

THE GLOBAL TRAFFICKING OF PANGOLINS:

A comprehensive summary of seizures and trafficking routes from 2010–2015

*Sarah Heinrich, Talia A. Wittman, Joshua V. Ross, Chris R. Shepherd,
Daniel W.S. Challender, Phillip Cassey*





TRAFFIC REPORT

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Front cover photograph: Seized pangolin scales
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Seized pangolin scales



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INTERNATIONAL TRAFFICKING ROUTES FOR PANGOLINS (2010-2015)

2010 - 2015

1270 seizures incidents
67 countries/territories

TOTAL
120
tonnes

BODY PARTS

20 749 kg

and
7154
individual
parts

WHOLE

44 475 kg

and
46 760
individual
pangolins

SCALES

55 251 kg

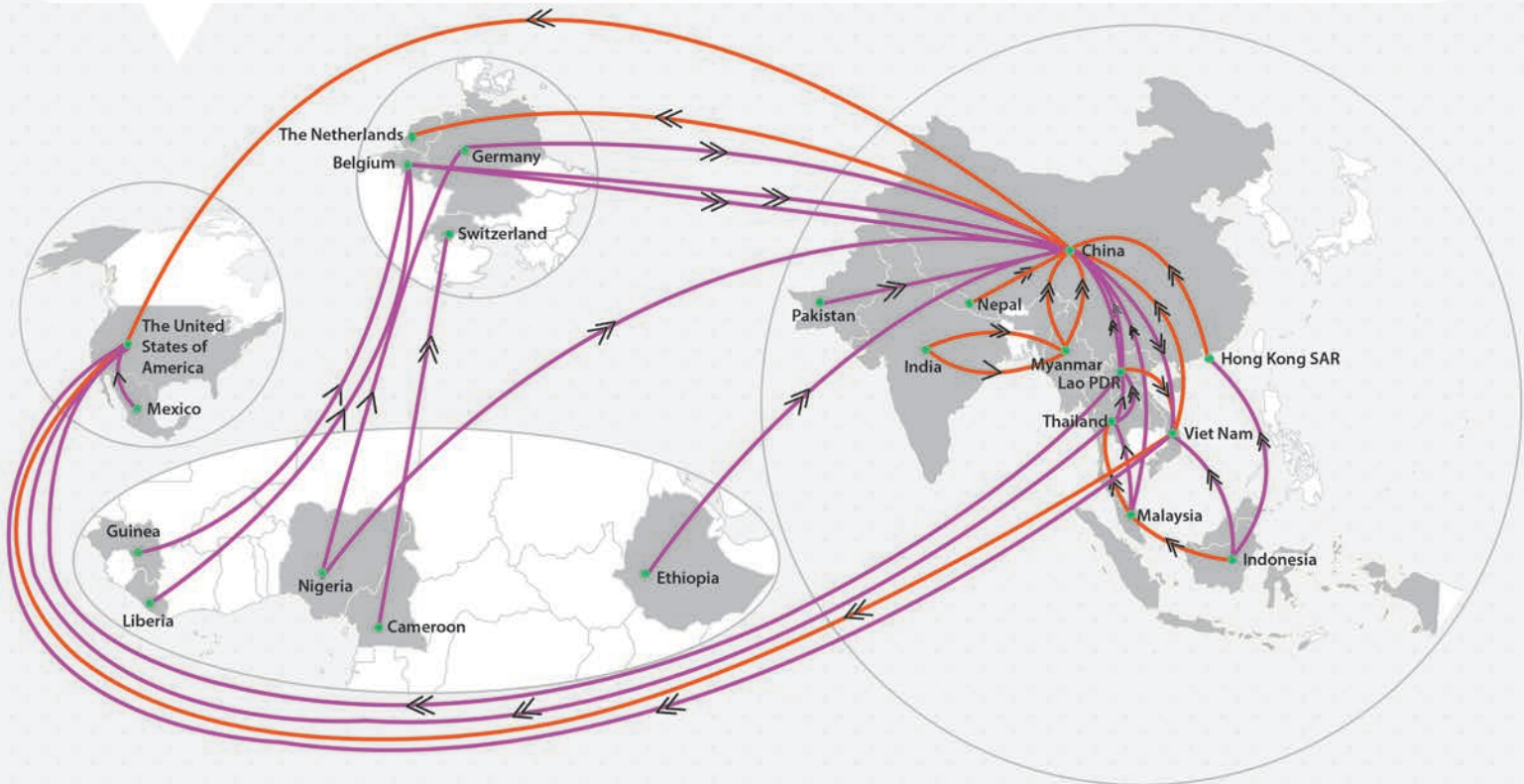
and
5613
scales

Seizure quantities were not always reported in the same measure. The weight and count shown above are independent of each other

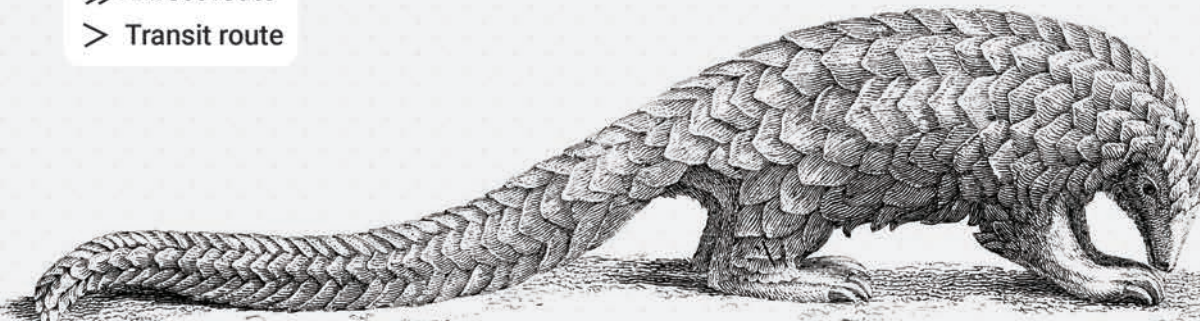
Trade routes

- 159 unique international routes.
- Average of 27 new unique routes emerged each year.

The top trade routes that have been used five times or more in international pangolin trafficking incidents. Routes in orange have been used in five or six consecutive years.



➤➤ Direct route
➤ Transit route



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ACRONYMS AND ABBREVIATIONS

AE	United Arab Emirates
BE	Belgium
CH	Switzerland
CI	Côte d'Ivoire
CITES	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
CM	Cameroon
CN	China
COP	Conference of the Parties
DE	Germany
EIA	Environmental Investigation Agency
ET	Ethiopia
EU-TWIX	European Union Trade in Wildlife Information eXchange
FR	France
GN	Guinea
GQ	Equatorial Guinea
HK	Hong Kong Special Administrative Region (SAR)
ID	Indonesia
IN	India
IUCN	International Union for Conservation of Nature
KE	Kenya
LA	Lao People's Democratic Republic (PDR)
LR	Liberia
MA	(CITES) Management Authority
Misc.	Miscellaneous
MM	Myanmar
MX	Mexico
MY	Malaysia
MZ	Mozambique
NG	Nigeria
NGO	Non-governmental Organization
NL	The Netherlands
NP	Nepal
PH	The Philippines
PK	Pakistan
SG	Singapore
TG	Togo
TH	Thailand
UG	Uganda
US	The United States of America
VN	Viet Nam

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EXECUTIVE SUMMARY

Pangolins are currently the most heavily trafficked wild mammals in the world. Their meat is considered a delicacy, and has been attributed to have a medicinal/tonic value, their scales are used in traditional medicines, and pangolin skins are processed into leather products. All eight species are listed as threatened on The IUCN Red List of Threatened SpeciesTM. An estimated one million pangolins have been trafficked in the period 2000–2013, however, there is little understanding of the trafficking routes used to transport pangolins globally. In this report, the illegal pangolin trade from 2010–2015 was investigated, focusing on the global trade routes used to traffic pangolins and their derivatives. A total of 1270 seizure incidents were collated, which included at least 20 749 kg and an additional 7154 individual pangolin body parts, 55 251 kg and an additional 5613 individual pangolin scales, and 44 475 kg and an additional 46 760 individual whole pangolins. This excluded a total of 7.6% of all incidents where no quantitative information was available. A subset of these data (excluding domestic trade) was used to study international trafficking routes.

An average of 33 countries and territories were involved in international pangolin trafficking per year. Notably, an average of 27 new trade routes were identified each year, highlighting that wildlife trafficking occurs through a highly mobile trade network with constantly shifting trade routes. The seizure incidents involved 67 countries and territories across six continents; demonstrating the global nature of pangolin trafficking, which is not limited to Asian and African range countries.

China and the United States of America (US) were identified as the most common destinations for international pangolin trafficking during the six-year period. China was the main destination for large-quantity shipments of scales (here defined as shipments involving ≥ 1000 kg of scales) and whole animals (here defined as shipments involving ≥ 500 pangolins), while the US was the main destination for large-quantity shipments of body parts (here defined as shipments involving ≥ 100 body parts).

Europe was identified as an important transit hub, mostly for African pangolins (and their parts and derivatives) being transported to Asia. Germany, France and Belgium were particularly prominent. An exception was the Netherlands, which was reported as a destination for large-quantity shipments of body parts and scales from China and Uganda respectively, as well as a common destination for shipments from China.

However, most international trafficking of pangolins (and their parts and derivatives) occurred within Asia, both in terms of number of incidents and quantity. Of the top ten countries and territories involved in the most trafficking incidents, seven were in Asia, namely China, Viet Nam, Malaysia, Hong Kong SAR, Thailand, Lao PDR, and Indonesia. The remaining three were the US, Nigeria, and Germany.

Body parts (including a variety of raw derivatives or processed commodities, such as skins, trophies, leather products, and medicinals) were significantly more likely to be from an Asian pangolin species relative to other commodities in trade and species origins, but the transport mode for body part shipments was largely unreported. The analysis of large-quantity shipments indicated that 80% of the trade in body parts was from China and Viet Nam and destined almost exclusively for the US, with the exception of one case, where the Netherlands was the reported destination.

Trafficking of scales was significantly more likely to be of African origin and to be transported by air, relative to other transport modes and origins. Analysis of large-quantity shipments involving scales indicated that 55% of these shipments were of African origin, namely from Cameroon, Nigeria, Sierra Leone, and Uganda. The number of large-quantity shipments of scales, as well as the weight

of such shipments, increased significantly through time, as did the number of incidents involving African pangolin species. China was the main destination for the large-quantity shipments of scales, but other destinations for these shipments were Hong Kong SAR, the Netherlands, and Viet Nam.

Whole animals were significantly more likely to be transported by land, relative to the other transport modes and commodities, and large-quantity shipments involving whole animals were exclusively traded within Asia. Of these large-quantity shipments, Indonesia and Malaysia were the most common origin countries, although Malaysia was also identified as an important destination and transit country. Other destinations for large-quantity shipments of whole pangolins included China, Singapore, Thailand, and Viet Nam.

Based on the findings of this study the following recommendations are made, recognizing the underlying caveats of the seizure data:

RECOMMENDATIONS

Legislation and enforcement

- All countries involved in the illegal pangolin trade should review, and amend where necessary, national wildlife laws and relevant Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)-implementing legislation to protect all eight pangolin species from trade (see also Challender *et al.*, (2014a), IUCN (2016), and (CITES 2017b)). This should include full protection for all species of pangolins, native and non-native, within national wildlife protection legislation and other legal instruments that govern CITES and international trade. This will provide for a stricter deterrent and provision of higher penalties, given the CITES Appendix I status of all pangolin species (i.e. all commercial international trade of wild caught specimens is prohibited).
- Law enforcement agencies (including Customs, police, and relevant wildlife departments) in the countries identified in this report as implicated in international pangolin trafficking should be vigilant to the persistence of illegal trade. However, the countries that most need to enhance their law enforcement efforts are those with low numbers of seizures, but at the same time implicated in the routes of many trafficking incidents. According to the presented data, this discrepancy is most notable in (descending order of importance): Lao PDR, Nigeria, Myanmar, Cameroon, Guinea, Mexico, the Philippines, Pakistan, Liberia, Equatorial Guinea, Cote d'Ivoire, Ethiopia, Kenya, Singapore, Mozambique, and Togo.
- Law enforcement agencies in all countries involved in pangolin trafficking should employ intelligence-led investigations to examine, identify, and prosecute all parties involved in the pangolin trade that violates national laws [see also CITES (2017b)], from collectors and traders, to logistics companies and importers, as well as the vendors, purchasers and users of pangolin parts and products. These efforts would be particularly useful in countries and territories that have been involved in large-quantity shipments identified here namely: Cameroon, China, Guinea, Hong Kong SAR, India, Indonesia, Kenya, Lao PDR, Malaysia, Myanmar, the Netherlands, Nigeria, Pakistan, the Philippines, Sierra Leone, Singapore, Thailand, Uganda, the US, and Viet Nam. Several European countries, especially, Germany, France, and Belgium are also implicated as they have been identified as important transit hubs, especially for African pangolins. Furthermore, analysis of the type of product, and the quantities seized, may be useful in determining the type of criminal activities and/or networks behind the shipments, and the enforcement response required.

- Profiling through intelligence-led investigations should be employed by source, transit and end-use destinations. The transnational network of illegal pangolin trafficking is highly mobile with new trade routes emerging every year. Enforcement approaches will need to be equally dynamic and responsive, similar to the methods that been recommended to stem the trade in African ivory and rhino horns to Asia (see e.g. Milliken and Shaw (2012)).
- Multi-agency collaboration (including Customs, police, wildlife departments, transportation and logistics companies), both at national and international levels, and between source, transit and end-use destinations, should be enhanced to tackle the international and organized criminal networks involved in smuggling pangolins across borders.
- Prosecutors and judiciaries in all pangolin range countries, and non-range countries implicated in trafficking, should be made aware of all applicable legislation and legal instruments available to prosecute and convict criminals, as well as the legal and environmental consequences of the illicit pangolin trade, as part of prioritizing attention to wildlife crime [see also CITES (2017b)]. This will be imperative to ensure an increase in successful conviction rates, and stronger penalties, which serve as meaningful deterrents. Zimbabwe is one leading example of the success of this (Shepherd *et al.*, 2016).
- Forensic techniques to identify the origin of pangolins and their derivatives in trade should continue to be developed to support law enforcement efforts and investigations into the trade chain [see also Challender *et al.*, (2014a), CITES (2017b)]. Countries making seizures should establish a forensics DNA protocol to ensure pangolin commodities seized can be identified to the species level. Such methods should be used more often in future pangolin seizures in order to assess better the threats to the different species of pangolin; particularly because of a potentially increasing threat to African pangolin species.

