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RESEARCH

Investigating the illegal online trade of Indonesian parrots (*Psittacine*)

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Abstract
Targeted for characteristics such as their colourful appearance, intelligence, and ability to recognize the human voice, parrots (order *Psittaciformes*) have become a coveted commodity. They are therefore common victims of the illegal wildlife trade, which in turn has contributed to their overall decline. Many of the world's most traded and threatened parrot species originate from Indonesia. Yet Indonesia is also a renowned transit and market country for (illegal) parrot trade. Our study is the first of its kind to document in detail the online trade of all parrot species on one of Indonesia's most popular social media platforms, Facebook, as pertaining to the trade within Indonesia. Over the period of 1 January 2020 until 31 August 2021, we analysed 283 posts, containing 861 identifiable parrots of 22 species across 38 Facebook user groups. Employing visual and textual analysis, we find clear trends for certain species that we highlight as a potential indicator for targeting. Overt indicators of illegality were common in visual references, despite textual references being coded to avoid detection. Finally, we find the online illegal trade of parrots increased during the global pandemic, despite the stricter approach taken by Facebook regarding trade in live animals on their platform. Overall, our analysis confirms the importance of Facebook as a virtual marketplace for parrots, and it is clear more rigorous monitoring of social media is needed to counter the harmful consequences of the illegal wildlife trade.

Keywords Illegal wildlife trade · Social media · Psittaciformes · Indonesia · Conservation

Introduction

All animal groups are affected by the illegal wildlife trade (IWT). One of the leading causes for the global loss of biodiversity, the IWT is also responsible for the emergence and spread of many zoonotic diseases, such as COVID-19, avian flu, SARS (Allen et al. 2017) and Psittacosis in parrots (Abdullah et al. 2024). According to the foremost database in this field, the Convention on International Trade in Endangered Species database (CITES Trade Database 2022), parrots (order *Psittaciformes*) are the most traded animal taxon. With CITES only reporting international trade in CITES listed species, it is important to note that this report can provide a skewed view of the abundance of different taxa in the trade, but regardless, parrots are frequently found in IWT marketplaces. Targeted for characteristics such as their colourful appearance, intelligence, and ability to recognise the human voice (Cassey et al. 2004; Olah et al. 2016; Pires et al. 2021), parrots have become popular pets worldwide. As a result, wild-caught parrots are dangerously affected by the IWT, with surveys to date observing at least 321 of the 355 extant parrot species appearing on the global market (Chan et al. 2021). The consequences of this prolific trade have revealed that Psittaciformes collectively have a higher extinction risk according to the IUCN Red List Index than any other bird group, with one-third of the 355 extant parrot species being threatened with extinction (Olah et al. 2016).

Indonesia, a biodiversity hotspot, hosts the greatest diversity of parrot species (Pires et al. 2021) and the highest proportion of threatened and endemic species of any nation (Olah et al. 2016), with non-endemic Southeast Asian parrots also prevalent throughout the country (Aloysius et al. 2020). Widely known as one of the world's most prominent source, transit and market countries for parrots (Chan et al. 2021), Indonesia

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has therefore consistently been identified as the highest priority country for parrot conservation (Olah et al. 2016). Bali, Java and Yogyakarta in particular are important sources for parrot species, but are also renowned hubs for illegal wildlife trade, especially for birds (Widodo 2005; Kristianto and Jepson 2011; Nijman et al. 2021).

Bird-keeping in Indonesia is a deeply rooted cultural practice, with captive birds held for pets, breeding, prayer release and for singing competitions (Marshall et al. 2020). The latter has caused a huge demand for Passerine songbirds and non-native parrot species such as lovebirds (Mirin and Klinck 2021), with keepers participating in local, national and regional competitions with large prizes at stake (Jepson et al. 2011). This huge demand has led to a surge in the number of songbirds taken illegally from the wild and placed into trade markets, with rarer species shown to drive a higher market price (Harris et al. 2015), therefore putting an already threatened species at further risk of extinction. For example, the endemic Javan pied starling (*Gracupica jalla*) is a highly prized songbird which is now extinct in the wild. This huge threat to biodiversity loss has been coined the "Asian songbird crisis" (Lees and Yuda 2022) and identified as a conservation priority. Regardless, the illegal trade of songbirds persists across Indonesia, with traditional bird markets selling huge species diversity. As a result, research has focussed on songbirds and failed to draw attention to the emerging trends of other bird groups that are increasingly prevalent in both physical and other marketplaces. With many potential parallels, we must explore the emerging threat of illegal parrot trading to ensure this biologically important group is effectively protected to prevent unrecoverable species loss.

Physical bird markets have historically been the primary mode of trade within Indonesia, with markets occurring in most towns and cities and hosting an array of native and non-native species (Chng et al. 2015; Chng and Eaton 2016; Chng, Krishnasamy and Eaton 2018; Rentschlar et al. 2018; Iskandar et al. 2020). However, recently, there has been a drive towards online marketplaces (see Siriwat and Nijman 2020; Nijman 2020; Nurbandi 2022). This increase in reachable customers has increased demand for certain species (Budiani and Raharningrum 2018). Cyberspace is increasingly used as a tool to conduct illegal trade due to its low entry barriers, potential for anonymity, facilitation of communication and exchange of information, wider distribution possibilities, possibilities to bypass longer trade chains in favour of higher profits, increased linkage with other offenders and criminal networks, and limited risks of getting caught (Lavorgna 2014). It is therefore imperative to reassess how the proliferation of trade in online marketplaces as opposed to physical marketplaces has altered the dimensions of the illegal trade in parrots with this increasing market divide. During the global COVID-19 pandemic, enforced lockdowns and travel restrictions resulted in the closure of physical bird markets within Indonesia, with the parallel songbird trade showing a large portion of the market moving online (Fink et al. 2021). However, no research has examined the effect of these closures on illegal parrot trade.

Social media sites are prolific hubs for both legal and illegal wildlife trade, including live and dead animals, as well as animal products. For example, the illegal trade of wildlife products such as ivory and rhino horn has increasingly shifted onto social media platforms such as Facebook and WhatsApp (Yu and Jia 2015). The surge in illegal trading on social media platforms has encouraged companies to declare various pledges to prevent further illegal trade: for example, Facebook has banned all forms of live animal sales since 2017, and listings should not promote the buying and selling of animals or animal parts (Meta 2023). Despite this, Facebook remains a popular venue for buying and selling live animals and animal products, particularly those that are a victim of the illegal wildlife trade (Nijman et al. 2021). Budiani and Raharningrum (2018) highlighted that although Facebook Asia Pacific does not permit the sale and trade of endangered animals at the regional level, there was no specific policy in place in Indonesia that prohibits wildlife trade on its network.

