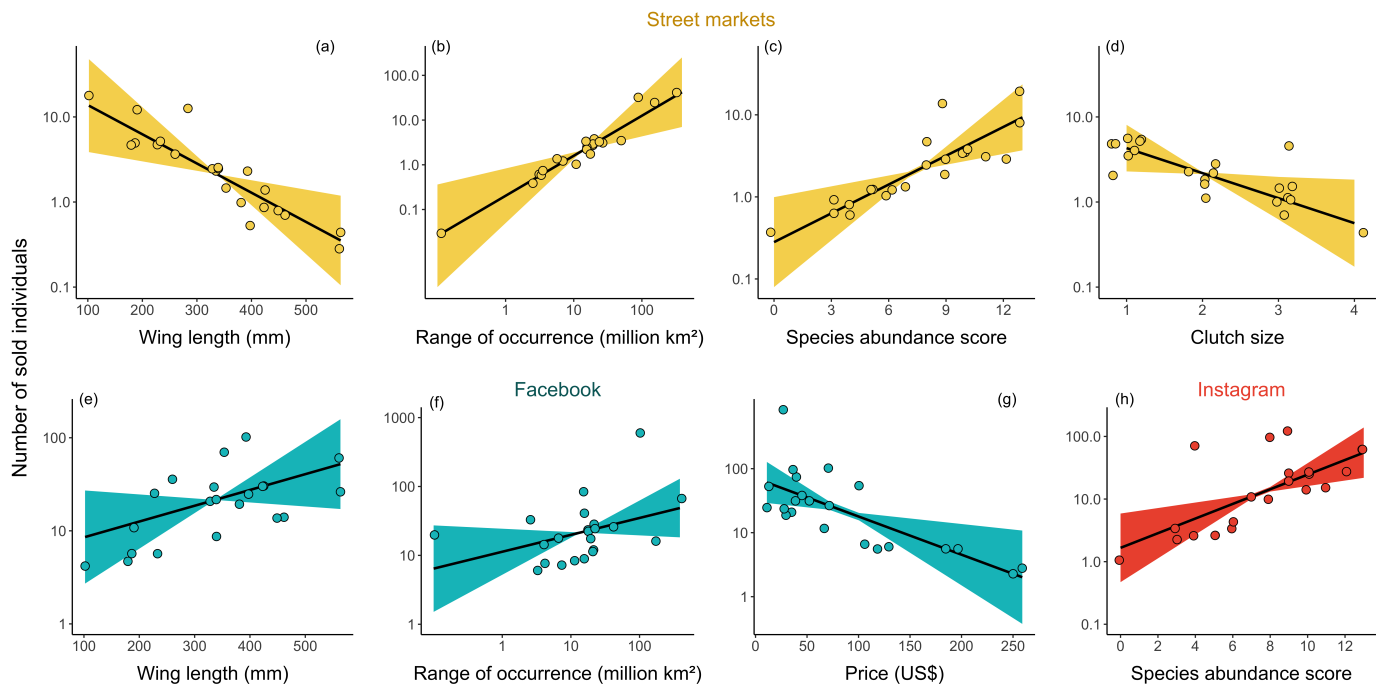
Figure 1. Relationship between the number of birds of prey for sale in physical bird markets ((**a**–**d**): model 1), on Facebook ((**e**–**g**): model 2) and on Instagram ((**h**): model 3), and the species' wing length, range of occurrence, score of abundance in the wild (0–15), clutch size and selling price. Statistical details are shown in Table 4. The shaded area represents the 95% confidence interval, and the original values are plotted on a log-transformed (ln) *y*-axis.

Table 4. Details on the best-fit model for each response variable for the factors influencing the trade, seizure and price of birds.

