An overview of international trade of *Macaca fascicularis* from Indonesia based on the CITES trade database

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Abstract. Wildlife trade is one of the main constraints in biodiversity conservation. International wildlife trade is regulated by The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Approximately 34,000 plants and animals are grouped into three Appendices related to the degree of threats posed due to international trade. Annually, CITES provides global trends in wildlife trade through its official website. However, there are some limitations demonstrated by the CITES database, which may indicate unsustainable trade. Using the CITES trade database, we offer an overview of the international trade of crab-eating Macaca (*Macaca fascicularis*) from Indonesia. Results show that Indonesia had recorded 440 transactions of *M. fascicularis* in both live animals and non-live forms for 30 years (1990-2019). A total of 117,193 live *M. fascicularis* had been traded, with the United States being the primary importer. There were challenges in using the CITES trade database in analyzing *M. fascicularis* trade, including a mismatch between trade volume reported by the exporters and importers, undefined trade purposes, and unitless reports. We hope that our findings can help the community understand international *M. fascicularis* trade and guide future conservation efforts and policy changes.

1. Introduction

Wildlife trade is one of the main constraints in biodiversity conservation. The growth of the global population and economy has contributed to the increase in demand for wildlife for science, biomedical research, pet, and commercial purposes [1]. As a result, the wildlife trade has been recognized as one of the most economically profitable activities in local and global markets [2][3]. However, unsustainable wildlife trade without proper regulation puts many species at risk of extinction [4][5], generate socio-economic losses [6], and causes major ecosystem imbalance [7]. For instance, increased demand for pangolins (*Manis* sp.) for medicine and commercial purposes has driven the species to be critically endangered [8].

Crab-eating macaques (*Macaca fascicularis*) are among the five taxa of primates frequently traded internationally [9]. International trade of live *M. fascicularis* reached 450,000 individuals from 2008 to 2019, mainly for biomedical research [10]. Indonesia has been exporting *M. fascicularis* since the 1970s [11] and has become one of the biggest exporters of *M. fascicularis* worldwide [9]. It is believed that although *M. fascicularis* is legally traded, illegal trade is still ongoing [12]. The population of crab-eating macaques is decreasing at an alarming rate across their geographic range due to habitat loss, fragmentation, and the pet trade [13]. As synanthropic species with high flexibility, *M. fascicularis* is also prone to conflict with humans [14]. A combination of all threats above is driving *M. fascicularis*
populations to a rapid decline. This will concern wildlife managers until IUCN updates its status from least concern to vulnerable [15]. At least three subspecies of *M. fascicularis* have been uplisted to vulnerable, including *M. fascicularis fascicularis*, *M. fascicularis condorensis*, and *M. fascicularis umbrosa* [10]. Similar to its relatives in other Southeast Asian countries, *M. fascicularis* in Indonesia is threatened.

International wildlife trade has been regulated by The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The convention introduced in 1975 attempts to ensure that the wildlife trade will not threaten their survival. Approximately 34,000 species are grouped into three Appendices related to the degree of threats posed due to international trade [16]. CITES usually releases annual wildlife trade reports via its official website. This website provides data to stakeholders to assess, evaluate, and monitor global primate trade. However, due to the complexity of the data, some limitations may indicate unsustainable trade [17]. To address this issue, we will provide an overview of the international trade of *M. fascicularis* based on the CITES trade database. We hope that our findings can offer insights into international *M. fascicularis* trade and guide conservation efforts and policy changes in the future.

2. Materials and Methods

Data on the international trade of *M. fascicularis* were downloaded from the official website of CITES [16] in February 2021. All trade between 1990 and 2019 was downloaded. On the main page, seven categories must be completed: year range, exporting countries, importing countries, source, purpose, trade item, and taxon. In addition, we selected the comparative tabulation report output as our data.

CITES has listed trade terms of wildlife for numerous categories such as live, bodies, skulls, bones, bone pieces, bone products, leather, skeletons, skins, skin pieces, etc. Likewise, units are also treated similarly, such as flasks, grams, kilograms, litters, pieces, meters, etc. We split the data into individual (live) and carcasses and their derivatives (specimen, skull, trophies, bodies, and skeletons). However, since many data are missing in the CITES database and difficulties in converting a body part into an individual, for the purpose of this study, the quantities of individuals were accounted merely on live animal trade. Where both exporters and importers report quantities, we conservatively used the larger of two quantities in analysis.

