

Human Caused Mortality in the Leopard (*Panthera pardus*) Population of Nepal

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ABSTRACT

Estimating cause specific leopard (*Panthera pardus*) mortality is critical to their conservation. This paper examined leopard death reports during 2006-2013 in order to estimate cause-specific mortality, identify conservation issues related to leopard mortality and provide recommendations for reducing human-caused mortality in Nepal. Data revealed that the leopards in the human dominated landscape are susceptible to variation in survival caused by human induced mortality (65%), with retaliation (31%) and lethal control (20%) of declared problem leopard as a significant part. Elevated human induced mortality can cause large scale stochasticity influencing population dynamics of leopard. The conservation of leopards needs to acknowledge strategies to limit retaliatory killings and lethal control in the plans, while addressing its conflicts with human. Efforts to reduce human-caused mortality should focus on reducing poaching and deaths from human-leopards conflicts.

Keywords: Human caused mortality, leopard population, retaliation, lethal control, conservation

INTRODUCTION

Knowledge on the causes of mortality are important parameter in understanding population dynamics of large carnivore. Mortality data provide an opportunity to assess whether observed mortality rates are sustainable and insight into ways to reduce mortality (Goodrich *et al.* 2008). Human caused mortality is one of the greatest threats to the survival of carnivore population worldwide (Noss *et al.* 1996; Woodroffe & Ginsberg, 1998; Woodroffe, 2001). Future population of these species depend on the survival of breeding adults (Weaver *et al.* 1996), but human-caused mortality often takes a heavy toll on this cohort (Fuller, 1989; McLellan *et al.* 1999). Even small scale changes in adult survivorship may have serious consequences for persistence of large carnivores because they are at the top of food chain; have large home range and sparse distribution. Long-term survival of adults, especially females, is critical to population well-being of the large carnivore (Knight & Eberhardt, 1985; Weaver *et al.* 1996).

Leopards are most widely ranging and most versatile big cat species (Bailey, 1991). They occur at low densities in human dominated landscape due to low prey biomass and have large area requirements (Nowell & Jackson, 1996; WII, 2007). On these unprotected landscape, human-leopard conflicts and associated mortality are common (Henschel *et al.* 2008; Athreya, 2012). Like other big carnivores (Woodroffe & Ginsberg, 1998; Gaona *et al.* 1998; Haight *et al.* 1998; Carroll *et al.* 2004, Neilsen *et al.*

2006), leopard populations are sensitive to unnatural death (Blame & Hunter, 2004), thus it is important to estimate causes of mortality. No published data exist on leopard mortality in Nepal. In this context, this study attempts to estimate cause-specific mortality status and also discuss conservation issues related to leopard mortality of Nepal. The data used in this study is limited because it relies on the reports, and leopards killed as human-leopard conflicts are often reported whereas poached or poisoned animals may not be detected properly. Natural deaths of this elusive species are rarely noticed.

MATERIALS AND METHODS

Wildlife conservation and protected area system (PAS) in Nepal is regulated by National Park and Wildlife Conservation Act 1973. Currently, over 23percent of the areas are under protected in Nepal, belonging to four main categories: National Parks, Wildlife Reserves, Hunting Reserve, Conservation Areas and Buffer Zones (Fig. 1).

Data on leopard death were collected from the Government offices (Department of National Park and Wildlife Conservation- the government agency responsible for protection and management of all wildlife, and District Forest Offices). In addition news reports published in daily news papers and literatures were through reviewed. Data logged at Chitwan National Park (CNP), Bardia National Park (BaNP), Banke National Park (BaNP), Parsa Wildlife Reserve (PWR), Suklaphanta Wildlife

Reserve (SWR), Annapurna Conservation Area (ACA), Regional Forest Directorate of Western Developmental Region (Pokhara) and District Forest Offices of Chitwan, Nawalparashi, Rupandehi, Banke, Bardia and Kaski were collected through the visit of respective offices. During visit to these offices, interactions were also made with the officials to discuss issues of leopard mortality. Killings of wildlife species are illegal in Nepal, therefore any offense to them are registered at offices of Protected Areas and District Forest Offices and then the information sent to centre at the Department of National Park and Wildlife Conservation. Similarly, the wildlife offense cases are covered by news papers also. However, the analysis was based only on verified leopard death cases.

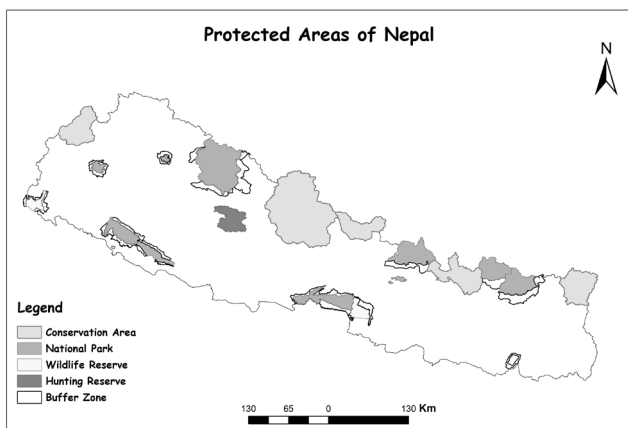


Fig. 1. Map of Nepal showing protected area system of Nepal.