Best-Fit Model Response Variables	Predictor Variables [a]	Estimate	t	*p* [b]	Generalised R^2	AIC (ΔAIC [c])
Model 1: Individuals traded in the market	(Intercept)	0.433	0.27	0.78	0.50	90.1 (2.37)
	Range of occurrence	0.894	3.5	0.003 *		
	Abundance	0.269	3.2	0.006 *		
	Wing length	−0.007	−3.2	0.006 *		
	Clutch size	−0.677	−1.8	0.08		
Model 2: Individuals traded on Facebook	(Intercept)	2.300	2.4	0.02 *	0.32	183.3 (12.02)
	Range of occurrence	0.245	2.2	0.04 *		
	Wing length	0.004	1.3	0.2		
	Price	−0.014	−3.1	0.007 *		
Model 3: Individuals traded on Instagram	(Intercept)	0.350	0.6	0.57	0.33	147.0 (3.1)
	Abundance	0.290	3.6	0.002 *		
Model 4: Individuals seized	(Intercept)	0.020	0.03	0.98	0.44	104.7 (2.75)
	Wing length	0.004	2.6	0.02 *		
	Amount traded online	0.024	3.7	0.002 *		
Model 5: Price	(Intercept)	32.487	2.0	0.07	0.64	212.9 (13.85)
	cs(Range of occurrence)	0.039	0.4	0.68		
	Abundance	−5.447	−5.3	0.0001 *		
	Wing length	0.243	6.1	0.0001 *		

[a] Non-linear effect was fit using cubic splines (cs). [b] * indicate significant values (*p* < 0.05). [c] AIC is the Akaike Information Criteria and ΔAIC is the difference between the selected model in relation to the best-ranked alternative model.

The mean price for a bird of prey was USD 86.76 ± 74.46, but there were large differences between species. The smallest migrant birds (Japanese Sparrowhawk, Chinese Goshawk) were offered for sale for between USD 11–13, whereas Peregrine Falcons *Falco perigrinus* and non-native Mountain Hawk-eagle *N. nipalensis* commanded an asking price of USD 250 or more. Larger species were more expensive than smaller ones, and prices were negatively correlated with their abundance (Figure 2).
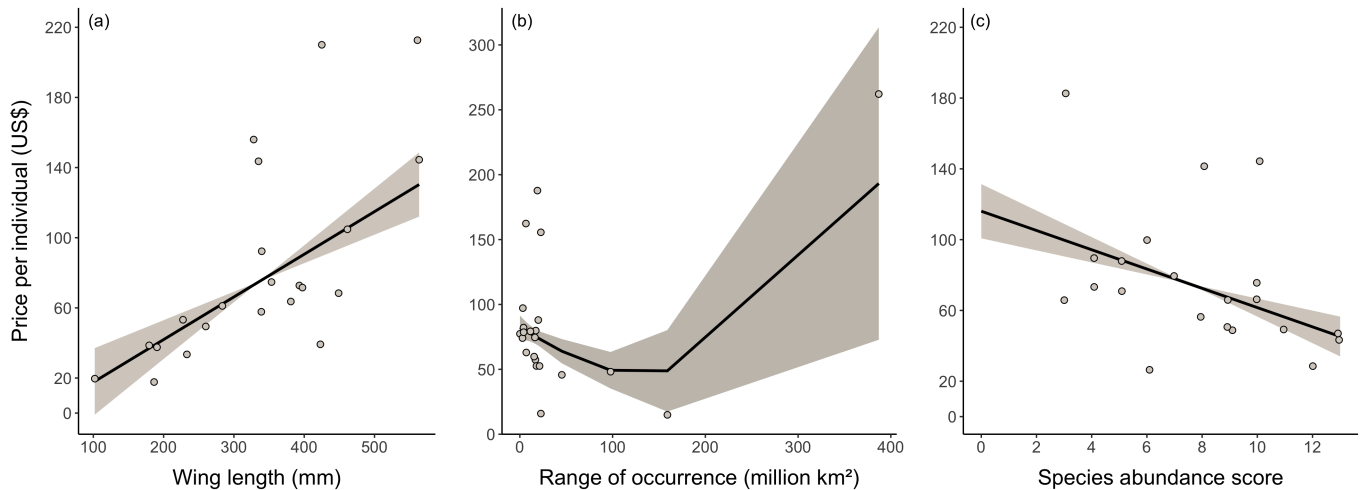

Figure 2. Relationships between the asking price of birds of prey and species' characteristics (**a**. wing length; **b**. global range of occurrence and **c.** species abundance in western Indonesia). Species abundance is a score based on field observations by three of the authors, and this ranges from 0 (not present) to 15 (all three observers agree it is very common). The shaded area represents the 95% confidence interval, and the original values are plotted on a log-transformed (ln) *y*-axis. Statistical details are shown in Table 4.

