RESEARCH ARTICLE

Fencing meant to benefit wildlife poses a threat to Kalahari antelopes

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Application of animal tracking in ecology is limited because academic specialists lack the experience and skills necessary for advanced track interpretation, now often confined to remote and marginalized communities. We applied advanced indigenous tracking skills in Botswana to examine the efficacy of a 'wildlife-friendly' livestock fence along a highway corridor. Certified Master Trackers reconstructed narratives of past wildlife interactions with the fence along its continuous length. Tracking data indicate that the 'wildlife-friendly' fence disrupts large antelope movements. Species and age classes showed differential ability to negotiate the fence: it appears permeable to kudu and large carnivores, a minor filter for hartebeest although especially problematic for their young, a major filter for gemsbok, and a nearly impermeable barrier for wildebeest. Although well-intentioned, we found the 'wildlife-friendly' fence fails to achieve its intended dual purpose of facilitating wildlife movement and restricting livestock. We argue that it should be deactivated to allow unrestricted wildlife mobility particularly important for survival of free-ranging Kalahari antelopes. Application of advanced tracking skills allowed us insights into antelope behavior in relation to a fence that would be difficult to gain by other means. Indigenous Master Trackers' applied talents can be valuable to both pre and post disturbance impact assessments of roads, railways, and fences upon wildlife in Botswana.

Key Words: *Botswana; Connectivity; Fencing; Interpretative tracking; Kalahari; Master tracker; Road ecology; Spoor; Traditional knowledge*

INTRODUCTION

Botswana's Kalahari is characterized by conflicts arising from competing land use between livestock and wildlife [1]. Most areas occupied by livestock are not fenced but communally grazed. Under this traditional 'cattlepost' system livestock wander untended in search of grazing, returning to the cattlepost to water [2]. During rainy months, when livestock are less tied to the cattlepost waterpoint, they often stray widely. At all times of the year the result is high numbers of domesticated animals on the few major Kalahari roadways, which poses an obvious danger to human safety. The engineering solution Botswana has typically taken is to construct not only livestock but wildlife-proof fencing along both sides of major roadways. Such wildlife-proof fences have the potential to disrupt and fragment semi-migratory antelope movements, causing disastrous population consequences [3-8].

The Kang-Hukuntsi highway is a 108 km-long paved road that branches off the Trans-Kalahari highway in Botswana. It connects the two largest towns (Kang and Hukuntsi) in between Central Kalahari Game Reserve (CKGR) and Kgalagadi Transfrontier Park (KTP) (Figure 1). The road bisects communal grazing areas mostly, but also a section of Wildlife Management Area (WMA) that is generally appreciated to be a wildlife movement corridor ultimately connecting KTP and CKGR [9-10]. Prior to 2011, a fatal traffic accident mobilized local constituents to advocate for complete fencing along both sides of the road. Discussions between Botswana's Roads and Wildlife Departments led to a compromise: an experimental 'wildlife-friendly' fence design [11] would be erected through the WMA, and a wildlife-proof fence erected along the remainder of the highway. The 'wildlife-friendly' design is intended to block livestock from accessing the road but remain permeable to wild antelopes. The fences were completed in 2011. Since then, no follow up monitoring has been conducted.

In the field of conservation science, Botswana's researchers frequently collaborate with expert local trackers. Advanced tracking skills are most often applied at a simple level to determine wildlife species presence [12], enumerate abundance [13], or pursue animals so that they can be telemetry collared (G Maude pers comm). For this study we moved beyond the limited frontier of simple tracking to investigate if advanced interpretative tracking may inform our knowledge about the modern and pervasive ecological impacts of roads, fences and other linear features on wildlife. We attempted to answer the question: is the Kang-Hukuntsi 'wildlife-friendly' fence achieving its intended purpose of allowing unrestricted wildlife movements, and if not, what are the proximate impacts the fence is having on wildlife?

