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# Livestock loss caused by predators outside the Serengeti National Park, Tanzania

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## ABSTRACT

Human–carnivore conflict is a serious management issue often causing opposition towards conservation efforts. In a survey of 481 households in seven different villages outside the Serengeti National Park in Tanzania, 67.4% of respondents owned livestock and 27.4% of all the households surveyed reported losses of a total of 4.5% of their livestock to wild predators over 12 months. This loss equated to an average annual financial loss of 19.2% (US \$26.8) of their cash income. Livestock depredation was reported to be caused most often by spotted hyena (*Crocuta crocuta*) (97.7%), leopard (*Panthera pardus*) (1.6%), baboon (*Papio cynocephalus*) (0.4%), lion (*Panthera leo*) (0.1%) and lastly black-backed jackal (*Canis mesomelas*) (0.1%). Total reported losses during 2003 amounted to US \$12,846 of which spotted hyena kills were reported to account for 98.2%. The mean annual livestock loss per household (of those that reported loss) was 5.3 head of stock, which represents more than two-thirds of the local average annual cash income. Depredation by large felids occurred only in a narrow zone along the protected area (<3 km), whereas spotted hyenas killed livestock even in households located far away (>30 km). Tolerance of livestock depredation among the respondents was low. Logistic regression models indicated that education improved tolerance, while for livestock owners higher depredation rates was linked to approval of lethal retaliation and effective protection measures was associated with a reduced desire of retaliation. We recommend that further research should identify the precise causes of livestock loss and which protection measures that can reduce depredation.

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## 1. Introduction

Human population increase and technological development is rapidly reducing and fragmenting the available habitat for large carnivores. Although protected areas in principal are shielded from most human activities, the majority of African reserves are not large enough to maintain viable populations of these wide ranging species (Newmark, 1996; Woodroffe and Ginsberg, 1998). Non-protected and partially protected areas (i.e. IUCN categories < IV) therefore play a vital role in main-

taining the existence of carnivores, both in order to increase population sizes and to allow greater genetic exchange between populations (Linnell et al., 2001; Treves and Karanth, 2003).

Large carnivores differ in their ability to adapt to anthropogenic landscapes. Behavioural plasticity and traits that give ecological flexibility and allow populations to recover rapidly from depletion have been identified as important factors for persisting close to humans (Cardillo et al., 2004). For example, in the Masai Mara National Reserve in Kenya, spotted hyenas

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(*Crocuta crocuta*) changed their daily activity rhythm, demographic structure, social behaviour and use of space as a response to increased disturbance from livestock grazing (Boydston et al., 2003). Small geographic range size, long gestation period, low species population density and high trophic level are all factors associated with high extinction risk in carnivores (Cardillo et al., 2004), but despite these biological traits, large carnivore survival ultimately depends on their conflict level with human interests and their social acceptability to humans, particularly outside protected areas (Linnell et al., 2001; Kleiven et al., 2004; Lindsey et al., 2005). For instance, in the Koyiaki ranches outside the Masai Mara National Reserve, Ogotu et al. (2005) attributed substantially lower densities of lions (*Panthera leo*) outside the reserve in comparison to spotted hyenas, to less tolerance among Maasai pastoralists to lion predation on livestock.

Lethal control has traditionally been the most common method for resolving conflicts between carnivores and livestock, leading to the eradication campaigns towards lions, spotted hyenas and African wild dogs (*Lycaon pictus*) in Southern Africa (Mills and Hofer, 1998; Rasmussen, 1999; Woodroffe and Frank, 2005). Some large carnivore species are therefore threatened after having experienced severe declines. For example, the African wild dog has been extirpated from 25 out of 39 former range countries, largely due to human persecution and habitat fragmentation (Fanshawe et al., 1997). According to the IUCN Red list, African wild dogs are listed as endangered, lions and cheetahs (*Acinonyx jubatus*) are listed as vulnerable, whereas spotted hyenas and leopards (*Panthera pardus*) are not categorised as threatened (i.e. lower risk and least concern respectively; IUCN, 2006). Although most large carnivores in Africa are by now legally protected, local people have few incentives to conserve them. Retaliatory killings of carnivores are common, since livestock depredation can have serious economic consequences for livestock keepers, and compensation schemes that may offset some of the costs are often lacking (Ogada et al., 2003; Frank et al., 2005; Graham et al., 2005). However, as examples from Europe and North America illustrate, compensation schemes do not provide an easy solution to the problem (Linnell et al., 1996; Treves and Karanth, 2003).