3.3. Seizures and Successful Prosecutions

We recorded 47 seizures of 131 birds of prey of 12 species (Table 5). Seizures were carried out in every province within our study area, with the largest number of seizures in the province of East Java (16) and relatively few in Banten (3) and Jakarta (3). In less than half of the seizures, the use of social media (Facebook, WhatsApp groups) by the traders was specifically mentioned (19/47). About half of the seizures of birds of prey (23/47) included other protected species. The most common of these were Green Peafowl *Pavo muticus* (6 seizures, 22 birds), Ebony Langurs *Trachypithecus auratus* (6 seizures, 19 individuals), Sunda Leopard Cats *Prionailurus javanensis* (5 seizures, 12 individuals) and Javan Porcupine *Hystrix javanica* (5 seizures, 5 individuals). We found evidence of only five successful prosecutions (Table 4), four of which were for solely trading between one and three birds of prey and one was for trading birds of prey in addition to other protected birds. Fines were low compared to the maximum possible fine (USD 6935), with two individuals fined USD 389 each for trading one Brahminy Kite *Haliastur indus* and one fined USD 713 for trading a wide range of protected birds.

Table 5. Data on 47 seizures of birds of prey recorded in the period January 2016 to October 2021 on the islands of Java, Bali and Lombok, Indonesia. For common names of the birds of prey, see Table 1. Online refers to whether in the reports of the seizure, it was specified that the birds were traded on social media. Provinces: B = Banten, C = Central Java, E = East Java, J = Jakarta, W = West Java, Y = Yogyakarta. Prosecution: months refers to sentencing of months imprisonment.

Date, City, Province	Raptors	Other Protected Species (Selection)	Online	Prosecution
January 2016, Ciamis, W	1 *N. cirrhatus*, 1 *F. perigrinus*			No evidence
Janary 2016, Ciamis, W	1 *N. cirrhatus*, 1 *A. trivirgatus*			Verbal warning
February 2016, Yogyakarta, Y	1 *H. indus*			9/3 months, USD 389
February 2016, Cimanggu, W	1 *N. spizaetus*, 1 *N. cirrhatus*			No evidence
March 2016, Pekalongan, C	3 *N. cirrhatus*	1 Javan Gibbon *Hylobates moloch*, 1 Ebony Langur *Trachypithecus auratus*, 1 Javan Slow Loris *Nycticebus javanicus*		No evidence
June 2016, Malang, E	1 *S. cheela*		Yes	No evidence
June 2016, Malang, E	2 *H. indus*, 2 *S. cheela*			No evidence
June 2016, Bantul, Y	1 *N. cirrhatus*	1 Sun Bear *Helarctos malayanus*, 1 *T. auratus*, 13 Green Peafowl *Pavo muticus*		No evidence
August 2016, Jakarta, J	1 *N. cirrhatus*			No evidence
January 2016, Soreang, W	1 *H. indus*	1 *P. muticus*, 1 Eclectus Parrot *Eclectus roratus*		No evidence
Janary 2017, Cilacap, C	1 *H. indus*		Facebook	No evidence
February 2017, Bandung, W	2 *N. cirrhatus*	2 Siamang *Symphalangus syndactylus*, 2 Binturong *Arctictis binturong*, 1 Wreathed Hornbill *Rhyticeros undulatus*, 2 *P. muticus*, 2 Yellow-crested Cockatoo *Cacatua sulphurea*		No evidence
July 2017, Pakis, E	8 *N. cirrhatus*, 3 *N. bartelsi*, 3 *I malaiensis*, 1 *E. caeruleus*		Facebook	No evidence
July 2017, Bangkalan, E	3 *H. indus*, 1 *N. cirrhatus*	2 *P. muticus*, 1 *C. sulphurea*, 1 *R. undulatus*		No evidence
July 2017, Bantul, Y	1 *H. indus*, 1 *S. cheela*, 1 *A. trivirgatus*			4 months
August 2017, Kulonprogo, Y	1 *F. moluccensis*	1 Leopard Cat *Prionailurus javanensis*, 1 *A. binturong*, 1 Sunda Pangolin *Manis javanica*, 1 Javan Porcupine *Hystrix javanica*	Facebook	No evidence
September 2017, Serang, B	1 *S. cheela*		Facebook	No evidence
October 2017, Cikareng, J	2 *H. indus*	2 Saltwater Crocodiles *Crocodylus porosus*, 1 *T. auratus*		
October 2017, Cilegon, B	1 *N. cirrhatus*	2 *P. javanensis*		Verbal warning
October 2017, Bogor, W	1 *N. bartelsi*, 3 *N. cirrhatus*	1 *H. javanica*, 1 Linsang *Prionodon linsang*		
January 2018, Bantul, Y	1 *S. cheela*		Facebook	4 months

