RESEARCH ARTICLE

Dissecting the illegal pangolin trade in China: An insight from seizures data reports

James Kehinde Omifolaji[1,2], Alice C. Hughes[3,4], Abubakar Sadiq Ibrahim[5], Jinfeng Zhou[3], Siyuan Zhang[3], Emmanuel Tersea Ikyaagba[6], Xiaofeng Luan[1]

1 *School of Ecology and Nature Conservation, Beijing Forestry University, Beijing, China* **2** *Department of Forestry and Wildlife Management, Federal University Dutse, Jigawa, Jigawa State, Nigeria* **3** *China Biodiversity Conservation and Green Development Foundation, Beijing, China* **4** *Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla, Yunnan, China* **5** *School of Economics and Management, Beijing Institute of Technology, Beijing, China* **6** *Department of Environmental and Social Forestry, Federal University of Agriculture, Makurdi, Nigeria*

Corresponding authors: Xiaofeng Luan (luanxiaofeng@bjfu.edu.edu.cn),
Alice C. Hughes (ach_conservation2@hotmail.com)

Citation: Omifolaji JK, Hughes AC, Ibrahim AS, Zhou J, Zhang S, Ikyaagba ET, Luan X (2022) Dissecting the illegal pangolin trade in China: An insight from seizures data reports. Nature Conservation 45: 17–38. https://doi.org/10.3897/natureconservation.45.57962

Abstract

Wildlife trafficking poses a major threat to global biodiversity. Species such as pangolins are particularly vulnerable and trade continues almost unabated despite numerous interventions aimed at eradicating illegal wildlife trade. Despite restrictions on the pangolin trade, thousands of pangolins continue to be intercepted annually. We focused on China because of the recent delisting of pangolins from the Chinese pharmacopeia, and their removal from healthcare insurance, despite deeply ingrained traditions of having pangolins for ethno-medicinal use. We collated pangolin interception data from public online media seizure reports to characterize the pangolin trade within China, and found that a total of 326 independent seizures equivalent to 143,130 pangolins (31,676 individuals and 222,908 kg of scale) were reported in 26 provinces. Pangolin domestic seizures are greatest in the southern cities of Dehong, Fangchenggang, and Guangzhou. Also, we found 17 countries within the global pangolins range which were the major source of the pangolin shipments to China. The number of arrests and convictions was much lower than the number of pangolin incidents reported. Our results show a significant increase in the volume of scales and number of live pangolin seizures after amended endangered species law came into effect in 2018, and recorded the highest number of individual pangolin interceptions. China has shown increasing wildlife seizures over time, owing partly to emergent trends in the international wildlife trade as well as increasing

global demand for ethnomedicine. The future eradication of illegal wildlife trade in China is dependent not only on stringent border control and offender prosecution but also the; removal of other threatened species from the pharmacopeia and healthcare insurance which includes wildlife derivatives. Furthermore, our work highlights importance of current policy intervention to combat the pangolin trade within China, and the need for further interventions both within China and in export countries.

Introduction

The illegal wildlife trade is a multibillion-dollar enterprise, the fourth-largest illegal trade, exceeded only by narcotics, human trafficking, and arms smuggling. The illegal wildlife trade involves thousands of wild animals and their products within pharmaceutical products (medicine), foods, pets, clothing, trophies, bracelets, religious amulets, and traditional chieftaincy regalia (Underwood et al. 2013; Nellemann et al. 2014; Patel et al. 2015; Aisher 2016). International wildlife trafficking is a major factor driving the extinction of many species, through both unsustainable harvest and unmonitored killing of non-target species, and has resulted in the global growth of organized crime syndicates (Wittemyer et al. 2014; Bennett 2015; Ripple et al. 2016). The complexity of the illegal harvest of wildlife for commercial trade means that understanding the patterns is very challenging (Gao et al. 2016).

Pangolin species of the family "Manidae" and order "Pholidota" have become one of the world's most trafficked terrestrial vertebrate (Challender et al. 2014). Eight extant pangolin species in three genera have been described (Gaubert and Antunes 2015), geographically distributed in two continents (Wilson and Reeder 2005; Gaudin et al. 2009; Ingram et al. 2019b) including four species from Afro-tropical regions: Giant ground pangolin (*Smutsia gigantea*), white-bellied pangolin (*Phataginus tetradactyla*), black-bellied pangolin (*Phataginus tricuspis*), Temminck's ground pangolin (*Smutsia temminckii*) are collectively distributed throughout sub-Sahara Africa; west and central Africa (Pietersen et al. 2019a, 2019b), as well as the east and south of Southern Africa; and also four species from Asia: the Chinese pangolin (*Manis pentadactyla*), Sunda pangolin (*M. javanica*), Philippine pangolin (*M. culionensis*) and Indian pangolin (*M. crassicaudata*), (Gaubert and Antunes 2005; Challender et al. 2014a, 2019a, 2019b; Mahmood et al. 2019; Nixon et al. 2019; Schoppe et al. 2019). Their range extends from Pakistan eastward through Southern China, south from the Himalayas in Nepal and entire Indian sub-continent including Sri Lanka as well much of Mainland and Island Southeast Asia including Palawan in the Philippines (Challender et al. 2014b). All eight pangolin species are threatened and listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), due to continued demand for their meat and body parts (scales) in ethnomedicine use (CITES 2016; UNODC 2016). This provides pangolins with the highest protection

through CITES and prohibits international trade in wild-caught pangolins for commercial purposes worldwide (CITES 2016). However, pangolins remain one of the most trafficked mammals globally, with estimates of over 2.7 million animals taken from the wild between 2000–2019 (Harrington et al. 2018; UNODC 2020). China and the United States of America (USA) were identified as the most common destinations for international pangolin (scale and body parts) trafficking (Heinrich et al. 2017; Shairp et al. 2016).

Recent estimates suggest that billions of wild animals and their products are involved in illegal transactions worldwide (Wittemyer et al. 2014). Due to the cryptic nature of transactions, advances in wildlife detection technology and methodological approaches are providing new insights into illegal wildlife trade (Hernandez-Castro and Roberts 2015), but are part of a constant arms-race between criminals and authorities. However, the majority of studies in the last century have been biased towards "charismatic" species (Underwood et al. 2013; Wittemyer et al. 2014; Patel et al. 2015; Gao et al. 2016; Haas and Ferreira 2016). Despite recent advances in wildlife detection technology and general descriptive work on the illegal pangolin trade importance and its impact on the population of ecologically valuable species, it is still difficult to quantify and monitor (Rosen and Smith 2010).

Illegal killing, quantitative trade estimate, and impacts are difficult to estimate using traditional data collection methods and analysis, as data on illegal wildlife trade are inherently incomplete (Rosen and Smith 2010; Phelps et al. 2016). Trade records such as those in CITES, and LEMIS databases are the primary source of information on many species in trade, though some species such as elephants have specialist portals (ETIS) (Gomez et al. 2016). Data is sometimes obtainable through law enforcement offices, Bureaus of Statistics, governmental agencies, non-government organizations (e.g., EIA, WWF, TRAFFIC), or designated databases system for high profile species (e.g., Elephant Trade Information System (ETIS) (Underwood et al. 2013; Haas and Ferreira 2016). Utilizing the CITES and TRAFFIC seizure data is also limited due to the time between occurrence and trade reporting, the dependence on each country reporting rates (Siriwat and Nijman 2018b), lack of information on local trade; as well as lack of interest in non-CITES listed species (Foley 2013; Wood et al. 2014).

In the last decade, other monitoring methods for data collection have been increasingly adopted to fill data gaps. Examples of this are the use of public online data and news articles: rhinos (Gao et al. 2016; Haas and Ferreira 2016), ivory (Foley 2013; Underwood et al. 2013; Vira et al. 2014; Wittemyer et al. 2014; Bennett 2015; Hernandez-Castro and Roberts 2015), rosewood (Siriwat and Nijman 2018b), pets (Spee et al. 2019; Bamrah and Girdhar 2020; Marshall et al. 2020), parrots (Martin et al. 2018; Ye et al. 2020; Yin et al. 2020), primates (Ni et al. 2018), leopards (Henschel et al. 2011; Li and Lu 2014), otters (Siriwat and Nijman 2018a; Harrington et al. 2019) and turtles (Liu et al. 2020; Ye et al. 2020).

