

Review on Leopard Ecology and Conservation in Human-Dominated Landscapes

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Peer Review Information	Abstract
Type: Article Received: 04 June 2026 Revised: 10 July 2026 Accepted: 05 Aug 2026 Published: 08 Sept 2026	The Indian leopard (<i>Panthera pardus fusca</i>) is an ecologically adaptable and widely distributed carnivore that holds significant cultural and ecological importance in India. Despite its adaptability, leopard populations face increasing threats from habitat loss and fragmentation, declining prey availability, human-leopard conflict, poaching, illegal trade, and disease. Leopards utilize diverse habitats, including protected forests, agricultural landscapes, and human-dominated areas, where their generalist and opportunistic feeding behavior enables them to exploit a wide range of prey. Studies indicate that adequate availability and diversity of wild prey may reduce livestock depredation and support coexistence with local communities. Habitat alteration, expansion of agriculture, livestock rearing, and settlement near forest boundaries, however, have increased encounters between leopards and humans. In addition, emerging evidence of parasitic infections highlights the importance of health monitoring in wild populations. Effective conservation therefore requires habitat restoration, maintenance of prey populations, systematic monitoring of leopard ecology and health, and site-specific strategies to mitigate human-leopard conflict. Community participation, awareness, and sustainable land-use practices are essential for promoting long-term coexistence and ensuring the conservation of the Indian leopard. (Qureshi et. al., 2022 WII, Mohan Ram et al. 2024, Kumara et al. 2026, Badhe and Jaybhaye 2021, Manandhar et al. 2025) Keywords: Keywords: <i>Panthera Pardus</i>; Leopard Conservation; Scat Analysis; Molecular Ecology; Movement Ecology; Population Genetics; Human-Wildlife Conflict; Conservation Technology; Community Participation; Coexistence.

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Introduction

Leopards commanded great reverence in ancient cultures (Egyptian, African and Indian cultures), symbolizing traits of power, agility, and nobility. Among Native cultures, the leopard's hunting prowess and camouflage were deeply respected, with tales highlighting their significance in transformational narratives and superstitions. Myths and folklore surrounding leopards often depict them as bold, cunning spirits intertwined with the spirit realm. Today, contemporary portrayals of leopards across fashion, literature, cinema, and art persist in symbolizing qualities of strength, courage, and sensuality. The Indian leopard, with its spotted coat and powerful presence, has long held a significant place in Indian art and culture. More than just a magnificent predator, it has been woven into the fabric of myths, folklore, and artistic expressions, representing a captivating blend of fear, power, and beauty. The Indian leopard (*Panthera pardus fusca*) is found in a variety of forested habitats, including tropical rainforests, dry deciduous forests, temperate forests, and coniferous forests. The subspecies is found in India, Nepal, Bhutan, and parts of Pakistan, and it is not found in mangrove forests or desert habitats (Prater 1980, Daniel 1996). According to the Wildlife (Protection) Act, 1972 leopard is listed in Schedule I, which accorded highest protection and as per International Union for Conservation of Nature (IUCN) Red List of Threatened Species, it is classified as "Vulnerable". Its population is decreasing across its range, primarily due to habitat loss, fragmentation, human-wildlife conflict, poaching, and illegal trade (Athreya et al., 2011 and Raza et al., 2012). Being one of the most widely distributed felids, leopards owe their extensive range to their dietary flexibility and ability to inhabit various environments, including human-dominated landscapes (Sunquist and Sunquist, 2002; Hayward et al., 2006; Athreya et al., 2013; Gubbi et al., 2020). However, this adaptability often leads to conflicts with humans, presenting a significant conservation challenge within their range (Rahalkar, 2008; Athreya et al., 2011; Navya et al., 2014; Sidhu et al., 2017; Naha et al., 2018).