Source and purpose codes were interpreted using the CITES Trade Database guide. We grouped trade sources into three categories: wild-caught, captive, and unknown. Wild-caught consisted of confiscated or seized specimens (I), ranched specimens (R), and specimens taken from the wild (W). However, animals bred in captivity (C, D) and animals born in captivity (F) were grouped as captive; unknown source (U) or unspecified data was categorized as an unknown group. The purposes of trading were classified into three categories: commercial, non-commercial and unknown. Commercial purposes comprised of breeding in captivity (B), hunting trophy (H), medical (M), personal (P), circus or traveling exhibition (Q), commercial (T) and zoo (Z); non-commercial purposes comprised of educational (E), botanical garden (G), law enforcement/judicial/forensic (L), reintroduction or introduction into the wild (N), and scientific ($) We added all unspecified data into the unknown group. Countries that no longer exist were dismissed from the analysis.

The accuracy of the CITES database depended on the quality of export-import reports from CITES parties. Studies have revealed a large mismatch between actual data and official quantity data reported in the CITES database [18] [17]. Likewise, we also noticed missing data either on the source or both source and purpose categories during data collection. However, in the present analysis, it was impossible to assess the extent of these limitations.

3. Results and Discussion

Indonesia recorded 440 transactions of *M. fascicularis* both in live animals and non-live forms for 30 years (1990-2019). Live macaques had been traded, totaling 117,193 individuals. The largest export quantity of live animals was in 1991 (12,301 individuals) (Figure 1). Between 1991 and 1995 the quantity declined. An increase in the export of live macaques started again in 1996. This was consistent
with [19], who found that global export of live primates has increased since 1995. However, from 2008 onward, export declined again, with the lowest numbers in 2012 with only 207 individuals. Of the 117,193 live macaques traded, 59.97% of them were exported to US (70,283 individuals), followed by Japan (22,792 individuals; 19.45%), China (9,550 individuals; 8.15%), Singapore (5,861 individuals; 5%), and Netherlands (2,714 individuals; 2.32%).

Figure 1. The number of live M. fascicularis exported from 1990 to 2019.

M. fascicularis was exported both in live animals and non-live forms, such as carcasses and other derivatives. Live macaques nearly dominated the trade until 2008, and then the trade pattern switched to non-live forms. The highest percentage of transactions for live animal trade was in 2001 (83.33%). Percent transaction for non-live forms peaked in 2013 (100%) and from 2015 to 2018 (each 100%) (Figure 2). Japan was the most frequent importing country for live macaques (33 transactions) from 1990 to 2019 (Figure 3). The second and third came from the US (32 transactions) and Singapore (25 transactions). Unlike live animals, non-live forms were most frequently imported to the US with 123 transactions, followed by Singapore with 29 transactions and Japan with 19 transactions.

Figure 2. Percentage of M. fascicularis transactions per year in both live animals and non-live forms.
Figure 3. Countries importing M. fascicularis from Indonesia between 1990 and 2019.

Live macaques were mostly traded for commercial purposes to the top three importing countries: the US (46.85%), Japan (20.28%), and Singapore (9.79%). Similarly, non-live forms were dominant for commercial purposes compared to non-commercial purposes and unknown: the US (53.47%), Singapore (13.19%), Japan (9.72%). The greatest incident of commercial purposes for live macaques occurred in 1991 with 12 transactions. Trade for unspecified purposes no longer existed post-2000 (Figure 4). Meanwhile, non-live forms were mostly traded for commercial purposes in 2012 and 2013 with 16 transactions, respectively. Like live animals, after 1999, the export of non-live forms for unknown purposes was non-existent except for 2010 (Figure 5). One of the commercial purposes of M. fascicularis trade is the medical industry, including biomedical research, which has existed since the 1970s Error! Reference source not found.. Primates, including M. fascicularis, are commonly used to test a new vaccine or new drug. Baroncelli et al. [20], for example, stated that M. fascicularis has the main role in developing a vaccine for HIV. The body of M. fascicularis is able to be infected by a virus resembling HIV-1, which infects humans.

