

Local hunting of carnivores in forested Africa: a meta-analysis

HUNTER L. DOUGHTY, SARAH M. KARPANTY and HENRY M. WILBUR

Abstract We conducted a meta-analysis of local hunting practices affecting the carnivores of forested Africa and Madagascar to collate the information available on this subject and to assess underlying trends in offtake rates. We located 62 relevant articles in a detailed literature search; the data included taxa reported as hunted, the purpose of hunting and the hunting method. The families most reported as hunted were Herpestidae and Viverridae (excluding *Civettictis civetta*), with 32.7 and 19.2% of total records, with *C. civetta* comprising 13.5% of records and *Nandina binotata* 9.9%. Hunting for consumption was the most commonly reported purpose (61.7% of all records). Sale for consumption was associated with 60.5% of all consumption records, and sale of any kind was reported for 56.6% of all records. The number of carnivore carcasses or parts sold at urban markets rose by 8.2% from the 1990s to the 2000s. The commonest hunting methods were traps (31.0% of records) and guns (16.6%). For records reporting the use of guns, 89.4% also reported sale of some kind. We conclude that carnivores are hunted pervasively across the forested regions of mainland Africa and Madagascar, and offtake rates for both personal use and income are probably increasing. These findings have implications for efforts to protect dwindling forest ecosystems and to establish sustainable consumptive practices.

Keywords Africa, bushmeat, carnivore, hunting, Madagascar, sustainability

This paper contains supplementary material that can be found online at <http://journals.cambridge.org>

Introduction

Forested landscapes across mainland Africa and Madagascar support an exceptionally diverse assemblage of carnivorous mammals (Happold, 1996; Ray, 2001). Varying in size, food preference and home ranges, these carnivores have important ecological roles and yet are in most cases poorly known (Ray, 2001). Despite this, they are cited in discussions of ever-growing anthropogenic

impacts, including the effects of local hunting practices. Examples are the unsustainable hunting of *Cryptoprocta ferox* in north-east Madagascar (Golden, 2009), local extinctions of *Panthera pardus* in various locations, such as south-west Cameroon (Abugiche, 2008), and local extinctions of *Civettictis civetta* at several sites in Ghana (Ryan & Attuquayefio, 2000).

Carnivores are a keystone species in forest ecosystems and so their absence or reduction can distort the trophic balance (Bond, 1993). If hunters are exploiting these species to fulfil subsistence or revenue needs, then understanding the full extent of such actions will enable us to prevent total depletion and to plan better for substitute food resources across Africa (Bennett et al., 2007).

Our objectives were to assess whether carnivores are commonly hunted across the forests of Africa and Madagascar for reasons beyond simple nuisance control or for their pelts. Our analysis provides a collation and assessment of information on the effect of hunting practices on carnivores. Our focus is on the purpose and means of hunting, along with the taxa most affected.

Methods

The term used to search for relevant articles included countries and carnivore taxa (Supplementary Material 1). Google Scholar (Google, Mountain View, USA) was used as the search engine because it examines all text fields in a large array of databases rather than only titles and abstracts. Google Scholar has been used previously for meta-analyses (e.g. Branton & Richardson, 2011; Lelieveld, 2013). Each search included the phrases 'bushmeat' and 'bush meat' (bushmeat describes any wild animal used for human consumption; Bennett et al., 2007). This search may miss articles referring to the hunting of carnivores solely for other purposes, such as cultural ceremonies, or articles that do not refer to wild meat as bushmeat. However, through the use of this search and many citation chains we believe that the majority of relevant studies were discovered. The search results included studies focused on alternative uses for carnivores, further suggesting that the search was thorough. Most of the research on local hunting has been referred to as bushmeat hunting and therefore even non-bushmeat studies often reference bushmeat research. The final search was completed on 1 March 2012.

