

HABITAT DEGRADATION AND INCREASING HUMAN-WILDLIFE CONFLICTS IN HIMACHAL PRADESH: A REVIEW

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ABSTRACT

This review paper focuses on the unique context of Himachal Pradesh, a region characterized by rich biodiversity, where the intricate interplay of habitat degradation and rising human-wildlife conflicts poses significant challenges. Himachal Pradesh's diverse ecosystems, from alpine meadows to dense forests, are undergoing rapid transformation due to human activities, such as agricultural expansion, infrastructure development, and changing land-use patterns. As a consequence, the fragile balance between the state's indigenous flora and fauna and its expanding human population is increasingly strained. This study explores the multifaceted drivers of habitat degradation, encompassing increasing population, urbanisation, deforestation for agriculture, industrial expansion, infrastructure development, unsustainable tourism, grazing and climate change. Additionally, it explores the escalating instances of human-wildlife conflicts, including encounters with species like leopards, bears, monkeys and ungulates, which have become more frequent in human-settled areas. Through an extensive review of literature, case studies, relevant data and news media, this review paper seeks to provide a comprehensive understanding of the intricate web connecting habitat health, human activities, and the increasing frequency of conflicts with wildlife in state.

The findings of this study contribute valuable insights into the region-specific challenges and opportunities for mitigating habitat degradation and human-wildlife conflicts in Himachal Pradesh. The proposed strategies encompass habitat conservation measures tailored to the region's unique ecosystems, community-based approaches to foster coexistence, and the development of region-specific policies and management practices. By addressing the nuances of this Himalayan state, this research aims to inform policymakers, conservationists, and local communities, facilitating the formulation of targeted interventions that promote both biodiversity conservation and the well-being of the human population in Himachal Pradesh.

KEY WORDS

Habitat, Human Wildlife conflicts, population, urbanisation, agriculture, infrastructure development, unsustainable tourism, grazing, climate change

INTRODUCTION

(i) Background

Himachal Pradesh, with its rich biodiversity and unique topography, has long been a refuge for a variety of wildlife species. The state's ecosystems encompass a rich tapestry of flora and fauna, contributing significantly to India's overall biodiversity. In the alpine meadows and coniferous forests of Himachal Pradesh, one can find a plethora of plant species, including endemic and rare varieties such as *Rhododendron arboreum*, *Aconitum heterophyllum*, and *Saussurea obvallata*¹. The region is also home to charismatic fauna, with notable mentions including the elusive snow leopard (*Panthera uncia*), Himalayan tahr (*Hemitragus jemlahicus*), and the Western Tragopan (*Tragopan melanocephalus*), an endangered pheasant species². The state's ecosystems play a crucial role in maintaining ecological balance and providing numerous ecosystem services. However, with increasing human activities and climate change, the region is facing unprecedented challenges that threaten its biodiversity. The state has been grappling with severe habitat degradation, a complex issue driven by a confluence of anthropogenic activities and climate change. The state's once-pristine ecosystems are facing unprecedented challenges, with deforestation and land-use changes emerging as primary contributors¹. Extensive logging, agricultural expansion, and rapid urbanization have led to the fragmentation and loss of critical wildlife habitats, disrupting the delicate balance that sustained the region's biodiversity for centuries¹. Climate change further exacerbates habitat degradation in Himachal Pradesh, with rising temperatures, altered precipitation patterns, and glacial retreat adversely impacting ecosystems². The fragility of alpine ecosystems and the intricate web of species interdependencies make them particularly susceptible to such environmental shifts². Additionally, infrastructure development, including roads and dams, further intensifies habitat degradation by fragmenting landscapes and impeding wildlife corridors³. These factors collectively contribute to habitat loss and fragmentation, disrupting the natural balance and pushing wildlife into closer proximity with human settlements. The altered landscapes and reduced availability of natural resources have intensified conflicts between humans and wildlife, leading to an alarming increase in instances of crop depredation, livestock predation, and direct encounters⁴. The loss of habitat forces wildlife to seek sustenance in cultivated fields and human habitations, exacerbating the potential for conflicts⁴. Moreover, the expanding network of roads and infrastructure projects has further fragmented habitats, impeding the traditional migration corridors of many species and escalating confrontations with humans⁵.

(ii) Objectives of the Review

This study explores the multifaceted drivers of habitat degradation, encompassing increasing population, urbanisation, deforestation for agriculture, industrial expansion, infrastructure development, unsustainable tourism, grazing and climate change. Additionally, it explores the escalating instances of human-wildlife conflicts, including encounters with species like leopards, bears, monkeys and ungulates, which have become more frequent in human-settled areas. Through an extensive review of literature, case studies, relevant data and news media, this review paper seeks to provide a comprehensive understanding of the intricate web connecting habitat health, human activities, and the increasing frequency of conflicts with wildlife in state. It will also try to explore the ecological, social, and economic impacts of these conflicts and propose recommendations for sustainable habitat conservation and conflict mitigation.

