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Human-Wildlife Conflict as a Hazard in Uttarakhand (India): Consequences, and Mitigation

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Abstract

Human-wildlife conflict has escalated into a critical socio-ecological hazard in the Himalayan state of Uttarakhand, severely impacting biodiversity conservation and rural livelihoods. This study examines HWC trends (2020–2023) and local perceptions in conflict hotspots, including Alakhnanda Ghati and the Rajaji-Corbett corridor. Integrating secondary data from the Uttarakhand Forest Department with a primary survey (n=42), the research highlights a rising fatality rate, and focus on human wildlife co-existence. Survey results reveal that 83.3% of residents perceive wild animals as a continuous threat, and a significant majority identify HWC as a primary driver of rural-urban out-migration. While leopards and monkeys are the most disruptive species, locals attribute the conflict to increasing social interference in wildlife habitats and a perceived "reluctant" government response. The study concludes that current reactive measures are insufficient and calls for structural interventions such as solar fencing and community-led habitat restoration.

Keywords: Human-wildlife conflict, Migration, Likert scale perception, Uttarakhand, Leopard-monkey conflict.

Research Background

Existing study underscores that the conceptualization of these interactions has shifted from a strictly adversarial "conflict" framework toward a nuanced spectrum of coexistence, acknowledging the interplay of biological, ecological, and societal. Researchers increasingly emphasize that technical damage-reduction measures, while necessary, are insufficient if they fail to address the underlying socio-cultural drivers and institutional power imbalances that dictate local community attitudes[1,2]. In the rugged terrain of the Indian Western Himalayas, the intersection of human development and wildlife corridors has led to chronic human-wildlife conflict[3]. The diverse topographical features of Uttarakhand, characterized by altitudinal gradients and fragmented forest patches, create dynamic interfaces where large carnivores and humans must balance resource acquisition against the risks of encounter[4]. Consequently, landscape-level conservation strategies must prioritize habitat management and the restoration of prey bases within core forests to effectively discourage wildlife encroachment into human-dominated areas[5].

In regions like the Himalayas, this phenomenon is further complicated by the spatial heterogeneity of risks, where individual home ranges of large carnivores often extend well beyond the borders of designated protected areas[6]. These conflicts are increasingly driven by habitat fragmentation and "social interference"—anthropogenic activities like grazing, mining, and infrastructure development that encroach upon traditional wildlife areas[7]. Hill states like Jammu and Kashmir, Uttarakhand and Himachal Pradesh are more prone to human wildlife conflicts and both day time and night time incidents are reported. In Jammu and Kashmir (2015-2021), 19% HWC encounters were reported in day time and 5.5% incidents reported in night time[8]. Beyond immediate physical harm, HWC acts as a powerful "push factor" in mountain regions, accelerating the abandonment of agro-pastoral lands and permanent out-migration to urban centres[9,10].

Literature Review

Studies indicate that the perception of threat and the reality of livestock depredation often diverge, creating disparities in how rural versus urban populations prioritize conservation objectives[11]. This divergence is exacerbated by the asymmetric distribution of risks, where rural residents bear the direct costs of living in close proximity to predators while receiving minimal tangible benefits from conservation initiatives. Unlike lowland regions, the Himalayan mid-hills experience unique dynamics involving leopards, wild boars, and monkeys that cause significant economic instability and human fatalities. These recurrent depredation events are increasingly linked to shifts in the local livestock economy and rigid protected area management strategies, which collectively erode community tolerance for wildlife presence[12]. Retaliatory actions against carnivores often function as a misguided attempt to safeguard limited assets, inadvertently perpetuating a cycle of instability that threatens both local livelihoods and biodiversity[13].

Research Gap: Rural regions people co-existence with wildlife have become a crucial issue that only could not be resolved by the Govt. but specific mitigation strategies and the opinion of

the locals may help better to overcome with this hazard.

Objectives: To examine the human wildlife conflicts in rural region of Uttarakhand. To know the perception of local people on the reasons behind Increasing Human wild life conflicts in Uttarakhand and suggest mitigation ideas.

Methodology

Study Area and Data: Site and data collection: the database was collected from the primary and secondary sources. We included resident's views in our studies to get more appropriate information. Primary data was gathered through a structured online questionnaire using Google Forms. Respondents were based on probability sampling as we selected the residents of some specific regions in Uttarakhand like Alakhnanda Ghati region (Srinagar 30.22°N & 78.78°E, Kirti Nagar 30.21°N & 78.74°E), Narendra Nagar region (Hindolakhal 30.23°N & 78.60°E, Chamba 30.34°N & 78.39°E) and Bhilangana Ghati region (Deo Prayag, 30°08’46’’N, 78°35’53’E).