Mortalities were first classified as natural, human-caused and unknown cause. Deaths were classified as natural when a death caused by starvation, disease, old age, violent interaction with other leopard, etc. natural cause was evident. Mortalities classified as human-caused were further categorized by the apparent reason: (1) lethal control of problem animals (leopard destroyed by government in response of series of human killing or threats); (2) retaliation (i.e., leopard being killed by local people); (3) accident such as vehicle collision (i.e., leopard carcass found at the road showing violent death) and (4) poached (i.e., the leopard killed illegally). Death was categorised unknown, when cause could not be determined. Mortality data was categorised on the basis of age as cub, subadult and adult (Sunquist, 1981) and sex.

RESULTS

Causes of mortality

A total of 51 leopards were confirmed died during 2006 to 2013 (Table 1). Sixty five percent of all confirmed death was human caused. Retaliation (31%) and lethal control (20%) of leopards involved in conflicts with

human were the most prevalent sources of human-caused mortality. Other sources included poaching (n=4) and collisions with vehicles (n=3). Thirty five percent (18) of total recorded deaths were possibly occurred due to natural causes.

Table 1. Mortality causes of Leopard in Nepal, based on confirmed report from 2006 to 2014

Year	Causes of death during 2006 to 2013					Total
	Natural	Lethal control	Poaching	Retaliation	Road accident	
2006	1	0	3	0	0	4
2007	0	1	0	0	0	1
2008	0	0	0	1	0	1
2009	0	0	0	1	0	1
2010	3	3	0	1	0	7
2011	3	2	0	3	1	9
2012	7	0	1	3	1	12
2013	4	4	0	7	1	16
Total	18	10	4	16	3	51

Age and sex of dead leopards

Of the 51 leopards, about 45 percent were adults, 31 percent sub-adults and 8 percent cubs, but the age of 16 percent dead leopards were not available. Among the dead leopards, more females were died than male in adult, but in case of subadult and cub more males were died than females (Fig. 2). Human-caused mortality was highest among the sub-adult (79%) followed by adult (57%) and cub (50%). Similarly, 43 percent dead individuals were male and 41 percent were female leopards and remaining dead animals were unknown interns of sex.

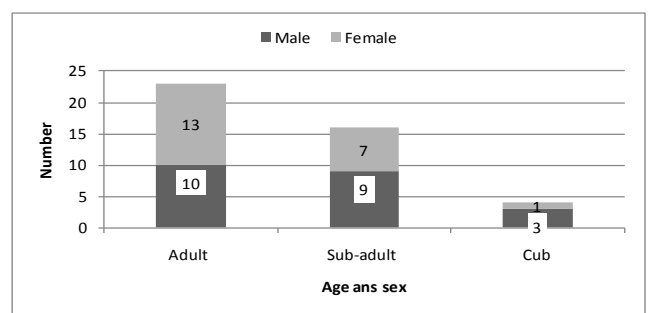


Fig.2. Age and sex of dead leopards

Leopard mortality was higher in the month of April and during December- February, while low number of deaths was observed low during July- September (Fig. 3). Among the leopard that killed by humans, about 48 percent was adults, 45 percent sub-adults and another 6 percent cubs (Fig. 4). Of the 33 individual died by human cause, nearly 50 percent killed by people in retaliation

of actual or perceived threat, 10 individuals shot by government order as problem animal, 12 percent killed by poachers and remaining 9 percent leopard died due to road accident.

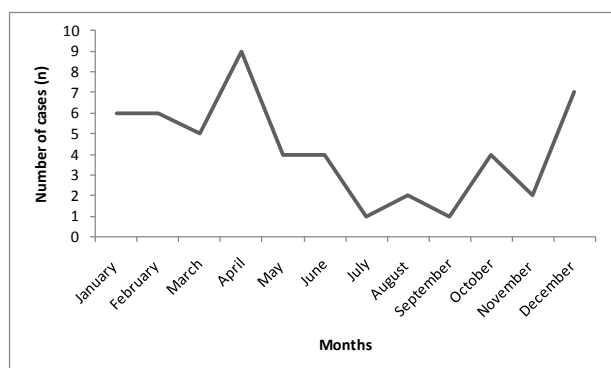


Fig. 3. Number of leopard died from different causes in Nepal (2006- 2013).

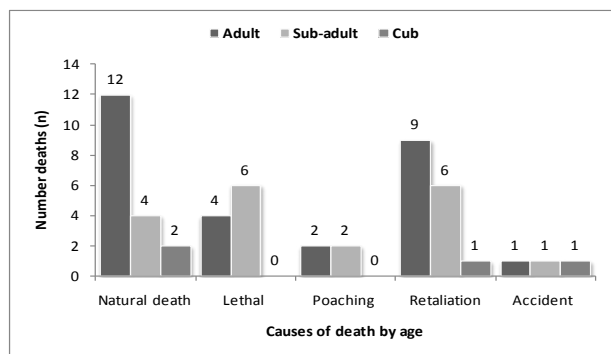


Fig. 4. Cause specific of leopard death by different age group

Spatial distribution of leopard death

Leopard death cases were recorded from 18 different districts. Maximum cases occurred at Kathmandu district (n=8), followed by Nuwakot (n=7), Kaski (n=6), Bardia (n=4), Kailali (n=4) and Syangja (n=4). Other districts where incidence of leopard death recorded are Bhaktapur, Tanahun, Baglung, Chitwan, Gulmi, Kabhre, Myagdi, Parbat, Rautahat and Solukhumbu.

