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Original Research Article

Characterising trafficking and trade of pangolins in the Gulf of Guinea

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ABSTRACT

Humans and pangolins have a long and intertwined history in Africa and Asia, with the species having been used for subsistence, livelihood, medicinal, and cultural purposes. Populations of Asian pangolins have severely declined, and intercontinental trafficking of African pangolin scales to Asia has emerged in the last decade. Coastal countries in the Gulf of Guinea have been highlighted as hotspots of illegal pangolin trade, and in 2017, international commercial trade in pangolins was banned. We characterise the trade and international trafficking of African pangolins in the coastal countries around the Gulf of Guinea using data across three tiers. First, we investigated which countries were most heavily involved in international trafficking using seizure data. Second, we investigated where domestic seizures of pangolins took place, and whether they were seized with other species. Finally, we tracked the open sale of pangolins across 20-years at the main wild meat market in Malabo, Equatorial Guinea, to investigate patterns of pangolin sales in a capital city. We found a total of 55893 kg of pangolin scales in 33 seizures between 2012 and 2018, with Cameroon and Nigeria being the most common export countries for international trafficking of pangolin scales. Cameroon had the largest number of domestic seizures (45); we also observed a shift from seizures of meat to scales from 2013 onwards. At the Malabo market a total of 11207 *Phataginus* pangolins and 366 *Smutsia* pangolins were sold between 1997 and 2017, and the number and price of pangolins increased over time for both genera and corresponded to a shift in the import of pangolins from Cameroon. Together, these results highlight the scale of trade and trafficking in pangolins within and from this region.

1. Introduction

Humans have harvested wildlife for millennia and it continues to be an important source of nutrition, traditional medicine and livelihood for millions of people (Milner-Gulland et al., 2003; Abernethy et al., 2016). However, overexploitation remains a primary threat to wildlife, driving many species towards extinction (Maxwell et al., 2016; WWF, 2016; Benítez-López et al.,

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2017). Pangolins (Pholidota: Manidae) are symptomatic of this trend, having been exploited across their range in Africa and Asia historically, and are currently threatened by international trafficking and local use (Challender et al., 2014; Waterman et al., 2014; Ingram et al., 2018). This has led to population declines in Asia (e.g., Wu et al., 2004), an increasing risk of extinction in Africa and Asia (Baillie et al., 2014; Waterman et al., 2014), and pangolins being considered a highly trafficked group of wild mammals (Heinrich et al., 2017). Although demand for pangolin products in Asia has historically been met by local supply or from regional range states, a seeming increase in seizures of African pangolin derivatives (almost exclusively scales) in Asia, in Europe en route to Asia, and in Africa but purportedly destined for Asian markets in the last decade suggests that Asian demand is, in part, now being met by African pangolins (e.g., Gomez et al., 2016; Challender and Waterman, 2017).

Little is known about the biology and ecology of African pangolins. In addition, limited quantitative information is available on levels of human use, which makes assessments of pangolin conservation status difficult. Few population estimates exist for any of the four species in Africa (black-bellied pangolin *Phataginus tetradactyla*, white-bellied pangolin *P. tricuspis*, giant pangolin *Smutsia gigantea* or Temminck's ground pangolin *S. temminckii*, although see Pietersen et al., [2014] for South Africa as an exception). However, evidence shows that they are consumed as wild meat and their body parts are used in a wide range of ethno-pharmacological applications (e.g. Boakye et al., 2015; Baiyewu et al., 2018). Recently, Ingram et al. (2018) estimated that between 0.4 and 2.7 million pangolins are harvested annually for wild meat in Central Africa, and that the proportion of pangolins out of all animals harvested was increasing over time. The same study found that the price of both *Phataginus* sp. and *S. gigantea* increased between 1993 and 2014 in urban wild meat markets but not in rural markets. Three of the four species of African pangolin (all but *S. temminckii*) inhabit areas of West and Central Africa, a region reported to be a source of large numbers of pangolins for international trade and trafficking to Asia. Heinrich et al. (2016), analysed the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) trade involving pangolins which revealed that many African nations are involved in exporting pangolins and their parts; Togo, South Africa, and Cameroon were the largest exporters of pangolins from Africa for the intercontinental trade before commercial international trade was banned in 2016.

Information from seizures suggests that coastal countries around the Gulf of Guinea could be a hub for pangolin exploitation and international trafficking. This is despite all pangolin species being included in CITES Appendix I as of January 2017, and all Gulf of Guinea countries we included here being Parties to CITES, thereby prohibiting international trade in wild-caught pangolins for commercial purposes.