We located and reviewed a total of 62 articles published during 1974–2012 (Supplementary Material 2). These included 337 reports of the hunting of carnivores. All articles

HUNTER L. DOUGHTY (Corresponding author) and HENRY M. WILBUR Department of Biology, The University of VA, 229 Gilmer Hall, 485 McCormick Road, Charlottesville, VA, 22904-4328, USA. E-mail h.doughty7@gmail.com

SARAH M. KARPANTY Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, Virginia, USA

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were restricted to forest habitats in Africa or Madagascar (Fig. 1). Madagascar was included because its carnivores, although taxonomically separate from those of mainland Africa, occupy similar niches and are hunted for similar reasons. For a few studies conducted across multiple habitat types, such as whole parks, it was difficult to exclude non-forest locations unless these were clearly distinguished.

There was a higher frequency of articles in more recent years, probably a result of increased research efforts and improved research techniques. Information was extracted on every carnivore taxon specifically cited by researchers as being hunted within their study area. Each taxon is considered one record in the analysis. The items noted for each record were: article citation, size class and species of carnivore, purpose of hunting, hunting method, method employed by researchers, political location and habitat of study area.

Only primary data, collected using one of the recorded research methods, were included in the analysis (Supplementary Table S1). Hearsay records, most books, many non-reviewed conference reports, and references to accounts of earlier explorers where the original publication could not be located, were discarded.

Size class was determined by a taxon's mean body weight, defined as small (< 6 kg), meso (6 < 23 kg) and large (> 23 kg; Animal Diversity Web, 2012). Family level groupings (Table 1) were formed with the taxonomy used by IUCN (2012; Supplementary Table S2). *Civettictis civetta* was separated from Viverridae for the purposes of this study because it is biologically dissimilar from other members of its family. Being large, the ecological role of *C. civetta* is different from its smaller relatives and it is perceived differently by local hunters. Its high prevalence in our literature search warrants particular interest. The African palm civet *Nandinia binotata* belongs to a monotypic family and, like *C. civetta*, is of particular interest because of its high prevalence in reports of offtake. Records that could not be classified at the family level as a result of vagueness in identification were not included in family level analyses.

The variables hunting purpose and method, and research method, were not mutually exclusive. Data were presence/absence and a record could be included in multiple categories. For example, if a researcher used market surveys and hunter interviews then both would be tallied under research method.

Recorded purposes for hunting are given in Supplementary Table S3: consumption, culture (use other than as food), pest (unwanted animals, such as nuisance species), and unknown (reason for hunting not specified). The hunting methods recorded are given in Supplementary Table S4.

Results

Records involving small carnivores were dominated by herpestids and viverrids. Meso carnivores were dominated by *C. civetta*. Large carnivores, such as felids and hyaenids,

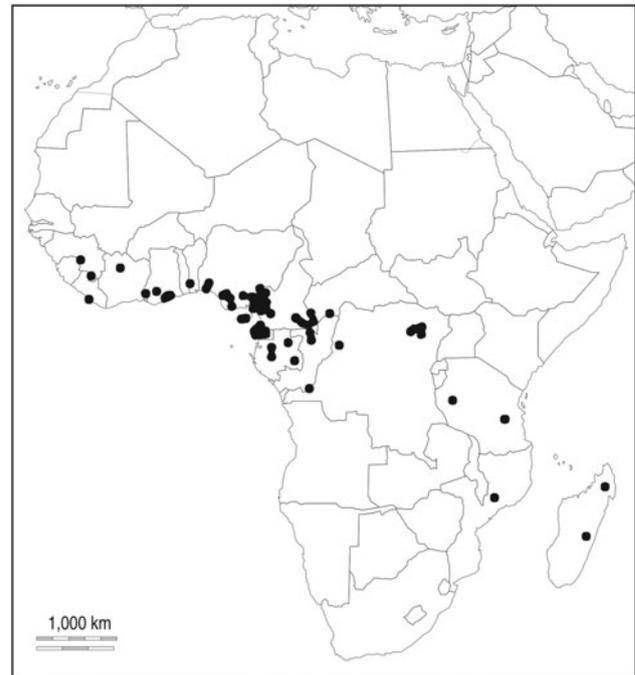


Fig. 1 Locations of study sites (black-filled circles) for the 62 articles (Supplementary Material 2) reporting hunting of carnivores across forested areas of Africa, with 2007 political boundaries. All copyrights of this royalty-free map belong to d-maps.com, 2007–2014.

were dominated by *P. pardus* (Table 1). A summary of the purposes of hunting is given in Table 2. Consumption comprised the majority of all records and was reported for all size classes, and was the primary purpose for hunting seven of the nine taxonomic groups. Records of *C. civetta* were associated primarily with consumption (71.2%), and of records reporting consumption 81.0% were for sale, and of these 47.1% were for urban sale. Records of *N. binotata* were also associated primarily with consumption (84.6%), and of records reporting consumption 81.8% were for sale, and of these 40.7% were for urban sale.