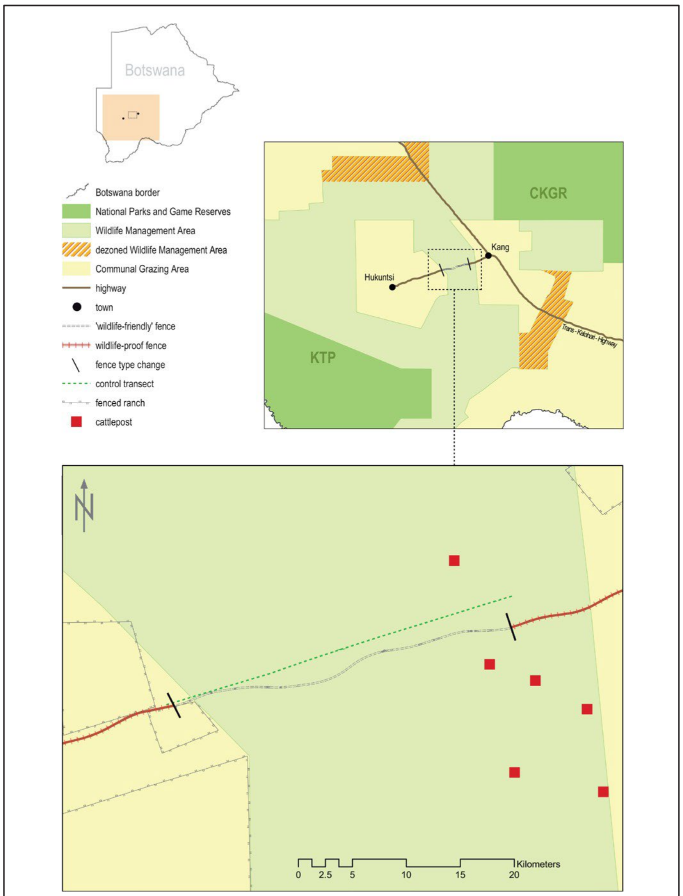

Figure 1) *Study area map displaying location of the 'wildlife-friendly' fence along the Kang-Hukuntsi highway bisecting a Wildlife Management Area that connects KTP and CKGR in Botswana,* **Note:** *( ) Botswana border, ( ) National parks and game reserves, ( ) Wildlife management area, ( ) Dezoned wildlife management area, ( ) Communal grazing area, ( ) Highway, ( ) Town, ( ) Wildlife friendly fence, ( ) Wildlife proof fence, ( ) Fence type change, ( ) Control transect, ( ) Fenced ranch, ( ) Cattlepost*

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MATERIALS AND METHODS

The 'wildlife-friendly' fence between Kang and Hukuntsi spans 31.5 km. It does not extend completely across the WMA through which the highway passes, perhaps because several cattleposts have encroached into the eastern part of the WMA resulting in high livestock numbers there (Figure 1). The fence is comprised of three equally spaced barbed wires, the top wire 80 cm above ground level, although varying with micro-topography. Both sides of the highway right-of-way are fenced, 60 metres apart. The 'wildlife-friendly' fence ends where it ties into a wildlife-proof fence comprised of 125 cm high page wire plus a single barbed wire above at height 140 cm (Figure 2). The wildlife-proof fence continues along both sides of the highway east and west to Kang and Hukuntsi respectively. Directly north of the Kang-Hukuntsi highway at a varying distance of 120 m to 2.7 km lies the old Kang-Hukuntsi Road. It is a narrow sand track that no longer receives traffic. This linear feature conveniently served as a control transect paralleling the 'wildlife-friendly' fence (Figure 1).