In Cameroon, *S.gigantea* has been afforded full protection since December 2006 (listed as Class A species in No. 0648/MINFOF). Since a new Ministerial Order was published in June 2013, the trade in pangolin scales from all species was prohibited. Another Ministerial Order in January 2017, included all species of pangolin in Cameroon under Class A, prohibiting the hunting, capture, killing and trade of pangolins in the country. In Equatorial Guinea, previous laws listed all three species of tropical African pangolin as fully protected, however newer legislation (Law N°7/2003, Environmental Regulations) abolishes previous legislation and does not include a protected species list. In 2005, a Presidential Decree (N°172/2005) stated that a list of endangered species would be provided two years later; however, to the knowledge of the authors this has not been issued. *S. gigantea* is fully protected in Gabon, however both *Phataginus* species are considered game species, whilst in the Republic of Congo, *P. tricuspis* and *S. gigantea* are fully protected. In Côte d'Ivoire, *S. gigantea* is fully protected, and both *Phataginus* species are only allowed to be hunted with a permit. All pangolin species can be hunted with a permit in Togo, however it is prohibited to hunt, capture or trade each species that occurs in Benin, Ghana, and Nigeria. Existing analyses of pangolin trafficking suggest Gulf of Guinea countries, Nigeria and Cameroon, had the highest number of incidents within Africa between 2010 and 2015 (Heinrich et al., 2017). In 2015, 2016, 12.3 tonnes of pangolin scales were shipped from Nigeria to Hong Kong and China, approximating 34118 pangolins if all were P. tricuspis (360.51 g of scales per individual) or 3417 if all were S. gigantea (3600 g of scales, following conversion information from Challender and Waterman, 2017).

Since 2008/2009, there has been an apparent increase in trafficking of African pangolins and their derivatives to Asia, which is facilitated by on-going demand in Asia (e.g., China, Vietnam; Challender and Hywood, 2012) but also broader economic and international development trends, including increasing investment, trade, and trade volumes between East Asian and many African countries (Wang and Bio-tchané, 2008). For instance, China has invested heavily in Cameroon and Equatorial Guinea, and these two countries received the most investment per capita in Africa between 2000 and 2013 from China (US$9894 and US$1872 per capita for Cameroon and Equatorial Guinea respectively; Constantaras, 2016). In addition, the number of Chinese companies and workers in these countries is on the rise (Zhang et al., 2015). In Gabon, recent evidence shows that Asian industry workers request pangolins from hunters more than any other species (Mambeya et al., 2018). Combined with inadequate enforcement, due to a range of factors including a lack of capacity and resources, especially in rural areas (see Challender and Waterman, 2017), these factors have facilitated international trafficking.

Given the difficulties of monitoring illegal trade (e.g., detection and reporting biases; see Underwood et al., 2013; Milliken et al., 2016), we demonstrate the use of integrating different types of data to understand more about trade and trafficking dynamics. Here, we aim to characterise the legal and illegal trade in pangolins in the Gulf of Guinea countries, by investigating questions across three tiers where law enforcement activities are typically employed:

a) International law enforcement

Which countries are involved in the international trade/inter-continental trafficking of African pangolins to Asia, and by which routes and methods are pangolins being transported?

b) Local law enforcement

Where have pangolin seizures taken place within Gulf of Guinea range states specifically, and to what extent are they seized with other illegal wildlife products?

c) Market *time-series*

Has the number, price, or origin, of pangolins offered for sale at wild meat markets changed over time?

2. Methods

2.1. International law enforcement and seizure data

To investigate the trade links and international trafficking routes for arboreal (*Phataginus* sp.) and giant pangolins between countries in West and Central Africa and Asia, we collated data collected by the Environmental Investigation Agency spanning 2000–2017 (EIA, 2017). We also supplemented the data with open source information on seizures (typically from the media) by using Google Alerts, collated by D. Challender and D. Ingram between 2009 and 2018. We subsequently extracted information on the location of seizures, export and destination countries, the parts and derivatives seized, quantities seized and transportation methods from the original articles, if reported.

2.2. Local trafficking

We used a broad definition of the Gulf of Guinea, inclusive of countries from Côte d'Ivoire to the Republic of Congo. To investigate whether local law enforcement efforts within Gulf of Guinea countries have intercepted trafficking of pangolins and their parts in-country, we collated law enforcement data from publicly available online reports from the EAGLE (Eco-Activists for Governance and Law Enforcement) Network, a network of non-governmental organisations (NGOs) that work with government authorities to combat wildlife crime. The first member of the network, LAGA (The Last Great Ape Organisation), has operated in Cameroon since 2003. Since then, additional members have been added, in the Republic of Congo (2008), Gabon (2010), Togo (2013), Benin (2014) and Côte d'Ivoire (2017). We extracted information on seizures that involved pangolins or their body parts from online monthly and annual reports for each EAGLE member. Where possible, we also extracted information on the location of the seizure, the genus of pangolin (*Phataginus* or *Smutsia*), the type (e.g. meat, scales, whole individuals) and quantity seized, and whether any other animals or their parts were seized (e.g. ivory).

We acknowledge that there are inherent biases in detection and reporting associated with seizure data (Underwood et al., 2013; Milliken et al., 2016; Siriwat and Nijman, 2018), including: i) the location of seizures could be biased due to uneven law enforcement effort, ii) member organisations of the EAGLE network were set up at different points in time, with different levels of resources, and these data are likely biased on a temporal scale, and iii) reporting rates (e.g. in annual reports) may differ. Therefore, we made no attempt to quantify illegal trade over space or time, and as such the data should not be considered as absolute trade volumes or trends.

