

The emergence of a commercial trade in pangolins from Gabon

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Abstract

Recent seizures of illegally held wildlife indicate a mounting global trade in pangolins involving all eight species. Seizures of illegally traded African pangolins are increasing as wild populations of Asian species decline. We investigated trade in pangolins and law enforcement efforts in Gabon; a country likely to have intact wild populations of three of the four species of African pangolin. We compared village sales and trade chains between 2002-2003 and 2014. Hunters reported pangolins to be the most frequently requested species in 2014, and the value of pangolins had increased at every point along their trade chain. In Libreville, giant pangolin prices increased 211% and arboreal pangolin prices 73% whilst inflation rose only 4.6% over the same period. We documented a low rate of interception of illegally traded pangolins despite increased law enforcement. Surveys of potential export routes detected exports across forest borders, in conjunction with ivory, but not through public transport routes. We conclude that whilst there is clear potential and likelihood that a wild pangolin export trade is emerging from Gabon, traditional bushmeat trade chains may not be the primary supply route. We recommend adjusting conservation policies and actions to impede further development of illegal trade within and from Gabon.

Des saisies récentes de produits de faune sauvage illégaux indiquent qu'il y a un commerce mondial croissant de pangolins, qui concerne les huit espèces. Les saisies de pangolins africains illégalement trafiqués sont en augmentation parce que les populations sauvages de pangolins asiatiques déclinent. Nous avons enquêté sur le trafic de pangolins et les efforts de maintien des lois au Gabon, un pays qui était susceptible d'abriter des populations sauvages intactes de trois des quatre espèces de pangolins africains. Nous avons comparé les ventes dans les villages et les réseaux commerciaux entre 2002-3 et 2014. Les chasseurs disaient que les pangolins étaient les espèces les plus souvent recherchées en 2014 et que leur valeur avait augmenté à chaque maillon de la chaîne commerciale. À Libreville, les prix du pangolin géant ont augmenté de 211% et ceux du pangolin arboricole de 73% alors que l'inflation n'a augmenté que de 4,6% sur la même période. Nous n'avons relevé qu'un faible taux d'interception de pangolins trafiqués malgré un renforcement du maintien des lois. Les études des voies d'exportation éventuelles ont détecté des

exportations à travers les frontières forestières, conjointement avec l'ivoire, mais pas par les routes de transports publics. Nous en avons conclu que s'il existe une possibilité, voire une probabilité qu'un trafic d'exportation de pangolins sauvages soit en train d'émerger au Gabon, les voies traditionnelles du commerce de viande de brousse pourraient ne pas être les premiers axes de fourniture. Nous recommandons d'adapter les politiques et les mesures en matière de conservation pour ralentir la progression du commerce illégal à l'intérieur et vers l'extérieur du Gabon.

KEYWORDS

bushmeat, Gabon, hunting, illegal wildlife trade, pangolins

1 | INTRODUCTION

Although trade in wildlife products is an ancient human endeavour, wild populations of many species are currently suffering declines as demand in global markets drives unsustainable exploitation. Drastic population declines attributed primarily to commercial harvests are reported in diverse terrestrial and marine taxa and IUCN's (International Union for Conservation of Nature) The Red List of Threatened Species™ now lists 8,613 species as threatened by overexploitation worldwide (IUCN, 2014; Ripple et al., 2016). The majority of impacts on terrestrial species are felt in tropical regions (Dirzo et al., 2014), and of these, mammals suffer more than any other species group (Ripple et al., 2016).

Commercial exploitation has been the key factor in the rapid decline of wild populations of Asian pangolin species in recent decades (Challender, 2011; Challender, Harrop, & Macmillan, 2015). Unsurprisingly, this has led to an overall rise in international trade as well as trafficking of African pangolins, primarily their scales, to Asia (Challender & Hywood, 2012; Challender & Waterman, 2017; Newman, Macdonald, & Zhou, 2014; Nijman, Zhang, & Shepherd, 2016). Increasing global economic and trade links but particularly new links between African nations and East Asia have possibly facilitated this trade (Challender et al., 2016; Wang & Bio-Tchané, 2008). The vast majority of international demand for pangolins comes from Asia, and in particular China and Vietnam (Challender et al., 2015; Nijman et al., 2016). However, exact countries of origin of traded African pangolins, which are found in many range states, are unattributed for the majority of seizures made (though see Challender & Waterman, 2017). Over the past decade, China has developed increasing economic ties with Africa, in particular through direct investment (Abernethy, Maisels, & White, 2016) and Chinese companies now have permanent bases, resident workers and administrative networks in countries across the continent (Putzel et al., 2011; Wang & Bio-Tchané, 2008).

