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1 **The emergence of a commercial trade in pangolins from Gabon**

2

3 **Running title: Emerging trade in pangolins in Gabon**

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59

60

61 **Abstract**

62 Recent seizures of illegally-held wildlife indicate a mounting global trade in pangolins  
63 involving all eight species. Seizures of illegally-traded African pangolins are  
64 increasing as wild populations of Asian species decline. We investigated trade in  
65 pangolins and law enforcement efforts in Gabon; a country likely to have intact wild  
66 populations of three of the four species of African pangolin. We compared village  
67 sales and trade chains between 2002-3 and 2014. Hunters reported pangolins to be  
68 the most frequently requested species in 2014 and the value of pangolins had  
69 increased at every point along their trade chain. In Libreville, giant pangolin prices  
70 increased 211% and arboreal pangolin prices 73% whilst inflation rose only 4.6%  
71 over the same period. We documented a low rate of interception of illegally-traded  
72 pangolins despite increased law enforcement. Surveys of potential export routes  
73 detected exports across forest borders, in conjunction with ivory, but not through  
74 public transport routes. We conclude that whilst there is clear potential and  
75 likelihood that a wild pangolin export trade is emerging from Gabon, traditional  
76 bushmeat trade chains may not be the primary supply route. We recommend  
77 adjusting conservation policies and actions to impede further development of illegal  
78 trade within and from Gabon.

79

80 **Keywords: pangolins, illegal wildlife trade, Gabon, hunting, bushmeat,**

81 **Main text**

82 **Introduction**

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

92 Commercial exploitation has been the key factor in the rapid decline of wild  
93 populations of Asian pangolin species in recent decades (Challender et al., 2015;  
94 Challender, 2011). Unsurprisingly, this has led to an overall rise in international trade  
95 as well as trafficking of African pangolins, primarily their scales, to Asia (Challender &  
96 Waterman, 2017; Challender and Hywood, 2012; Newman et al., 2014; Nijman et al.,  
97 2016). Increasing global economic and trade links but particularly new links between  
98 African nations and East Asia have possibly facilitated this trade (Challender et al.,  
99 2016; Wang and Bio-Tchané, 2008). The vast majority of international demand for  
100 pangolins comes from Asia, and in particular China and Vietnam (Challender et al.,  
101 2015; Nijman et al., 2016). However, exact countries of origin of traded African  
102 pangolins, which are found in many range states, are unattributed for the majority of  
103 seizures made (though see Challender & Waterman, 2017). Over the past decade  
104 China has developed increasing economic ties with Africa, in particular through

105 direct investment (Abernethy et al., 2016) and Chinese companies now have  
106 permanent bases, resident workers and administrative networks in countries across  
107 the continent (Wang and Bio-Tchané, 2008; Putzel et al., 2011).

108 Based on available evidence, which is likely to be a partial picture, international  
109 seizures of illegally traded products from African pangolins are increasing. Four kg of  
110 African pangolin products were seized in 2008, 312 kg in 2012, 4 tonnes of scales  
111 were seized in Cameroon in 2016 and another 5.4 tonnes were seized in early 2017  
112 (LAGA, 2017), this last representing 10,000 – 20,000 pangolins (see Challender &  
113 Waterman, 2017 for a comprehensive overview of global seizures). This is ostensibly  
114 an exponential rise which, despite some targeted international law enforcement  
115 efforts, may be signalling a mushrooming illegal trade, rather than dramatic  
116 improvements in the detection of trafficking.

117 Gabon is home to three of the four African species of pangolin, the fossorial giant  
118 pangolin (*Smutsia gigantea*, Illiger 1815); and the arboreal white-bellied pangolin  
119 (*Phataginus tricuspis*, Rafinesque 1821) and black-bellied pangolin (*Phataginus*  
120 *tetradactyla*, L. 1766) (Kingdon and Hoffman, 2013). Giant pangolins have been  
121 integrally protected nationally since 1987 (Republique Gabonaise, décret n°  
122 189/PR/MEFCR), but both *Phataginus* (arboreal) species can be legally hunted  
123 locally, although hunting methods, catch sizes, seasons and trade are regulated.  
124 However, despite regulation, a nationwide six-year survey of sixteen bushmeat  
125 markets (2000-2006) recorded arboreal pangolins in all markets in all months,  
126 accounting for 10% of all animals traded annually (Abernethy and Ndong Obiang,  
127 2010). In two year-long village hunting studies during the same period white-bellied  
128 pangolins were caught by village hunters every month and formed approximately 6%

129 of all animals caught annually (Coad, 2007; Van Vliet, 2008). There is no census data  
130 for any pangolin species in the wild in Gabon.

