

Farmer–African wild dog (*Lycaon pictus*) relations in the eastern Kalahari region of Botswana



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African wild dogs (*Lycaon pictus*) are the most endangered large carnivores in southern Africa. Direct and indirect persecution by farmers causes significant conservation challenges. Farmer–wild dog conflict in Botswana commonly occurs as a result of cattle and stocked game depredation by wild dogs, affecting farmer livelihood and causing economic and emotional distress. Although wild dogs predate livestock at lower levels than other carnivores, they continue to be killed both indiscriminately and in retaliation for incidents of depredation. Investigating farmer–wild dog conflict is a necessary step towards establishing appropriate conflict mitigation strategies. Eighty livestock and game farmers were interviewed in order to examine farmers' value of, perceptions of and experiences with wild dogs as well as their insights on wild dog impacts and conservation in the eastern Kalahari region of Botswana. Interviews were semi-structured and used open-ended questions to capture complexities surrounding farmer–wild dog relations. This research contributes baseline data on wild dogs in understudied tribal land and commercial livestock and game farms in eastern Kalahari. It confirms the presence of wild dogs, livestock and stocked game depredation by wild dogs and negative perspectives amongst farmers towards wild dogs and their conservation. Mean losses were 0.85 livestock per subsistence farmer, 1.25 livestock per commercial livestock farmer, while game farmers lost 95.88 game animals per farmer during January 2012 through June 2013. Proportionally, more subsistence farmers than commercial livestock farmers and game farmers held negative perspectives of wild dogs ($\chi^2 = 9.63$, $df = 2$, $p < 0.05$). Farmer type, education level, socioeconomic status and land tenure, as well as positive wild dog characteristics should be considered when planning and operationalising conflict mitigation strategies. As such, conservation approaches should focus on conservation education schemes, improved wild prey base for wild dogs, poverty alleviation, and community engagement in order to offer long-term opportunities for addressing farmer–wild dog conflict in Botswana.

Conservation implications: Our research contributes to wild dog conservation in Botswana by confirming the presence of wild dogs and the occurrence of livestock and stocked game depredation in previously understudied tribal land and commercial livestock and game farms in eastern Kalahari. To improve predominately negative perceptions of wild dogs and reduce conflict, practitioners should focus their efforts on conservation education schemes, improved wild prey base for wild dogs, poverty alleviation, and community engagement.

Introduction

Human encroachment on large carnivore habitat leads to competition for space and food (livestock and stocked game) and threats to human safety. As a result, humans often engage in indiscriminate and retaliatory killings of large carnivores, the main cause for this being livestock depredation (Hemson et al. 2009; Madden 2004; Muir 2010; Sillero-Zubiri & Laurenson 2001; Valeix et al. 2012). Human-caused mortality remains a leading cause of large carnivore population declines (Hemson et al. 2009; Lindsey, Du Toit & Mills 2005), while the well-being and livelihoods of those sharing space with carnivores are often compromised (Dickman 2010; Gusset et al. 2009; Muir 2010; Swarner 2004). With the persecution of large carnivores occurring outside protected areas across Africa, conflict with humans, especially farmers, remains a significant challenge for carnivore conservation (Woodroffe & Ginsberg 1999). Community support for conservation is, therefore, essential for large carnivore populations to persist in shared spaces (Sillero-Zubiri & Laurenson 2001).

African wild dogs (*Lycaon pictus*) are listed as 'endangered' by the International Union for Conservation of Nature (IUCN) Red List, with the current population estimated at 6600, of which 1400 are considered mature individuals (Woodroffe & Sillero-Zubiri 2012). Wild dogs are social canids, recognised by their individually unique brown, black and white coat patterns and large

ears. Their social structure typically includes four to eight adults, with one adult breeding pair, non-breeding male and female adults as well as their dependent juvenile pups (litters average 10 pups). During the denning season (May–August), wild dogs tend to remain in one location within their home range (Fanshawe, Frame & Ginsberg 1991; Swarner 2004). Wild dogs feed predominately on medium-sized ungulates, such as impala, wildebeest and kudu (Childes 1988; Hayward et al. 2006). They are typically wide-ranging, often occurring in human-dominated landscapes (Woodroffe & Ginsberg 1999), with up to two-thirds of potential wild dog range falling outside of protected areas (IUCN/SSC 2007). Furthermore, human encroachment leading to habitat fragmentation makes wild dogs vulnerable to conflict with farmers over livestock and stocked game, road incident mortality, snaring and disease (Creel & Creel 1998; Fanshawe et al. 1991; Gusset et al. 2008, 2009; Woodroffe & Ginsberg 1999; Woodroffe et al. 2005, 2007). Therefore, focusing conflict mitigation efforts outside protected areas is a significant conservation strategy (Lindsey et al. 2005).

Northern Botswana supports approximately 700–800 wild dogs (Department of Wildlife and National Parks [DWNP] 2009). Most recent IUCN estimates from 2012 of adult and yearling wild dogs in Botswana's Central Kalahari/Khutse Game Reserves was 150 and the Chobe Complex (Chobe Enclave) was 363 (Woodroffe & Sillero-Zubiri 2012). In Botswana, conflict between humans and wild dogs most commonly occurs because of wild dog depredation of cattle essential for local livelihoods and ungulates stocked for hunting and photographic safaris (Boast 2014; Gusset et al. 2009; Muir 2010). Livestock depredation affects subsistence farmers, causing economic and emotional distress (Gusset et al. 2009; Muir 2010; Swarner 2004). Cattle in particular represent a source of income and sociocultural status and have been assigned moral and social importance greater than simply their economic value; as such, they are often referred to as 'a God with a wet nose' (Hoon 2004). Stocked game depredation affects commercial farmers, causing financial burden over time (Boast 2014). Wild dogs like other carnivores may be feared by humans as posing risk to their personal safety (Dickman 2010; Lagendijk & Gusset 2008). Although wild dogs predate livestock at lower levels than other carnivores, they are killed indiscriminately and in retaliation (Gusset et al. 2009; Muir 2010; Schiess-Meier et al. 2007; Swarner 2004). As such, humans, cattle, stocked game animals and wild dogs themselves, experience vulnerability in and around human settlements outside of protected areas (Fanshawe et al. 1991; Woodroffe & Ginsberg 1999).