The majority of records of consumption were of *Herpestes*, followed by species of viverrids and *C. civetta*. Cultural use was the second most commonly reported purpose, with herpestids and then viverrids the most commonly reported families. Nearly a third of the records of large carnivores were taken for cultural purposes (Table 2). The highest percentage involved herpestids and then viverrids. Cultural uses were recorded for > 20% of all observations for five out of the nine groups. Twelve of 33 purpose observations of the large-size class were for cultural use. Sale for fetish uses comprised 18.3% of all reports for cultural use. Pest control was the third most frequently reported reason for hunting, with felids most commonly reported for this purpose, followed by viverrids and mustelids. *N. binotata* was not hunted as a pest. Records reporting sale of any kind (consumption, fetish or unknown) composed 56.6% of all 488 purpose observations. Carnivores taken for sale

TABLE 1 Number of reports of the hunting of carnivores (of a total of 337 reports) in 62 studies (see text for details), by family (*Civetta civetta* and *Nandinia binotata* are treated as separate groups for the purpose of this analysis; see text for further details) and size class (see text for details), with number and percentage of total records for each group.

Family	Frequency			Total no.	%
	Small (< 6 kg)	Meso (6 < 23 kg)	Large (> 23 kg)		
Canidae		3		3	0.9
<i>C. civetta</i>		45		45	13.5
Eupleridae	8			8	2.4
Felidae	14	6	25	45	13.5
Herpestidae	109			109	32.7
Hyaenidae			2	2	0.6
Mustelidae		24		24	7.2
<i>N. binotata</i>	33			33	9.9
Viverridae	64			64	19.2
Total (%)	231 (68.6)	79 (23.4)	27 (8.0)		

were sold for consumption (82.3% of all reports of animals taken for sale and 46.5% of all animals taken for a reported purpose) and for fetish use (7.6% of all reports of animals taken for sale and 4.3% of all animals taken for a reported purpose). Personal consumption was reported in 182 records and consumption for sale in 227 records. Of the sales records 50.7% were for local sale and 47.6% for urban sale. Herpestidae (31.1%) and Viverridae (22.6%) contributed most to records of sale in urban areas. Sale in urban areas for reports published between 1974 and 2009 is shown by decade in Fig. 2. Of the 108 records for urban sale, 99 are from studies conducted in the 1990s and the 2000s.

The numbers of reports by hunting method are presented in Fig. 3. Traps were the most popular hunting method (31.0% of records), followed by guns (23.7%). Traps were the primary method of hunting for five of the nine groups. However, for the other four groups, *N. Binotata* was reported as taken equally by guns and traps, and Canidae, Hyaenidae and Felidae were all reported as being taken by unknown methods more frequently than by traps.

There were only 28 reports of night hunting but 64.3% of these were from records associated with sale for consumption, and 43.0% were for urban sale for consumption (Table 3). Only two reports of night hunting did not also report the use of guns. Of the 160 reports of the use of guns, 89.4% also reported sale of some kind. Additionally, 51.8% of all sale reports were associated with use of guns, and 48.2% of reports of urban sale for consumption were associated with the use of guns.

Carnivores specifically defined by the original authors as rare but still hunted totalled 17 reports in eight articles. Carnivores specifically defined as locally extinct totalled 11 reports in seven articles. *Civettictis civetta* was the carnivore most recorded as rare and *P. pardus* was the carnivore most recorded as locally extinct (Supplementary Table S5).

Discussion

Pest

Pest control was in general not the sole reason reported for killing carnivores. Even in areas where carnivores were considered village marauders and poultry killers, they were also still considered a protein source (Campbell, 2009, Ghana; Djagoun & Gaubert, 2009, Benin; Kotschwar et al., 2014, Madagascar). Where nuisance was the sole reason reported (e.g. Carpaneto & Fusari, 2000), species were not eaten because it was either taboo to do so or they were poor tasting.