Figure 2) *Relative height of the top barbed wire of the 'wildlife-friendly" fence (left) where it ties into the wildlife-proof fence (right)*

Once during November 2016, and again during April 2018, we sampled both the 'wildlife-friendly' fence and the control transect. These months are transitional between wet and dry seasons, and therefore expected to have higher wildlife movement rates than average. November-March typically spans the rainiest months, Kang receiving an average 344 mm annual precipitation and Hukuntsi 327 mm (Botswana Department of Meteorological Services, unpublished). The area is an expansive savanna dominated by *Acacia erioloba* and *A. luderitzii*; classified as the Kalahari Camel Thorn Woodland and Savanna ecosystem type [14]. This semi-arid vegetation overlays an extensive sandy substrate ideal for interpreting animal tracks. During each sampling period both the 'wildlife-friendly' fence and control transect were driven once. DK drove approximately 10 kph while certified Master Trackers HL and NK [15] were seated on tracker seats elevated over the 4 × 4 bonnet for optimal searching. All three observers scanned for tracks of target wild large herbivore and carnivore species. When tracks were encountered, species and number were recorded, the age of the tracks estimated to the nearest 24 hr period, and GPS location taken.

Observations along the 'wildlife-friendly' fence were collected in more detail. We sampled the southern fence only, driving inside the highway right-of-way next to the fence so that animals approaching the fence from the north (tar road) were detected in addition to animals approaching from the south. Once tracks were detected, HL and NK sprang into action. Frequently, even before alighting from the tracker seats, they would voluntarily announce a speculative hypothesis explaining the animal's behaviour in relation to the fence based on their instantaneous observations. This was followed by examining the track evidence in more detail, both back-tracking and forward-tracking the animal, if necessary, until a clear story emerged of each wildlife-fence interaction. DK detailed each narrative on paper. Multiple questions were asked by DK through the process. Details of individual animal behaviour in relation to the 'wildlife-friendly' fence were explained by HL/NK while they pointed out the track evidence, until it could be verified satisfactorily by DK. Additional data collected included the height of the top fence wire from ground level at every location that an animal attempted to cross the fence, or was deflected, measured using a folding ruler.

RESULTS AND DISCUSSION

It took us two days, working 8 hours and 50 minutes each day, to sample both the 'wildlife-friendly' fence and the control transect once. Summing both sampling periods we documented 751 track observations of large wild herbivore and carnivore species. Of this sum, 555 (74%) track interceptions occurred on the control transect, while 123 (16%) successful crossings of the 'wildlife-friendly' fence were documented, and 73 (10%) unsuccessful crossing attempts or 'deflections' were noted (Table 1). The median track age for observations along the 'wildlife-friendly' fence was 4 days old. Spatial locations of observations are provided in the Appendices.

TABLE 1

Categorical summary of track observations along 'wildlife-friendly' fence in relation to control transect from both November 2016 and April 2018 sampling periods

			'Wildlife-friendly' fence						
		Control transect	Successful crossings	Unsuccessful crossings (deflections)	Permeability Rate (% successful crossings of attempted crossings)	Physical impact causing damage	Injury	Mortality	Separation from young
Hartebeest	*Alcephalus buselaphus*	215	88	44	67%	1	—	—	5
Gemsbok	*Oryx gazella*	152	6	17	26%	6	1	1	—
Wildebeest	*Connochaetes taurinus*	41	0	12	0%	—	—	—	—
Kudu	*Tragelaphus strepsiceros*	95	22	0	100%	—	—	—	—
Ostrich	*Struthio camelus*	25	0	0	—	—	—	—	—
Springbok	*Antidorcas marsupialis*	4	s0	0	—	—	—	—	—
Brown hyaena	*Parahyaena brunnea*	13	0	0	—	—	—	—	—
Cheetah	*Acinonyx jubatus*	2	2	0	100%	—	—	—	—
Leopard	*Panthera pardus*	8	4	0	100%	—	—	—	—
Lion	*Panthera leo*	0	1	0	100%	—	—	—	—

We suggest a 'permeability rate' equal to the number of successful fence crossings for each species as a percentage of the total attempted crossings for that species (Table 1). Among large antelope, kudu successfully negotiated the fence 100% of attempts, hartebeest showed fair ability to cross the fence (67%), gemsbok showed poor ability (26%), and wildebeest failed to cross the fence at all (0%). Ostrich, springbok and brown hyaena were detected in low numbers on the control transect, but not at the fence. Large cats successfully crossed underneath or through the fence wires with no deflections observed, although sample sizes were low. Gemsbok displayed the most instances of physical impact with the fence causing damage, and additionally injury and mortality. Hartebeest showed instances whereby young calves became separated from their mothers on either side of the fence because young had greater difficulty crossing the fence. Such detailed behavioral information was evident from the reconstructed tracking narratives.