Implementing appropriate and effective conflict mitigation strategies in such areas represents an important goal for conservation agendas (Boast 2014). Yet, wild dog needs and interests often come into direct conflict with those of humans. For example, when local communities believe that wild animals are prioritised over domesticated or procured game animals, there is increased antagonism towards wildlife and tension between communities and government wildlife departments (Lagendijk & Gusset 2008; Madden 2004).

In Botswana, communities often hold the DWNP directly responsible for livestock depredation, as the government has ownership over the country's wildlife (Hemson et al. 2009). This, in turn, compromises local support for and participation in predator conservation efforts (Hemson et al. 2009; Sillero-Zubiri & Laurenson 2001).

Research on farmer–wild dog relations remains an important step towards planning and implementing appropriate conflict mitigation strategies (DWNP 2009). Researchers investigate the conditions under which wild dogs may prey on livestock by exploring problem animal control records, natural prey monitoring, wild dog population monitoring and scat analysis (Schiess-Meier et al. 2007; Swarner 2004). Other researchers explore how ecological consequences, including habitat loss, genetic diversity loss, edge mortality and changes in population structures, may impact wild dogs particularly in human-populated landscapes (Maude 2011a, 2011b, 2012, 2015; Woodroffe & Ginsberg 1998, 1999). Relatively little research has been conducted on local people's attitudes towards and experiences with wild dogs, despite being a necessary step towards understanding conflict scenarios and designing mitigation strategies (Dickman 2010; Kansky & Knight 2014; Muir 2010). The need for more ethnographic methodological approaches is thus warranted (Goldman, Roque De Pinho & Perry 2010).

Our objective for this research was to document farmers' value of, perceptions of and experiences with wild dogs, as well as their insights on wild dog impacts and conservation, in the eastern Kalahari region of Botswana. We used an open-ended qualitative interview guide to explore the 'complex and sometimes ambivalent ways in which local people think about, and relate with, wildlife' (Goldman et al. 2010:333). We also generated baseline data of farmer–wild dog relations in understudied tribal land and commercial livestock and game farms in eastern Kalahari in Botswana to complement existing research in the Okavango Delta (McNutt & Boggs 1997); the Ghanzi area in western Kalahari (Boast 2014; Klein 2013; Muir 2009); the Hainaveldt, Samedupi and Makalamabedi areas in northern Kalahari (Boast 2014; Gusset et al. 2009); the Central Kalahari Game Reserve (CKGR) (Maude 2011a, 2011b, 2012, 2015); the Khutse Game Reserve (Schiess-Meier et al. 2007) and in the southern Kalahari (Klein 2013).

Research methods and design

Study area

We conducted research in the eastern Kalahari region of Botswana (Figure 1), focusing specifically on villages, cattleposts on tribal land and commercial farms in the Central Boteti region (Figure 2) and Kweneng East (Figure 3). The two study sites exhibit similar ecological circumstances given that they fall within the Kalahari Basin – a large lowland area of semi-arid climatic conditions, scrub vegetation and sandy soils. The study areas also exhibit similar socioeconomic and land tenure circumstances. They are characterised by moderate human population density, with 57 376 persons residing in Central Boteti and 256 752 in

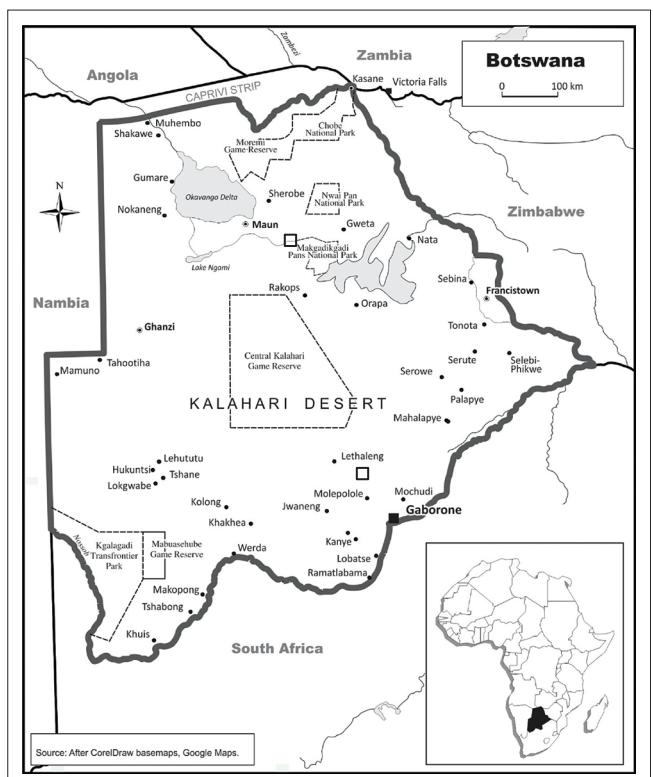


FIGURE 1: Study areas of Central Boteti (north) and Kweneng East (south), eastern Kalahari, Botswana, Africa.

