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Long-Term Monitoring of Livestock Depredation in Amboseli Ecosystem, Kenya

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ABSTRACT

Conflict between humans and large carnivores is a key factor driving their population declines in Africa especially in the dispersal areas adjacent to protected areas. We monitored and assessed livestock predation in the community areas around Amboseli National Park between 2009 and 2012 using a network of established and trained community scouts. Using a standardized data collection form, all the depredation cases reported by pastoralists were verified and recorded included; year, month, type of livestock, carnivore species and location. Results indicated high levels of livestock depredation, with attacks highest on shoats (84%) then cattle (14%). Incidences of livestock attacks varied between carnivore species where hyena had the highest incidences (58%) followed by cheetah (22%) and jackal (11%). The economic loss for the four year period tabulated was between US$ 392,000 and 470,588 with 2012 recording the highest loss. However, predation was on a downward unpredictable trend. This could be attributed to the introduction of ant-predation mitigation measures such as predator proof bomas, solar lighting around livestock bomas and awareness creation on good hearing strategies. We recommend a continuous monitoring of livestock predation incidences for long in order to obtain sufficient data that will inform proper trends. Additionally, this will be useful evaluation of the impact of the ongoing adoption of the mitigation strategies by the local Masai community.

Keywords: Amboseli National Park, community scouts, livestock, depredation, carnivores, pastoralists.

INTRODUCTION

In Kenya, 70% of all households are engaged in crop and livestock farming; about of 84% of them depend on livestock for livelihoods in rural areas (KIPPRA, 2009). Further, it is estimated that over 60 percent of livestock in Kenya is kept by pastoralists in the arid and semi-arid lands (which constitute about 80% of Kenya's landmass) providing employment to about 90% of the population in those areas and contributing nearly 95% of their income

(KIPPRA, 2009; Otieno, 2008). According to Omiti and Irungu (2002), nomadic pastoralism and agro-pastoralism contribute about 65% of total beef output in Kenya, while the rest is obtained from ranches and a small proportion of dairy-culls. However, more than 50% of pastoralists in Kenya live below the poverty line, i.e., they survive on less than USD$1 per day (Thornton *et al*., 2007). While improving the efficiency and productivity of crop and livestock enterprises is important for enhancing economic growth and reducing poverty in agriculture-dependent developing countries such as Kenya Larsen *et al*., (2009), wildlife menace continues to hamper this effort (Sitati *et al*., 2003; Okello *et al*., 2014). As a result, due to poor policies, the livestock farmers through protection of their livestock also devastates the wildlife especially the carnivores that are a major source of foreign exchange for Kenya through tourism. Hence, the need to harmonize the two competing land uses that contributes substantially to both local and national economy.

Kenya is world renowned for its abundant populations of large carnivores and mammals especially in pastoral Maa speaking inhabited landscapes. The Amboseli ecosystem comprising of Amboseli National Park, surrounding group ranches, and community conservancies supports one of the remnant of the large carnivore population (KWS, 2008a and KWS 2008b). It is also a re-known ecotourism destination that promotes national and local economy (Wishitemi and Okello, 2003; Okello *et al.*, 2005). Being a critical wildlife ranging area (Western, 1982; Western and Lindsay, 1984; Wishitemi and Okello, 2003), the protected area alone is not ecologically large enough to support most wildlife without dispersal into community areas (Western, 1982; Campbell *et al.*, 2000). Hence, the pastoral inhabited dispersal are also supports a huge livestock population, estimated at over 201,872and large carnivores (Kenana *et al.*, 2013a). Livestockis the livelihood of the local Masai people and often in conflict with large predators. Consequently, livestock predation is of special concern because of the potentially catastrophic effect for both people and carnivores (Nyhus*et al.*, 2009; Treves & Karanth, 2003). It is regarded as one of the major threat to the survival of large carnivores (Woodroffe & Frank, 2005).