Here, we searched public online media reports to investigate and characterize the pangolin trade in China. We analyzed patterns in the geographical distribution of the illegal pangolin trade and enforcement with data from China to evaluate open-source

data's effectiveness to explain the current effort to halt the illegal international pangolin trade. We also aimed to assess whether available data were sufficient to provide accurate estimates of the magnitude, scope, and detectability of illegal pangolin trafficking across China over-time. To do this, we compiled records of illegal trade from various media reports that varied in quality and quantity of information. We used data from China because it has recently delisted pangolin from the Chinese pharmacopeia and has a tradition of using pangolins for ethnomedicine (Anonymous 1938; NPC 2020). This study provides critical information to appraise the current temporal changes after enacting a total ban on the pangolin trade.

Methods

Data collection

We conducted online searches of pangolin seizures from June 2018 to December 2019 and limited the period from September 7, 2008 to December 31, 2019, in both Chinese and English language using the world's largest search engine; Google.com, and two of China's most popular search engines: Bing.com and Baidu.com, the latter being the largest and most popular Chinese online search engine, fulfilling a similar role to Google. We used the words '新闻'(news)category to search and select news articles. The news articles related to seizure events were filtered using keywords in Chinese 穿山甲 (pangolin), 穿山甲贸易(pangolin trade), 获救的穿山甲 (pangolin rescue) or 抓获 (seize), 穿山甲麟/没收 (pangolin scale seize/confiscate), 穿山甲 被捕/穿山甲肉 (pangolin arrest/pangolin meat). A comprehensive search was conducted for each year until there were no result pages left. For each web seizures report observed in web media; the month/year of the seizures, the quantity/number or volume (kg) seized, location (province, prefecture, county, and township), trade sources, destination, pangolins/pangolin products, number of arrest and conviction recorded, arresting agency involved and form of transportation were recorded. The Public Security Bureau of Forest online web news page, General Administration of Custom online news section on the web was checked by searching on pangolin seizures, rescue, rehabilitation, arrests, and prosecutions. Each report was treated as an independent case and extensively cross-checked for duplication and accuracy. We combined and included all the seizure reports in public media for the period, and we excluded all repeated news articles based on date, source, and sites.

Data analysis

The individual seizures were treated as one unit of analysis regardless of the quantity and the number of pangolin /meat/scales seized. The quantities seized per incident were converted into whole pangolins using the estimate to obtain the minimum and maximum average number of pangolins per incident. As most reports documented the

number of pangolin and quantities seized, we standardized pangolin scale quantity into the individual estimate using a minimum of 0.5 kg and a maximum of 3.5 kg per pangolin using the conversion rate for individual pangolins. This ratio varies by species and water content but ranges from 0.36 to 0.57 kg (Zhou et al. 2014; Zhang et al. 2015).

Data collected were curated and divided into 3-year periods to analyze temporal trends and broken down to the provincial level for spatial analysis. To calculate the provincial changes of the total number of pangolin incidents and the number of seizures, the shortest distance in kilometers was used to calculate the overland distance from one province to another, using the city with the largest number of seizures as the center point and provincial population size. Also, data collected were curated and separated into the number of individual pangolins (live or dead) and pangolin scale in a kilogram. We also analyzed seizure data between 2017 and 2019 to test if there is any significant difference after the ban on pangolin trade was introduced.

All data were log-transformed prior to analysis and was conducted using R Version 3.3.2 (R Core Team 2018); using linear regression model in R environment, the significance level was accepted as $p < 0.05$ in a two-tailed test.

We also employed social network analysis to visualize the pangolin trade flows using Circos Software 0.69-9 version Circos Team 2019 (Krzywinski et al. 2009). We produced a circular graph for networks of two regimes: Origin country with imported cities and provinces/cities within China. In each regime, both trade flow (incident number) between cities and gravity of pangolin trade equivalents quantities were visualized based on web-seizure reports.

Results

Overall volume of pangolin seizure

In China between 2008 and 2019, n = 326 pangolin seizures containing 222,908 kg of scale, and 31,676 pangolins from 26 of the 34 provinces, equivalent 143,130 individual pangolins. Based on comprehensive information on seizures, 87.57% were exclusively pangolin scale. A total of 96% (313/326) of seizures have information on pangolin scale seized, totaling 244,054 tons, suggesting that the total pangolins seizures would have been higher than the reported seizures. Intercepted pangolins were either whole (meat or live) or in scale reported into categories based on the type of product (75 seizures were only scales, 267 as individual pangolins both live and meat). Data wise estimation indicates that 22% seizures had information to species level identification.

Information related species interception

Since data is not perfect, and given that is illegal, it is also hard to quantify or even estimate the volume of undetected illegal trade; this analysis only represents patterns reflected in available data. Approximately 72/326 (22%) of seizure reports had information to species

identification level, all the extant eight pangolin species were recorded. The incident reports related to species identification indicates that 43 Sunda pangolin (*Manis javanica*), 22 Chinese pangolins (*Manis pentadactyla*), 3 Indian pangolins (*Manis crassicaudata*), 2 White-bellied Pangolin (*Phataginus tricuspis*) incidents; 1 Giant Ground pangolin (*Smutsia gigantea*); and 1 Black-Bellied pangolin (*Phataginus tetradactyla*) were intercepted and recorded; and 254 seizures lacked detailed information related to individual species.

Geographical distribution of pangolin seizure

At least 17 countries, mainly from pangolin range-countries (ten in Asia, seven in Africa) were a source or transit route for pangolins intercepted in China. Most of the pangolin seizures were from West and Central Africa region (3.5% Cameroon, 8% Democratic Republic of Congo (DRC), 6.5% Equatorial Guinea, and 16% Nigeria). Live pangolins interception was predominantly concentrated in Guangxi, Hunan, and Yunnan provinces in the southwest China, and the borders of Vietnam, Myanmar, and Laos. Fangchenggang, Dehong, Guangzhou recorded the highest number of pangolin incidents (Fig. 2). The intercepted pangolins per city and provinces indicated a significant relationship with the distance to the nearest airport and land border (Linear regression: $r21,35 = 20.90$, $p < .05$) and with the GPP per Capita (Linear regression: $r21,15 = 6.63$, $p < .05$). Population size, market closeness and pangolins demand showed a positive significant relationship with pangolins seizures rate (Linear regression: $r21,28 = 13.45$; $r21,31 = 18.33$, $p < .05$ respectively).

Temporal trends of pangolin interceptions

Over time the number of pangolin interception records increased in quantity and incidence, however, 2019 showed a decline in pangolin interception (Fig. 1). Yet, between 2017 and 2018, there was a significant increase in pangolin scale interception, and an increase in live pangolin seizures, and pangolins caught in the wild (Linear regression; pangolin scale: t-test$1,22 = 4.75$, $p \leq .05$; whole (live) pangolin t-test$1,61 = 12.10 \geq .05$; wild caught: t-test $1,21 = 4.59 \geq .05$).

Guangzhou (Guangdong), Fangchenggang (Guangxi), Dehong, Kunming (Yunnan), Nanning were the major hub cities and supply routes to the hinterland. The disruption can effectively lead to the collapse of more than sixty-five percent of the illegal pangolin trade networks. Fangchenggang and Dehong serve as the major cities for pangolin trade, and Guangzhou as a key distribution network to the hinterland (Fig. 3).