Kweneng East (Botswana's total population is 2 024 904); residents predominantly belong to a variety of Tswana subgroups, with a few persons of Asian and European descent (Statistics Botswana 2014a). The minority of farmers in this area depend upon cattle ranching or stocked game hunting or photographic safaris. The majority of residents depend upon subsistence cultivation and cattle rearing. Subsistence farmer households tend to experience high levels of poverty, with an average monthly income of Botswana Pula (BWP) 2425 (\$242) (Central Statistics Office [CSO] 2004). They base their herding activities in settlement areas known as cattleposts, comprising a thatched hut and fenced enclosures (*kraals*) to house livestock (Hemson et al. 2009; Perkins 1996). They (or their hired herders) release cattle for grazing during the day – often unattended – and wait for cattle to return to the cattlepost for drinking water. An estimated 13% of cattle are left out at night (Valeix et al. 2012).

The wild dog population in the Kalahari is relatively undocumented and believed to be lower than in other areas of the country (Maude 2015). The study area is close to the Central Kalahari Game Reserve, Makgadikgadi Pans National Park and Khutse Game Reserve, and had recently identified wild dog packs. Individual wild dogs from two such packs were used to establish geographical boundaries for the study area. One wild dog in Boteti was collared and tracked on a game farm and within surrounding village and cattlepost areas from November through December 2011 until it was killed in a road incident with subsequent pack sightings noted through July 2013. One wild dog in Kweneng East was collared and tracked – again on a game farm and

within surrounding village and cattlepost areas – from January through June 2013 with subsequent pack sightings and dynamics, including relocation of three wild dogs to CKGR in February 2014.

Data collection and analysis

Our methodological approach was primarily ethnographic, generating quantitative data (e.g. frequencies and statistical analysis) and qualitative data (e.g. thematic texts) similar to recent work by other conservation biologists and social scientists (e.g. Goldman et al. 2010; McGuiness & Taylor 2014). We collected data from May through July 2013; 80 farmers were selected for interviews (Central Boteti $n = 43$, Kweneng East $n = 37$) based on purposive and snowball sampling within the established range areas of the two collared and tracked wild dogs in each locale. Our goal was to provide a resultant sample that includes a cross-section of subsistence farmer households and commercial stocked game and cattle farmers. Semi-structured interviews included 14 open-ended questions on the following topics: (1) value (e.g. importance, role of wild dogs), (2) perception (e.g. attitudes and emotions towards wild dogs, beliefs about and knowledge of wild dogs), (3) experiences (e.g. specific interactions with and behaviour around wild dogs during the last year), (4) impacts (e.g. depredation or damage caused by or attributed to wild dogs during January 2012 through June 2013) and (5) conservation (options regarding protection, tolerance, coexistence). Open-ended interviews were selected in order to elicit dialogue between the researcher and the respondent, and to capture nuances, complexities and contradictions that traditional surveys may overlook (Goldman et al. 2010; Seymour & Wolch 2010). Because of language differences, interviews were conducted in English and translated into Setswana with the assistance of a research assistant. Interviews lasted between 20 and 60 min. Anonymity and right of refusal were explained to each participant; only one commercial cattle farmer refused to participate in the study. Because of the sensitive nature of certain questions, interviews were recorded through extensive note-taking instead of tape-recording.

We based quantitative analysis on a frequency tabulation of responses, where we calculated the percentage based on the number of respondents who answered each question, and based the qualitative analysis on thematic coding. We initially analysed data according to each study site, yet comparable themes were found and no significant differences emerged. Thus, results from Central Boteti and Kweneng East were combined to ensure robust analytical insights on farmer–wild dog relations in eastern Kalahari. We explored demographic trends in these data by analysing aggregate responses for each respondent and farmer subgroup. A chi-square test was used to test the null hypothesis that subsistence, commercial livestock and game farmers are equally negative towards wild dogs. Bonferroni simultaneous confidence intervals were used to compare if similar proportions of subsistence, commercial livestock and game farmers have negative attitudes towards wild