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

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

- 139 a) describe the current trade of pangolins in rural areas and rural-to-urban  
140 scenarios;
- 141 b) evaluate the extent of change over the past decade in the species and  
142 relative value of species involved this trade, with particular attention to  
143 change in the value of pangolins relative to other species;
- 144 c) assess the extent to which rural hunting communities may be the source of  
145 pangolins for export or whether the species are potentially sourced outwith  
146 the traditional bushmeat trade;
- 147 d) evaluate the trade routes for pangolins within and from Gabon,
- 148 e) evaluate the current control of trade; and using the data we acquire for  
149 points a-e;
- 150 f) propose actions to more effectively combat any emerging high-value trade in  
151 these species outside the traditional subsistence economy.

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

## 156 **Methods**

### 157 *Village hunting and 'forestgate' trade in 2014*

158 Pangolin offtake and sales were assessed in local communities living in rural  
159 subsistence economies (which include hunting for meat and income). The hunted  
160 areas were not protected areas and arboreal pangolins could be legally hunted  
161 under traditional customary rights. We assessed the numbers of pangolins traded in  
162 2014 from villages in the Ogooué-Ivindo and the Nyanga provinces in Gabon both to  
163 local clients and, via roadside sales to traders, into larger markets. The two key  
164 provinces were chosen for the following reasons: a) comparative data were available  
165 from the previous decade (Okouyi Okouyi, 2006; Abernethy and Ndong Obiang,  
166 2010); b) both provinces have relatively recently seen the arrival of populations of  
167 migrant Asian workers, specifically in the construction, agro-industrial and logging  
168 industries (Oxford Business Group, 2015); and (c) these areas broadly represent the  
169 two major catchment habitats of completely forested (Ogooué Ivindo) and  
170 savannah/forest mosaic (Nyanga) found in Gabon. Surveys of village hunters were  
171 made in the dry season during a 43-day study period in the Ogooué-Ivindo (June-July  
172 2014), and a 10-day period in the Nyanga (early August 2014). During these studies,  
173 24 villages were surveyed (Figure 1). Surveys comprised data collection on village  
174 characteristics (questionnaires filled by the village chief or elder hunter) and semi-  
175 structured interviews with hunters on hunting activity, client requests, sales and

176 revenues from the past month. Examples of the questionnaires are given in  
177 Supplementary Materials and can also be found in Baker, (2014) and Mambeya,  
178 (2015).

179 A total of 138 villagers participated in the research. Of these initial survey  
180 respondents, 69 villagers in ten villages in the Ogooué Ivindo and 34 villagers in ten  
181 villages in the Nyanga (total 103) reported hunting actively and were further  
182 interviewed. Villages ranged from 64-800 people (median 200) with between one  
183 and fifteen hunters (median 4). All interviewed hunters were men, aged between 16  
184 and 70 years, with the majority in the 31-50 year-old age class (57. 3%). Over 90% of  
185 interviewees were native to the village (born there or living with family born there)  
186 and gave subsistence as their primary reason for hunting. Culture, protection of  
187 plantations and supplementary income were also reasons (9.3%), but no hunter  
188 reported even legitimate local commercial trade as their primary motivation for  
189 hunting. Hunters used guns (47.6%) or snares (28.1%) or both (24.3%) and all  
190 hunters reported hunting within one day's walk from their village without using  
191 camps. Comparison with available literature shows that these village hunting  
192 communities conform to previously established profiles for subsistence communities  
193 in Gabon in terms of hunter ages, hunter numbers per village, hunting catchment  
194 distances from the village (one day's walk or max 10 km), species caught,  
195 percentages traded and price equivalency between species (Coad, 2007; Foerster et  
196 al., 2011; Okouyi Okouyi, 2006; Starkey, 2004; Van Vliet, 2008).

