

# Livestock predation by common leopard in Binsar Wildlife Sanctuary, India: human–wildlife conflicts and conservation issues

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**Abstract:** We investigate livestock predation by the common leopard (*Panthera pardus*) and emerging conflicts between this species, local people, and wildlife authorities at the Binsar Wildlife Sanctuary in the Himalayan region of India. We scrutinized secondary data that were collected by wildlife authorities; we also conducted informal interviews of villagers living within sanctuary, and wildlife staff to understand various human–leopard conflicts. Leopard density was approximately 0.33/km<sup>2</sup> in the sanctuary. Leopards killed 1,763 domestic animals, about 90% of which were cattle, during a 14-year period. Within the sanctuary, leopards killed 1 person and injured 9 others. This high depredation rate may be due to many factors, including low density of wild prey species in the sanctuary. The high level of livestock depredation by leopards in and around the sanctuary has caused severe conflicts.

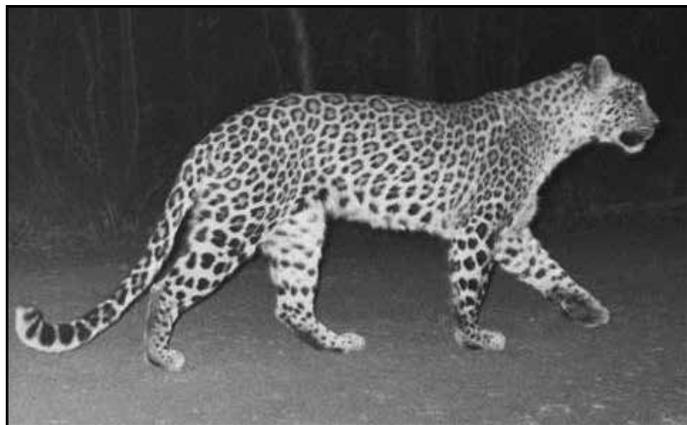
**Key words:** leopard, human–wildlife conflicts, Himalaya, India, livestock depredation, wildlife conservation

**POPULATIONS OF MANY CARNIVOROUS** species have declined worldwide during past 100 years, and, as a consequence, many of these are now endangered either regionally or globally, according to the International Union for the Conservation of Nature (IUCN; 2002). The common leopard (*Panthera pardus*; Figure 1) is a large carnivore species that has been listed as “near threatened” by the IUCN due to population decline and range contractions (Henschel et al. 2008). One of the major causes of this decline is attributed to the conflicts with local communities due to livestock depredation by leopards throughout their range (Karanth and Sunquist 1995, Ogada et al. 2003, Edgaonkar 2008). Indiscriminate poaching of wild ungulates for meat, skins, horns, and medicine has caused decline of leopards’ natural prey populations (Williamson 2002, Kala 2005). Such reduction of wild prey, which has, consequently, forced leopards to depredate livestock and to attack humans, is the ultimate cause of conflict with local communities (Schaller et al. 1988, Oli et al. 1994, McCarthy 2000). The population decline and extinction of many carnivore species can be traced to direct conflicts with humans arising from livestock depredation (Mishra 2001, Mishra et al. 2002).

India hosts a rich diversity of flora and fauna. The 410 species of Indian mammals comprise

about 8.9% of all mammal species worldwide (Nameer 1998). To conserve the diversity of flora and fauna, the government of India has established 102 national parks and 520 wildlife sanctuaries, 57 conservation reserves, and 4 community reserves, covering 5% (164,981 km<sup>2</sup>) of India’s total land area (Rodgers et al. 2000, Wildlife Institute of India 2012). However, livestock grazing in protected areas is extensive, with grazing occurring in 73% of wildlife sanctuaries and 39% of national parks (Kothari et al. 1989). Within wildlife sanctuaries, land-use practices include agriculture, livestock grazing, and forestry. These activities have negatively impacted wild ungulate populations. Because wild ungulate prey occur in low densities within wildlife sanctuaries, wild carnivores resort to depredating on livestock, and large cats (including leopards) also occasionally attack and prey on humans. This causes severe conflicts between conservation agencies and local communities.