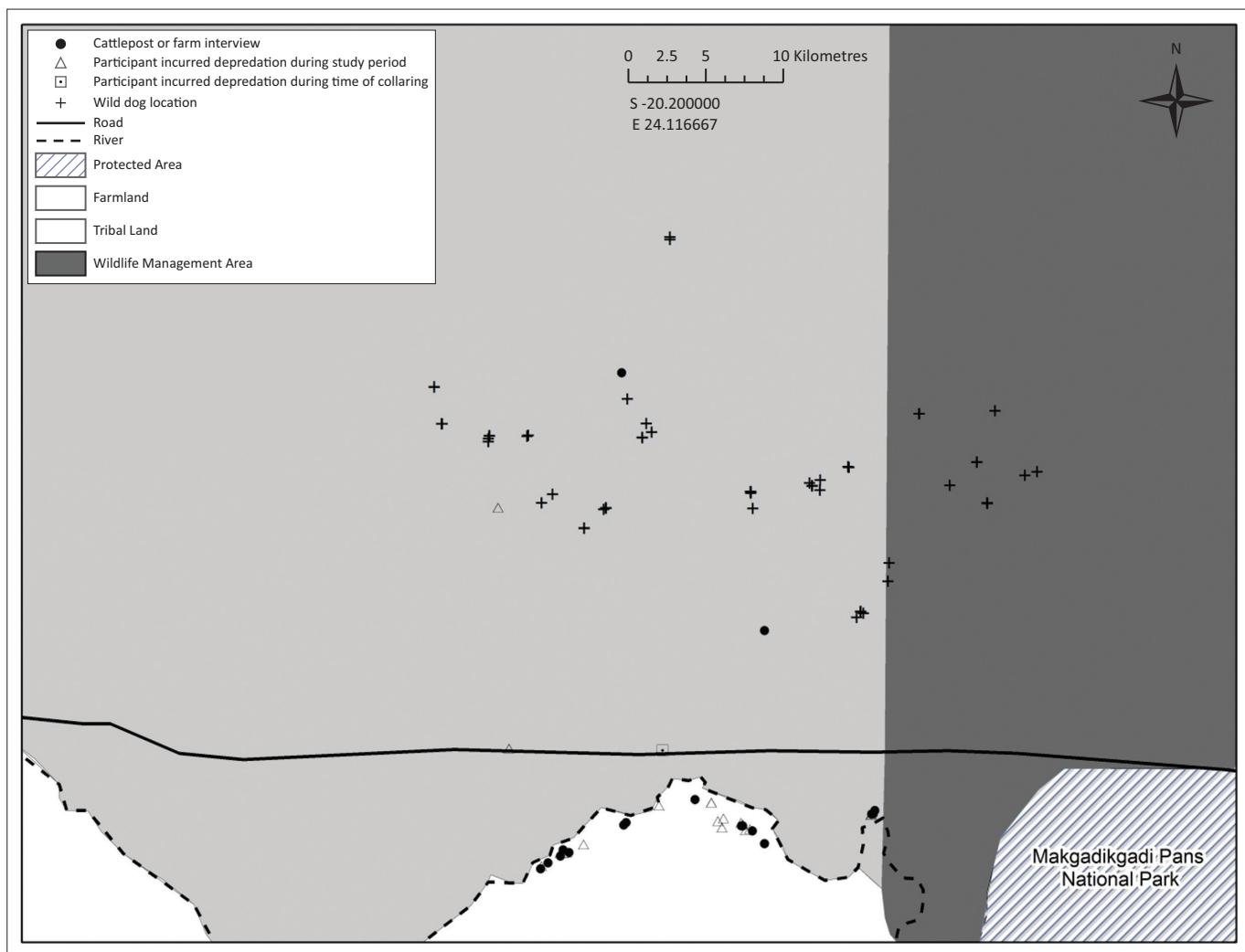


FIGURE 2: Respondent and wild dog locales in Central Boteti, eastern Kalahari, Botswana, Africa.

dogs (Byers, Steinhorst & Krausman 1984). The expected proportions were calculated from the total number of farmers with negative attitudes, and the number of subsistence farmers ($n = 60$), commercial livestock farmers ($n = 8$) and commercial game farmers ($n = 8$) interviewed with either positive or negative perspectives ($n = 76$ of 80); perceptions were compared with the observed number with negative attitudes in each category ($k = 3$, $\alpha = 0.05$, $Z = 2.6383$).

Results

We collected data from May through July 2013; 80 farmers were selected for interviews (Central Boteti $n = 43$, Kweneng East $n = 37$). We approached 81 farmers, but one commercial cattle farmer in the Central Boteti refused to participate.

Value

Fifty-two per cent of respondents ($n = 39$ of 75) claimed that wild dogs are not important animals to Botswana given their perceived and actual predatory role whereby they 'destroy livestock' and 'can kill a cow before [the owner] can sell it'. Thirty-two per cent of respondents claimed that wild dogs are important given their role in tourism and the national

economy. Some farmers noted that 'if we kill them here, they go extinct and we become poor' or 'they can escape to other countries and make them rich'. Twelve per cent of respondents argued that wild dogs are only important to certain groups of people, such as the Government of Botswana who 'put them in parks and tourists come to see them and government gets money'.

Perceptions

Eighty per cent of respondents ($n = 62$ of 78) held a negative attitude towards wild dogs, as illustrated by their response to what first came to mind when thinking about them. The most frequent words were *destroy* (42%) and *dangerous* (14%), with less frequent yet still negative words including *kill*, *troublesome*, *tricky*, *shoot*, *chase*, *dead animal*, *sadness* and *poor*. Twelve per cent of respondents held a positive attitude towards wild dogs, reflected by words such as *beautiful*, *conservation*, *endangered* and *exceptional hunters*. Seven per cent of respondents held a neutral attitude towards wild dogs, reflected by the words *dog* and *animals*. One respondent held mixed attitudes towards wild dogs: 'as a farmer, [my word is] *destroy/do not protect*; as a tourist, *beautiful*; as a conservationist, *protect*'.

