Research Article:

BITE INCIDENTS AND FARMER-REPORTED CROP DAMAGE BY RHESUS MACAQUES IN LANSDOWNE FOREST DIVISION, UTTARAKHAND, INDIA

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ABSTRACT

Monkeys play a crucial role in the ongoing conflict between humans and wildlife across the globe. This article examines the dynamics of human-monkey conflicts (HMC) within the Lansdowne Forest Division (LFD), drawing on data collected from 2015 to 2018 on reported bite incidents involving rhesus macaques (*Macaca mulatta*). Descriptive analysis showed that males aged 16 to 35 were more frequently involved in reported bite incidents compared to females of the same age group. Moreover, many respondents reported substantial local cropraiding; farmers-reported, perception-based estimates indicate that in some localities approximately 70% of the agricultural lands in the region have been affected by rhesus macaques foraging; these values were not validated by field measurements. Habitat destruction and improper disposal of human waste likely contribute to this conflict. To effectively address these issues, it is essential to develop sustainable strategies that balance the needs of local communities with the imperative of conserving monkey populations.

Keywords: Garhwal himalayas, human-monkey conflict, human-wildlife conflict, *Macaca mullata*, rural wildlife

INTRODUCTION

The rhesus macaque (*Macaca mulatta*) is the most prevalent species of macaque found in India. Interactions between humans and monkeys represent a significant aspect of human-wildlife conflict (HWC) in the region. These monkeys are of considerable importance in Indian culture, especially within the realms of mythology and history. Demonstrating their reverence, individuals often provide food to monkeys, which are seen as embodiments of Lord Hanuman (Kumara et al., 2010; Reddy & Chander, 2016). This cultural importance has caused monkeys to have a reliance on human resources to the extent that they are increasingly found near human habitats. Monkeys have become a significant source of disruption, especially in proximity to temples, where devotees present Prasad, or sacred food, to these animals, as their food sources become more similar to those available to humans (Sharma & Acharya, 2017). Monkeys can cause significant damage to property and instill fear in local populations, and illegal human encroachment into forested areas for settlement expansion has been identified as a key driver of human–monkey conflict, leading to habitat destruction (Devi & Saikia, 2008).

They further argue that the overpopulation of monkeys, coupled with the tendency of residents to feed them, exacerbates this conflict. Furthermore, degradation of forested regions, along with a decrease in the cultivation of natural food sources and an increase in the planting of exotic

crops, drives monkeys closer to human settlements in search of food. This incursion results in substantial crop damage, posing a serious challenge for farmers and leading to financial losses, food scarcity, and undermining the efforts of agricultural workers. Ahsan and Uddin (2014) explored the dynamics between humans and monkeys in Bangladesh, revealing that the transformation of forested land into agricultural fields often triggers conflicts, as monkeys venture into human territories in search of food. They also noted that the destruction of nonedible plants due to food shortages among rhesus macaques can provoke human aggression and further escalate HMC. Beisner et al. (2015) highlighted that local communities and farmers frequently respond with hostility toward monkeys, driven by the economic repercussions of crop damage.

Indian perspectives view the relationship between humans and monkeys in both positive and negative aspects. According to Rajpurohit et al. (2006), a positive aspect of this relationship is the amicable bond that can develop, resembling that of pets. In contrast, in some regions, humans are exploiting monkey meat and body parts for food and medicine. Furthermore, there exists a fear among humans regarding monkeys, as these animals are known to have an increased tendency of kleptoparasitism on food and other objects, as described by Barrett et al., 2018, and sometimes cause damage to personal belongings or it may be a feeding strategy, often a learned behavior.

Human–wildlife conflict affects human livelihoods, safety, and well-being, particularly in mountainous regions (Bhatt et al., 2025). Previous studies (Kukreti & Bhatt, 2014) have shown that HWC frequently occurs in the Terai Arc of the Lansdowne Forest region, particularly involving leopards, which are identified as the most difficult species to manage. In addition to leopards, other species that contribute to the conflict include elephants (*Elephas maximus*), black bears (*Ursus thibetanus*), wild boars (*Sus scrofa cristatus*), and monkeys (*Macaca mulatta*) found in nearby areas (Rathi & Bhatt, 2020). We conducted a preliminary assessment of rhesus macaque bite records and farmer-reported crop damage in the Lansdowne Forest Division (LFD) to describe general patterns and highlight key issues related to human–monkey conflict. Crop-loss estimates are based on farmers' reports and were not validated through field-based measurements in this study.

