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Short communication

Poisoning poached megafauna can boost trade in African vultures

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ABSTRACT

Illegal wildlife trade threatens iconic species, such as elephants, rhinos or giraffes, on which poaching pressure has increased in recent times. By poisoning the carcasses of poached megafauna to prevent the early detection of poachers, this illegal activity is contributing to push African vultures to the brink of extinction. But poisoning vultures at poached carcasses of megafauna can also boost belief-based trade of vulture body parts by facilitating access to otherwise difficult-to-reach species. Since increased vulture availability through megafauna poaching could stimulate not only domestic, but also international trade, we call for transboundary coordination to effectively track the real dimension of this pervasive synergy. Existing monitoring schemes of megafauna poaching (e.g. CITES Monitoring of the Illegal Killing of Elephants, MIKE) and wildlife poisoning (e.g. African Wildlife Poison Database) can be a promising starting point. For example, by counting the number of vultures with missing parts at each megafauna carcass, while guiding the implementation of similar monitoring for other species threatened by poaching. Besides straightforward impacts on target species, illegal wildlife trade affects non-target species, with collateral damages being increasingly highlighted. Pervasive synergies such as the one we describe here deserves further international attention to prevent that poaching will spread for other purposes.

1. Megafauna poaching in Africa

Illegal wildlife trade, grounded on poaching and trafficking activities, is one of the largest illegal business, with an estimated annual profit ranging between US$7 and $23 billion (TRAFFIC, 2019). This illicit activity increasingly threatens national and regional security worldwide (Nellemann et al., 2014; Haenlein and Smith, 2017), as acknowledged in the recent London Illegal Wildlife Trade Conference Declaration (2018), signed by 65 nations from all the continents, mostly in Africa and Asia. Indeed Africa concentrates the biggest number of large herbivores worldwide (Ripple et al., 2015), including iconic animals such as elephants, rhinos or giraffes, on which poaching is increasingly pressuring these species across the continent, i.e. from Central to East and Southern Africa (e.g., Biggs et al., 2013; Wittemyer et al., 2014; Strauss et al., 2015; Ripple et al., 2016; Poulsen et al., 2017; Martin, 2019; Schlossberg et al., 2019).

Substantial population declines have been estimated for African savannah (*Loxodonta africana*) and forest (*Loxodonta cyclotis*) elephants in recent times (Stiles, 2004; Maisels et al., 2013; Chase et al., 2016; Poulsen et al., 2017). In 1976, the first continental approximation to elephant numbers in Africa concluded that there were around 1.34 M elephants ranging over 7.3 M km^2 (Douglas-Hamilton, 1979). Forty years later, in 2016, it was estimated 415,428 ± 20,111 elephants, plus an additional guess from 117,127 to 135,384 animals, in systematically and not systematically surveyed areas, respectively, i.e., over a total area of ca. 1.9 M km^2 accounting for 62% of the estimated known and possible elephant range (Thouless et al., 2016). The CITES programme for Monitoring of the Illegal Killing of Elephants (MIKE) (https://cites.org/eng/prog/mike/) has recorded 9558 carcasses of elephants poached for ivory between 2002 and 2018 in 67 MIKE African sites. Increasing poaching rates have been observed across the continent in recent times (Wittemyer et al., 2014; Schlossberg et al., 2019). Poaching levels have increased since 2006 peaking in 2011 (CITES, 2016a; Thouless et al., 2016) and existing calculations suggests that ca. 30,000 elephants might be poached yearly (Wittemyer et al., 2014).

Similarly, rhino poaching of the two African species (i.e. white *Ceratotherium simum* and black *Diceros bicornis* rhinoceros) for their horns has escalated in the last years, — due to the growing demand in traditional Asian medicine, and as a symbol of wealth (Emslie et al., 2016). For example, in South Africa, the country holding ca. 80% of the worldwide population of African rhinos (estimated in 20,306 animals in 2015; Emslie et al., 2016), poaching has dramatically increased from 2008 onwards, with 7899 poached rhinos recorded until 2018 (yearly

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averaging 718 rhinos, range 83–1215; between 2000 and 2007 this figure was 15 rhinos, range 7–25 and a total number of 120 rhinos; Department of Environmental Affairs, 2019). Rhino poaching has also been observed in other African countries such as, for example, 210, 130 and 436 poached rhinos recorded in 2008–2015 in Kenya, Namibia and Zimbabwe, respectively (estimated rhino populations in 2015: 1122, 2768 and 802 rhinos, respectively; Emslie et al., 2016).