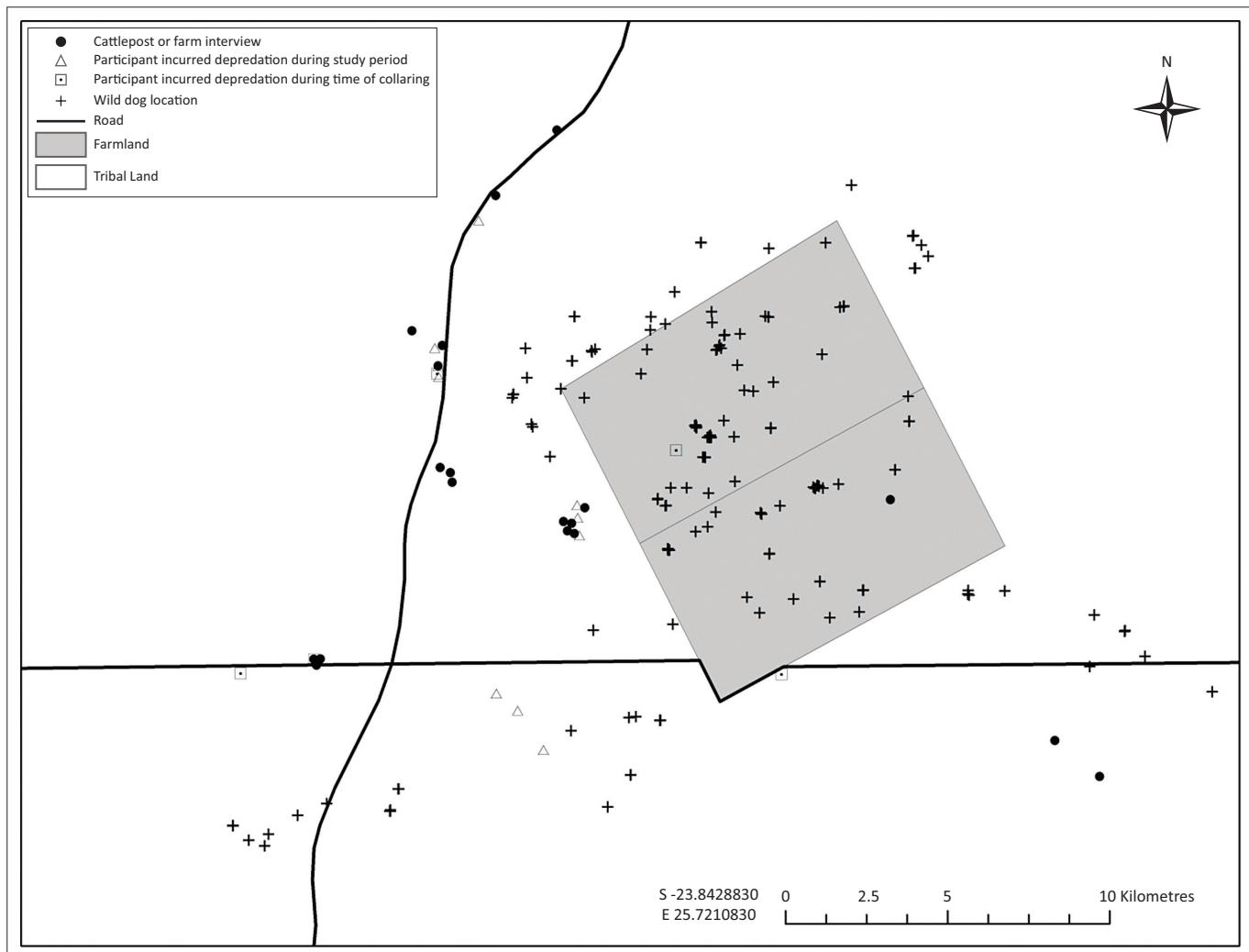


FIGURE 3: Respondent and wild dog locales in Kweneng East, eastern Kalahari, Botswana, Africa.

Fifty-three per cent of respondents ($n = 41$ of 77) selected *sadness* as their predominant emotion associated with wild dogs, given livestock depredation, resulting in income loss or mourning the loss of the cow or the bull itself. Twenty-three per cent of respondents selected *fear* given the potentially dangerous behaviour of wild dogs towards humans or their cattle, and the fear of livestock loss; an additional 7% of farmers selected *anger* on account of potential livestock loss caused by wild dogs. Of the remaining respondents, 9% selected *happiness* given past positive experiences or because of their uniqueness amongst wild animals, while 6% of respondents selected mixed emotions (e.g. happiness seeing them but sadness when considering potential livestock loss).

Additionally, when asked specifically about perceptions of risk, 53% of respondents ($n = 40$ of 76) claimed to be fearful because of threats to personal safety, while 95% ($n = 69$ of 73) claimed to be fearful because of potential depredation.

Experiences

Seventy-nine per cent of respondents ($n = 57$ of 72) learned about wild dogs from family members, elders, community members, other herders or personal experience. The most

prominent topic discussed was their threat to livestock. They were also taught how to identify wild dogs, that they kill wild animals and how to react if they encounter a wild dog, which included chasing them, running away from them and ignoring them. Only one respondent learned from their family to kraal livestock in order to prevent depredation. Eleven per cent of respondents learned about wild dogs at school or from books or television, 5% learned about wild dogs by visiting game reserves or working on game farms, one respondent learned about wild dogs from a DWNP workshop on conflict mitigation.

Respondents claimed a historical presence of wild dogs since the 1990s in both study sites. Wild dog observations for the study period were noted particularly between March and July 2013 with spoor observed throughout the year. Wild dogs were often sighted on game farms and surrounding cattleposts. Respondents provided multiple reports of packs of at least 10 wild dogs, with the largest pack comprising 26 individuals in Central Boteti and wild dogs were seen as lone individuals in several instances.

Seventy-eight per cent of respondents ($n = 49$ of 63) confirmed having direct encounters with wild dogs in the study areas

during the past year. Specific interactions with wild dogs included observing them while driving, walking or working in fields or at cattleposts, watching them on game farm camera traps, coming across them during a kill, tracking them on foot or by vehicle or being chased by them. Seventy per cent of these direct encounters were characterised as negative given that they involved livestock or stocked game depredation or feeling threatened by wild dogs; 22% of encounters were characterised as neutral, where respondents had no strong reaction to the encounter and 8% were described as positive encounters.

Fifty-three per cent of respondents ($n = 32$ of 60) claimed that direct encounters with wild dogs encouraged them to change their behaviour. Thirty per cent of respondents improved their livestock husbandry practices following encounters. These practices included increased kraaling of cattle especially at night time, kraaling calves for extended periods of time, accompanying cattle into the bush during grazing, actively watching for wild dogs and training domestic guard dogs. Other behaviour changes included increased vigilance while walking in the bush often accompanied by domestic dogs or other persons, shouting at wild dogs, walking less often at night time, leaving cattle out more often and carrying a stick for protection. The remaining 47% of respondents claimed that they did not change their behaviour as a result of direct wild dog encounters.

Seventy-seven per cent of respondents ($n = 55$ of 71) claimed that they had never injured or killed a wild dog in retaliation or for deterrence. Notably, 21% of these respondents explained that they did not have the means to do so given lack of firearm access or fear of government punishments. According to one farmer: 'I would kill all of them. I'm afraid of government regulations of killing them. Once I kill the wild dogs I'll be imprisoned'. Additionally, one respondent admitted to shooting wild dogs as a population control technique, one respondent shot three wild dogs (one was caught in the fence, one had a broken leg and one was deemed a nuisance), two respondents tried to kill wild dogs by shooting at them and chasing them with domestic dogs and one respondent witnessed a fellow community member shooting and burying the largest wild dog of the pack. A total of four wild dogs were killed in Central Boteti and no reports of killed wild dogs were identified in Kweneng East. Respondents were more inclined to use scare tactics rather than outright killing, although perceptions that 'the best wild dog is a dead wild dog' were notable.