Culture

Nearly a quarter of records that gave reasons for taking carnivores reported cultural uses, primarily as skins or in fetish practices. Uses of fetish products for spiritual vs medicinal practices are often difficult to distinguish. For example, skins of genet, civets, and felids are used in utilitarian and ornamental fashions (Maisels et al., 2001). The Mbuti people of the Democratic Republic of the Congo (DRC) use genet and civet skins in wrist guards for archery and for hats used in initiation ceremonies (Carpaneto & Germe, 1989). *Genetta servalina* and *Genetta pardina* skins are used as a mark of importance in Cameroon (Pollard, 1997). Genets are used as medicine in Ghana (Ntiamo-Baidu, 1987), the oil from *C. civetta* glands is used against respiratory problems in Cameroon (Laurent, 1992), and *Crossarchus obscurus*, and *Herpestes ichneumon* are used in animist rituals in Benin (Djagoun & Gaubert, 2009). In Nigeria leopard parts are believed to increase fertility, protect against or invoke witches, and to counter snake venom (Sodeinde & Soewu, 1999). Otters are used in Tanzania as

TABLE 2 Number of reports of the purpose of hunting (for consumption, cultural use, as a pest, or unknown) by family (*C. civetta* and *N. binotata* are treated as separate groups for the purpose of this analysis; see text for further details), with the percentage of reports within a group and percentage of reports within a use type.

Family grouping	Consumption			Culture			Pest			Unknown		
	No.	% of group	% of use	No.	% of group	% of use	No.	% of group	% of use	No.	% of group	% of use
Canidae	1	33.3	0.3	0	0	0	2	66.7	5.1	0	0	0
<i>C. civetta</i>	42	71.2	14	13	22	11.3	2	3.4	5.1	2	3.4	6.1
Eupleridae	7	63.6	2.3	0	0	0	3	27.3	7.7	1	9.1	3
Felidae	29	47.5	9.6	19	31.2	16.5	9	14.8	23.1	4	6.6	12.1
Herpestidae	105	69.1	34.9	31	20.4	27	7	4.6	18	9	5.9	27.3
Hyaenidae	0	0	0	1	50	0.9	1	50	2.6	0	0	0
Mustelidae	21	43.8	7	15	31.3	13	6	12.5	15.4	6	12.5	18.2
<i>N. binotata</i>	33	78.6	11	7	16.7	6.1	0	0	0	2	4.8	6.1
Viverridae	59	56.7	19.6	29	27.9	25.2	7	6.7	18	9	8.7	27.3
Family total (%)	297 (61.6)			115 (23.9)			37 (7.7)			33 (6.8)		
Overall total (%)*	301 (61.7)			115 (23.6)			39 (8.0)			33 (6.8)		

*Total number of reports differs between the family and overall because some reports (such as those for small carnivores) were not sufficiently specific to be included in the family level analysis but were included in the overall analyses.

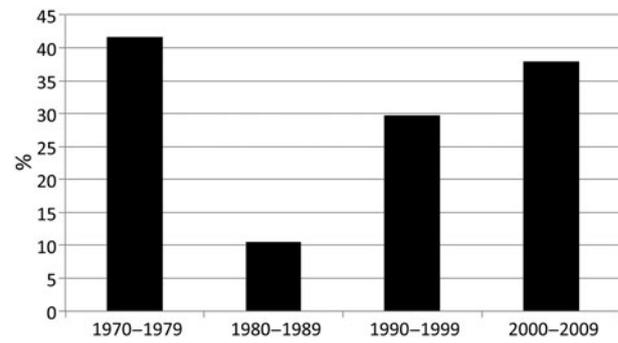


FIG. 2 Percentage of all records within a given decade that reported urban sale of carnivores for consumption.