Among large carnivore found in the Amboseli ecosystem include lion (*Pantheraleo*), leopard (*Pantherapardus*), cheetah (*Acinonyxjubetus*), hyena (*Crocutacrocuta*), black-backedjackals (*Canismesomelas*) and wild dogs (*Lycaonpictus*) (Kenana *et al.*, 2013b). Due to large range requirement and wide ranging behavior of these species, carnivore frequently roam beyond protected areas increasing their chances of conflict with humans and are often persecuted and killed (Worden *et al.*, 2003; Nyhus*et al.*, 2009). However, the Amboseli ecosystem, is under increased threat as land use changes and development occur in the region, intensifying resource use competition (Okello, 2005; Campbell *et al.*, 2000; Campbell *et al.*, 2003) and the dwindling resources base and environmental degradation risk putting wildlife and local populations in conflict and jeopardy (Worden *et al.*, 2003). As range and habitat for wildlife prey is diminished, livestock becomes the easy targets by carnivores.

Most carnivores, due to the globally declining populations, have been extirpated from at least 30% of their historical range in Eastern and Southern Africa (KWS, 2008a).For instance, the lion population in Kenya was estimated at 2,749 (Chardonnet, 2002) and 2,280 (Bauer & Van Der Merwe, 2004), respectively, but the current estimate is about 2000 individuals (KWS, 2008a). Nonetheless, the current carnivore population remains unknown as KWS is collating all the carnivore data across the country (Musyoki per communication). As a consequence, lion is classified as vulnerable by IUCN and it is listed by CITES Appendix II while in Kenya, it is listed as a protected animal (KWS, 2008a). The same applies with the hyena population which was estimated at between 2000 to 4000individuals by 1998. Highly disliked in community areas due to serious livestock predation incidences, hyenas are susceptible to poisoning and experience a slow recovery rate. To mitigate this decline, in Kenya, KWS has developed strategies for their conservation and management (KWS, 2008a and KWS, 2008b).

According to the recent survey, about 60% of the carnivore population is found outside Amboseli National Park (KWS / TAWIRI, 2013). However, despite negative interactions between humans and carnivores, Maasai pastoral dispersal areas remain essential for dispersal movement of large carnivores in the ecosystem. Large prey population in the dispersal area may reduce predation. Such large mammals include wildebeest (*Connochaetestaurinus*), zebra (*Equusburchelli*), Grant's gazelle (*Gazellagranti*), Thomson's gazelle (*Gazellathomsonii*) impala (*Aepycerosmelampus*) among others (Estes, 1991). Nonetheless, the prey population has suffered a catastrophic decline due to the frequent and prolonged droughts that have been experienced in Amboseli ecosystem especially in 2009 where over 65% of the Masai livestock population and 75% of the prey population were lost (Western, per communication).

Local people are still bearing "the cost of wildlife conservation by tolerating livestock losses (Sindiga, 1995) since the government does not pay compensation for livestock losses. As an attempt to offset predation-related losses, monetary consolation fees by NGOs is only towards reducing retaliatory killings, which is not only below the market price (USD 240) but the process involved in verification is arduous and expensive. However, in the revised wildlife bill proposal, the government plans to pay compensation to damages caused by wildlife in order to reduce animosity between people and wildlife and ensure their conservation. In this paper, we analyses livestock predation incidences in the Amboseli ecosystem over the last four years.

Study Area

The 25,000 km^2 Amboseli ecosystem comprises of 392 km^2 of Amboseli National Park and the rest is the dispersal area inhabited by the Masai pastoralists (Figure 1). Located to the south east of Kenya, the ecosystem is critical for diverse wildlife species including ungulates and carnivores. The rainfall in this ecosystem is low and irregular between years, with a mean annual rainfall of less than 300 mm (Irigia, 1995) and this influences wildlife distribution and densities (Western, 1982). The low rainfall is typical of semi-arid areas which have low and erratic rainfall, high temperatures (14^{o}C to 30^{o}C), and frequent and prolonged droughts. This climate supports grasses, shrubs, and Acacia species that are adapted to withstand periods of long drought and supports ungulates which are prey for carnivores.