Contrastingly, despite poaching being considered an important threat for giraffes (*Giraffa* spp.) (Caro, 2008; Strauss et al., 2015; CITES, 2019a), estimates of poached individuals are lacking across most of Africa (Caro, 2008; Muller, 2008). Giraffes are poached for their meat (bushmeat), bones, hides or because of cultural beliefs (e.g., tails are appreciated by many African cultures) (Okello et al., 2015; CITES, 2019a). Approximately 3.5 times less giraffes than African savannah elephants (ca. 97,500 vs. ca. 352,000 individuals) roam in Africa (Chase et al., 2016; Muller et al., 2018), and, in the last three decades, its populations have plunged by 36–40%, being recently uplisted as "Vulnerable" by the IUCN (Muller et al., 2018). The United Nations Convention on Migratory Species has recently listed the species under its Appendix II, acknowledging the increasing threat of poaching (CMS, 2017). On August 2019, the 18th Conference of the Parties agreed to list giraffes under Appendix II of CITES (CITES, 2019b). This will tighten the monitoring and regulation of the species international trade, reducing the uncertainty around its extent and contributing to fight against illegal practices (López-Bao, 2019).

Megafauna poaching, however, does not only exert pernicious effects on the targeted species, but on African wildlife. Because the carcasses of poached megafauna are increasingly poisoned, apparently to avoid vulture overhead cycling revealing poachers activity (BirdLife, 2009; Simmons et al., 2015; Ogada et al., 2016a), poaching entails also a major threat for species such as vultures and other scavengers (e.g., large carnivores).

2. The decline of African vultures

The populations of the eight species of African vultures have plummeted by an average of 62% in only three decades (Ogada et al., 2016b; Botha et al., 2017), with their ranges decreasing, between 3% and 58% within this period (Fig. 1). Severe population reductions, of > 50% decline over three generations, have been estimated in at least 27 vulture populations in 15 African countries; with strong declines, of > 25% over three generations, detected for other 58 national vulture populations across the continent (Ogada et al., 2016b). Continent-wide population changes projected for African vultures range from −70% over three generations for the bearded vulture (*Gypaetus barbatus*) up to −96% for the white-headed vulture (*Trigonoceps occipitalis*) (Ogada et al., 2016b). Poisoning outstands as the major cause of these declines, accounting for the 61% of the vulture known mortality ($n = 7819$ dead vultures recorded in the 1972–2014 period; Ogada et al., 2016b), followed by trade in traditional medicine (Ogada et al., 2016b).

Although the causes of vulture poisoning are several (e.g., unintended victims of illegal predator control; Ogada et al., 2016a), mortality figures at poisoned megafauna carcasses in Africa greatly outweigh other poisoning events for vulture species in the continent and elsewhere. For example, a mean of 191 dead vultures recorded at elephant carcasses versus a mean of 6 dead vultures at other poisoning events in Africa (Ogada et al., 2016a), and a total of 34 condors (*Vultur gryphus*), 70 Egyptian vultures (*Neophron percnopterus*), and 23 white-rumped vultures (*Gyps bengalensis*) dead at mass poisoning events recorded in Argentina, Macedonia and Cambodia, respectively (Plaza et al., 2019).

As an illustrative example of the potential impact of poisoned megafauna carcasses on African vultures, if only half of the poached elephant carcasses annually recorded by MIKE across Africa in recent times (a mean of 791 carcasses/year in 2010–2018) would be laced with poison, and assuming an average mortality of 191 vultures/carcass (extracted from Ogada et al., 2016a), > 75,000 vultures could be killed annually. This would be equivalent to 28% of the white-backed vulture (*Gyps africanus*) population, the most abundant African vulture, with an estimated population size of 270,000 individuals (Botha et al., 2017). This species is rapidly declining (−90% over the last three generations; Ogada et al., 2016b), being uplisted from "Least Concern" in 2004 to "Critically Endangered" in 2015 by IUCN (Botha et al., 2017).