Based on available evidence, which is likely to be a partial picture, international seizures of illegally traded products from African pangolins are increasing. Four kg of African pangolin products was seized in 2008, 312 kg in 2012, four tonnes of scales were seized in Cameroon in 2016 and another 5.4 tonnes were seized in early

2017 (LAGA, 2017), this last representing 10,000–20,000 pangolins (see Challender & Waterman, 2017 for a comprehensive overview of global seizures). This is ostensibly an exponential rise which, despite some targeted international law enforcement efforts, may be signalling a mushrooming illegal trade, rather than dramatic improvements in the detection of trafficking.

Gabon is home to three of the four African species of pangolin, the fossorial giant pangolin (*Smutsia gigantea*, Illiger 1815); and the arboreal white-bellied pangolin (*Phataginus tricuspis*, Rafinesque 1821) and black-bellied pangolin (*Phataginus tetradactyla*, L. 1766) (Kingdon & Hoffman, 2013). Giant pangolins have been integrally protected nationally since 1987 (Republique Gabonaise, décret n° 189/PR/MEFCR), but both *Phataginus* (arboreal) species can be legally hunted locally, although hunting methods, catch sizes, seasons and trade are regulated. However, despite regulation, a nationwide 6-year survey of sixteen bushmeat markets (2000–2006) recorded arboreal pangolins in all markets in all months, accounting for 10% of all animals traded annually (Abernethy & Ndong Obiang, 2010). In 2-year-long village hunting studies during the same period, white-bellied pangolins were caught by village hunters every month and formed approximately 6% of all animals caught annually (Coad, 2007; Van Vliet, 2008). There is no census data for any pangolin species in the wild in Gabon.

In the face of the global rise in illegal wildlife trade in recent years and in particular the threat to African mammals (Kasane Statement on the Illegal Wildlife Trade, 2015; London Declaration on the Illegal Wildlife Trade, 2014), anti-poaching efforts have been increased in Gabon and in particular for species likely to be at highest risk. Sniffer dogs trained for the detection of ivory, ape and pangolin products have been working at roadblocks, railway stations, airports and seaports since 2013, in an effort to intercept wildlife being traded illegally.

In this first evaluation of trade risk to Gabonese pangolins, our specific objectives were to:

1. describe the current trade of pangolins in rural areas and rural-to-urban scenarios;
2. evaluate the extent of change over the past decade in the species and relative value of species involved this trade, with

particular attention to change in the value of pangolins relative to other species;

3. assess the extent to which rural hunting communities may be the source of pangolins for export or whether the species are potentially sourced out with the traditional bushmeat trade;
4. evaluate the trade routes for pangolins within and from Gabon,
5. evaluate the current control of trade; and using the data we acquire for points 1-4;
6. propose actions to more effectively combat any emerging high-value trade in these species outside the traditional subsistence economy.

To address these objectives, we collected data in traditional subsistence villages on hunter sales; trade prices at the “forestgate”; in the provincial town markets supplied and in the capital; and law enforcement efforts in 2014. We compared our results to existing data collected variously between 2000 and 2006.

2 | METHODS

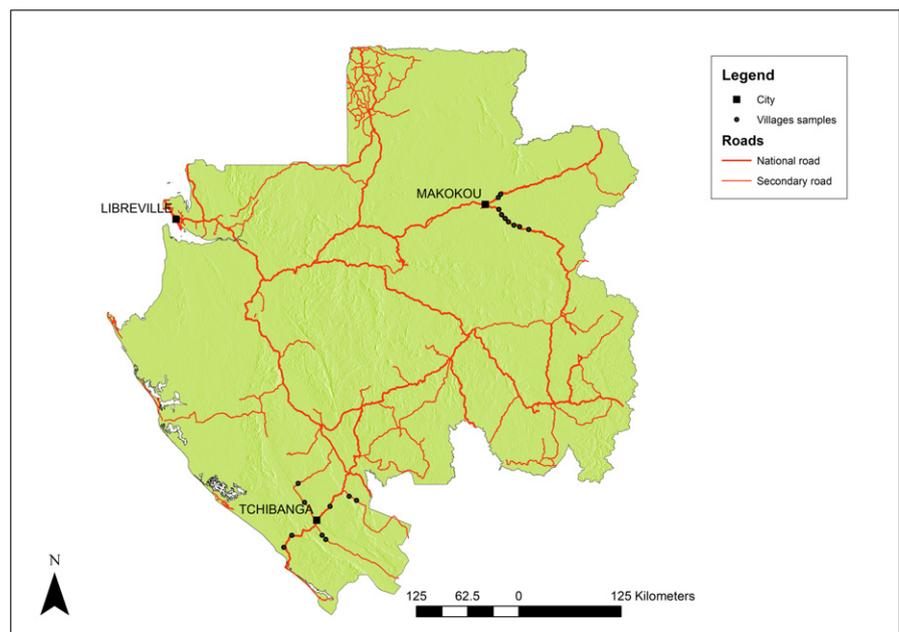
2.1 | Village hunting and “forestgate” trade in 2014