Table 5. *Cont.*

Date, City, Province	Raptors	Other Protected Species (Selection)	Online	Prosecution
February 2018, Jakarta, J	1 *H. indus*	1 *C. porosus*, 1 *T. auratus*, 1 Grizzled Langur *Presbytis comata*, 1 *N. javanicus*	Facebook	No evidence
February 2018, Cilegon, B	1 *N. bartelsi*			No evidence
February 2018, Malang, E	3 *N. bartelsi*			No evidence
March 2018, Bandung, W	1 *I. leucogaster*, 1 *H. indus* 2 *N. cirrhatus*, 1 *F. moluccensis*		WhatsApp	No evidence
March 2018, Kebumen, C	1 *F. perigrinus*, 2 *I. leucogaster*	1 *H. javanica*	Yes	No evidence
March 2018, Bondowoso, E	2 *I. leucogaster*, 2 *H. indus*, 1 *A. trivirgatus*			No evidence
April 2018, Kulonprogo, Y	1 *S. cheela*			No evidence
April 2018, Kebumen, C	1 *I. leucogaster*, 1 *F. perigrinus*	1 *H. javanica*	Facebook	No evidence
August 2018, Pacitan, E	1 *H. indus*, 1 *F. moluccensis*	1 Sumatran Slow Loris *N. coucang*, 1 *C. porosus*		No evidence
September 2018, Kediri, E	1 *N. bartelsi*, 1 *M. migrans*		Yes	No evidence
October 2018, Praya, Lombok	2 *H. indus*	1 Black-capped Lori *Lorius lory*		No evidence
October 2018, Jember, E	1 *S. cheela*, 2 *A. gularis*	4 *P. javanensis*	Yes	No evidence
November 2018, Surabaya, E	2 *E. caeruleus*, 3 *H. indus*, 1 *I. malaiensis*		Yes	No evidence
January 2019, Denpasar, Bali	2 *M. migrans*	1 Red Bird-of-paradise *Paradisaea rubra*, 2 *P. muticus*, 1 Oriental Pied Hornbill *Anthracoceros albirostris*	Facebook	7 months, USD 713
February 2019, Badung, Bali	1 *H. indus*	2 *P. muticus*		No evidence
March 2019, Surabaya, E	1 *S. cheela*	5 Komodo Dragons *Varanus komodoensis*, 5 *P. javanensis*, 7 *T. auratus*, 6 *M. javanica*	Yes	No evidence
April 2019, Cianjur, W	1 *I. leucogaster*			No evidence
June 2019, Denpasar, Bali	1 *S. cheela*		Facebook	No evidence
July 2019, Kidiri, E	1 accipiter	1 *N. javanicus*, 1 *H. javanica*		No evidence
November 2019, Surabaya, E	7 *E. caeruleus*, 2 accipiters			12 months
November 2019, Malang, E	1 *H. indus*			No evidence
December 2019, Cilacap, C	1 *I. leucogaster*	1 Black-capped Nuri *Lorius lory*		No evidence
February 2020, Yogyakarta, Y	1 *A. trivirgatus*, 1 *N. cirrhatus*, 1 *F. moluccensis*	4 Pig-nosed Turtles *Carettochelys insculpta*	Yes	No evidence
September 2020, Probolinggo, E	1 *S. cheela*			No evidence
February 2021, Surabaya, E	1 *N. cirrhatus*	8 *T. auratus*, 8 Moluccan Cockatoo *C. moluccensis*	Facebook	No evidence
April 2021, Sleman, Y	1 *H. indus*	1 *A. binturong*	WhatsApp	No evidence