2.3. Market time-series

We investigated the availability and trends in the numbers of *Phataginus* sp. and *Smutsia* sp. offered for sale at a wild meat market using one of the longest market time-series datasets in existence. We used data on carcass counts and prices spanning October 1997–November 2017 at the wild meat market in Malabo, the capital city of Equatorial Guinea on Bioko Island. Data were extracted from Cronin et al. (2015) for October 1997–September 2010, and additional data were added subsequently from ongoing surveys collected using the same methodology up to and including November 2017 (Bioko Biodiversity Protection Program, unpubl. data). This dataset is particularly informative because it provides details about the price and approximate origin (determined from the market vendor or intermediaries bringing carcasses to the market) of each pangolin offered for sale, and comparisons can be made against the total number of carcasses from all species at the market. Only *P. tricuspis* is known to occur on Bioko Island.

We adjusted prices of pangolin carcasses to 2018 real prices using the Consumer Price Index (CPI) from the World Bank database (The World Bank, 2018). To test whether the prices of *Phataginus* sp. or *Smutsia* sp. species have changed over time or differed by origin, we fitted generalized linear models (Quasipoisson error distribution and log link function) to the adjusted prices with year (up to third order polynomial terms) as explanatory variables. All analyses were performed in R v 3.2.5 (R Core Team, 2016).

3. Results

3.1. International law enforcement

We identified 33 seizures involving a 55893 kg of pangolin scales between 2012 and 2018 that could link the illegal trade from Gulf of Guinea countries to Asia. One seizure in China in 2012 also contained 3000 kg of pangolin meat exported from Nigeria. Following conversion parameters in Challender and Waterman (2017), we estimate that if all scales were from *Phataginus* sp., then the seized scales could approximate 155039 pangolins, while if all were *S. gigantea*, it could correspond to 15526 pangolins.

Pangolins were trafficked from 4 countries (Cameroon, Ghana, Nigeria, and Republic of Congo) and were destined for 4 countries (China (incl. Hong Kong SAR), Laos PDR, Malaysia, and Vietnam; Fig. 1). China and Hong Kong were grouped in Fig. 1, and if consignments were intercepted in a transit country but the source stated the intended destination, we included it in the figure. The largest number of seizures took place in China (n = 20), of which 9 were in Hong Kong, totalling 42543 kg of African pangolin scales and accounting for 76% of seized scales. The largest number of consignments were exported from Nigeria (n = 20, totalling 39073 kg), followed by Cameroon (n = 7, totalling 6626 kg). The main method of transportation of pangolin scales was air (n = 14), then sea (n = 6); the rest are unknown. Shipments of pangolin scales were frequently disguised as fish scales, cashew nuts or oyster shells, or labelled as logs or metal/plastic scraps.

3.2. Local trafficking

Most data on seizures of pangolins or their body parts were available for Cameroon, where 45 law enforcement records were found between January 2006 and June 2018 (Table 1). Of these, most records (22) were reported as involving *Smutsia* sp., and 1 was reported as *Phataginus* sp., the remainder were unidentified (Table 1). Up to 2010, all records (4) involved only pangolin meat, and from 2012 onwards all records involved pangolin scales and sometimes also meat. The available data indicate that 53% of pangolin seizures also involved seizures of carcasses or body parts of other wildlife such as chimpanzees (*Pan* sp.), elephants (including ivory; *Loxodonta* sp.), gorillas (*Gorilla* sp.), and sea turtles (Family: Cheloniidae).

Seizures were made in other countries in the region, however due to relatively recently joining the EAGLE network, information is only available for recent years (Table 2). In Gabon, six law enforcement records were identified between 2012 and 2018. Three seizures were recorded in Benin between 2015 and 2018, one in Togo in 2014, and four in Republic of Congo between 2015 and 2018 (records were missing between October and December 2015), four in Côte d'Ivoire between 2013 and 2018, and five in Nigeria between 2016 and 2018. In Congo, two people were arrested with ivory in 2017, and one confessed to working with a Chinese client to traffic pangolins (PALF, 2017). In 2017, in Côte d'Ivoire, eight people belonging to a criminal network were arrested for attempted trafficking of 3000 kg of pangolin scales.

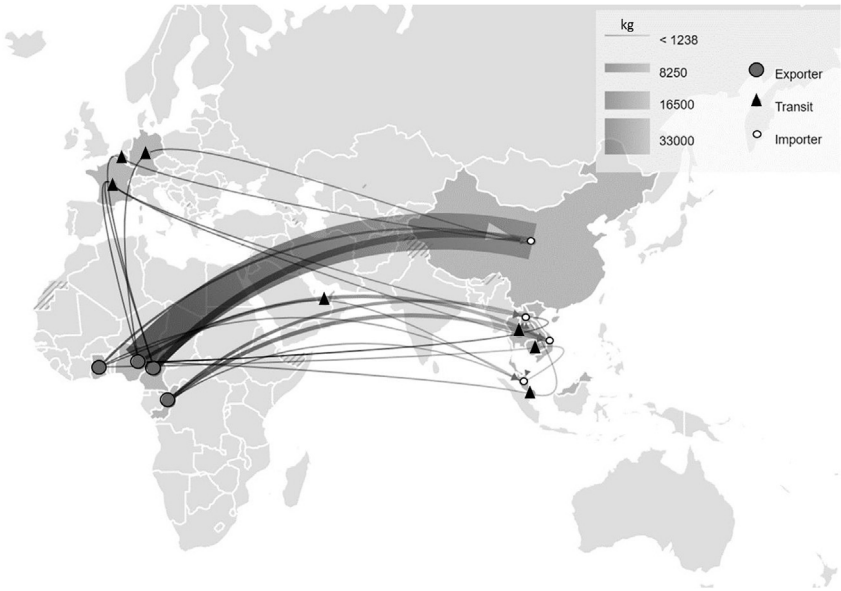

Fig. 1. Flow of trade in pangolin scales (kg) between 2012 and July 2018. If a seizure was made in a transit country but stated where the consignment was being shipped to, then we included these as arrows. Cross-hatch shaded areas show disputed territories. Modified map, originally produced with TradeMapper (TRAFFIC/WWF-UK, 2018).