Arrests and transports related information

Pangolin interception indicates that six agencies were involved in the illegal pangolin trade crackdown. The Bureau of Public Security, Forestry Police and Customs Services recorded 94% of all interceptions, with other agencies only registering around 6% (Fig. 4). For 66 incidents, 264 suspects were arrested, 65 detained, and 28 people were found
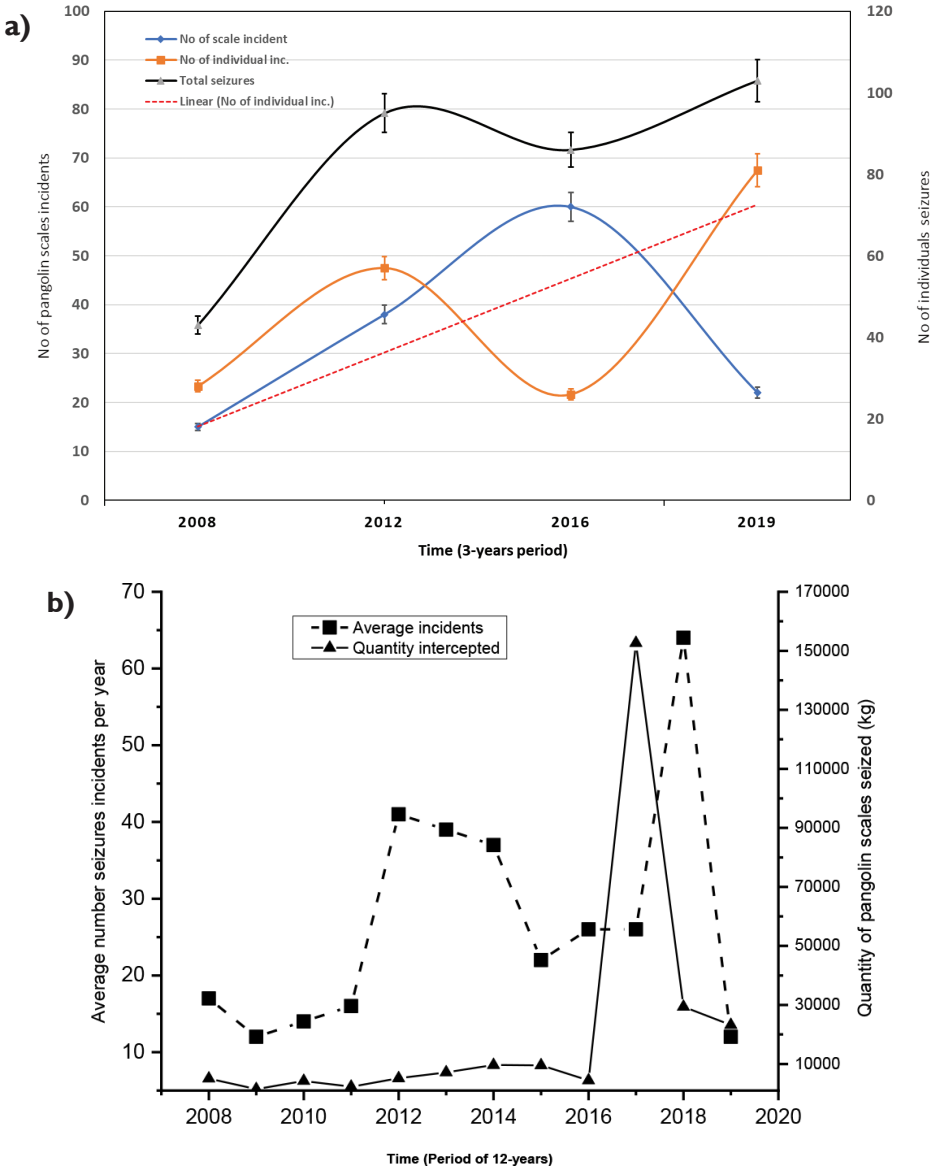
Figure 1. Plot of the mean number of scales seizures incidents (Blue); and mean number of individual pangolins seized (Brown square); the plot of linear (Dot-redline) shift in pangolin incidents per 3 years from January 2008 to December 2019 (**a**), and (**b**) the plot number of average seizures incidents (squares) and quantity of pangolin scales seized (triangles) in kilogram.

guilty and convicted accordingly. The imprisonment ranges from 2.5–15 years, and the option of a fine which varied from 500RMB–200,000RMB for illegal possession of an animal under State protection. The records indicate 25.46% of the enforcement made had no information on the arresting agency and the number of suspects arrested (Fig. 5).
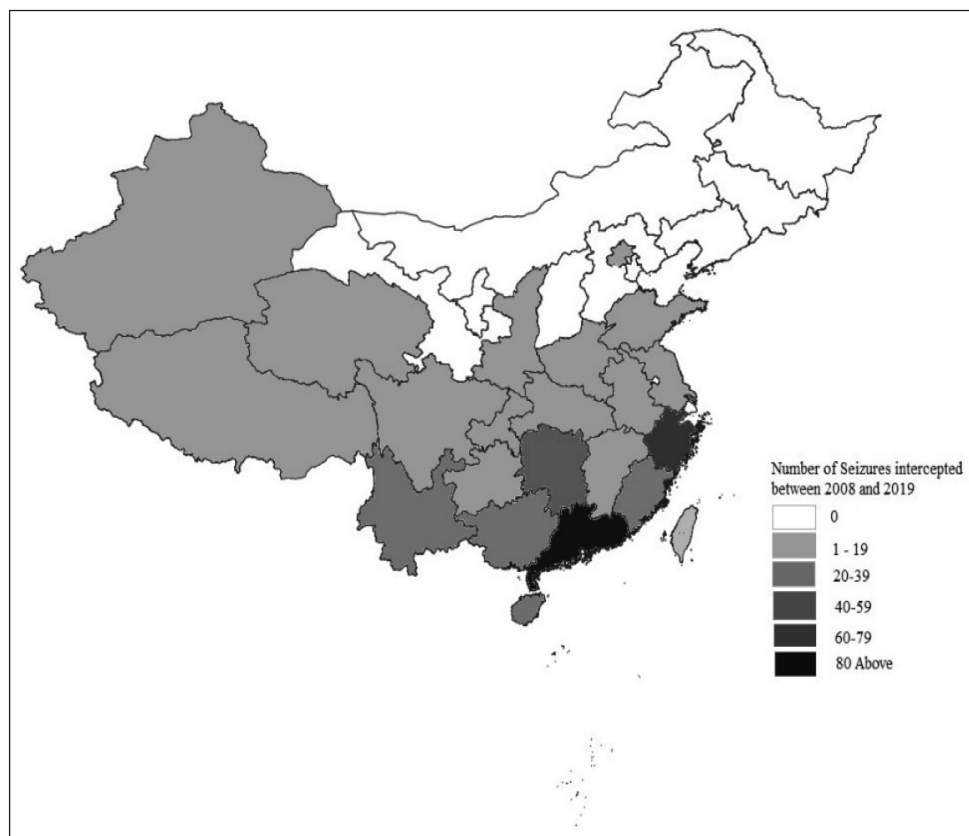
Figure 2. Spatial patterns distribution showing the number of seizures for each province in China from 2008 to 2019.

Private car 30%, Cargo 28%, and luggage 12% were the most common form of pangolins' trafficking and represent 84% of interceptions. Pangolin scale shipment in cargo and containers made up the highest volume of seizures (21185 kg) per annum. Recent evidence suggests private cars remained the primary method of live pangolins trafficking, and mail delivery is evolving as a new mode of pangolins scale shipment (Fig. 6).

Discussion

Overall volume of pangolin seizure

Our analysis of 326 seizures of pangolins showed that a large number of incidents as well as a high volume of pangolin was illegally trafficked to, from or via China during the studied period. The reported illegal trade involved pangolins (live, scales, meat)
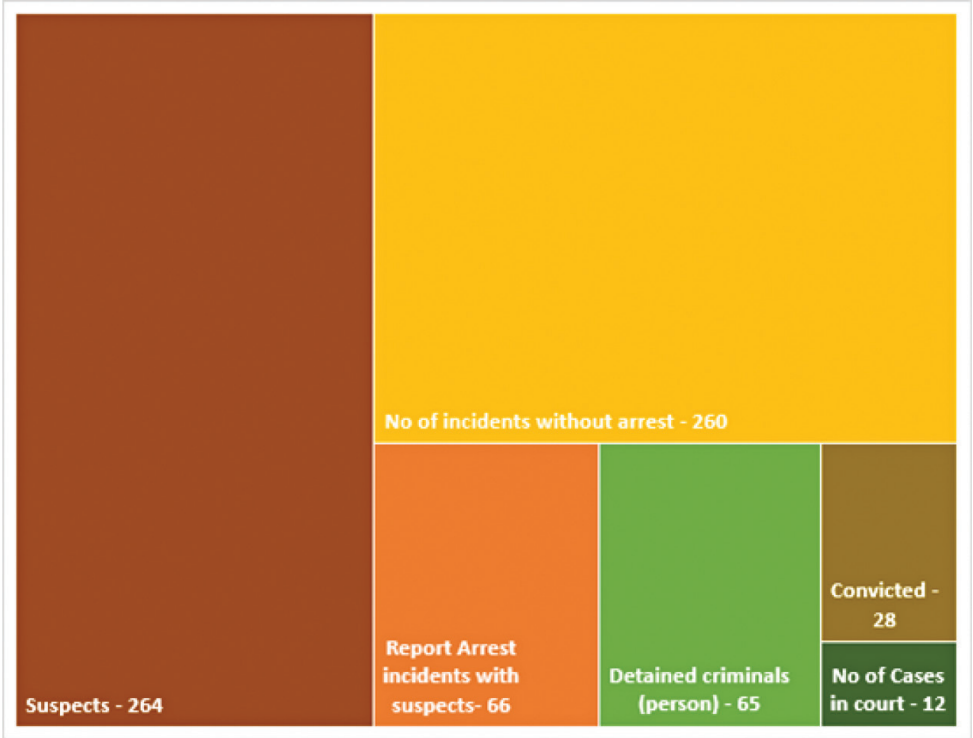
Figure 3. Circular graph visualization of intercities social network interaction of pangolins seizure incident reports.