Impacts

Respondents confirmed livestock and stocked game depredation by witnessing wild dog kills or identifying their tracks at kill sites. According to respondents, 61 livestock animals were killed by wild dogs during the study period (January 2012 through June 2013), including 23 cows, 17 calves, 2 goats and 1 donkey in Central Boteti and 9 cows, 8 calves and 1 bull in Kweneng East. The economic losses reportedly totalled BWP239 740 (\$23 974). Moreover,

historical livestock losses were noted as follows: in Kweneng East 15 cows in 1997, 7 in 2005 and 15 in 2011, as well as 1 cow in Central Boteti during 2005. Farmers expressed disappointment with government compensation offering 35% of livestock market value (based on 2004 value), with no compensation offered for those livestock injured during a wild dog attack. Farmers noted that application processes were arduous and compensation was rarely received. Additionally, respondents estimated that wild dogs killed one game animal per day in the last year; one respondent estimated that 17 game animals were lost in the past year worth BWP960 (\$96); others confirmed losses but could not provide estimates. No government compensation is provided to commercial farmers for game animals. Job loss was also a concern for game farm workers if stocked game were to disappear because of wild dogs. Finally, respondents noted that wild dogs cause damage to farm fences during hunting episodes, requiring minimal repair costs but frequent repairs deemed time consuming and an obstacle to other livelihood activities. Furthermore, damage to fences can also result in game animals escaping from farms and increasing overall losses; one respondent estimated 20 game animals lost to fence damage in addition to depredation.

Conservation

Thirty per cent of respondents ($n = 24$ of 79) claimed that wild dogs should be protected because of their status as endangered species or government-owned animals or because of their role in tourism and the national economy. Twenty-nine per cent of respondents claimed that wild dog protection is necessary to ensure that they are confined and kept away from livestock and people. Twenty per cent of respondents believed that wild dogs should not be protected given extensive livestock losses, limited compensation and lack of utility as food or skin. Nine per cent of respondents said that wild dogs should be protected or confined only for certain groups of persons, including government, tourists and future generations. Eleven per cent did not know if wild dogs should be protected, while the rest had mixed feelings, for example, wild dogs should only be protected if compensation is provided.

Sixty-two per cent of respondents ($n = 48$ of 77) felt that coexistence with wild dogs is not possible given livestock losses or the potential for losses, their potentially dangerous nature, their lack of confinement and their supposed fear of humans. Eleven per cent of respondents claimed that coexistence with wild dogs was possible given their contributions to tourism, that they ensure 'balance in a harmonious ecosystem', because wild dogs 'were here before humans', that humans can defend themselves, and that the government has mechanisms to promote harmony or control populations. According to one farmer: if we 'can't live together, wild dogs would be extinct'. Twenty-seven per cent of respondents expressed an ability to live with or tolerate wild dogs under certain circumstances, including restricted numbers of wild dogs, confinement, depredation prevention, decreased livestock dependence, domestication, increased

education regarding wild dog behaviour and changing attitudes through education. For example, 'If I don't have livestock, I can afford to live with six. It's not many. With livestock, none'. Or '(I can) own them like my domestic dogs and sell them to people'. Respondents claimed that certain groups of people are able to coexist with wild dogs more easily than others: 'The people that won't, we all know that it is the farmers', with tourists and those with non-agrarian livelihoods viewed as more likely to coexist in harmony with wild dogs.

Demographic trends

Ninety-two per cent of these respondents ($n = 70$ of 76) had less than 12 years of education, while 54% never attended school. Only 8% ($n = 6$ of 76) of respondents had over 12 years of education (Table 1). Farmers with less than 12 years of education had less knowledge about wild dogs and referred mainly to predation of cattle, with references to their threat to human safety, their pack sizes, their carnivorous nature and their hunting abilities. Farmers with over 12 years of education had more knowledge of wild dogs and broader conservation issues, such as habitat encroachment, their endangered status, gene pools, pack dynamics and social

TABLE 1: Demographic summary data on respondent perspectives of wild dogs in Central Boteti and Kweneng East, eastern Kalahari, Botswana, Africa, collected between May and July 2013.

Description	Negative perspective	Positive perspective	Total
Commercial game, education < 12 years, income < P1900	0	0	0
Commercial game, education < 12 years, income \geq P1900	1	5	6
Commercial game, education \geq 12 years, income < P1900	0	0	0
Commercial game, education \geq 12 years, income \geq P1900	0	2	2
Commercial livestock, education < 12 years, income < P1900	0	0	0
Commercial livestock, education < 12 years, income \geq P1900	1	4	5
Commercial livestock, education \geq 12 years, income < P1900	0	0	0
Commercial livestock, education \geq 12 years, income \geq P1900	1	2	3
Subsistence, education < 12 years, income < P1900	57	2	59
Subsistence, education < 12 years, income \geq P1900	0	0	0
Subsistence, education \geq 12 years, income < P1900	1	0	1
Subsistence, education \geq 12 years, income \geq P1900	0	0	0
Total	61	15	76

Source: Income information: Lane, K., Hovorka, A. & Legwegoh, A., 2012, 'Urban food dynamics in Botswana: Insights from Gaborone's Central Business District', *African Geographical Review* 31(2), 111–125. <https://doi.org/10.1080/19376812.2012.715975>

TABLE 2: Perspectives of wild dogs based on farmer type and losses in Central Boteti and Kweneng East, eastern Kalahari, Botswana, Africa.