There was great similarity between what was observed in trade (online and in the physical markets) and what was seized by the authorities. Furthermore, seizures were positively correlated with the size of the birds, so that larger species were more frequently seized than smaller ones (Figure 3; Table 3).
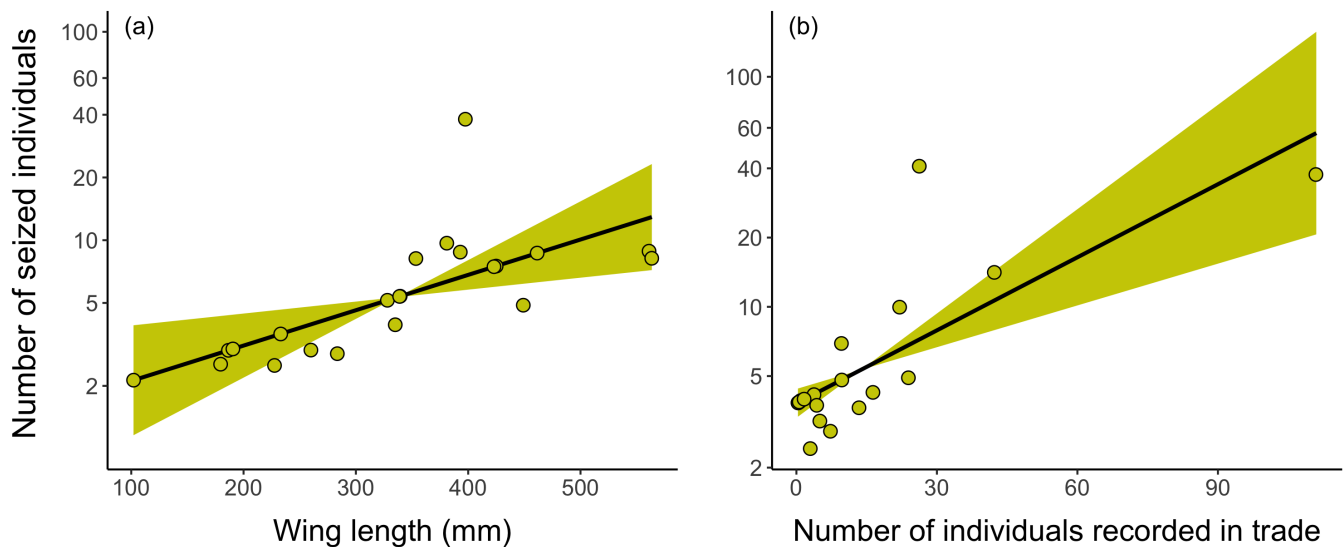
Figure 3. Relationship between the number of seized individuals with the (**a**) size of birds of prey (expressed as wing length) and (**b**) the number of individuals observed in trade (sum of individuals recorded per species considering street and online markets). The shaded area represents the 95% confidence interval, and the original values are plotted on a log-transformed (ln) *y*-axis. Statistical details are shown in Table 4.