197

198 *Village surveys in 2002-2003 and change over time 2002-2014*

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

212

### 213 *Change in relative value of species, within and along the traditional trade chain*

214 To investigate change over time in the relative value of traded bushmeats we looked  
215 specifically at the Ogooué-Ivindo market chain, from which we had comparable data  
216 from 2002-2003 and 2014. Market surveys in Makokou and surrounding villages  
217 were carried out for all sales in six markets on one day per week during 2002-2003  
218 and one to three days per location during three months May-July in 2014. Data from  
219 Libreville Mont Bouët market, also collected from 2002-2003 allowed analysis of the  
220 evolution of relative value of species over the past twelve years for these locations.  
221 We included the five most common other species groups recorded in our national  
222 surveys in both 2002-2003 and 2014 (blue duiker (*Philantomba monticola*, Thunberg

223 1822), brush-tailed porcupine (*Atherurus africanus*, Gray 1842), red duikers  
224 (*Cephalophus* spp.), red river hog (*Potamochoerus porcus*, L. 1758) and guenons  
225 (*Cercopithecus* spp.) and both pangolin types (Table 1). Prices were standardized to  
226 per kg prices for comparisons between species, using mean weights of hunted  
227 animals recorded directly in villages in Gabon (Coad, 2007; Abernethy & Ndong  
228 Obiang, 2010). For comparison of the price of the same species over space and time,  
229 we used sales of whole animals only to reduce inherent noise from standardizing  
230 weights of butchered animals. We did not use a purchasing power parity or  
231 Consumer Price Index (CPI) correction between years, as inferences were drawn  
232 from the relative rank value of traded species across space, rather than from their  
233 absolute values. However, between the start of 2002 and the end of 2014, Gabon's  
234 inflation (percentage change in CPI) was approximately 4.6% (World Bank, 2017),  
235 thus a rise of up to 5% in absolute value of products, may not indicate any real  
236 change over time in value relative to other products.

237

#### 238 *Law enforcement in 2014*

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

247 Authority for Gabon, National Police Force (*Gendarmerie Nationale*), the Border  
248 Police (*Police des Aires et Frontières*), Customs (*Douanes Nationales*) and National  
249 Parks Agency (*Agence Nationale des Parcs Nationaux; ANPN*) for assessment of law  
250 enforcement efforts (2012-2015) and potential export routes.

251

## 252 **Results**

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

256

### 257 ***Village hunting and 'forestgate' trade in 2014***

258 Of village hunters who gave information on sales (90/103), all hunters reported  
259 catching an arboreal pangolin 'commonly' and 89% of hunters reported sale of an  
260 arboreal pangolin in the past three months.

261 The average price per kg for all bushmeat carcasses recorded as sold at the roadside  
262 in villages was not significantly different between the two provinces. Mean 2014  
263 roadside price for all bushmeat was  $1008 \pm 400$  FCFA (US\$ $1.81 \pm 0.72$ ) per kg for 514  
264 records from hunter sales. Figure 3 shows mean price per kg for all sales reported by  
265 hunters in 2014. Both types of pangolin sold at a higher price per kg than the mean  
266 price of all bushmeat: whole arboreal pangolins (estimated at 1.8kg from a sample of  
267 93 hunted animals weighed in Gabon; Coad, 2007, Hymas, unpublished data) were  
268 sold at a mean roadside price of  $2,447 \pm 930$  FCFA (US\$ $4.40 \pm 1.67$ ), equivalent to  
269  $1,359 \pm 517$  FCFA (US\$ $2.45 \pm 0.93$ ) per kg (n=65 sales observed during field study).

270 Giant pangolins (estimated at 28.75kg) sold at the roadside at a mean price of

271 38,100 ± 17,822 FCFA (US\$68.39 ±32.07) equivalent to 1,325 FCFA (US\$2.38±1.28)  
272 per kg (n=25).

273

#### 274 **Expressed demand for pangolins in rural areas in 2014**

275 The majority (70%) of hunters reported only selling their meat opportunistically. Of  
276 the 30% of hunters that took orders for meat before hunting, 34% of their customer  
277 base (by number of clients) were Asian immigrants, although hunters did not know  
278 the particular nationality of individual clients. All hunters that took orders for meat  
279 before hunting were from the Ogooué Ivindo. Meat orders placed by Asian clients  
280 were heavily biased to pangolins (Figure 2). Hunters and village chiefs reported no  
281 knowledge of hunting in the forest by immigrant workers themselves, in either  
282 province.