Monitoring and reporting

- CITES Management Authorities (MAs) in co-ordination with all relevant enforcement agencies in all countries involved in the illegal trade in pangolins, their parts and derivatives, should improve reporting of all seizures to the CITES Secretariat as per the new annual illegal trade reporting requirements i.e. CITES Notification 2016/007 (CITES 2016a). Recent changes to CITES reporting requirements (CITES 2016a, 2017a) should be considered and implemented in a standardized way, and data should be made available for statistical analysis and criminological research, to assist law enforcement and guide ongoing collection of data. Seizure reports, including comprehensive accounts of actions and outcomes, specifics of seizure and prosecution details are needed for analysis of a country's wildlife trade levels and trends, and, eventually, a better understanding of the international illegal wildlife trade.
- Monitoring and reporting on the trafficking of pangolins by CITES MAs, NGOs and independent researchers should continue, and be expanded to countries where information on the trade is lacking. Improved monitoring and reporting should be prioritized for: (i) commodity quantities; (ii) the specific roles of countries involved; and (iii) transport modalities used in pangolin shipments. Co-operation from transportation and logistics companies involved in movement (however unwittingly) of shipments along trade routes is also necessary; these companies are encouraged to share information on methods of concealment or trafficking, specific routes used, and other notable information to enable effective law enforcement investigations. These will assist in gauging levels of illegal trade, detecting emerging trends and influencing enforcement, conservation actions and decision-making.

Demand reduction and awareness

- Efforts should be increased to understand and reduce demand for pangolin products traded illegally in consumer countries, through increased awareness and well-informed and targeted behavioural change efforts (see also CITES (2017b), Challender *et al.*, (2014a) and IUCN (2016)). Efforts should include an improved analysis of the use of pangolin products being seized to meet certain types of demand in consumer countries. This would provide further insights into the targeted behaviour change initiatives required based on motivational variations amongst consumers.
- Law enforcement agencies, especially those in countries identified as priorities in this study, should ensure officers are aware of the significance and relative prevalence of the illegal pangolin trade, able to recognize pangolin products, and increase their vigilance to detect and intercept shipments (see also Challender *et al.*, (2014a) and CITES (2017b)).
- While the drivers of trade in Asia are largely known, the demand from priority countries outside Asian demand centres (particularly the US and the Netherlands) is poorly understood. Further studies by conservation organizations, research institutions and relevant government agencies are required to decipher what is driving the illegal trade into these countries, what commodities are being traded, and in what quantities. This will greatly assist in identifying the role of non-Asian countries as centres of demand for international pangolin trafficking. Targeted awareness or demand-reduction campaigns may also be warranted.



Pangolin scales weighing 136 kg seized at the Guangzhou Customs post offices in 2010.

INTRODUCTION

Overexploitation of wildlife is a major driver of current biodiversity loss (Hoffmann *et al.*, 2010; Maxwell *et al.*, 2016). This includes wildlife trade, both legal and illegal, which is largely regulated and monitored by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Illegal wildlife trade is highly unsustainable in many cases, and has major implications for a diverse range of species of animals and plants (Challender *et al.*, 2015b; Phelps and Webb 2015). It is estimated to be among the most lucrative transnational crimes, alongside trafficking in drugs, humans and weapons; and often involves highly organized criminal networks (Wyatt 2013; Nellemann *et al.*, 2016).

Pangolins are often cited as currently the most heavily trafficked wild mammals worldwide, with estimates of over one million animals taken from the wild between 2000–2013 (Challender *et al.*, 2014a). All parts of the pangolin's body, but particularly its scales, are used for a variety of purposes in traditional medicines or for ornamentation, their meat is consumed, both as a luxury dish and a local source of protein, and their skins are made into leather products (Bräutigam *et al.*, 1994; Sodeinde and Adedipe 1994; Katuwal *et al.*, 2013; Boakye *et al.*, 2014; Pietersen *et al.*, 2014b; Mohapatra *et al.*, 2015; Soewu and Sodeinde 2015; Shairp *et al.*, 2016). It is widely believed that pangolin trade is primarily driven by demand in Asian countries, especially China and Viet Nam (Pantel and Chin 2009; Challender 2011; Challender *et al.*, 2014a; Nijman *et al.*, 2016), although it has also been shown that demand exists in non-range countries, such as the United States of America (US), some European countries, and Japan (see e.g. Heinrich *et al.*, (2016)). With declines in populations of Asian pangolins, there is now evidence of fast-developing intercontinental trafficking of African pangolins to Asian markets, facilitated by increasing economic ties between East Asia and many African nations (Challender and Hywood 2012; Challender *et al.*, 2016; Gomez *et al.*, 2016b). Research has also shown an increase in regulated (legal) pangolin trade activity reported to CITES after the year 2000, particularly in African pangolin species, which coincided with the establishment of a zero export quota for commercial trade in wild-caught Asian pangolins (Heinrich *et al.*, 2016).

Eight extant pangolin species have been described¹ (Figure 1) and all are threatened according to The IUCN Red List of Threatened SpeciesTM—the four African species are listed as Vulnerable (Giant Pangolin *Manis gigantea* (Waterman *et al.*, 2014a); Ground Pangolin *M. temminckii* (Pietersen *et al.*, 2014a); Black-bellied Pangolin *M. tetradactyla* (Waterman *et al.*, 2014b); and White-bellied Pangolin *M. tricuspis* (Waterman *et al.*, 2014c)), whereas the four Asian species are listed as Critically Endangered (Chinese Pangolin *M. pentadactyla* (Challender *et al.*, 2014b); and Sunda Pangolin, *M. javanica* (Challender *et al.*, 2014c)), and Endangered (Philippine Pangolin *M. culionensis* (Lagrada *et al.*, 2014); and Indian Pangolin *M. crassicaudata* (Baillie *et al.*, 2014)). In addition, all pangolins were recently transferred from CITES Appendix II to Appendix I (CITES 2016b). This important step provides pangolins with the highest protection status through CITES, and prohibits international trade in wild-caught pangolins for commercial purposes globally.

¹ Note: The nomenclature used in this report follows Wilson and Reeder (2005), aligning with the nomenclature used in CITES and the Catalogue of Life. It is acknowledged that the IUCN Red List and other sources follow Gaudin *et al.* (2009), placing the species in three genera (*Smutsia*, *Phataginus*, and *Manis*).

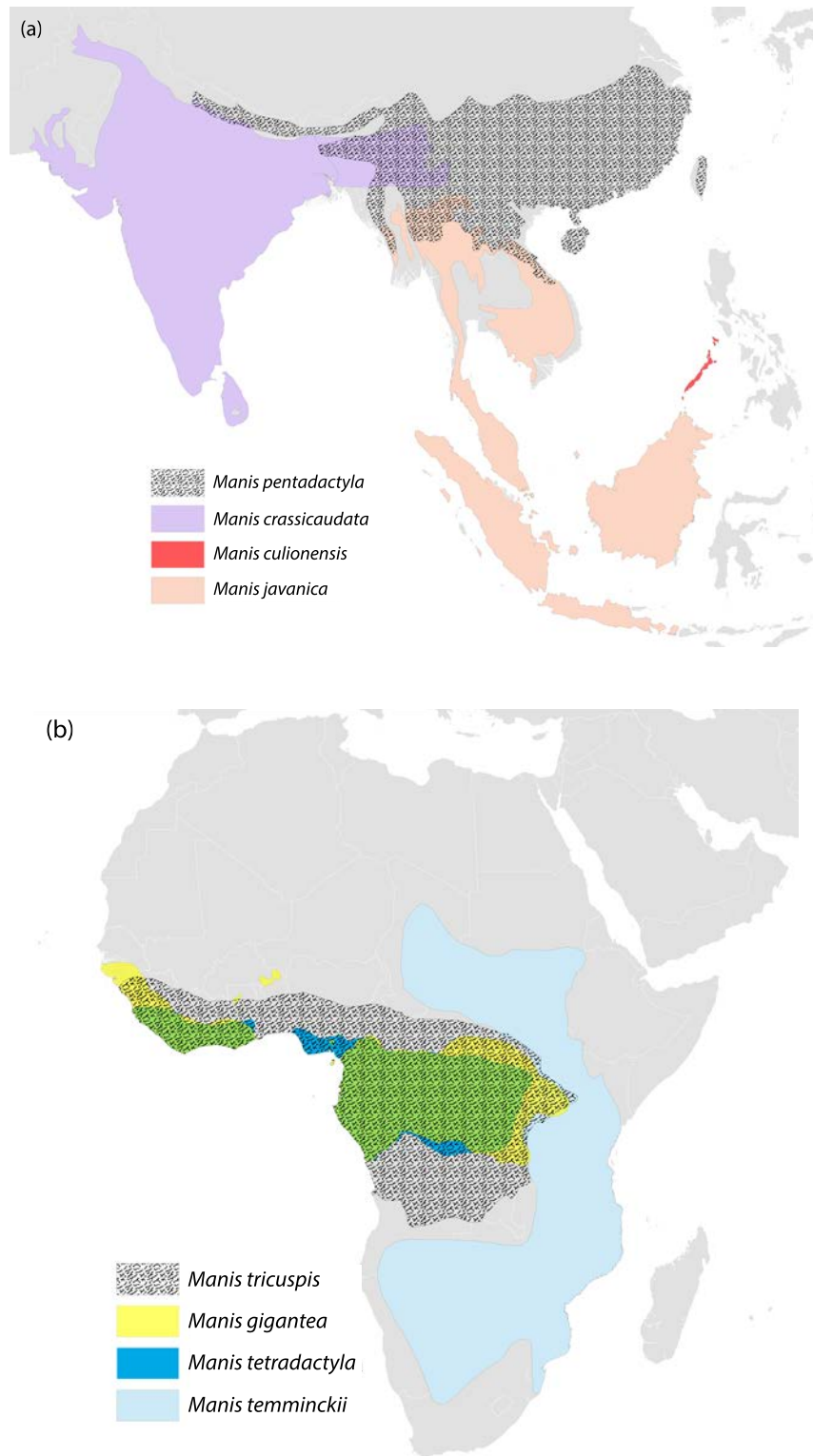


Figure 1: Species distribution maps of the eight extant pangolin species showing (a) the Asian species (b) the African species. A mix of colours within the maps indicates an overlap in the different species' distributions. The species' ranges are based on the IUCN Red List assessments (IUCN 2014).

Note: The distribution maps are currently being updated by the IUCN Pangolin Specialist Group.

Pangolin seizure data were collected from a variety of sources. Seizures are an indirect measure of actual trafficking levels and, across countries, seizure data are likely to be biased by a large number of complex factors (see also Underwood *et al.*, (2013), and Utermohlen and Baine (2017)). These factors will influence both the “level of enforcement” (i.e. corruption, environmental crime, lack of awareness) and “level of reporting” (i.e. non-English media, non-compliant enforcement, variation in the in-country activity of non-governmental organization (NGO) agencies). In addition, Customs authorities intercept an unknown percentage of all contraband. Consequently, the seizure incidents reported here are only a proportion of the total number of trafficking incidents worldwide. This is an inherent bias of all seizure data.

The purpose of this report is to determine trafficking routes for the illegal transnational pangolin trade and enhance knowledge of where pangolins are sourced from. This information can be used to understand better where demand exists, which is critically important to inform conservation action and decision-making, species management, and law enforcement efforts. Despite increasing attention on pangolins globally, a detailed understanding of international trafficking routes used in the illegal pangolin trade is largely lacking in the existing literature. Some studies have partially described illegal pangolin trade dynamics, but they have always focussed on specific regions or countries, and mostly Asia (Challender *et al.*, 2015a; Gomez *et al.*, 2016a; Nijman *et al.*, 2016; Cheng *et al.*, 2017; Zhang *et al.*, 2017). To the authors’ knowledge this is the first study to describe the international trafficking routes for pangolins on a global scale



A ground pangolin

METHODS

Pangolin seizure data were collated for the period 2010–2015 from a variety of sources, including online media reports, openly accessible data from CITES documents from the CITES website (it should be noted that legal pangolin trade reported to CITES has been previously analysed in Heinrich *et al.*, (2016); whereas only illegal incidents were used for this study, hence the legal CITES trade database was *not* queried), and from NGO publications, including Education for Nature Viet Nam (ENV), the *TRAFFIC Bulletin*, and Last Great Ape Organization (LAGA) annual reports. Additional data were received from the African Pangolin Working Group (APWG; Namibia only) and the EAGLE Network. Datasets previously collated by Dan Challender (data from 2010–2013), and TRAFFIC (2010–2015) were also included. In addition, data were received from Healthmap (www.healthmap.org; 2011–2015) and the Environmental Investigation Agency (EIA; 2010–2015). Data from the European Union Trade in Wildlife Information eXchange (EU-TWIX) database (for data from Europe; 2010–2015) were included, as well as data from the Law Enforcement Management Information System (LEMIS; 2010–2014) for the US.

Seizure data were requested from 179 CITES Management Authorities (CITES MAs). Data requests to the CITES MAs were sent via email in September 2016 and, where no initial response was received, a follow up request was sent in October 2016 (with the exception of Syria). Four MAs were not contacted: the European Union was not contacted as all member countries were contacted individually; Panama and Tonga could not be contacted with the details provided on the CITES webpage, nor through the relevant national departmental webpages; and Liechtenstein was not contacted as it shares a Customs union with Switzerland. New Zealand provided data (from 2010–2016, 67 seizure incidents), but were unable to assign any of the incidents to specific years, and were excluded from further analysis. Furthermore, while Hong Kong Special Administrative Region (SAR) is a territory of China, data are provided separately through their respective CITES MAs, and therefore data from each source has been kept separate for the purpose of this study. Reference to China in the Results and Discussion sections of this study is to mainland China only and does not include data from Hong Kong SAR, Macao SAR, nor Taiwan.

All available seizure data were collated into a bespoke SQL database (Microsoft Access). The data were collected based on seizure events pertaining to a particular seizure location, hereafter referred to as an “incident”. Information collected for each incident included, but was not limited to: (i) location and date of seizure; (ii) species, commodities and quantities seized; (iii) transport mode; and (iv) trade route information (i.e. links between origin, transit and destination countries or territories), where available. In some cases an incident consisted of more than one trade route (e.g. when more than one origin or destination location were reported, i.e. if a shipment of pangolins was seized in an Asian country or territory, but the commodities that made up the shipment originated from two different African countries). When curating the trade route information for each incident, an “origin country” was defined as the first known point, and a “destination country” as the last known point in any trade route. All reported countries and territories in-between were designated as transit countries. The country or territory of seizure could occur at any point along the trade route, and could be an origin, transit or destination country or territory, as reported.