With over 70% of the wildlife utilizing areas outside protected areas especially during the wet season, this sustains carnivore populations outside the PAs (Western, 1997). Pastoralism and conservation are regarded as the only viable land use options and the ecosystem supports over 201,872 livestock (Kenana *et al.*, 2013a) which occasionally are killed by predators. This occurs on the group ranches including Kimana, Kuku, Olugulului, Imbirikani, Selengei and Rombo. Some group ranches have been sub divided and communities have established conservancies to derive benefits from tourism such as Kilitome, Osupuko, Kimana sanctuary, among others.

METHODS

A systematic monitoring and enumeration of livestock predation incidents and lion mortality that ran continuously from 2009 to 2012 was used in this study. Data were collected on livestock killed by large carnivores and other related data included; year, month, type of livestock, carnivore species, location, among others variables among others were recorded on a standardised reporting form. A team of community scouts were selected from the ecosystem and trained to enumerate livestock predation incidents. Enumerators, hence, were stationed at different locations within the ecosystem that had been previously identified as a high conflict zone. Using enumerators in this way to record conflict avoids the problem of over exaggeration by farmers themselves (Siex and Struhsaker, 1999).

During analysis, the UTM coordinates of each conflict incident were imported into the ArcGIS*v.10.2* (ESRI, Redlands, USA) geographical information system (GIS) software package for spatial analysis. All statistical tests were analyzed using SPSS *v16* (SPSS Inc., Chicago, USA).

RESULTS

Attacks on livestock by carnivore species

Six carnivores including lions (*Pantheraleo*), cheetah (*Acinonyxjubetus*), spotted hyena (*Crocutacrocuta*), Leopard (*Pantherapardus*), jackal (*Canismesomelas*) and caracal (*Caracal caracal*) were involved in livestock attacks. During the four year period, 4,272different livestock types namely; cattle, shoats (sheep and goats) and donkey were attacked by large carnivores. Incidences of livestock attacks varied between carnivore species with hyena recording the highest incidences (n=2,521, 58%) followed by cheetah (n=967, 22%) and jackal (n=463, 11%) (Table 1).

Table 1: The status of livestock predation in Amboseli ecosystem between 2009 and 2012 by individual carnivore species

	2009	2010	2011	2012	Total	%
Lion	65	75	54	58	252	6%
Cheetah	410	215	162	180	967	22%
Hyena	984	313	413	811	2521	58%
Leopard	16	37	13	39	105	2%
Jackal	148	76	132	107	463	11%
Caracal	7	0	0	0	7	0%

All carnivore species had a low but steady decline except the hyena which showed a sharp drop between 2009 and 2010 followed by a gradual but steady increase of predation (Figure 1). The spatial patterns of conflicts by different carnivore species were focused on Imbirikani Group Ranch (Figure 2) which is less than one third of the entire Amboseli ecosystem. Other conflicted incidences were recorded across the border in Tanzania but they were not included in the analysis.

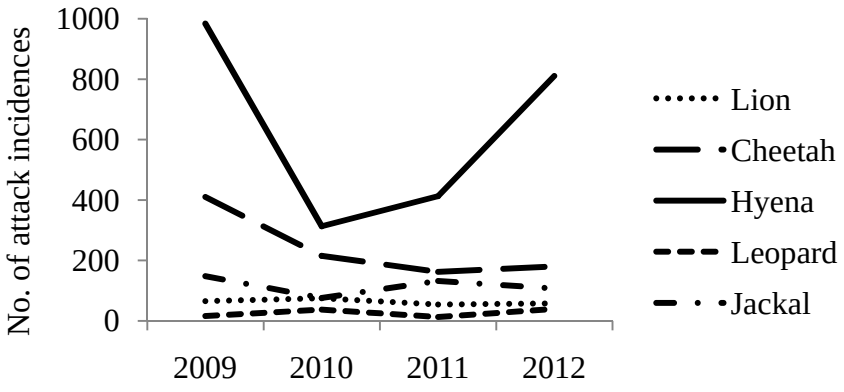

Figure 1: The temporal pattern of the number of predation incidences recorded by different carnivore species between 2009 and 2012

Types of Livestock Killed By Predators

A total of 4,272 livestock were killed by predators between 2009 and 2012 (Table 2). The highest livestock kills were recorded in 2009 (n=1,641, 38.4%) followed by 2012 (n=1,190,

27.9%) and the lowest being 2010 and 2011 with 16.9% each, respectively (Table 2). Shoats were the most attacked (n=3,604, 84%) followed by cattle (n=598, 14%) and donkey (n=70, 2%), respectively.