Along its 31.5 km length, the 'wildlife-friendly' fence is mostly intact, with a lesser proportion of sections that are damaged, although we did not quantify these linear proportions. For both hartebeest and gemsbok, the mean fence height at which animals voluntarily (as opposed to being frightened by traffic and running blindly towards the fence) made successful crossings was 61 cm, while the mean fence height where animals deflected was 74 cm. Of voluntary hartebeest crossings, 55% occurred where the fence was damaged (i.e., the highest barbed wire was lower than 70 cm), while only 12% of deflections occurred at damaged sections. Of voluntary gemsbok crossings, 80% occurred where the fence was damaged, while 25% of deflections occurred at damaged sections.

A sampling of few of the more interesting wildlife-fence interactions illustrate the level of behavioral detail interpreted through tracks (Box 1).

Example wildlife interactions with 'wildlife-friendly' fencing along Kang-Hukuntsi highway as reconstructed from track and sign evidence by Master Trackers.

Gemsbok

- A large bull gemsbok tried to escape from the highway right-of-way southward, impacting the fence and deflecting. From there it walked 17 m west, turned around and walked 93 m east, then galloped at a right angle from the highway, impacting the fence again and bending two metal fence posts, before deflecting back towards the road. It then walked 651 m eastwards before finding a damaged section of fence where two remaining wires were on the ground. It stepped one foot over the wires, then deflected back toward the road. It continued walking eastwards in the highway corridor for 248 m. At this point it became frightened by a vehicle causing it to gallop fast towards the fence. It was pre-dawn but getting light enough for the gemsbok to see the fence wires. It jumped at an oblique angle, contacting a metal fence post and bending it. While in mid-flight, the top barbed wires scraped its underside and legs leaving grey hair along 21 barbs (273 cm between the first and 21st barb) and blood between the 20th and 21st barb. The impact caused the gemsbok to flip forward and land upside down on the other side of the fence, it's long horns both deeply gouging the sand as it landed on its back. It stood up and walked off to the south, slowly and in a manner as though injured.

- A gemsbok approached the fence and road from the south at a walk. It became entangled in the fence wires, bent a metal fence post during the struggle (Figure 3), then ran back south, failing to cross the fence.

- A large bull gemsbok was startled by traffic and ran south from the highway towards the fence. Head down, it smashed into a sturdy stabilizing fence post, breaking its neck as its body flipped over the wires onto the other side of the fence (Figure 4).

Hartebeest

- A hartebeest was frightened by a vehicle and sped in a gallop towards the fence at an oblique angle. It attempted to brake and deflect just before contact at a particularly high point (98 cm), bent a metal fence post, left hair on the top barbs as it went over, and whilst airborne spun 180 degrees, landing on its side with horn digging into the sand (Figure 5). It recovered and continued southwards.

Figure 3) *Master Tracker HL indicating where a gemsbok contacted the 'wildlife-friendly' fence, bending the metal fence post and damaging the top wire*

Figure 4) *Remains of a gemsbok killed upon impact with a stabilizing fence post along the 'wildlife-friendly' fence*

Figure 5) *Master Tracker NK showing where a hartebeest contacted the 'wildlife-friendly' fence at a fast gallop, bending a metal fence post and falling turned 180 degrees on the other side*

- A mother hartebeest and small calf attempted to cross the fence heading south. They became separated when the calf jumped a damaged section of fence and the mother remained inside the right-of-way. Panicked, they both ran westwards on either side of the fence. The calf hit the fence as it ran, trying to rejoin its mother. After 69 m, the calf squeezed through the bottom and middle wires rejoining its mother inside the right-of-way, and they changed direction, running together eastwards. After 111 m, they turned westwards again, running, scared. After 54 m, they doubled back eastwards. They slowed and walked 234 m inside the right-of-way while the mother searched for places to cross the fence with her young, deflecting each time. The mother eventually jumped the fence (78 cm); we did not follow up if/how the calf joined her.