Figure 4. Agencies involved in Arresting of Pangolins traffickers and offenders.

Figure 5. Proportion of arrest made with criminal suspects and convicted cases reported for pangolin confiscation.
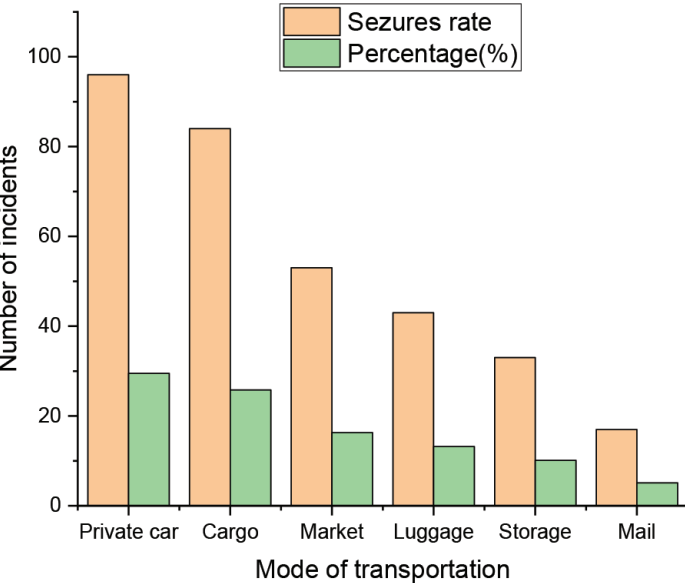

Figure 6. Proportion of pangolin seizure incidents from a different form of transportation.

with 7 species in 326 seizures from 26 of the 34 provinces. Seven of the 8 eight pangolins listed on CITES Appendix I were intercepted by the authority. Among the species, 6 were illegally trafficked and imported from another country within the pangolin distribution range, particularly Asia and Africa. All the four pangolin species (White-bellied pangolin (*Phataginus tricuspis*) Giant-ground pangolin (*Smutsia gigantea*); and Black-Bellied pangolin (*Phataginus tetradactyla*)) found in Africa were illegally sourced and imported from different countries in West and Central African Regions. Overall, the seizures resulted in the confiscation of > 143,130 pangolins including live (n = 925), scales (n = 22,2908 kg) and dead/specimen (n = 31,676).

The detection and interception of pangolins has continued to increase in China, with the embargo placed on the pangolin trade. Our findings are in accordance with the research of (Cheng et al. 2017; Zhang et al. 2017; Ingram et al. 2019a), who have similarly shown that the rate of pangolin interception in China from Africa and Southeast Asia is not decreasing overtime. First, increasing level of international trade may provide an opportunity for laundering. Second, the rapidly changing nature and migration of the online illegal wildlife trade means that alternative transaction platforms become increasingly desirable, increasing international trade in wildlife (Lavorgna 2014; Cheng et al. 2017; Harrington et al. 2018; Ingram et al. 2018). Lastly, potential increases in search efforts, law enforcement synergy and reporting overtime by government agencies and non-government organizations have led to a high frequency of wildlife interception including pangolins over the last three years in China. There was an increasing trend for live pangolin species mainly from the southwest area of China to be associated with private car transport rather than scale consignment interceptions through border surveillance post, which has important implications for Chinese biosecurity and public health issues in the near future. The country (Vietnam 32.52%, Myanmar 21.14%; Nigeria 4.07%, DRC 3.25% and Cameroon 1.63%) of origin data was reliably determined from incidents originating from airports, mail, cargo shipments, and private pangolin interceptions reports published and obtained from the agencies press release in public media, while shipping cargoes constituted the bulk of pangolin scale interception. The gradual increase in annual pangolins scale from areas proximal to ports or from mail delivery during arrival or tip off inspections. Similarly, new incidents of pangolin trafficking in the near future are likely to involve smuggling via means not currently familiar to law enforcement agents (Alacs and Georges 2008; Challender and MacMillan 2014; Heinrich et al. 2019).

An analysis of law enforcement agencies interception, and the arrest of offenders involved in the trade of pangolins trade records shows a bias in security agency status participation and detection categories. The law enforcement agencies known to be widely involved in cracking down on the trade of pangolins in China, through pre and post border interceptions those involved in over 68% of all confiscations are the Public Security Bureau, Custom Services and Forestry Police Bureau. This highlights the significance of law enforcement synergy in effectively dismantling pangolin trafficking in China, given their prominence and participation in curbing wildlife trade criminal

activity. Annual smuggling incidents remained high even after the introduction of pangolin trade embargo. However, the pangolin trade network is well dispersed throughout the Subtropical monsoon forest zone and coastal areas in China. In general, China serves as a destination and transit route for intercepted pangolin scales. Live pangolin seizures were largely intercepted in the western provinces of Yunnan and Guangxi.

Pangolin smuggling routes and hotspots

Seizure data suggest that countries and area predominantly from West and Central Africa Region (Angola; Cameroon, Democratic Republic of Congo (DRC), Equatorial Guinea, and Nigeria) and Asia (Vietnam, Myanmar, Indonesia, Pakistan) were involved in the illegal pangolin importation and trafficking to China. The majority of the pangolin scale confiscations originate in Africa and the majority of confiscations of live pangolins originates in Southeast Asian countries. Vietnam and Hong Kong are the most prominent entrance points for pangolin trafficked by land and sea from Southeast Asia and Africa into China. The terrestrial pangolin routes include Guangzhou (Guangdong), Fangchenggang (Guangxi), Dehong, Kunming (Yunnan), Nanning (Cheng et al. 2017; Zhang et al. 2017). Also, the coastal areas include Mekong River serves as the pangolin routes and other related illicit trade and sold to the local markets, TCM shops, and restaurants in Guangzhou, Guangdong province (Zhang et al. 2017; Wong 2019; van Uhm and Wong 2019), according to confession statements of offenders during interrogation. Previous studies reported increased evidence of pangolin trafficking for meat and body parts used in traditional medicine (TM), TRAFFIC, LEMIS, and regional, national-level case studies (Luczon et al. 2016; Wong 2019). The large-scale pangolin interceptions during cargo screening have served to increase the detection rate of illegal consignments of pangolins concealed either as logs of wood and iron scraps which are passed off as legitimate products. Smugglers often employed different methods to smuggle pangolins to evade detection from law enforcement, disguising the pangolins with plant materials and using overnight transportation (Mwale et al. 2017; Heinrich et al. 2019; Omifolaji et al. 2020).