The common leopard has 14 recognized subspecies worldwide, of which India contains four: *Panthera pardus fusca*, *P. pardus pernigra*, *P. pardus sindica*, and *P. pardus millardi*. Fossil records indicate that common leopards occurred in the Indian Siwaliks approximately 2 million years ago (Daniel 1996). About 14,000 leopards exist in 196 sanctuaries and national



**Figure 1.** Common leopards are major predators in the Binsar Wildlife Sanctuary. (Photo courtesy A. Edgaonkar)

parks across the 28 states and Union Territories of India (Daniel 1996). This species still has a wide distributional range and inhabits a broad array of habitats and regions (Srivastav 1999). In northern India, it is distributed widely and occurs  $\leq 3,000$  m above mean sea level.

There are serious conflicts between wildlife conservationists and local communities regarding the conservation of common leopards throughout the northern Indian states because of the numbers of leopards outside of protected areas (Srivastav 1999). Several strategies have been employed to mitigate the conflicting interests of conservationists and local villagers, including cash compensation, indirect compensation through integrated conservation and development programs, and selective sustainable extraction of resources. However, conservation policies that restrict traditional rights to resources and that increase losses of livestock and human life to wildlife cause antagonistic feelings in the local people who once were stewards of the resources (Mehta and Kellert 1998, Wang et al. 2006).

This study was initiated as a response to increasing and persistent human–leopard conflicts in a protected area of Uttarakhand and its surroundings. The primary aim of this study was to describe the conflicts between common leopards and people living in and around the Binsar Wildlife Sanctuary. The economic losses associated with livestock depredation on local communities also were examined. The impacts of leopard mauling and predation upon humans were also studied to understand the local resentment for conservation of leopards.

## Study area

The Binsar Wildlife Sanctuary is situated in the Almora district of Uttarakhand state in northern India, between  $29^{\circ} 30'$  to  $29^{\circ} 43'$  N and  $79^{\circ} 41'$  to  $79^{\circ} 47'$  E, and has an area of  $45.6 \text{ km}^2$ . Mean monthly temperatures ranged from  $2.2^{\circ} \text{ C}$  to  $15.5^{\circ} \text{ C}$  during winter and from  $17.2^{\circ} \text{ C}$  to  $26.6^{\circ} \text{ C}$  during summer. Average rainfall was approximately  $1,200 \text{ mm}$  (Sharma et al. 1999). Throughout the sanctuary, the terrain is hilly and characterized by deep ravines, crevices and

elevated ridges. The forested area starts at an elevation of  $1,600 \text{ m}$  and rises to about  $2,400 \text{ m}$ . Lower altitude areas in the sanctuary are used for livestock grazing and agriculture. The forested hilltops and slopes in the sanctuary are covered by chir pine (*Pinus roxburghii*), banj oak (*Quercus leucotrichophora*), and rhododendron (*Rhododendron arboreum*) as pure or mixed stands. Pure pine forests are present between  $1,600$  and  $1,900 \text{ m}$ , while mixed forests of pine and oak are distributed over  $1,900$  to  $2,100 \text{ m}$ . The pure oak and mixed oak forests (*Quercus leucotrichophora* and *Quercus floribunda*) are present between  $2,100$  and  $2,400 \text{ m}$ . Other dominant tree species include *Lyonia ovalifolia*, *Quercus leucotrichophora*, *Rhododendron arboreum*, *Myrica esculenta* and *Alnus nepalensis* (Majila et al. 2005, Majila and Kala 2010, Kala and Majila 2013).