2. Habitat Degradation in Himachal Pradesh

Himachal Pradesh's diverse ecosystems, from alpine meadows to dense forests, are undergoing rapid transformation due to human activities, such as agricultural expansion, infrastructure development, and changing land-use patterns. As a consequence, the fragile balance between the state's indigenous flora and fauna and its expanding human population is increasingly strained. This study explores the multifaceted drivers of habitat degradation, encompassing increasing population, urbanisation, deforestation for agriculture, industrial expansion, infrastructure development, unsustainable tourism, grazing and climate change.

(i) Increasing Population:

The population of Himachal Pradesh has increased from 23.86 lakhs (1951) to approx. 75.70 lakhs (2021 projected) in last 70 years (Figure 1). The escalating population growth in Himachal Pradesh has profound implications for its natural habitats, placing them under increasing pressure due to urbanization, infrastructure development, and expanding agricultural activities. The state's picturesque landscapes, characterized by diverse ecosystems, are experiencing habitat degradation and fragmentation as a consequence of anthropogenic activities driven by a rising population¹. Rapid urbanization and the demand for housing and amenities lead to the conversion of pristine habitats into urban landscapes, contributing to habitat loss⁶. Additionally, the expansion of agricultural land to meet the food requirements of the growing population results in deforestation and further habitat fragmentation⁷. These trends underscore the urgent need for sustainable development policies that balance the needs of a burgeoning population with the imperative to preserve Himachal Pradesh's unique biodiversity.

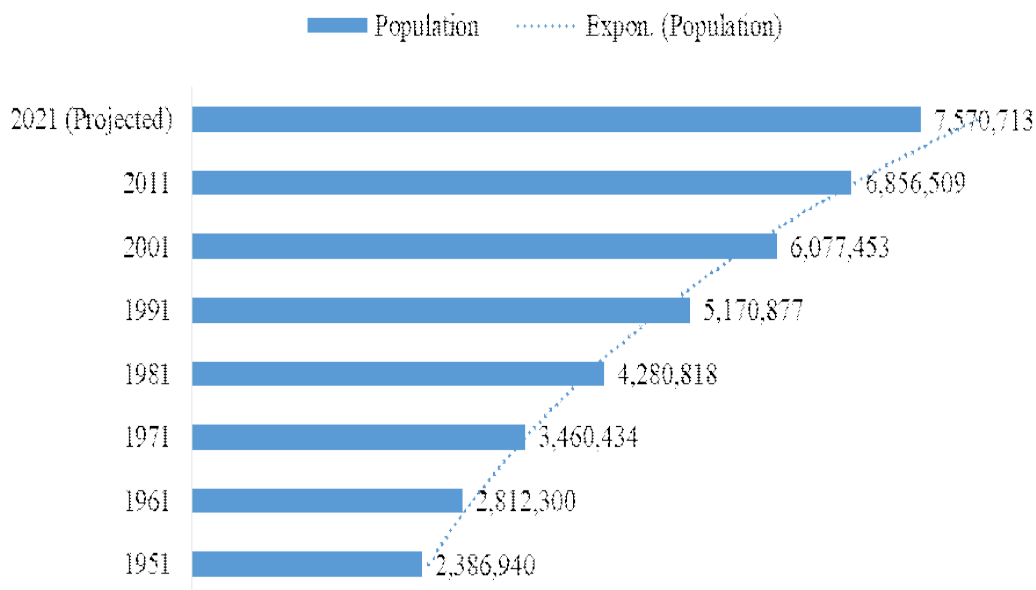


Figure 1: Population Growth in Himachal Pradesh (1951-2021)

(ii) Urbanisation

With the increase of state's population the human settlements have increased considerably since last 70 years. There were 29 towns in 1951 which almost doubled in 2021 with total 59 townships in state (Table 1). The urban population of state although least in country, but increased considerably from 4.06 % to 12.25 % (approx.) from 1951 to 2021. Not only towns but the number of villages also increased from 8382 to 17882. The rapid urbanization in Himachal Pradesh has brought about significant transformations in the state's natural habitats, with profound implications on biodiversity and ecological balance. Urban expansion, driven by a growing population and increasing developmental needs, results in the conversion of pristine landscapes into built environments, leading to habitat loss and fragmentation⁶. Infrastructure projects associated with urbanization, such as roads and settlements, disrupt critical wildlife corridors, impacting the movement patterns of species and exacerbating human-wildlife conflicts⁵. Additionally, urbanization contributes to soil sealing, altering hydrological cycles and affecting the availability of water resources, further stressing the delicate ecosystems of Himachal Pradesh⁸.