All data were subset to only include: (i) verified incidents (i.e. those that were either provided by restricted access sources or where open access sources could be independently verified online); and (ii) international incidents (i.e. trade routes crossing at least one international border, and excluding all domestic trade links). It is acknowledged that this potentially precludes incidents that were supposed to be exported but were intercepted before reportedly crossing an international border.

Commodities were grouped into three categories, namely: (i) “Scales” (including only scales); (ii) “Whole animals” (including whole animals that were either live, dead, or whole but uncertain of their condition); and (iii) “Body Parts” (including all other commodities and medicinals, i.e. legs, claws, skins, and undefined raw or processed products). Three rules were constructed in order to assign a home continent (Africa or Asia) to the pangolins traded. First, if the pangolin species was reported in the incident, it was assigned its respective native home continent; secondly, if the commodity source country or territory was reported (this being the actual source country or territory where the trafficked pangolins originated) it was assigned to the home continent of that source country or territory; and thirdly, the trade flow between continents was used to assign a home continent. If the home continent differed from the destination continent (intercontinental trade) the origin was assumed to be the home continent of the pangolins being traded. A conservative approach was adopted and a home continent was not assigned where only intracontinental trade occurred. The modes of transport were grouped into: (i) “Air” for transport by plane; (ii) “Sea” for transport by boat; (iii) “Land”, including transport by car, bus, and similar vehicles, or by train and foot; and (iv) “Unknown”, where none of the above transport modes was reported.

As part of the data collection, the reported quantities of pangolins trafficked, or their parts/derivatives, per incident was also recorded. Quantities of seized commodities, where this information was reported, were provided either in count or weight. The reported weight was reported in grammes, kilogrammes (kg) or tonnes, and was converted into kg during the data curation process. The quantities reported in counts were provided in various units, e.g. cups, individual number of specimens, bags, packages, boxes, vials and pills, and were maintained as reported. It is important to note that quantitative information was not available for every incident, and non-quantitative information, including qualitative information (e.g. “hundreds of animals”, “bags of scales” etc.), was not included in further analysis. For the international incidents subset of the dataset, scales with a known weight quantity were reported in 244 records (86.9% of records), whole animals with a count were reported in 177 records (86.4%), and body parts with a count were reported in 149 records (87.9%).

All data analyses were conducted in the R environment (R Studio, version 3.3.2) for statistical and graphical computing (R Core Team 2016). The visualisation of the maps was conducted in ArcGIS (ArcMap, version 10.3.1).

A circle network diagram was constructed representing the frequency of trade flow between the countries or territories involved in illegal pangolin trade from 2010–2015; including the direct links (edges) between two countries or territories (nodes) in a trade route using the R package “igraph” (Csardi and Nepusz 2006). The directional trade arrows (edges) were weighted by the natural logarithm of the total number of links between exporter and importer, while the size of the pie charts (nodes) were weighted by the natural logarithm of the total number of incidents the country or territory was involved in. The displayed countries or territories were classified as: (1) within the native range of Asian pangolin species; (2) within the native range of African pangolin species; or (3) outside the native range of any pangolin species (non-range countries).

To visualize the most commonly used trade routes, trade routes that occurred in five incidents or more were identified. The directional trade arrows were weighted by the normalized number of incidents that a particular trade route was used in. The intercontinental trade flow map was constructed in a similar way, by summing the trade route edges between continents. For each of the commodity categories, the quantity was summed per trade route and a “large-quantity shipment” was defined to consist of 1000 kg or more for scales, at least 100 body parts, and 500 whole animals or more. The top trade routes for each commodity category were visualized in a similar manner to the top commonly used trade routes, although the size of the directional trade arrows was unweighted.

A generalized linear model (glm) was used to test for a change in the number of incidents, and in the number of countries involved in the international pangolin trafficking through time, as well as large-quantity shipments for the three different commodity categories. A glm was also used to test for a change in the weight and number of incidents of large-quantity shipments of scales. Contingency-type frequency tests were used to assess and visualise the independence of categorical variables (commodity, transport mode, and home continent) (Zeileis *et al.*, 2007; Meyer *et al.*, 2016). Wald Chi-square tests for independence ($\alpha = 0.05$) were used to evaluate the homogeneity of frequencies. The relative proportion of occurrences of each category within the variables, commodity type and home continent, were calculated through time.



African pangolin scales weighing 320 kg seized off the coast of Hong Kong in October 2013

RESULTS

Seizure summary

A total of 1270 seizure incidents were recorded from the period 2010–2015. Seizure incidents have been reported consistently through time, with an average of 212 incidents per year (estimate = -3.2 , Standard Error (SE) = 6.125 ; $t = -0.522$, $p = 0.629$; Figure 2). The illegal trade involved 67 countries or territories across all continents, except Antarctica (Figure 3).

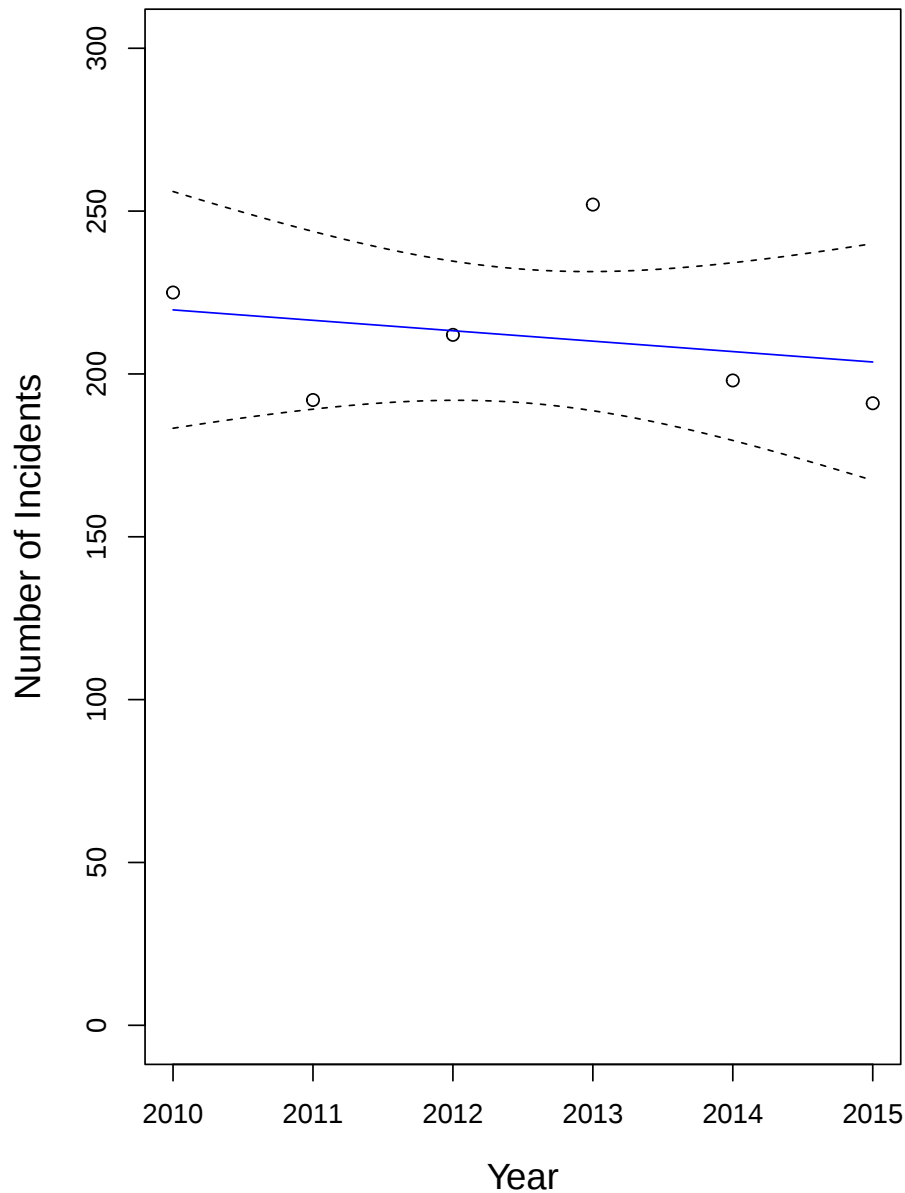


Figure 2: Total number of pangolin (*Manis* spp.) seizure incidents through time from 2010–2015, based on all available data ($n = 1270$ incidents).

Of the 1270 seizure incidents, 117 included multiple commodities (e.g. when scales and live animals were seized in the same incident), and the quantity of each commodity was recorded separately (hereafter referred to as a “record”). In total there were 1387 records, of which 105 did not contain quantitative information (7.6%). The quantities of the remaining records are provided in Table 1.

Table 1: Seized quantities of pangolin (*Manis* spp.) commodities, excluding records with no or only qualitative information on quantities (n = 1282).²

Commodity	Quantities		Number of records + (missing quantitative information %)
	Count (number of items)	Weight (kg)	
Body parts	7154	20 749.11	209 (16.27)
Scales	5613	55 251.09	432 (10.4)
Whole	46 760	44 474.60	746 (3.5)

Prominent examples of “whole” animals included the seizure of 8.5 tonnes of dead pangolins along with 350 kg of pangolin scales in Jakarta (Indonesia) in November 2012; or the seizure of 2764 pangolin carcasses hidden in cooling boxes and weighing a total of 11.5 tonnes in September 2015 in China’s Guangdong Province. The seizure of an estimated 10 tonnes of dead pangolins from a boat, which ran aground on a protected coral reef in Palawan (Philippines) in April 2013, marks one of the biggest confiscations of seized whole animals during the study period. Additionally, the seizures of 7.45 tonnes of pangolin meat along with 64.6 kg of scales in Indonesia on its way to Viet Nam, and the seizure of 3000 undefined medicinals in the US, which were imported from Viet Nam, are among the biggest seizures for “Body parts”.



A seizure of 249 kg of pangolin scales discovered in nine suitcases at Shanghai port in 2015

² Commodity quantities were not always reported in the same measure, hence the sum of the quantities per commodity for each measure is presented in weight (kg) and count (number of items of individuals, scales or body parts). The two measures are independent, i.e. each record only contains one measure, being either count or weight.

International trafficking

The top 10 countries or territories involved in illegal international pangolin trade, based on the number of incidents they were involved in, and regardless of their role in the trade route (i.e. origin, transit, or destination), are provided in Table 2 and Figure 4, along with the traded quantities associated with the most commonly implicated countries. Commodities were reported in weight (kg) or count (individual number of items per commodity). The number of items represents the number of scales, body parts or whole animals; e.g. the count would represent the number of individual scales that were seized, or the number of individual body parts.

Table 2: Top 10 countries or territories ranked by the total number of international trafficking incidents of pangolin (*Manis* spp.) in which they were involved, regardless of their role in the trade route (i.e. origin, transit, destination, or seizure country).³

Rank	Country/ Territory	Number of incidents	Commodity Quantities					
			Scales		Body parts		Whole	
			Weight (kg)	Count (number of items)	Weight (kg)	Count (number of items)	Weight (kg)	Count (number of items)
1	China	342	16 291	474	2290.4	1444	6407.5	15 764
2	US	127	1.4	417	5.1	6662	-	15
3	Viet Nam	90	7487	-	2119.1	5828	19 125.3	10 490
4	Malaysia	60	10 534.3	-	-	-	5061	8460
5	Hong Kong SAR	57	7147.6	10	-	2	600	157
6	Thailand	56	1222.2	7	-	103	61	3608
7	Lao PDR	44	1914	16	-	48	61	2565
8	Nigeria	41	6372.7	71	26.2	-	10.4	-
9	Indonesia	40	4103.4	-	-	1	45 140.3	8070
10	Germany	38	666.5	71	26.2	11	-	1

Relative to the other countries or territories, mainland China was by far the most heavily involved, in terms of number of incidents, followed by the US. However, the overall quantities traded were far less in the US compared to China or countries involved in fewer trafficking incidents, such as Indonesia, or Nigeria (see Table 2 and Figure 4). The same applies for other countries or territories that are not listed in Table 2. Additional countries that were involved in high quantities of trafficked pangolins and their parts and derivatives were Uganda, Cameroon, Myanmar, India, the Philippines, Singapore, Pakistan, and the Netherlands (see also Figure 10).

³ The countries or territories have been ranked, where the highest ranked country (rank = 1) is the country or territory that was involved in the most international incidents relative to other countries or territories in the available data (n = 539 incidents). The trafficked commodities and their corresponding quantities per country are also shown. Commodity quantities were not always reported in the same measure, hence the sum of the quantities per commodity for each measure is presented in weight (kg) and count (number of items of individuals, scales or body parts). The two measures are independent, i.e. each record only contains one measure, being either count or weight.