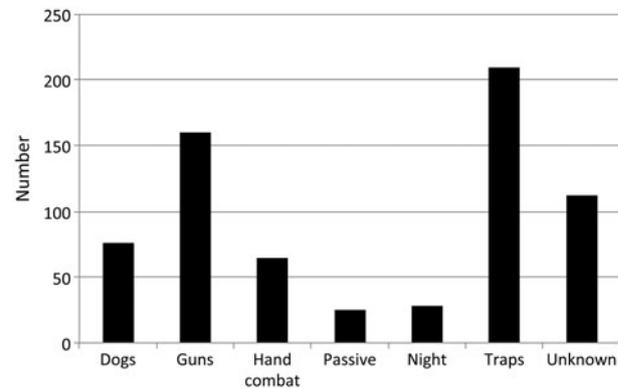


FIG. 3 Number of reports (of a total of 337) in 62 articles (Supplementary Material 2) of the hunting methods used for carnivores.

medicine and belt buckles (De Luca & Mpunga, 2005), and in Central and West Africa otter fur is believed to render the bearer invisible to enemies (Jacques et al., 2009).

Many supposedly protected carnivores used in traditional medicine are commonly and openly sold throughout West Africa. Ntiamoa-Baidu (1987) notes that carnivore parts are sold for traditional medicine in at least one location in all major towns in West Africa. Sodeinde & Soewu (1999) found that 77% of fetish market stalls in Nigeria carried the protected serval *Leptailurus serval*. Hunters in southern Benin use fetish markets as their primary means for selling small carnivores, especially *N. binotata*, Lutrinidae and Viverridae (Djagoun & Gaubert, 2009). This prevalence of sales for fetish purposes implies animals once used within a family or village for local traditions are now sold at a regional scale, suggesting a large network of trading for this purpose and growing demand.

Consumption

Consumption was the most frequently reported reason for hunting but it is difficult to determine who is consuming the meat. Some areas have a religious prohibition against

TABLE 3 Number of reports of carnivores in which night hunting or gun use is given as the hunting method, and sale of any kind is given as the hunting purpose, showing affiliations between these hunting methods and hunting for profit.

	All sale types ¹			Sale for consumption ²			Sale for urban consumption		
	n	Row %	Column %	n	Row %	Column %	n	Row %	Column %
Night	18	64.3	6.5	18	64.3	7.9	12	42.9	11.1
Guns	143	89.4	51.8	116	72.5	51.1	52	32.5	48.2

¹Includes sale for consumption, sale for fetish uses, and unknown uses.

²Includes records reporting sale for consumption through local, urban, or unspecified markets.

eating certain carnivores whereas in other areas the same species command high prices. Taboos preventing hunting of various carnivores were present in areas such as Equatorial Guinea (Keylock, 2002), Republic of the Congo (Mbeté et al., 2011) and Madagascar (Kotschwar et al., in press). Many taboos referred to pregnant women. Genets in Cameroon, for example, are said to cause mother and child to catch a cough, and *C. civetta* to cause a child to be born with body odour (Ayeni et al., 2001). In DRC both *N. binotata* and *C. civetta* are thought to cause developmental anomalies in children (Carpaneto & Germi, 1989). Taboos can also have a spiritual basis. Where leopards are considered a totem animal, villagers believe they can transform into totem species, and therefore killing a leopard could kill the totem's owner (Nzouango & Willcox, 2000; Abugiche, 2008; Wright & Priston, 2010).

Although taboos may protect carnivores, the belief that physical and mental ailments are associated with meat intake may be applicable only to a gender or age group, such as child-carrying women. These beliefs are waning (Nzouango & Willcox, 2000; Wright & Priston, 2010) because of increased interaction with outside education and beliefs (Sifuna, 2012), and perhaps from an increased need for meat or money.

Of reports of consumption 60.5% cited immediate personal use. Noss (1998), Vliet & Nasi (2008) and Keylock (2002) noted that carnivores are often kept and eaten within the hunter's family. Carnivores are also eaten in the forest during extended hunting trips (Kümpel, 2006) because they are less favoured by traders and buyers (Noss, 1998; Nzouango & Willcox, 2000). Personal consumption of carnivores could negatively affect carnivore populations in forested Africa if these less desirable animals are a major food source for the hunter and his family. Halle (2002) reported that in South America the more desirable meat goes to market and the less favoured meat stays within the hunter's family, which invariably results in the 'urban markets indirectly generat[ing] additional pressure on less preferred species.'