Farmer type	Negative perspective			Positive perspective			Combined		
	Number of farmers	Number of animals lost	Mean loss per farmer	Number of farmers	Number of animals lost	Mean loss per farmer	Number of farmers	Number of animals lost	Mean loss per farmer
Subsistence	58	48	0.83	2	1	0.50	60	49	0.82
Commercial livestock	2	1	0.50	6	9	1.50	8	10	1.25
Commercial game	1	385	385.00	7	382	54.57	8	767	95.88
Total	61	434	-	15	392	-	76	826	-

structure, and hunting abilities. One hundred per cent of subsistence farmers lived on tribal land ($n = 60$ of 60); 25% ($n = 4$ of 16) of commercial farmers lived on tribal land and 74% ($n = 12$ of 16) lived on freehold or state-held land.

Livestock owners suffered fewer losses than game farmers (Table 2). Mean livestock losses of subsistence farmers (0.85 animals per farmer per year) were similar to commercial livestock farmers (1.25 animals per farmer per year) while game farmers lost an estimated (based on general approximations of losses) 95.88 game animals per farmer per year. Small sample sizes limited statistical analysis of education, income and stock losses on the perspectives of wild dogs held by respondents.

Eighty per cent of respondents ($n = 61$ of 76) held overall negative perspectives of wild dogs and 20% of respondents ($n = 15$ of 76) held overall positive perspectives of wild dogs. We rejected the null hypothesis that equal proportions of subsistence, commercial livestock and game farmers hold negative perspectives of wild dog ($\chi^2 = 9.63$, $df = 2$, $p < 0.05$). More subsistence farmers held negative perspectives of wild dogs than expected and fewer commercial livestock farmers and game farmers held negative perspectives than expected (Table 3).

Ethical considerations

Ethical and logistic guidelines for involvement of human participants (Research Permit #EWT 8/36/4 XXII [3]) and animal subjects (Research Permit #EWT 8/36/4 XXVII [37]) were followed in accordance with those provided and approved by the Ministry of Wildlife, Environment and Tourism, Government of Botswana, as well as the University of Guelph Research Ethics Board (Protocol #12MY031).

Discussion

Our research confirms historical and present-day presence of wild dogs in the eastern Kalahari of Botswana, including in and around villages, cattleposts and commercial farms beyond protected areas. According to the IUCN/SSC (2007:34) Southern African Conservation Strategy for Cheetah and Wild Dogs, a significant amount of wild dogs' geographical range falls outside government-protected areas. Therefore, areas outside protected areas are important for the conservation of wild dogs in Botswana and southern Africa in general. Eastern Kalahari is an area where resident populations are present and has potential as a connecting range for wild dogs. As with cheetahs (*Acinonyx jubatus*), it is possible that stocked game

TABLE 3: Bonferroni simultaneous confidence intervals to compare if similar proportions of subsistence, commercial livestock and game farmers in Central Boteti and Kweneng East, eastern Kalahari, Botswana, Africa have negative attitudes towards wild dogs.

Category	Observed	Expected	Chi-square	Expected proportion <i>P₀</i>	Observed proportion <i>P_i</i>	Bonferroni intervals for observed proportion <i>P_i</i>	Use index <i>P_i/P₀</i>	Significant ($\alpha = 0.05$)
Commercial game negative	1	6.42	4.58	0.105263	0.016393	-0.0265 \leq <i>P_i</i> \leq 0.0593	0.16	-
Commercial livestock negative	2	6.42	3.04	0.105263	0.032787	-0.0274 \leq <i>P_i</i> \leq 0.0929	0.31	-
Subsistence negative	58	48.16	2.01	0.789474	0.950820	0.8778 \leq <i>P_i</i> \leq 1.0239	1.20	+
Total	61	61.00	9.63	-	1.000000	-	-	-

Source: Byers, R.C., Steinhorst, R.K. & Krausman, P.R., 1984, 'Clarification of a technique for analysis of utilization-availability data', *The Journal of Wildlife Management* 48(3), 1050–1053. <https://doi.org/10.2307/3801467>

farming has contributed to wild dogs moving into human settlements, with livestock depredation as an unintended consequence of broader zoning practices (Selebatso, Moe & Swenson 2008). With large carnivores in general preferring wild prey to livestock, the presence of wild prey outside protected areas could mitigate livestock depredation (Schüssel-Meier et al. 2007). For example, Woodroffe et al. (2005) found that livestock depredation by wild dogs in areas with serious wild prey depletion cost residents \$389 per wild dog per year compared to \$3.40 per wild dog per year in areas where wild prey was present. Wild prey availability is an important conservation strategy, as the unavailability of wild prey may increase livestock depredation and the subsequent retaliatory killing of wild dogs and other predators (Boast 2014; Winterbach, Winterbach & Somers 2014). Research focused on the role of land-use decisions shaping farmer–wild dog relations is thus warranted.

We found livestock losses that fall within the numbers documented by others (e.g. Gusset et al. 2009; Schüssel-Meier et al. 2007) and we found significant stocked game animal depredation. Wild dogs present an economic and emotional concern to farmers in Central Boteti and Kweneng East given livestock and monetary losses, as well as psychological stress that accompanies compromised livelihood. Farmers' perceptions of risk to their personal well-being and safety also emerged as a concern, despite no human fatalities reported in Botswana to date. These concerns could result from an intrinsic fear of carnivores (Dickman 2010; Lagendijk & Gusset 2008), a lack of knowledge of wild dog behaviour and ecology, and the emotional and psychological impact of witnessing or experiencing livestock depredation. Additional research exploring the specific causes of fear will be important, given that intrinsic dread of carnivores drives hostility and may impede conservation efficacy (Dickman 2010).

While our findings confirm farmers' overall negativity towards wild dogs (Boast 2014; Gusset et al. 2008, 2009; Muir 2010; Romañach, Lindsey, Woodroffe 2007; Woodroffe et al. 2005), the following notable trends emerged with implications for conflict mitigation schemes.