Common leopards are major wild predators in the sanctuary. Other predators include jungle cats (*Felis chaus*). Major ungulate species include gorals (*Nemorhaedus goral*), barking deer (*Muntiacus muntjak*), serows (*Capricornis sumatrensis*), and wild boar (*Sus scrofa*). Other mammal species in the sanctuary are common langurs (*Presbytus entellus*), rhesus macaques (monkey; *Macaca mulatta*), Himalayan black bears (*Selenarctos thibetanus*), and jackals (*Canis aureus*). The sanctuary also harbors diverse birds, including black francolins (*Francolinus francolinus*), koklass pheasants (*Pucrasia macrolopha*), kaleej pheasants (*Lophura leucomelana*), hill partridges (*Arborophilla torqueola*), great barbets (*Megalaima virens*), hawk eagles (*Spizaetus nipalensis*), Himalayan griffons

(*Gyps himalayensis*), lammergeiers (*Gypaetus barbatus*), and yellow-billed magpies (*Cissa flavirostris*; Khan et al. 2000, Majila and Kala 2010).

Farming and animal husbandry are the main economic activities of the people living in and around the sanctuary. Livestock provide the basis for livelihoods and are used for ploughing and composting crop fields. A variety of products important for socioeconomic and cultural advancement are also produced.

### Methods

We examined the data on leopard depredation collected during 1990 to 2003 by the wildlife authorities of the Binsar Wildlife Sanctuary. The data included depredations on domestic livestock, including buffaloes, cattle, goats, and mules. We also collected information on attacks and predation on humans by leopards, including time of attack, ages, and habitat types. We examined the Binsar Wildlife Sanctuary’s Wildlife Department (WD) records on livestock and humans in the sanctuary area. The WD conducts wildlife surveys on various species each year. The field staffs responsible for the census were familiar with local topography and forests. In addition to recording direct sightings, the WD carries out encounter surveys of wildlife in different areas. Techniques include water hole surveys, pugmark tracking, identifying droppings (scats and pellets), vocalizations (roars), scraps, and leopard claw-marks on tree trunks. The density of wildlife species (individuals/km<sup>2</sup>) was calculated for the sanctuary area (45.6 km<sup>2</sup>).

We scrutinized the applications and compensation payments for the loss of human life and livestock to understand patterns of approval and rejection by the WD and also to cross-check numbers. To avoid exaggerated claims, the authorities visited the spot within 24 hours of the incidence to find out whether the leopard killed the livestock or it was a natural death. Attacks by leopards were identified by bites under the throat and on the back of livestock’s neck. The feeding pattern of kills, mainly between back legs and shoulder, also indicated that leopards were responsible for the attack. Dragging a carcass from the site of

**Table 1:** Estimated value (in US\$) of different livestock species by age and sex in and around the Binsar Wildlife Sanctuary, India.

Age	Cows	Bulls	Buffaloes		Goats	
			Male	Female	Male	Female
6 months	3.4	5.7	4.5	3.4	18.0	13.6
1 year	11.4	14.8	5.7	4.5	25.0	20.5
2 years	17.0	18.0	7.9	5.7	68.1	40.9
3 years	18.0	22.7	11.4	6.8	68.1	40.9
4 years	34.0	45.5	56.8	22.7		
6 years	63.6	50.0	136.4	113.6		
≥ 7 years	68.1	51.1	102.3	181.8		

killing and pug marks and scats also indicated if leopards had killed the livestock. We calculated the rate of depredation and annual changes in predation on the basis of WD census data. The sanctuary is prone to fire and, therefore, WD fire records were used to determine if there was a relationship between fire incidents and leopard kills.

Forty-two villagers in 16 villages within the sanctuary were randomly interviewed to obtain information on livestock depredation. This information was compared with information gathered during group discussions with villagers. Those interviewed were screened to exclude people with official ties to the Binsar Wildlife Sanctuary or who had political connections to other concerned authorities. The interviews were held in a casual manner without note-taking to obtain the best possible information. The respondents were asked about their personal experiences regarding depredation events. The villagers that had livestock that were injured or killed by leopards were also interviewed to understand attitudes and conflicts regarding the leopards.