3. Megafauna poaching and belief-based trade of African vultures

Besides the direct impact of megafauna poaching on African vulture declines resulting from the consumption of poisoned carcasses, a new pervasive threat emerges for this guild. By killing large numbers of vultures at once — as illustrated by the recent massive poisoning of 537 vultures from five species at poached elephant carcasses in Botswana (de Greef, 2019)—, megafauna poaching comes out as a remarkable and easy source of vulture body parts for belief-based trade, otherwise limited by the difficulty of accessing vulture corpses (Mander et al., 2007; Groom et al., 2013; Saidu and Buij, 2013). For example, while a mean of 26 vultures were found in three poisoning events serving traditional medicine, 65 out of 191 vultures poisoned at a poached elephant carcass lacked their beaks (Fig. 2), a clear sign of belief-based use (Mander et al., 2007; Groom et al., 2013; Vulture Conservation Foundation, 2019).

Trade in traditional medicine is considered the second largest threat for African vultures, accounting for 29% of the dead vultures records between 1972 and 2014 (Ogada et al., 2016b). So far, vulture trade in traditional medicine has been reported in at least 15 African countries, from Morocco to South Africa (Fig. 3; Saidu and Buij, 2013; Buij et al., 2016; Ogada et al., 2016b). In countries like Nigeria and South Africa, traditional use of body parts is considered a major cause of the sharp declines experienced by vulture species (e.g. -50% in white-backed vulture over a 27-year period in South Africa; McKean et al., 2013; Murn et al., 2013). It is estimated that at least 160 vultures are sold yearly in eastern South Africa markets, with ca. 59,000 consumers annually purchasing vulture body parts from some 1230 traditional healers supposed to prescribe vulture use in the area (McKean et al., 2013). Similarly, 93% of traditional medicine dealers in Nigeria had vultures, or their body parts, on offer; with prices increasing from US$ 10–20 up to US$ 100 per vulture in one decade (1999–2011; Saidu and Buij, 2013).

In addition to the health risks of consuming poisoned vultures, megafauna poaching could boost the already unsustainable levels of vulture harvesting for traditional medicine (Mander et al., 2007; Saidu and Buij, 2013; Ogada et al., 2016b), increasing access to highly-valued large vultures. Large vulture species, such as, for example, those of the genus *Gyps*, are otherwise difficult to access for trade because they have become scarcer (Saidu and Buij, 2013; Buij et al., 2016), after experiencing the largest declines across Africa (e.g., > 20% range lost for white-backed, Rüppell's *G. rueppellii* and lappet-faced *Torgos tracheliotos* vultures, Fig. 1; Ogada et al., 2016b; Botha et al., 2017). Thus, increased vulture availability through megafauna poaching could in turn stimulate not only domestic, but also international belief-based trade. It has been reported that after the collapse of Nigerian vultures, traders in this country deal with vultures from an area encompassing at least from Burkina Faso to Chad (Fig. 3; Saidu and Buij, 2013; Buij et al., 2016).

4. Transboundary collaboration to monitor an emerging threat

Considering this scenario, and the large foraging ranges of African vultures (e.g., recorded up to > 580,000 km^2, and across six different countries, in less than one year; Phipps et al., 2013) — with records of poisoned vultures at poached elephants 1000 km away from their tagging sites (IUCN, 2013; Botha et al., 2017) —, international action is mandatory, with especial focus on transboundary coordination. African