Table 2: Different types of livestock killed by predators between 2009 and 2013

	2009	2010	2011	2012	Total
Cattle	284	129	82	103	598
Shoats	1319	579	630	1076	3604
Donkeys	38	13	8	11	70
Total	1641	721	720	1190	4272

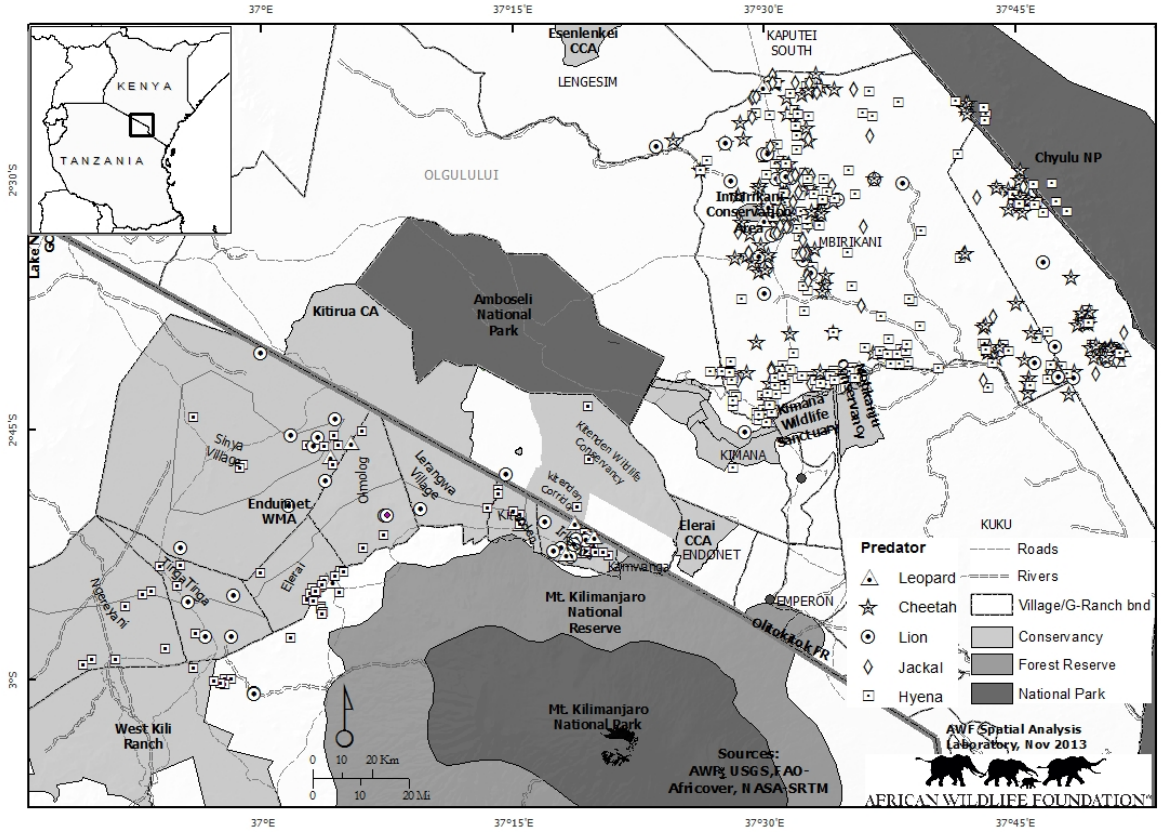

Figure 2: Spatial distribution patterns of livestock predation in Mbirikani Group ranch dispersal areas of Amboseli National Park in Kenya and in Enduimet Wildlife Management Areas in Tanzania

The attack on shoats declined sharply between 2009 and 2010, and then followed by a gradual increase (Table 3). Cattle showed a very gradual decline only. The logarithmic model shows weak (explained by only 37.5%) but significant relationship of the trend over the four year period (Figure 3).