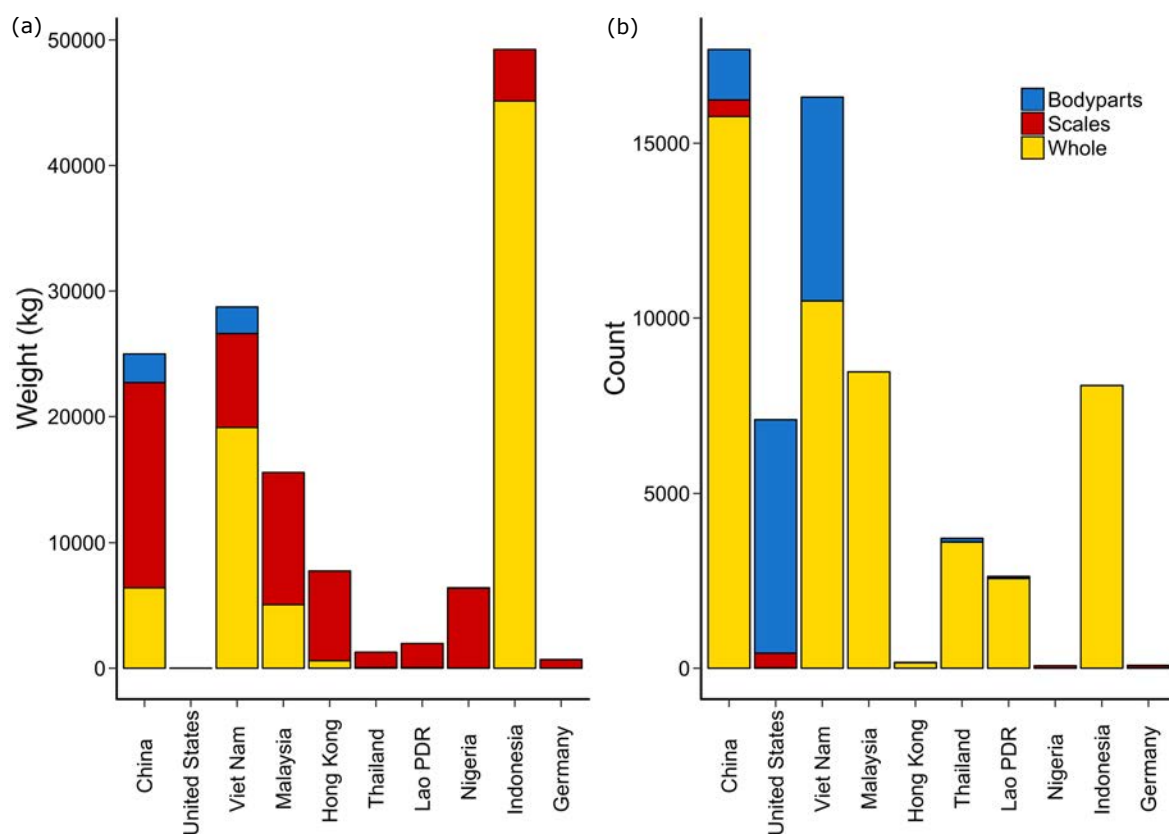


Figure 4: Trafficked quantities of pangolins (*Manis* spp.) and their products showing: (a) the weight in kg; and (b) the count (number of items of individuals, scales or body parts). The quantities are shown for the top ten countries/territories involved in the most incidents of pangolin trafficking. Countries/territories are ordered by their involvement in trafficking, starting on the lefthand side with the country most involved. Note that the two quantity measures are independent, i.e. each record only contains one measure, being either count or weight.

Notably, Nigeria, Lao People's Democratic Republic (Lao PDR), and Hong Kong SAR were ranked in the top 10 countries or territories involved in the most pangolin trafficking incidents, they were not, however, ranked within the top 10 countries or territories where seizures occurred (Figure 5, and Table S1). Other countries with a high discrepancy between the number of incidents they were involved in (≥ 5) in pangolin trafficking and the number of seizures (≤ 3) that occurred in these countries were Lao PDR, Nigeria, Myanmar, Cameroon, Guinea, Mexico, the Philippines, Pakistan, Liberia, Equatorial Guinea, Côte d'Ivoire, Ethiopia, Kenya, Singapore, Mozambique, Uganda, and Togo.

In terms of number of incidents a country was involved in, African countries mostly served as origin countries, most notably Nigeria, Cameroon, Guinea, Liberia, Equatorial Guinea, Côte d'Ivoire, Kenya, Ethiopia, Mozambique, Uganda, and Togo (in descending order), as they were all involved in five or more incidents. Of the Asian range countries or territories involved, China, Viet Nam, Indonesia, Hong Kong SAR, Malaysia, India, Thailand, and Myanmar were origin countries in 20 or more incidents. The major destination countries in Asia were China, Viet Nam, Malaysia, and Thailand, with 15 or more incidents, and Lao PDR, Thailand, Viet Nam, and Myanmar served as the major inner Asian transit countries, with nine incidents or more. In Africa, several countries were involved in five or more incidents, but no seizures were recorded to have occurred, for example in Nigeria, Equatorial Guinea, Liberia, Guinea, Côte d'Ivoire, and Ethiopia (Figure 5, and Table S1).

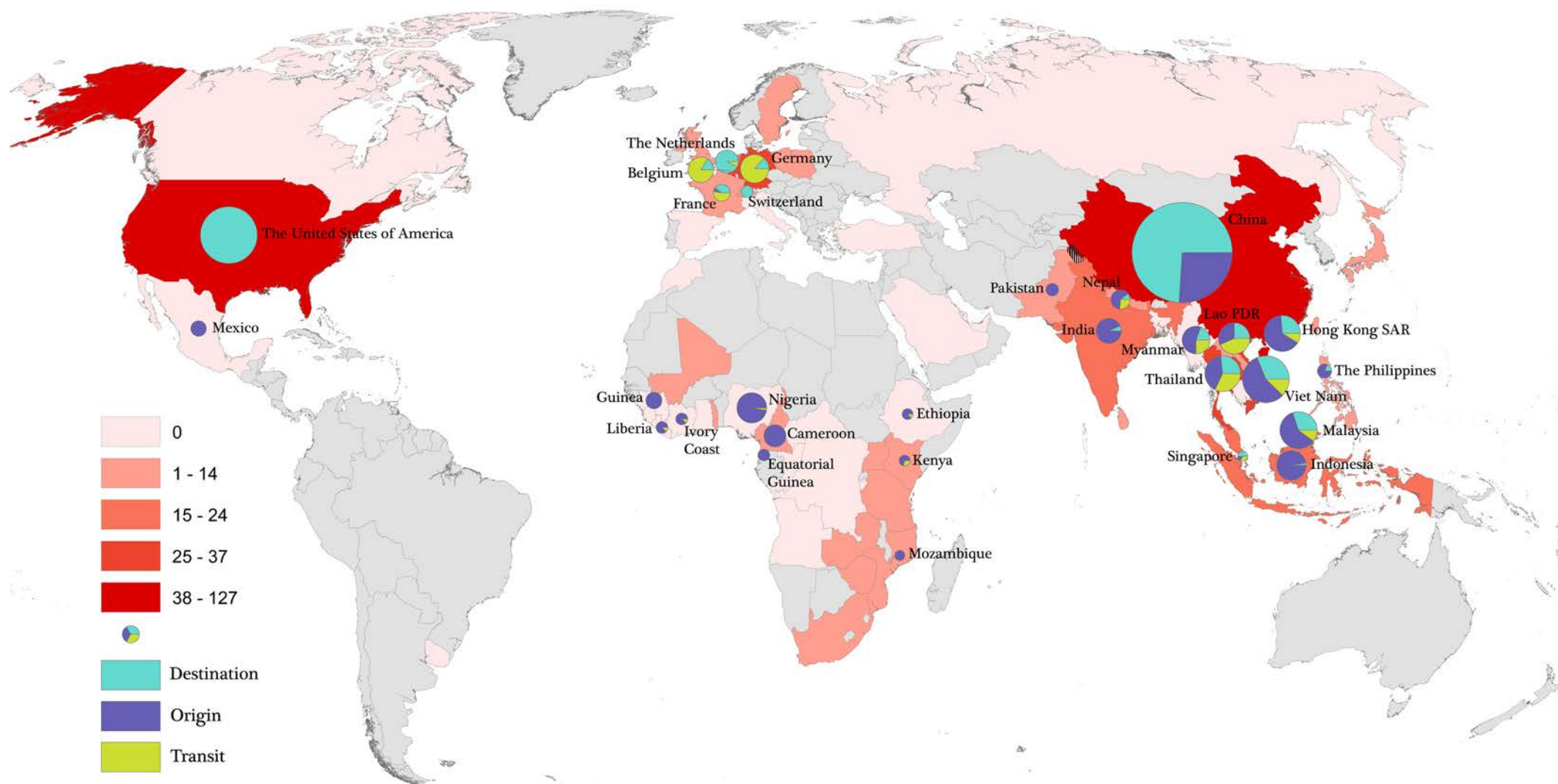


Figure 5: Countries or territories involved in pangolin (*Manis* spp.) trafficking incidents between 2010 and 2015 based on the available data of verified international incidents (n = 539). The shading of the countries or territories (light to dark) reflects the number of seizures that took place in these locations. The country or territory of seizure could occur at any point along the trade chain, and could be an origin, transit or destination country/territory. For all countries or territories involved in more than five incidents (regardless of the location role), the pie chart indicates the relative proportion of the number of incidents a country or territory was involved in for each role. The size of the pie charts is weighted by the total number of incidents a country or territory was involved in (across all location roles).

For international incidents, 539 records out of 570 contained quantitative information. Of these, 55% contained count information (number), and 45% contained weight information.

Of all records involving scales, 10 records involved large-quantity shipments of scales (i.e. ≥ 1000 kg). The sum of the scale weights across these 10 records constituted 60% of the weight across all records involving scales.

The proportion of large-quantity shipments containing scales has increased significantly through time (Figure 6a: estimate = 0.65, SE = 0.27, $z = 2.43$, $p = 0.015$). This proportional increase cannot simply be explained by the number of very small shipments (less than 1 kg) decreasing through time (Figure 6b: estimate = 0.56, SE = 0.27, $z = 2.08$, $p = 0.038$), as shown in Figure 6.

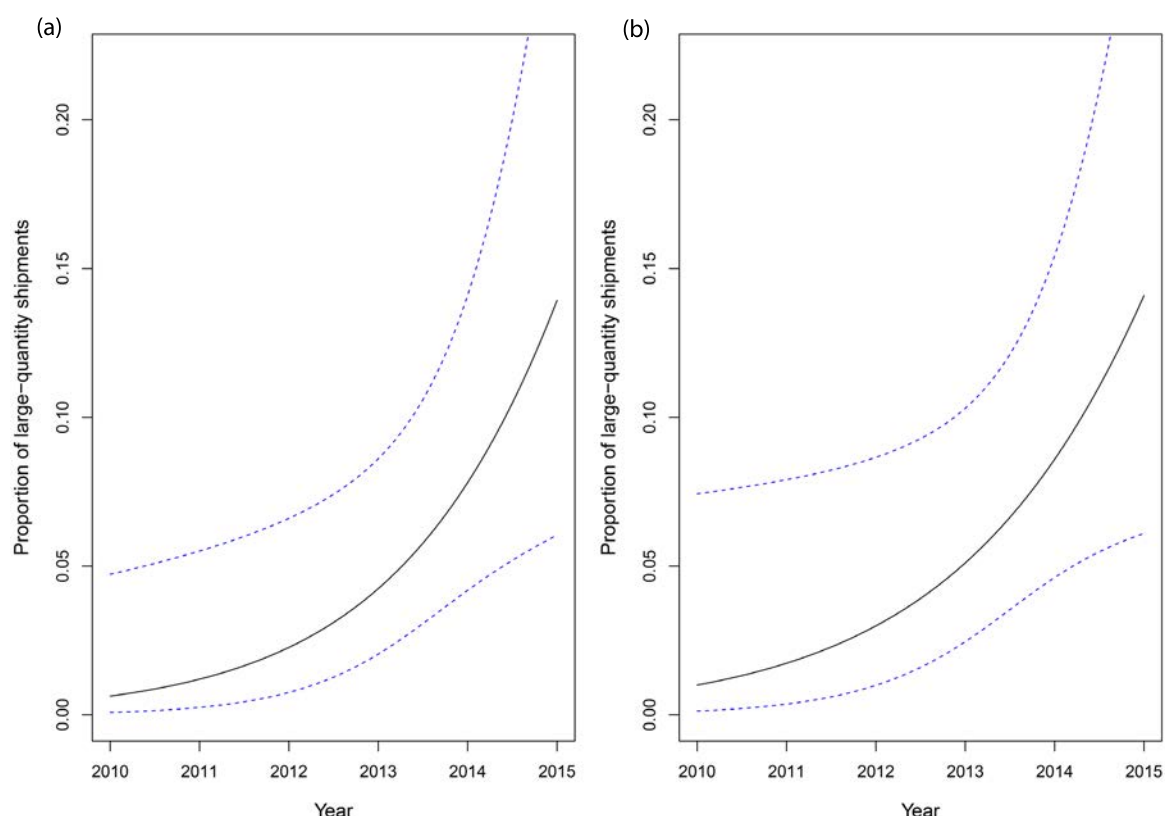


Figure 6: Proportional increase of large-quantity shipments of scales (i.e. ≥ 1000 kg): (a) with all seizures of scales, and (b) without “small” seizures of scales involving less than 1 kg. It is important to note that the significant increase in the proportion of large-quantity shipments through time is not simply due to a change in the frequency of “small” seizures of scales.

However, the proportion of large-quantity shipments of body parts measured as a count (i.e. ≥ 100 body parts; estimate = -0.62 , SE = 0.41 , $z = -1.52$, $p = 0.13$), and the proportion of large-quantity shipments for whole animals measured in count (i.e. ≥ 500 animals; estimate = -2.9 , SE = 0.23 , $z = -1.25$, $p = 0.21$) has not increased significantly through time. The eight large-quantity shipments of body parts (≥ 100 body parts) and the eight large-quantity shipments of whole animals (≥ 500 animals), made up 85% and 69% of the quantity of all shipments of body parts and whole animals respectively (both measured in count).

There was, however, a highly significant increase in the size of the shipments of scales (measured in kg) through time (Figure 7a: estimate = 0.24 , SE = 0.04 , $t = 5.41$, $p < 0.001$). This result was partly affected by “small” seizures of scales declining through time, but the positive trend was still statistically significant (Figure 7b: estimate = 0.1 , SE = 0.04 , $t = 2.85$, $p = 0.005$).

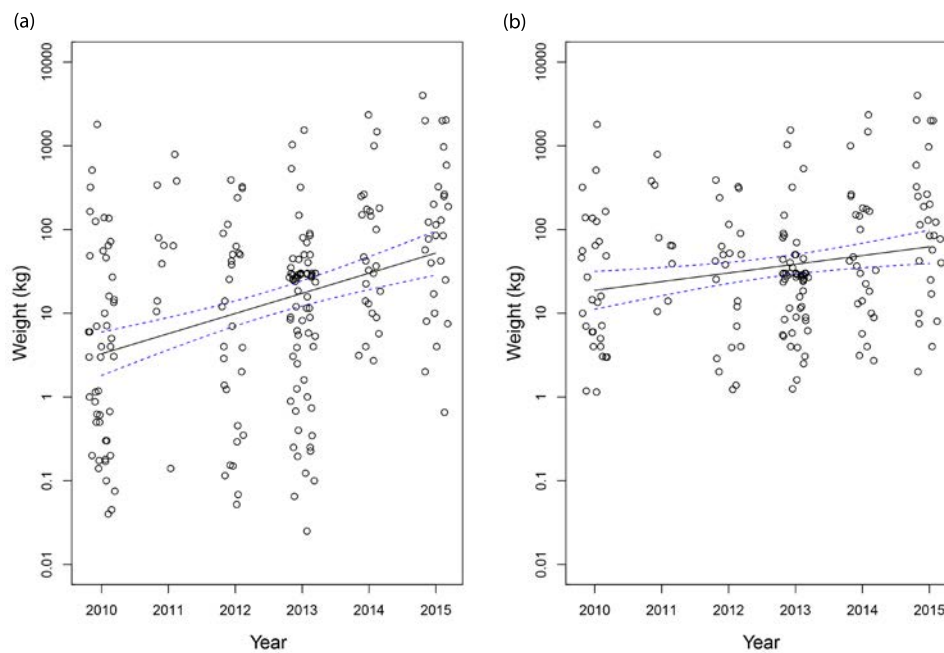


Figure 7: Scale weight (kg) through time: (a) Scale weight of all available records; (b) Scale weight excluding “small” records (i.e. less than 1 kg).