The importance of social media sites as trading channels for the legal and illegal trade of live birds in Asia has previously been highlighted in birds of prey (raptors) (Siriwat and Nijman 2020). Additionally, bird trade on Indonesian Facebook groups has been surveyed in the past (Budiani and Raharningrum 2018; Fink et al. 2021; Iqbal 2015), with previous research determining that buy-and-sell groups on Facebook that are classified as "open" (free to join with no joining restrictions) do not offer many live birds. However, to our knowledge, no previous research has examined the illegal online trade of parrots in Indonesia on this platform.

The trade in protected parrots violates current Indonesian legislation such as 1990 Law on Conservation of Living Natural Resources and their Ecosystems (Republic of Indonesia 1990). Before 2018, only 12 parrot species were listed as threatened in Indonesia and as a result were regulated using catch-quotas set by the Indonesian Directorate General of Forest Protection and Nature Conservation (Republic of Indonesia 1999, 2018). Such catch-quotas were rarely enforced, and most parrot species continued to be removed from the wild to respond to national and international demand (Setiyani and Ahmadi 2020). The subsequent biodiversity loss led to a revision of its threatened species list in 2018 (for the first time since 1999) – with a total of 919 endemic species added to the list in a revised appendix (Pires et al. 2021). Despite this, as of 2021, 34% of

Indonesia's parrot species are still commonly traded (Pires et al. 2021) and with no new quotas for national sale issued, all wild harvests are technically illegal. The IWT and specifically the illegal parrot trade, has remained an issue in Indonesia. Recently, calls for stricter laws and enforcement to address wildlife trafficking in Indonesia have increased as more reports regarding the online trade in protected animals have emerged (Satriastanti and Arumningtyas 2023).

In this study, we examine the role of social media platforms in facilitating the online trade of parrot species within Indonesia. We determine the extent to which parrot species are sold through the Facebook platform, alongside documenting their CITES classification, health, and wild or captively bred status. It is important to note that the ban on live animal sales on Facebook was already in place. We surveyed both public and closed forums from 2020 to 2021, during which Indonesia was subject to a series of local lockdowns due to the COVID-19 pandemic to determine whether closures of physical bird markets drove the illegal parrot trade to online platforms. Our data therefore provides an insight into the scale and movement of live bird trading through online platforms during such unprecedented times, and allows us to determine whether the online parrot trade in Indonesia during our study period could be considered an opportunistic crime, or driven by other means. This study highlights a thriving, overt illegal trade in Indonesian parrots on Facebook and encourages further research and law enforcement efforts to counter such illegal trade in protected species.

Materials and methods

Overall data collection process

This study surveyed public and private forums on the social media networking site Facebook for activity relating to the buying, selling and keeping of native parrot species within Indonesia, to identify and quantify the illegal trade of native parrots on this platform. Whilst there are a variety of social media platforms, Facebook is commonly used for wildlife trafficking in Indonesia, particularly for avian taxa (AVAAZ 2022; Maqoma 2023). This is likely due to the platform offering a vast and easily accessible online marketplace, linking over 3 billion users worldwide, of which at least 135 million users were in Indonesia in 2023 (We Are Social & Meltwater, 2023).

Following the rationale of Gibbs and Hall (2021), we situated our research in the non-reactive phase of a digital ethnography. This is sometimes referred to as 'lurking' - with the ethnographer inhabiting online field sites for passive observation. The authors' approach was non-exceptionalist in this regard, arguing that online ethnography should be ethically evaluated in the same way as more traditional 'offline' ethnographic methodologies, including practicing an ethics of care towards human and nonhuman participants.

The total period in which data was obtained was 1 st January 2020 to 31 st August 2021. Data was collected in real time from 1 st May 2021 to 31 st August 2021 with data retrospectively collected from dates preceding this period. Surveys were conducted weekly, with posts collected on the Thursday of each week over a ten-hour period. Once a post was identified, it was coded in a spreadsheet which contained details such as post information (date, link, name of the group, text, location, visuals, and a screenshot); content details (species, amount, age, origin, price); and notes (e.g. comments on the post). The species were identified manually, using the authors' existing knowledge of parrot taxonomy in Indonesia alongside reference to a field guide of birds of the Indonesian archipelago (Eaton et al. 2021). Any individuals that could not be identified to species level were discounted from the analysis. A total of 283 posts were recorded from 26 "public" groups (or "open") and 12 "closed" groups in this way. All data was stored in encrypted folders. A similar 'snapshot' approach, or cross-sectional analysis, of online sales, is common in the study of online trade of cultural objects (Brodie and Yates 2019).

Data was obtained from online groups frequented by users in Indonesia. Users were identified as specifically present in Indonesia rather than in another location, either because the post provided specifics about location was written in Bahasa Indonesian, or because it had an added Facebook location tag. Following an initial search using key search terms (as detailed below), groups were targeted for data collection based on their title (relevant to keeping and trading parrots), or because posts in other groups would refer to these groups. The distinction between public and closed groups is based on accessibility by the general public, with "closed" groups only allowing access and visibility to group members, whereas anyone can view and post in "public" groups. Public groups can therefore be monitored by anyone, whereas closed groups required moderators' approval to join. There were two ways to gain access to the closed groups. The first was through a 'tick box' approval and the second was through answering basic questions, such as declaring the purpose for joining. Any questions were always answered truthfully, and we were subsequently admitted or rejected. We used our own Facebook accounts to monitor all groups.

Importantly, online IWT posts commonly use slang, code words, specific vernacular, hashtags or emojis to refer to the species and products for sale, to disguise their origin and identity, whilst simultaneously signalling their expertise and ultimately circumventing manual and AI detection (Sharma

and Kumar 2019; Xu et al. 2020; Alfino and Roberts 2020). Previous studies have identified some of those specialist textual components for the online Indonesian parrot trade (Budiani and Raharningrum 2018). During our data collection, we selected a collection of common phrases used to describe parrots and their trade, alongside searching using species/genus name separately, or with a (consumer) location of interest (please see the Appendix Table 2 for a complete list of search terms). For example, search terms were used for lories (*nuri*), cockatoos (*kakatua*) and hanging parrots (*serindit*).