Wildebeest

- Three wildebeest approached from the south, encountered the fence, then walked back the way they came. Days later the same 3 wildebeest approached the same spot. HL and NK offered, "They tried on many days to cross here, but just stopped to look at the fence because they know they can't jump." After deflecting again, they meandered westwards, paralleling the fence some distance away from it, often hidden in trees and shrubs. After 1.9 km they timidly approached the fence together, stopping some distance to examine it. One of the three approached within 1.5 m. They deflected back into the trees at a slow walk, continuing westwards. 215 metres on a hartebeest joined the group and they continued together walking westwards another 1.1 km. At this point they passed the end of the 'wildlife-friendly' fence where it ties into the wildlife-proof fence and continued walking steadily westwards now trapped to the south by the tall fence. HL and NK commented, "Because of this fence, they will kill (poach) these three wildebeest and hartebeest in Hukuntsi.

Although sample sizes were small, we believe observed patterns reflect predictable species-specific behaviors in relation to fencing. Prior to sampling, Master Trackers hypothesized each species' relative ability to negotiate the 'wildlife-friendly' fence. Interestingly, they correctly predicted that wildebeest would be afraid of the fence and refuse to jump, gemsbok would perform only slightly better at jumping the fence, and hartebeest would be ordinally better yet. They maintained that kudu and eland are jumpers, while springbok can jump about as well as hartebeest. This knowledge obviously comes from a cumulative lifetime experience observing antelopes interacting with other fences.

Track count differences between control and fence transects suggest an impediment to semi-migratory antelope movement. Almost 3 times as many tracks were observed on the control transect compared to the fence transect. Gemsbok showed the most disparate counts, with nearly 7 times as many observations at the control transect as at the fence. Given their proximity, there is no geographical reason for wildlife to cross the control transect but not the nearby highway. While differences between control and fence transects are suggestive, the number of deflections interpreted along the 'wildlife-friendly' fence is direct evidence that it is impeding antelope movements independently of the road. Furthermore, antelope behavior in relation to the road differed from behavior at the fence. Once large antelopes had successfully negotiated the fence on one side of the road, they typically crossed the road at a relaxed walking pace. Exceptions occurred when they were startled by vehicles. Previous sampling along fenceless sections of the nearby Trans-Kalahari highway revealed the same ease by which large antelopes cross the road at night when traffic-free intervals of up to 30 minutes occur [16]. At the 'wildlife-friendly' fence, antelope behavior changed. Rarely did antelopes exhibit relaxed seamless movements over the fence, only shown by kudu and occasionally hartebeest. HL and NK suggested that these individuals were crossing regularly so they had learned safe travel routes and developed habitual crossing points at the fences-often damaged sections where wires were either missing or completely down. More frequently, as animals moved towards the fence and then became aware of it, they hesitated, and assessed. Deflections frequently followed, animals deciding to move parallel to the fence in search of safe passage, or even turning back the way they came across the road. Such observations provide insight into the relatively high numbers observed on the adjacent control transect, i.e., animals moving north to south encountered the first fence and deflected, some turning back to cross the control transect a second time to be counted again. In contrast to antelopes, the pattern observed among large cats suggests the 'wildlife-friendly' fence poses little hindrance to their movements. Cats easily passed underneath or through the barbed wires, although the wildlife-proof page wire fence is likely to pose a barrier that predators must dig or modify existing burrows to pass underneath [17].