Economic loss incurred by pastoralists as a result of livestock predation

The economic costs incurred by pastoralists were calculated using the lowest and highest cost of each livestock type as given by the Ministry of Agriculture and Livestock Development depending on the size of livestock (Table 3). The cost of cattle ranged between Ksh 25,000 and 30,000 (US$ 294 and 353) while the shoats were sold between Ksh 5,000 and 6,000 (US$ 59 and 71). Donkey was sold between Ksh 5,000 and 7,000 (US$ 59 and 82.4). These were considered as reasonable prices for livestock as they could take care of the outlier costs. Based on the price indicators, the total cost of livestock lost during the four year period

ranged between Ksh33.3 million and 40 million (US$ 392,000 and 470,588 at exchange rate of Ksh 85 per dollar).

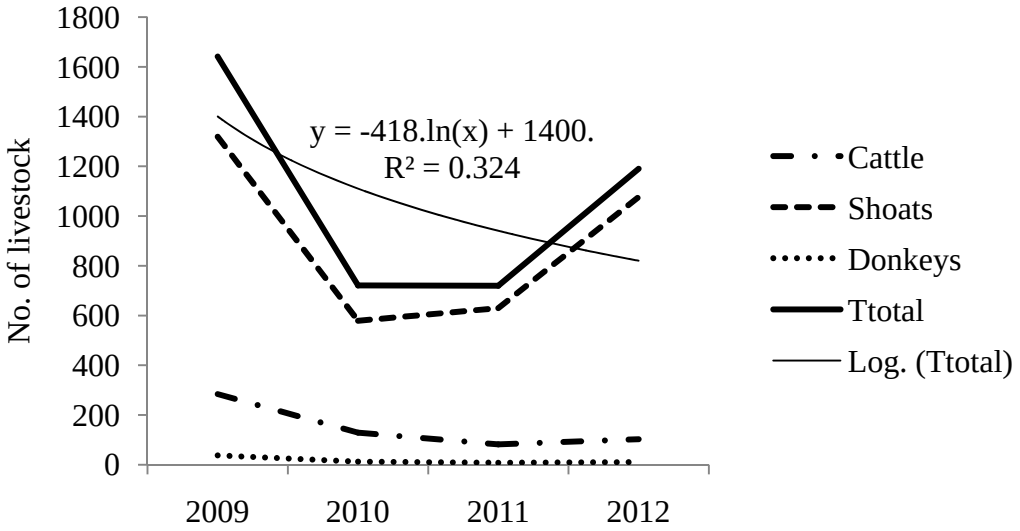

Figure 3: Trend line (logarithmic) showing a general decline of livestock predation over the last four year period, 2009 – 2012 based on the total number of livestock. The significant decline (p>0.05) shows a weak relationship between the number of attacks and years (R^2=0.3247).

Table 3: The economic costs ('000) of livestock predation in Amboseli ecosystem

Livestock type	2009		2010		2011		2012		Total cost (Ksh)	
	Lower cost	Upper cost	Lower cost	Upper cost	Lower cost	Upper cost	Lower cost	Upper cost	Lower cost	Upper cost
Cattle	7,100	8,520	3,225	3,870	2,050	2,460	2,575	3,090	14,950	17,940
Shoats	6,595	7,914	2,895	3,474	3,150	3,780	5,380	6,456	18,020	21,624
Donkeys	190	266	65	91	40	56	55	77	350	490
Total	13,885	16,700	6,185	7,435	5,240	6,296	8,010	9,623	33,320	40,054

Shoats incurred the highest cost of predation between 18 and 21 million (US$ 211,764.7 and 247,058.8) followed by cattle between Ksh 15 and 17.9 million (US 176,471 and 211,059) and donkey being the least (Table 3). Based on the period, 2012 recorded the highest cost incurred from livestock predation of between Ksh 8 and 9.6 million (US$ 94,117.7 and 112,941.2).

