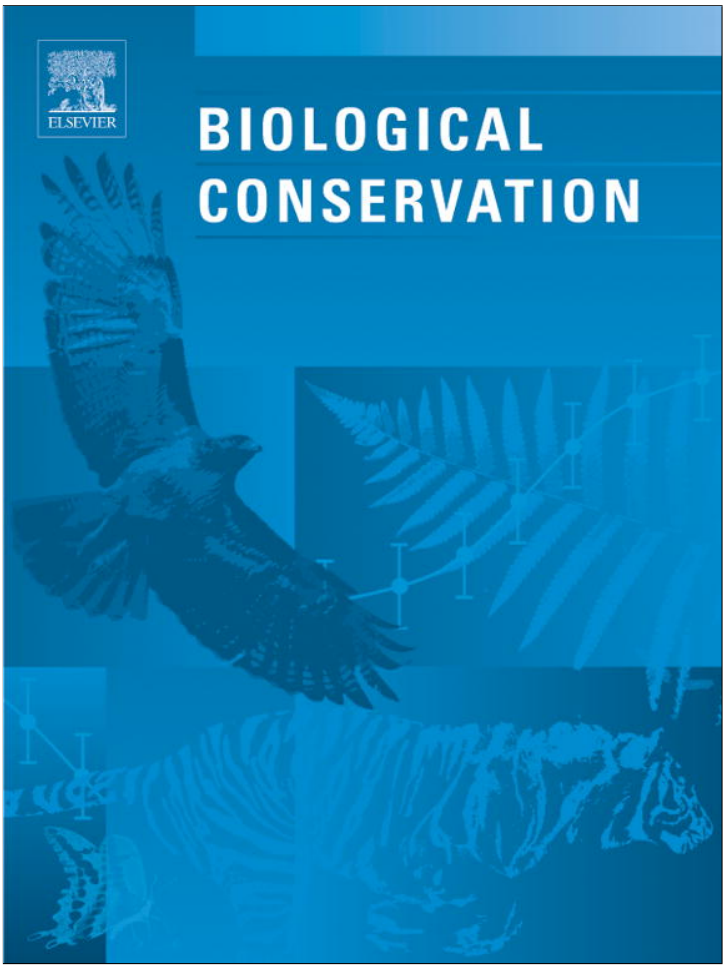

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Review

The bushmeat trade in African savannas: Impacts, drivers, and possible solutions

Peter Andrew Lindsey [a,b,*], Guy Balme [a,z], Matthew Becker [c,y], Colleen Begg [d,ab], Carlos Bento [e], Clara Bocchino [f], Amy Dickman [g], Richard W. Diggle [h], Heather Eves [i,aa], Philipp Henschel [a], Dale Lewis [j], Kelly Marnewick [k,ad], Jaco Mattheus [l], J. Weldon McNutt [m], Rachel McRobb [n], Neil Midlane [a], James Milanzi [o], Robert Morley [x], Michael Murphree [f], Vincent Opyene [p], Joe Phadima [q], Gianetta Purchase [r,ac], Dennis Rentsch [s], Christopher Roche [t], Joanne Shaw [u], Hugo van der Westhuizen [s], Nathalie Van Vliet [v], Patience Zisadza-Gandiwa [w]

[a] Lion Program, Panthera, 8 West 40th Street, 18th Floor, New York, NY 10018, USA
[b] Mammal Research Institute, University of Pretoria, Private Bag X20, Hatfield, Pretoria 0028, South Africa
[c] Zambia Carnivore Programme, PO Box 80, Mfuwe, Zambia
[d] Niassa Carnivore Project, Mozambique
[e] Museu de História Natural, Maputo, Mozambique
[f] North West University, Potchefstroom, South Africa
[g] University of Oxford, United Kingdom
[h] WWF in Namibia, Windhoek, Namibia
[i] College of Natural Resources and Environment, Virginia Tech, Arlington VA, USA
[j] COMACO, Zambia
[k] Endangered Wildlife Trust, Carnivore Conservation Programme, Private Bag X11, Modderfontein, 1645 Johannesburg, South Africa
[l] Global Supplies, South Africa
[m] Botswana Predator Conservation Trust, Private Bag 13, Maun, Botswana
[n] South Luangwa Conservation Society, Mfuwe, Zambia
[o] Zambia Wildlife Authority, Chilanga, Zambia
[p] Uganda Wildlife Authority, Kampala, Uganda
[q] Ezemvelo Kwa-Zulu Natal Wildlife, Pietermaritzburg, South Africa
[r] Zoological Society of London, London, United Kingdom
[s] Frankfurt Zoological Society, Serengeti Community Outreach Office, Tanzania
[t] Wilderness Safaris, Johannesburg, South Africa
[u] TRAFFIC East/Southern Africa, Johannesburg, South Africa
[v] University of Copenhagen, Copenhagen, Denmark
[w] Zimbabwe Parks and Wildlife Management Authority, Chipinda Pools, Gonarezhou National Park, Zimbabwe
[x] SFM Africa, Johannesburg, South Africa
[y] Department of Ecology, Montana State University, Lewis Hall, Bozeman, MT 59717, USA
[z] Department of Zoology, University of Cape Town, Private Bag X3, Rondebosch, 7701, Cape Town, South Africa
[aa] Department of Biology, Ecology & Conservation, St. George's University, Caribbean House, Grenada, West Indies
[ab] The Ratel Trust, South Africa
[ac] Wildlife Conservation Society, Bronx, New York, USA
[ad] Centre for Wildlife Management, University of Pretoria, Pretoria 0002, South Africa

* Corresponding author. Tel.: +27 (0)11 0216727, mobile: +27 (0)82 342 7329, +263 (0)778 008 410, +260 (0)963 750 394; fax: +27 (0)86 569 0077.
E-mail addresses: plindsey@panthera.org (P.A. Lindsey), gbalme@panthera.org (G. Balme), matt@zambiacarnivores.org (M. Becker), ratel@iafrica.com (C. Begg), bentomcarlos@yahoo.com.br (C. Bento), clara.bocchino@gmail.com (C. Bocchino), amy.dickman@zoo.ox.ac.uk (A. Dickman), rwdiggle@wwf.na (R.W. Diggle), heather.eves@aya.yale.edu (H. Eves), phenschel@panthera.org (P. Henschel), dlewis@wcs.org (D. Lewis), kellym@ewt.org.za (K. Marnewick), jaco@globalsupplies.co.za (J. Mattheus), predatorconservation@gmail.com (J. Weldon McNutt), rachel@slczambia.org (R. McRobb), neilmidlane@yahoo.co.uk (N. Midlane), jmsmilanzi@yahoo.co.uk (J. Milanzi), murphreemj@gmail.com (M. Murphree), vincent.opyene@gmail.com (V. Opyene), phadimal@kznwildlife.com (J. Phadima), cheetah@zsl.org (G. Purchase), dennisrentsch@fzs.org (D. Rentsch), chrisr@wilderness.co.za (C. Roche), joannes@ewt.org.za (J. Shaw), hugo@fzs.org (Hugo van der Westhuizen), vanvlietnathalie@yahoo.com (N.V. Vliet), patiencezisadza@gmail.com (P. Zisadza-Gandiwa).

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ABSTRACT

The bushmeat trade, or the illegal acquisition and exchange of wild meat, has long been recognised as a severe problem in forest biomes, but receives little attention in savannas, perhaps due to a misconception that bushmeat hunting is a low-impact subsistence activity. Though data on impacts are scarce, indications are that bushmeat hunting is a widespread problem in savannas, with severe impacts on wildlife populations and wildlife-based land uses. The impacts of the bushmeat trade in savannas vary from edge-effects around protected areas, to disproportionate declines of some species, to severe wildlife declines in areas with inadequate anti-poaching. In some areas, bushmeat contributes significantly to food security, but these benefits are unsustainable, and hunting is wasteful, utilising a fraction of the wildlife killed or of its financial value obtainable through tourism, trophy hunting and/or legal game meat production. The bushmeat trade appears to be becoming increasingly commercialised due to elevated demand in rural areas, urban centres and even overseas cities. Other drivers for the trade include human encroachment of wildlife areas; poverty and food insecurity; and inadequate legal frameworks to enable communities to benefit legally from wildlife, and to create incentives for people to desist from illegal bushmeat hunting. These drivers are exacerbated by inadequate wildlife laws and enforcement and in some areas, political instability. Urgent efforts are needed to address these drivers and raise awareness among local and international governments of the seriousness of the threat. Failure to address this will result in severe wildlife declines widely in African savannas, with significant ecological, economic and social impacts.

Contents

1. Introduction

The illegal bushmeat trade is recognised as a major threat to biodiversity in the forests of Central and West Africa (Fa et al., 2003), where it forms a significant component of local and even national economies (Bowen-Jones et al., 2003). Bushmeat contributes significantly to food security, often representing the most important source of protein in rural areas (Nasi et al., 2008), as well as providing a source of cash which is often used to purchase other foods and essentials during lean harvests. However, bushmeat hunting is unsustainable, causing widespread wildlife population declines and extirpation of larger-bodied species (Wilkie, 1999; Fa et al., 2000). Consequently, the current food security benefits associated with bushmeat will falter (Bennett, 2002); supplies from African forests are expected to drop by 81% over the next 50 years (Fa et al., 2003). The bushmeat trade is thus a crisis from both a conservation and human development perspective.