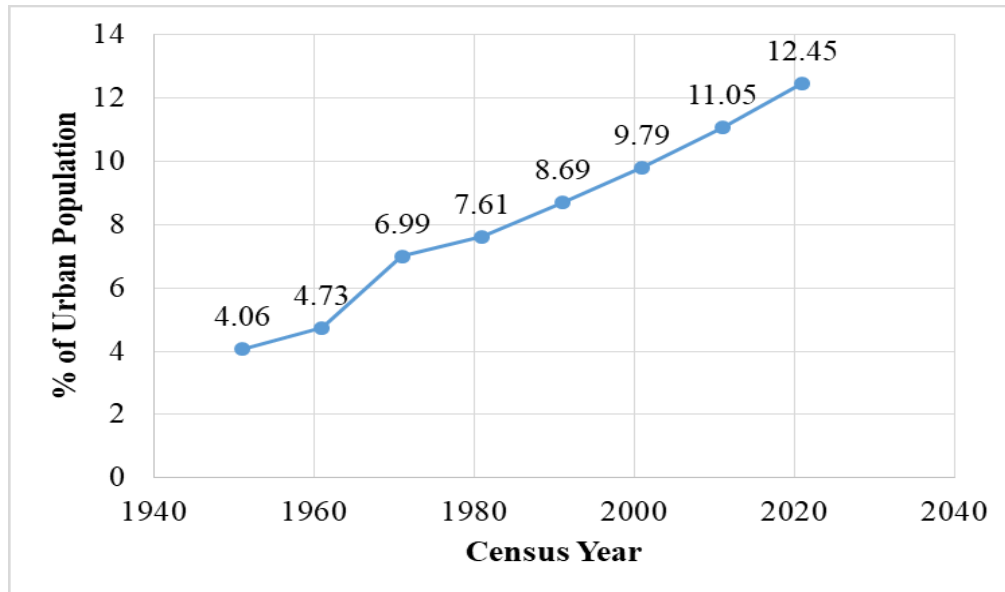


Figure 2: Percentage of Urban Population in Himachal Pradesh (1951-2021)

Year	Number of towns	Number of Villages
1951	29	8384
1961	30	10438
1971	36	16916
1981	47	16807
1991	58	16997
2001	57	17495
2011	59	17882
2021	59	17882

Table 1: Towns and Villages in Himachal Pradesh (1951-2021)

(iii) Agriculture

The state's economy is agriculture based and to cater the food requirements of increasing population the total cropped area has also increased from 406.3 Ha in 1950-51 to 944 Ha in 2021-22. Agricultural expansion in Himachal Pradesh has contributed to significant alterations in biodiversity and habitats, presenting a complex interplay of ecological consequences. As demands for food production escalate with the burgeoning population, traditional agricultural practices often encroach upon forested areas, leading to deforestation and habitat loss⁷. The conversion of natural habitats into agricultural landscapes disrupts the delicate balance of ecosystems, impacting plant and animal species dependent on these environments⁷. Furthermore, the use of pesticides and fertilizers in agriculture can result in soil and water contamination, affecting both terrestrial and aquatic biodiversity⁹. Sustainable agricultural practices that prioritize biodiversity conservation, such as agroforestry and organic farming, are crucial for mitigating the adverse impacts of agriculture on Himachal Pradesh's unique ecosystems.

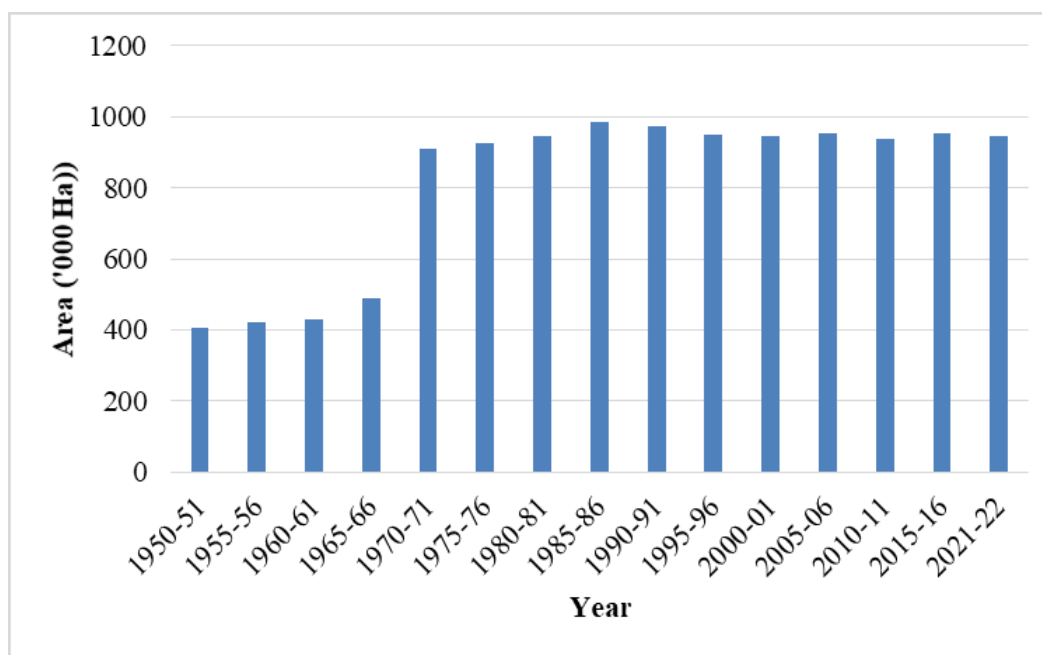


Figure 3: Area under Cultivation in Himachal Pradesh (1951-2021)