When advertising online, traders mostly referred to the species for sale by easily deciphered English and/or Indonesian code names. Thus, birds of prey are "BOP", Grey-headed Fish-eagle were advertised as "Ghfe", Javan Hawk-eagles as "JHE" and Changeable Hawk-eagles as "CHE". For the latter, it was typically indicated if it was of the dark or light morph (indicated as "DM", "LM"). Fledglings that were capable of standing on their own feet, called branchers, were indicated by "brncr" or similar abbreviations (Figure 4). Traders also frequently added written signs indicating the date at which the photograph was taken.
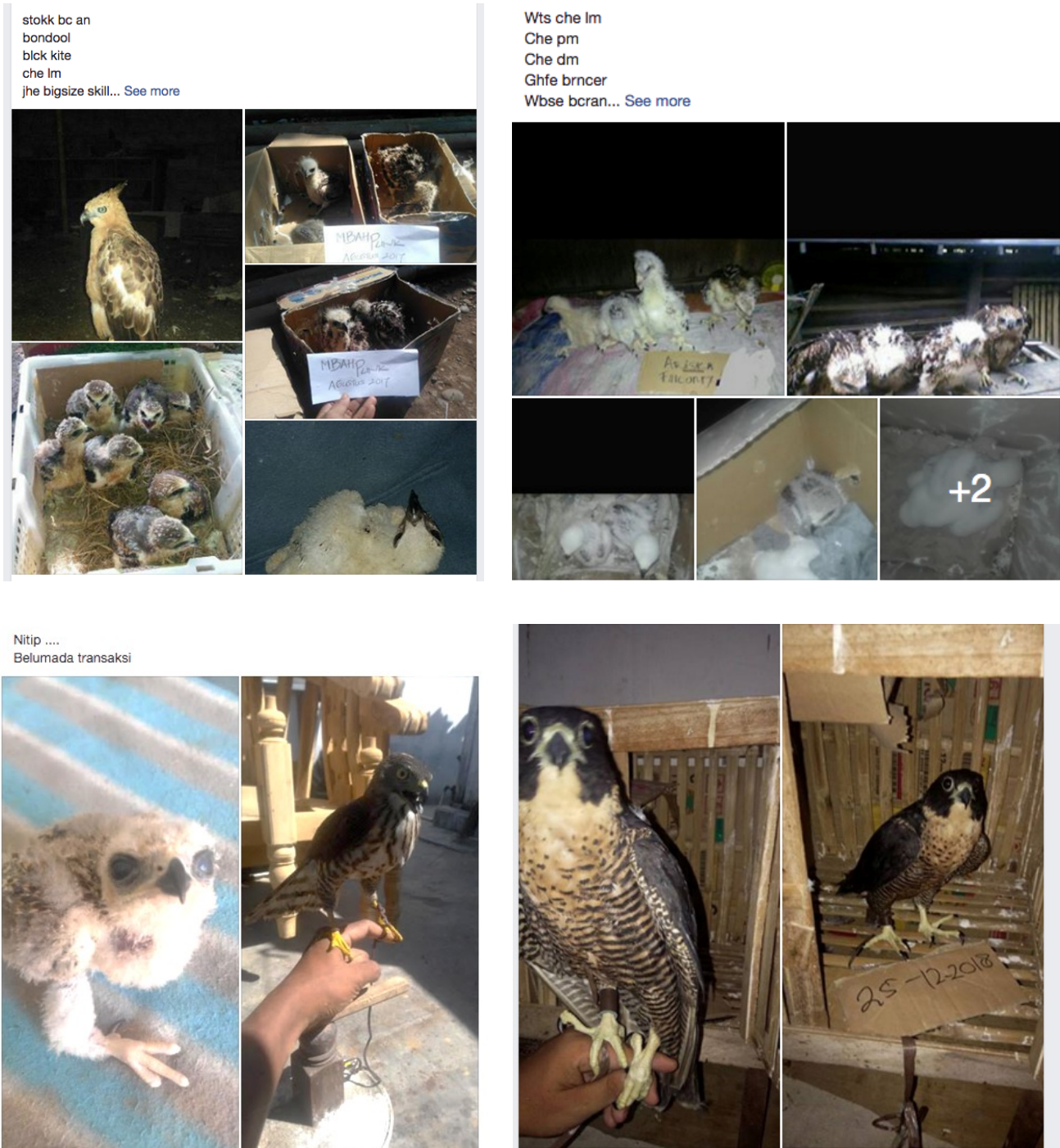
Figure 4. Birds of prey offered for sale online in Indonesia. Bondool refers to Elang Bondol, Brahminy Kite; blck kite to Black Kite; che to Changeable Hawk-eagle (lm = light morph, pm = pale morph, dm = dark morph); jhe is Javan Hawk-eagle; Ghfe is Grey-headed Fish-eagle; Wbse bcran is White-bellied Sea-eagle, brancher.

4. Discussion

4.1. Overview of Trade of Birds of Prey in Indonesia

In this work, we examined the open sale of birds of prey both in physical markets and online. With close to a thousand birds recorded, the scale of the trade is such that it almost certainly has a negative impact on local populations. This will be especially pronounced for the species that are traded in substantial numbers and that are either rare globally, such

as the Javan hawk-eagle, or rare locally, such as Brahminy Kites. Furthermore, species that are traded in large numbers, such as Black-winged Kites and Changeable Hawk-eagles, will undoubtedly be negatively affected by this trade.