© <http://www.customs.gov.hk/>

Seizure of pangolin scales at Kwai Chung Customhouse Cargo Examination Compound in 2014

Trafficking routes

A total of 159 unique international trade routes were identified (recognizing it is difficult to be certain that *complete* trade routes have been documented) and it was found that 29 of these have been used at least five times during the study period (Figure 8).

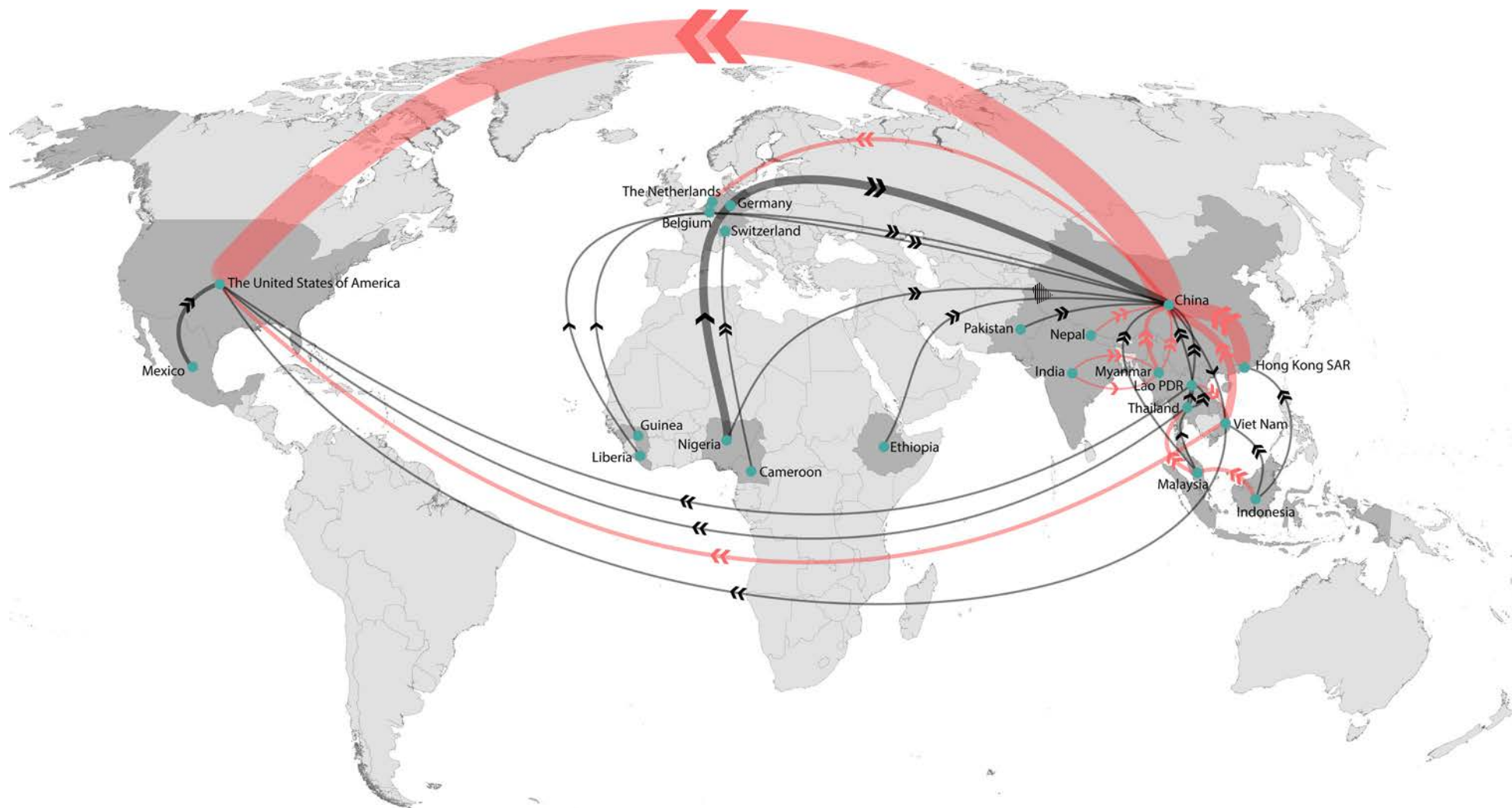


Figure 8: The top 29 trade routes that have been used five times or more in international pangolin (*Manis* spp.) trafficking incidents between 2010 and 2015 (n = 539). The directional arrows (edges) are weighted by the normalized total number of incidents occurring along each unique trade route. The 12 trade routes that have also been used in five or six consecutive years are displayed in red. Single arrow heads (>) indicate a transit edge in a trade route, and double arrow heads (>>) indicate the last edge in the trade route. Note: The start and end points of a trade route have been approximately centralized per country/territory and do not indicate a specific location within it a country.

Based on the most commonly used unique trade routes (Figure 8), and the overall involvement of the different countries or territories (number of trafficking incidents, not quantities traded) (Table 2), the top two destination countries were China and the US. The US was a major destination country, receiving shipments almost exclusively from Asian countries (54 times directly from China, and six times from China via Viet Nam). Mexico was the only non-Asian country (within the top trade routes) exporting directly to the US, a trade route that has been detected 13 times. The US was never an exporting or transit country, but always a destination (see Figure 8).

China was the major destination of pangolin products, relative to other countries. Based on the 29 trade routes relating to China, the most commonly used direct trade route was between Hong Kong SAR and China, which was used 36 times. China was also a destination for pangolins from other Asian countries/territories, most notably Viet Nam (28 times) and Myanmar (28 times; 10 of these seizures originating from India), but also directly from African countries, e.g. Nigeria (five times) and Ethiopia (six times), or indirectly from African countries via Europe (44 times; see Figure 8).

Of all European countries involved in the top 29 trade routes, only the Netherlands and Switzerland were destinations for pangolins and their products. The Netherlands was a destination for 18 shipments from China, whereas five shipments from Cameroon were destined for Switzerland. The other European countries, Germany and Belgium, were transit countries (Figure 8).

The trade routes that were used in at least five years of the study period were mostly within Asia, but also from China and Viet Nam to the US, as well as from China to the Netherlands (Figure 8). It also appears that some trade routes, which were used in a large number of incidents, such as the trade route Nigeria → Germany → China, have not been used consistently through time, but only for short periods; i.e. less than five years (Figure 8). On average, 27 new unique trade routes were formed each year (SE = 3.19), i.e. trade routes that had not occurred or been reported in any of the previous years (Figure 9).

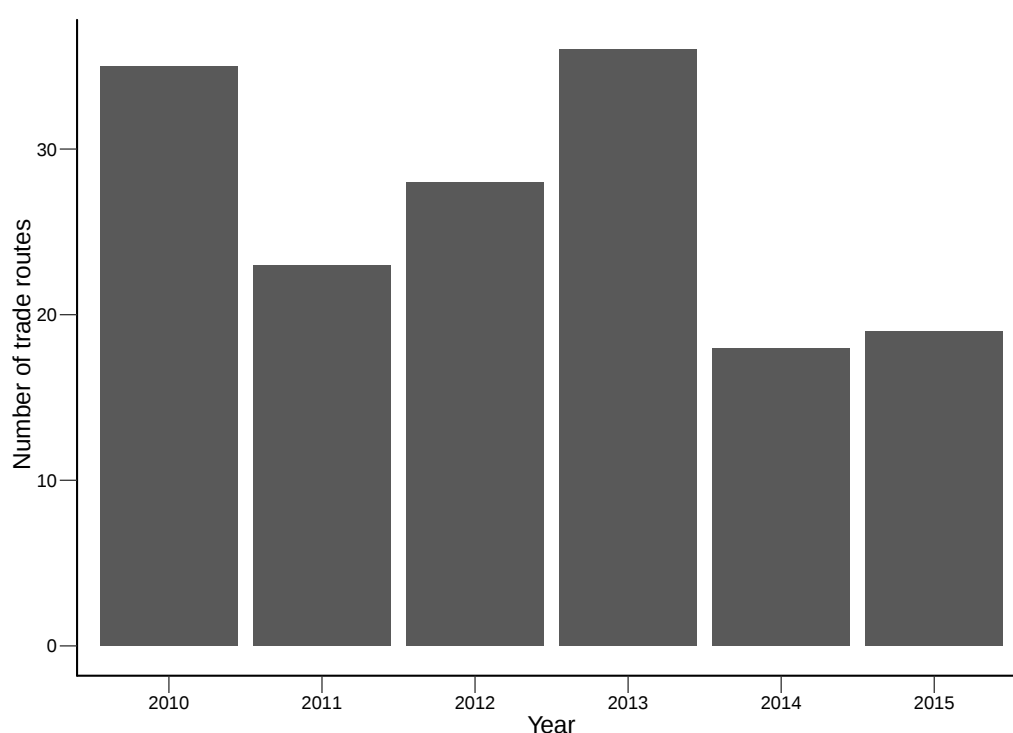


Figure 9: Newly detected pangolin (*Manis* spp.) trafficking routes that had not been detected in any of the previous years through time, based on available data of international incidents (n = 539) during the study period 2010–2015.

The top trade routes for large quantities of pangolin commodities varied slightly in comparison to the top trade routes in terms of number of incidents.

- The largest quantities of body parts were trafficked almost exclusively from China and Viet Nam (80%), with the exception of the trade route Guinea → Thailand → US, and all large-quantity body part shipments were destined almost exclusively for the US, with the exception of the trade route China → Netherlands (Figure 10).

- Large-quantity shipments of whole animals were trafficked only within Asia, and 55% of these shipments were destined for China. Other destination countries for large-quantity shipments of whole animals were Malaysia, Viet Nam, Thailand, and Singapore. Most of the large-quantity whole animal shipments originated in Indonesia (36%), and Malaysia (36%).

- Of the largest shipments of scales, 55% originated in African countries, namely Sierra Leone, Nigeria, Cameroon, and Uganda. The top destination for these large-quantity shipments of scales was China (64%). Apart from the US, The Netherlands was the only non-range country that received large-quantity shipments—scales from Uganda, and body parts from China (Figure 10).



Thai Customs seized 97 live pangolins that were being smuggled in from a neighbouring country in September 2011.

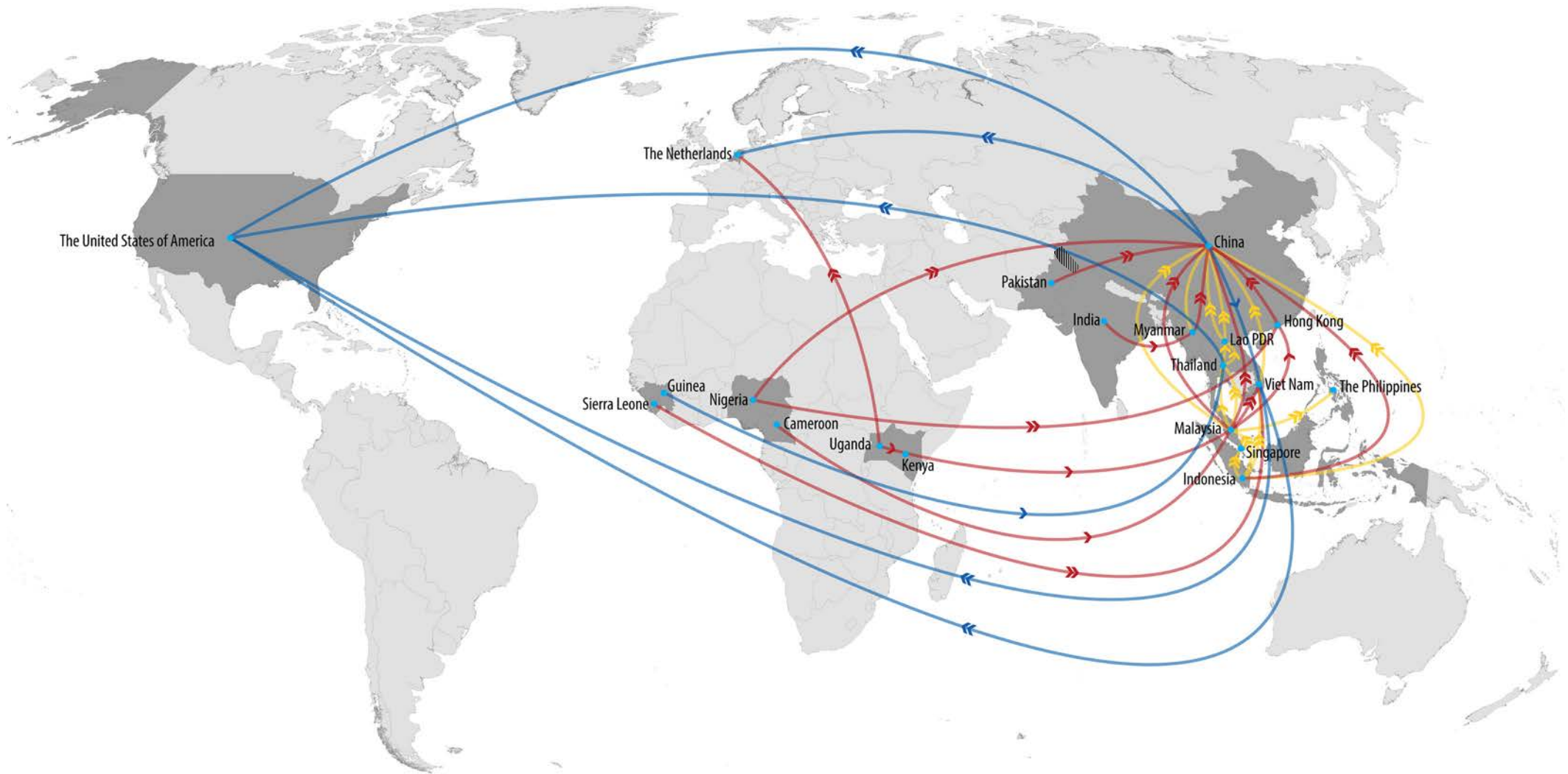


Figure 10: The top trade routes used for large-quantity shipments of pangolins (*Manis* spp.), based on the available data of international incidents with quantitative information. Trade routes for body parts are depicted in blue (sum ≥ 100 body parts), for scales in red (sum ≥ 1000 kg), for whole animals in yellow (sum ≥ 500 animals). Large-quantity shipments are weighted equally (using the same line thickness) across the three different commodities. Single arrow heads (>) indicate a transit edge in a trade route, and double arrow heads (>>) indicate the last edge in the trade route. Note: The start and end points of a trade route have been approximately centralized per country/territory and do not indicate a specific location within it a country.