(iv) Road Development:

The extensive road development in Himachal Pradesh from merely 288 kms in 1951 to more than 40,000 kms in 2021, driven by the need for connectivity and infrastructure improvement, has emerged as a significant factor contributing to habitat degradation and fragmentation. Since last few years construction of four-lane national highways in Himachal Pradesh has brought about significant and multifaceted impacts on the region’s habitat and biodiversity. The construction of roads leads to the conversion of natural habitats into linear corridors, disrupting the ecological connectivity of landscapes and impeding wildlife migration routes⁵. Additionally, the associated activities such as earth excavation and land clearing for road widening result in direct habitat loss¹⁰. Fragmentation caused by roads not only isolates populations of various plant and animal species but also increases the vulnerability of wildlife to vehicular accidents and human disturbances¹¹.

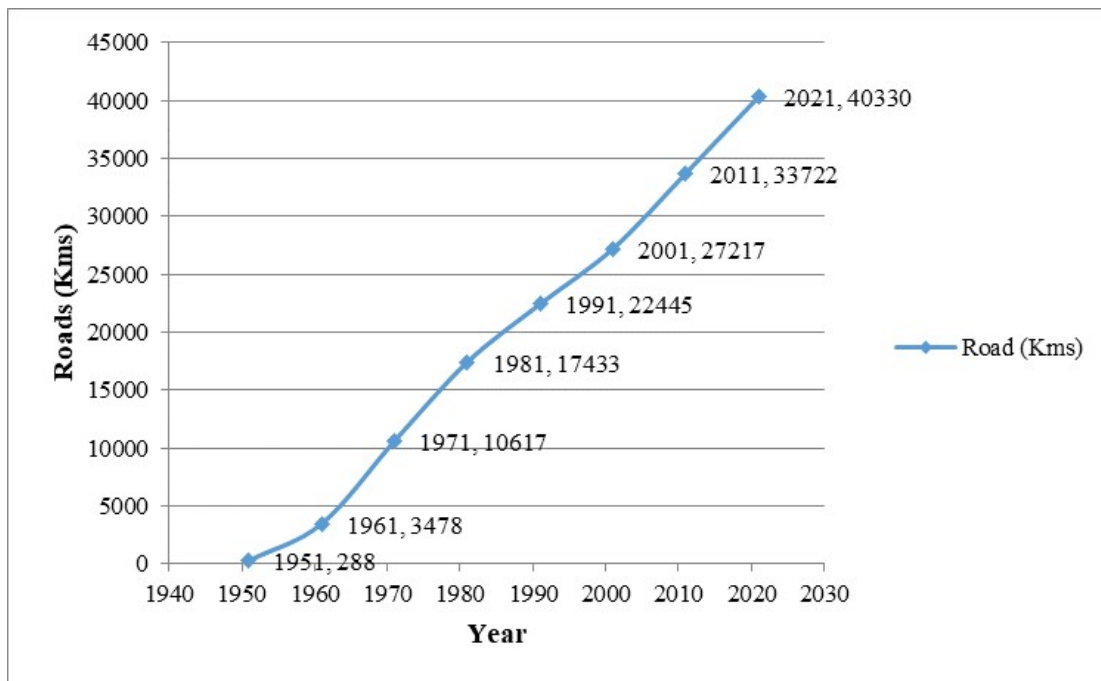


Figure 4: Road Development in Himachal Pradesh (1951-2021)

(v) Tourism:

The number of tourists visiting state in 2022 was more than double from year 2005 (**Figure 5**). Due to COVID pandemic the number of tourists decreased considerably in year 2020 and 2021 but have increased again last year. The burgeoning tourism industry in Himachal Pradesh, while contributing significantly to the state's economy, has brought about notable impacts on its delicate habitats and biodiversity. The influx of tourists has led to increased infrastructure development, including hotels, resorts, and recreational facilities, resulting in habitat fragmentation and loss⁵. The establishment of trekking trails and tourist pathways can disrupt wildlife habitats and breeding grounds, influencing the behavior and distribution of species¹². Additionally, the rise in waste generation associated with tourism poses a threat to local ecosystems, impacting water quality and soil health¹³. The heightened human activity, including noise and disturbance, can contribute to altered animal behaviors and increased stress on wildlife populations¹⁴.