Table 1
Seizures of pangolins and their parts in Cameroon from January 2006 – June 2018.

Year	Location	Genus	Item seized	Quantity	Additional items seized	Source
2007	Mezam	*Smutsia*	meat	–	Meat from chimpanzee and other protected species	LAGA
2008	Haut-Nyong	*Smutsia*	meat	–	2 tusks and meat of elephant and gorilla	LAGA
2009	Mfoundi	*Smutsia*	meat	–	Meat from dwarf crocodile, potto, monkey and gorilla	LAGA
2010	Dja-et-Lobo	*Smutsia*	meat	–	Chimpanzee, duiker and water chevrotain meat	LAGA
2012	Haut-Nyong	*Smutsia*	Whole animal	1	Other meat	LAGA
2013	Fako	*Smutsia*	Scales	7 sacs	–	LAGA
2013	Limbe, Fako	-	Scales	80 kg	–	EIA
2013	Mfoundi	-	Scales	7 sacs	Live forest tortoise	LAGA
2013	Mfoundi	*Smutsia*	Scales	44 kg	4 elephant tusks and 25 pieces of worked ivory	LAGA
2014	Mfoundi	*Smutsia*	Scales	4 bags	–	LAGA
2014	Yaoundé, Mfoundi	-	Scales	120 kg	–	EIA
2014		-	Scales	150 kg	5 gorilla skulls, 7 chimpanzee skulls, elephant jawbone	EIA
2014	Kadey	*Smutsia*	Scales	>100 kg	Elephant, gorilla and chimpanzee bones	LAGA
2014	Noun	*Smutsia*	Scales	4 kg	Chimpanzee: 1 Live, 7 skulls and 30 hands	LAGA
2015	Yaoundé, Mfoundi	*Smutsia*	Scales	100 kg	–	EIA
2015	Near Deng Deng National Park	*Smutsia*	Scales	14 kg	–	EIA
2015	Bertoua, Lom-et-Djérem	-	Scales	200 kg	–	EIA
2015	Bafoussam, Mifi	-	Whole	1	Olive baboon, porcupine, civet and duiker meat	EIA
2015	–	-	–	–	–	EIA
2015	Mbam-et-Kim	*Smutsia*	Scales and legs	4 legs	1 baby colobus monkey	LAGA
2015	Mfoundi	*Smutsia*	Scales	114 kg	–	LAGA
2015	Kadey	Both	Scales	2.5 kg	2 Chimpanzee skulls	LAGA
2015	Mfoundi	*Smutsia*	Scales	2.5 kg	–	LAGA
2015	Mèfou-et-Afamba	*Smutsia*	Scales	100 kg	–	LAGA
2015	Lom-et-Djérem	*Smutsia*	Scales	15 kg	–	LAGA
2016	Bertoua, Lom-et-Djérem	*Smutsia*	Scales	200 kg	12 ivory tusks	LAGA
2016	Nyong-et-Kéllé	-	Scales	–	Sea turtle shells and chimpanzee skulls	LAGA
2016	–	*Smutsia*	Scales	–	–	LAGA
2016	–	-	Scales	128 kg	–	LAGA
2016	Yaoundé airport, Mfoundi	-	Scales	670 kg	–	EIA
2016	Ngaoundal, Region of Adamaoua	-	Scales	128 kg	–	EIA
2017	Douala, Wouri	*Smutsia*	Scales	5 tonnes	–	EIA
2017	Messamena	-	Scales	94 kg	–	LAGA
2017	Yaoundé, Mfoundi	-	Scales	45 kg	Leopard skin	LAGA
2017	Ebolowa, Mvila	-	Scales	35 kg	Baby chimpanzee	LAGA
2017	Yaoundé, Mfoundi	-	Scales	41 kg	Baby mandrill	LAGA
2017	Ebolowa	-	Scales	50 kg	–	LAGA
2017	Bangangté, Ndé	-	Scales	–	2 leopard skins	LAGA
2017	Sangmélima, Dja-et-Lobo	*Smutsia*	Scales	10.5 kg	4 ivory tusks	LAGA
2017	Douala, Wouri	-	Scales	128 kg	–	LAGA
2018	Ambam, Vallée-du-Ntem	-	Scales	80 kg	Baby chimpanzee	LAGA
2018	Betare Oya, Lom-et-Djérem	-	Scales	36.5 kg	6 hippopotamus teeth, 2 boa skins	LAGA
2018	Santchou, Menoua	-	Scales	–	Elephant bones, ivory	LAGA
2018	Doumé, Haut-Nyong	-	Scales	35 kg	–	LAGA
2018	Douala airport		Scales	1000 kg	Ivory	Author search