In contrast to the situation in forests, the bushmeat trade has received comparatively little attention in African savannas. We define African savannas as being areas that receive 300–1500 mm of rainfall annually (following Riggio et al., 2012), encompassing a broad array of habitats comprising an area of ~13.5 million km^2. Lack of research focus has perhaps reflected a misconception that bushmeat hunting in savannas is typically a low impact, subsistence phenomenon (Barnett, 2000; Lindsey et al., 2011a). Literature on the bushmeat trade in savannas is limited to a review of the bushmeat trade in southern and East Africa (Barnett, 2000), and sporadic studies in Serengeti National Park (Hofer et al., 2000; Loibooki et al., 2002; Marealle et al., 2010), other sites in Tanzania (Nielsen, 2006; Wilfred and MacColl, 2010), Mozambique (Fusari and Carpaneto, 2006; Lindsey and Bento, 2012), Zimbabwe (Gandiwa et al., in press; Lindsey et al., 2011a,b) and Zambia (Lewis and Phiri, 1998; Lewis, 2005; Brown, 2007; Lewis et al., 2011; Becker et al., 2013). While these studies demonstrate significant negative ecological impacts, the drivers, impacts and interventions needed to address the bushmeat trade in savannas are not well understood.

Lack of research and actions to address the bushmeat trade to date may reflect an under-appreciation of the problem's significance among contemporary governments, wildlife agencies, and non-governmental organisations in the region. Recently, however, the bushmeat issue received recognition that extended beyond forest biomes when the Convention on Biological Diversity (CBD) established a liaison group on bushmeat (Secretariat of the Convention on Biological Diversity, 2011). In addition, growing concern over the impacts of the bushmeat trade in savannas catalysed a meeting of conservation practitioners to brainstorm the issue in May 2012. This paper summarises existing knowledge and the recommendations that emanated from the meeting.

2. Methods

Participants for the meeting were selected based on known involvement in issues relating to the bushmeat trade in African countries encompassing savannas. The 29 attendees provided insights and experience from 18 African countries.

To describe the bushmeat hunting methods in savanna systems, a literature search was conducted using Web of Science® and search terms such as: bushmeat trade; bows; arrows; dogs; firearms; gin traps; hunting; poaching; snaring; trapping. The legality of hunting methods was assessed for 16 countries in the savanna biome by reviewing legislation derived from http://faolex.fao.org/faolex/index.htm (accessed June 2012). Information on the prevalence of various hunting methods, reasons and drivers for bushmeat hunting, and impacts on wildlife populations were gleaned from the literature and from the collective expertise, experience and data of the meeting attendees.

3. Bushmeat hunting and the law

In most African countries, hunting is regulated by legal instruments, with harvests being controlled through systems of licensing and quotas. In terms of ownership, wildlife is generally either

Table 1
The legality of various bushmeat hunting methods in 15 African countries.[a].

Country	Fire	Snares	Poison	Automatic weapons	Dogs	Nets	Traps	Reference
Benin	0	0	0	0	0	0	0	Loi n° 87–014 portant réglementation de la protection de la nature et de l'exercice de la chasse en République Populaire du Bénin
Burkina Faso	0	0	0	0	1	1	0	Décret N 96–061, portant réglementation de l'exploitation de la faune. Loi N 006/97/ADP du 31 janvier 1997 Portant Code Forestier
Cameroon	0	?	0	0	0	0[b]	1	Loi n° 94/01 portant régime des forêts, de la faune et de la pêche (20 January 1994); Décret n° 95–466 fixant les modalités d'application du régime de la faune
Central African Republic	0	0	0	0	0	0	0	Ordonnance No. 84.045, portant protection de la faune sauvage et réglementant l'exercice de la chasse
Chad	0	0	0	0	0	0	0	Ordonnance n° 14–63 du 28 mars 1963 réglementant la chasse et la protection de la nature
Botswana	0	0	0	0	1	0	0	Wildlife Conservation and National Parks Act, 1992
Mozambique	0	0	0	0	1	0	0	Forest and Wildlife Act (No. 10/1999)
Namibia	0	0	0	0	0	0	0	Namibia Nature Conservation Ordinance, 1975
Niger	0	0	0	0	0	0	0	Loi N° 98–07 du 29 avril 1998 fixant le Régime de la Chasse et de la Protection de la Faune
Senegal	0	0	0	0	0	0	0	Code de la chasse et de la Protection de la faune. Loi N 86–04 du janvier 1986. Décret N 86–844 du juillet 1986
South Africa	0	?	0	0	0	0	0	Threatened and Protected Species regulations, 2006
Sudan	0	0	0	0	0	0	0	Wildlife Conservation and National Parks Act, 2003
Tanzania	0	0	0	0	0	0	0	Wildlife Conservation Act, 2009
Zambia	0	0	0	0	0	0	0	Zambia Wildlife Act, No.12 of 1998
Zimbabwe	0	0	0	0	1	0	0	Trapping of Animals (Control) Act (2002)
Average	0	0	0	0	0.27	0.13	0.6	

[a] The legality of hunting with single-shot firearms, muzzle-loading firearms, shot guns and bows and arrows is more complex as these methods are legal under some circumstances in some countries, albeit when in possession of the necessary permits and in some cases given specific calibres/bow strengths for particular species.
[b] 'Modern' nets prohibited.

considered to be '*res nullius*' (without ownership) or belonging to the state or president. In southern Africa, however, varying degrees of ownership or user-rights are allocated to private (and in some instances, communal) landholders under conditions that vary from country to country, such as: following application for a quota (e.g. Zimbabwe, communal lands in Namibia); erection of fencing (e.g. South Africa, Botswana, Zambia); application for permits for the use of certain species (e.g. Namibia, South Africa); application for a temporary certificate of ownership (Zambia) (Barnett and Patterson, 2006; Cirelli and Morgera, 2009; Lindsey et al., 2013). Using these user-rights, private land owners either hunt wildlife for their own use, or sell hunting rights to hunting operators or tourists (Bond et al., 2004). Rights to hunt for trophies on communal and state lands are typically sold to private safari operators according to quotas (Lindsey et al., 2007). In some countries, e.g. Zambia, Tanzania, Botswana and Malawi, hunting licenses are allocated to citizens to hunt for meat, and in some scenarios subsistence hunting is allowed without a permit on certain categories of land (e.g. Malawi, Angola and Mozambique) (Cirelli and Morgera, 2009).

Hunting laws typically stipulate restrictions on the times of year that hunting is permitted, prohibitions on hunting in certain protected areas, hunting certain species, young or pregnant animals, on the use of certain hunting methods and without permits (Table 1) (Cirelli and Morgera, 2009). Hence, bushmeat hunting is illegal in most contexts within which it occurs, due to contravention of one or more of these restrictions. The meat obtained from illegal hunting is referred to as "bushmeat" to prevent confusion with legal harvest of wildlife for "game meat".

4. Bushmeat hunting methods

Snares are the most common method used by bushmeat hunters (Table 2). Snares typically comprise a noose, usually attached to trees along trails (Hofer et al., 1996). Animals are caught when they put their head (or a leg) into the snare and pull it tight (Noss, 1998). Snares can be made from natural fibre, nylon or wire. Increasingly wire for snares is widely available from telephone and electricity lines, fencing, bicycle brakes and burnt tyres (Hofer et al., 1996; Lindsey et al., 2011a; Becker et al., 2013). Snares are cheap, difficult to detect and can cause rapid declines in wildlife populations (Lindsey et al., 2011a). They can catch species ranging from rodents to elephants (*Loxodonta africana)* depending on the snare size and material (Hofer et al., 1996; Noss, 1998; Hofer et al., 2000). Snares are unselective and frequently kill non-target animals (Lindsey et al., 2011a; Becker et al., 2013). Because of the low value of snares, hunters often check them infrequently, causing wastage (Noss, 1998). For example, in Zimbabwe's Savé Valley Conservancy, at least 1410 animals rotted in snares during 2001–2009 (Lindsey et al., 2011a). Finally, there are animal welfare issues associated with snares as they cause slow deaths and high rates of non-fatal wounding (Noss, 1998).

Dogs are often used by hunters to bay wildlife (Jachmann, 2008a; Grey-Ross et al., 2010) (Table 2). In some areas firearms are used, though automatic weapons are rarely used (Fusari and Carpaneto, 2006; Brown, 2007). In Mozambique, bushmeat hunters commonly use gin traps manufactured from vehicle leaf-springs to kill animals as large as buffalo *Syncerus caffer* and elephant (Fusari and Carpaneto, 2006; Lindsey and Bento, 2012). Fire is used by hunters to flush wildlife, clear undergrowth, increase visibility,

Table 2
The prevalence of methods used to hunt wildlife for bushmeat in savanna Africa (NB that in cases where information was sourced from literature, it may be the case that some hunting methods are used in the study areas but were not mentioned in the papers by the authors).

Area	Snares	Firearms	Dogs	Fire	Bows & arrows	Gin traps	Nets	Small mammal/ bird traps	Pit fall traps	Source
Hunting concessions near Okavango, Botswana	1	1	1	1	0	0	0	0	0	K. Collins (unpublished data)
Tsavo National Park, Kenya	1	0	0	0	0	0	0	0	0	Wato et al. (2006)
Sokoke Forest, Kenya	0	0	1	0	1	0	0	1	0	Fitzgibbon et al. (1995)
WAP complex, Benin, Burkina Faso, Niger	0	1	0	1	0	1	0	0	0	P. Henschel (unpublished data)
Comoé NP, Ivory coast	0	1	0	1	0	1	0	0	0	P. Henschel (unpublished data)
Batéké Plateau, SE Gabon	1	1	1	1	0	0	1	1	0	P. Henschel (unpublished data)
Gile Game Reserve, Mozambique	1	0	0	1	0	1	1	0	0	Fusari and Carpaneto (2006)
Coutada 9, Mozambique	1	1	0	1	1	1	0	0	0	Lindsey and Bento (2012)
Niassa Reserve, Mozambique	1	1	1	1	0	0	1	1	1	C. Begg (unpublished data)
Pafuri, South Africa	1	0	1	0	0	1	0	0	0	C. Roche (unpublished data)
Dwesa/Cwebe Reserves, RSA	1	1	1	0	0	0	0	0	0	Hayward (2009)
Munyawana Game Reserve, RSA	1	1	1	0	0	0	0	0	0	J. Mattheus (unpublished data)
Ruaha ecosystem, Tanzania	1	1	1	0	1	1	0	1	0	A. Dickman (unpublished data)
Serengeti National Park, Tanzania	1	0	1	1	1	0	0	1	1	D. Rentsch (unpublished data)
North western Tanzania	1	1	0	1	1	0	0	0	0	Jambiya et al. (2007)
North Luangwa National Park, Mukungule, Munyamadzi, and W/E Musalangu game management areas	1	1	0	0	0	0	0	0	0	van der Westhuizen (2007)
South Luangwa National Park, Upper and Lower Lupande, and Sandwe game management areas, Zambia	1	1	1	0	0	0	0	0	0	D. Lewis, R. McRobb (unpublished data) and Becker et al. (2013)
Kafue National Park, Zambia	1	1	0	1	0	0	0	0	0	N. Midlane (unpublished data)
Private conservancies, Zimbabwe	1	0	1	0	1	0	1	0	0	Lindsey et al. (2011a)
Gonarezhou National Park, Zimbabwe	1	0	1	1	1	0	1	0	0	H. van der Westhuizen (unpublished data) and Gandiwa (2011)
Average	0.85	0.65	0.6	0.55	0.35	0.3	0.25	0.25	0.1	

stimulate green-growth which concentrates wildlife, and cover tracks (Lindsey and Bento, 2012).