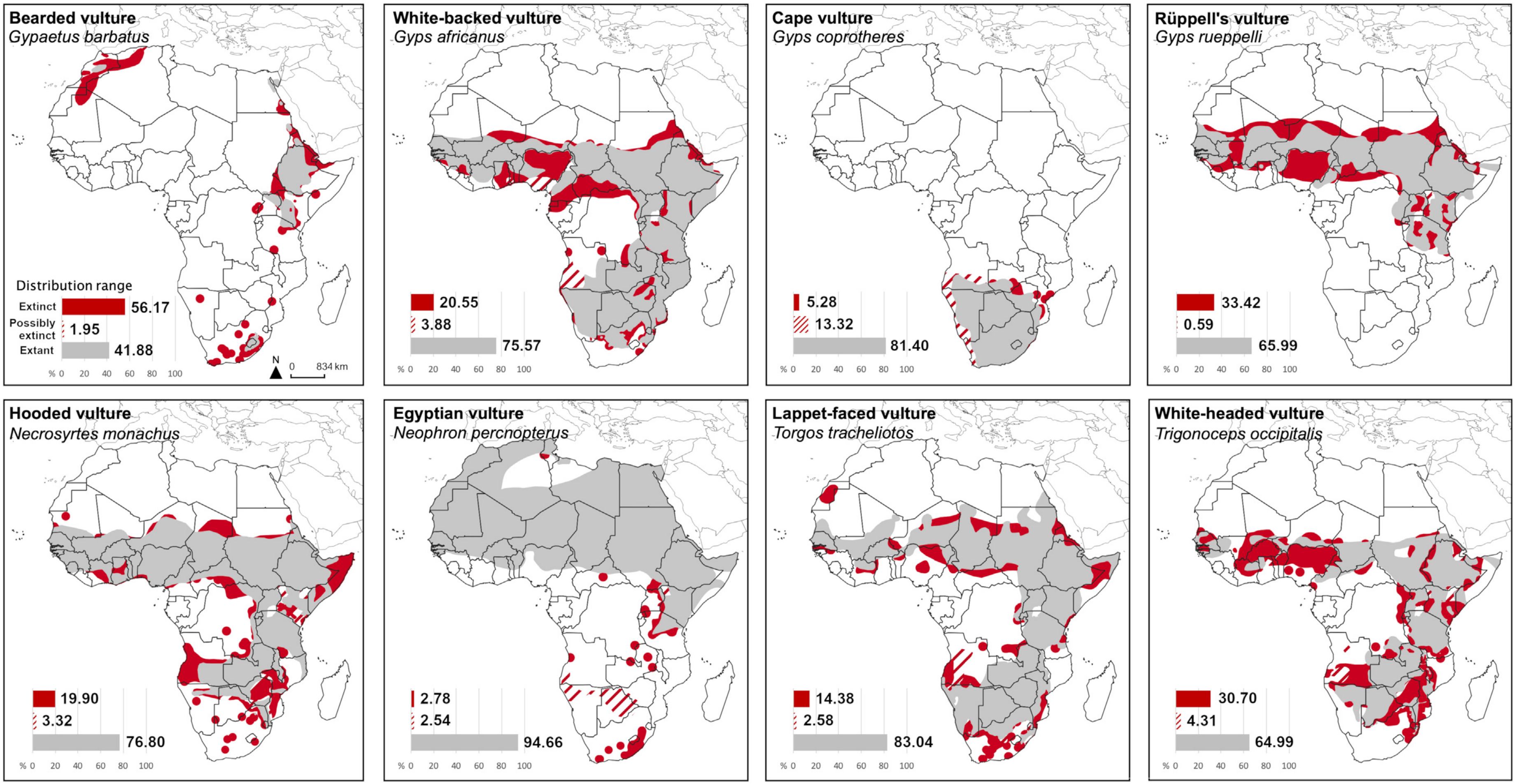

Fig. 1. African vultures have reduced their distributions in the last three decades, becoming extinct (i.e. no records in the last 30 years in areas formerly known/thought to be occupied) or possibly extinct (i.e. likely to have been extirpated owing to a lack of records in the last 30 years) in > 57% for the bearded vulture, > 33% for the Rüppell's and white-headed vultures, and > 23% for the white-backed and hooded vultures (BirdLife International and Handbook of the Birds of the World, 2017; see Appendix S1 for details).