An average of 33 countries or territories (SE = 2.372) were involved in international pangolin trafficking per year. The overall number of countries or territories (estimate = 0.66, SE = 1.52, $t = 0.43$, $p = 0.69$), as well as the number of African countries (estimate = 1.06, SE = 0.85, $t = 1.25$, $p = 0.28$) involved in international pangolin trafficking increased slightly through time, although this increase was not statistically significant (Figure 11).

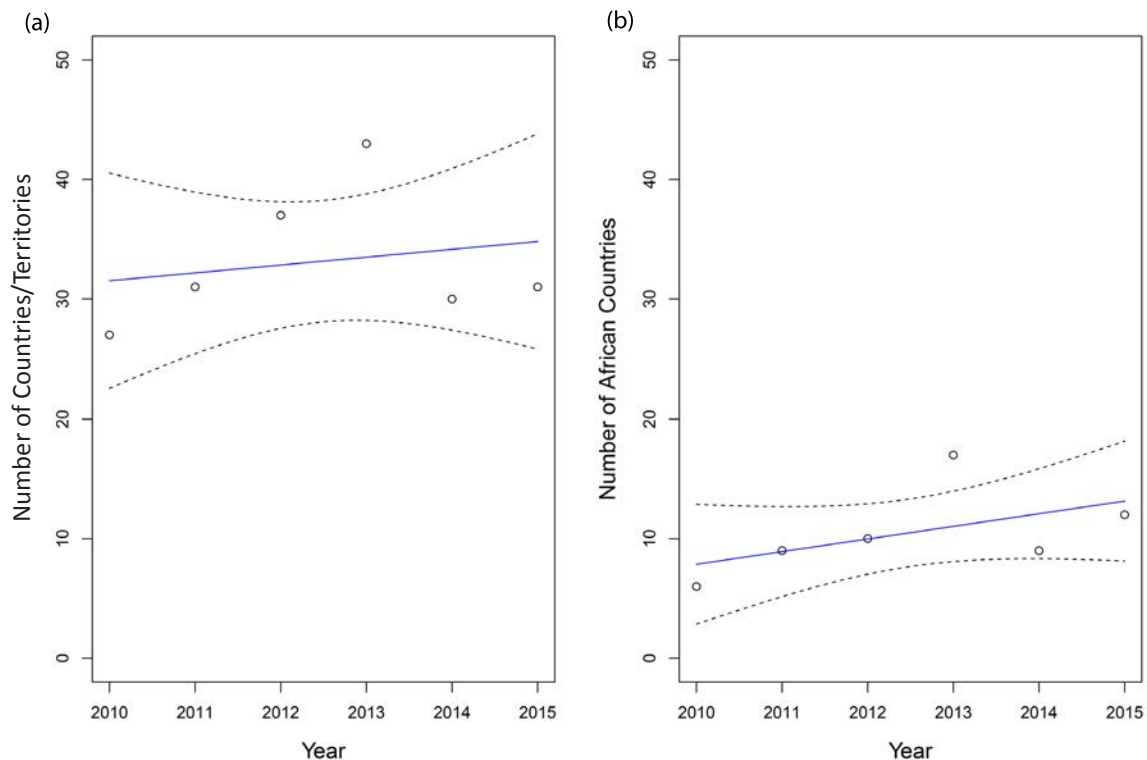


Figure 11: (a) Number of all countries or territories involved in verified international pangolin trafficking through time from 2010–2015 (n = 539 incidents), and (b) Number of African countries involved in verified international pangolin trafficking through time from 2010–2015 (n = 539).

African countries also exported pangolins and their products primarily to Asia via Europe (44% of the trade coming from African countries), directly to Asia (33%), to Europe (14%), to North America directly (7%) or to North America via Asia (2%) (Figure 12). The biggest proportion of the trade consisted of intra-continental trade within Asia (45.9% of the total trade), while 17.5% of the total trade voyaged from Asia to North America (specifically only to the US). Trade also occurred from Asia to Europe (6.7%) and interestingly also from Asia via Europe to Africa and from Asia via Europe to South America (although each of these two trade routes were only recorded once in the timeframe and available data studied here; see Figure 12).

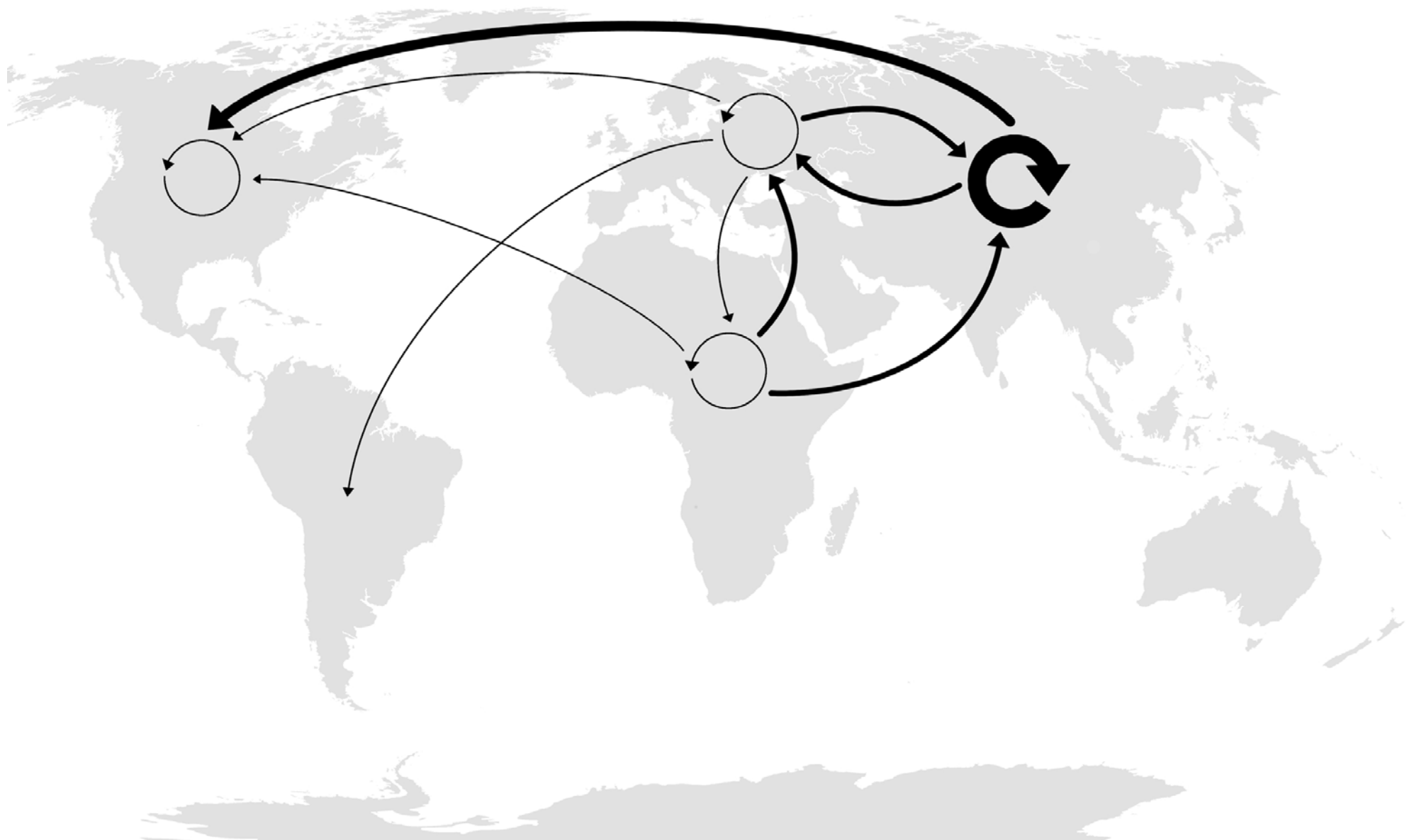


Figure 12: The intercontinental trade flow in international pangolin (*Manis* spp.) trafficking incidents between 2010 and 2015 (n = 539). The arrows and circles are weighted by the normalized number of links between continents. The arrows represent the directional intercontinental trade flow, while the circles display the intra-continental trade.

The most common (≥ 5) direct trade links (exporter to importer) between countries are identified in the network below (Figure 13). China and the US were the major players in the network, acting primarily as importing countries (and in the case of the US, entirely importing). Furthermore, Viet Nam, Malaysia, Thailand, Lao PDR, Hong Kong SAR, Myanmar, and Indonesia were important links in the network. Of the African range countries, Nigeria and Cameroon, followed by Guinea, stand out (see Figure 13). Notably, these African countries are also among the origin countries for large-quantity shipments (see Figure 10).

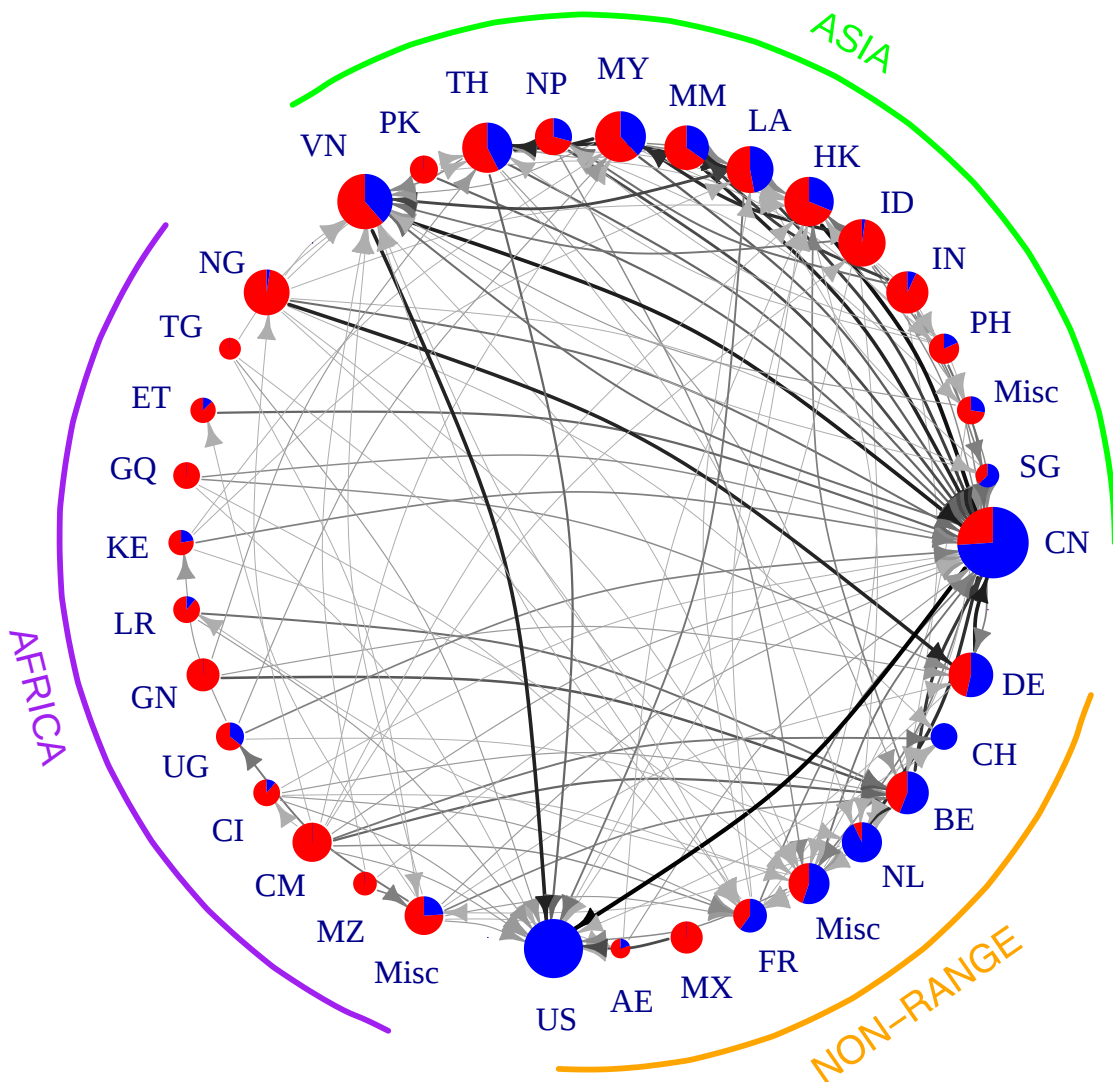


Figure 13: International pangolin (*Manis* spp.) trafficking network based on direct trade links between exporter and importer countries or territories from 2010–2015, regardless of complete trade routes. The thickness of the directional trade arrows (edges) and the size of the nodes (and the coloured pie charts, with blue for imports and red for exports) are natural log transformed and are weighed by the number of links between an exporter and an importer, and the total number of incidents a specific country or territory was involved in respectively. The countries or territories are displayed as: (1) within the native range of Asian pangolin species; (2) within the native range of African species; or (3) outside the native range of any pangolin species (non-range countries). Refer to “Abbreviations and Acronyms” for corresponding country or territory names associated with each ISO country or territory code. Miscellaneous (“Misc”) includes countries involved in less than four incidents.

Contingency type analysis of African and Asian pangolin trade revealed that the modes of transport and commodities traded were different for the different species (Figure 14). African pangolins were significantly more likely to be transported by air, and to be in the form of scales, relative to Asian pangolins and other modes of transport. African pangolins were also comparatively significantly less likely to be transported by land, to be whole animals or in the form of body parts. Alternately, Asian pangolins were significantly more likely to be body parts, which can potentially be attributed to the high number of incidents in which undefined medicinals were traded. Asian pangolins were also less likely to be transported by air, but this may be due to a large proportion of unknown transport modes for Asian pangolins (see Figure 14).