Health status

We used a three-step scale of very good, average, and poor health to quantify the health status of parrots involved in online trade. These measures of health were characterised by the same person each time based on their respective experience, to ensure reliability and repeatability of results. Birds of good health had no visible physical deterioration - feathers were glossy and birds were seemingly alert in their environment. Birds of average health had one or two obvious issues, such as misplaced feathers and some dirt or grime present, but birds generally looked alert in their behaviour. Finally, birds of poor health had several identifying factors, including many missing feathers, shabby tail/wing feathers and presence of dirt. Signifiers of illness were also a key measure for birds displaying poor health, with birds displaying illness being generally ruffled, often with cloudy eyes and presence of tail bobbing. Other aspects of bird behaviour were also used to determine health status - birds who were sitting at the bottom of the cage for example, were seen to be experiencing poor health. In some cases, users provided statements on the bird's condition or health status, which were used in conjunction with our own measures of health.

Illegality

We limited the scope of our analyses to posts of a suspected illegal nature. We classified a post as illegal based on 3 different determinants: (1) if a species is known not to breed in captivity; (2) if any evidence of their capture was present in the visual or textual elements of the posts; (3) if they were classified as 'wild-caught' but lacked information regarding quotas or national restrictions for bird transportation.

Clues for illegality within the posts were visual (photographs and videos) and/or textual: for example, if a bird had no leg ring, was a protected species, in poor condition, or clear physical indicators of trapping were present, birds were classified as illegal. Some visual indicators of trapping included clearly immobilised birds and use of cloth bags and/or PVC tubes for transport. Similarly, birds clearly shown enclosed in a human hand outside were also classed as indicator of illegal capture, as they had clearly been removed from a trapping device. Please note that this paper does not include any reproductions of visual references to parrots traded to incorporate an ethics of care not only towards human participants of this study, but also towards nonhumans and their ecosystems.

Textual identifiers of illegality included describing birds as semi-tame or wild in the accompanying text. Birds that were described as semi-tame were assumed to be of wild origin due to the known difficulties of taming wild birds in comparison to those reared in captivity. In some cases, descriptions of the bird's origin were absent. In these cases, if the species in question is not known to breed in captivity, then they were classified as illegal through the underlying assumption that the bird was wild caught. Alternatively, if the text included references to the birds as semi-tame or wild but lacked information regarding quotas or national restrictions for bird transportation, they were also deemed illegal due to being illegally harvested or transported from another country.

Ethical Considerations

Social media provides a valuable resource to explore the various dimensions of wildlife trade. However, much like all ethnographic research into sensitive topics and with hard-to-reach populations, it requires a commitment to the highest standards of data privacy and data protection before, during and after the research (Bishop and Gray 2017; Di Minin et al. 2021). Although the posts analysed for this study were publicly accessible, we ensured that we collected, stored, protected, shared, and managed the data in a way that prevented the potential risks to the original owners of the posts. For example, we decided not to include any visual data in the dissemination of this research to prevent potential identification of the post owners.

Statistical analysis

Statistical analysis was performed in R version 4.4.2 (R Core Team 2021). Due to the nature of the data collected, not all recorded data was able to be analysed statistically and therefore is reported descriptively. The number of posts in public and closed groups were analysed using Chi-squared with the Wilcoxon rank-sum test, to test for significance between posts during the COVID-19 period. An exact binomial test was used to test for significance in the origin of birds that were recorded (such as wild, tame or semi-tame). Finally, a Chi-squared goodness of fit test was used to test for any significance in the species of parrots recorded across all posts.

Results

This study examines the extent to which parrot species were sold online in Indonesia through the Facebook platform during a specific time, alongside documenting other qualifiers such as CITES classification, health, and their wild or captively bred status.

Prevalence of online trading on Facebook

In total, we recorded and analysed 283 posts, which contained 861 identifiable parrots of 22 species (as summarised in Table 1), across 38 Facebook user groups. These user groups were either listed as 'general' groups or as 'buy-and-sell' groups. We find that both public and closed groups were used by a range of individuals with varying objectives, including as forums for discussions on bird keeping/ownership, for the trading of live birds, and to highlight effective trapping methods for catching wild individuals. The highest number of posts that included illegal signifiers were all found on freely available, public groups. Two groups specifically dedicated to hanging parrots of the genus *Loriculus* (*srindit* or *serindit* in Bahasa Indonesian) counted 111 posts, and 28 posts with illegal characteristics such as those described above, therefore amounting to 49.12% of all 'illegal' posts. Another group dedicated to the blue-rumped parrot, *Psittinus cyanurus (Nuri tanau* in Bahasa Indonesian) counted 43 posts with illegal characteristics (15.19%).

Posts on both public and closed groups had a high turnaround. Posts would often be removed once someone had shown interest in the parrots for sale to signify potential sales or more likely as a means to avoid detection. Similarly, groups would also often change names or be deleted. As of July 2022, of the 38 groups analysed for this study, 23 have been deleted; 9 remain public, 3 remain closed, and 3 groups have changed from public to closed.

Most analysed posts contained minimal textual information in the initial posts, and instead this was provided in the comments. In addition to the visual references to captivity tools, the owner of the original post would sometimes add further information regarding the origin of the birds for sale in the comments. For example, in one post (SIL7) the trapper states the location where the trapping occurred, and describes the methods used for trapping: bendo sap mixed with forest rubber. Other posts describe that metal from an umbrella frame can be used to as a trapping tool (SIL28). Another post (SIL11) in the same group contained a comment by the post owner that they caught 6 females on the day of posting, to which another user requested the post owner to release the females so that the species does not go extinct, highlighting that these groups are not only frequented by buyers and sellers, but also by hobbyists (such

Table 1 All species of *Psittacines* found for sale in online posts on the social media platform, Facebook, in Indonesia. Birds were documented in both public and closed groups. The species is listed alongside their current IUCN status (IUCN 2023), CITES status (CITES Trade Database 2022), the number of individuals, and the number of posts observed. We also documented whether these species were known to breed in captivity as this was used as a proxy for illegality. Ability/inability to breed in captivity was established through a combination of historical records (Lindholm 1999) and consultation with Indonesian Parrot breeding experts to obtain an up-to-date report per species. Asterisk (*) highlights species for which very rare instances of captive breeding have occurred but produced no viable offspring or had severely high mortality