The major factor influencing pangolin demand is a culture steeped in traditional ethnomedicine use; high return for profit, high global demand for TCM, and decreases of Chinese pangolin populations (Anonymous 1938; Wu and Ma 2007; van Uhm 2016; Lv et al. 2020). The limited stocks and quota set by the authority which fall below the required stock to meet the TCM manufacturer and local demands has resulted in the proliferation of the illegal pangolin trade (Yin et al. 2015; van Uhm 2016; Wong 2019; van Uhm and Wong 2019). Another motive driving pangolin demand is the financial rewards for all the actors (transporter, middlemen, and vendors) involved in the illegal wildlife trade network, to augment alternative income from low paying jobs in rural areas (Katuwal et al. 2015; Nash et al. 2016; Trageser et al. 2017; D'Cruze et al. 2020; Xinhuanet 2021)). Trade is partly operated by criminal gangs, and organized from the village level up to the point of, and beyond, export (Katuwal et al. 2015). Recent evidence suggests that low involvement of the Traditional Chinese

Medicine (TCM) community and informal stakeholders' participation in pangolin conservation advocacy are the key factors facilitating the illegal trade. Also, poverty and lack of public awareness of wildlife trade among the locals has been highlighted as a driver of the illegal wildlife trade (Zhang and Yin 2014; Yin et al. 2015; Wong 2019; van Uhm and Wong 2019). However, although many illegal pangolins scale seizure reports coming into China originated from Africa, cross-border seizure reports of live pangolins and frozen pangolin meat are predominantly from Southeast Asia. Pangolin species in China are thought to have become commercially extinct by c. 1995 (Wu et al. 2002, 2004, 2005; Chaber et al. 2010), Chinese demand for pangolin products subsequently being met through imports, mainly from Southeast Asia (Newton et al. 2008), and most recently Africa (Mambeya et al. 2018; Omifolaji et al. 2020). Over the last decade the number and volume of pangolin interceptions has increased, especially in China and Vietnam (Heinrich et al. 2016; Harrington et al. 2018; Omifolaji et al. 2020). This has triggered a more than 90% decline in the Chinese pangolin population (Wu et al. 2002, 2004; Challender et al. 2015). Overexploitation for commercial trade and ethnomedicine use across Southeast Asia drives pangolin trafficking across their ranges. Since the late 20th century, with the enactment of animal protection law that prohibited use, or trade without permission; by the appropriate authority has contributed to neighboring countries demands and caused neighbors to act as transit routes for pangolin trade (Xiao et al. 2017).

The advantage of seizure data

Web-seizure reports are a useful alternative to traditional methods (such as interviews, questionnaires, market visits, etc.) given the careful and systematic data collection; with a degree of flexibility in exploring and conducting studies in different languages with few geographical barriers (Challender et al. 2015; Harrington et al. 2018; Esmail et al. 2019; Omifolaji et al. 2020). However, online news outlets are dependent on reporting rates in the same way as official seizure data are given out via press conference by the reporting agency (Zhou et al. 2010, 2014, 2016; Zhang et al. 2015; Harrington et al. 2018; Ingram et al. 2019a; D'Cruze et al. 2020). Multiple agencies' reports are used to evaluate seizure data, which enhances our understanding of the trade patterns (Harrington et al. 2018).

China's decision to ban the trade and consumption of terrestrial live wild animals, and stakeholders' involvement in pangolin awareness campaigns, have helped to sensitize public ecological consciousness and protect pangolins. Despite the current alarming rate of pangolin seizure, evidence suggests heightened policy intervention and awareness campaigns. Greater awareness among conservation practitioners and stakeholders is necessary to eradicate the pangolin trade. It is also possible that, increased seizures could also relate to increased rates of detection. Moreover, the development of a centralized real-time online seizure database platform will help to cross-check official reports for export and import database similar to Elephant Trade Information system (ETIS) (Underwood et al. 2013), HealthMap wildlife trade database (Patel et

al. 2015) and consumption of illegal wildlife using social media tools like WhatsApp, QQ, Weibo, WeChat, could also produce a comprehensive data for future analyses of market trends and corresponding future interventions. Another idea is for non-governmental organizations to develop a wildlife database to complement existing databases through citizen science data and regular market surveys, or even the development of easy reporting apps.

Legislation and policy intervention to protect pangolin

The recent removal of pangolin scales from health insurance cover from National Healthcare Security Administration and the Ministry of Human Resources and Social Security (2019), indicates that pangolin-based medicine is no longer covered under national health insurance. Both the manufacturer and practitioners must consider alternatives to reduce patients' medical expenses and treatment dependence on pangolin scale-based medication. In June 2020, China upgraded all Asia pangolin species (*Manis* spp.) from Class II to Class I National-level protection, following the upgrade of all the extant eight pangolin species from CITES Appendix II to Appendix I (UNODC 2016). Following these changes pangolin scales were subsequently removed from the official database of Chinese Pharmacopoeia due to the risk of extinction and status of pangolin populations (NPC 2020). This nation-wide policy change indicates that pangolin scale should no longer be dispensed and regarded as an authorized medication. Pangolin scales as an ingredient are still used in some of the patented drugs included in the Pharmacopoeia. Yet, the TCM community could also play a crucial role in regulating legal trade and eradicating illegal trade in pangolin scale. However, conservation interventions have neglected the TCM community involvement directed at pangolin scale trade in China. TCM practitioner and public awareness is very poor (Soewu and Adekanola 2011; Boakye et al. 2015; Wang et.al. 2020; Xing et al. 2020) and there is still disagreement on the use of pangolin scale products in medicines.

It is essential to note that targeted education programs and public awareness campaigns focusing on regulations and current market status are critical to moving towards the path of sustainable substitute usage. Conservationists should liaise with TCM practitioners as they are currently underrepresented in pangolin conservation efforts and are seen by the Chinese society (Song et al. 2013; Burges et al. 2020) and authorities in the traditional healthcare system as playing an important role in the illegal pangolin trade campaign, to guide public demand towards a sustainable lifestyle and transition through sustainable alternatives.

Since the removal of the pangolin scale from Chinese pharmacopeia and healthcare insurance (NPC 2020), media organizations and NGO campaigns have bolstered the government announcement with major media outlets (e.g., People's Daily), eCommerce platforms (Alibaba, Taobao, etc.), and celebrities lend credibility to media campaigns to help conserve and protect pangolin. Also, the COVID-19 pandemic has placed a spotlight on the illegal trade in pangolins as some scientists have found a similar coronavirus in Sunda pangolins, suggesting they have the potential

to serve as an intermediate host in the transmission from bats to humans. Yet, this remains a matter of ongoing scientific debate (Cui et al. 2020; Volpato et al. 2020; Yang et al. 2020).

Conclusion

This study contributes to the global growing knowledge of illegal pangolin trade research that has identified and prioritized the patterns of illegal pangolin interceptions in the last decade. Our findings show that the illegal pangolins trade is disproportionally (pangolin scales and meats) domiciled in Guangdong, Guangxi and Yunnan provinces. These interceptions are mostly likely a reflection of the policy change priority on wildlife trade ban and law enforcement synergy to eradicate illicit demand and opportunities to smuggle pangolins within Chinese territory. Overall, regarding the illegal trade in pangolins, there has been an increased in the quantity intercepted but a decrease in the number of incidents analyzed over time, and it is fair to assume that smugglers are changing the mode of their illicit trade. Future plans to tackle wildlife (pangolins) trafficking in China are dependent not only on measures already achieved such as stringent border controls, the prosecution of offenders, the removal from Chinese pharmacopeia, and healthcare insurance cover. They also hinge on effective participation and engagement of TCM practitioners in public awareness campaigns at grassroots level. The adoption of alternatives will in no small measure contribute to eradicating pangolin trade and help lend credence to pangolin conservation efforts. Our work provides an important insight into the ongoing policy patterns and interventions on the pangolin trade and the effectiveness of current efforts at eradicating illegal trade within China. We recommend the involvement of a community-based solutions approach to eradicate the illegal pangolin trade. These could also serve as alternative interventions to top-down enforcement-led responses at the regional and national level.