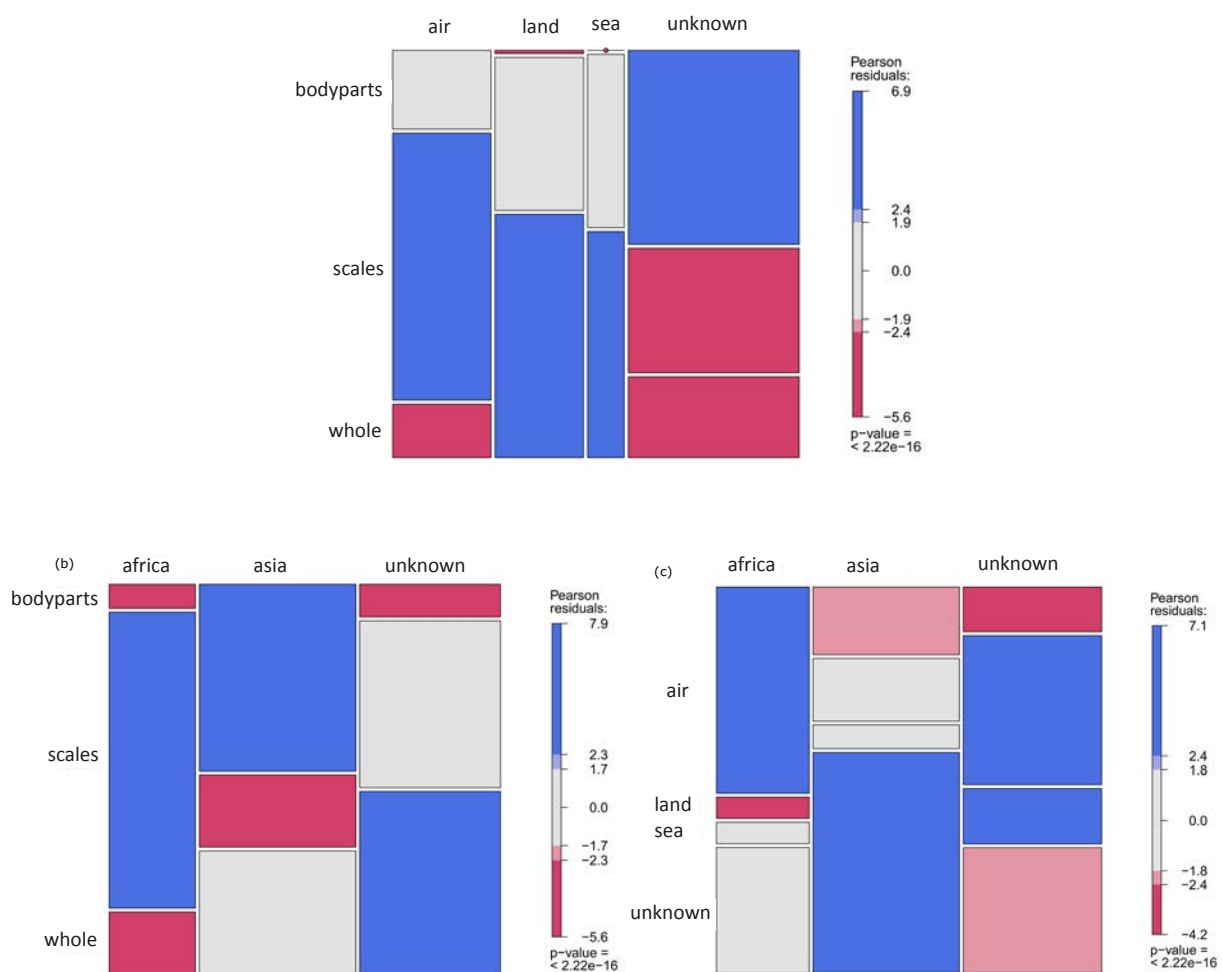


Figure 14: Mosaic plots of the deviation in conditional independence between (a) Commodity and mode of transport; (b) Commodity and home continent; and (c) Home continent and mode of transport, for all incidents between 2010 and 2015 (n = 539). The plot is constructed so that the size of each cell (rectangle) is proportional to the observed cell frequency for each trait. The residual-based shading reflects the cell contribution to the Chi-square statistic: shades of blue, when the observed frequency is substantially greater than the expected frequency under independence; shades of red, when the observed frequency is substantially less, as shown in the legend.

The relatively big proportion (44.2%) of “unknown” modes of transport is due to many seizure reports lacking this level of detail, but it should be noted that even if the transport modes were reported, in most cases these only reflected the mode of transport during the seizure event itself, and it remains uncertain in many cases how a shipment was transported before the seizure in the trade chain, or how it was supposed to be transported after the seizure.

The relative proportion of the number of trafficking incidents increased through time, for trade in pangolin scales and whole animals, while the proportion of trade in body parts appears to be decreasing, relative to the other commodity categories (Figure 15a). The relative proportion of international trafficking incidents in African pangolins appears to be increasing through time, compared to Asian and unknown species, which have constituted a large proportion of the overall trade (Figure 15b).

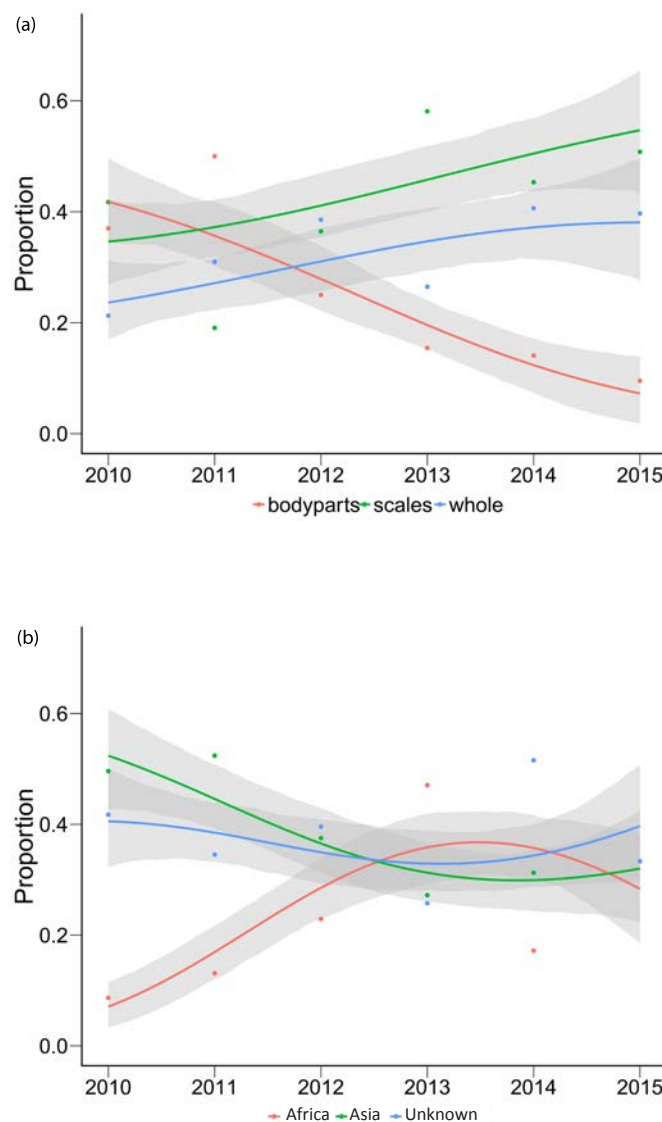


Figure 15: The relative proportion of occurrences in each category of (a) commodity type and (b) home continent, through time for international pangolin (*Manis* spp.) trafficking incidents (n = 539).

DISCUSSION

The illegal pangolin trade is of global conservation concern, and trafficking occurs well beyond African and Asian pangolin range States. In this report, the analysis focused on the number of incidents, trade routes, and quantities available, which is acknowledged to be incomplete, due to the nature of seizure reporting and detection (see e.g. Underwood *et al.*, (2013), Utermohlen and Baine (2017), and discussion below). The illegal trade involved 67 countries/territories during the period under review, and non-range countries played a considerable role in international pangolin trafficking. However, the countries or territories most commonly involved in international trafficking were largely within Asia, with the exception of several African countries (e.g. Nigeria and Cameroon). Asian countries or territories were mostly implicated as origin and destination countries or territories, while African countries were mostly implicated only as origin countries. It is possible that some of the commonly used trade routes, which have stopped being used in consecutive years, were impacted by improved law enforcement. Shifting trade routes, which have led to a highly mobile trade network are evidenced by the detection of an average of 27 new trade routes emerging per year. It should be noted that the analysis was focussed on a country-by-country basis, therefore the number of individual trade routes would obviously be higher if the analysis had been focussed on specific locations (or ports) within a given country.

Europe was identified as a major transit region, mostly for African pangolins being transported to Asia, but also as a destination in the case of the Netherlands and Switzerland. The Netherlands was also the only European destination country for large-quantity shipments of body parts and scales from Uganda and China respectively. Europe has previously been identified as a transit hub, and also as a major destination for a large variety of wildlife species and their products (Engler and Parry-Jones, 2007; Challender and Hywood, 2012; Auliya *et al.*, 2016; Heinrich *et al.*, 2016; Janssen and Blanken, 2016). The European transit countries that were found to be involved in the highest number of incidents were Germany and Belgium, both of which also happen to be among the countries that directly supplied seizure data for this analysis. It is acknowledged that some countries or territories may be over-represented relative to others that did not provide data, however, this does not change the fact that pangolin trade is occurring in non-range countries. Some of these non-range countries are potentially unaware that pangolins are being smuggled across their borders, especially Middle Eastern States like the United Arab Emirates (UAE) and Qatar which were reported to be involved in four incidents each. These countries are also in a geographically convenient position, and have well connected transport infrastructure, for the trafficking of African pangolins to Asia and could potentially represent another current (or future) transit hub. This prediction is supported by more recent incidents outside the period analysed, for example, the seizures in May 2017 of 304 kg and 408 kg of African pangolin scales in Malaysia, which were reportedly transiting through the UAE (Anon. 2017; Krishnasamy and Shepherd 2017).

In terms of the number of incidents, China and the US were identified as the two major destination countries. China appears to be an endpoint for much of the illegal trade, supporting the findings of the existing literature (see e.g. Challender *et al.*, (2015a), Gomez *et al.*, (2016a), and Nijman *et al.*, (2016)). Not only was China the most commonly involved country, but it was also the main destination for large-quantity shipments of scales and whole animals. This can most likely be attributed to an ongoing demand for pangolin meat and scales, which is believed to be increasing (Xu *et al.*, 2016). It has been suggested that urban consumption of meat might be tied to increasing affluence (Challender 2011), while the use of pangolins for medicinal and tonic food purposes in China dates back to the 16th century and is deeply rooted culturally (Coggins 2003; Ellis 2005; Zhang 2009). There also remains a legal market in China for pangolin scales, for which scales must be certified, but uncertified scales are still sold illegally within the country (Vallianos 2016; Xu *et al.*, 2016).

Alongside China, the US was heavily implicated in pangolin trafficking, most notably in terms of number of incidents, but also as the main destination for large-quantity shipments of body parts. It should be noted, that across the three commodity categories, quantities are not comparable. The thresholds were chosen differently, based on the distribution of the data within the three commodity categories, and 100 body parts cannot be compared to 1000 kg of scales for example. Nevertheless, the large-quantity shipments for body parts accounted for 85% of all body parts traded (by count), and in all but one case, these large-quantity shipments went to the US.

In terms of the number of incidents, the US is also one of the most heavily involved countries. Arguably, the US appears heavily implicated because they have been effective at preventing illegal pangolin products from entering their country. Other countries, with comparable law enforcement, and reporting practices, e.g. Switzerland, Germany, and Belgium, also directly provided their seizure data for the purposes of this analysis—yet none of these other countries came close to the large number of incidents involving the US. Frequent trafficking into the US may potentially be explained by the historic trade in Asian pangolin skins to America (Challender *et al.*, 2015a; Heinrich *et al.*, 2016), which were mostly used to fabricate leather boots and other goods (e.g. shoes, belts, wallets) (CITES 2000; Challender 2011). Even today, pangolin leather cowboy boots can be found for sale in the US, for example on eBay (Heinrich *et al.*, unpublished data). It is suspected, however, that the illegal leather trade into the US today mostly comes from Mexico, not Asia directly. The strong ties between Mexico and the US in the historic legal pangolin trade have been documented (Heinrich *et al.*, 2016) and based on the findings of this report it is suspected that Mexico may also be supplying the US with illegal pangolin products. Body parts were the most trafficked commodity into the US, and this commodity category, by definition in this study, was by far the most diverse group of commodity categories, including undefined medicinals, skins, tails, trophies, and leather products among others. Further studies are therefore required to decipher what is driving this ongoing illegal trade into the US, and what exact commodities are being traded, and in what quantities, in order to shed light on the role of the US in international pangolin trade. This is particularly important as high frequency, but comparably low volume shipments, will require a different type of law enforcement response, compared to a large multi-tonne shipment. The level of organization required for high volume transactions is fundamentally different, which will be reflected in the individual players involved in this trade.

The proportion of incidents involving trafficked scales appears to be increasing through time, as does the proportion of trade involving African pangolins, and scales were more likely to be of African origin. Trade in Asian species on the other hand appears to be decreasing, as does the trade in body parts, which was the commodity category that Asian species were most likely to be trafficked in. This trend may be an indicator of declining Asian pangolins throughout their ranges (although further studies are required to support this) and an increase in trade of African species, a shift which has already been inferred in other studies (Challender and Hywood 2012; Gomez *et al.*, 2016b; Heinrich *et al.*, 2016). It remains to be tested if this holds true for traded quantities of African and Asian species as well, as this was not explored in detail in the current analysis.

However, it was found that 55% of all large-quantity shipments of scales (involving 1000 kg or more of scales) originated in Africa, and large-quantity shipments of scales were also increasing through time, as was the weight of these shipments. Furthermore, the 10 shipments involving 1000 kg scales or more accounted for 60% of all scales (by weight) traded during the study period, highlighting the immense significance of these shipments from Africa.