Species name	IUCN Status	CITES status	Number. of individuals recorded	Number of posts	Known to breed in captivity
Black lory *(Chalcopsitta atra)*	LC	II	4	3	Yes
Black-capped lory *(Lorius lory)*	VU	II	51	11	Yes
Blue rumped parrot *(Psittinus cyanurus)*	NT	II	130	43	No
Blue-crowned hanging parrot (*Loriculus galgulus)*	VU	II	469	118	No*
Brown lory *(Chalcopsitta duivenbodei)*	LC	II	3	3	Yes
Coconut lorikeet *(Trichoglossus haematodus)*	LC	II	6	4	Yes
Dusky lory *(Pseudeos fuscata)*	LC	II	8	2	Yes
Eclectus parrot *(Eclectus roratus)*	LC	II	4	3	Yes
Enggano parakeet *(Psittacula longicauda modesta)*	NT	II	1	1	No
Flores hanging parrot *(Loriculus flosculus)*	VU	II	2	2	No
Flores lorikeet *(Trichoglossus weberi)*	NT	II	6	4	No
Javan hanging parrot (*Loriculus pusillus)*	NT	II	57	21	No
Jonquil parrot *(Aprosmictus jonquillaceus)*	NT	II	2	2	No*
Large fig parrot *(Psittaculirostris desmarestii)*	LC	II	2	1	No*
Long-tailed parakeet *(Psittacula longicauda)*	NT	II	70	24	No*
Moluccan cockatoo *(Cacatua moluccensis)*	VU	I	7	7	Yes
Moluccan king parrot *(Alisterus amboinensis)*	LC	II	1	1	No
Palm cockatoo *(Probosciger aterrimus)*	LC	I	7	5	No*
Pesquets parrot *(Psittrichas fulgidus)*	VU	II	2	2	No*
Red lory *(Eos bornea)*	LC	II	4	3	Yes
Sulawesi hanging parrot *(Loriculus stigmatus)*	LC	II	18	15	No*
Tanimbar cockatoo *(Cacatua goffiniana)*	NT	I	5	5	Yes

as parrot enthusiasts which do not use these sites for the buying or selling of live birds). This is further exemplified by the number of posts in which comments offered advice on the health or care of the birds.

Online trade and the COVID-19 pandemic

During our overall study period (1st January 2020 to 31 st August 2021), we find a consistent rise in the number of posts with live birds for sale across the entire data collection period (Fig. 1), with significantly more posts recorded in public ($N = 738$) compared to closed groups ($N = 170$, $X^2(1) = 355.31$, $p < 0.00$). This increase in post number was significantly higher for both groups during a period of national lockdowns associated with the COVID-19 pandemic in Indonesia. During the May-July 2021 period, we find significantly more posts in public groups ($W = 8613.5$, $p = 0.0117$) and closed groups ($W = 944.5$, $p < 0.001$), than any other time period (Fig. 1). Subsequently, from July 2021, a decrease is found in the number of posts for sale.

High prevalence of wild individuals

To determine the origin of live birds available on online marketplaces, we introduced wild or captive status as a qualifier of interest. We found significantly higher numbers of wild parrots advertised for sale when compared to tame or semi-tame birds (binomial test, p-value < 2.2e-16) (Fig. 1). Further, we observed several signifiers of illegal capture on posts listing birds for sale (Fig. 2).

Trends for certain genera and species

We observed a variety of parrot species for sale in online trade (Table 1). Using a Chi-square goodness of fit test, we identified significant differences in species representation across both public and closed groups ($\chi^2(21) = 1101.38$, $p < 0.001$). Standardised residuals identified *Loriculus galgulus* (std. residual = 30.51), *Psittinus cyranus* (std. residual = 8.57) and *Psittacula longicauda* (std. residual = 3.16) occurring far more frequently than would be expected due to chance (Fig. 3).