Carnivores compose a small but consistent portion of a hunter's total sales, with 75.4% of reports of consumption associated with sale. Examples of the percentage of carnivores of total sales are: 1.71% (Juste et al., 1995), 3.8% (all

viverrids; Martin, 1983), < 5% (Kümpel, 2006), and 18% (Keylock, 2002). At the other extreme, Kümpel (2006) listed *N. binotata* and *G. servalina* as two of the most frequently seen species at market. Bushmen of south-east Nigeria traded carnivores and artiodactyls more than any other animal type (Angelici, 1999), and *Atilax paludinosus* was one of the six most expensive meats per unit mass in eastern Cameroon (Tieguhong & Zwolinski, 2009). Carnivores appear to be increasingly sold in urban areas. Bassett (2005) reported that carnivores increased in the bushmeat trade in northern Côte d'Ivoire from his first survey in 1981–1982 to his second in 1997–1999. This increase was attributed to depletion of other wildlife, especially of large, preferred herbivores. These examples support the notion that as preferred species are depleted a general shift of trade towards less desired animals, including carnivores, is likely.

Hunting methods

The hunting method was unknown for 16.6% of reports (Supplementary Table S4). For known hunting methods however, trapping, predominantly by snares, was the most frequent catch technique (Nzouango & Willcox, 2000; Fa & Yuste, 2001; Golden, 2009). Trapping may be indiscriminate, capturing any species, but Abugiche (2008) found that snares selectively trap *C. obscurus*, and Fa & Yuste (2001) found that carnivores were particularly vulnerable to snares, suggesting that the discrimination of a trap may depend on its design and/or placement.

Guns were the hunting method in 23.7% of reports. Use of guns is currently expanding to locations such as Cameroon (Willcox & Nambu, 2007), Guinea (Ziegler et al., 2002) and Ghana (Crookes et al., 2005). The percentage of carnivores killed with a shotgun rose from c. 30% in 2003 to c. 80% in 2010 in Equatorial Guinea (Gill, 2010). This rise was attributed to an increase in income, enabling more hunters to afford guns and cartridges. Similarly, Kümpel (2006) argued that waxing accessibility to guns and waning trapping success caused hunters to transition from traps to guns. Over half of all reports of sale of bushmeat for consumption were associated with guns, and almost 90% of all gun reports were associated with sale of

some kind, suggesting that guns are being employed almost exclusively where hunting is for profit. If hunting for sale is increasing, the percentage of hunters with guns will probably also increase.

Night hunting (jacklighting), in which a hunter uses a light to halt an animal and shoot it (Hennessey & Rogers, 2008), was reported in 4.1% of records. Hunters in the Republic of the Congo reported jacklighting as one of the easiest means of hunting, and civets as one of the two main animals targeted (Hennessey & Rogers, 2008). Likewise, hunters in Gabon reported night hunting as being more efficient and that small nocturnal carnivores such as *C. civetta*, *N. binotata*, *Bdeogale nigripes* and *Poiana richardsoni* are mostly killed this way (Vliet & Nasi, 2008). About 64% of all night hunting records were associated with sale. This is not as strong an association as with all gun methods but rising sales would logically lead to increased night hunting, for if hunters are transitioning to seeking smaller prey then more profitable hunting methods would be desirable.

Government curbs on these hunting methods may be effective in many locations but appear readily ignored in others. Snares, although illegal, are the most popular method of hunting in the Republic of the Congo (Hennessey & Rogers (2008). Vermeulen et al. (2009) reported snaring, guns, and night hunting as illegal, but used commonly. Wilkie et al. (1992) noted that illegal jacklighting and non-traditional snares are 'openly employed and are acknowledged as the most common, preferred, and effective techniques'.