Alakhnanda Ghati (Chamoli-Tehri-Pauri Garhwal), and the Narendra Nagar region. These areas have experienced a significant increase in HWC incidents in recent years, primarily due to their proximity to dense forests and suitable wildlife habitats. Villages such as Paini, Nand Prayag, Deval, Karn Prayag, Langsu, Pokhari, Kaleshwar, Khairi, Phakot, Naikhari, Gaja, Hindolakhal, and Chamba are particularly vulnerable, frequently reporting leopard attacks on both livestock and humans. The Rajaji-Corbett corridor serves as a vital ecological passage for tigers, leopards, nilgai, and various bird species, intensifying the risk of conflict. This study analyses recent trends, the underlying causes, and the consequences of recurrent human-wildlife conflicts in Uttarakhand.

A limited set of targeted questions was posed to local residents regarding the nature and extent of human-wildlife conflicts, focusing on areas most affected by leopards and other wildlife, perceptions of increased leopard activity, and the adequacy of government support following attacks on people and livestock. Secondary data were sourced from a diverse range of reputable outlets, including official government websites (e.g., forest.uk.gov.in, government reports, newspapers (e.g., Times of India), local news channels, and regional academic platforms (e.g., Garhwalpost.in). This comprehensive approach ensured a robust and detailed analysis of human-wildlife conflict in the selected regions of Uttarakhand.

The study emphasized a detailed trend analysis of injury and fatality cases from 2020 to 2023. Statistical methods, including the calculation of means and the application of the Pearson correlation coefficient, were used to examine relationships between incident rates and compensatory payments. Data visualization techniques, such as simple bar diagrams, composite bar graphs, scatter plots generated using Word and Excel were employed to illustrate key trends and comparisons. Pearson formula was used to calculate correlation (r) :

$$r = \frac{\sum (dxdy)}{\sqrt{\sum dx^2 \times \sum dy^2}}$$

Where: dx: deviation of x from its mean (x-\bar{x}), dy: deviation of y from its mean (y-\bar {y}), Sum (dxdy): sum of the product of deviations (covariance numerator), Sum dx^2: sum of squared deviations of x (variance of x), Sum dy^2: sum of squared deviations of y (variance of y)

Survey Design and Questionnaire: A primary survey (n=42) was conducted using a 5-point Likert scale to gauge community sentiment. Key variables included: Safety Perception: "Are wild animals harming people continuously in your village/region?" Migration Drivers: "Is wildlife interaction responsible for rural-urban migration?" Causality: "Do you consider HWC due to social interference in animal habitats?" Government Efficacy: "Is the government's reluctant aspect responsible for persistent conflict?" Infrastructure: "Is the lack of fencing a primary reason for conflict?"

Results and Discussion

Trends and Statistical Analysis: Secondary data reveals that while leopard attacks remain a primary source of human fatalities (approx. 30%), tiger attacks and snakebites have seen localized spikes. Statistical correlation shows that death and injury cases are moderately tied to compensation disbursement (to), suggesting the system is purely reactive rather than preventive.

Questionnaire Findings: The survey results indicate deep-seated community distress.

Table-1: Community Perception of HWC (N= 42).

Questionnaire Variable	Predominant Response	Contextual Finding
Hazard Frequency	Strongly Agree	83.3% stated animals harm people continuously.
Migration Link	Yes/Agree	Respondents identified HWC as a key driver for leaving villages.
Primary Species	Leopard & Monkey	Leopards threaten lives; monkeys devastate agriculture.
Root Cause	Social Interference	Majority agree that human expansion into wild areas triggers HWC.
Conflict Trend	Increasing	Perception that interactions are rising annually
Govt. Performance	Reluctant/Inadequate	Perception of government apathy toward mountain safety.
Mitigation Gaps	No Fencing	Residents pointed to the lack of physical barriers (fencing) as a failure.

Table-2: Human wildlife conflicts incidents in Uttarakhand due to wildlife attacks (2020-2023)[19].