Gates et al., [18] provide a list of the effects of fences on the ecology of antelope including "partial to complete obstruction of daily movements, reduced access to seasonal habitat, food, cover and water, blockage or diversion of seasonal migration, increased energy demands, separation of juveniles from does, entanglement or impact injuries". All these impacts were either observed or could be inferred from tracking reconstructions. The level to which tracking narratives revealed the events leading up to and consequences of physical impacts with the 'wildlife-friendly' fence was particularly insightful. In such instances fright and panic were frequently interpreted internal states. This was evident from the tracks of hartebeest mothers and young that became separated on either side of the fence. It was also often deduced from the gait, speed, and trajectory of animal movement away from the road towards the fence, the most plausible cause being traffic. Most wildlife movement occurs after dark, and the combination of panic and reduced visibility clearly was supported by track evidence as animals careened towards the fence and either did not see it, or attempted to break last minute only when they came into immediate proximity with it. Thus, whilst the fence alone causes difficulties for wildlife, the combination of fence with the highway appears to exacerbate injuries and mortalities as frightened animals run blindly at the fence rather than selecting suitable points to cross it. This also appears to be the predominant mechanism causing fence damage. Six out of seven events damaging the fence were instigated by traffic frightening animals and causing them to run towards it. The single exception was a gemsbok that walked into the fence and struggled to free itself after it became entangled in the wires (Figure 3). As these wildlife-caused damages accumulate over time, they facilitate increased permeability. Since the 'wildlife-friendly' fence is now in an intermediate state of decay, disrupted movements, injuries and mortalities were presumably greater when the fence was new. Kang's Roads Department indicate intention to repair the 'wildlife-friendly' fence, less than 10 years after initial construction (O. Mothobi pers comm).

Wildlife responses to the fence suggest there is no easy design solution to allow unhindered safe passage, whilst maintaining its barrier property for livestock. Among the three large antelope species that voluntarily crossed the fence successfully, most of those crossings occurred at damaged sections of fence or where it was down completely, whilst they more often deflected where the fence was higher. However, these choices were not consistent. Sometimes the reverse occurred whereby animals deflected at damaged sections of fence and then attempted to cross where the fence was intact. There were also several entanglements involving damaged wires that were low to the ground. Thick cover-adapted browsing antelope species such as kudu appear to have little problem negotiating the 'wildlife-friendly' fence. By contrast, the fence clearly poses a confusing obstacle to grazing antelopes. Nowhere in the natural environment can be found above-ground horizontal obstructions that are continuous, and although adult grazing antelopes have the physical ability to jump an 80 cm fence, their aptitude to do so is poorly developed. Even very low fences may act as a barrier to wildebeest and antelope young, while fencing material at any height will pose a threat to animals that are frightened by traffic and cannot see clearly. Ito et al., [19] found no successful crossings of 3-strand barbed wire fences along railroads by GPS-tracked Mongolian gazelles (*Procapra gutturosa*) and recommended no fence zones to allow uninhibited movement to access seasonal resources.

Globally, where roads pose a barrier to wildlife the application of wildlife crossing structures (underpasses and overpasses) in combination with tall wildlife-proof fencing has several demonstrated successes at reducing wildlife mortality and connecting populations [20]. This solution is expensive, and application therefore limited [21]. In the Kalahari generally, and on the Kang-Hukuntsi highway specifically, traffic volume is low, and antelope-vehicle collisions are rare relative to the large number of antelopes crossing unfenced sections of highway on a nightly basis [16]. The motivation for fencing is rather to restrict livestock, which are the main cause of collisions, whilst facilitating free wildlife movement. It is believed that fencing roadways in western Botswana reduces collisions with livestock. However, just as the Roads Department's assumption that improving roads reduces accident rates is invalid [22], so too does the excluding livestock with fences assumption need to be scrutinized. As wildlife-caused damages to the 'wildlife-friendly' fence accrue, it becomes more permeable to livestock. However, even if maintained, the fence is not a barrier to livestock. During our survey, young cattle were observed jumping an undamaged section of fence. Furthermore, cattle, donkeys and horses can be observed in numbers throughout the entire 108 km length of highway right-of-way between the fencelines, i.e., not only the 'wildlife-friendly' fence but also the full wildlife-proof fence fails to keep the highway livestock-free. This pattern is observable throughout western Botswana wherever fencing has been erected along roads. One problem appears to be the gated accesses to cattleposts off the highway, whereby gates are left open or removed, perhaps even purposefully to allow cattle grazing throughout the highway right-of-way when grazing is depleted outside of the fences. Thus, fences might be exacerbating the problem by concentrating livestock inside the highway rights-of-way [16]. Although the 'wildlife-friendly' fence was well-intentioned, a valid argument supporting its continuance seems to be lacking, other than psychological amelioration for motorists.