283

#### 284 **Change in rank position of pangolin species within the traditional bushmeat trade**

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

#### 291 **Change over time and space in market value**

292 The price of any bushmeat at the forestgate in Ogooué Ivindo had risen from a mean  
293 761±236 FCFA (US\$1.31±0.42) per kg in 2002-2003 to 1008±400 FCFA (US\$1.81±  
294 0.72) in 2014; an increase of 32% of the 2002 price. Pangolins were traded at above

295 average per kg prices in both 2002 and 2014, but the relative price increase was far  
296 greater for giant pangolins, which sold in 2014 for 52% more than their 2002 price,  
297 whilst the price of arboreal pangolins had only risen by 9% on the 2002 forestgate  
298 value.

299 Using prices of whole animals of the most common and comparable species; blue  
300 duikers and brush-tailed porcupines account for around 50% of all sales, Makokou  
301 town prices for whole, fresh animals had risen from 3631±1177 FCFA (US\$6.53±2.12)  
302 to 5453±1297 FCFA (US\$9.81± 2.33) per carcass, and Libreville prices had risen from  
303 8455±1716 FCFA (US\$15.22±3.09) to 15700±4461FCFA (US\$28.26±8.03), relative  
304 rises of 50% and 87% on 2002 prices. During the same period, the average price of  
305 giant and arboreal pangolins in Libreville rose by 212% and 74% respectively (Figure  
306 4).

307

### 308 **Law enforcement**

309 During 2014, government wildlife law enforcement teams with sniffer dogs carried  
310 out 209 control missions on potential export routes at the Libreville seaport and  
311 airport, the N1 major road artery into and out of Libreville and the train station.  
312 Daily controls without dogs also operated at five roadblocks on major road arteries  
313 across the country. Standard customs controls not specialized to wildlife issues also  
314 operated on all flights departing the international airport and ships departing the  
315 seaport. Illegally held pangolins were located and seized on only four occasions:  
316 three on the N1 road and one at the train station, recovering in total twelve arboreal  
317 pangolins, equivalent to approximately 21 kg total weight. In 2015 (January-June)  
318 teams working at the same locations made one seizure of scales in the town of

319 Oyem. These scales were reportedly destined for a Chinese buyer in Equatorial  
320 Guinea who regularly placed orders with Gabonese hunters and were associated  
321 with a seizure of ivory. No seizures of pangolins or products were made at the  
322 international transport hubs.

323

## 324 **Discussion**

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

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

338 2. All pangolins have increased in value over time, relative to other species within  
339 the existing bushmeat trade structure. Relative value increases are most  
340 extreme in most urban areas and smaller in rural areas. This is consistent with  
341 absence of a high-value trade developing from within the traditional market  
342 trade and otherwise primarily involving village hunters.

343 3. Specific demand for pangolins expressed to village hunters is high in certain  
344 areas relative to expressed demand for other species, and particularly for  
345 consumption by the immigrant Asian population.

346 4. Giant pangolins have become relatively more valuable than arboreal pangolins,  
347 which is in line with their much higher weight of scales, if scale price is a  
348 determinant of value.

349 5. Despite an intensification of law enforcement effort to detect pangolin  
350 trafficking, no movement through public international or domestic transport  
351 hubs has been detected. Instead, a very small number of informal trade routes  
352 have been found across forest borders where no enforcement is routinely made.  
353 It is probable that clients within established illegal trade chains for ivory may  
354 also be expressing a demand for pangolin scales.

355 There is little evidence from our surveys of village hunters that they are engaging at  
356 present in hunting pangolins for more commercial purposes, nor in greater numbers,  
357 than in 2002-3. The top five species reported by hunters in this study as most  
358 frequently caught are very similar to those found by hunter studies a decade ago  
359 (the top five species in 2014 village catches were also found in the top eight species  
360 in all 2002-2006 studies: Okouyi Okouyi, 2006, Coad 2007, van Vliet, 2008). These  
361 results suggest that this hunting is still primarily oriented towards subsistence, rather  
362 than newer commercial possibilities associated with intercontinental trafficking.

363 Although village hunters are experiencing high local demand for pangolins from  
364 Asian immigrant workers, and are providing supply, it would be possible to achieve  
365 more pangolin sales in 2014 than in 2002-3 without initially increasing offtakes. Coad  
366 (2007) found village hunters traded only 10% of the pangolins they hunted,

367 consuming the rest at home. Thus, there is significant potential for increased trade  
368 to be recorded without necessarily increased offtakes, simply by hunters deciding to  
369 sell, rather than consume, their catch.