The problems experienced by families were documented when they applied for compensation. The wildlife guards and people in neighboring villages were cross-examined regarding conflicts within the sanctuary. The economic value of lost livestock was estimated by using the general market price for the area that was obtained through local market survey (Table 1). We relied upon local perceptions of the value of different age classes of livestock. The total economic damage attributed to

leopard depredations on livestock was calculated (see Ikeda 2004) by combining the incidence occurring the same year. We also correlated data between the fire incidences and depredation of leopard to understand the intensity of impacts created by fire.

## Results

The density of leopards was about 0.33 individual/km<sup>2</sup> in Binsar Wildlife Sanctuary of Uttarakhand. The leopard population remained stable from 1995 to 2003, while populations of ghorals and barking deer decreased (Table 2). During 1990 to 2003, most leopard depredations (90.3%) were on cattle (Table 3), and primarily adult livestock were killed. On average, each leopard killed 1 domestic animal per month. During the 14-year period (1990 to 2003), depredations peaked in 1995, while 1998 was the year with the lowest depredation (Table 3). On average, 126 livestock per year were killed by leopards.

Locals reported that they drove livestock out of the cattle sheds each day from 0800 to 0900 hours for grazing and returned them to the sheds before sunset; livestock were depredated while grazing in the forests during the daylight. All livestock were monitored by  $\geq 1$  herder during the day. At cattle sheds, village residents and in some cases domestic dogs were the major deterrents to the predator attacks on livestock.

Humans also were attacked in the sanctuary, resulting in 9 injuries and 1 fatality during the period 1996 to 2003. The WD had not registered leopard-caused fatalities prior to 1996. According to the local people, the person killed was at home, whereas the injured people were working in crop fields or in the forest. Most people attacked by leopards were alone

**Table 2:** Wild animal census data of the Binsar Wildlife Sanctuary, India, from 1995 to 2003.

Species	1995	1997	1999	2001	2003
Common leopard	15	17	15	13	15
Ghoral	50	64	32	43	46
Barking deer	35	36	23	28	31
Wild boar	38	43	56	63	57
Common langur	97	164	230	135	149
Monkey	153	195	271	251	150
Yellow-throated martin ( <i>Martes flavigula</i> )	-	3	2	-	6
Black bear	1	1	1	1	

**Table 3:** Number of livestock depredations by leopards inside the villages of the Binsar Wildlife Sanctuary, India.

Year	Cattle			Buffaloes	Goats	Mules	Total
	Cows	Bulls	Calves				
1990	44	52	2	1	10	-	109
1991	41	31	2	1	8	-	83
1992	48	33	6	-	7	-	94
1993	63	45	6	3	10	-	127
1994	53	56	4	5	17	-	135
1995	67	83	9	1	10	2	172
1996	49	58	4	1	6	-	118
1997	61	67	5	1	7	-	141
1998	28	41	1	-	10	-	80
1999	66	55	1	-	7	-	129
2000	52	74	-	1	39	-	166
2001	72	2	2	2	7	-	135
2002	65	70	-	2	1	-	138
2003	61	73	-	-	2	-	136
Total	770	780	42	18	141	2	1763

or at a distance from other people working in the crop field.

The WD paid US\$ 50,685 to compensate villagers who had lost livestock to leopard depredation during the period 1990 to 2003. During this period, the WD rejected 119 depredation claims due to lack of supportive evidence (Table 4). The differences in compensation as paid by wildlife authorities and actual cost of livestock are given in Table 5. The highest difference between compensation paid and actual cost of domestic animals was for goats, followed by buffaloes.

**Table 4:** Total yearly compensation paid to villagers for the alleged killing of the animals in the Binsar Wildlife Sanctuary, India, from 1990 to 2003.