In semi-arid regions like the Kalahari, wildlife populations have exceptional space use demands. They require unrestricted mobility to access seasonal resources with high spatial-temporal variability [23]. Landscape connectivity will become increasingly important for survival of Kalahari wildlife in the face of climate change [24]. The Kang-Hukuntsi 'wildlife-friendly' fence bisects one of the last remaining habitat linkages between CKGR and KTP [9,25]. This pinchpoint of connectivity is further squeezed by cattlepost encroachment inside KD/12 WMA from the east (Figure 1). These cattleposts have already shifted wildlife distribution, especially that of poaching-sensitive gemsbok, towards the west resulting in less space available to wildlife than the WMA boundaries suggest (see Appendix 1-5). Local pastoralists want access to the pristine grazing inside the WMA for their expanding cattle. As a result of these local opinions, the official reduction of size of the WMA between Kang and Hukuntsi has been suggested [26-29] (Figure 6).

Figure 6) *Example signage to affect motorist behaviour where unfenced highways bisect major wildlife travel corridors. British Columbia, Canada*

CONCLUSION

Spatial threats to wildlife at this narrowing corridor are substantial without the additional stress of the 'wildlife-friendly' fence. Our data show that this area remains an active wildlife movement corridor. We also show that the 'wildlife-friendly' fence fails its mitigation purpose to allow unhindered wildlife movements through the WMA, whilst also failing its primary purpose of keeping livestock off the highway. We therefore recommend that the 'wildlife-friendly' fence be deactivated, and all fencing materials be removed as even downed wires pose an entanglement hazard to wildlife. Alternatively, cattle grids could be installed over the highway at both tie-ins with the wildlife-proof fence (consistent with the design used at other wildlife corridor areas along the Trans-Kalahari highway) to limit livestock movement into the high-fence right-of-way. This could be done in combination with enhanced signage that educates motorists and encourages safer driver behavior. Although in practice all fence types fail to keep Kalahari highways livestock-free, there is even less reason to fence sections that bisect WMAs which have the least livestock numbers and pose the least risk of collisions.

Transportation and wildlife management agencies often lack empirical data to inform wildlife-highway mitigation, the limited time frame for decisions precluding preconstruction studies. The decision to fence the Kang-Hukuntsi highway proceeded because the Department of Roads produced data on traffic accidents and the Department of Wildlife and National Parks had no specific data to bring to the table (DWNP pers comm). Track surveys are low-tech, low-cost, quick and logistically simple to do. In two days, we collected continuous spatial data along a linear feature about past events stretching back days, weeks, and in some cases months (e.g., gemsbok mortality).

Collinson et al., highlight the pressing need for accelerated study of the impacts of roads on African wildlife and appropriate mitigation measures, as well as improvements to the EIA process in African countries. Master Trackers and co-authors HL and NK confidently applied their interpretive tracking skills to help us understand how large-bodied Kalahari wildlife are contending with a roadside fence. Advanced tracking skills are presumably on the decline globally, now largely confined to remote and marginalized communities. However, Botswana still has an exceptional opportunity to employ indigenous Master Trackers for pre and post disturbance impact assessments of roads, railways, and fences, solving both time and expense constraints that typically limit or preclude the application of preconstruction studies and monitoring programs.

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Example wildlife interactions with 'wildlife-friendly' fencing along Kang-Hukuntsi highway as reconstructed from track and sign evidence by Master Trackers.

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