Pangolin offtake and sales were assessed in local communities living in rural subsistence economies (which include hunting for meat and income). The hunted areas were not protected areas, and arboreal pangolins could be legally hunted under traditional customary rights. We assessed the numbers of pangolins traded in 2014 from villages in the Ogooué-Ivindo and the Nyanga provinces in Gabon both to local clients and, via roadside sales to traders, into larger markets. The two key provinces were chosen for the following reasons: (i) comparative data were available from the previous decade (Abernethy & Ndong Obiang, 2010; Okouyi Okouyi, 2006); (ii) both provinces have relatively recently seen the arrival of populations of

migrant Asian workers, specifically in the construction, agro-industrial and logging industries (Oxford Business Group, 2015); and (iii) these areas broadly represent the two major catchment habitats of completely forested (Ogooué Ivindo) and savannah/forest mosaic (Nyanga) found in Gabon. Surveys of village hunters were made in the dry season during a 43-day study period in the Ogooué-Ivindo (June-July 2014), and a 10-day period in the Nyanga (early August 2014). During these studies, 24 villages were surveyed (Figure 1). Surveys comprised data collection on village characteristics (questionnaires filled by the village chief or elder hunter) and semi-structured interviews with hunters on hunting activity, client requests, sales and revenues from the past month. Examples of the questionnaires are given in Supplementary Materials and can also be found in Baker (2014) and Mambeya (2015).

A total of 138 villagers participated in the research. Of these initial survey respondents, 69 villagers in ten villages in the Ogooué Ivindo and 34 villagers in ten villages in the Nyanga (total 103) reported hunting actively and were further interviewed. Villages ranged from 64–800 people (median 200) with between one and fifteen hunters (median 4). All interviewed hunters were men, aged between 16 and 70 years, with the majority in the 31- to 50-year-old age class (57.3%). Over 90% of interviewees were native to the village (born there or living with family born there) and gave subsistence as their primary reason for hunting. Culture, protection of plantations and supplementary income were also reasons (9.3%), but no hunter reported even legitimate local commercial trade as their primary motivation for hunting. Hunters used guns (47.6%) or snares (28.1%) or both (24.3%) and all hunters reported hunting within 1 day’s walk from their village without using camps. Comparison with available literature shows that these village hunting communities conform to previously established profiles for subsistence communities in Gabon in terms of hunter ages, hunter numbers per village, hunting catchment distances from the village (1 day’s walk or max 10 km), species

FIGURE 1 The study sites in Gabon. Libreville is the national capital city and Makokou and Tchibanga are provincial capitals. Hunters were interviewed in the villages (shown as black dots) supplying these two provincial town markets. Villages in Gabon are generally situated along the road network, in similar densities to those shown around the two provincial towns studied



caught, percentages traded and price equivalency between species (Coad, 2007; Foerster et al., 2011; Okouyi Okouyi, 2006; Starkey, 2004; Van Vliet, 2008).

2.2 | Village surveys in 2002-2003 and change over time 2002-2014

Detailed studies of village hunting had been carried out in 2002-2003 in the Ogooué-Ivindo (Okouyi Okouyi, 2006) which allowed us to analyse changes over time in local farmgate, or rather “forest-gate,” sale prices for the Ogooué Ivindo. Data on date, time and location of sale, species sold, carcass state (whole or butchered parts, fresh or smoked) and price obtained were collected over 14 months in 2002-2003 in six villages around Makokou (detailed methods in Okouyi Okouyi, 2006) and Makokou market itself. Comprehensive surveys of sixteen town and village markets in Gabon from 2000 to 2006 showed that prices did not fluctuate significantly between seasons of a year (Abernethy & Ndong Obiang, 2010); however, hunter offtake rates could alter between seasons (Coad, 2007). We limited the hunter sales data analysed from 2002 to 2003 to the months of May–August (dry season) to limit any potential bias of offtake volume or composition on hunter trade decisions between the compared study periods.