5. Spatial and temporal patterns in bushmeat hunting

With wildlife disappearing from unprotected lands (Newmark, 2008), illegal hunters are increasingly focusing their efforts on protected areas. Within protected areas, bushmeat hunting is more prevalent close to the borders and near human settlements (Muchaal and Ngandjui, 1999; Hofer et al., 2000; Wato et al., 2006; Marealle et al., 2010). Greater distances mean increased time, effort and costs for hunters to find wildlife and transport meat, and higher risk of apprehension (Hofer et al., 2000). Bushmeat hunters typically focus efforts in areas where wildlife concentrates, such as near water, game trails, green-flushes or flowering/fruiting trees (Lindsey and Bento, 2012; Becker et al., 2013).

There are consistent temporal patterns in bushmeat hunting, with peaks in the late dry season when wildlife concentrates around water (Brown, 2007; Holmern et al., 2007; Lindsey et al., 2011a), and following poor crop harvests (Lindsey et al., 2011a), and lulls during peak agricultural activity when hunters are often otherwise occupied (Knapp, 2007; Brashares et al., 2011). In the Serengeti, bushmeat hunting increases during the wildebeest (*Connochaetes taurinus*) migration (Holmern et al., 2007). Hunters using dogs are most active during moonlight when it is easy to see, and on rainy nights (Lindsey et al., 2011a; J. Mattheus, pers. comm.).

6. Scale of the bushmeat trade

Sporadic (though largely meaningless) insights into the volumes of bushmeat traded are provided in the literature. For example; in Tanzania, 2078 tonnes of bushmeat are confiscated annually with a value of >US$50 million; in Central African Republic, an estimated 59,000 tonnes of bushmeat are sold illegally each year; and in Mozambique 182,000–365,000 tonnes are consumed annually, with an economic value of US$365–730 million/year (Barnett, 2000; Secretariat of the Convention on Biological Diversity, 2011). The authors quoting those figures do not indicate whether those quantities are traded on a once off or ongoing basis, or shed light into trends in the scale of the trade. Accurately quantifying the amount of wildlife hunted or the quantity bushmeat traded is extremely difficult given the illicit nature of the activities and lack of research on the topic in savannas.

7. Impact of bushmeat hunting

7.1. Ecological impacts

Wildlife populations are declining in most African countries (Craigie et al., 2010; Scholte, 2011) and bushmeat hunting is a key contributor. In Kenya and Zambia, for example, bushmeat hunting has emerged as the primary threat to wildlife (Barnett, 2000; Okello and Kiringe, 2004). From our sample of 25 case studies (which often incorporate multiple sites, and providing insights from 14 countries), the impacts of bushmeat hunting on wildlife appear to fall into three categories (Table 3).

(a) *Edge-effects*, including reduced effective park sizes and depressed wildlife densities close to human settlements (recorded in 64% of case-studies) (Table 3). Impacts of bushmeat hunting are exacerbated by the use of fire by hunters, which reduce dry-season grazing, and force wildlife from protected areas in search of grazing.

(b) *Disproportionate impacts on particular species*, which can have severe consequences for ecosystem services (e.g. seed dispersal and predation) (Wright et al., 2007; Brodie et al., 2009). Such impacts were recorded in 60% of case-studies (Table 3). Large species are generally targeted by bushmeat hunters, and declining populations are reflected in their waning prevalence in bushmeat markets (Barnett, 2000). Wide-ranging predators are particularly affected by snaring, because they are attracted to carcasses of trapped animals and are also impacted by declining prey populations (Table 3).

(c) *Dramatic, generalised wildlife population declines* have occurred at a number of sites where large-scale bushmeat hunting has been allowed to proceed in the absence of effective law enforcement (Table 3). For example, wildlife populations in Central and West African savannas are collapsing due to excessive bushmeat hunting (Fischer and Linsenmair, 2001; Renaud, 2011; Bouché et al., 2012) (Table 3). In some countries, vast wildernesses exist where wildlife has been depleted, and empty savannas are as real as 'empty forests' (Redford, 1992; Bouché et al., 2012). In Zambia, for example, wildlife populations have been severely depleted in 70% of game management areas (comprising 166,000 km^2), largely through excessive bushmeat hunting (Simasiku et al., 2008). In some areas bushmeat hunting represents a more severe threat than habitat loss (Wilkie et al., 2011), and the two issues often act synergistically, with severe ecological consequences (Ogutu et al., 2009; Wilkie et al., 2011).

Available data preclude rigorous quantification of the ecological impact of bushmeat beyond that allowed for by the available case-studies. However, we are confident that the case-studies in Table 3 represent a tiny fraction of the areas in savannas that are severely impacted by bushmeat hunting. Furthermore, one can expect the impacts to increase in future: as wildlife disappears from human-dominated landscapes, off-takes will focus increasingly on protected areas, resulting in greater proportional impacts on those populations. The scale and apparent ubiquity of the threat posed by bushmeat hunting suggests that without urgent intervention, wildlife resources will be lost in many areas with severe economic and social impacts in addition to the ecological implications.

7.2. Economic and social impacts

Bushmeat hunting can reduce the viability of and even preclude wildlife-based land uses. Trophy hunting is financially unviable in many concessions (18.8–92.3% depending on the country) due to bushmeat hunting (Lindsey et al., 2012a). For example, bushmeat hunting reduced trophy hunting income by 96% in Coutada 9 (Mozambique), by 67% in Burigi and Biharamulo Game Reserves in Tanzania, and by US$1.1 million per year in Savé Valley Conservancy (Jambiya et al., 2007; Lindsey et al., 2011a; Lindsey and Bento, 2012). Ecotourism operations are even more sensitive to bushmeat hunting as they require higher densities of wildlife (Wilkie and Carpenter, 1999). For example, in the Makuleke concession of Kruger National Park, ecotourism operators incurred losses for the first 6 years of operation as wildlife recovered from previously high levels of bushmeat hunting (which was reflected by the removal of >2000 snares during the first 2 years of operations) (C. Roche, pers. comm.).

Social consequences of illegal bushmeat trade include negative impacts on food security in the long term through the loss of a potentially sustainable and greatly elevated supply of meat protein through legal wildlife-based land uses, the loss of tourism-based employment and the loss of wildlife heritage. In some cases, bushmeat hunting is done primarily by communities living away from

Table 3
Impacts on illegal hunting observed in multiple sites from the literature and a survey of $n = 12$ attendees at a bushmeat meeting.