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

378 The 2015 seizure of 2kg of scales in Oyem was the first domestic interception of  
379 scale trade, despite considerable efforts since 2012 dedicated to controlling major  
380 transport hubs and focusing search efforts on pangolins and their derivatives. The  
381 trader intercepted was also dealing in ivory and reported having regularly supplied  
382 the Chinese client involved for the past two years, exporting scales informally across  
383 a forest border to a specific recipient, rather than using established bushmeat  
384 traders within the country to offer the product for general sale alongside meat. In  
385 2016 a second ivory trader was also intercepted in the Minkébé region of Gabon,  
386 with 2 sacks of pangolin scales associated with a seizure of raw ivory (ANPN, 2016).  
387 Although these are small pieces of evidence, combined with the lack of seizures of  
388 pangolins in major domestic transport hubs and the traditional bushmeat trade  
389 network, even these anecdotes provide some insight into the possible mechanisms  
390 of new illegal trade emergence.

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

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

412 Specific recommendations are:

- 413 1. Improved enforcement and interception efforts in less frequently-used  
414 domestic trade and potential export routes, to complement current efforts

415 on larger transport hubs, including paying particular attention to detecting  
416 and recording concurrent seizures of pangolins and ivory.

417 2. Improved traceability of seizures involving pangolins and their derivatives,  
418 through

419 a. improved national capacity for tracing origins of domestic illegal trade  
420 (giant pangolins) to source, for example by monitoring transport links;

421 b. improved collaboration and participation of the Gabonese State  
422 agencies in international enforcement tools for all pangolins (i.e.  
423 CITES permits and trade monitoring; Heinrich et al., 2016, Challender  
424 & Waterman, 2017); and

425 c. mapping of genotypic variation of wild Gabonese pangolin  
426 populations to enable differentiation of origin within the country, as  
427 well as across the species' global range (i.e. Gaubert et al., 2016).

428 3. to ensure robust monitoring of subsistence hunter pressure by working with  
429 local hunters and villages in order to:

430 a. detect changes in offtake, including to better understand the  
431 sustainability of current harvests (Coad et al., 2013; Ingram et al;  
432 2017); and

433 b. to enable early reactivity to increased commercial trade and/or  
434 trafficking.

435 4. to support and encourage robust scientific research on wild pangolin  
436 populations in Gabon, with a particular focus on determining the status of  
437 populations in quantitative terms and temporal trends, such that baselines  
438 can be established to properly underpin national conservation measures and

439 international decision-making, including within CITES, and re-assessment of  
440 African pangolins for The IUCN Red List of Threatened Species™.  
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550

551 **Tables.**

552 Table 1. Hunter sale ‘forestgate’ price changes over 12 years from 2002-2014 in the  
 553 Ogooué Ivindo villages. Data from the 2002-2003 sample were limited to records  
 554 from May-September for comparison to the 2014 sampling period. The lines for  
 555 pangolin records are shaded.  
 556

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

557

558 **Figure legends**

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

564

565 Figure 2. Requests received from locally based Asian industrial workers between  
566 March and May 2014 by hunters from surveyed Ogooué-Ivindo villages, for supply of  
567 particular species (N=34 specific requests recorded).

568

569 Figure 3. Mean price per kg FCFA (\$1USD = 555 FCFA) for species sold by hunters at  
570 the forestgate in 2014 (N sales). Error bars represent the SE of prices. Bodyweights  
571 were taken from empirical data for weighed carcasses in Gabon (Coad, 2007 &  
572 Abernethy & Ndong Obiang, 2010). At equal meat value, by bodyweight, giant  
573 pangolins would be expected to sell for a similar price to red duikers and red river  
574 hog, approximately half their actual sale price. The bar for the mean of all species is  
575 shown in white and bars for pangolin species in brown.

576

577 Figure 4. Percentage (of earlier price) rise in mean price between 2002-2003 and  
578 2014 for whole animal sales of a) most commonly sold taxa under 5kg (palm civet,  
579 blue duiker, brush-tailed porcupine, arboreal pangolins and guenons) b) arboreal  
580 pangolins c) Giant pangolins recorded from forestgate villages, Makokou town and in  
581 Libreville's largest market (Mont Bouët).