Firstly, perspectives of wild dogs vary according to farmer type. Subsistence farmers hold primarily negative views of wild dogs given livestock depredation (Boast 2014; Davies & Du Toit 2004; Gusset et al. 2008, 2009; Lindsey et al. 2005; Muir 2010; Selebatso et al. 2008). Negative views may also originate from

the social, moral and cultural significance of cattle in Botswana and the relative lack of cultural importance assigned to wild dogs (and their perceived threat to cattle). For subsistence farmers, the loss of a single cow is substantial, compromising livelihood security in terms of food, status or capital access. Compensation did not improve attitudes towards wild dogs, with respondents claiming that compensation was never received or that it did not provide adequate remuneration. They also have fewer options for responding to conflict (Carter, Riley & Liu 2012) and are more inclined to support wild dog conservation in fenced protected areas. Cattle's diminished anti-predator defence, coupled with the relaxed nature of livestock husbandry practices in Botswana, make cattle particularly vulnerable to predation (Hemson et al. 2009; Muir 2010). Given that the cattle industry is dominated by the traditional sector (27 583 farm workers work in the traditional sector, cattle holdings cited for the traditional sector was 1 985 595 versus 262 298 for the commercial sector in 2012, Statistics Botswana 2014b; commercial farms represent less than 1% of all farms [approximately 63 000 farms] and 8% of the total land area, USAID n.d.), subsistence farmers are key to wild dog conservation and mitigation actions.

Learning about wild dogs' ecology would fill a gap in the knowledge of many farmers and equip them to properly deal with or avoid conflict scenarios (Parker et al. 2014). Furthermore, learning about alternative livestock husbandry would also be beneficial for those farmers wishing to be more proactive in their relationship with wild dogs through techniques including accompanying cattle during grazing and secure fencing. Farmers with higher levels of formal education are more likely to have positive attitudes towards wild dogs (Parker et al. 2014). Conservation education has been cited as an important way to gain public support for large carnivores and their conservation (Sillero-Zubiri & Laurenson 2001). Education programmes can shift negative attitudes, develop tolerance and explain the potential value of carnivores to local communities (Goldman et al. 2010; Romañach et al. 2007). However, they can become costly, and it can sometimes take up to a generation to notice a positive difference in attitude (Sillero-Zubiri & Laurenson 2001). Nevertheless, conflict mitigation strategies that engender positive attitudes towards carnivores may have a more substantial long-term impact than those that focus on simply preventing livestock depredation (Thorn et al. 2002). Therefore, conservation education focused on wild dog ecology and effective domestic animal husbandry may

engage farmers directly in conflict mitigation strategies and generate productive avenues for coexistence (Gusset et al. 2008; Parker et al. 2014; Rasmussen 1999; Winterbach et al. 2013; Woodroffe et al. 2005).

Commercial game farmers in our study hold primarily positive views of wild dogs (see also Boast 2014) despite depredation, potential job loss for game farm workers and lack of compensation for stocked game animals, recounting encounters emphasising their natural characteristics and ecological significance. Our small sample of commercial game farmers supported wild dog conservation beyond protected areas. Given that even though some game farmers suffer significant losses, their continued positive attitudes towards wild dogs means that game ranches could potentially be an important land-use practice for wild dog conservation (Boast 2014). However, implications for wild dogs over time could have negative conservation consequences if tolerance diminishes and conflict with game farmers increases. Therefore, conserving wild prey populations outside protected areas and alongside livestock could minimise interactions between stocked game and wild dogs (Gusset et al. 2009).

Those farmers providing or acquiring socioeconomic security are less likely to be antagonistic towards predators (Dickman 2010). Therefore, what is required is a broader, structural approach that considers and genuinely addresses the marginalised position of subsistence farmers who have little means of coping with livestock loss or the immobility caused by wild dogs' impeding daily activities. Government commitments to poverty alleviation schemes (e.g. community-based tourism), encouraging diversified and robust livelihoods options rather than simply relying on compensation schemes, which reinforce government ownership of wildlife (Demotts & Hoon 2012), are essential to this end.

Secondly, interactions with wild dogs were memorable across farmer type. Farmers recalled specific sightings, numbers or behaviours, observed tracks and shared stories with others. They also highlighted positive wild dog attributes, such as their importance to tourism and the national economy, and the sense of wonderment they inspire on account of their appearance or hunting skills. Farmers expressed an aesthetic value of wild dogs, describing them as 'the tattoo of Africa' and explaining that they 'decorate our nature'. They also expressed a desire to domesticate them and to 'witness and know how a wild dog lives'. Capitalising on such positivity through meaningful community engagement that results in achievable and measurable conflict mitigation outcomes may aid in ensuring the continued viability of wild dogs in human-dominated landscapes.

Conclusion

Our research contributes to wild dog conservation in Botswana by confirming the presence of wild dogs in the eastern Kalahari region and the occurrence of cattle and stocked game animal depredation. More subsistence farmers

held negative perceptions of wild dogs than commercial livestock farmers and commercial game farmers. Alleviating poverty through community-based tourism would provide diversified livelihood strategies for marginalised communities while conservation education, effective livestock husbandry practices and wild prey availability outside protected areas may reduce conflict in the long term. Although farmers' perceptions remain predominately negative, positive perceptions were expressed by both commercial and subsistence farmers. Positive perceptions focused on wild dogs' importance to tourism and the national economy, a sense of wonderment associated with their appearance and hunting skills, their aesthetic value and the desire to domesticate them. Capitalising on such positive perceptions may provide an opportunity for meaningful community engagement with wild dog conservation and conflict mitigation programmes, thereby fostering more positive relations between farmers and wild dogs in Botswana and elsewhere.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

V-L.F-C. was responsible for fieldwork and data analysis. A.J.H. is the Principal Investigator and provided support for project design. M.H. provided biological and ecological insights and was closely involved in project design. G.M. provided logistical and project design support and insights into African wild dogs in the Kalahari region of Botswana.

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