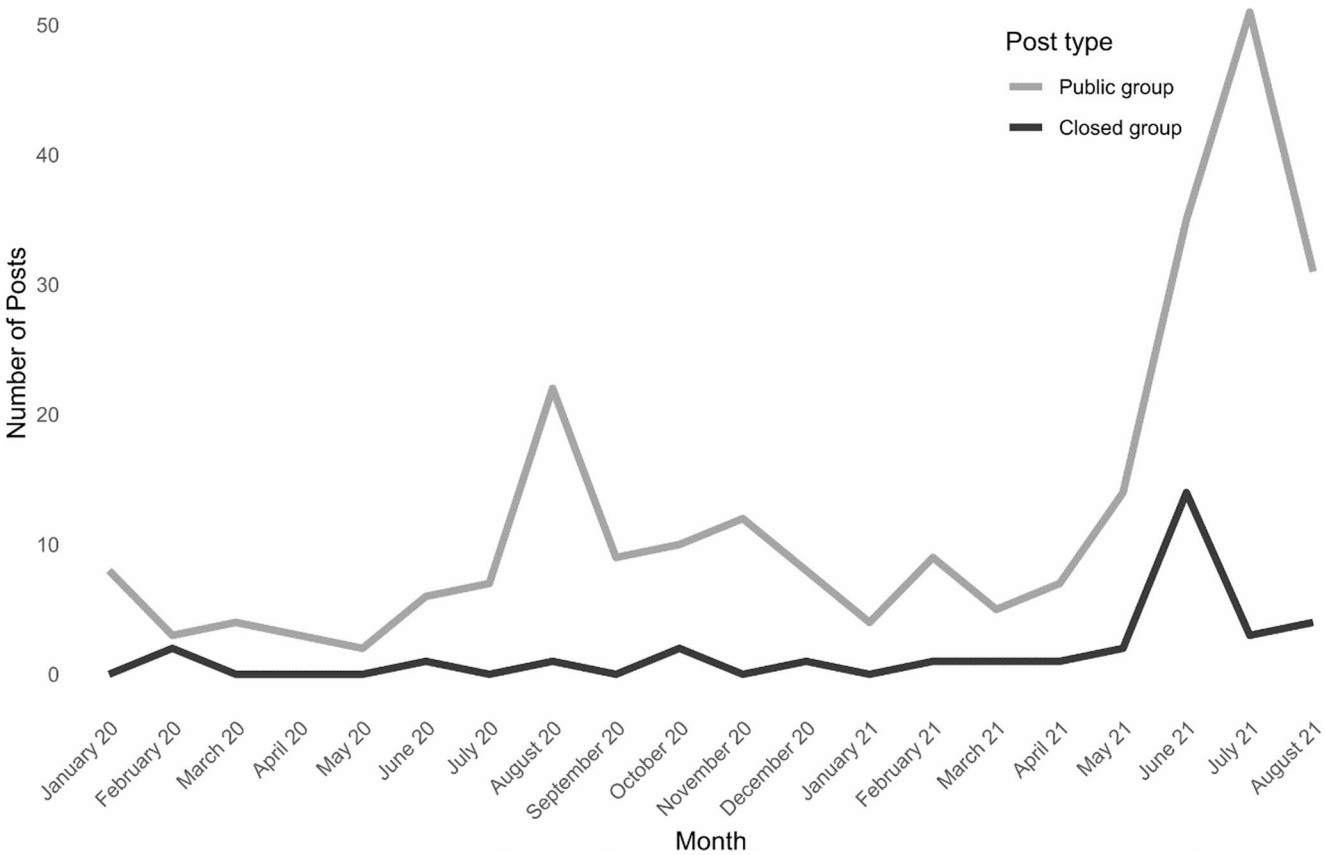

Fig. 1 Total number of illegal posts of *Psittacines* (parrots) for sale in Indonesia on both public and closed groups on the social media platform, Facebook, over the study period of 1 st January 2020 to 31 st August 2021. The lighter line represents the number of illegal groups found in public groups, whereas the darker line represents the number of posts found in closed groups. Total sample sizes of groups surveyed are 26 public and 12 closed

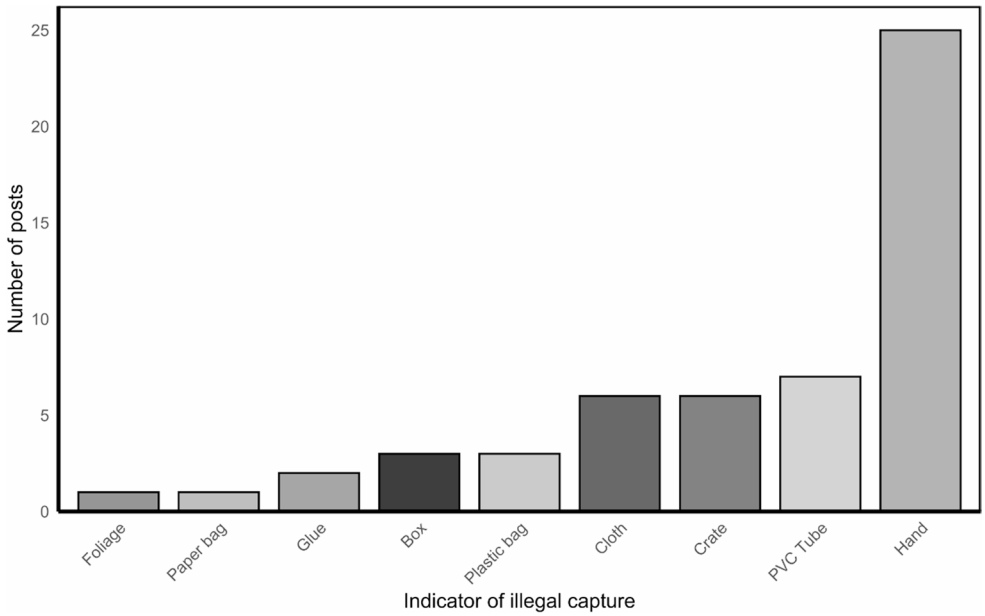

Fig. 2 Several indicators of illegal capture were observed in posts advertising *Psittacines* for sale on the social media platform, Facebook ($N=54$). Instances were documented in both public ($N=26$) and closed ($N=12$) groups and were found across the species we observed for sale