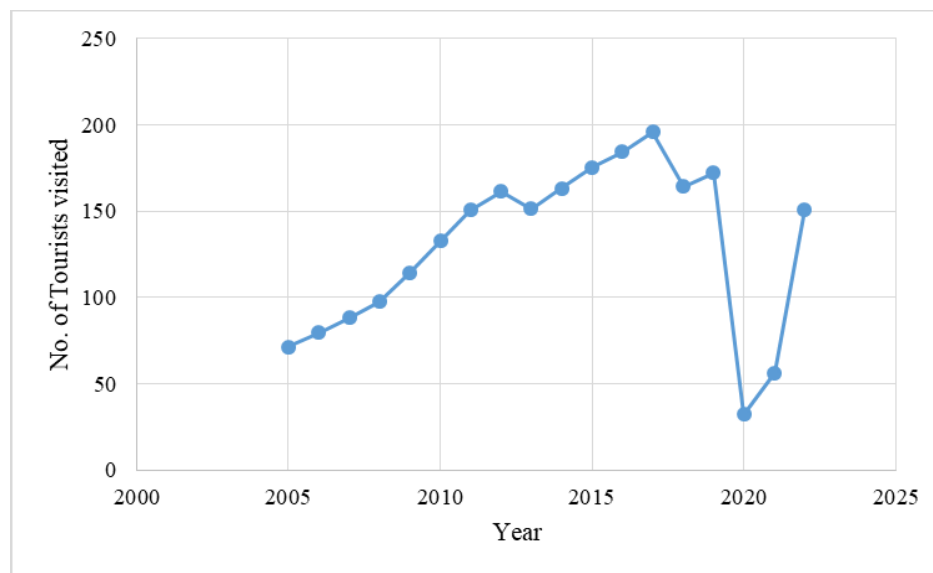


Figure 5: No. of Tourists visited in last 18 years (2005-2022) in Himachal Pradesh

(vi) Deforestation and Land Use Changes

The extensive logging and conversion of forested areas for agriculture, infrastructure development, and urbanization have significantly contributed to habitat degradation in

Himachal Pradesh. Deforestation and land use changes in Himachal Pradesh have significantly altered the region's landscape and posed grave threats to its biodiversity. The conversion of forested areas for agriculture, urbanization, and infrastructure development has led to widespread habitat loss and fragmentation, disrupting the intricate balance of ecosystems⁵. This degradation of natural habitats directly impacts the diverse flora and fauna endemic to the region, reducing species richness and altering species composition. Furthermore, deforestation diminishes the ecosystem services provided by forests, such as carbon sequestration, soil stabilization, and water regulation, leading to adverse effects on the overall ecological health of Himachal Pradesh². The loss of forest cover also exacerbates the risk of soil erosion, landslides, and floods, particularly in hilly terrains, posing threats to human settlements and further exacerbating environmental degradation⁶.

(vii) Climate Change

The Himalayan region is highly vulnerable to the impacts of climate change, including rising temperatures, changing precipitation patterns, and glacial retreat.

Climate change in Himachal Pradesh is manifesting through various observable impacts, including altered precipitation patterns, rising temperatures, and changes in the frequency and intensity of extreme weather events. These shifts in climatic conditions are exerting significant pressures on the region's biodiversity and habitats. Changes in temperature and precipitation regimes influence the distribution and abundance of plant and animal species, leading to shifts in ecosystems and changes in species composition¹⁵. Furthermore, the retreat of glaciers and changes in snowmelt patterns affect water availability, particularly during the dry season, which can have cascading effects on aquatic ecosystems and the species dependent on them¹⁶. The increased frequency of extreme weather events, such as floods and landslides, poses direct threats to biodiversity and habitats, leading to habitat destruction, loss of habitat connectivity, and the displacement of species¹⁷.

3. Human-Wildlife Conflicts in Himachal Pradesh

(i) Overview of Human-Wildlife Conflicts

Human-wildlife conflicts have emerged as a significant challenge in Himachal Pradesh, India, owing to the region's rich biodiversity and the increasing encroachment of human activities into wildlife habitats. As human populations expand and urbanization encroaches upon natural landscapes and habitats, interactions between humans and wildlife become inevitable, leading to conflicts over resources, territory, and safety⁴. The state's diverse array of wildlife, including species such as leopards, bears, monkeys, and ungulates,

often come into direct contact with humans, resulting in incidents of crop depredation, livestock predation, property damage, and occasional attacks on humans¹¹. These conflicts not only pose risks to human safety and livelihoods but also threaten the conservation of wildlife populations and their habitats, thereby necessitating effective management strategies that balance the needs of both humans and wildlife.

(ii) Spatial and Temporal Patterns

Analyzing the spatial and temporal patterns of human-wildlife conflicts is crucial for understanding the dynamics of these interactions. Certain regions in Himachal Pradesh experience higher incidences of human-wildlife conflicts due to proximity to wildlife habitats and agricultural areas. A study identified hotspot areas in Kangra and Mandi districts where conflicts with leopards and bears are prevalent due to agricultural encroachment into forested lands¹⁸. Conflict occurrences vary with the type of wildlife present and their habitat preferences. Leopards (*Panthera pardus*) are often involved in conflicts in areas like Shimla and Solan districts, where forest fragmentation has intensified interactions with human settlements¹⁸. Villages and towns situated near forest fringes or wildlife corridors are particularly susceptible to conflicts. The Himachal Pradesh Forest Department's annual reports highlight conflicts escalating in peri-urban areas like Hamirpur, where increased urbanization and agricultural expansion intersect with wildlife territories.