Taxa affected by hunting

Civettictis civetta is thought to be widely distributed throughout forested Africa and is categorized as Least Concern on the IUCN Red List (IUCN, 2012), although it is commonly taken for sale of its musk to the perfume industry. The relatively large size of this civet (7–20 kg), and its terrestrial habits, make it a desirable and easy target (Carpaneto & Germi, 1989). Laurent (1992), Lupo & Schmitt (2002), and Mbete et al. (2011) report that it is one of the most commonly hunted species. Carpaneto & Fusari (2000) found that *C. civetta* is the only animal to be eaten in hunting of nuisance animals in Tanzania. Djagoun & Gaubert (2009) noted the high resale value of *C. civetta* in the fetish markets of southern Benin. In addition to the five occurrences of known rarity for *C. civetta* and one of local extinction (Supplementary Table S5), 13 studies within the species range (IUCN, 2012) failed to report it, suggesting that this presumed widespread species is undergoing localized depletion.

The Least Concern *N. binotata* (IUCN, 2012) is an easy target for hunters because of its conspicuousness and gregariousness (Okiwelu et al., 2009). Hunters net large numbers of this frugivore as they descend from fruiting palms. This may explain why it is one of the most common species

sold in markets (Kümpel, 2006), where it is also the only carnivore commonly sold (Foerster et al., 2011), and why it is one of the most expensive (Gill, 2010). Although *N. binotata* is considered a common species in many places, 22 of the 58 studies within the species' range (IUCN, 2012) did not report it as present, suggesting it is also undergoing localized depletion.

Although Herpestidae account for a high percentage of records, harvest relative to other carnivores may be inflated because of the high numbers of this family in a given study area. Three herpestids (marsh mongoose *A. paludinosus*, black-footed mongoose *B. nigripes* and dwarf mongoose *C. obscurus*; Laurent, 1992; Pollard, 1997; Puit et al., 2004) comprised 5.0% of all records. Mongoose species are commonly hunted (Lupo & Schmitt, 2002; Carpaneto et al., 2007) but it is not easy to assess any impact because hunters are unaware of species distinctions and because of the difficulty in identifying smoked or butchered specimens.

The family Viverridae (excluding *C. civetta*) presents similar uncertainties: 15 of 64 references to the genus *Genetta* were for 'genet species', and genets are often grouped together as one taxon. This is doubtless because these often solitary, 1–3 kg species are frequently mistaken for one another (Nowak, 1999). Regardless of this uncertainty, species of *Genetta* were observed in many studies. *Genetta servalina*, the most reported species, was noted as the most frequently sold species in at least one location.

The families Felidae and Mustelidae appear to be commonly hunted, and the most hunted felid is the Near Threatened leopard. No species of Mustelidae represented more than 3% of total records but species of the subfamily Lutrinae are commonly used for cultural purposes. There are relatively few records of the family Eupleridae, found solely in Madagascar, being hunted.

Conclusions

Biases in this analysis potentially arise from the keywords used in the search and non-random coverage in the literature of the topics we address. Most studies of localized hunting concern bushmeat and therefore most articles report the purpose of take to be for consumption. Only a few studies focused primarily on cultural uses. However, research that included structured interviews, questionnaires or anecdotal information documented additional non-consumptive purposes for hunting carnivores. Our meta-analysis suggests, nevertheless, that carnivores are hunted pervasively across forested Africa. Research on hunting therefore needs to consider carnivores in more detail. In addition, as much hunting is for personal uses (consumption, culture or pest control), information needs to be gathered on carnivores not intended for sale.

The impacts of hunting on carnivores affect not only the assemblage of species to which these animals belong but also

have implications for the people causing these impacts. If local hunters continue to use carnivores for subsistence or revenue then it is imperative that we understand the sustainability of such actions, to prevent a collapse of food supply should this resource become exhausted.

The effects of hunting on the carnivores of forested Africa appear to be escalating and remain poorly understood. The notion that carnivores are hunted solely for pest control is untenable, the taboos preventing their use as food are deteriorating, and there is a lack of conservation attention to their increased use for both personal consumption and sale for consumption.

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Biographical sketches

HUNTER DOUGHTY is interested in the behavioural ecology and conservation of large mammals, and has field experience in Namibia, Madagascar and Thailand. This article is based on her MA thesis at the University of Virginia. SARAH KARPANTY is a vertebrate ecologist and conservation biologist who works on avian and mammalian communities in Madagascar and along the coasts of North America. HENRY WILBUR is a population and community ecologist who works in the southern Appalachian Mountains of North America.