Conservation efforts for the Indian leopard require habitat restoration initiatives, protection outside Protected Area system and the implementation of measures to mitigate human-leopard conflict. There is a need to collaborate with local communities to raise awareness, and promote coexistence between humans and leopards. Research on leopard ecology, behavior, and population dynamics is needed for informed conservation strategies and management decisions. (Qureshi et. al., 2022 WII)

Dietary Ecology and the Role of Prey Availability

Ram et al., (2024) has concluded that wild ungulates are among the important wild prey species for leopards in Gir forest and multi-use land matrix. they strongly believe that high wild prey consumption in the multi-use land matrix surrounding the Gir forest might buffer livestock predation, indicating the importance of wild prey in reducing livestock depredation. A long-term study on leopards' foraging ecology is required to identify factors governing livestock depredation by leopards, which could be helpful in decreasing the magnitude of livestock depredation by leopards. Also, there is a need to assess the population of leopards from the surrounding multi-use landscape, which can help create a better understanding of the coexistence of both the predator and ultimately be helpful in the long-term conservation of leopards and Asiatic lions. Kumara et al. (2026) observed varied diet, lacking strong selection and predominant species, was consistent with a generalist, opportunistic predator and underscores the ecological adaptability of leopards and their capacity to exploit prey of various sizes and types. This flexibility is probably essential for their survival in such landscapes. Awareness of this broad and diverse feeding habit can inform conservation measures, highlighting the need to maintain prey diversity. In terms of future directions, in addition to quantifying primate availability on the landscape, it would be beneficial to conduct further research to determine the impacts of human activities on leopard behavior, prey availability, and habitat utilization, as understanding how anthropogenic variables influence predator prey dynamics. This can provide data driven insights for conservation strategies.

Human–Leopard Conflict

Junnar forest division suffers from this serious issue of human leopard conflict, Badhe and Jaybhaye (2021) further studied that the western part of the study area comes under the Western Ghats, which is the original habitat of the leopard, where the human and wildlife as a part of nature, had decent co-occurrence. But, due to the human encroachment in the natural forest area, the majority of the leopard moved into alternative habitat where agricultural activities are dominant. These Leopards are unable to adapt to altered habitats and induce to attack marginal habitats that created a threat to human and domesticated animals. The decision-makers and conservers are believed that instead of conflict and fear, it is essential to have decent coexistence. Hence, to avoid this conflict in the study area, identification of habitat site suitability for leopard would help to mitigate the problem. The suitable sites for leopard habitat are classified into very low, low, moderate and highly suitable categories that shows which area is more suitable for leopard habitat. The result also shows that the problem is severe in the non-suitable area and alternative habitat region. The western part of study region is more suitable due to the mountains area and comparatively dense forest with rich in biodiversity. Hence, there is a need to demarcate the habitat zones and restore its original characteristics which are suitable for the rich ecosystem and suitable for leopard habitat.

Badhe and Jaybhaye (2024) studied a spatial understanding of human leopard conflict, originated from human–environment interaction-based unsustainable practices at both the original habitat and the newly adopted alternative habitat of the leopards. The degradation of the

original habitat leads to prey unavailability and compels leopards to move in search of prey in new habitats. The availability of ample water for drinking and irrigation in the area caused the growth and sprawling of sugarcane agriculture and orchid cultivation for higher economic incentives to the farmers, attracting more settlements near the agricultural fields. For additional income, farmers practice dairy activities near their residences on the farm, which increases livestock numbers. This change attracts leopards as a pull factor to exploit such favorable new habitats. It provides a safe place to hide, easy prey, and water for survival. This change in land use induced new space dynamics of leopard movement and the concentration of hotspots of human leopard conflict near the alternatively used environment. The spatial and temporal understanding achieved in this study gives a holistic dimension to minimize the human leopard conflict problem, helping to understand the need for new sustainable human environment practices by restoring original habitats and changes in land use patterns.

Manandhar et al., (2025) concluded that further research should evaluate stress, reproductive physiology, diseases, and genetic health status of leopards to understand the impact of anthropogenic factors on urban leopards. Furthermore, undertaking sex id tests to ascertain the sex of the predators that produced the scats and increasing the sample size would contribute to a more comprehensive understanding of the carnivores. Based on the records of the forest department, village survey, and interview with the local people and assessing leading print media's coverage of ten years in this study, recommendations are made to effort to minimize human leopard conflict in the study area. The forests of Vansda are patchy and fragmented. Sugarcane, Paddy and Vegetables are being grown in abundance around the villages. Leopard increasingly use the Sugarcane farm for hiding, ambush and attacking livestock. Villages are scattered but most of them are located in the close vicinity of forests. The pariah dogs are the delicacy of leopard, villagers should keep dogs in their houses. In the late evening and night, dogs can be kept inside rooms or in safe pet house. This will greatly help in keeping leopard away and attacks can be minimized. Livestock especially young ones should be kept in secure shed and movement during evening time should be reduced or taken care. To further minimize human-leopard conflict in Vansda, education and awareness programmers related to ecology and behavior of leopard, genesis of leopard menace, possible mitigation strategies need to be devised. For conducting systematic research study, we recommend a detailed study on population ecology including habitat use, movement, activity and dietary pattern of leopard. A site specific human-leopard conflict mitigation plan is recommended for long term solution, Dahya et al. (2021).