3.3. Market time-series

Over the time-period that the Malabo wild meat market was surveyed (1997–2017), 11207 *Phataginus* pangolins and 366 *Smutsia* pangolins were offered for sale. *Phataginus* sp. were found continually in the market over the period of the market surveys, i.e. 20 years (Fig. 2A). *Smutsia* sp. were imported from mainland Equatorial Guinea initially (Bata, the main transit hub for travel to Bioko from mainland Equatorial Guinea, Fig. 2B), and from 2007 were largely imported from Cameroon. In general, carcasses from many species were regularly imported to the market starting in September 2003 from the mainland (Cameroon and Bata, Equatorial Guinea; Cronin et al., 2015). *Smutsia* sp. are not found on Bioko Island, and did not appear at the Malabo market until 2004 after imports began. Before imports began, the proportion of all carcasses on the market that were *Phataginus* sp. was decreasing (Fig. 3A); after imports began the proportion of carcasses comprising *Phataginus* sp. and *Smutsia* sp. generally increased over time (Fig. 3A and B). We note that the proportion of imported carcasses that were pangolins was an order of magnitude higher than the proportion of unimported carcasses that were pangolins on the market for both genera (Fig. 3C and D). These results suggest that the presence of pangolins on the market is driven either by demand or ease of sale (supply), but further studies are needed to better understand these dynamics. Before the majority of pangolins were imported from Cameroon (before 2007), 57.9% of the *Phataginus* pangolins on the market were alive, whereas afterwards 97.1% were freshly killed. Across all years, 1.9% of *Phataginus* individuals were also sold as dried carcasses. For *Smutsia* sp., 99.5% were fresh; the rest (2) were alive. Most of the pangolins in the market were adults, 98.3% of *Phataginus* pangolins and 99.7% of *Smutsia* pangolins, whilst a fraction were juveniles. The most common hunting method was traps/snares; this

Table 2
Seizures in Gulf of Guinea countries excluding Cameroon, from multiple sources.

Year	Location	Genus	Item seized	Quantity	Additional items seized	Source
Gabon						
AALF has been a member of the EAGLE Network since 2010, with data available between October 2010 and April 2018.						
2012	–	-	Scales	–	–	AALF
2013	Nkoltang, Estuaire Province	-	Scales	–	–	EIA
2014	Guiétsou province Ngounié	-	Whole	1	–	EIA
2016	Idoumi (Mouila)	-	Whole	1	Antelope, porcupine	AALF
2017	Oyem	*Smutsia*	Scales	2 kg	Ivory tip, buffalo horn, gorilla skull, duiker horn, panther teeth and skull	AALF
2017	Libreville	*Smutsia*	Scales	–	Ivory, civet skin	AALF
Côte d'Ivoire						
EAGLE - Côte d'Ivoire has been a member of the EAGLE Network since 2017, with data available between May 2017 and June 2018.						
2013	Agboville, Agnéby-Tiassa Region	-	Whole	12	–	EIA
2015	Allangouassou, N'zi-Comoé Region	-	Whole	2	–	EIA
2017	Cocody, Abidjan Department	-	Scales	3000 kg	–	EAGLE - Côte d'Ivoire
2018	Abidjan	-	Scales	600 kg	578 kg ivory	Author search
Togo						
TALFF has been a member of the EAGLE Network since 2013, with data available between January 2013 and July 2018.						
TALFF records were unavailable for 2015, 2016, and February 2018.						
2014	Lomé	-	Scales	198 kg	–	TALFF
Congo						
PALF has been a member of the EAGLE Network since 2008, with data available between January 2014 and February 2018.						
PALF records were unavailable for 2008–2010, 2012 and between October and December 2015.						
2015	Yengo, Sangha Department	-	Scales	3 bags	–	EIA
2015	Point Noire	*Phataginus*	Whole	7	Chimpanzee skulls	PALF
2015	–	*Smutsia*	Whole	1	–	PALF
2018	Sibiti, Lekoumou Department	*Smutsia*	Scales	1 bag	3 ivory tips	Robin Des Bois
Nigeria						
Data for Nigeria came solely from EIA records and those collated by the authors from media records.						
2016	Lagos	-	Scales	8 bags	678 pieces of ivory	EIA
2018	Ikeja, State of Lagos	-	Scales	10263 kg	–	Robin Des Bois
2018	Lagos	-	Scales	2001 kg	343 kg ivory	Robin Des Bois
2018	Lagos	-	Scales	200 kg	–	Author search
2018	Lagos	-	Scales	1031 kg	4 pieces elephant tusk	Author search
Benin						
AALF-Benin has been a member of the EAGLE Network since 2014, with data available between August 2015 and July 2018.						
2016	Cotonou	*Smutsia*	Scales	70 kg	–	EIA
2017	Dassa-Zoumé		Whole	2	–	AALF-Benin
2018	Cotonou airport	-	Scales	513		Author search