DISCUSSION

Despite limitations with data, this study shows the human induced mortality of leopards in Nepal is a widespread problem. Data revealed that at least 65% reported leopard mortality was human caused. Thapa (2011) reported over 70% of recorded leopard mortality caused by anthropogenic factors in Chitwan. The actual killing rates probably higher than these estimates because human caused leopard death is difficult to record in many rural areas. Similar high mortality rates of big cats from anthropogenic causes have been reported elsewhere

(Chetkiewicz & Raygorodetsky, 1999; Carvalho & Pezzuti, 2010; Ramalho, 2012). Effective management of protected areas does not guarantee the conservation of this felid in Nepal. Although, there is no estimates for leopard population and its trend in Nepal except Chitwan National Park (Thapa, 2011), but human caused mortality may have driven a decline in leopard abundance.

Human caused mortality

Retaliatory killing in response to livestock depredation and human attacks was the single most important cause of mortality for adult and sub-adult leopards. Retaliatory killing occurs across the leopard range, but it is correlated with human attacks and livestock depredation (Shah *et al.* 2004; Kissui 2008; Ikanda & Packer, 2008). High rates of retaliation are common among large cat species (Bauer *et al.*, 2008; Packer *et al.* 2011) and are major threats for their survival (Stahl & Vandel, 1999, Andren *et al.* 2006). Nonetheless, it is clear that conflict is an important cause of mortality. Another important human caused mortality of leopard is lethal control of declared problem leopards. Both retaliation and lethal control of problem leopard related with real or perceived threats of leopard on human lives and livestock. Poaching and road accidents are other cause of leopard mortality. In the view of current law enforcement capacity, habitat degradation, prey depletion and extension of road network, poaching and road accident can be major challenge in future.

Both adult and sub-adult leopards were vulnerable for human induced death. Data on sex ratio of human induced mortality indicates almost equal number of death of both sexes. However, a female bias sex ratio is expected under the classic cat social organization in which the larger home range of male overlaps with the smaller ranges of multiple females (Sunquist, 1981; Smith, 1993; Nowell & Jackson, 1996; Jenny 1996; Karanth & Chundawat, 2002; Oden & Wegge, 2005; Harmsen, 2006), therefore death of more female is expected in specific area. But because of larger home range and mobile nature, the males probably encountered and attacked to human and more death in retaliation than female.

Elevated human-caused mortality of female and sub-adults, can affect population structure and spatial ecology in human dominated landscape. The human induced mortality have been found to affect inter population vital rates with consequences for local and regional populations (Newby *et al.* 2013). Inter population dynamics, and their population consequences depend on the characteristics of dispersal including emigration, dispersal distance, and establishment success (Bowler & Benton, 2005). Dispersal is essential to maintaining genetic connectivity within the population of leopards, but elevated human-caused mortality reduces ecological dispersal (Newby *et al.* 2013).

Data on human caused leopard mortality revealed that problems are more acute in the human dominated landscapes: hill districts and urban areas, and currently its population safe only in the protected areas. Most leopard populations live in human dominated landscape, often alongside humans and feeding on livestock and dogs (Sedeisnsticker *et al.* 1990; Mukharjee & Mishra, 2001; Edgaonkar & Chellam, 2002; Thapa, 2011). Large carnivores, living mostly outside protected areas, accidental or intentional killing by people drives local extinction or reduces their numbers (Noss *et al.* 1996; Woodroffe & Ginsberg, 1998; Blame & Hunter, 2004, Joshi & Agarwal, 2012). High human caused mortality might affect source-sink dynamics of leopards, almost all the recorded mortality occurred in non protected areas and protected areas are generally considered as source population. High rates of mortality in a dispersal habitat patch (sink) could lead to reduced population growth in a source habitat (Gundersen *et al.* 2001).

CONCLUSION

This study clearly revealed that leopard populations in Nepal are subject to high human caused mortality and such an elevated unnatural death probably reduced dispersal (emigration, dispersal distance, and establishment) and can affect population structure and spatial ecology of leopards in human dominated landscape. In cat society, female have reduced emigration rates, greater philopatry, shorter dispersal distances and an overall reduction in the extent of inter population exchange under elevated human-induced mortality. Hence, human-caused mortality can have important consequences on leopard population dynamics. Therefore, there needs conservation actions that must included changes in national legislation to enlist leopard under the protected species category, development of leopard conservation program and addressing human- leopard conflict. Estimating nationwide population and rates of mortality and survival are preliminary steps for the long term conservation of leopard in Nepal.

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