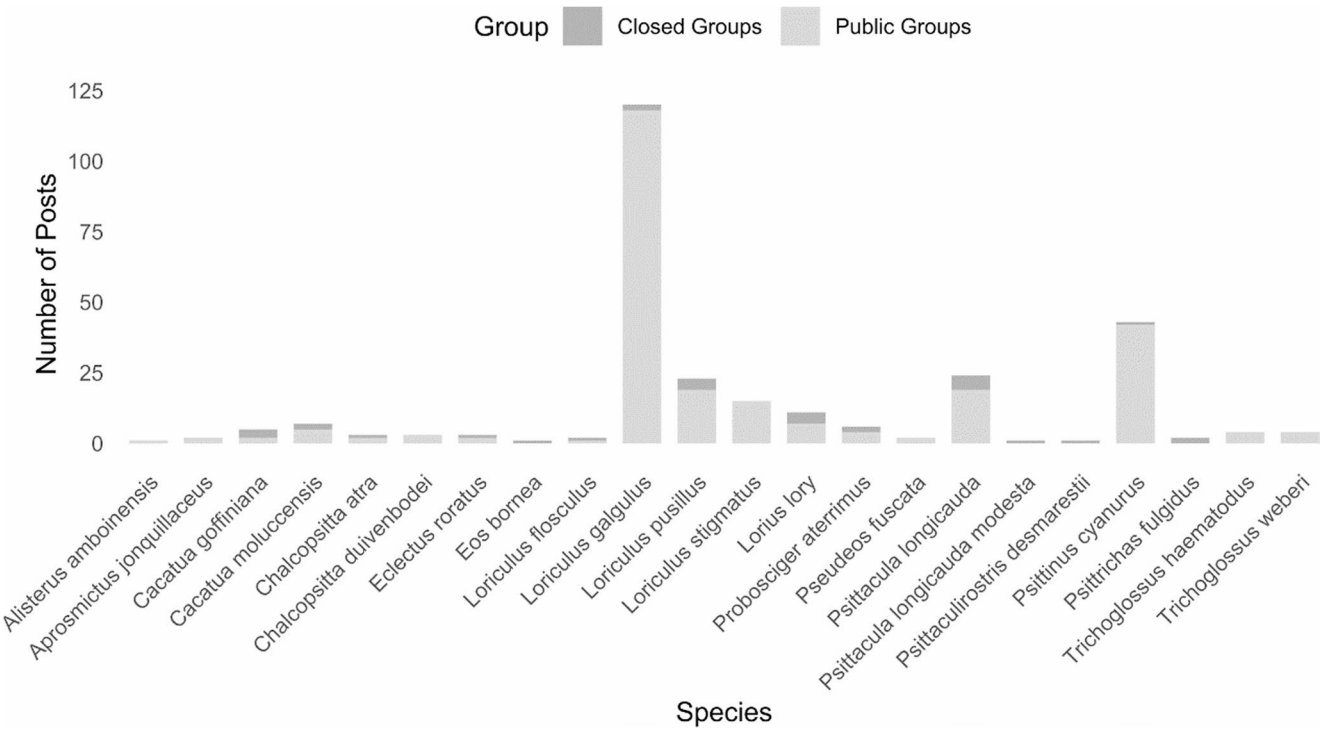

Fig. 3 Number of posts ($N=283$) of *Psittacines* species ($N=23$) for sale listed across public ($N=26$) and closed ($N=12$) groups on the social media platform, Facebook. Public groups are freely available to join with no prior information required. Closed groups require joining approval to be granted by the group administrator

We observed very low numbers of members of the lory and lorikeet family (*Eos* and *Lorius* (lory) and *Trichoglossus* (lorikeet) across all groups. This finding is contrary to a previous study examining the market and seizure data in Indonesia, in which the chattering lory (*Lorius garrulus*) was found to be one of the most highly traded birds in Indonesia (Pires et al. 2021). In line with these previous findings on market and seizure data, we find both *Cacatua moluccensis* and *Prosobsciger aterrimus* for sale on Facebook. Both species are included as most endangered in Appendix I of CITES.

We find an overwhelming trend for the demand and sale of hanging parrots (*Loriculus spp.*) within both public and closed groups on Facebook (Fig. 3). The most abundant

species within the *Loriculus* genus highlighted for sale were *Loriculus galgulus*, *Loriculus stigmatus* and *Loriculus pusillus*. The genus *Loriculus* contains 13 species of which 10 are resident in Indonesia (Eaton et al. 2021). For these 13 species, ten are classified as Least Concern (IUCN Red List 2023), two are classed as Near Threatened (*L. pusillus* and *Loriculus catamene*), with one species (*Loriculus flosculus*) listed as Vulnerable. All three species listed as Near Threatened and Vulnerable are known to be undergoing decreasing population trends and are resident to Indonesia (IUCN 2023). There was a broad range exhibited of hanging parrots from captive and wild origins. Most notably, 15 of 17 posts advertising *L. stigmatus* for sale were found to be of wild origin. Further, within the ten species listed as Least Concern, seven are resident to Indonesia: *L. galgulus*, *L. stigmata*, *L. amabilis*, *L. sclateri*, *L. exilis*, *L. tener* and *L. aurantiifrons.* Both *L. tener* and *L. exilis* are undergoing decreasing population trends.

The second most popular parrot species we identified for sale was the blue-rumped parrot (*Psittinus cyanurus*). Both public and closed member groups on Facebook were specifically dedicated to the trade of this species. Residing in forests and terrestrial environments within Indonesia and neighbouring islands, *P. cyanurus* are listed as Near Threatened with decreasing population trends (IUCN 2023).

Price data

Despite most posts advertising birds for sale, prices were rarely stated in the initial post. Instead, the price would often be listed in the comments section, following direct queries from prospective buyers or other interested parties. The seller would either respond with a price or a message to check their direct messages. We recorded price data for a total of six species (Fig. 4). Interestingly, prices used were coded to avoid detection by Facebook and other parties. For example, one post (KBPBDJL6) stated "A2B1 5 ekor lagi" (translation: please I need 5 birds more for the price IDR 250,000 each bird). The letter A stands for IDR 100,000, so A2 would be IDR 100,000 × 2 = IDR200,000. The letter B stands for IDR 50,000, so A2B1 refers to an asking price of IDR 250,000. Subsequently, the letter C stands for IDR 20,000, D stands for IDR 10,000, the letter E stands for IDR 5,000, the letter F stands for IDR 2,000, and the