While most of the attention of researchers and conservationists has been on the trade of songbirds [17,19,41–45], some work has been conducted on which birds of prey are traded, often as part of surveys alongside songbirds. Djuwantoko recorded 31 Crested Serpent-eagles *Spilornis cheela* and eight Crested Goshawks *Accipiter trivirgatus* for sale by collectors and a further four and two at pet shops in central Java [46]. Nursaid and Astuti [47] conducted seven monthly surveys of the Splindit bird market in Malang and recorded three Crested Serpent-eagles, two Rufous-bellied Eagles and one Black-winged Kite [47]. ProFauna surveyed 70 bird markets in Java and found 28 individuals of seven species of raptor in 13 markets openly offered for sale [48]. The most commonly observed species were Crested Serpent-eagles (11 individuals) and Indonesian Kestrel *Falco moluccensis* (seven individuals), and the most prominent bird markets were those in Jakarta, where 10 individuals of three species were recorded on one day.

Shepherd et al. [22] surveyed three bird markets in the city of Medan, North Sumatra. They recorded 179 raptors of 15 species, with the black-winged kite (69 individuals), Brahminy Kite (35 individuals) and Changeable Hawk-eagle (23 individuals) being the most common. These numbers are high enough for concern, especially given that raptors are very rare in certain parts of western Indonesia [25,49]. Based on a three-week survey of five forest reserves in 1986, Thoillay and Meyburg stated: "Among over 50 countries where we have counted raptors, we have never seen one where birds of prey are so rare outside the reserves. On 3550 km of roadside counts by day between protected areas, we saw only [four birds of prey] . . . In densely populated and cultivated areas (which cover the major part of Java) one can today easily travel several hundred kilometres without seeing a single raptor" [49]. For species such as the Javan Hawk-eagle, Indonesia's National Rare Animal, their trade, largely as domestic pets, has been seen as a clear impediment to their conservation [24].

Our study adds to work conducted by other researchers focussing on South Sumatra [33] and Sumatra and Java [32]. In general, there is a great deal of agreement in terms of what species are offered for sale and their asking prices, but the numbers in previous studies are higher than ours. Gunawan et al. [32] were unable to find a clear explanation for what drives the numbers in trade and asking prices. They noted that the asking price for a particular species was not related to the number of individuals that were offered for sale, nor did they find a clear pattern in terms of price and IUCN Red List status. From our study, it is clear that one of the main drivers of the trade of birds of prey in Java, Bali and Lombok is their abundance in the wild (more abundant equates to more in trade), their size (smaller raptors are offered for sale in larger numbers) and their global range of occurrence.

Our results agree with previous studies [32,33] that the trade of birds of prey in Indonesia is almost exclusively directed towards domestic Indonesian buyers. Very few posts had the complete Indonesian name of the raptor offered for sale included, presumably to avoid easy detection by the authorities. The posts had short descriptions on what was offered for sale, and these were all written in a combination of Indonesian (*Bahasa Indonesia*) and regional languages (*Bahasa Sunda*, *Bahasa Jawa*, etc.), slang and code. Species are given easily deciphered English "code names".

Birds of prey have been protected by Indonesia law since 1972. This means that it is not only illegal not only to offer these species for sale, but it is also not permitted to buy them, to keep them as pets or to transport them from one location to another. Almost 50 years of protection should be sufficient for it to be known to the public at large that these species cannot be traded. Yet, the trade in bird markets and online occur in the open, in clearly recognisable spaces (be it physical markets situated at the same location year in, year out, or on public Facebook pages with names such as Selling and Buying of Eagles and Falcons). Many of the physical bird markets operate under a mayoral or district licence, and lawbreakers can and should be dealt with by the local policy, local authorities and/or

officers of the regional natural resource management agencies. The open and consistent presence of birds of prey demonstrate that there are weaknesses in the enforcement of legislation. Facebook and Instagram, in their terms and conditions, make it very clear that the sale of live animals, protected species or globally threatened species is not permitted. As with other taxa, ranging from turtles to orangutans [26,28,35,50], it is evident that neither Facebook nor Instagram effectively implement their own policies.

Birds of prey in Indonesia are mainly traded as novelty pets [22], to show power and wealth [24,51] and, increasingly, to meet the demand for different levels of falconry [32,52,53], whereby the raptor is used to catch specific prey. Elsewhere in Asia, falconry is a much bigger driver of the trade in raptors [54], as can be the trade for medicinal purposes, with Zhang et al. [55] reporting the annual sale of thousands of birds of prey in three cities in southern China.