Acknowledgements

References

Aisher A (2016) Scarcity, alterity and value: Decline of the pangolin, the world's most trafficked mammal. Conservation & Society 14(4): 317–329. https://doi.org/10.4103/0972-4923.197610

Alacs E, Georges A (2008) Wildlife across our borders: A review of the illegal trade in Australia. The Australian Journal of Forensic Sciences 40(2): 147–160. https://doi.org/10.1080/00450610802491382

Anonymous (1938) Chinese Medicine and the Pangolin. Nature 141(3558): 72–72. https://doi.org/10.1038/141072b0

Bamrah IS, Girdhar A (2020) A Citizen-Centred Sentiment Analysis Towards India's Critically Endangered Avian and Mammalian Species. In: Chaki R, Cortesi A, Saeed K, Chaki N (Eds) Advanced Computing and Systems for Security. Advances in Intelligent Systems and Computing, vol. 1136. Springer, Singapore, 79–93. https://doi.org/10.1007/978-981-15-2930-6_7

Bennett EL (2015) Legal ivory trade in a corrupt world and its impact on African elephant populations. Conservation Biology 29(1): 54–60. https://doi.org/10.1111/cobi.12377

Boakye MK, Pietersen DW, Kotzé A, Dalton D-L, Jansen R (2015) Knowledge and uses of african pangolins as a source of traditional medicine in Ghana. PLoS ONE 10(1): e0117199. https://doi.org/10.1371/journal.pone.0117199

Burges G, Olmedo A, Veríssimo D, Waterman C (2020) Changing consumer behavior for pangolin products, In: Challender DWS, Nash HC, Waterman C (Eds) Pangolins: Science, Society and Conservation, Academic Press, 349–366. https://doi.org/10.1016/B978-0-12-815507-3.00022-8

Chaber AL, Allebone-Webb S, Lignereux Y, Cunningham AA, Rowcliffe MJ (2010) The scale of illegal meat importation from Africa to Europe via Paris. Conservation Letters 3(5): 317–321. https://doi.org/10.1111/j.1755-263X.2010.00121.x

Challender DWS, MacMillan DC (2014a) Poaching is more than an enforcement problem. Conservation Letters 7(5): 484–494. https://doi.org/10.1111/conl.12082

Challender DWS, Waterman C, Baillie JEM (2014b) Scaling up Pangolin Conservation, IUCN SSC Pangolin Specialist Group Conservation Action Plan. Zoological Society of London, London.

Challender DWS, Harrop SR, MacMillan DC (2015) Understanding markets to conserve trade-threatened species in CITES. Biological Conservation 187: 249–259. https://doi.org/10.1016/j.biocon.2015.04.015

Challender DWS, Willcox DHA, Panjang E, Lim N, Nash H, Heinrich S, Chong J (2019a) *Manis javanica*. The IUCN Red List of Threatened Species: e.T12763A123584856. https://doi.org/10.2305/IUCN.UK.2019-3.RLTS.T12763A123584856.en [Accessed on 27 January 2021]

Challender DWS, Wu S, Kaspal, P, Khatiwada A, Ghose A, Ching-Min SN, Mohapatra RK, Laxmi-Suwal T (2019b) *Manis pentadactyla* (errata version published in 2020). The IUCN Red List of Threatened Species 2019: e.T12764A168392151. https://doi.org/10.2305/IUCN.UK.2019-3.RLTS.T12764A168392151.en [Accessed on 26 January 2021]

Cheng W, Xing S, Bonebrake TC (2017) Recent pangolin seizures in China reveal priority areas for intervention. Conservation Letters 10(6): 757–764. https://doi.org/10.1111/conl.12339

CITES (2016) Consideration of Proposals for Amendment of Appendices I and II. Seventeenth meeting of the Conference of the Parties Johannesburg, South Africa. https://cites.org/sites/default/files/eng/cop/17/prop/060216/E-CoP17-Prop-11.243.pdf

Cui HT, Yu-Ting L, Li-Ying G, Xiang-Guo L, Lu-Shan W, Jian-Wei J, Liao JB, Miao J, Zhai-Yi Z, Wang L (2020) Traditional Chinese medicine for treatment of coronavirus disease 2019: A review. Traditional Medicine Research 5(2): 65–73. https://doi.org/10.53388/TMR20200222165

D'Cruze N, Assou D, Coulthard E, Norrey J, Megson D, Macdonald DW, Harrington LA, Ronfot D, Segniagbeto GH, Auliya M (2020) Snake oil and pangolin scales: Insights into wild animal use at "Marché des Fétiches" traditional medicine market, Togo. Nature Conservation 39: 45–71. https://doi.org/10.3897/natureconservation.39.47879

Esmail N, Wintle B, Athanas A, Beale C, Bending Z, Dai R, Fabinyi M, Gluszek S, Haenlein C, Harrington LA (2019) Emerging illegal wildlife trade issues in 2018: A global horizon scan. Conservation Letters 13(4): e12715. https://doi.org/10.1111/conl.12715

Foley M (2013) Good things come to those who wait: CITES and the move toward legalizing the international trade in ivory. Journal of Animal and Environmental Law: 5–67.

Gao Y, Stoner KJ, Lee AT, Clark SG (2016) Rhino horn trade in China: An analysis of the art and antiques market. Biological Conservation 201: 343–347. https://doi.org/10.1016/j.biocon.2016.08.001

Gaubert P, Antunes A (2015) What's behind these scales? Comments to "The complete mitochondrial genome of Temminck's ground pangolin (*Smutsia temminckii*; Smuts, 1832) and phylogenetic position of the *Pholidota* (Weber, 1904)". Gene 563(1): 106–108. https://doi.org/10.1016/j.gene.2015.03.021

Gaubert P, Antunes A (2005) Assessing the taxonomic status of the Palawan pangolin *Manis culionensis* (Pholidota) using discrete morphological characters. Journal of Mammalogy 86(6): 1068–1074. https://doi.org/10.1644/1545-1542(2005)86[1068:ATTSOT]2.0.CO;2

Gaudin TJ, Emry RJ, Wible JR (2009) The Phylogeny of Living and Extinct Pangolins (Mammalia, Pholidota) and Associated Taxa: A Morphology Based Analysis. Journal of Mammalian Evolution 16(4): 235–305. https://doi.org/10.1007/s10914-009-9119-9

Gomez L, Leupen B, Hwa T (2016) The trade of African pangolins to Asia: A brief case study of pangolin shipments from Nigeria. Traffic Bulletin 28: 3–5.

Haas TC, Ferreira SM (2016) Combating rhino horn trafficking: The need to disrupt criminal networks. PLoS ONE 11(11): e0167040. https://doi.org/10.1371/journal.pone.0167040

Harrington LA, D'Cruze N, Macdonald D (2018) Rise to fame: Events, media activity and public interest in pangolins and pangolin trade, 2005–2016. Nature Conservation 30: 107–133. https://doi.org/10.3897/natureconservation.30.28651

Harrington L, Macdonald D, D'Cruze N (2019) Popularity of pet otters on YouTube: Evidence of an emerging trade threat. Nature Conservation 36: 17–45. https://doi.org/10.3897/natureconservation.36.33842

Heinrich S, Wittmann TA, Ross JV, Shepherd C, Challender DWS, Cassey P (2017) The Global Trafficking of Pangolins: A Comprehensive Summary of Seizures and Trafficking Routes from 2010 e2015. TRAFFIC, Southeast Asia Regional Office, Petaling Jaya, Selangor, Malaysia.

Heinrich S, Wittmann TA, Prowse TA, Ross JV, Delean S, Shepherd CR, Cassey P (2016) Where did all the pangolins go? International CITES trade in pangolin species. Global Ecology and Conservation 8: 241–253. https://doi.org/10.1016/j.gecco.2016.09.007

Heinrich S, Koehncke A, Shepherd CR (2019) The role of Germany in the illegal global pangolin trade. Global Ecology and Conservation 20: e00736. https://doi.org/10.1016/j.gecco.2019.e00736

Henschel P, Hunter LT, Coad L, Abernethy K, Mühlenberg M (2011) Leopard prey choice in the Congo Basin rainforest suggests exploitative competition with human bushmeat hunters. Journal of Zoology 285: 11–20. https://doi.org/10.1111/j.1469-7998.2011.00826.x

Hernandez-Castro J, Roberts DL (2015) Automatic detection of potentially illegal online sales of elephant ivory via data mining. PeerJ Computer Science 1: e10. https://doi.org/10.7717/peerj-cs.10

Ingram DJ, Coad L, Abernethy KA, Maisels F, Stokes EJ, Bobo KS, Breuer T, Gandiwa E, Ghiurghi A, Greengrass E, Holmern T, Kamgaing TOW, Ndong Obiang A-M, Poulsen JR, Schleicher J, Nielsen MR, Solly H, Vath CL, Waltert M, Whitham CEL, Wilkie DS, Scharlemann JPW (2018) Assessing Africa-wide pangolin exploitation by scaling local data. Conservation Letters 11(2): e12389. https://doi.org/10.1111/conl.12389