2.3 | Change in relative value of species, within and along the traditional trade chain

To investigate change over time in the relative value of traded bushmeats, we looked specifically at the Ogooué-Ivindo market chain, from which we had comparable data from 2002 to 2003 and 2014. Market surveys in Makokou and surrounding villages were carried out for all sales in six markets on 1 day/week during 2002-2003 and one to 3 days per location during 3 months May–July in 2014. Data from Libreville Mont Bouët market, also collected from 2002 to 2003, allowed analysis of the evolution of

relative value of species over the past 12 years for these locations. We included the five most common other species groups recorded in our national surveys in both 2002-2003 and 2014 (blue duiker (*Philantomba monticola*, Thunberg 1822), brush-tailed porcupine (*Atherurus africanus*, Gray 1842), red duikers (*Cephalophus* spp.), red river hog (*Potamochoerus porcus*, L. 1758) and guenons (*Cercopithecus* spp.) and both pangolin types (Table 1). Prices were standardized to per kg prices for comparisons between species, using mean weights of hunted animals recorded directly in villages in Gabon (Abernethy & Ndong Obiang, 2010; Coad, 2007). For comparison of the price of the same species over space and time, we used sales of whole animals only to reduce inherent noise from standardizing weights of butchered animals. We did not use a purchasing power parity or Consumer Price Index (CPI) correction between years, as inferences were drawn from the relative rank value of traded species across space, rather than from their absolute values. However, between the start of 2002 and the end of 2014, Gabon's inflation (percentage change in CPI) was approximately 4.6% (World Bank, 2017), thus a rise of up to 5% in absolute value of products, may not indicate any real change over time in value relative to other products.

2.4 | Law enforcement in 2014

One-day surveys at potential export locations in the capital, Libreville (seaport, airport, train station and bus station) were carried out in collaboration with law enforcement agencies and concentrated on current practices used for interception of illegal trade and collation of annual seizures, rather than numbers seized during the survey days. Nationwide data on seizures of pangolins or pangolin products were obtained from all relevant government agencies (Ministry of Forests and Protection of the Environment (*Ministère des Forêts de de la Protection de la Nature*), the Convention on International Trade in Endangered Species (CITES) Management Authority for Gabon, National Police Force (*Gendarmerie Nationale*), the Border Police

TABLE 1 Hunter sale ‘forestgate’ price changes over 12 years from 2002-2014 in the Ogooué Ivindo villages

Species group	Body Weight (kg)	2002			2014			Price increase (% 2002)
		Price/kg FCFA (SD)	Equivalent Price/kg US \$ (SD)	N	Price/kg FCFA (SD)	Price/kg US\$ (SD)	N	
Red duiker	16.2	661 (126)	1.19 (0.23)	347	715 (239)	1.29 (0.43)	72	8
Arboreal pangolin	1.8	1,252 (209)	2.25 (0.38)	16	1,359 (334)	2.45 (0.60)	57	9
Blue duiker	4.2	744 (182)	1.34 (0.33)	34	879 (312)	1.58 (0.56)	56	18
Brush tailed porcupine	3.4	1,013 (175)	1.82 (0.31)	63	1,240 (257)	2.23 (0.46)	58	22
All species		761 (236)	1.37 (0.42)	966	1,008 (400)	1.81 (0.72)	515	32
Red river hog	55.0	569 (97)	1.02 (0.17)	73	765 (301)	1.38 (0.54)	91	34
Guenon	4.0	676 (204)	1.22 (0.37)	36	945 (619)	1.70 (1.11)	25	40
Giant pangolin	28.8	874 (598)	1.57 (1.08)	53	1,325 (517)	2.38 (0.93)	66	52

Data from the 2002-2003 sample were limited to records from May–September for comparison to the 2014 sampling period. The lines for pangolin records are shaded.

(Police des Aires et Frontières), Customs (Douanes Nationales) and National Parks Agency (Agence Nationale des Parcs Nationaux; ANPN) for assessment of law enforcement efforts (2012-2015) and potential export routes.

3 | RESULTS

Hunters and traders did not reliably differentiate between the two *Phataginus* species of pangolin in either the 2014 surveys or the 2002-2003 village studies; thus, data are given collectively for “arboreal pangolins.”