Wilds	2020		2021		2022		2023	
	Deaths	Injuries	Deaths	Injuries	Deaths	Injuries	Deaths	Injuries
Leopard	30	100	23	98	22	99	18	100
Snake	19	58	30	119	30	113	25	138
Elephant	10	11	13	17	09	13	05	07
Bear	03	99	02	95	01	57	0	53
Tiger	01	10	02	08	16	10	17	09
Wild Boar	03	45	01	22	0	29	01	07
Crocodile	01	01	0	01	04	04	0	08

The Leopard-Monkey Dichotomy: While leopards account for high human mortality, 91.7% of respondents identified monkeys as the most persistent threat to economic stability. Furthermore, 91.7% of locals believe these monkeys were artificially released from research or urban facilities, exacerbating social tensions and mistrust in wildlife management.

Table-3: Compansatory action by Forest department (session of 2020-21 to 2023-24)[19]

Year	Incidents	Distributed amount (in lacs)
2020-21	Human death 67	243.8
	Human injuries 324	82.84
	Total 391	326.64
2021-22	Human death 71	365.28
	Human injuries 361	91.39
	Total 432	456.67
2022-23	Human death 82	286.62
	Human injuries 325	78.7
	Total 407	365.32
2023-24 (till Dec. 2023)	Human death 66	189.200
	Human injuries 325	45.814
	Total 391	235.014
All Total		1383.644

Table-4: Statistical Analysis (Correlation of HWC incidents and provided compensation amount).

Parameter	Death Cases	Injury Cases
Mean ((\bar{x}))	71.5	333.75
Mean Compensation ((\bar{y}))	271.315	74.6865
Correlation Numerator	783.2	2597.06
Correlation Denominator	1636.2	4356.06
Correlation Coefficient (r)	0.47	0.59

Table-5: Interpretation of Statistical analysis.

Case Type	r Value	Strength	Interpretation
Death Cases	0.47	Moderate	There is a moderate positive relationship between the number of death cases and compensation. As death cases increase, compensation tends to increase, but not perfectly.
Injury Cases	0.59	Moderate to Strong	A stronger positive relationship compared to death cases. As injury cases increase, compensation also tends to increase more consistently.

Discussion: Uttarakhand, which recorded 64 fatalities in 2023 alone, faces a crisis where annual deaths have more than doubled since the early 2000s[14,15]. The finding that HWC drives migration aligns with broader research suggesting that "environmental hazards" (including wildlife) are now comparable to lack of education as a reason for mountain depopulation. The community's perception of "social interference" is supported by evidence that degrading forest corridors forces animals into settlements.

The "reluctant" perception of government policy is often tied to the "Extreme Loss Perception" among marginal farmers, who feel that compensation (often delayed) does not cover the true emotional and economic cost of living in fear[16]. Furthermore, the lack of structural interventions like solar fencing—perceived by locals as a major failure—is echoed in studies showing that physical exclusion barriers are often the most requested but least effectively maintained government measures[17].

6,704 human-wildlife conflicts between 2000 and October 31, 2023, 1126 human deaths, and 5578 human injuries were noticed[18]. A total of 64 causalities, 14 due to leopard attacks, seven due to tiger attacks, three due to bear incidents, and 24 deaths due to snake bites were reported in the year 2023. Due to lack of immediate medical facilities or first aid in rural regions Snakebites injury and death cases are the highest, followed by leopard, elephant, tiger, wild boar, and others. The shrinking

pattern of agriculture led to barren land and shrubs increase near villages and that's why leopards has changes its place and timing. In most of region leopard has been seen mostly venturing in day time near to villages that allows negative encounters of human leopards. A forest department report also says that in Uttarakhand, 30% of all human deaths and injuries by wildlife were caused by leopards. Fatalities by leopard attacks decreased slightly from 2020 to 2023, but injury cases remain consistently high. Bear and wild attacks are fluctuating and moderate, while tiger and elephant injury attacks are comparatively lower but fluctuating. 2022 is the peak year for human fatalities as the ratio goes up to 82 fatalities in a year (Table-1)[19].

Notable instances, such as the attack on a resident of Chaubattakhal Block, Pauri Garhwal, and the fatal incident involving a 17-year-old near Devprayag, highlight the escalating frequency and severity of such encounters. Community responses have included public demonstrations and appeal to the forest department for more proactive measures, such as installing leopard traps and increasing monitoring, amid perceived governmental inaction.

Field observations and interviews underscore that HWC is particularly acute in regions adjacent to dense forests, such as Bhilangana Ghati and Alakhnanda Ghati. The proliferation of leopards in human settlements, including daytime sightings, has disrupted daily life, instilled fear, and negatively affected local economies and educational activities. Some residents attribute increased leopard presence to the release of zoo animals lacking natural hunting instincts, further exacerbating the situation.