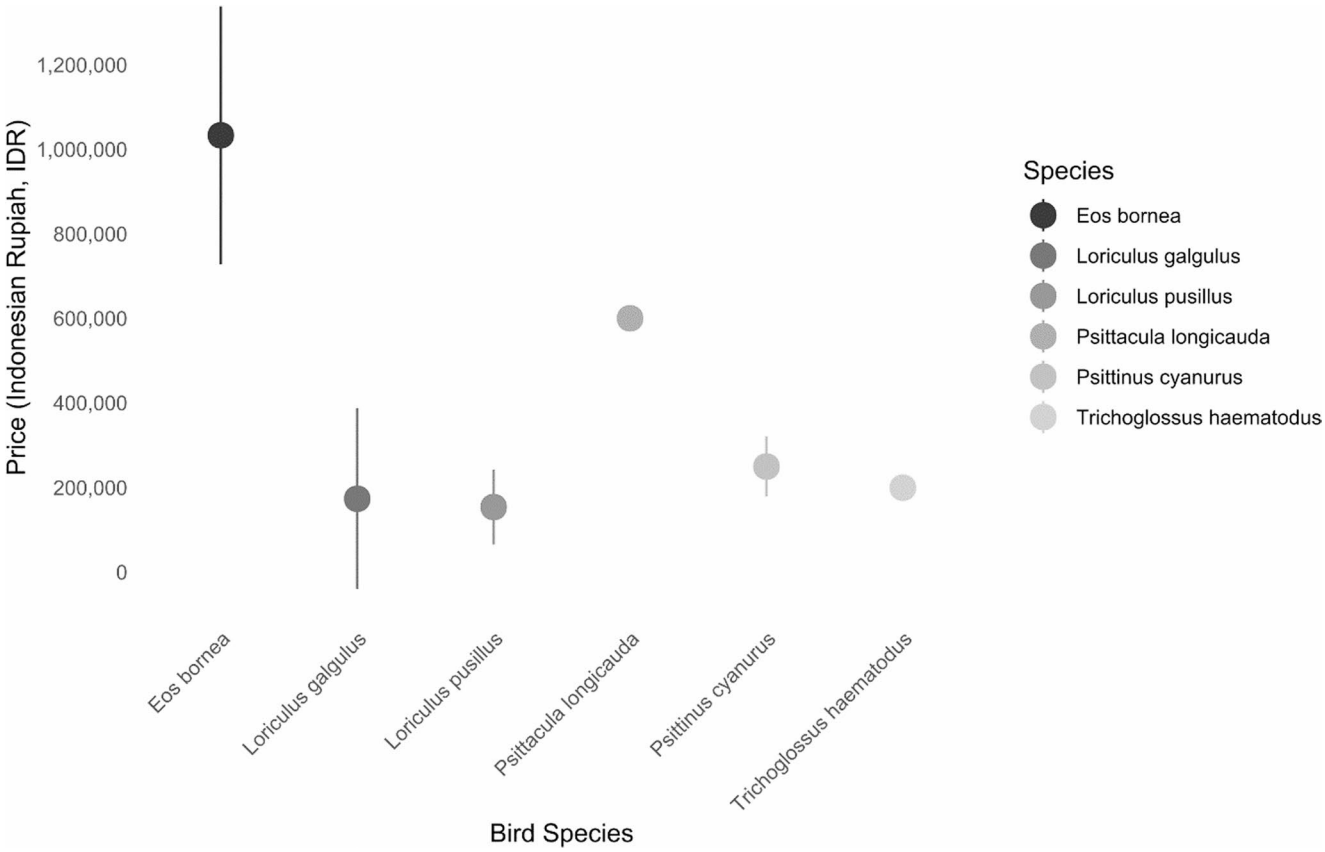

Fig. 4 Price data observed from textual and photographic information posted alongside *Psittacines* for sale on the social media platform, Facebook. Prices were documented on posts advertising birds for sale in both public ($N=26$) and closed ($N=12$) groups. Prices were advertised in IDR. The mean price point is documented in instances where more than one price was recorded. Price data was recorded for six species – *Loriculus galgulus*, *Psittinus cyranus*, *Trichoglossus haematodus*, *Loriculus pusillus*, *Psittacula longicauda*, *Eos borneo*

letter G stands for IDR 1,000, corresponding to Indonesian currency notes. Other codes commonly used were 'fs' (fast) and 'nego' (negotiation), alongside abbreviated locations, such as "jaktim" as Jakarta Timur (KRLT3). The comment section for each post commonly included questions regarding if the birds were tame, their location, if they could be sent to another location, contact details, as well as coded price negotiations.

Health status of birds involved in trade

Finally, we classified the health status of birds advertised for sale to determine if bird condition effected saleability, as feather condition is often used as a proxy for health condition of birds (Monclús et al. 2017). We find that most wild-caught birds are listed as 'good'. This can have two indicators. The first is that photos and posts for wild-caught birds were posted immediately after catching, therefore there have been no ill effects of captivity on health or feather status which would result in a poorer condition score. This is reinforced through the numerous indicators of trapping shown directly in the photographs. The second indicator is that condition is a sought-after characteristic for consumers.

Discussion

This study offers a comprehensive review of the online trade of parrot species in Indonesia via the social media platform, Facebook. We focus on a specific snapshot of time - a period between 1 January 2020 and 31 August 2021 - to provide an insight into how such trade is conducted online and highlight demand for specific species. Our findings enhance the few studies examining the trade in Indonesian parrots and the detrimental effect on species health and ecosystems (Olah et al. 2016; Budiani and Raharningrum 2018; Chan et al. 2021) by confirming that social media platforms play an important role in the local trade of parrots. Notably, during our study period, we find the influence of the unprecedented global COVID-19 pandemic, with significantly more posts appearing online during a period of national lockdown in Indonesia. The substantial number of posts analysed and the number of individual parrots for sale emphasizes Indonesia's role as a market nation, and highlights it's potential as a source and transit nation for illegal parrot trade.

Our results clearly demonstrate that illegal wildlife trade is occurring overtly on Facebook, despite the widely documented pledges detailed by Facebook (and Meta) that all illegal wildlife trade, whether it is live animals or their products, is banned and removed from this platform. We not only observe that Facebook groups are the primary source of advertising birds for sale, but that users are often directed off these groups to complete sales via WhatsApp messaging, with both platforms key tools in facilitating illegal online trade, as paralleled in other illegal trades (Wyatt et al. 2022). Regulation of these platforms are difficult to enforce due to the spaces between relevant laws and the sheer number of user-generated content.

We find a consistent and steady increase in the number of parrots for sale in online communities on Facebook during the research period. Specifically, we find significantly higher trade levels documented between May 2021 and July 2021. This directly correlates to a period during the COVID-19 pandemic during which national lockdowns were enforced (Chng and Eaton 2016), suggesting that traders shifted from physical bird markets to online marketplaces in a response to COVID-19 restrictions. In August 2021, social restrictions were eased following a decrease in COVID-19 cases, which we suggest is associated with the reopening of local, live bird markets on hotspot islands such as Bali and Java (Chng and Eaton 2016) and the subsequent slight decrease in online parrot trading in our findings for this month. However, further research is needed to identify whether online posts continued to decline beyond this timeline, to therefore show that the reopening of live bird markets replaced online trade in this way.

Overall, we find a total of 22 species recorded across both public and closed Facebook groups, with significantly more wild birds encountered than captive. We find high numbers of *Loriculus* (hanging parrots) species, with lower numbers of larger parrots and cockatoos present. It is worthwhile noting that as we surveyed *Loriculus* specific groups, it would therefore be anticipated that we found higher numbers of this genus compared to others for which targeted (genus/species specific) groups were not found during our search. We observe seven palm cockatoos (*P. aterrimus*), four eclectus parrots (*Eclectus rotatus*), seven salmon-crested cockatoos (*Cacatus moluccensis*) and five Tanimbar cockatoos (*C. goffiniana*). Excluding *E. rotatus*, these species are listed as CITES Appendix I species - species that are severely threatened with extinction and thereby any international trade is prohibited without an exemption certificate. This finding is in line with market and seizure data, which finds similar trends in the sale of these species (Pires et al. 2021), which are challenging to breed in large quantities in captive environments (Nurbandi 2022). Despite this, the majority of these larger parrot species were of captively bred origin, with the exception being *P. aterrimus*, of which we identified 71% were of wild origin. This finding correlates with a recent report documenting a major trade of *P. aterrimus* in Aru, a remote Indonesian island in which *P. aterrimus* are openly harvested from the wild in large quantities and exported to larger islands such as Java (Morse 2018).