The theory of a proportional market shift to African pangolins is further supported by the increasing number of African countries involved in the international pangolin trafficking network through time. The relatively large proportion of “unknown” home continents (i.e. where it was not possible to assign an incident to a home continent) also reflects that pangolins are rarely reported

to the species level, as is also the case with other illegally traded wildlife (Smith *et al.*, 2009; Burgess *et al.*, 2014), and there is an urgent need for the accuracy of species identification to improve. Increasing research is already being conducted into the identification of different species and their geographic origins using forensic methods (Wasser *et al.*, 2007; Johnson *et al.*, 2014; Mwale *et al.*, 2016; Ziegler *et al.*, 2016). It is suggested that these techniques should be used in future pangolin seizures as well, in order to assess better the threats to the different individual species of pangolins, particularly because of a potentially increasing threat to African pangolin species.

It is important to note that country and territory rankings may change if the analyses focussed on the whole dataset of seizures, not only international incidents. Domestic incidents were not included, as this report aimed to focus on international trafficking routes. Due to missing trade route information in many reported seizure incidents, some countries may appear less involved than they likely are in reality, or may not be mentioned in this report at all. Future analyses need to focus on confirming the identity of these countries, as well as the role they play in pangolin trafficking.

There are many biases inherent to seizure data, which will ultimately influence the results of any seizure analysis. The most obvious ones are reporting and law enforcement biases. There are different levels of law enforcement within each country, as well as the level of reporting (e.g. through media and NGOs, but also reporting by governments and law enforcement agencies). In the seizure data there is also a language bias, meaning in most cases the received datasets were largely based on English-language media reports, while it has been shown that vernacular language reports will provide additional information pertaining to particular non-Anglophone countries and news reports (Nijman 2015). In the available datasets, some of the incidents were reported in languages other than English (mostly in Indonesian, Malay, Thai and Chinese), but newspaper articles in other languages were not specifically searched.

The trade routes are also potentially incomplete due to a number of biases. Destination countries or territories may represent the true final destination, or may just be a transit country or territory, if the true final destination (final importer) was not reported in the incident. An origin country or territory may also be a transit country or territory, if the true origin country or territory (first exporter) was not reported in the incident. Hence, origin and destination countries or territories were defined as the first and last known point in any trade route, respectively. Regardless of whether countries or territories were the intended true final destination in a trade route, they were still an importer of illegally traded pangolin products.

As data were received following the requests to the CITES MAs, the countries or territories that sent data will likely be over-represented in the analysis, compared to others that did not provide data or did not respond. In some cases (such as Namibia) data were not received from the CITES MA, but from an independent NGO; thus the likelihood to receive data from a country or territory also depends on the amount and management of local NGOs in any one country. Also, two major datasets were only available for Asia (from TRAFFIC, and Dan Challender) and while every attempt was made to collate seizure data from African countries, similar datasets were not available for Africa (but see Ingram *et al.*, (2017) for local scale data of hunting and market surveys). It is now also a well-established fact that China is a major destination country for pangolin products (Pantel and Chin 2009; Nijman *et al.*, 2016), and while this is certainly true, there might be a potential reporting bias towards China, especially in media reports covering seizure events that assume China to be the final destination. Future accurate reporting of potential destination countries is important for identifying other major demand countries.

Further analysis of these data will require careful consideration of the potential seizure and reporting biases. It has now been clarified by the CITES Secretariat in the new Guidelines for submission of annual reports, that illegal shipments should not be included in the annual legal

report, using the source code “I” (CITES 2017a). The source code “I” should only be used in instances of subsequent legal transactions of a previously seized specimen (CITES 2017a). Misreporting has previously caused confusion (Heinrich *et al.*, 2016) and might have impacted the analysis of CITES trade data in other studies (see also D’Cruze and Macdonald (2016)). Parties are now required to submit an annual illegal trade report, separate from the information entered into the legal CITES trade database. The new report is mandatory, but not subject to compliance procedures, and the first report was due on 31 October 2017 (CITES 2016a).

The reporting of seizures of pangolins specifically has been made a requirement through Notification No. 2017/35 of CITES (CITES 2017c). Parties have been asked to report on information including pangolin seizures, prosecution effort, forensics analysis, stockpile management, and inventories of captive populations, to enable a more thorough assessment on the conservation of African and Asian pangolin species. The results will be made available at the 69th meeting of the Standing Committee in November 2017 (CITES 2017c).

The aim of this report is to explore and summarize the pangolin trafficking routes from 2010–2015. In conclusion, based on the available data, it was found that China and the US were the two countries most commonly involved (i.e. having the highest number of incidents regardless of the quantity involved in each incident) in international pangolin trafficking from 2010–2015. China was also the main destination of large-quantity shipments of scales and whole pangolins, while the US was the main destination for large-quantity shipments of body parts. The quantities entering the US were, however, not comparable to the massive shipments trafficked through Africa and Asia. European countries served as transit points, with the exception of the Netherlands (and potentially Switzerland), which was primarily a destination for pangolins and their products. The Netherlands was also the only European destination country for large-quantity shipments of body parts and scales from Uganda and China respectively.

The involvement of African countries (and African pangolin species) in terms of number of incidents increased through time. African countries also emerged as the major origin countries for large-quantity shipments of scales. However, most trafficking occurred within Asia during the study period, both in terms of number of incidents, but also quantities. Given the global extent of the trade, it is recommended that all CITES Parties, within and beyond the native pangolin range States, be vigilant of trafficking in these threatened species. Further studies into the quantities and commodities of pangolins and their derivatives being trafficked, and the role of non-range countries are imperative to present a more holistic solution to the problem of illicit trade.

Given the global extent of the trafficking, and the findings presented in this report, the following recommendations for both range- and non-range countries are made:

RECOMMENDATIONS

Legislation and enforcement

- All countries involved in the illegal pangolin trade should review, and amend where necessary, national wildlife laws and relevant Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)-implementing legislation to protect all eight pangolin species from trade (see also Challender *et al.*, (2014a), IUCN (2016), and (CITES 2017b)). This should include full protection for all species of pangolins, native and non-native, within national wildlife protection legislation and other legal instruments that govern CITES and international trade. This will provide for a stricter deterrent and provision of higher penalties, given the CITES Appendix I status of all pangolin species (i.e. all commercial international trade of wild caught specimens is prohibited).
- Law enforcement agencies (including Customs, police, and relevant wildlife departments) in the countries identified in this report as implicated in international pangolin trafficking should be vigilant to the persistence of illegal trade. However, the countries that most need to enhance their law enforcement efforts are those with low numbers of seizures, but at the same time implicated in the routes of many trafficking incidents. According to the presented data, this discrepancy is most notable in (descending order of importance): Lao PDR, Nigeria, Myanmar, Cameroon, Guinea, Mexico, the Philippines, Pakistan, Liberia, Equatorial Guinea, Cote d'Ivoire, Ethiopia, Kenya, Singapore, Mozambique, and Togo.
- Law enforcement agencies in all countries involved in pangolin trafficking should employ intelligence-led investigations to examine, identify, and prosecute all parties involved in the pangolin trade that violates national laws [see also CITES (2017b)], from collectors and traders, to logistics companies and importers, as well as the vendors, purchasers and users of pangolin parts and products. These efforts would be particularly useful in countries and territories that have been involved in large-quantity shipments identified here namely: Cameroon, China, Guinea, Hong Kong SAR, India, Indonesia, Kenya, Lao PDR, Malaysia, Myanmar, the Netherlands, Nigeria, Pakistan, the Philippines, Sierra Leone, Singapore, Thailand, Uganda, the US, and Viet Nam. Several European countries, especially, Germany, France, and Belgium are also implicated as they have been identified as important transit hubs, especially for African pangolins. Furthermore, analysis of the type of product, and the quantities seized, may be useful in determining the type of criminal activities and/or networks behind the shipments, and the enforcement response required.
- Profiling through intelligence-led investigations should be employed by source, transit and end-use destinations. The transnational network of illegal pangolin trafficking is highly mobile with new trade routes emerging every year. Enforcement approaches will need to be equally dynamic and responsive, similar to the methods that been recommended to stem the trade in African ivory and rhino horns to Asia (see e.g. Milliken and Shaw (2012)).
- Multi-agency collaboration (including Customs, police, wildlife departments, transportation and logistics companies), both at national and international levels, and between source, transit and end-use destinations, should be enhanced to tackle the international and organized criminal networks involved in smuggling pangolins across borders.
- Prosecutors and judiciaries in all pangolin range countries, and non-range countries implicated in trafficking, should be made aware of all applicable legislation and legal instruments available to prosecute and convict criminals, as well as the legal and environmental consequences of the

- illicit pangolin trade, as part of prioritizing attention to wildlife crime [see also CITES (2017b)]. This will be imperative to ensure an increase in successful conviction rates, and stronger penalties, which serve as meaningful deterrents. Zimbabwe is one leading example of the success of this (Shepherd *et al.*, 2016).
- Forensic techniques to identify the origin of pangolins and their derivatives in trade should continue to be developed to support law enforcement efforts and investigations into the trade chain [see also Challender *et al.*, (2014a), CITES (2017b)]. Countries making seizures should establish a forensics DNA protocol to ensure pangolin commodities seized can be identified to the species level. Such methods should be used more often in future pangolin seizures in order to assess better the threats to the different species of pangolin; particularly because of a potentially increasing threat to African pangolin species.

Monitoring and reporting

- CITES Management Authorities (MAs) in co-ordination with all relevant enforcement agencies in all countries involved in the illegal trade in pangolins, their parts and derivatives, should improve reporting of all seizures to the CITES Secretariat as per the new annual illegal trade reporting requirements i.e. CITES Notification 2016/007 (CITES 2016a). Recent changes to CITES reporting requirements (CITES 2016a, 2017a) should be considered and implemented in a standardized way, and data should be made available for statistical analysis and criminological research, to assist law enforcement and guide ongoing collection of data. Seizure reports, including comprehensive accounts of actions and outcomes, specifics of seizure and prosecution details are needed for analysis of a country's wildlife trade levels and trends, and, eventually, a better understanding of the international illegal wildlife trade.
- Monitoring and reporting on the trafficking of pangolins by CITES MAs, NGOs and independent researchers should continue, and be expanded to countries where information on the trade is lacking. Improved monitoring and reporting should be prioritized for: (i) commodity quantities; (ii) the specific roles of countries involved; and (iii) transport modalities used in pangolin shipments. Co-operation from transportation and logistics companies involved in movement (however unwittingly) of shipments along trade routes is also necessary; these companies are encouraged to share information on methods of concealment or trafficking, specific routes used, and other notable information to enable effective law enforcement investigations. These will assist in gauging levels of illegal trade, detecting emerging trends and influencing enforcement, conservation actions and decision-making.

Demand reduction and awareness

- Efforts should be increased to understand and reduce demand for pangolin products traded illegally in consumer countries, through increased awareness and well-informed and targeted behavioural change efforts (see also CITES (2017b), Challender *et al.*, (2014a) and IUCN (2016)). Efforts should include an improved analysis of the use of pangolin products being seized to meet certain types of demand in consumer countries. This would provide further insights into the targeted behaviour change initiatives required based on motivational variations amongst consumers.
- Law enforcement agencies, especially those in countries identified as priorities in this study, should ensure officers are aware of the significance and relative prevalence of the illegal pangolin trade, able to recognize pangolin products, and increase their vigilance to detect and intercept shipments (see also Challender *et al.*, (2014a) and CITES (2017b)).

- While the drivers of trade in Asia are largely known, the demand from priority countries outside Asian demand centres (particularly the US and the Netherlands) is poorly understood. Further studies by conservation organizations, research institutions and relevant government agencies are required to decipher what is driving the illegal trade into these countries, what commodities are being traded, and in what quantities. This will greatly assist in identifying the role of non-Asian countries as centres of demand for international pangolin trafficking. Targeted awareness or demand-reduction campaigns may also be warranted.

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SUPPLEMENTARY MATERIAL

Table S1: Number of pangolin (*Manis* spp.) seizure incidents that occurred in each country/territory across international pangolin trafficking incidents (n = 539). Provided also, is the relative percentage that each country/territory played as either an origin, transit or destination, in the international trafficking routes.

Country/Territory	Number of Seizures	Percentage		
		Destination	Origin	Transit
US	127	100	0	0
China	113	73.4	25.7	0.9
Germany	37	13.2	0	86.9
Viet Nam	35	31.1	56.7	12.2
Thailand	32	26.8	41.1	32.1
Belgium	30	16.1	0	83.9
Malaysia	24	30	60	10
Netherlands	24	92.3	0	7.7
India	23	6.7	93.3	0
Indonesia	21	2.5	97.5	0
France	14	40	6.7	53.3
Nepal	11	10.5	63.2	26.3
Hong Kong	8	26.3	64.9	8.8
Switzerland	8	100	0	0
Cameroon	3	0	100	0
Malta	3	100	0	0
Philippines	3	18.2	81.8	0
Uganda	3	0	67	33
Poland	2	100	0	0
Sri Lanka	2	0	100	0
Zimbabwe	2	100	0	0
Japan	1	100	0	0
Kenya	1	0	71.4	28.6
Lao PDR	1	25	31.8	43.2
Mali	1	100	0	0
Mozambique	1	0	100	0

Country/Territory	Number of Seizures	Percentage		
		Destination	Origin	Transit
Pakistan	1	0	100	0
Singapore	1	50	16.7	33.3
South Africa	1	0	66.7	33.3
Sweden	1	100	0	0
Taiwan	1	33.3	66.7	0
Tanzania	1	0	100	0
Togo	1	0	100	0
UK	1	100	0	0
Zambia	1	100	0	0
Angola	0	0	100	0
Bangladesh	0	0	0	100
Burundi	0	0	100	0
Cambodia	0	0	100	0
Canada	0	0	66.7	33.3
Central African Republic	0	0	100	0
Congo	0	0	100	0
Côte d'Ivoire	0	0	87.5	12.5
Democratic Republic of the Congo	0	0	100	0
Ethiopia	0	0	85.7	14.3
Equatorial Guinea	0	0	100	0
Ghana	0	50	0	50
Guinea	0	0	100	0
Italy	0	0	100	0
Liberia	0	0	87.5	12.5
Liechtenstein	0	0	100	0
Mexico	0	0	100	0
Morocco	0	0	0	100
Myanmar	0	19.4	55.6	25
Nigeria	0	0	97.6	2.4

Country/Territory	Number of Seizures	Percentage		
		Destination	Origin	Transit
Qatar	0	0	75	25
Russia	0	100	0	0
Saudi Arabia	0	0	0	100
Sierra Leone	0	0	100	0
Spain	0	0	50	50
Turkey	0	50	0	50
United Arab Emirates	0	0	75	25
Uruguay	0	100	0	0

TRAFFIC, the wildlife trade monitoring network, is the leading non-governmental organization working globally on trade in wild animals and plants in the context of both biodiversity conservation and sustainable development.

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