Ingram DJ, Cronin DT, Challender DW, Venditti DM, Gonder MK (2019a) Characterising trafficking and trade of pangolins in the Gulf of Guinea. Global Ecology and Conservation 17: e00576. https://doi.org/10.1016/j.gecco.2019.e00576

Ingram DJ, Shirley MH, Pietersen D, Godwill Ichu I, Sodeinde O, Moumbolou C, Hoffmann M, Gudehus M, Challender D (2019b) *Phataginus tetradactyla*. The IUCN Red List of Threatened Species 2019: e.T12766A123586126. https://doi.org/10.2305/IUCN.UK.2019-3.RLTS.T12766A123586126.en [Accessed on 27 January 2021]

Katuwal HB, Neupane KR, Adhikari D, Sharma M, Thapa S (2015) Pangolins in eastern Nepal: Trade and ethno-medicinal importance. Journal of Threatened Taxa 7(9): 7563–7567. https://doi.org/10.11609/JoTT.o4202.7563-7

Krzywinski MI, Schein JE, Birol I, Connors J, Gascoyne R, Horsman D, Jones SJ, Marra MA (2009) Circos: An information aesthetic for comparative genomics. Genome Research 19(9): 1639–1645. https://doi.org/10.1101/gr.092759.109

Lavorgna A (2014) Wildlife trafficking in the Internet age. Crime Science 3(1): e5. https://doi.org/10.1186/s40163-014-0005-2

Li J, Lu Z (2014) Snow leopard poaching and trade in China 2000–2013. Biological Conservation 176: 207–211. https://doi.org/10.1016/j.biocon.2014.05.025

Liu S, Newman C, Buesching CD, Macdonald DW, Zhang Y, Zhang KJ, Li F, Zhou ZM (2020) E-commerce promotes trade in invasive turtles in China. Oryx 55(3): 1–4. https://doi.org/10.1017/S0030605319001030

Luczon AU, Ong PS, Quilang JP, Fontanilla IKC (2016) Determining species identity from confiscated pangolin remains using DNA barcoding. Mitochondrial DNA. Part B, Resources 1(1): 763–766. https://doi.org/10.1080/23802359.2016.1238752

Lv H, Li Z, Xie Z, Hu X, Li H, Sun J, Chen X, Wen C (2020) Innovated formulation of TCM pangolin scales to develop a nova therapy of rheumatoid arthritis. Biomedicine and Pharmacotherapy 126: 109872. https://doi.org/10.1016/j.biopha.2020.109872

Mahmood T, Challender D, Khatiwada A, Andleeb S, Perera P, Trageser S, Ghose A, Mohapatra R (2019) *Manis crassicaudata*. The IUCN Red List of Threatened Species 2019: e.T12761A123583998. https://doi.org/10.2305/IUCN.UK.2019-3.RLTS.T12761A123583998.en [Accessed on 27 January 2021]

Mambeya MM, Baker F, Momboua BR, Koumba-Pambo AF, Hega M, Okouyi-Okouyi VJ, Onanga M, Challender DWS, Ingram DJ, Wang H, Abernethy K (2018) The emergence of a commercial trade in pangolins from Gabon. African Journal of Ecology 56(3): 601–609. https://doi.org/10.1111/aje.12507

Marshall BM, Strine C, Hughes AC (2020) Thousands of reptile species threatened by under-regulated global trade. Nature Communications 11(1): 1–12. https://doi.org/10.1038/s41467-020-18523-4

Martin RO, Senni C, D'Cruze NC (2018) Trade in wild-sourced African grey parrots: Insights via social media. Global Ecology and Conservation 15: e00429. https://doi.org/10.1016/j.gecco.2018.e00429

Mwale M, Dalton DL, Jansen R, De Bruyn M, Pietersen D, Mokgokong PS, Kotzé A (2017) Forensic application of DNA barcoding for identification of illegally traded African pangolin scales. Genome 60(3): 272–284. https://doi.org/10.1139/gen-2016-0144

Nash HC, Wong MH, Turvey ST (2016) Using local ecological knowledge to determine status and threats of the Critically Endangered Chinese pangolin (*Manis pentadactyla*) in Hainan, China. Biological Conservation 196: 189–195. https://doi.org/10.1016/j.biocon.2016.02.025

National Healthcare Security Administration and the Ministry of Human Resources and Social Security (2019) National drug catalogue for basic medical insurance, work-related injury insurance, and maternity insurance. http://www.nhsa.gov.cn/art/2019/8/20/art_37_1666.html

Nellemann C, Henriksen R, Raxter P, Ash N, Mrema E [Eds] (2014) The Environmental Crime Crisis – Threats to Sustainable Development from Illegal Exploitation and Trade in Wildlife and Forest Resources. A UNEP Rapid Response Assessment. United Nations Environment Programme and GRID-Arendal, Nairobi and Arendal. www.grida.no. http://hdl.handle.net/20.500.11822/9120

Newton P, Van Thai N, Roberton S, Bell D (2008) Pangolins in peril: Using local hunters' knowledge to conserve elusive species in Vietnam. Endangered Species Research 6: 41–53. https://doi.org/10.3354/esr00127

Ni Q, Wang Y, Weldon A, Xie M, Xu H, Yao Y, Zhang M, Li Y, Li Y, Zeng B, Nekaris KAI (2018) Conservation implications of primate trade in China over 18 years based on web news reports of confiscations. PeerJ 6: e6069. https://doi.org/10.7717/peerj.6069

Nixon S, Pietersen D, Challender D, Hoffmann M, Godwill Ichu I, Bruce T, Ingram DJ, Matthews N, Shirley MH (2019) *Smutsia gigantea*. The IUCN Red List of Threatened Species 2019: e.T12762A123584478. https://dx.doi.org/10.2305/IUCN.UK.2019-.RLTS.T12762A123584478.en [Accessed on 27 January 2021]

NPC (2020) Pharmacopoeia of the People's Republic of China. Pharmacopoeia Commission of the Ministry of Health of the People's Republic of China, Beijing.

Omifolaji JK, Ikyaagba ET, Jimoh SO, Ibrahim AS, Ahmad S, Luan X (2020) The emergence of Nigeria as a staging ground in the illegal pangolin exportation to South East Asia. Forensic Science International: Reports 2: 100138. https://doi.org/10.1016/j.fsir.2020.100138

Patel NG, Rorres C, Joly DO, Brownstein JS, Boston R, Levy MZ, Smith G (2015) Quantitative methods of identifying the key nodes in the illegal wildlife trade network. Proceedings of the National Academy of Sciences of the United States of America 112(26): 7948–7953. https://doi.org/10.1073/pnas.1500862112

Phelps J, Biggs D, Webb EL (2016) Tools and terms for understanding illegal wildlife trade. Frontiers in Ecology and the Environment 14(9): 479–489. https://doi.org/10.1002/fee.1325

Pietersen D, Moumbolou C, Ingram DJ, Soewu D, Jansen R, Sodeinde O, Keboy MLIC, Challender D, Shirley MH (2019a) *Phataginus tricuspis*. The IUCN Red List of Threatened Species: e.T12767A123586469. https://dx.doi.org/10.2305/IUCN.UK.2019-.RLTS.T12767A123586469.en [Accessed on 27 January 2021]

Pietersen D, Jansen R, Connelly E (2019b) *Smutsia temminckii*. The IUCN Red List of Threatened Species: e.T12765A123585768. https://dx.doi.org/10.2305/IUCN.UK.2019-.RLTS.T12765A123585768.en [Accessed on 27 January 2021]

R Core Team (2018) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna. https://www.r-project.org/

Ripple WJ, Abernethy K, Betts MG, Chapron G, Dirzo R, Galetti M, Levi T, Lindsey PA, Macdonald DW, Machovina B, Newsome TM, Peres CA, Wallach AD, Wolf C, Young H (2016) Bushmeat hunting and extinction risk to the world's mammals. Royal Society Open Science 3(10): 160498. https://doi.org/10.1098/rsos.160498

Rosen GE, Smith KF (2010) Summarizing the evidence on the international trade in illegal wildlife. EcoHealth 7(1): 24–32. https://doi.org/10.1007/s10393-010-0317-y

Schoppe S, Katsis L, Lagrada L (2019) *Manis culionensis*. The IUCN Red List of Threatened Species 2019: e.T136497A123586862. https://doi.org/10.2305/IUCN.UK.2019-3.RLTS.T136497A123586862.en [Accessed on 27 January 2021]