Area	Edge-effects	Pronounced impacts on particular species	Catastrophic population declines	Notes	Source
Comoé NP, Ivory coast	1	1	1	– Near-collapse of populations of large mammals. Near extinction of buffalo, elephant and hippo	P. Henschel (unpublished data)
Batéké Plateau, SE Gabon	1	1	1	– Decline in large ungulates, local extinction of waterbuck, reedbuck, lions and spotted hyaena (due to loss of their prey base)	P. Henschel (unpublished data)
Private conservancies, SE Zimbabwe	1	1	1	– Near eradication of wildlife in areas settled during land reform and declining populations in adjacent areas, local extinction of wild dogs in several areas	Lindsey et al. (2011a)
Gonarezhou National Park, Zimbabwe	1	1	1	– Wildlife population densities lower in areas adjacent to settlement within the park, suppressed lion population	H. Van der Westhuizen (unpublished data)
Pafuri, RSA	1	1	1	– On taking over the concession, illegal hunting had reduced wildlife populations to the point that a reintroduction of impala and zebra was deemed necessary to supplement remaining populations. Lions were entirely absent from the concession.	C. Roche (unpublished data)
Coutada 9, Mozambique	1	1	1	– Reduced wildlife densities close to human settlements. Five large mammal species have been extirpated (including endangered African wild dogs), wildlife densities reduced by >90%	Lindsey and Bento (2012)
Niokolo Koba National Park, Senegal	1	1	1	– Ungulate populations declined by 66–97%, reduced densities close to edges, large species most affected	Renaud (2011)
Kafue National Park, Zambia	1	1	0	– Reduced wildlife densities close to boundaries, high incidence of snaring of large predators	N. Midlane (unpublished data)
South Luangwa National Park, Zambia	1	1	0	– Declining populations in areas close to human settlements, close to boundary of park, declining eland, buffalo and puku populations, strong edge effects from illegal hunting on large carnivores and herbivores	R. McRobb, M. Becker, D. Lewis (unpublished data)
Hunting concessions near Okavango, Botswana	1	1	0	– Declining populations near human settlements, declining giraffe, impala, wildebeest, lechwe populations	K. Collins (unpublished data)
Village land around Ruaha National Park, Tanzania	1	1	0	– Declining large carnivore populations	A. Dickman (unpublished data)
Serengeti National Park, Tanzania	1	1	0	– Resident ungulates locally extirpated in some areas, reduced densities close to boundaries, 78,000–110,000 migratory wildebeest killed annually, skewed gender ratios in impala and giraffe	Hofer et al. (2000), Nyahongo et al. (2005), Ndibalema and Songorwa (2007) and Marealle et al. (2010)
WAP complex, Benin, Burkina Faso, Niger	1	0	1	– Major population declines have occurred in parts of the complex with weak law enforcement	P. Henschel (unpublished data)
Niassa Reserve, Mozambique	0	1	0	– Low densities of lion with low litter sizes and instability in prides, rapid turnover in leopard populations, low densities of wildlife around villages	C. Begg (unpublished data)
Dwesa/Cwebe Reserves, RSA	0	1	0	– Local extinction of red hartebeest, decline in zebra, wildebeest and white rhinoceros populations	Hayward (2009)
Private farms, Kwa-Zulu Natal, RSA	0	1	0	– Declining populations of oribi in some areas	Grey-Ross et al. (2010)
Sokoke Forest, Kenya	1	0	0	– Large ungulate populations reduced to low densities throughout reserve, the density of small mammals has been reduced for 1–2 km from the boundary	Fitzgibbon et al. (1995)
Niassa Reserve, Mozambique	1	0	0	– Reduced wildlife densities close to human settlements in the reserve, and generally depressed densities throughout the reserve	C. Begg (unpublished data)
North Luangwa National Park, Zambia	1	0	0	– Reduced wildlife densities close to the reserve boundary	van der Westhuizen (2007)
North western Tanzania	0	0	1	– Wildlife populations in Burigi and Biharamulo Game Reserves were reduced to less than 10% of their former numbers largely through illegal exploitation by refugees and local populations	Jambiya et al. (2007)
Ranches in the Kalahari ecoregion of north western Zimbabwe	0	0	1	– Reductions of wildlife populations of up to 90% due to excessive harvests to supply the bushmeat trade following the settlement of ranches during land reform	du Toit (2004)
Agricultural farms on the Zimbabwe central plateau	0	0	1	– Dramatic declines (50–60%) in antelope populations during the 1–2 years following the land reform programme, due to excessive off-takes for the bushmeat trade, 50% loss of national tsessebe population	du Toit (2004)
Game management areas, Zambia	0	0	1	– 24 Out of 36 game management areas (which collectively cover 170,000 km^2) are 'under-stocked' or 'depleted', due primarily to illegal bushmeat hunting	Simasiku et al. (2008)
Northern Central	0	0	1	94% Decline in large mammal populations over 30 years,	Bouché et al. (2012)

(*continued on next page*)

Table 3 (*continued*)

Area	Edge-effects	Pronounced impacts on particular species	Catastrophic population declines	Notes	Source
African Republic				across an area of 95,000 km^2	
Gorongosa National Park, Marromeu Buffalo Reserve, Mozambique	0	0	1	90–100% Population declines due to hunting for bushmeat and trophies during and after the civil war, several other reserves severely depleted but lacking 'before' data to make quantitative assessments	Hatton et al. (2001)
Average	0.64	0.60	0.56		

wildlife populations, with the effect that the people bearing the costs of living with wildlife are not those who benefit from bushmeat (van der Westhuizen, 2007).

8. Bushmeat hunters and traders

Hunting is an almost exclusively male activity, though women often butcher meat (Brown, 2007; Lindsey et al., 2011b). Where hunting grounds are distant from hunters' homes, meat carriers are employed (Brown, 2007). In many cases, bushmeat hunters are poor, unemployed, with little education and few livestock (Loibooki et al., 2002; Knapp, 2007; Lindsey et al., 2011b). Bushmeat hunting can be lucrative, however, and in Tanzania, hunters are wealthier than non-hunters (Knapp, 2007). Similarly, in Zambia, some hunters earn nearly US$100 from a single expedition, which approaches the mean per capita annual income for citizens of US$120, and hunters are among the wealthiest community members (Brown, 2007). In some cases, hunters enjoy elevated social status as a result of their profession (Brown, 2007) and are preferred by women (Lowassa et al., 2012).

Bushmeat hunting is rarely practised purely for subsistence and operates on a continuum from provisioning meat for local consumption and trade, up to providing meat for urban or even international markets (Brashares et al., 2011) (Table 4). In several southern and East African countries, well-developed and complex rural–urban trade supply networks exist (Barnett, 2000). Outlets for the sale of bushmeat, such as open-air markets, chop-bars and butcheries, have arisen in some areas, and full-time commercial bushmeat traders occur in most southern and East African countries (Barnett, 2002). In the Serengeti area for example, 34.3% of traders rely on bushmeat as their sole source of income, and sell meat up to 200 km away (Barnett, 2000). In central Mozambique, middlemen purchase bushmeat from hunters to

Table 4
The most common reasons for bushmeat hunting in various savanna sites in Africa.

Area	Own use	Local commercial trade	Commercial trade to urban areas	For body parts for traditional medicine/ ceremonies	Prestige of hunting/ social status	Sport	Source
Hunting concessions near Okavango, Botswana	0	1	1	0	0	0	K. Collins (unpublished data)
WAP complex, Benin, Burkina Faso, Niger	0	1	1	1	0	0	P. Henschel (unpublished data)
Comoé NP, Ivory coast	1	0	1	1	0	0	P. Henschel (unpublished data)
Batéké Plateau, SE Gabon	1	1	1	0	0	0	P. Henschel (unpublished data)
Sokoke Forest, Kenya	1	1	0	0	0	0	Fitzgibbon (2005)
Gile Game Reserve, Mozambique	1	1	1	0	0	0	Fusari and Carpaneto (2006)
Coutada 9, Mozambique	1	1	1	1	0	0	Lindsey and Bento (2012)
Niassa Reserve, Mozambique	1	1	0	1	0	0	C. Begg (unpublished data)
Pafuri, RSA	1	1	0	1	0	0	C. Roche (unpublished data)
Various reserves, RSA	1	1	0	0	0	1	Warchol and Johnson (2009)
Private farms, Kwa-Zulu Natal, RSA	1	0	0	0	0	1	Grey-Ross et al. (2010)
Ruaha ecosystem, Tanzania	1	1	1	0	1	0	A. Dickman (unpublished data)
Serengeti National Park, Tanzania	1	1	1	1	1	0	Hofer et al. (2000), Barnett (2002), Ndibalema and Songorwa (2007), Nyahongo et al. (2005), Loibooki et al. (2002) and Rentsch (unpublished data)
North western Tanzania	1	1	0	0	0	0	Jambiya et al. (2007)
Kafue National Park, Zambia	1	1	1	0	0	0	N. Midlane (unpublished data)
North Luangwa National Park, Mukungule, Munyamadzi, and W/E, Musalangu game management areas	1	1	1	1	1	1	Van der Westhuizen (2007)
South Luangwa National Park, Upper and Lower Lupande, and Sandwe game management areas, Zambia	1	1	1	1	1	0	D. Lewis, R. McRobb, M. Becker (unpublished data) and Becker et al. (2013)
Private conservancies, SE Zimbabwe	1	1	0	1	0	0	Lindsey et al. (2011a,b)
Gonarezhou National Park, Zimbabwe	1	1	1	1	0	0	H. van der Westhuizen (unpublished data)
Average	0.90	0.90	0.60	0.50	0.17	0.17	

re-sell in urban centres (Lindsey and Bento, 2012). Bushmeat is dried or smoked for preservation, and transported to urban markets via foot, bicycle, vehicle or train (Edderai and Dame, 2006; Lindsey et al., 2011a).

The price of bushmeat is related to distance from harvestable wildlife populations (Brashares et al., 2011), with prices relative to alternatives (livestock, poultry, and fish) significantly higher in urban (by 1.57 ± 0.28 times [mean ± S.E.], $n = 10$ published studies) than rural areas (where prices are 0.72 ± 0.07 those of alternatives, $n = 19$) (Mann Whitney Test, $U = 21.0$, $p < 0.01$). Bushmeat transported $\geqslant$90 km from its source costs almost 50% more than fish and chicken (Brashares et al., 2011). Correspondingly, hunters operating close to urban centres sell more of their catch than distant hunters (Brashares et al., 2011). Rural consumers typically select bushmeat over alternatives because it is cheaper or more available (78.5% of buyers, $n = 12$ published studies), whereas urban consumers select it for its taste (100% of buyers, $n = 5$ sites) (Fisher's Exact Test, $p < 0.01$).

9. Drivers of bushmeat hunting and trade

9.1. Increasing demand for bushmeat

Human populations are growing faster in Africa than elsewhere, high population densities occur close to wildlife populations in some areas, urban populations in African cities are becoming wealthier and there are increasing African populations in international cities, resulting in elevated demand for bushmeat from multiple markets. Bushmeat comprises a small proportion of the

Table 5
Drivers for illegal hunting and the bushmeat trade in the savanna biome (NB that where information was extracted from literature, the lack of mention of some drivers does not necessarily mean those drivers are not in play in those areas).