Conflicts exhibit distinct seasonal patterns influenced by wildlife behaviour and human activities. During the crop season (summer and autumn), conflicts peak as herbivores such as wild boars and monkeys raid agricultural fields¹⁸. Winter months see heightened conflicts with large carnivores like leopards and occasional snow leopards as prey availability decreases in higher altitudes¹⁹. Nocturnal animals like leopards and jackals frequently cause conflicts during night-time, while diurnal species such as langurs and macaques may create issues during daylight hours¹⁸. As per the compensation scheme data available with the HP Forest Department for attacks on human by wildlife in last 21 years (2000-2021), monkeys holds the top place with approximately 69% of the cases followed by leopard and bear accounting for 12% cases each and wild boar for 6% of the cases, other species like fox, jackal, monkey holds very few cases of human attacks as given in Figure 6. In last 21 years (2000-21), a total number of 92 human deaths, 3617 human injuries and 15 cases of permanent incapacitation have been reported due to wildlife attacks as per the compensation schemes data available with the HP Forest Department (Figure 7). However, these are only reported cases and the actual number of cases may be even higher.

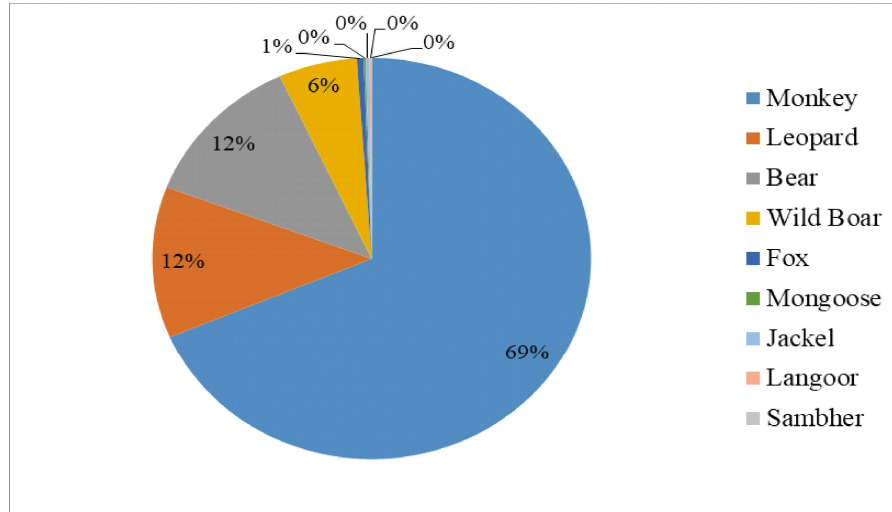


Figure 6: Wild animals involved in human attacks

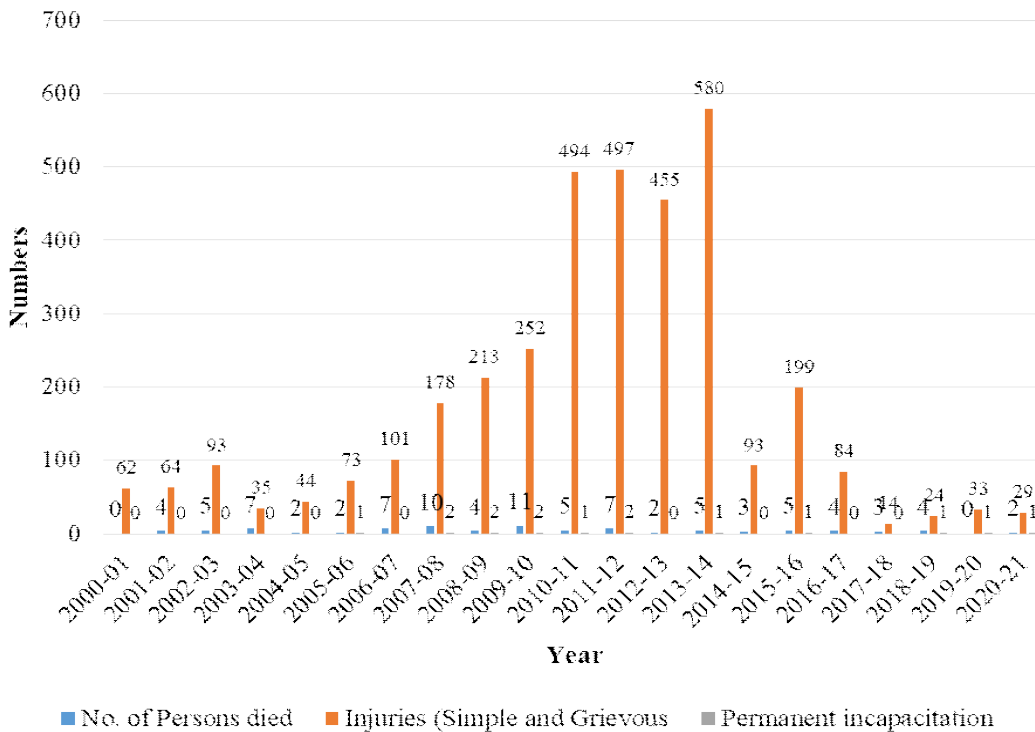


Figure 7: Human Death/Injury due to Wildlife attacks in last 21 years (2000-2021)