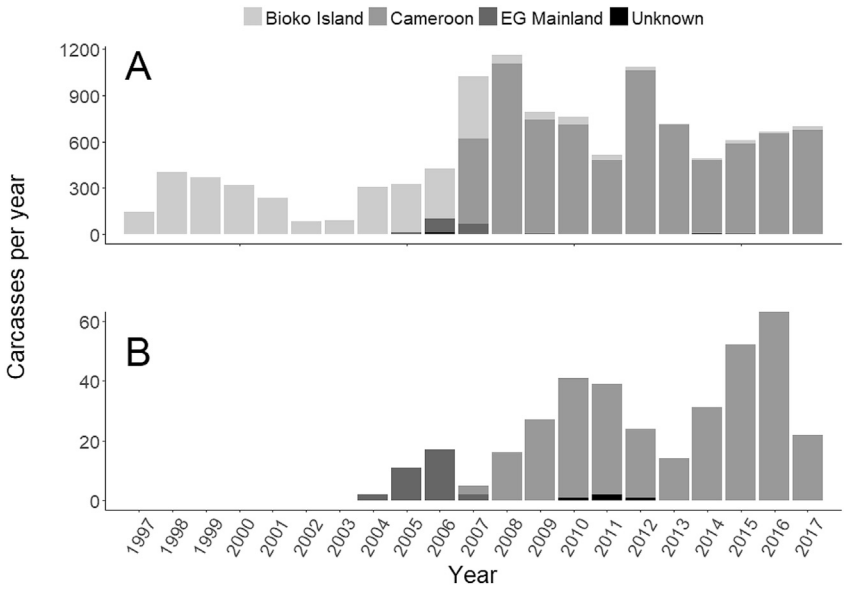

Fig. 2. The number of arboreal pangolins (*Phataginus* sp., A) and giant pangolin (*Smutsia gigantea*, B) carcasses per year at Malabo wild meat market, Bioko Island, Equatorial Guinea. Shades of grey refer to whether pangolins came from Bioko Island, Cameroon, Bata (Equatorial Guinea mainland), or an unknown location. Data from 1997 includes October–December; data for 2017 includes data for January–November inclusive.

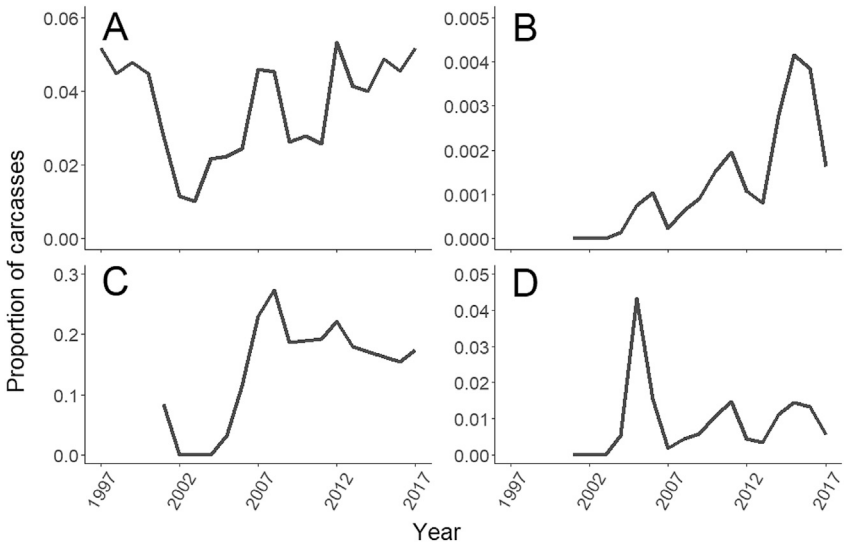

Fig. 3. The proportion of the total number of carcasses on the Malabo wild meat market (Equatorial Guinea) that were arboreal pangolins (*Phataginus* sp., A) and giant pangolins (*Smutsia gigantea*, B), and the proportion of the total number of imported carcasses that were arboreal pangolins (C) and giant pangolins (D).

applied to 96% and 96.7% of *Phataginus* and *Smutsia* individuals respectively. Shotguns were used in 4% of *Phataginus* kills and in 3.9% of *Smutsia* kills.

Price data for 11128 whole *Phataginus* sp. between October 1997 and November 2017, and 357 *Smutsia* sp. between February 2004 and November 2017 indicate prices increased over time. Prices increased significantly for both *Phataginus* sp. (Chi: $p < 0.000$; Fig. 4A) and *Smutsia* sp. (Chi: $p < 0.000$; Fig. 4B) but appear to have remained stable since 2008 at the Malabo market. The price increase between 2004 and 2008 for *Smutsia* sp. corresponds to pangolins being shipped to the market from the mainland, most noticeably from Cameroon. Across all years, the adjusted price of *Phataginus* sp. from Bioko Island was significantly lower (mean = 15900 CFA) than those from mainland Equatorial Guinea (mean = 19600 CFA; $p < 0.000$) and Cameroon (mean = 20400 CFA; $p < 0.000$). Furthermore, *Smutsia* sp. imported from Cameroon (mean = 139700 CFA) were significantly higher than those imported from the Equatorial Guinea mainland (mean = 60100 CFA; $p < 0.000$).