Health, Parasites and Disease Ecology

Kolangath et al., (2025) detected *Sarcocystis spp.* and other parasites in tigers and leopards in Maharashtra underscores the pressing need for proactive health management in both captive and wild populations. The study demonstrates that wild felids are susceptible to a wide array of parasitic infections that could impact their health, especially when exposed to stressors like habitat fragmentation and human-wildlife conflict. Conservation efforts should prioritize health monitoring, habitat protection, and cross-species disease management strategies to ensure the survival and well-being of these iconic species. Enhanced diagnostic and management practices will be essential to mitigate the risks associated with parasitic infections, contributing to the conservation of endangered felid populations in India.

135 scats of leopards from Melghat Tiger Reserve were analyzed by Shirbhate (2007) for any undigested remains. The analysis of scats of leopards revealed remains of 11 prey species with a high preponderance of small mammals including Indian hare (*Lepus nigricollis*), sambar (*Cervus unicolor*) and wild pig (*Sus scrofa*). The prey preference on the basis of biomass was sambar > wild pig > domestic animals > chital > four horned antelope. But the order of predation on the basis of undigested remains in scats was Indian hare > sambar > wild pig > langur > domestic animals. In the present study 50.37% of leopard scats contained single prey species and 49.62 % contained two prey species. No scat was found to contain 3 or 4 prey species simultaneously. Daily consumption of each leopard was found to be 1.3037 kg/day/leopard and annual consumption was 475.8505 kg/annum/leopard. Leopards were also found to be the host of a number of gastro intestinal parasites. 65.18% samples were seen infected with the various parasitic infections.

Table 1. Parasites recorded/reported in leopard (*Panthera pardus*)

S. No.	Parasite species/taxon	Broad taxonomic group
1	<i>Taenia pisiformis</i>	Cestoda
2	<i>Dipylidium caninum</i>	Cestoda
3	<i>Hydatigera taeniaeformis</i>	Cestoda
4	<i>Uncinaria stenocephala</i>	Nematoda
5	<i>Ancylostoma caninum</i>	Nematoda
6	<i>Toxocara cati</i>	Nematoda
7	<i>Isospora felis</i>	Protozoa
8	<i>Toxascaris leonina</i>	Nematoda

9	<i>Capillaria hepatica</i>	Nematoda
10	<i>Diphyllbothrium latum</i>	Cestoda
11	<i>Fasciola hepatica</i>	Trematoda
12	<i>Hymenolepis diminuta</i>	Cestoda
13	<i>Metagonimus spp.</i>	Trematoda
14	<i>Paragonimus kellicotti</i>	Trematoda
15	<i>Paragonimus westermani</i>	Trematoda
16	<i>Spirometra erinacea</i>	Cestoda
17	<i>Trichuris trichiura</i>	Nematoda
18	<i>Trichuris vulpis</i>	Nematoda

Chaudhary et al. (2023) concluded in their research that to conserve leopard effectively in human dominated landscape, a good understanding of its population estimates is required, which is also important in providing local and regional level conservation and management efforts. The present study is first effort towards the leopard population density estimation in New Delhi which was estimated at 4.5 ± 0.019 animals/100km². It is comparable to the leopard densities from other human dominated landscapes of Ahmednagar district, western Maharashtra which was $6.4 \pm 0.78/100$ km² (Athreya et al. 2013), $6.38 \pm 2.4/100$ km² in Jawai, Rajasthan (Sharma, 2017) and $3.1 \pm 0.4/100$ km² in Sariska Tiger Reserve (Mondal et al. 2012) and 5.40 ± 2.99 leopards/ 100 km² in Tungreshwar Wildlife Sanctuary, Mumbai (Surve et al. 2022). The moderate density of leopards in this small protected area can be due to the lack of any major anthropogenic threats, absence of other large predators, high availability of prey base and intensive integrated wildlife and habitat management by forest department. If habitat is holistically managed and prey base augmentation and attempts to increase the wild herbivores, this sanctuary can sustain a very good leopard population. In India, some of the regions having very high leopard population density are 26.34 ± 4.96 leopards/100 km² in Sanjay Gandhi National Park, Mumbai (Surve et al. 2022), 12.04 ± 2.98 leopards/100 km² in Chanakya Tiger Reserve 14.99 ± 6.9 leopards/100 km² in Rajaji National Park (Harihar et al. 2009) etc. future study is recommended to quantify the density gradient and diet of leopards in protected and non-protected areas to understand the anthropogenic impact on leopard populations.