3.1 | Village hunting and “forestgate” trade in 2014

Of village hunters who gave information on sales (90/103), all hunters reported catching an arboreal pangolin “commonly” and 89% of hunters reported sale of an arboreal pangolin in the past 3 months.

The average price per kg for all bushmeat carcasses recorded as sold at the roadside in villages was not significantly different between the two provinces. Mean 2014 roadside price for all bushmeat was 1008 ± 400 FCFA (US\$1.81 \pm 0.72) per kg for 514 records from hunter sales. Figure 2 shows mean price per kg for all sales reported by hunters in 2014. Both types of pangolin sold at a higher price per kg than the mean price of all bushmeat: whole arboreal pangolins (estimated at 1.8 kg from a sample of 93 hunted animals weighed in Gabon; Coad, 2007, Hymas, unpublished data) were sold at a mean roadside price of $2,447 \pm 930$ FCFA (US \$4.40 \pm 1.67), equivalent to $1,359 \pm 517$ FCFA (US\$2.45 \pm 0.93) per kg ($n = 65$ sales observed during field study). Giant pangolins (estimated at 28.75 kg) sold at the roadside at a mean price of $38,100 \pm 17,822$ FCFA (US\$68.39 \pm 32.07) equivalent to $1,325$ FCFA (US\$2.38 \pm 1.28) per kg ($n = 25$).

3.2 | Expressed demand for pangolins in rural areas in 2014

The majority (70%) of hunters reported only selling their meat opportunistically. Of the 30% of hunters that took orders for meat before hunting, 34% of their customer base (by number of clients) were Asian immigrants, although hunters did not know the particular nationality of individual clients. All hunters that took orders for meat before hunting were from the Ogooué Ivindo. Meat orders placed by Asian clients were heavily biased to pangolins (Figure 3). Hunters and village chiefs reported no knowledge of hunting in the forest by immigrant workers themselves, in either province.

3.3 | Change in rank position of pangolin species within the traditional bushmeat trade

Sixteen species were recorded in the markets in 2014. The top five species, or species groups, sold by total number of carcasses in all markets were, in rank order; blue duiker (26.1% carcasses), brush-tailed porcupine (20.3%), red duikers (18.8%), red river hog (9.4%) and guenons (7.2%). Arboreal pangolins were the sixth most traded species, forming 4.3% of all carcasses and giant pangolins were the seventh most traded species, forming 3.6% of all carcasses sold.

3.4 | Change over time and space in market value

The price of any bushmeat at the forestgate in Ogooué Ivindo had risen from a mean 761 ± 236 FCFA (US\$1.31 \pm 0.42) per kg in 2002-2003 to 1008 ± 400 FCFA (US\$1.81 \pm 0.72) in 2014, an increase of 32% of the 2002 price. Pangolins were traded at above average per kg prices in both 2002 and 2014, but the relative price increase was far greater for giant pangolins, which sold in 2014 for 52% more than their 2002 price, whilst the price of arboreal pangolins had only risen by 9% on the 2002 forestgate value.

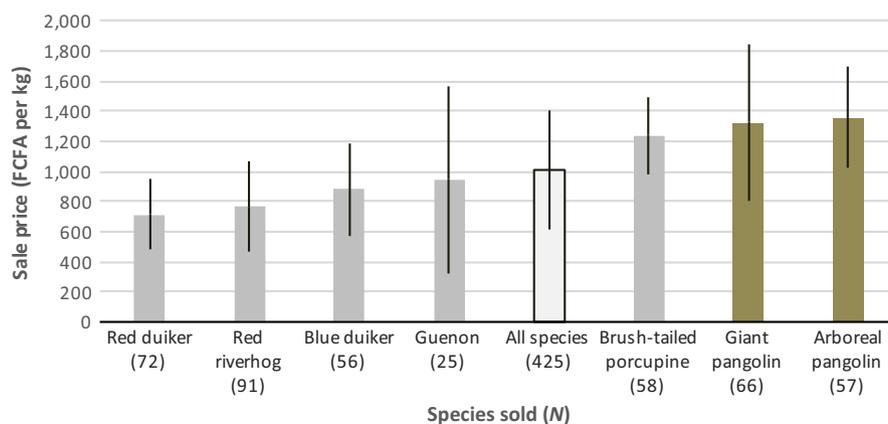


FIGURE 2 Mean price per kg FCFA (\$1USD = 555 FCFA) for species sold by hunters at the forestgate in 2014 (N sales). Error bars represent the SE of prices. Bodyweights were taken from empirical data for weighed carcasses in Gabon (Abernethy & Ndong Obiang, 2010 & Coad, 2007). At equal meat value, by bodyweight, giant pangolins would be expected to sell for a similar price to red duikers and red river hog, approximately half their actual sale price. The bar for the mean of all species is shown in white and bars for pangolin species in brown