	Inadequate enforcement	Money making opportunity	Protein shortages	Poverty/lack of alternative livelihoods/ employment	Weak penal systems	Corrupt game scouts/ employees	Human influxes/ population increase	Livestock held as assets/lack of livestock	Lack of benefits from wildlife
Hunting concessions near Okavango, Botswana[a]	1	1	0	0	1	1	0	1	0
WAP complex, Benin, Burkina Faso, Niger[b]	1	1	0	0	1	1	0	0	0
Comoé NP, Ivory coast[c]	1	1	0	1	0	0	0	0	0
Batéké Plateau, SE Gabon[c]	1	1	1	1	0	0	0	0	0
Sokoke Forest, Kenya[c]	0	0	1	0	0	0	0	0	0
Protected areas in Kenya[d]	1	1	1	1	1	0	1	0	0
Gile Game Reserve, Mozambique[e]	1	1	1	1	0	0	1	0	0
Coutada 9, Mozambique[f]	1	1	1	1	1	1	1	1	1
Niassa Reserve. Mozambique[s]	1	1	1	1	1	1	1	1	1
Pafuri, RSA[g]	1	1	1	1	1	0	0	1	0
Various reserves, RSA[h]	1	1	1	1	1	1	0	1	1
Private farms, Kwa-Zulu Natal, RSA[i]	1	0	1	1	1	1	0	0	0
Kilombero, Tanzania[j]	1	0	0	0	0	0	0	0	1
Ruaha ecosystem, Tanzania[k]	1	1	1	1	1	1	1	0	1
Serengeti National Park, Tanzania[l]	1	1	1	1	1	1	1	1	1
North western Tanzania[m]	1	1	1	1	1	0	1	0	0
Kafue National Park, Zambia[n]	1	1	1	1	1	1	1	1	1
North Luangwa NP, Mukungule, Munyamadzi, and W/E Musalangu game management areas[o]	0	1	1	1	0	0	0	0	1
South Luangwa National Park, Upper and Lower Lupande, and Sandwe game management areas, Zambia[p]	1	1	1	1	1	0	1	1	1
Savé Valley Conservancy, Zimbabwe[q]	1	1	1	1	1	1	1	1	1
Gonarezhou National Park, Zimbabwe[r]	1	1	1	1	1	1	1	1	1
Average	0.90	0.86	0.81	0.81	0.71	0.52	0.52	0.48	0.52

[a] K. Collins (unpublished data).
[b] P.Henschel (unpublished data).
[c] Fitzgibbon et al. (1995).
[d] Saru (2012).
[e] Fusari and Carpaneto (2006).
[f] Lindsey and Bento (2012).
[g] C. Roche (unpublished data).
[h] Warchol and Johnson (2009).
[i] Grey-Ross et al. (2010).
[j] Haule et al. (2002).
[k] A. Dickman (pers. comm).
[l] Hofer et al. (2000), Barnett (2002), Ndibalema and Songorwa (2007) and Nyahongo et al. (2005) and Marealle et al. (2010).
[m] (Jambiya et al., 2007).
[n] N. Midlane (unpublished data).
[o] van der Westhuizen (2007).
[p] D. Lewis, R. McRobb, M. Becker (unpublished data) and Becker et al. (2013).
[q] Lindsey et al. (2011a).
[r] Gandiwa (2011).
[s] C. Begg (unpublished data).

protein consumed by urban societies (e.g. 2% in Gabon), but the large human populations involved mean that demand for the commodity is significant (Wilkie et al., 2011). There are significant inflows of bushmeat into Europe and the US, where it is sold for elevated prices (Chaber et al., 2010). Such demand is driving increased commercialisation of trade, greater numbers of hunters, erosion of traditional hunting seasons and taboos (which meant that certain species were spared in some areas and that some cultures eschewed hunting), and the adoption of more effective hunting techniques, placing unprecedented pressure on wildlife populations (Barnett, 2000; Stiles, 2011).

9.2. Increasing human encroachment of wildlife areas

Growing human populations are increasingly encroaching wildlife areas (Kiringe et al., 2007), driving elevated bushmeat hunting (Table 5). For example, various categories of protected areas in Ethiopia, Mozambique, Tanzania and Zambia are increasingly settled (Simasiku et al., 2008; Lindsey and Bento, 2012). Human population growth rates are high on the boundaries of protected areas and may even be higher in such areas than elsewhere (Wittemyer et al., 2008) (though that postulation is contested (Joppa et al., 2009)). In Zambia, for example, population growth rates in game management areas are higher than the mean in some cases (e.g. 4.1% in Mambwe District, which encompasses two GMAs c.f. 2.8% for Zambia as a whole) (Zambia Central Statistical Office, 2011).

Human encroachment can be greatly exacerbated by poorly planned infrastructure such as roads, clinics, schools and boreholes in or close to wildlife areas (van der Westhuizen, 2007; Dobson et al., 2010). Though well-intentioned, such developments tend to result in influxes of people into areas poorly suited to human settlement, creating dependency on exploitation of natural resources such as wildlife. In some cases, human influxes may be the result of failure of different government ministries to communicate effectively and plan in a coordinated fashion. For example, human encroachment has been worsened through efforts to control tsetse flies (*Glossina* spp.) which has enabled livestock-keeping and subsequent settlement in previously unfavourable areas (Muriuki et al., 2005). Similarly, encroachment of wildlife areas is exacerbated by forestry and mining, which increase the prevalence of bushmeat hunting due to road construction and human influxes (Clark et al., 2009; Poulsen et al., 2009). Logging companies often perceive bushmeat as a free commodity with which to supplement workers' income (Wilkie et al., 2011). The frequency of bushmeat hunting and rate of bushmeat consumption declines with distance from human settlements (Hofer et al., 1996; Muchaal and Ngandjui, 1999; Brashares et al., 2011; Lindsey et al., 2011a) and wildlife populations fare better where human settlement is not permitted (Stoner et al., 2007).

9.3. Poverty and food insecurity

Rural African communities suffer high levels of unemployment and poverty (Brown, 2007), and the quick income possible from selling meat is a common incentive for bushmeat hunting (Table 5). Individuals with part-time or seasonal employment allocate more time to hunting than those with full-time jobs (Brashares et al., 2011). Lands where wildlife persists are frequently poorly suited to agriculture and food shortages prevail. Reliance on bushmeat is created by shortages of alternative proteins and carbohydrates (as meat is often traded for grain (Lindsey et al., 2011b)) (Table 5). Demand for bushmeat is exacerbated in some areas by diseases such as trypanosomiasis and Newcastle's disease which preclude or reduce livestock production (Lewis, 2005). Furthermore, communities often retain livestock as assets and use bushmeat for daily protein needs (Barnett, 2000). Consequently, bushmeat contributes significantly to food security in many areas (Nyahongo et al., 2005). Around the Serengeti, bushmeat comprises 31% of meat consumed (D. Rentsch, unpublished data). However, declining wildlife populations in many areas mean that the contribution of bushmeat to food security will wane without interventions to make harvests sustainable.

9.4. Lack of clear rights over wildlife or land

In many countries, communities lack rights over their land or the wildlife that they live with, meaning that bushmeat hunting is the only way they can access benefits from wildlife. In some places, efforts have been made to remedy this situation via devolution of user-rights over wildlife to communities and development of community-based natural resource management (CBNRM) programmes. However, in most cases (e.g. Botswana, Tanzania, Zambia and Zimbabwe), governments retain significant proportions of revenue from wildlife and incentives for conservation are weak (Suich et al., 2009). Marginalizing local people from benefits of wildlife can create strained relations with the wildlife sector, which are often worsened by human–wildlife conflict, heavy-handed anti-poaching and historical grievances over land. In such instances, bushmeat hunting may be a form of protest (Holmes, 2007).

10. Contributing factors that facilitate the bushmeat trade

10.1. Inadequate legal protection for wildlife, law enforcement or penal systems

In many countries, gazetted punishments for bushmeat hunting are inadequate and do not reflect the value of wildlife (Barnett, 2000). Penalties typically comprise warnings, community service or fines of lower value than the meat obtained from bushmeat hunting (Barnett, 2000), and in many cases, bushmeat hunters are not convicted at all. For example, 60 hunters were arrested in the NG26 concession in Botswana from 2010 to 2012, but none were convicted (K. Collins, pers. comm.). Due to poor record-keeping, magistrates often fail to consider the criminal history of bushmeat hunters, so first-time and repeat offenders receive similarly weak punishments (V. Opyene, unpublished data). Wildlife laws are not harmonised among neighbouring countries, which can create loopholes and encourage cross-border poaching (V. Opyene, unpublished data). Wildlife offences are typically granted much lower priority than those involving livestock, despite the fact that the wild animals killed often have a much higher value, prejudicing the development of wildlife-based land uses (Lindsey et al., 2011a).

Many governments lack the will, and most state wildlife agencies lack the necessary resources or expertise to enforce laws effectively (Manousrian and Dudley, 2008) (Table 5). The Zambia Wildlife Authority (ZAWA), for example, has a force of 1179 scouts to protect a wildlife estate of ~233,000 km^2 (ZAWA, pers. comm.). Consequently, the risk of bushmeat hunters being caught is low in many places. In the Serengeti, for example, <1% of illegal hunters are apprehended (Loibooki et al., 2002). In some cases, protected areas are simply overwhelmed by the scale of the threat; for example, ~9600 poachers were arrested in 2 months following establishment of refugee camps in Tanzania in the mid-1990s, 7480 of whom escaped from custody (Jambiya et al., 2007).

The efficacy of anti-poaching is often undermined by poor morale resulting from low salaries, corruption, and lack of equipment and supervision (Lindsey et al., 2011a). Scouts are sometimes bribed by bushmeat hunters to turn a blind-eye, and scouts themselves sometimes poach (Lindsey et al., 2011a). In Mozambique, police and local government officials (those responsible for

penalising bushmeat hunters) often buy bushmeat (Lindsey and Bento, 2012) and in Central Africa, government officials sometimes pay poachers to hunt elephants for ivory, who then accrue the meat for sale (Stiles, 2011).

10.2. Political instability

Bushmeat hunting typically increases during periods of political instability due to a breakdown in law enforcement and reduced availability of alternative food. This was observed on wildlife ranches in Zimbabwe during land 'reform', in North West Tanzania following the establishment of refugee camps, and in Mozambique, Democratic Republic of Congo and Central African Republic during periods of armed conflict (de Merode et al., 2007; Bouché et al., 2012).

10.3. Demand for wildlife body parts for traditional use

Wildlife body-parts are often used for traditional medicines and cultural practises, and the sale of such items can increase the profitability of bushmeat hunting. For example, the skins of spotted carnivores such as leopards (*Panthera pardus*) and genets (*Genetta* spp.) fetch high prices (e.g. US$83-$2500 for leopard skins in Mozambique, C. Begg, unpublished data). In addition expanded trade of wildlife parts such as the recent practice of selling lion (*Panthera leo*) as tiger (*Panthera tigris*) bones in Asian markets is an indication that such trade may increase in future (Lindsey et al., 2012b).