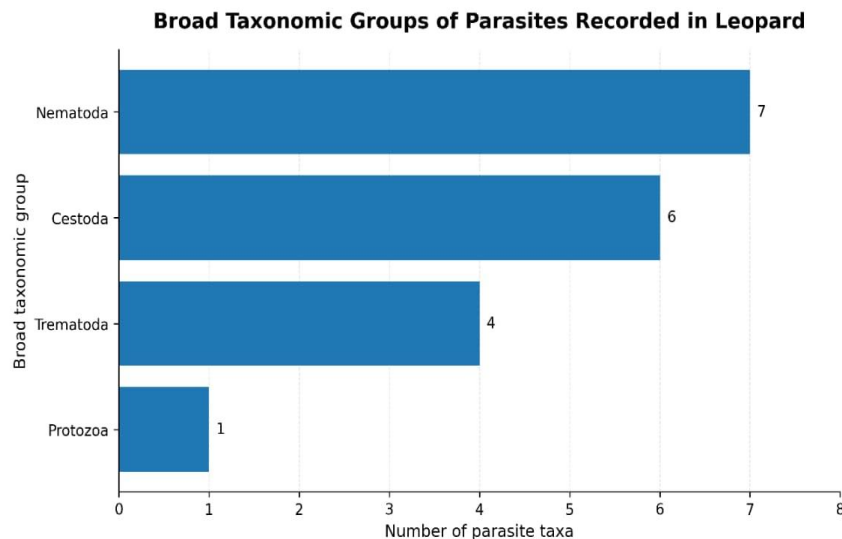


Fig. 1. Distribution of Parasite Taxa across Broad Taxonomic Groups Recorded in Leopards

Research gaps and future priorities

Although existing studies have generated valuable information on leopard diet, prey selection, population density, habitat use, health, and human-leopard conflict, several important research gaps remain, particularly in fragmented and human-dominated landscapes. Future research should adopt a long-term, multidisciplinary and spatially explicit approach to understand how habitat fragmentation, land-use change, agricultural expansion, prey availability, livestock density, and human activities influence leopard population dynamics, movement, behavior, diet, health, and conflict. In particular, future studies should:

1. Estimate leopard population density, abundance, demographic structure and distribution in protected areas and surrounding multi-use landscapes using camera trapping, spatial capture–recapture and genetic approaches.
2. Assess wild prey availability and leopard diet across seasons and habitats to determine prey selection and test whether higher wild prey availability can reduce livestock depredation.
3. Use GIS and remote sensing techniques to map land-use/land-cover change, habitat fragmentation, forest patches, agricultural areas, water sources, settlements, roads and other landscape features influencing leopard habitat use.
4. Apply spatial modelling and GIS-based habitat suitability analysis, including multi-criteria approaches, to identify suitable leopard habitats, critical refuges, movement corridors and areas requiring habitat restoration.
5. Use GPS telemetry, camera traps and GIS-based movement analysis to understand leopard home ranges, movement pathways, dispersal and connectivity between forests and surrounding agricultural landscapes.
6. Develop spatial and temporal models of human–leopard conflict by integrating conflict records with livestock density, prey availability, land use, crop type, settlement distribution, water availability and human activity to identify and predict conflict hotspots.
7. Evaluate the role of agricultural landscapes, particularly sugarcane fields, as refuge and movement habitats and determine how seasonal agricultural practices influence leopard behaviour and conflict.
8. Assess the effectiveness of conflict-mitigation measures through before–after and spatial comparisons, including improved livestock sheds, livestock management, domestic dog management, awareness programmes and habitat restoration.
9. Strengthen health and disease surveillance by assessing parasites, pathogens, stress, nutritional condition and reproductive health and by investigating disease transmission among leopards, livestock, domestic animals and wild prey.
10. Integrate ecological and socioeconomic information through community surveys and spatial analysis to understand human perceptions, tolerance, livestock losses and factors influencing coexistence.

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