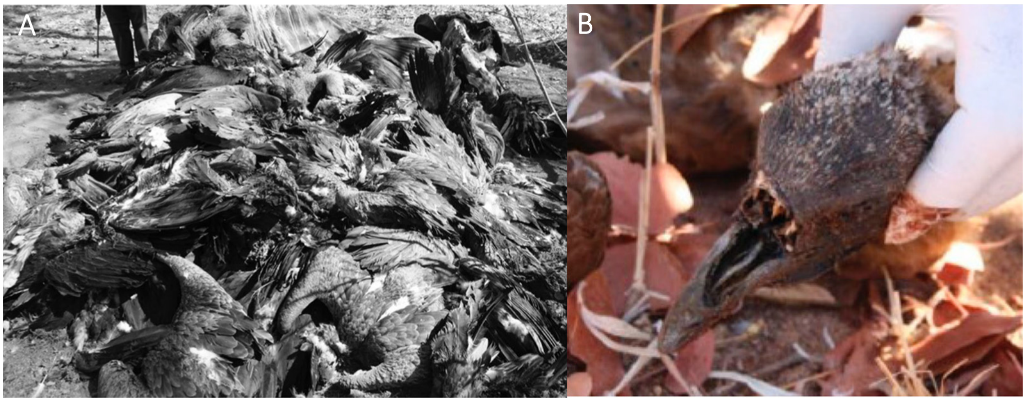

Fig. 2. A). A total of 184 dead white-backed and lappet-faced vultures were found at the poisoned carcass of an African elephant poached for ivory in the Gonarezhou National Park, Zimbabwe, in 2012. B). Upper beaks were harvested from at least 65 vultures, probably for traditional medicine. See further details of this case in Groom et al., 2013. Photos: Rosemary Groom. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

vultures are listed in CITES Appendix II, which obliges to regulate and monitor their international trade (CITES, 2017a). Additionally, an African Wildlife Poison Database exists to gather information on poisoning incidents across the continent (Peregrine Fund and the Endangered Wildlife Trust, 2019). This, together with the ongoing monitoring schemes of megafauna poaching, such as, for example, the MIKE database on elephant poaching, provides a unique opportunity to realize the magnitude of this emerging threat for African vultures. Recording the number of vultures with missing parts at each megafauna carcass (as in Groom et al., 2013) would help to track the pervasive synergy that could be emerging among megafauna poaching, poisoning and belief-based trade; disentangling, for example, if vultures poisoned at such carcasses are also taken by poachers or opportunistically by others. To this end, the existing monitoring of megafauna poaching should be improved (e.g. through enhancing coordination and data sharing among countries and institutions) and expanded, e.g., a programme similar to MIKE could be implemented for other megafauna species, such as giraffes and rhinos.

Changes in demand can fuel poaching and trade, threatening target species in a few years (Frank and Wilcove, 2019). A paradigmatic example is that of pangolins, considered as the most poached mammals in the world, with ca. 1 M pangolins traded illegally in 2000–2013, mainly for their meat and scales, which are used in traditional Asian medicine (Challender et al., 2014; CITES, 2016b; Heinrich et al., 2017). As a result, between 2008 and 2013, the eight pangolin species were uplisted in their threat categories by IUCN, with all species being considered as “Vulnerable” (4 species), “Endangered” (2 species) or “Critically Endangered” (2 species) (CITES, 2016b). In 2019, only two species remain listed as “Vulnerable”, 3 species are listed as “Endangered” and other 3 as “Critically Endangered” (IUCN, 2019). Moreover, all pangolin species have been recently uplisted to the Appendix I of CITES, with a ban of international trade of wild taken individuals (CITES, 2017b). Besides the straightforward impacts of illegal trade on target species, collateral impacts of poaching activities on non-target species, and even on ecosystems, are increasingly highlighted. Examples range from vulture and carnivore mortality associated to large herbivore poaching in Africa (Ogada et al., 2016a) to the dramatic situation for vaquitas *(Phocoena sinus)*, indirectly being affected by poaching on totoaba *(Totoaba macdonaldi)* (Goldfarb, 2016; Rodríguez-Quiroz et al., 2019), or atypical trophic alterations caused by rhino poaching (Everatt et al., 2016).

Considerably less attention has been however paid to pervasive

Fig. 3. Vultures, and other wildlife, are sold for traditional medicine in markets (A, B) across Africa, from Benin or Nigeria to South Africa (C, D, E). Photos: (A) jbdodane and (B) Alexander Sarlay, from Wikimedia Commons under Creative Commons Attribution 2.0 Generic and Attribution-Share Alike 4.0 International license, respectively, (C) Gerhard Nikolaus, (D) Joseph Onoja, and (E) Vivienne L. Williams.

synergies involving illegal wildlife trade, such as, for example, those arising when poaching of target species facilitates access to (initially) non-target species, potentially boosting their otherwise limited trade. Our example brings therefore attention to an emergent threat for species being indirectly impacted by poaching, which deserves further international attention. African vultures can be originally considered as a collateral damage from megafauna poaching, which, by increasing the accessibility to vulture body parts, may in turn boost their trade. As a consequence, we face the risk that the poisoning of poached megafauna carcasses to prevent the early detection of this illegal activity, will spread for other purposes, affecting not only vultures, but many other African wild species.

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CRediT authorship contribution statement

Patricia Mateo-Tomás: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing. **José Vicente López-Bao:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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