Figure 4. Frequency of live macaque trade by purpose.
Sources of *M. fascicularis* involved in the trade were dominated by “captive” both for live animals and non-live forms, which accounted for 147 transactions (66.82%) and 150 transactions (68.49%), respectively. We only recorded 42 transactions (19.09%) and 60 transactions (27.40%) with “wild-caught” for living and non-live, respectively. Among the trading countries, “captive” was frequently exported to the US (live = 48.30%; non-live = 43.33%).

In terms of live animals, the export of animals derived from the wild was more common prior to 2004. It was noted that the greatest number of transactions was in 1991 with 16 transactions. Since 2004, there has been a shift from wild-caught to captive animals, except in 2012. Indonesia even stopped the wild-caught animal trade from 2015 to 2018 (Figure 6). Using wild-caught animals instead of captive ones has been prohibited by the Ministry of Forestry of Indonesia [21]. Harvesting wild animals are allowed only for breeding operations, such as for founder breeding stock. For instance, in 2015, the Ministry of Forestry permitted a breeding company to collect 200 wild *M. fascicularis* from Lampung, South Sumatra [22]. Nevertheless, harvesting wild animals for captivity can risk animals unless appropriately conducted [22].

In contrast, non-live forms acquired from wild-caught animals remained traded until 2015, with the highest number of incidents in 2012 (10 transactions) (Figure 7). Moreover, unlike live animals, non-live forms were exported through the 2000s.

Figure 5. Frequency of non-live form trade by purpose.
Indonesia has ratified CITES since 1978, so that all international trade must follow CITES regulation. Consequently, all trade for species listed in Appendix II requires export and re-export permits granted by the management authority. The management authority issues export and re-export permits after considering recommendations from scientific authority. From this mechanism, it appears that CITES prevents misuse of wildlife trade and contributes to wildlife conservation. However, CITES does not deny that their data have limitations. Within the *M. fascicularis* trade data, we found mismatches in reports by importers and exporters. Different reports between importers and exporters also became a concern [17]. They argued that the discrepancy was due to the source of data and that data reported by CITES was questionable. These data discrepancies may unintendedly influence the conservation
strategies of a species. Thus, unclear trade purpose was a challenge in analyzing data. However, since we overlooked unspecified data after 2000 for live macaques and 1999 for non-live forms, we suggested improving database management. Another limitation we noticed was unitless counts (Figure 8).

Apart from the described limitations, CITES data is reliable to figure out international wildlife trade. The management authority should eliminate potential uncertain data sources to develop effective conservation strategies for *M. fascicularis*. Staff training and assisting are some examples to create skilled human resources in data collecting and reporting. A connected system should be developed to ensure data match between importers and exporters, such as a unified application or relevant mechanisms. Further, the origin of traded macaques should be of concern since 50% of the total subspecies of *M. fascicularis* are located in Indonesia, and the trend of its population is declining or unknown [10].

![Figure 8](image.png)

Figure 8. Data mismatch and unitless are some of the limitations found in the CITES trade database.

4. Conclusion

Thousands of *Macaca fascicularis* were exported to a wide variety of countries. The number of live *M. fascicularis* included in legal trade declined significantly for 30 years. Live macaques were mainly traded to the US. International trade of *M. fascicularis* consisted of live animals and non-live forms which were mainly derived from captive facilities. Both live animals and non-live forms were imported for commercial purposes. In order to minimize incorrect interpretation, data provided by CITES must be treated with caution to avoid bias in the analysis. We found some potential sources of bias: data mismatch between origin countries and destination countries, unspecified purposes of export, and unitless counts. While the CITES trade database has limitations, it remains a reliable way to analyze trends in the international wildlife trade. Some recommendations to improve data quality are increasing staff training, assisting in data collecting and reporting, and developing a connected system between traders and buyers.

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Author’s contribution
All authors contributed equally to this work as the main contributor.