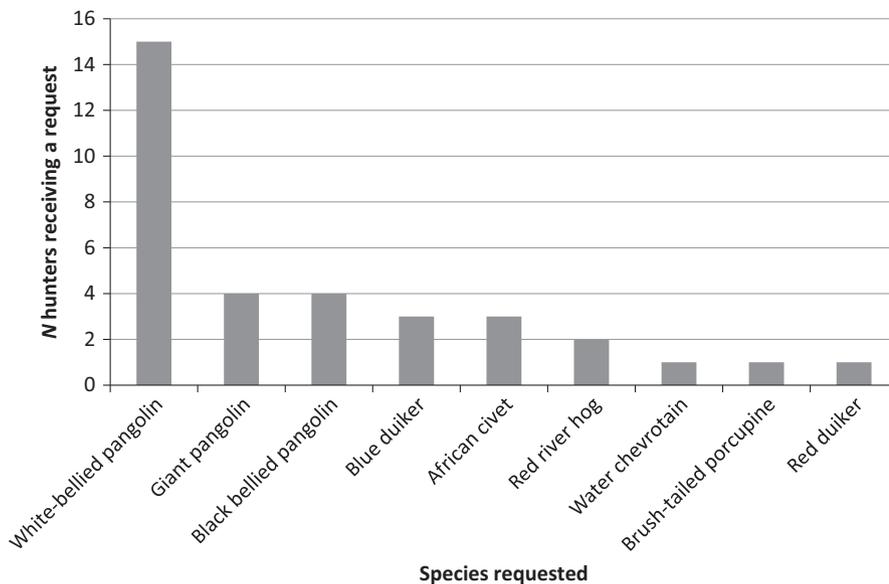


FIGURE 3 Requests received from locally based Asian industrial workers between March and May 2014 by hunters from surveyed Ogooué-Ivindo villages, for supply of particular species ($N = 34$ specific requests recorded)

Using prices of whole animals of the most common and comparable species; blue duikers and brush-tailed porcupines account for around 50% of all sales, Makokou town prices for whole, fresh animals had risen from 3631 ± 1177 FCFA (US\$6.53 \pm 2.12) to 5453 ± 1297 FCFA (US\$9.81 \pm 2.33) per carcass, and Libreville prices had risen from 8455 ± 1716 FCFA (US\$15.22 \pm 3.09) to 15700 ± 4461 FCFA (US\$28.26 \pm 8.03), relative rises of 50% and 87% on 2002 prices. During the same period, the average price of giant and arboreal pangolins in Libreville rose by 212% and 74%, respectively (Figure 4).

3.5 | Law enforcement

During 2014, government wildlife law enforcement teams with sniffer dogs carried out 209 control missions on potential export routes at the Libreville seaport and airport, the N1 major road artery into and

out of Libreville and the train station. Daily controls without dogs also operated at five roadblocks on major road arteries across the country. Standard customs controls not specialized to wildlife issues also operated on all flights departing the international airport and ships departing the seaport. Illegally held pangolins were located and seized on only four occasions: three on the N1 road and one at the train station, recovering in total twelve arboreal pangolins, equivalent to approximately 21 kg total weight. In 2015 (January-June) teams working at the same locations made one seizure of scales in the town of Oyem. These scales were reportedly destined for a Chinese buyer in Equatorial Guinea who regularly placed orders with Gabonese hunters and were associated with a seizure of ivory. No seizures of pangolins or products were made at the international transport hubs.