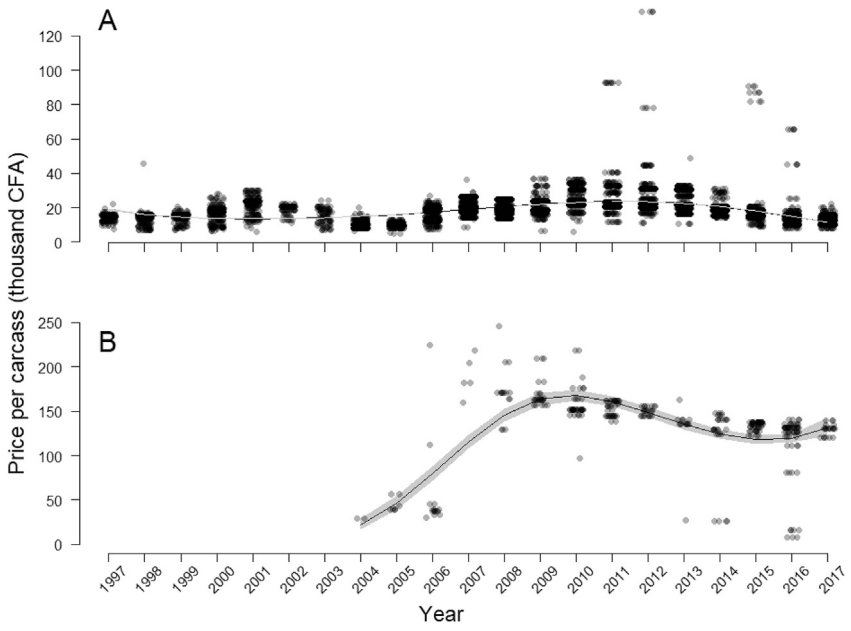

Fig. 4. 2018 real price of arboreal pangolin (*Phataginus* sp., A) and giant pangolin (*Smutsia gigantea*, B) carcasses at the Malabo wild meat market, Bioko Island, Equatorial Guinea. Points are jittered and transparent to show sample size. Lines show model fit, and grey shading shows confidence intervals. USD 1 = CFA 572.

4. Discussion

Until the last five or so years, trafficking in African pangolins has gone largely unnoticed. However, over the past decade the international, commercial trafficking of pangolins, almost exclusively scales, to meet demand in Asia has seemingly been increasing, while populations of Asian pangolins have continued to decline. Recognising this international illegal trade trend, and the recent inclusion of all pangolins in CITES Appendix I, our aim was to investigate the role that the Gulf of Guinea countries play in pangolin trade and trafficking to inform conservation and policy actions.

Asia represents the largest global market for pangolins and their derivatives, with China being the largest market (Challender and Waterman, 2017). In Asia, pangolin scales are used in traditional medicines, and other products such as wine are also consumed (Nijman et al., 2016). In addition to several Southeast Asian countries supplying China, Cheng et al. (2017) found that Nigeria, Cameroon and Kenya were also key sources of pangolins in China. Our study corroborates this; at the international level, we found that the majority of seizures that could be directly linked to Asia were consignments of pangolin scales that were either exported from or originated in Nigeria and Cameroon. There are likely biases in the differences in enforcement effort across airports, ports, and roads; we expect that enforcement efforts are higher at airports, which could explain why the largest number of seizures were made at airports. Thus, the trafficking rates we present here are likely conservative. Moreover, seizures may be highest in Nigeria and Cameroon because of the relatively good infrastructure, and existence of established trafficking routes for other species (e.g. ivory, leopard skins, live parrots; UNODC, 2016).

Within-country seizure data was available for Cameroon, a country implicated in the intercontinental trafficking in pangolins, and where the enforcement activities of the EAGLE network have been conducted over the longest time-period. Our analyses suggest that in Cameroon, illegal trade in *Smutsia* sp. has shifted from meat to scales, from approximately 2013 onwards, although we recognise that our results may be biased by law enforcement effort. Nonetheless, these results suggest that in Cameroon, knowledge that pangolins and their scales are sought after in Asia has spread. However, trafficking dynamics are not yet fully understood; it is not yet clear whether pangolin scales are sourced from the wild meat trade or whether pangolins are being hunted for scales in addition to wild meat. Our results indicate that traffickers of pangolins in Cameroon were also illicitly trading other protected species (e.g., elephants, gorillas and chimpanzees), suggesting that pangolin traffickers are part of organised criminal groups (UNODC, 2016). This observation suggests that focused law enforcement efforts that target traffickers of other high value protected species could help reduce the trafficking of pangolins, though increased intelligence is also needed. Seizures were made in 6 other countries in the region, and whilst data is limited due to the recent establishment of the organisations involved, many of the seizures involved other protected species.

From market time-series data on Bioko Island, Equatorial Guinea, we found that both genera of African pangolins were openly sold in the capital city, and *Phataginus* sp. were continuously sold over the 20-year sampling period. We identified a shift in the source of *Phataginus* sp. at the market, originally sourced from Bioko Island, shifting largely to Cameroon from 2007 onwards. This shift in the source may suggest that pangolins on Bioko Island (*Phataginus* sp.) have been depleted in areas that are easily accessible to hunters (i.e. commercial extinction), as has been shown for monkeys on the island (Cronin et al.,