DISCUSSION

Livestock contribute about 42% of agricultural output in Kenya; 35% of this is derived from beef cattle. Generally, beef production is considerably less than estimated consumption (FAO, 2005; MoA and KIPPRA, 2009). However, development of the livestock sub-sector is relatively neglected by policy. For instance, lack of compensation for livestock killed by wildlife, low allocation of public funds to livestock development (less than 10% of the annual national development expenditure) (Mugunieri *et al.*, 2011; Otieno, 2008). Consequently, most farmers have limited access to better farm technologies, requisite skills and market services. Further, weak linkages between research-extension service providers and pastoralist are considered to contribute to inappropriate livestock keeping strategies in wildlife dominated areas (Okello *et al.*, 2014). As a result, agricultural productivity and growth are

relatively low; yet the agricultural sector is expected to play an important role as the engine of national economic development (Mugunieri and Omiti, 2007; Oluoch-Kosura, 2010).

One of the most common complains in the carnivore inhabited areas is the conflict between them and the local people (Woodroffe, 2001; Kolowski and Holekamp, 2006). This is true across a wide range of carnivore species, from small non-recognizable species to large carnivores that cause significant impact on people's livelihood through predation. In this study, we have focused on identifying and analyzing the types of predator species involved in conflict, the target livestock, the four year trend and comparison of predation incidences and the economic losses incurred by the local community relating to livestock. This rather small subset of conservation problems nonetheless receives a large amount of attention because of the high profile of carnivores and the importance of livestock to local economies.

Whilst there was a downward trend of livestock predation between 2009 and 2012, the predictability of the predation occurrence is difficult due to compounding factors involved (Figure 3). This decline could be attributed partly to the mitigation strategies that have recently been introduced and are being adopted by the local people (Okello and Kiringe, 2013). According to their evaluation survey on the predator proof bomas being used in the ecosystem, livestock predation declined by almost 98%. This study has showed that high levels of livestock depredation exist, with attacks highest on shoats (Table 2). Incidences of livestock attacks varied between carnivore species where hyena had the highest incidences followed by cheetah (Table 1). The economic loss for the four year period tabulated was between US$ 305,882 and 370,588 with 2012 having the highest loss (Table 3). This loss is offset by Predator Consolation Fund (PCF) that was set up by a conservation NGO as a mitigation strategy to reduce retaliatory killings of predators by the local community. The government of Kenya does not pay compensation for livestock losses (KWS, 1994). However, in the new Wildlife Act, the government will pay for any losses caused to people by wildlife (Wildlife Act, 2013). If this is not effected and the donor dependent consolation funds runs out, high revenge killings are anticipated which will be a disaster for the large carnivore living on outside the protected area.

Monitoring livestock predation has been a long-standing and traditional focus of basic ecological research to understand the approaches to its mitigation. Myriad studies have simply examined the conflict dynamics, intensities and spatial patterns. Most research, however, do not provide tangible practical recommendations, and consequently the predation problem persists even after the research. Hence, long term monitoring coupled with applied research may provide scenarios of predation and thus making it easy to design and implement conflict mitigation strategies and monitor the extent of predation after intervention. Thus, the four-year data although may not be enough reliable data to detect patterns, but it can inform where intervention is needed to avoid the loss of more predators through retaliatory killings as well as local livelihoods. Furthermore, there is need for a consistent approach to data collection and mitigation of the conflicts and monitor the efficacy of the mitigation strategies. This long term data will be useful to the government when implementing the revised Wildlife Act 2013 in coming up with regulations on how to implement and manage the compensation scheme.

CONCLUSION

Livestock predation around protected areas is quite high depending on the density of large carnivore, and Amboseli is a classic example. Predation is not only a threat to community livelihood due to high economic costs incurred but also threatens the future of large carnivore conservation in Amboseli ecosystem especially outside the protected area. The government should design better ways of compensating for livestock losses to avoid retaliatory killings that have seen a drastic decline in the large carnivore population. Equally, the local community should also benefit from conservation in order to support conservation efforts and

avoid incompatible land use practices that are detrimental to wildlife conservation and tourism development.

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