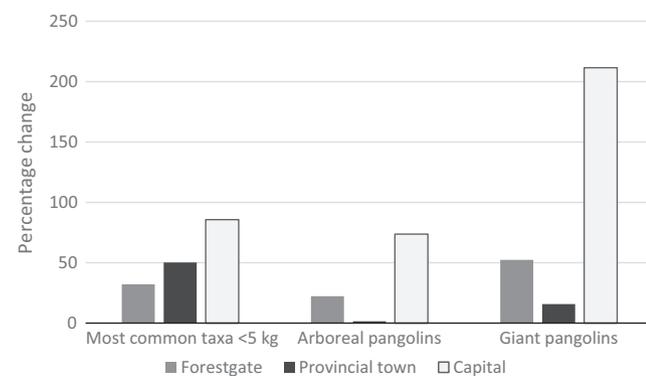


FIGURE 4 Percentage (of earlier price) rise in mean price between 2002-2003 and 2014 for whole animal sales of (a) most commonly sold taxa under 5 kg (palm civet, blue duiker, brush-tailed porcupine, arboreal pangolins and guenons) (b) arboreal pangolins (c) Giant pangolins recorded from forestgate villages, Makokou town and in Libreville's largest market (Mont Bouët)

4 | DISCUSSION

We set out to describe the current position of pangolins within the traditional subsistence trade chain, to evaluate the extent of change over the past decade in the trade from forestgate to city, and to assess the extent to which rural hunting communities may be a source of pangolins for international trade, and how and where illegal trade may be emerging. We have found that

1. Frequency of sale of pangolins, particularly giant pangolins, may be increasing within the traditional bushmeat market chains, but that these increases are (as yet) small and may not reflect an increase in hunter offtakes for arboreal pangolins. In 2000-2006, although giant pangolins were recorded in trade, the species did not appear in the eighteen most commonly traded species from a comprehensive survey across Gabon (Abernethy & Ndong Obiang, 2010). Yet, in our 2014 study, they are the seventh most traded species. It is likely that their sale frequency has risen overall in our study areas and possibly nationwide.

2. All pangolins have increased in value over time, relative to other species within the existing bushmeat trade structure. Relative value increases are most extreme in most urban areas and smaller in rural areas. This is consistent with the absence of a high-value trade developing from within the traditional market trade and otherwise primarily involving village hunters.
3. Specific demand for pangolins expressed to village hunters is high in certain areas relative to expressed demand for other species, and particularly for consumption by the immigrant Asian population.
4. Giant pangolins have become relatively more valuable than arboreal pangolins, which is in line with their much higher weight of scales, if scale price is a determinant of value.
5. Despite an intensification of law enforcement effort to detect pangolin trafficking, no movement through public international or domestic transport hubs has been detected. Instead, a very small number of informal trade routes have been found across forest borders where no enforcement is routinely made. It is probable that clients within established illegal trade chains for ivory may also be expressing a demand for pangolin scales.

There is little evidence from our surveys of village hunters that they are engaging at present in hunting pangolins for more commercial purposes, nor in greater numbers, than in 2002-2003. The top five species reported by hunters in this study as most frequently caught are very similar to those found by hunter studies a decade ago (the top five species in 2014 village catches were also found in the top eight species in all 2002-2006 studies: Okouyi Okouyi, 2006; Coad, 2007; Van Vliet, 2008). These results suggest that this hunting is still primarily oriented towards subsistence, rather than newer commercial possibilities associated with intercontinental trafficking. Although village hunters are experiencing high local demand for pangolins from Asian immigrant workers and are providing supply, it would be possible to achieve more pangolin sales in 2014 than in 2002-2003 without initially increasing offtakes. Coad (2007) found village hunters traded only 10% of the pangolins they hunted, consuming the rest at home. Thus, there is significant potential for increased trade to be recorded without necessarily increased offtakes, simply by hunters deciding to sell, rather than consume, their catch.

Arboreal pangolins were only the tenth and twelfth most traded species in markets nationally between 2000 and 2006 (Abernethy & Ndong Obiang, 2010), yet in this study were the sixth most traded species (by number of carcasses sold). The large difference in sample size and period means that this result must be interpreted with caution; however, it supports the conclusion that arboreal pangolins may be traded more often in 2014 than they were in 2002-2003, whether or not offtakes from the forest are higher. Sustained demand and high value will be almost certain to create increased offtakes from the village hunting grounds over time.

The 2015 seizure of 2 kg of scales in Oyem was the first domestic interception of scale trade, despite considerable efforts

since 2012 dedicated to controlling major transport hubs and focusing search efforts on pangolins and their derivatives. The trader intercepted was also dealing in ivory and reported having regularly supplied the Chinese client involved for the past 2 years, exporting scales informally across a forest border to a specific recipient, rather than using established bushmeat traders within the country to offer the product for general sale alongside meat. In 2016, a second ivory trader was also intercepted in the Min-kébé region of Gabon, with two sacks of pangolin scales associated with a seizure of raw ivory (ANPN, 2016). Although these are small pieces of evidence, combined with the lack of seizures of pangolins in major domestic transport hubs and the traditional bushmeat trade network, even these anecdotes provide some insight into the possible mechanisms of new illegal trade emergence.