2017), but further investigations are needed. Furthermore, before imports began from the mainland the number and proportion of carcasses on the market that were pangolins was decreasing, whereas after imports began in 2003 the proportion increased. *Smutsia* sp., which do not occur on Bioko Island, have been openly sold at the Malabo market every month since 2004. All *Smutsia* carcasses arrived at the market from Cameroon or mainland Equatorial Guinea. These findings demonstrate a lack of law enforcement at ports in Cameroon for shipments to the market in Malabo. While the pangolins were illegally sold openly at the market prior to 2003, the legality of *Phataginus* sp. and *Smutsia* sp. being sold on the market after 2003 is unclear (see Introduction), which could be a reason for why they (particularly *Smutsia* sp.) continued to be sold on the Malabo market. In comparison, in Ghana, where hunting and possession of pangolins is prohibited, McNamara et al. (2015) reported only one pangolin at Atwemonom market between 1978 and 2004 (26 years), though the same study reported that during visits to the market in 2011 pangolins were observed for sale daily. Furthermore, in a survey of urban wild meat markets in the coastal Cross-Sanaga rivers region of Cameroon, it was estimated that 2811 *P. tricuspis* and 2 *S. gigantea* were offered for sale over a year (2002/2003 when pangolins were not protected), compared to the urban markets on the Nigerian side of the region where 40 *P. tricuspis* were estimated to be sold, and where pangolins were protected by law (Fa et al., 2006). At the Malabo market, we also found that price increases for *Smutsia* sp. between 2004 and 2009 coincides with the shift to sourcing these pangolins from Cameroon, rather than the mainland of Equatorial Guinea. The adjusted price of *Phataginus* sp. increased gradually over time, but reflects increases accrued from shipping pangolins from the mainland.

Increases in the number of pangolins being sold at the Malabo market could be due to general increases in hunting wildlife for commercial purposes in recent decades in Central Africa (Abernethy et al., 2016). However, the law enforcement data analysed suggests that pangolins have not only been sold for meat in recent years (i.e., also scales), but that the trade may have changed primarily from meat to scales, at least based on the analyses presented here. For one of the seizures included in our analyses, an arrested trafficker of Nigerian nationality, was reported to regularly source pangolins from across Gabon, the Republic of Congo and from the Nigeria-Cameroon border area to supply Chinese clients with scales; the trafficker was apprehended in Cameroon with 12 elephant tusks and 200 kg of pangolin scales in 2016 (EAGLE, 2016). These trends present a threat to *S. gigantea* in particular. Studies across the region have reported that *S. gigantea* populations have declined in Korup National Park in Cameroon between 1999 and 2009 (Ngoufo et al., 2014), and in Liberia (Flesher, 2013). Similarly, others have stated that *S. gigantea* have likely been extirpated from the Rumpi Hills in Cameroon (Laurent, 1992), the Dassioko Sud Forest Reserve in Côte d'Ivoire (Gonedelé Bi et al., 2016), and from Cross River National Park in Nigeria (Enuoh and Bisong, 2014).

We have highlighted the international trafficking of pangolins through countries in the Gulf of Guinea, and in particular, we highlight this threat to *Smutsia* sp., primarily the giant pangolin. The Gulf of Guinea countries are home to three of the eight species of pangolin, and if concerted efforts are not made to protect African pangolins, their trajectory could well follow that of their Asian counterparts. To ensure the future of African pangolins in the Gulf of Guinea, we recommend the following research needs and urgent actions based on our results.

Research needs:

- Research, and increased funding to conduct the research, is urgently needed in the Gulf of Guinea, but also in West and Central Africa more broadly, to gain a deeper understanding of where people are sourcing pangolins, hunting rates (including protected areas), the drivers of pangolin hunting, and trafficking dynamics. Critically, whether pangolin scales are sourced as a by-product of the current wild meat trade, or whether pangolins are specifically targeted for their scales to supply international demand.
- There is an equally urgent need to undertake ecological monitoring of pangolin populations, particularly on Bioko Island and in Cameroon and Nigeria based on our analyses, to inform and direct further protection and conservation efforts.
- Current legislation and enforcement efforts in Gulf of Guinea pangolin range states need to be critically evaluated, focussing especially on gaps in legislation, the effectiveness of current penalties, and the likelihood of detection to act as a deterrent for different actors involved in trafficking, including organised criminals.

Urgent actions include:

- Increase and enhance law enforcement measures and equipment (e.g. industrial scanners), particularly at key transport hubs, such as key airports and ports, and along international borders in order to intercept international shipments, and field-to-market transit choke-points to interrupt trafficking chains.
- An updated endangered species list should be produced and distributed by the government of Equatorial Guinea to accompany the most recent wildlife protection laws, so that enforcement officials have a mandate to enforce the law.
- Actively increase capacity building, government support, resources (e.g. sniffer dogs) and training programmes in the region, particularly on Bioko Island (including for officials working in protected areas) and identified trafficking routes. For example, training for enforcement officials and police regarding the status of wildlife and environmental laws, identification of pangolins and their parts (Challender and Waterman, 2017), and how to effectively enforce legislation.
- Pangolins are often killed by indiscriminate snaring (Ingram et al., 2018), the use of which is illegal in many areas, thus enforcement of snare bans and increased access to alternative hunting means are needed in areas where hunting of species is permitted for subsistence purposes (e.g. traditional species-specific traps).

- Transnational collaboration between law enforcement agencies and networks (e.g. Wildlife Enforcement Networks [WENs] and through Interpol operations) in West and Central Africa to promote greater intelligence gathering and sharing and increase regional and sub-regional enforcement efforts.

Conflicts of interest

The authors declare no conflicts of interest.

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