10.4. Abundant material for making snares

Controlling bushmeat hunting is made difficult in some areas due the abundance of wire which is used to make snares. In Zambia, the electricity supply corporation has increased wire availability in rural areas during expansion of the national grid, particularly in areas with expanding wildlife-based tourism economies (Becker et al., 2013). In Savé Valley Conservancy, most of the >84,000 snares removed during 2002–2009 were made from wire from the perimeter fence (Lindsey et al., 2011a). Where wire is scarce, illegal hunters are forced to use materials (e.g. gin traps) that are easier to control and harder to replace (Lindsey and Bento, 2012).

11. Potential solutions and associated challenges

11.1. Land use planning

Creating distance or minimizing the interface between people and wildlife is a key means of reducing bushmeat hunting (Lindsey et al., 2011a). Developing and maintaining large protected areas is essential as there is a positive relationship between reserve size and retention of wildlife diversity (Newmark, 2008). Effective reserve size can be increased in some cases by creating transfrontier protected areas (Newmark, 2008). Gazetting semi-protected areas and promoting of wildlife-based land uses adjacent to reserves can create buffers, help conserve critical habitats and reduce edge-effects (Stokes et al., 2010). Where human settlement in reserves is prohibited, enforcing such prohibitions is crucial. Furthermore, human movement through and within parks should be controlled, as livestock grazing and resource collection are used as covers for bushmeat hunting (Lindsey and Bento, 2012; H. van der Westhuizen unpublished data). Where human settlement in reserves is permitted/tolerated, land zoning can help reconcile conservation and human needs (Naughton-Treves et al., 2005). Zoning can help protect wildlife areas and encourage agencies to focus human development initiatives in defined settlement and agricultural areas. Zoning has been implemented in Coutada 9 in Mozambique, resulting in reduced bushmeat hunting and recovering wildlife populations (Lindsey and Bento, 2012).

Fencing can assist land-use planning, limit edge-effects in habitat fragments and reduce bushmeat hunting by reducing wildlife movement from and human incursion into reserves (Lindsey et al., 2012). Fences demarcate reserves and emphasise the illegality of entering and hunting therein (Hayward, 2009). Fences can also assist anti-poaching as the cleared ground maintained within fence lines enables detection of human incursion (Lindsey et al., 2012c). Fences can also sometimes reduce human-wildlife conflicts, thereby improving relations between the wildlife-sector and adjacent communities (Lindsey et al., 2012c).

Careful positioning of infrastructure development can discourage human influxes into wildlife areas. Similarly, other land uses that occur within wildlife areas require careful management. When allocating forestry rights, for example, governments should ensure that concessions are large and contain patches of unlogged forest (Clark et al., 2009). Care is required to prevent an unregulated influx of people to forestry and mining concessions, restrict movement within wildlife areas and ensure that workers are supplied with protein (Poulsen et al., 2009). Mining and forestry companies should also be encouraged to actively protect wildlife populations as part of their corporate responsibility. The De Beers mining company, for example, actively protects wildlife across 2300 km^2 of concessions (http://www.debeersgroup.com/Sustainability/Environment/Biodiversity/, accessed November 2012). Finally, care is required with refugee camp establishment, to ensure that they are not located near wildlife areas and to ensure that adequate meat protein is provided (Jambiya et al., 2007).

11.1.1. Challenges associated with land-use planning

Effective land use planning is likely to require cross-ministerial communication and cooperation. Such cooperation is likely to require significant efforts to raise awareness among ministries of the ecological impacts associated with human encroachment in wildlife areas. Zoning is costly, time consuming and only effective with local support (Naughton-Treves et al., 2005). Where wildlife or people are dependent on seasonal migration to exploit natural resources, zoning is of limited applicability (Goldman, 2003). Convincing governments to consider issues such as bushmeat hunting will be challenging when they are implementing land uses as profitable as mining and forestry. Finally, fences are costly to erect and maintain, can impose ecological impacts by blocking seasonal movements of wildlife and can create massive supplies of snare-wire if designed poorly (Lindsey et al., 2011a; Hayward, 2012).

11.2. Promoting development of alternative livelihoods

Providing alternative income options is vital for reducing reliance of communities on bushmeat. To this end, integrated conservation and development projects (ICDPs) have been established around several reserves (Naughton-Treves et al., 2005). ICDPs are designed to promote sustainable development options (e.g. ecotourism, agro-forestry and sustainable harvest of biological resources) compatible with conservation objectives (Naughton-Treves et al., 2005). Several small-scale projects have been attempted close to wildlife areas, such as honey production, crafts production, nurseries, and food-crop production (Van Vliet, 2011). Agricultural projects have particular potential given the relationship between bushmeat hunting/consumption and food insecurity. In Zambia, the Community Markets for Conservation project aims to improve farming skills adjacent to wildlife areas and reward conservation-compliant communities with elevated prices for their produce, and is succeeding at reducing bushmeat hunting (Lewis et al., 2011).

11.3. Providing alternative protein and carbohydrate supplies

Several options exist for reducing reliance on bushmeat for food. (a) Protecting/increasing fish supplies. Fish represents a direct replacement for bushmeat in some areas (Wilkie et al., 2005). In Ghana, for example, bushmeat hunting consumption is negatively correlated with fish supplies (Brashares et al., 2004). Fish supplies per person in Africa declined by 14% during 1984–2000 (Ronnback et al., 2002), and improved management of fish stocks is necessary to help reduce demand for illegal bushmeat. Fresh-water and coastal aquaculture has potential to supply fish, molluscs, crustaceans and seaweed and reduce demand for wild fish and bushmeat (Ronnback et al., 2002). (b) Addressing veterinary diseases and promoting poultry production. For example, vaccinating chickens against Newcastle disease (coupled with improved husbandry) can increase poultry production by 3–4 times (Lewis, 2005). (c) Farming of indigenous mammals such as cane rats (*Thryonomys spp.*) can potentially generate sustainable supplies of bushmeat (Jori, 1995). (d) Legal production of game meat has significant potential and is discussed in more detail below.

Ensuring that availability of grain foods are sufficient for the entire year is also essential, to prevent reliance on the sale of bushmeat to generate cash to buy grain. The effectiveness of alternative protein approaches may be improved by interventions to increase the price and/or reduce the supply of illegal bushmeat such as by imposing controls on transport of the product, increasing anti-poaching, and providing hunters with alternative livelihoods.

11.3.1. Challenges with solutions based on alternative livelihoods and proteins

There is little information on the success of alternative livelihood or protein projects on bushmeat hunting (Van Vliet, 2011). ICDPs have been criticised for failing to improve livelihoods or confer conservation gains (Naughton-Treves et al., 2005). Where development projects are successful, there is a risk of local population influxes (Wittemyer et al., 2008). There is no guarantee that alternative income or protein options would reduce bushmeat hunting. Hunting and selling bushmeat yields quick profits, confers elevated social status, is usually low risk and requires relatively little time or capital: characteristics often not true of alternative livelihood options (Van Vliet, 2011). Promoting the preferential use of alternative proteins will be challenging where bushmeat prices are low, such as near wildlife areas. There is no guarantee that the income/protein will not be used to augment that from bushmeat, or that other individuals would not take the place of 'reformed' hunters. Such augmentation may be discouraged by including conditional clauses in alternative livelihood/protein projects whereby participation is contingent on the community involved desisting from hunting (Van Vliet, 2011) and by combining such approaches with law enforcement.

There is a risk that increased wealth will increase demand for bushmeat. Relationships between wealth, livestock ownership and bushmeat consumption are complex and variable (Wilkie et al., 2005, 2011; Foerster et al., 2012). In Gabon and Equatorial Guinea, bushmeat consumption increases with income (East et al., 2005; Wilkie et al., 2005; Fa et al., 2009). In the Serengeti, livestock ownership is a poor predictor of bushmeat use, and a chicken vaccination programme increased household cash income and bushmeat usage (D. Rentsch unpublished data). By contrast, on Bioko island in Equatorial Guinea, bushmeat consumption declined with increasing income, as costlier proteins were selected (Albrechtsen et al., 2005; Fa et al., 2009). In western Tanzania, as income from agriculture and livestock increases, the frequency of bushmeat hunting declines (Wilfred and MacColl, 2010). Generally, in rural areas the poorest households consume the most bushmeat, whereas in urban settings wealthier households consume more (Brashares et al., 2011). This finding stresses the importance of alternative income approaches targeting poor households in communities adjacent to protected areas.

Meat from domestic sources may not be considered acceptable replacements for bushmeat by some communities, due to cultural preferences (Van Vliet, 2011) and demand for the product is unlikely to disappear regardless of the availability of alternative proteins. Consequently providing legislative and policy frameworks to allow communities to access meat and other benefits from wildlife in a legal and sustainable way are important.

There are potentially significant negative environmental externalities associated with improved livestock production and aquaculture, though such impacts can be reduced through proper management (Ronnback et al., 2002). Aquaculture and indigenous species farming requires significant start-up capital and expertise, and can create reliance on protracted donor support. Farming of indigenous species has had limited success as hunting is often easier, productivity sometimes suffers from disease outbreaks; and the necessary legal and policy frameworks, markets, and extension services are lacking (Van Vliet, 2011).

As a result of these challenges, alternative livelihoods and protein supplies are unlikely to be effective at reducing bushmeat hunting in isolation, and must be combined with other interventions such as enforcement and legal bases for communities to benefit from wildlife.