We conclude that the beginnings of higher value trade chains are possible and indeed probable for each species of pangolin both within and from Gabon, and that pathways for increasing the trade of pangolins hunted in villages are already evident, even if this trade is not yet fully realized. The value of giant pangolins in domestic trade has increased greatly in urban markets, despite the species' fully protected status, which is an indicator that pressure on this species may be higher and expressed more rapidly than demand for arboreal pangolins. Whilst we demonstrate that illegal trade networks for pangolins may evolve outside of the traditional bushmeat market structure and be "invisible" to traditional meat market surveys and controls, evolution of pangolin trade both within and outside the traditional bushmeat supply is of course possible.

If the international pangolin trade is not sourcing animals from the traditional bushmeat markets, then it may be difficult to detect a parallel trade structure using the current conservation strategies. We see an immediate need for pro-active monitoring of the hunting and trade of pangolins in villages and a diversification of pangolin-focused law enforcement activities. Such actions will require innovation on the part of government agencies and NGOs supporting such efforts, an increase in resources dedicated to combatting the illegal wildlife trade in and from Gabon, and strengthening of multiple international collaborations. However, we feel it is useful to all future partners to set out a road map for conservation action for pangolins in Gabon from this point forwards.

Specific recommendations are:

1. Improved enforcement and interception efforts in less frequently used domestic trade and potential export routes, to complement current efforts on larger transport hubs, including paying particular attention to detecting and recording concurrent seizures of pangolins and ivory.
2. Improved traceability of seizures involving pangolins and their derivatives, through
 - a. improved national capacity for tracing origins of domestic illegal trade (giant pangolins) to source, for example by monitoring transport links;

- b. improved collaboration and participation of the Gabonese State agencies in international enforcement tools for all pangolins (i.e., CITES permits and trade monitoring; Heinrich et al., 2016; Challender & Waterman, 2017); and
 - c. mapping of genotypic variation of wild Gabonese pangolin populations to enable differentiation of origin within the country, as well as across the species' global range (i.e., Gaubert et al., 2016).
3. to ensure robust monitoring of subsistence hunter pressure by working with local hunters and villages in order to:
 - a. detect changes in offtake, including to better understand the sustainability of current harvests (Coad et al., 2013; Ingram et al., 2017); and
 - b. to enable early reactivity to increased commercial trade and/or trafficking.
 4. to support and encourage robust scientific research on wild pangolin populations in Gabon, with a particular focus on determining the status of populations in quantitative terms and temporal trends, such that baselines can be established to properly underpin national conservation measures and international decision-making, including within CITES, and re-assessment of African pangolins for The IUCN Red List of Threatened Species™.

ACKNOWLEDGEMENTS

To our immense sadness, the primary author of this work, Meine Marie Mambeya, passed away in January 2017 after a long struggle with cancer. Her dedication to her work, to ecological research and to the protection of African pangolins was an inspiration to all of us and a model for the new generation of African conservation scientists. We thank her enormously for her contribution and hope that the publication of her work will be an everlasting tribute to her. We thank CENAREST for permission for research in Gabon and the Institut de Recherche en Ecologie Tropicale (IRET) and the Agence Nationale des Parcs Nationaux (ANPN), Gabon for support for the field work. In particular, we thank Conservators Daniel Nzame and Rostand Ab'aa; Professors Lee White, Jacques Mavoungou and EJ Milner-Gulland; Drs Kathryn Jeffery and Vincent Mejibe and M. Christian Mbina for general support and advice. Data collection costs and resources were supported by IRET (VJOO); ANPN (MMM, FKP, MO, BRM); the IUCN SSC Pangolin Specialist Group (FB, MMM, BRM); University of Masuku (BRM) and the University of Stirling (KA). Analysis and writing costs in addition to the support of the authors' institutions were provided by the IUCN SSC Pangolin Specialist Group and the Gabonese Republic (Student grants service). We thank Christopher Orbell for producing Figure 1.

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How to cite this article: Mambeya MM, Baker F, Momboua BR, et al. The emergence of a commercial trade in pangolins from Gabon. *Afr J Ecol*. 2018;00:1–9. <https://doi.org/10.1111/aje.12507>