Year	Cattle			Buffalo	Goats	Mules	\$ US <sup>a</sup>	Rejected applications
	Cows	Bulls	Calves					
1990	44	52	2	1	10	-	2584	-
1991	41	31	2	1	8	-	1812	-
1992	48	33	6	-	7	-	2007	14
1993	63	45	6	3	10	-	2747	26
1994	53	56	4	5	17	-	2997	24
1995	67	83	9	1	10	2	4123	11
1996	49	58	4	1	6	-	2881	8
1997	61	67	5	1	7	-	3402	-
Compensation paid (revised rates) <sup>b</sup>								
1998	28	41	1	-	10	-	2949	5
1999	64	55	1	-	7	-	4652	7
2000	52	74	-	1	39	-	5476	-
2001	72	42	2	2	7	-	4313	1
2002	57	70	-	2	11	-	5365	17
2003	57	73	-	-	2	-	5377	6

<sup>a</sup>Rate of the compensation per killed animal by forest department up to December 1997 are as follows (Rs. = rupies): cow: Rs. 750; bull: Rs. 1,500; goat: Rs. 100; calf: Rs. 350; buffalo: Rs. 1,000; mule: Rs. 750 (1 US\$ = Rs. 44 as of September 21, 2005).

<sup>b</sup>Revised rate of compensation of killed animal by the forest department from January 1998 are as follows: cow: Rs. 1,200; bull: Rs. 2,300; goat: Rs. 150; calf: Rs. 350; buffalo: Rs. 2,500; mule: Rs. 750. (1 US\$ = Rs. 44 as of September 21, 2005).

**Table 5:** Difference between compensation paid and actual value of livestock killed by common leopards in the Binsar Wildlife Sanctuary, India.

Animal type	No. of animal	Total market cost (US\$)	Compensation paid (US\$)	Difference (US\$)
Cattle	1,592	88,955	45,095	43,860
Buffaloes	18	3,270	580	2,690
Goats	141	3,525	430	3095
Mules	2	NA	NA	NA

Fire is one of the major anthropogenic pressures in and around the sanctuary. The highest frequency fire occurred in 1999 and varied greatly among years (Table 6). The greatest proportion of the sanctuary affected by fire in a single year was 1994 when 2,850 ha were burned. There was a weak correlation ( $r = 0.33$ ) between the fire incidences and annual killings of livestock by leopards. Similarly, there was a weak correlation between the number of leopard and killings of domestic animals in the sanctuary.

## Discussion

### Livestock depredation

Our results indicate that livestock depredation rates by leopards in the Binsar Wildlife Sanctuary were high and varied between 7 and 14 animals killed per month. This has led to severe conflicts between the conservation of wild predators and local people. The high depredation rate was the result of the low density of wild prey species in the wildlife sanctuary. While foraging in the

forest, livestock were generally attended by people to reduce losses to leopards, there also were reports of nocturnal attacks on livestock in the cattle sheds (Kolowsky and Holekamp 2006), but during our study, all livestock were depredated while they were grazing in the forests.

Mostly cattle were depredated in the sanctuary by the leopards. Patterson et al. (2004) has pointed out that the selection of prey species depends mainly on the body size and availability of prey species. Determining the number of cattle killed by leopards is difficult in areas where lions and tigers also occur. In our study, the leopard was the only large cat, so we could easily assess the number of livestock killed by leopards. In Kenya, leopards account for the highest number of livestock killings (Karani 1994).

Authorities feel that many villagers intentionally inflate the number of livestock depredated to get more compensation. Most of the compensation claims in the study area were registered on a single victim. Attempting to prove the cause of death of livestock due to predation by leopards is one of the problems in determining the degree of human–wildlife conflict. Similar observations on human–wildlife conflicts have been made in the United States by Wagner (1988).