11.4. Developing formal wildlife-based land uses

Bushmeat hunting is an inefficient form of wildlife-use due to wastage, lack of selectivity of the gender and age of animals killed, failure to capture the tourism or trophy values of the animals killed, and low prices often obtained for bushmeat. In Zimbabwe, bushmeat hunters capture <1% of the value of the wildlife they destroy (Lindsey et al., 2011a). Efficient, regulated and selective wildlife harvesting can potentially produce significant quantities of meat sustainably. Legal harvest can yield a fresher, more hygienic product, of guaranteed and preferred species-origin, with lower risks of zoonoses (Lindsey et al., 2011a; Alexander et al., 2012). Legal wildlife-based land uses can generate income from trophy hunting, ecotourism and the sale of by-products such as skins, which is why wildlife-ranching has replaced (or complements) livestock production across large areas of private land in semi-arid southern Africa (Bond et al., 2004). Wildlife-based land uses could be used to address bushmeat hunting and trade in the following contexts:

11.4.1. Wildlife-ranching on private land

In several southern African countries, user-rights over wildlife were devolved to private land owners during the 1960–1970s, resulting in the rapid spread of wildlife-ranching (Bond et al., 2004). Wildlife-ranching is practised across ~287,000 km^2 in Namibia, 200,000 km^2 in South Africa and 27,000 km^2 in Zimbabwe (pre- land reform), with smaller (but expanding) areas in Botswana, Zambia and Mozambique (Bond et al., 2004; Lindsey et al., 2013). In Namibia, 16,000–26,000 tonnes of game meat are produced annually on wildlife ranches (Lindsey et al., 2013), and 2.4 million tonnes were produced annually in Zimbabwe prior to the land seizures (Le Bel et al., 2004). In South Africa, game meat may comprise 10% of total meat consumption during the hunting season (G. Dry, unpublished data). These meat harvests have been achieved sustainably and wildlife populations on private land in Namibia, South Africa and Zimbabwe (pre-land reform) have increased dramatically (Bond et al., 2004). In countries with little private land, governments could encourage wildlife-ranching on state

land by allocating long leases to private investors and/or communities.

In southern Africa, wildlife ranches could potentially reduce demand for bushmeat both in urban and rural areas if ranched meat is channelled appropriately. There is scope for the export of game meat from countries with large legal supplies (e.g. South Africa, Namibia) to countries with high demand and low legal supplies (e.g. Zambia, Mozambique, Tanzania). Concurrent with efforts to promote legal game meat production, there is a need to streamline procedures for transporting legal game meat (while addressing the potential for disease transmission), and to impose tighter controls on transporting illegal bushmeat.

11.4.2. Wildlife-based land uses on communal land

Significant potential exists for developing wildlife-based land uses and producing game meat on communal lands if governments devolve user-rights over wildlife to communities adequately, to provide incentives for the conservation of the resource. The most successful CBNRM programme is the communal conservancy programme in Namibia, where a combination of relatively complete devolution of wildlife user-rights, adequate technical and funding support, and low human densities have resulted in strong incentives for sustainable use of wildlife, sharp reductions in bushmeat hunting, the development of 77 communal conservancies covering ~158,000 km^2, and recovering wildlife populations (http://www.nacso.org.na/SOC_profiles/Namibia's%20Communal%20Conservancies.pdf, accessed January 2013). Tourism and trophy hunting in Namibian communal conservancies currently generate US$26.4 million, 2850 jobs and 315,000 kg of game meat annually (significant quantities accruing to households: e.g. 120 kg/household/year in Nyae Nyae) (R. Diggle unpublished data). Similarly, in Ankasa in Ghana, the devolution of user-rights over wildlife to communities has resulted in reduced bushmeat hunting and increasing wildlife populations (M. Murphree unpublished data).

In some cases alternative models of developing wildlife-based land uses on communal land may be appropriate. One option is for the development of wildlife ranches in communal areas through establishment of private-community partnerships. If established correctly, such arrangements could provide the capital necessary to re-stock wildlife (if necessary) and develop infrastructure required for hunting or photo-tourism (and/or meat harvesting), while creating scope for ongoing benefits for communities and incentives for desisting from bushmeat hunting. Scope exists for such arrangements where there are blocks of wilderness remaining in areas partially occupied by communities, such as the Zambian Game Management Areas, Mozambican hunting Coutadas, or Tanzanian Open/Game Controlled Areas (Lindsey, unpublished data).

Finally, in some community areas (including Guruve in Zimbabwe, and adjacent to Serengeti NP), legal wildlife-cropping has been attempted in order to replace bushmeat with a regulated harvest, though these initiatives all failed (Feron, 1995; Holmern et al., 2002; Le Bel et al., 2004).

11.4.3. Extending benefits from protected areas to communities

Extending the benefits from protected areas to neighbouring communities can create disincentives for bushmeat hunting. Various possibilities exist, including: employment; allocating portions of park earnings; involving communities in park management; environmental education; purchasing of produce for tourism from communities; cultural tourism; and allocating stake-holdings (or even complete ownership) of conservation areas to communities (Grossman and Holden, 2008). For example, in Namibia, communities are granted concessions in state reserves which they can use to attract tourism opportunities (Weaver, 2011). Ownership of state/private protected areas could be converted into shareholdings available for purchase by communities (perhaps with donor support) and private companies, thus developing public–private-community partnerships. Such models are business-like and create linkages between park-performance and income for communities, thus creating disincentives for bushmeat hunting.

11.4.4. Challenges associated with developing legal wildlife-based land uses

Pressure from Western protectionist organisations for restrictions on the sustainable use of wildlife and on the international movement of hunting trophies poses a threat to wildlife-based land uses (Norton-Griffiths, 2007). Maximising the financial value of wildlife through legal forms of utilisation is essential to allow wildlife-based land uses to compete with alternatives, and international restrictions on the imports of hunting trophies should be avoided (Lindsey et al., 2012a).

Internal policy and legislative constraints also limit the development of wildlife-based land uses in several countries, perhaps most notably a failure of governments to devolve user rights adequately to private landowners and/or communities and a tendency to introduce bureaucratic barriers to the use of wildlife and/or legal sale of wildlife products (Child, 2009; Lindsey et al., 2013). In some cases, internally-imposed restrictions on the consumptive use of wildlife, as imposed in Botswana and Kenya greatly undermine potential for wildlife-based land uses and the potential for generating legal supplies of game meat (Norton-Griffiths, 2007; Lindsey, 2010). Challenges associated with replacing illegal bushmeat with legally sourced game meat include the difficulty of achieving competitive pricing and overcoming veterinary restrictions on the movement of wildlife products in many countries. There is a need for altered marketing strategies by game ranchers to ensure that game meat produced is distributed to the areas where demand for bushmeat is highest. Finally, there is a risk that illegal bushmeat could be laundered and sold as legal game meat, and some kind of certification system may be required. Another barrier to the development of wildlife-based land uses is the misconception, particularly among politicians, that they threaten food security (du Toit, 2004).

There are a number of challenges specifically associated with CBNRM, including; the need for protracted technical and donor input; difficulty associated with defining communities; and limited returns per household in areas with high human population densities (Jones, 2007). Wildlife harvesting programmes in communal areas have faced a number of challenges, including: low financial viability; elite capture of benefits; high start-up costs; failure to generate comparable quantities of meat to that produced from bushmeat hunting; failure to capture other value streams from wildlife; uncertainty over appropriate recipients of meat and income; veterinary restrictions on meat distribution; competing claims for shared resources; erratic meat supplies and the low purchasing power of local communities (Parker, 1986; Balakrishnan and Ndhlovu, 1992; Féron et al., 1998; Holmern et al., 2002; Le Bel et al., 2004). Combinations of these factors have led to the dissolution of operations described by Féron et al. (1998) and Le Bel et al. (2004). Wildlife cropping is only likely to be viable as part of CBNRM programmes which aim to capture multiple-use values from wildlife.

11.5. Payments to encourage coexistence

Payments to promote coexistence with wildlife and to encourage communities to desist from hunting illegally represent an additional option to address the bushmeat trade. Such payments can help overcome the mismatch between external groups who capture the actual and existence values of wildlife and the local people who bear the costs associated with living with it. Diverse

income streams (e.g. from legal wildlife-use and external financing such as via payments for biodiversity credits) could be combined into payments to encourage coexistence, to be allocated if conservation objectives are achieved (e.g. reduced bushmeat hunting or recovering wildlife populations) and to help compensate for wildlife damages (Dickman et al., 2011). This approach would link conservation investment directly to actual conservation success and help reduce poverty and food insecurity (Groom and Palmer, 2010). This kind of economic approach can attract more funding than traditional conservation from a wider range of donors (Goldman et al., 2008).

11.5.1. Challenges associated with payments for coexistence

A key challenge would be securing long-term, reliable funding, as markets for biodiversity off-sets have not yet been fully developed. Once a payment scheme is established, stopping it could cause elevated antagonism towards wildlife (Montag, 2003). Other challenges include: identifying reliable indicators of success; dealing with fluctuating environmental conditions; determining who should receive payments (in a manner agreeable to the whole community) and ensuring that payments are transparent, equitable and sufficient to offset the costs of wildlife presence; and, avoiding corruption and elite capture of funds (Dickman et al., 2011).

11.6. Adequate legal protection and law enforcement

While 'fortress conservation' has rightly been eschewed in favour of approaches that combine conservation and local development, wildlife laws are often not complied with voluntarily (Rowcliffe et al., 2004) so enforcement through anti-poaching and measures to control bushmeat transport and sale is essential. The need for enforcement is acknowledged in the Lusaka Agreement (http://www.lusakaagreement.org/Documents/3.5.pdf, accessed May 2012), the African Convention on the Conservation of Nature and Natural Resources (http://www.africa-union.org/root/au/Documents/Treaties/Text/nature%20and%20natural%20recesource.pdf, accessed May 2012) and the SADC (southern African Development Community) Protocol on Law Enforcement and Wildlife Conservation (SADC Protocol on Law Enforcement and Wildlife Conservation, accessed November 2012). By increasing the costs associated with bushmeat hunting, effective enforcement can increase the likelihood of alternative livelihood-type interventions working. Governments (and NGO partners) can improve law enforcement in various ways. In the short term, the most important step is to improve the level of investment in and quality of management associated with anti-poaching.