(iii) Ecological Impacts

Human-wildlife conflicts have cascading effects on the ecological balance of the region. Here we will discuss the impacts of conflicts on wildlife populations, species interactions, and the overall health of ecosystems. Direct conflict incidents often result in injuries or fatalities among wildlife species, particularly large carnivores like leopards and bears²⁰. Continuous disturbances from human activities can disrupt natural behaviours such as feeding, breeding, and migration patterns, leading to long-term stress and reduced reproductive success²¹. Human settlements and agricultural expansion into wildlife habitats cause fragmentation, reducing available space for wildlife and increasing their vulnerability to conflicts²¹. Loss of connectivity between habitats due to infrastructure development or land-use changes further isolates wildlife populations, impacting genetic diversity and resilience¹⁸. Intense predation pressure on livestock due to reduced natural prey availability can lead to imbalances in predator-prey relationships within ecosystems²⁰. Changes in wildlife behaviour and population dynamics can disrupt local food webs and ecosystem processes, affecting biodiversity and ecosystem stability¹⁸.

(iv) Social and Economic Impacts

The section will examine the social and economic consequences of human-wildlife conflicts on local communities. Direct encounters with wildlife, particularly large carnivores like leopards and bears, can result in injuries or fatalities among villagers and tourists²⁰. Persistent fear of wildlife attacks affects daily activities and mental health, especially among vulnerable groups such as children and elderly¹⁸. Sometimes communities may be forced to relocate due to repeated wildlife conflicts, disrupting social networks and community cohesion¹⁸. The crop raids by herbivores and predation on livestock can lead to significant economic losses for farmers, exacerbating poverty and food insecurity²¹. Wildlife conflicts can also challenge traditional agricultural practices and cultural norms related to coexistence with wildlife¹⁸. Species-specific conflicts may threaten cultural practices and local knowledge associated with wildlife conservation and traditional beliefs²¹.

Wildlife raids on agricultural crops can lead to substantial economic losses, particularly in rural areas where agriculture is a primary livelihood²⁰. Losses from livestock predation by carnivores further strain household incomes and agricultural productivity²¹. Investment in fencing, guard animals, and other preventive measures to reduce conflict risks entail additional costs for communities and local governments¹⁸. Compensation schemes for crop and livestock losses, although essential, can strain local budgets and delay economic recovery²¹. As per the compensation scheme data available with the HP Forest Department for cattle/livestock depredation by wildlife in last 21 years (2000-2021), approximately 26,652 livestock has been killed and 10,229 livestock lost due to wildlife attacks. However, these

are only reported cases and the actual number of cases may be even higher.

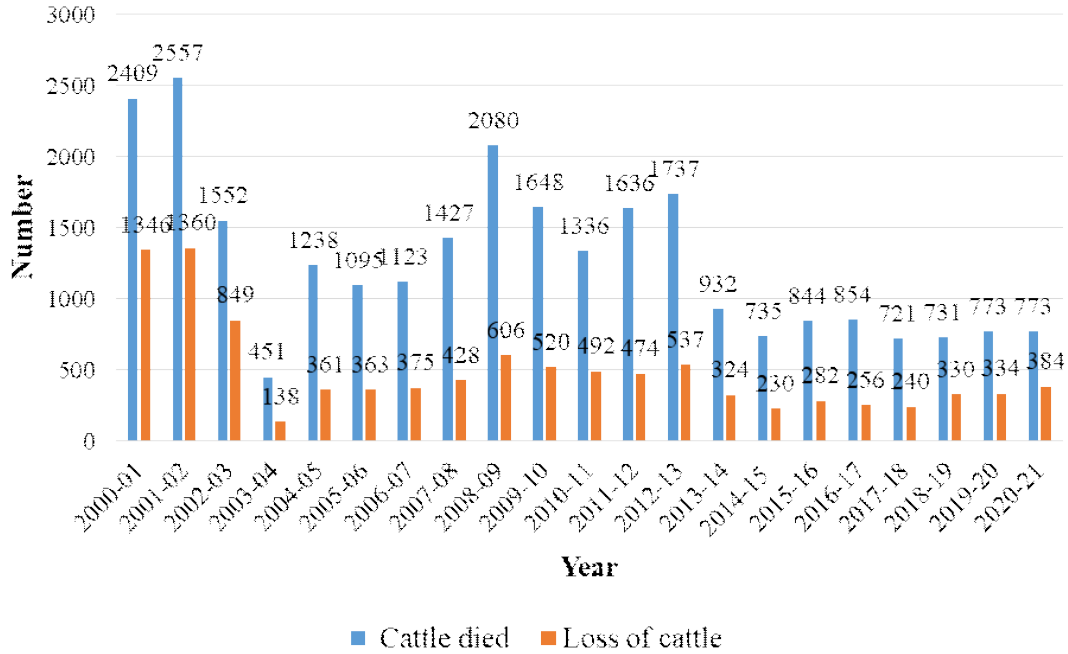


Figure 8: Livestock death/loss in last 21 years (2000-2021)