### Adaptive strategies and attacks on humans by leopards

In our study area, the leopard population was stable over 14 years, despite scarcity of wild ungulates. In southern India, leopards feed on smaller and less-preferred prey species due to low ungulate populations. Yet, in southern India, the low density of large prey species has not adversely affected the leopard (Ramakrishnan et al. 1999). In the absence of wild prey species, leopards tend to become man-eaters. The entire hilly region of Uttarakhand state has been historically known as an area where man-eating leopards exist (Corbett 1948), and they may exist all across the hill districts of Uttarakhand (Kala 1999). Killing and mauling of humans is another major cause of conflicts in the study area. Within 45 km<sup>2</sup> of our study site, 10 people were attacked by leopards over a period of 7 years. Once leopards are declared man-eaters, the WDs ask hunters to kill or to

**Table 6:** Number of fires and area burned in the Binsar Wildlife Sanctuary, India.

Year	Number of fires	Area affected (ha)
1992	13	733
1993	21	522
1994	10	2,850
1995	22	1,410
1996	-	-
1997	-	-
1998	8	95
1999	34	1,238
2000	-	-
2001	-	-
2002	9	245
2003	10	109

trap the man-eating leopards, but other leopards are also gunned down.

### People–sanctuary conflicts

The local people tolerated leopards in the past, but now they are demanding action by the government. There were reports of local people eradicating leopards through poisoning of livestock carcasses. Apart from livestock depredation, human mauling by leopards was a major source of confrontation and clashes between the local people and the authorities. It is understood that no compensation can overcome the loss of human life; however, villagers complained that they had to pass through a rigorous bureaucratic system to be compensated for the loss of humans and livestock. If a person survives after a leopard attack, his or her life often becomes miserable; there were several such victims in Uttarakhand. The prolonged fear of leopards has paralyzed the lives of local villagers who depend on the forest and forest resources for their livelihood. These facts have resulted in a deteriorating relationship between local communities and those who manage the sanctuaries, consequently, undermining the conservation success of the protected areas (Rao et al. 2002, Mukherjee and Borad 2004).

At present, the leopard population has increased in India due to continuous conservation measures. According to the wildlife

census report, the number of leopards has increased from 6,830 to 9,850 from 1993 to 2001 (Singh 2005). The highest number of leopards live in the state of Uttarakhand, followed by Madhya Pradesh, Gujarat, Himachal Pradesh, Maharashtra and Karnataka (Singh 2005). The high density of leopards in Uttarakhand has increased intra-specific competitions among leopards for scarce food resources. Other known reasons for human-wildlife conflicts are: habitat degradation, forest fragmentation, expansion of human settlement right to the edge of wildlife habitats, decreasing tolerance level of local people toward wild animals, decimation of natural prey, and intense uses of forests by humans (Panwar 1979; Johnsingh and Negi 2003; Rishi 2005). Local people become highly intolerant of leopards when a conflict is not resolved. To decrease depredation on domestic stock, there is the need to increase the abundance and density of wild prey species by controlling poaching and fires and diminishing domestic stock inside the protected areas. Developing antipredation strategies to reduce the vulnerability of the diverse livestock species to leopard attacks also is needed.

### Conclusion

The Binsar Wildlife Sanctuary of India has low populations of wild ungulates; therefore, leopards kill domestic livestock for food. The scarcity of wild prey species, intraspecific competition for limited food resources, and habitat loss are some of the reasons of killings and mauling of humans by leopard. The rising confrontation between humans and leopards may be resolved by conducting awareness campaigns about the need to restore leopards' habitats and how to mitigate the adverse impact of people in wilderness and protected areas. The vulnerability of human and domestic livestock to leopards may decline if the populations of wild prey species are enhanced in the sanctuary. Policy makers and managers should develop a tangible conservation strategy for solving the problems faced by local people. Improving the local people's understanding about wildlife and keeping them involved in management decisions may cultivate a more positive attitude toward conserving leopards.

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