11.6.1. Improved anti-poaching security

There is abundant evidence that elevated anti-poaching security can be effective at reducing bushmeat hunting (Hilborn et al., 2006; van der Westhuizen, 2007; Jachmann, 2008a; Stokes et al., 2010) and compelling evidence that stiff punishments for bushmeat hunting are ineffective if the risks of being caught are low (Leader-Williams and Milner-Gulland, 1993; Hofer et al., 2000). Bushmeat hunting is generally less well addressed than other threats in protected areas (Bruner et al., 2001) and greatly elevated investment in anti-poaching is needed in many reserves (Scholte, 2011). There are several key steps that can be taken by governments to improve enforcement:

(a) Allocation of adequate funding. In Ghana, snaring was effectively controlled in six savanna parks with an enforcement budget of US$51/km^2/year (Jachmann, 2008a). In the 3872 km^2 Coutada 9 in Mozambique, an expenditure of US$28.4/km^2 on anti-poaching has been sufficient to enable wildlife populations to start recovering following historical illegal harvest (Lindsey and Bento, 2012). In the 3500 km^2 Save Valley Conservancy, a security budget of US$72/km^2 was sufficient to prevent wildlife population declines everywhere but the highest-pressure areas close to areas settled during the recent land seizures (Lindsey et al., 2011a).
(b) Adequate manpower to enable sufficient patrol days per month. The manpower and funding needed to control illegal hunting is likely to vary with: the degree of threat from illegal hunting; terrain; vegetation; the size and shape (surface area:volume) of the wildlife area; and, the presence/absence of rhinoceroses (which are a key target for trophy poachers) (van der Westhuizen, 2007; Jachmann, 2008a).
(c) Strategic deployment of scouts to cater for temporal and spatial patterns of bushmeat hunting and prevent hunters from predicting timing and location of patrols (Jachmann, 2008a).
(d) Employment of experienced staff, qualified for all anti-poaching tasks, and ongoing training programmes to maintain and improve their skills. In addition, there is a need for wildlife agencies to take measures to avoid being burdened by high proportions of inadequately skilled, unfit or sick employees.
(e) Adequate working conditions, salaries and equipment (taking into account the strenuous and dangerous nature of the work), to maintain morale, prevent high rates of staff turnover and reduce the likelihood of collusion between scouts and hunters (Jachmann and Billiouw, 1997; Lindsey et al., 2011a). Essential equipment for scouts includes uniforms, hats, boots, radios, handcuffs, GPS units, and firearms.
(f) Timely payment of sufficient bonuses for arrests or confiscation of weapons (Jachmann and Billiouw, 1997).
(g) Adequate management and supervision of anti-poaching scouts, to maintain morale, reduce corrupt practises among scouts and ensure optimal allocation of effort (Jachmann, 2008a). In Ghanaian parks, visits of scout camps by senior staff members increased the effectiveness of anti-poaching patrol teams (Jachmann, 2008a).
(h) Intelligence gathering on planned activities of bushmeat hunters, as this can dramatically improve the effectiveness of anti-poaching (Martin, 1996). Such information can be gathered by employing appropriately connected individuals and/or by paying informants within nearby communities.
(i) Developing a good working relationship with the police and local magistrates to ensure effective processing of detainees following apprehension.
(j) Adequate monitoring of law enforcement efforts to allow for adaptive deployment of resources and assessment of the performance of staff (discussed in more depth below).

11.6.2. Reform of wildlife laws

An additional step needed over the longer term is to reform wildlife laws to achieve greater uniformity among neighbouring countries and provide stronger deterrents. Databases of bushmeat hunters are needed to enable identification of repeat offenders. Efforts are needed to raise awareness among the judiciary and law enforcement agencies of the value of wildlife and the threat posed by bushmeat hunting. Such efforts were made by the Uganda Wildlife Authority and achieved a shift from minor penalties for bushmeat hunting (small fines [~US$10–20] or community service) to custodial sentences of 6–12 months for first-time offenders (V. Opyene pers. comm.).

11.6.3. Challenges associated with law enforcement

Communities who rely most on bushmeat are often also the poorest and most food insecure, so efforts to enforce wildlife laws should be combined with efforts to provide alternative livelihoods

(Brashares et al., 2011). Anti-poaching is expensive and specialised, and can create animosity with local communities if not handled sensitively and not coupled with efforts to extend benefits from wildlife to communities (Keane et al., 2008).

11.7. Reducing availability of snare wire

Reducing the availability of wire is essential to help control snaring. This can be achieved by securing wire stocks and by using alternative materials for fences. Fencing constructed from barbed or steel wire can be readily converted to snares, whereas that made with kinked, mesh (bonnox/veldspan™) fencing cannot (Lindsey et al., 2012). It is important to raise awareness among governments, businesses and landowners about the negative environmental impacts of wire, which wire-types are less amenable to use in snares, and the need to secure wire to reduce theft by hunters.

12. Monitoring the effectiveness of interventions

Monitoring of illegal hunting and the bushmeat trade can provide insights into the effectiveness of interventions. The eventbook system is a simple method for monitoring the incidence of illegal hunting that is easily applied and interpreted by anti-poaching scouts and not reliant on high-levels of training or education (Stuart-Hill et al., 2005). Alternatively, higher-tech monitoring systems such as the Management Information System or Spatial Monitoring and Reporting Tool programmes offer scope for monitoring the nature and extent of illegal hunting (corrected for anti-poaching effort), evaluating the efficacy of law enforcement and assessing the personnel performance. Such tools allow adaptive management of law enforcement in line with temporal and spatial trends in the threat. In Ghanaian parks, evaluation of the effectiveness of anti-poaching patrol teams created a spirit of competition among parks which improved performance (Jachmann, 2008b). Finally, monitoring of the bushmeat trade, via assessment of indices such as catch-per-unit-effort of hunters or species compositions in bushmeat markets can provide insights into the impacts of offtakes (Fa et al., 2000; Rist et al., 2010).

13. Funding the necessary interventions

Necessary interventions will require substantial funding. Providing adequate performance-based funding for state wildlife agencies represents an essential step, as declining budgets severely undermine their ability to protect wildlife (Cumming, 2004). For example, ZAWA operates with a budget of <20% of that needed to function effectively, and consequently their mandate of protecting the vast wildlife estate is impossible to fulfil (World Bank, 2012).

Maximising the economic value of wildlife is important to generate funds for wildlife management and restrictions on legal sustainable use are unadvisable (Lindsey et al., 2012a). Where state land is leased to tourism and hunting operators, long-term leases should be allocated to incentivize investment in anti-poaching (Lindsey et al., 2007). Funding for reserves could be generated by developing the shareholding structures discussed earlier and encouraging external investment, or by seeking co-management arrangements with NGOs or the private sector. Co-management agreements have potentially to significantly bolster the funding and capacity available to manage protected areas and have achieved some notable successes at reducing illegal bushmeat harvests (e.g. North Luangwa, Lower Zambezi and Liuwa Plains national parks in Zambia and Gonarezhou National Park in Zimbabwe) (Child et al., 2004). Finally, the potential for generating funding for protected area management via markets for carbon offsets and biodiversity credits should be pursued.

There is a need to raise awareness amongst the international community of the threat posed by bushmeat hunting, to leverage more funding to address the problem. Because of the obvious links between bushmeat and food security, gaining funding from development and humanitarian agencies is a realistic possibility (Lindsey et al., 2011a, 2011b); however attention must be paid to evidence of repeated failures of development aid (Moyo, 2009).

14. Differences between savanna and forest biomes

Key differences exist between forest and savanna biomes with regard to bushmeat hunting and potential solutions. Bushmeat hunting is easier and cheaper to control in savannas (Jachmann, 2008a). There are better established and larger tourism and trophy hunting industries in many savanna countries (Wilkie and Carpenter, 1999), so there is likely to be stronger political recognition of the value of wildlife, and greater wildlife-management and scientific capacity. Frameworks necessary to enable land owners and communities to benefit legally from wildlife are better developed in some southern African countries (Bond et al., 2004). Savannas are more productive than forests, and so wildlife-based land uses are more likely to be viable (Robinson and Bennett, 2004). Savannas can also support higher densities of livestock, so communities need not necessarily rely on bushmeat for protein (H. Eves, personal communication).

In the literature on bushmeat in forests, the idea is often espoused that bushmeat hunting should be accepted, but regulated (Muchaal and Ngandjui, 1999; Wilkie et al., 2005; Mockrin et al., 2011). In savannas, however, accepting wasteful, inefficient utilisation of wildlife via illegal bushmeat hunting is not advisable or likely to be politically acceptable. Rather, the legal and sustainable utilisation of wildlife should be pursued in a manner that confers maximal benefits to communities, in conjunction with other the interventions highlighted.

15. Research needs

There is an urgent need for more research on bushmeat hunting and trade in the savanna biomes. Lack of available data makes it difficult to assess the extent of the threat relative to other issues, to determine whether (as suspected) the threat is increasing in scope, or to identify how the threat varies in time and space. This lack of information undermines efforts to mobilise governments to develop coordinated, inter-ministerial responses to address the issue, or to encourage greater focus and investment from NGOs. Research is urgently needed to assess the scale, distribution, trends and patterns associated with bushmeat hunting and trade, and to quantify the ecological, economic and social impacts. In addition, an assessment of the role played by bushmeat in meeting food security needs is needed. Finally, there is a need to assess the scale of potential meat and financial benefits that could be generated from legal wildlife-based land uses in areas where they do not currently occur (or succeed), and to identify the legislative, policy and marketing frameworks necessary for them to arise and work.

16. Conclusions

Bushmeat hunting is a severe threat to wildlife in savannas. The drivers of bushmeat hunting are complex and varied, so multiple interventions will often be required, with the suite of appropriate solutions varying between sites. Failure to address the problem will have dire consequences for wildlife in savanna ecosystems. Economic impacts will include the loss of potentially significant

revenues from tourism and legal wildlife-based land uses. Social impacts will be felt through the loss of actual (and potentially greatly elevated) food security benefits from wild meat, the loss of tourism-based employment and the loss of wildlife heritage.

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