4.2. Seizures and Successful Prosecutions

The trade of birds of prey in Indonesia is in clear violation of the country's domestic legislation. The bird markets in Indonesia are open to the public, are socially accepted [19–22,38,39,41,43,45–48] and are officiated and visited by presidents and governors. They offer a wide range of products and services (animals, animal supplies and accessories, food and drinks for humans, etc.). Legally protected species, while invariably present, make up a small proportion of what is offered [39]. Many of the wildlife markets are situated in the same location, and shops are being run by the same families for decades. Certainly, when it comes to the trade of birds, vendors in wildlife markets have very little to fear in terms of being fined, having their birds confiscated or of being prosecuted for violation of protected species, harvest or animal welfare laws [22,39].

As not only the sale but also the keeping of native birds of prey is not permitted, many of the Facebook group members (with their details clear for all to see) and Instagram account holders are in direct violation of the law. According to Facebook's terms and policies, listings may not promote the buying or selling of animals or animal products, and this includes live animals, livestock and pets. Instagram has a similar prohibitive policy referring to endangered wildlife [35].

In recent years, the Indonesian authorities have made a start with preventing the online sale of protected eagles, and the occasional trader has been apprehended and relatively small numbers of eagles have been seized [56]. However, it is clear that this has not deterred the open sale of raptors on Facebook, similar to how in the past, trade continued with impunity in the bird markets. The small number of prosecutions we were able to confirm were solely for violating Law 5 (Conservation of Natural Resources and Ecosystems) and never for additional violations (money laundering, corruption, etc.). The offering of protected species for sale is in violation of national laws but also of the terms and conditions of the online platforms. The low prosecution rate with minimal fines shows a lack of recognition of the urgency of the threat that trade poses to already imperilled wildlife.

4.3. Monitoring the Trade of Birds of Prey in Indonesia

It is important to consider some of the weaknesses and biases in our study. Firstly, not all birds of prey are detected in the markets; some may have been kept back areas or at traders' homes. We expect this number to be relatively small, as in order for traders to sell their birds, potential customers have to be able to see what is offered. However, it is important to consider that in the absence of enforcement actions by the authorities, there is little incentive for traders in bird markets to not display their birds of prey. Overall, this may have resulted in fewer birds being recorded than were actually present, but it is unlikely that this would significantly change the species composition. Secondly, bird markets were only in Java, Bali and Lombok, and it would have been beneficial to have included markets in Sumatra, Kalimantan and Sulawesi [20,22,42,57]. By including these other islands, undoubtedly, a larger range of species would have been detected. Thirdly,

we only monitored public and open Facebook groups and not closed groups [35,51]. There are a number of closed wildlife trade Facebook groups and these may offer some of the rare birds of prey for sale. Fourthly, we only were able to pick up seizure reports and prosecutions when these were made public—an unknown number of additional seizures may have been made, and there may have been additional successful prosecutions that may not have been made public [56]. We expect that this number is relatively small, given that one of the reasons why authorities prosecute is to deter potential lawbreakers.

It is clear from our research, conducted over a 5-year period and in the same regions, that the majority of birds of prey are now traded over the Internet (c.f., [32,33,51]). This included a wide range of species from within Indonesia, but also a small number of species that must have been imported into the country. Monitoring the illegal online trade of birds of prey is much easier and significantly cheaper than visiting traditional markets. In our surveys, we employed a single research assistant to visit bird markets. If one were to focus just on birds of prey, a visit to a bird market should not take more than an hour, as in that time period, all corners of even the largest bird market can be visited. In cities with more than one market, we assumed that there would be enough time to visit all bird markets in one day. We hypothetically positioned our market surveyor geographically in the centre of all the markets we visited over the 5-year period, and we calculated the time to visit the markets. For ease of calculation, we assumed that all were reachable in one day of travel, such that each survey of a city could be performed within two days (one day of travel, one day of surveying). To visit the 12 bird markets in our survey, the research assistant realistically needed 3 weeks for the visits and then 1 week for the write-up. To complete the nearly 200 visits we included in our survey, this would require 18 months of continuous employment (in our study, this was spread out over nearly 6 years). We estimate this would require some 25,000 km of travel by road. Properly monitoring 12 Facebook groups or Instagram accounts offering birds of prey for sale can realistically be carried out in one 2- to 3-day session each month. It would require no travel, just access to good Internet, and this can be realised both in Indonesia and abroad.

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Data Availability Statement: All data are included in the paper; for any additional requests, please contact the corresponding author.

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