Through our comprehensive review of all live parrot species for sale, we identified novel trends for the sale and purchase of hanging parrots (genus *Loriculus*) and blue-rumped parrots (*P. cyanurus*), highlighting that trade is concentrated on preferred "hotspot" species. We find *Loriculus* species advertised across general public bird groups and dedicated *Loriculus* groups, with *L. galgulus* observed significantly more than any other species. Previous studies have found incidences of *Loriculus* for sale with large variation reported in the quantities. For example, studies record ranges of instances of only one or two birds for sale (Iqbal 2015; C hiok and Chng 2021), in comparison to much larger numbers recorded by Chng et al. (2015, 2018a, b) that match our findings One reason for this could be that we only accessed open and easy-to-join closed groups, and did not infiltrate harder to access groups for which we were required to state the purpose of our joining. Additionally, with the majority of *Loriculus* species, and indeed, two of the most popular species we observe for sale, being less endangered (LC, IUCN 2023), there could be a much lower perceived level of risk when advertising these birds on open user groups. This is in comparison, for example, to more highly documented species, such as CITES Appendix I species (e.g. the Tanimbar cockatoo, (Keeton-Olsen 2022), for which there would be a higher associated risk involved in online trade. Trends for smaller bodied parrots could also be attributed to their profitability per bird. For example, this could be due to lower procurement for middlemen traders or even reduced transport costs, with more birds able to be moved in a smaller space.

The large numbers of hanging parrots we observed for sale in online groups correlates with previous market data (Shepherd 2006) identifying that hanging parrots that were once extremely prevalent and popular in physical bird markets are also found in large numbers within the online marketplace. Conversely, it could also represent species that had previously garnered little interest in physical markets but are now sellable online (Nijman et al. 2022). Although largely listed as Least Concern, several species of hanging parrots are listed as decreasing in numbers. This could result in a rapid drive towards species decline if this group is being over-targeted in online marketplaces. It is also worthwhile noting that the IUCN data for this genus has not been updated since 2016, meaning that actual numbers within this genus may be considerably more at risk of extinction than has previously been considered.

Whilst many posts did not describe the bird's origin, we found a variety of factors overtly highlighting illegal capture through visual markers in photos that provided evidence of wild origin and trapping. These included identifiers of captivity: the absence of leg rings, the presence of chains and the use of trapping cages or other methods to capture birds (rubber, lime stick on trees, use of playback recorders). A particularly interesting finding was the clear indications of trapping present in the visual data of some of the analysed posts, even when specific codes were used in the textual data. For example, visual references included in the posts included birds in paper bags, trapping cages, or PVC tubes, or wrapped in cloths. Such openness of traders regarding the wild and therefore illegal origins of the birds for sale emphasizes the clear lack of fear for repercussions from either Facebook or Indonesian law enforcement. Marshall et al. (2020) previously suggested that the proportion of birds that originate from low-intensity, recreational trapping in Java is unknown. Although our results do not quantify this level of wild-trapping, they reinforce the need to explore this in more detail.

Despite the large numbers of wild birds we found for sale and the clear indicators of trapping, it could be argued that some restriction efforts from Facebook have succeeded. Less parrot species were encountered for sale that are classified as more endangered (IUCN 2023) than has previously been documented (Nurbandi 2022). However, as we did not infiltrate closed member groups where access would conflict with this project's ethical constraints, it is possible that evidence for these species is only found on closed forums. It is evident that although the forced closure of groups could temporarily disrupt trade, group users can circumvent such restrictions by forming new groups and adapt to the challenges that current online surveillance poses to virtual buy-and-sell communities. For example, five groups that were closed during the research period were re-opened with similar names, pointing towards persistent efforts by both traders and buyers to circumvent enforcement and continue online trade. This presents a significant challenge for relevant enforcement authorities and will contribute to the depletion of wild bird populations in the long run if not imminently addressed.

Our study is the first of its kind to provide a comprehensive insight into the online trade of parrot species in Indonesia through the globally popular social media platform Facebook. This study took place during a pinnacle point of the online market potential, due to the closure of traditional, physical markets within Indonesia due to the global COVID-19 pandemic. We confirm the trend for the smaller-bodied and potentially more abundant, hanging parrot genus, *Loriculus* is present in online marketplaces, alongside their physical counterparts. Our findings on the sale of larger, highly regulated parrot species, such as the palm cockatoo (*P. aterrimus*), are consistent with previous reports in the market and seizure data, suggesting that the physical market traders are moving towards an online marketplace.

By providing a snapshot analysis of a specific period of illegal trade posts, this study contributes to a growing body of work that call attention to the ways in which social media platforms facilitate illegal trade of wildlife, while encouraging a more holistic, sustainable, and contextualized legislative and enforcement framework to counter such detrimental, harmful trade. Finally, we suggest that these

findings determine that parrot trading is not an opportunistic crime, by shining a light on the scope and depth of this lucrative bird group - one that has received relatively little attention in comparison to its songbird counterpart.

Appendix 1

Table 2 Complete list of search terms used to identify posts of interest on the social media platform, Facebook, in both public (open) and private (closed) groups. Search terms include a selection of common phrases used to describe parrots and their trade, alongside species/genus name, and (consumer) location of interest

Search term	
Bahasa Indonesian	English Translation
betina	female
black luriy	black lory
Betsum	Long tailed lorikeet
burung	bird
Kandang	bird cage/aviary
liar	wild
manuk	bird (bahasa jawa)
murah	cheap
nuri dora	ornate lorikeet
pecinta	interested in/special interest group
lb	lovebird
WA	whatsapp
rekber	Rekening Bersama - money transfer service similar to Paypal, commonly used as a payment method as allows ratings of buyers/sellers and trust
beo	slang for the Hill Myna, Gracula religiosa
jantan	male
betina	female
muda	young, juvenile
jalak	starling
Molucan	Moluccan cockatoo
kelamin	gender
pasar	market
Cenderawasih	bird of Paradise, from the genus Paradisea
burung kakaktua	parrot
kondisi	condition
colibri	hummingbird
serindit	hanging parrot of *Loriculus* genus
pleci	white eyes
parkit	parakeet
AfGrey	African Grey Parrot
Mejeng	
Mulus nominus	
Jakut	article
ff	freeflying
Plat BH	location of Jambi, Sumatra
Plat BE	location of Bandung, Java
Plat H	Central Java
jantan	male

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Declarations

Competing interests The authors declare no competing interests.

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