In Africa, Tanzania is one of the most important countries for large carnivore conservation (Nowell and Jackson, 1996; Mills and Hofer, 1998). Despite having an extensive protected area system, with several very large protected areas (>10,000 km<sup>2</sup>), carnivore populations are still severely affected by human activity (Hofer et al., 1993, 1996; Packer et al., 2000). Moreover, human encroachment upon protected areas is intensifying the conflict between carnivores and livestock keepers. However, up to now most studies investigating livestock depredation in Africa have been conducted in areas with relatively low human density or immediately adjacent to protected areas (Rudnai, 1979; Mizutani, 1993; Karani et al., 1995; Butler, 2000; Ogada et al., 2003; Patterson et al., 2004; Kolowski and Holekamp, 2006). Few studies have investigated livestock depredation in areas with high human densities and how distance from the protected area influence livestock depredation. In this study, we explored through a questionnaire study the extent and impact of conflict between carnivores and agro-pastoralist outside the Serengeti

National Park. Moreover, we quantify the perceived economic losses to local communities, and examine which factors influenced the approval of retaliatory killing as a carnivore depredation deterrent, since this is a common but illegal practice in Tanzania that has serious implications for carnivore persistence.

## 2. Methods

### 2.1. Study area

#### 2.1.1. Climate and large mammals

The study was carried out on the north-western side of the Serengeti National Park (1°15'–3°30' S, 34°–36° E, Fig. 1). The Serengeti National Park (14,763 km<sup>2</sup>) is a World Heritage Site and the largest National Park in Tanzania. On the northern side it is buffered by several partially protected areas: Ikorongo Game Reserve (ca. 563 km<sup>2</sup>), Grumeti Game Reserve (ca. 416 km<sup>2</sup>) and the Ikoma Open Area (ca. 600 km<sup>2</sup>). The average annual temperature in the study area is 21.7 °C, with an average annual precipitation of 800 mm in the east to 1050 mm in the north-western parts. The protected area network in the western Serengeti harbours large populations of resident ungulates including giraffe (*Giraffa camelopardis*), buffalo (*Syncerus caffer*), topi (*Damiliscus korrigum*), impala (*Aepyceros melampus*) and gazelles (*Gazella thomsoni* and *G. granti*), as well as large carnivores, such as spotted hyena, lion, leopard and cheetah (African wild dogs are currently absent from this area). The western corridor of the Serengeti National Park is characterised by the annual wildebeest (*Connochaetes taurinus*) migration, which in June–July travels through the partially protected areas on their way north (Sinclair, 1995). However, the partially protected areas only contain low numbers of resident wildlife, because of illegal bushmeat hunting, while the village areas contain almost no large wildlife (Rusch et al., 2005). In the partially protected areas all the larger carnivores are included in the trophy hunting quota, except cheetahs and African wild dogs.

#### 2.1.2. People and livestock husbandry

In the agro-pastoral areas in the western Serengeti there is a high human population density (70 people/km<sup>2</sup>), and a population growth rate of 2.5% in the period from 1988 to 2002 (human population in Mara Region in 2002 was 1.37 million) (URT, 2002). The villages are administrative units consisting of widely dispersed houses with no clear cut border to households belonging to other villages (Fig. 1), where the multiethnic villages consist of subsistence farmers who complement their livelihoods to varying degrees with livestock keeping and illegal bushmeat hunting. Generated income from these activities is partly used to pay taxes, village development contributions and levies, buy food and to purchase clothing (Loibooki et al., 2002; Holmern et al., 2004). The areas immediately adjoining the Serengeti National Park are experiencing a high pressure for scarce resources, and have a particularly high immigration rate (Campbell and Hofer, 1995).

In the western Serengeti, livestock husbandry is commonly practiced with mixed species herds of cattle, goats and sheep. A few farmers also keep donkeys and pigs. Livestock are usually taken out in the early morning (<09:00) and returned to night enclosures before sunset. Grazing

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