Analysis of community interviews (N=66) and Titli Trust reports identify key drivers of conflict: depletion of wild prey, expansion of roads and settlements, changes in vegetation (notably decreases in lantana and eupatorium), reduced livestock rearing, and migration-driven declines in farming. Broader contributors include habitat loss, forest fires, large-scale infrastructure projects, and insufficient bio-fencing. These factors collectively increase the likelihood that wildlife will venture into human settlements in search of food and shelter.

The consequences of HWC extend beyond immediate physical harm, encompassing psychological distress, economic losses from crop and livestock depredation, and increased financial strain on government compensation schemes. Disruption of ecological balance through habitat destruction also forces wildlife into closer proximity with humans, heightening the risk of conflict.

In response, the government has implemented mitigation strategies such as bio-fencing, patrolling, camera traps, and drone surveillance. Community-based programs like "Living with Leopard," initiated in collaboration with NGOs, aim to enhance human preparedness and promote coexistence. However, the persistence of conflict indicates the need for more robust, integrated approaches that address both ecological and socio-economic dimensions of HWC in Uttarakhand[20].

Human wild life coexistence is necessary for a healthy environment, still most of the research papers survey finds it difficult. People are in favour of killing wildlife to be in a safer side, people also consider negative action while protecting wildlife without the proper management[21].

Compensation is considered as a mitigation strategy of government; it strengthens the co-existence of human wildlife. Sometimes it is also considered a financial burden to the government of any state that's why sometimes compensation is delayed or do not justify its amount with regard to incidents[22]. Compensation decreased in 2023-24 and that correlates with reduced injury or death incidents. The highest compensation amount was disbursed in 2021-22 as this year had the highest injury and death cases. 1383.84 lacs were disbursed as Compensation for injured and death cases from 2020 to 2024 (Table-2). Another source says that the Uttarakhand government increased the amount of Compensation to the fatality's family from 3 lakh to 6 lakh. Where injured people get 3 lakh compensatory money, and 6 lakh is given to an expired person's family[23].

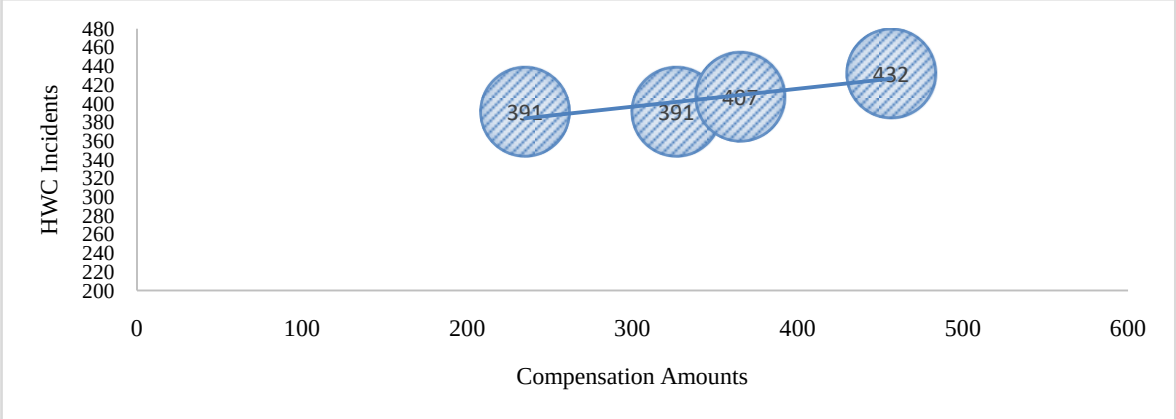


Figure-1: Scattered diagram of HWC incidents and provided compensation amount.

Conclusion

Human-wildlife conflict in Uttarakhand is intensifying, with leopards, elephants, wild boars, and bears posing significant risks to local communities. Government compensation schemes have not sufficiently reduced the incidence or impact of injuries and fatalities. Sustainable solutions require community involvement, habitat restoration, and improved forest management to minimize conflict and promote coexistence. HWC in Uttarakhand has evolved from an ecological management issue into a humanitarian hazard. The community survey highlights three critical areas for policy reform. Urgent installation of solar and bio-fencing to provide immediate safety.

Restoring forest corridors and removing invasive species like *Lantana* to reduce the need for wildlife to enter villages. Moving away from a "reluctant" top-down approach toward community-led *Van Panchayat* management, which can increase local tolerance and improve early warning systems.

Without these integrated steps, HWC will continue to fuel the depopulation of the Uttarakhand Himalayas, undermining both regional development and conservation goals.

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