Shairp R, Veríssimo D, Fraser I, Challender D, MacMillan D (2016) Understanding urban demand for wild meat in Vietnam: Implications for conservation actions. PLoS ONE 11(1): e0134787. https://doi.org/10.1371/journal.pone.0134787

Siriwat P, Nijman V (2018a) Illegal pet trade on social media as an emerging impediment to the conservation of Asian otters species. Journal of Asia-Pacific Biodiversity 11(4): 469–475. https://doi.org/10.1016/j.japb.2018.09.004

Siriwat P, Nijman V (2018b) Using online media-sourced seizure data to assess the illegal wildlife trade in Siamese rosewood. Environmental Conservation 45(4): 352–360. https://doi.org/10.1017/S037689291800005X

Soewu DA, Adekanola TA (2011) Traditional-medical knowledge and perception of pangolins (*Manis* spp) among the Awori people, Southwestern Nigeria. Journal of Ethnobiology and Ethnomedicine 7(1): e25. https://doi.org/10.1186/1746-4269-7-25

Spee LB, Hazel SJ, Dal Grande E, Boardman WS, Chaber AL (2019) Endangered Exotic Pets on Social-Media in the Middle East: Presence and Impact. Animals (Basel) 9(8): e480. https://doi.org/10.3390/ani9080480

Trageser SJ, Ghose A, Faisal M, Mro P, Mro P, Rahman SC (2017) Pangolin distribution and conservation status in Bangladesh. PLoS ONE 12(4): e0175450. https://doi.org/10.1371/journal.pone.0175450

Underwood FM, Burn RW, Milliken T (2013) Dissecting the illegal ivory trade: An analysis of ivory seizures data. PLoS ONE 8(10): e76539. https://doi.org/10.1371/journal.pone.0076539

UNODC (2016) World Wildlife Crime Report: Trafficking in protected species. New York, USA.

UNODC (2020) Wildlife Crime: Pangolin scales, United Nations Office on Drugs and Crime. New York, USA.

van Uhm DP (2016) The illegal wildlife trade: inside the world of poachers, smugglers and traders. Springer, Switzerland, [XXVII +] 328 pp. https://doi.org/10.1007/978-3-319-42129-2

van Uhm DP, Wong RW (2019) Establishing Trust in the Illegal Wildlife Trade in China. Asian Journal of Criminology 14(1): 23–40. https://doi.org/10.1007/s11417-018-9277-x

Vira V, Ewing T, Miller J (2014) Out of Africa: mapping the global trade in illicit elephant ivory. media1.s-nbcnews.com/i/MSNBC/Sections/NEWS/OutofAfrica_Report.pdf [Accessed January 11, 2021]

Volpato G, Fontefrancesco MF, Gruppuso P, Zocchi DM, Pieroni A (2020) Baby pangolins on my plate: Possible lessons to learn from the COVID-19 pandemic. Journal of Ethnobiology and Ethnomedicine 16(1): e19. https://doi.org/10.1186/s13002-020-00366-4

Wang Y, Turvey ST, Leader-Williams N (2020) Knowledge and attitudes about the use of pangolin scale products in Traditional Chinese Medicine (TCM) within China. People and Nature 2(4): 903–912. https://doi.org/10.1002/pan3.10150

Wilson DE, Reeder DM (2005) Mammal species of the world: a taxonomic and geographic reference. 3rd edn. Johns Hopkins University Press, Baltimore, 142 pp.

Wittemyer G, Northrup JM, Blanc J, Douglas-Hamilton I, Omondi P, Burnham KP (2014) Illegal killing for ivory drives global decline in African elephants. Proceedings of the National Academy of Sciences of the United States of America 111(36): 13117–13121. https://doi.org/10.1073/pnas.1403984111

Wong RWY (2019) China and the Illegal Wildlife Trade. In: The Illegal Wildlife Trade in China. Palgrave Studies in Green Criminology. Palgrave Macmillan, Cham, 13–38. https://doi.org/10.1007/978-3-030-13666-6_2

Wood KL, Tenger B, Morf NV, Kratzer A (2014) Report to CITES: CITES-Listed Species at Risk from the Illegal Trafficking of Bushmeat; Results of a 2012 study in Switzerland's International Airports. An Unpublished Report to CITES, Switzerland, 127 pp. https://doi.org/10.5167/uzh-111850

Wu S, Ma G (2007) The status and conservation of pangolins in China. TRAFFIC East Asia Newsletter 4: 1–5.

Wu S, Ma G, Tang M, Chen H, Liu N (2002) The status and conservation strategy of pangolin resource in China. Ziran Ziyuan Xuebao 17: 174–180.

Wu S, Liu N, Zhang Y, Ma G (2004) Assessment of threatened status of Chinese Pangolin (*Manis pentadactyla*). Chinese Journal of Applied and Environmental Biology 10: 456–461.

Wu S, Wang Y, Feng Q (2005) A new record of Mammalia in China: *Manis javanica*. Dong Wu Fen Lei Xue Bao 30: 440–443.

Xiao Y, Guan J, Xu L (2017) Traffic Wildlife Cybercrime in China. Traffic, Copenhagen.

Xing S, Bonebrake TC, Cheng W, Zhang M, Ades G, Shaw D, Zhou Y (2020) Meat and medicine: historic and contemporary use in Asia. In: Chalender DWS, Nash HC, Waterman C (Eds) Pangolins. Elsevier, 227–239. https://doi.org/10.1016/C2017-0-02849-5

Xinhuanet (2021) China jails 17 for smuggling pangolin scales. http://www.xinhuanet.com/english/2021-01/05/c_139643119.htm

Yang Y, Islam MS, Wang J, Li Y, Chen X (2020) Traditional chinese medicine in the treatment of patients infected with 2019-new coronavirus (SARS-CoV-2): A Review and Perspective. International Journal of Biological Sciences 16(10): 1708–1717. https://doi.org/10.7150/ijbs.45538

Ye YC, Yu WH, Newman C, Buesching CD, Xu Y, Xiao X, Macdonald DW, Zhou Z-M (2020) Effects of regional economics on the online sale of protected parrots and turtles in China. Conservation Science and Practice 2(3): e161. https://doi.org/10.1111/csp2.161

Yin F, Meng M, Xu L, Liu D (2015) Survey on illegal trade in endangered medicinal species in China's traditional Chinese medicine wholesale markets. Forest Resource Management 2: 24–30.

Yin RY, Ye YC, Newman C, Buesching CD, Macdonald DW, Luo Y, Zhou ZM (2020) China's online parrot trade: Generation length and body mass determine sales volume via price. Global Ecology and Conservation 23: e01047. https://doi.org/10.1016/j.gecco.2020.e01047

Zhang L, Yin F (2014) Wildlife consumption and conservation awareness in China: A long way to go. Biodiversity and Conservation 23(9): 2371–2381. https://doi.org/10.1007/s10531-014-0708-4

Zhang H, Miller MP, Yang F, Chan HK, Gaubert P, Ades G, Fischer GA (2015) Molecular tracing of confiscated pangolin scales for conservation and illegal trade monitoring in Southeast Asia. Global Ecology and Conservation 4: 414–422. https://doi.org/10.1016/j.gecco.2015.08.002

Zhang M, Gouveia A, Qin T, Quan R, Nijman V (2017) Illegal pangolin trade in northernmost Myanmar and its links to India and China. Global Ecology and Conservation 10: 23–31. https://doi.org/10.1016/j.gecco.2017.01.006

Zhou HS, Tang JQ, Guo BX, Wang XQ, Dong JH, LI K, Hou SI (2010) Characteristics and resolve measures of damage accidents resulted by national key protected wild animals in China. Journal of Beijing Forestry University 9: 37–41.

Zhou ZM, Zhou Y, Newman C, Macdonald DW (2014) Scaling up pangolin protection in China. Frontiers in Ecology and the Environment 12(2): 97–98. https://doi.org/10.1890/14.WB.001

Zhou ZM, Newman C, Buesching CD, Meng X, Macdonald DW, Zhou Y (2016) Revised taxonomic binomials jeopardize protective wildlife legislation. Conservation Letters 9(5): 313–315. https://doi.org/10.1111/conl.12289