4. Management Strategies for human wildlife conflict mitigation and management:

(i) Community-Based Conservation

Engaging local communities in conservation efforts is essential for the success of any management strategy. Community-based conservation (CBC) measures play a vital role in mitigating human-wildlife conflicts in Himachal Pradesh by involving local communities in conservation efforts and decision-making processes. Engaging local communities in wildlife monitoring and patrolling activities to track wildlife movements and behaviours is useful in early detection of potential conflicts and facilitates timely responses²². Further establishing village-level committees comprising local residents, forest department officials, and conservationists to discuss and address wildlife-related issues is helpful in devising localized strategies for conflict mitigation²³. Livelihood diversification by promoting alternative livelihood options such as ecotourism, handicrafts, and organic farming to reduce dependency on natural resources that might attract wildlife to human settlements is one of the best approaches to mitigate such conflicts²². Incorporating traditional ecological knowledge and practices of

local communities into conservation and management plans enhances the effectiveness of conservation measures and fosters a sense of ownership among community members²³. Capacity Building by providing training programs on wildlife conservation, conflict resolution, and sustainable resource management to equip local communities with necessary skills and knowledge is essential to deal with the issues of HWC²². Another method could be introducing and supporting community-driven crop protection measures such as scare tactics, crop diversification, and use of organic deterrents to minimize crop damage by wildlife²³.

(ii) Technological Interventions

Incorporating technological solutions, such as early warning systems, remote sensing, and data analytics, can enhance the efficiency of conservation and conflict management strategies. Installation of solar-powered electric fences around agricultural fields and human settlements to deter wildlife such as wild boars and monkeys has been effective in reducing crop damage and human-wildlife conflicts²². Planting thorny shrubs and trees around agricultural lands as bio-fence to create natural barriers that discourage wildlife from entering fields is particularly useful against herbivores like deer and wild ungulates²². Introducing guard dogs to protect livestock from predation by carnivores such as leopards and wolves helps in reducing livestock losses and thereby mitigates conflicts between villagers and wildlife²³. Implementation of compensation programs for farmers and villagers who suffer livestock depredation or crop damage due to wildlife helps in reducing negative attitudes towards wildlife and encourage local communities to support conservation efforts²².

Awareness and Education Programs through conducting workshops, seminars, and outreach activities among local communities about wildlife behavior, conservation importance, and effective mitigation strategies are crucial for fostering coexistence and reducing human-wildlife conflicts²³. Enhancing natural habitats within protected areas to ensure sufficient food and water sources for wildlife species helps reduce wildlife encroachment into human settlements in search of resources²².

(iii) Policy Recommendations

In Himachal Pradesh, addressing habitat conservation alongside human-wildlife conflict mitigation requires a balanced and evidence-based policy approach. Firstly, strategic habitat conservation efforts should prioritize maintaining and enhancing wildlife corridors and connectivity across landscapes²⁴. This approach ensures that wildlife populations can move safely between fragmented habitats, reducing the likelihood of conflicts with human settlements. Secondly, promoting sustainable agricultural practices such as crop diversification and the use of non-lethal deterrents like electric fencing can effectively mitigate human-wildlife conflicts²⁵. These measures not only protect agricultural yields but also contribute to minimizing negative interactions between humans and wildlife species.

Furthermore, community involvement is crucial; empowering local communities through participatory conservation initiatives can build support for habitat conservation efforts and foster coexistence²⁶. Strengthening the enforcement of wildlife protection laws and enhancing collaboration between government agencies, NGOs, and local communities are essential to ensure the effectiveness of these policies²⁷. By integrating these recommendations into policy frameworks, the state of Himachal Pradesh can advance sustainable development practices while conserving its rich biodiversity and reducing conflicts between humans and wildlife.

CONCLUSION

In conclusion, the escalating human-wildlife conflicts in Himachal Pradesh underscore the urgent need for integrated conservation strategies that address habitat degradation and mitigate conflicts effectively. Habitat loss and fragmentation due to developmental activities have significantly impacted wildlife populations, forcing them into closer proximity with human settlements. This spatial overlap has heightened conflicts, particularly concerning crop raiding and livestock depredation, thereby threatening both agricultural livelihoods and wildlife conservation efforts. To mitigate these challenges, it is imperative to prioritize habitat conservation through the establishment and maintenance of wildlife corridors and protected areas. Sustainable land-use planning that considers wildlife habitats alongside human needs is essential to minimize further habitat fragmentation. Additionally, promoting community-based conservation initiatives that empower local communities to coexist harmoniously with wildlife can foster stewardship and reduce negative interactions.

Moreover, enhancing compensation schemes and implementing non-lethal deterrents can mitigate economic losses for farmers while ensuring the protection of wildlife. Strengthening enforcement of wildlife protection laws and enhancing interdisciplinary collaboration between government agencies, NGOs, researchers, and local communities are critical steps toward achieving sustainable solutions. By addressing habitat degradation through comprehensive conservation strategies and promoting coexistence between humans and wildlife, Himachal Pradesh can strive towards safeguarding its biodiversity while securing the livelihoods of its residents for future generations. Effective implementation of these measures will be pivotal in mitigating human-wildlife conflicts and preserving the natural heritage of the region.

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