RESEARCH METHODS

Study area and methodology

Research was carried out in the Lansdowne Forest Division (LFD) which is segmented into five distinct forest ranges: Kotdwar, Laldhang, Lansdowne, Dugadda, and Kothri (Lal, 2004). This region encompasses several rural (villages) and peri-urban (towns), and the study specifically focuses on the towns of Kotdwar and Dugadda, along with various villages within the LFD. The geographical location is between latitudes 29°37′ N–30°02′ N and longitudes 78°19′ E –78°43′ E (Fig. 1). The Lansdowne Forest Division lies to the north-west of Corbett Tiger Reserve (TR), a protected area in India with high biodiversity and an important tiger population. The study area climate is temperate with three seasons: winter (Oct.–Feb.); summer (Mar.–May); and the monsoon season (June–Sept.) (Kukreti & Bhatt, 2014).

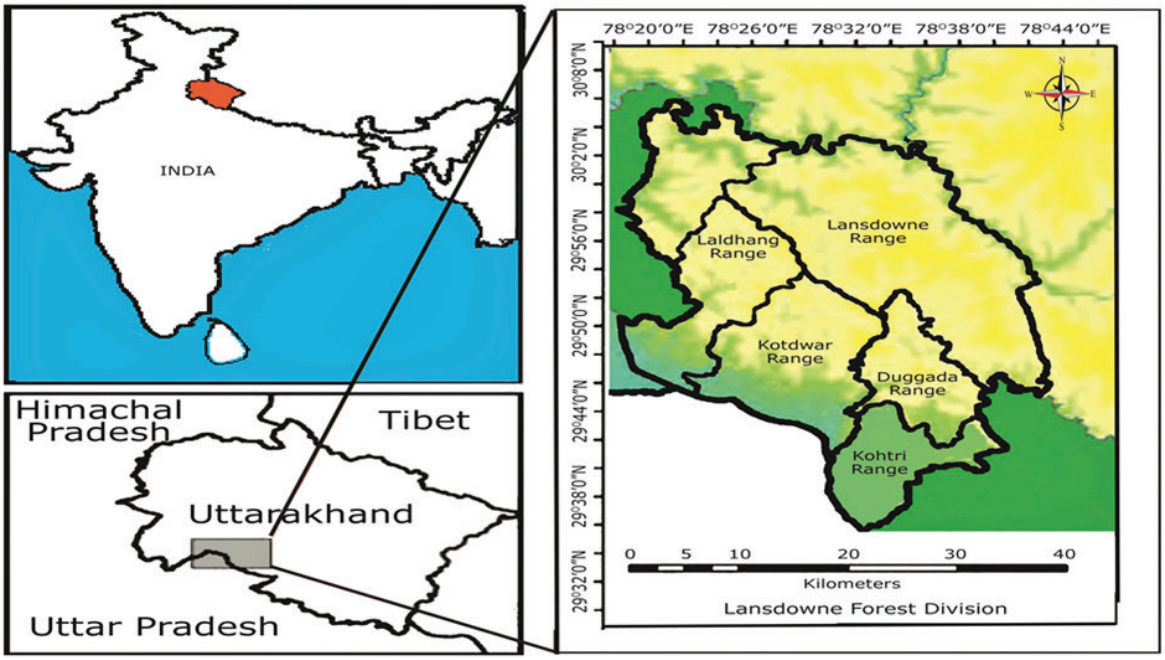

Fig. 1. Location of Dugadda and Kotdwar ranges in the Lansdowne Forest Division of the State of Uttarakhand, India (source: Kukreti, 2020)

Cultivated crops like wheat (*Triticum aestivum*), rice (*Oryza sativa*), and various legumes like pea (*Pisum sativum*), black gram (*Vigna mungo*), common bean (*Phaseolus vulgaris*) and cowpea (*Vigna unguiculata*) are found in home gardens close to cultivated crops in the study area. In addition, farmers also grow vegetables such as eggplant (*Solanum melongena*), cauliflower (*Brassica oleracea*), and tomato (*Solanum lycopersicum*).

Data on monkey bite injuries were obtained from self-reported bite incidents using variables (name, age, sex, household ID/address, and date of bite) with the permission by the office of the Chief Medical Superintendent of Government Base Hospital in Kotdwar and Primary Health Center in Dugadda. The information collected was verified against by Gram Panchayat offices and municipal records, and a pretested, structured questionnaire in Hindi was administered between (March 2016) and (October 2018) to affected people. Discrepancies were resolved by recontacting respondents where possible, and unmatched self-reports were retained and flagged for sensitivity analysis. All responses were anonymized at the time of collection, and personal identifiers were removed prior to analysis. Only fully completed questionnaires with internally consistent responses were included in the final analysis; partially completed, ambiguous, or contradictory questionnaires were excluded. A questionnaire was created in Hindi language for this research, concentrating on communities across LFD, including both rural and peri-urban zones, and designed to elicit information on issues related to monkey bite incidents, and crop damage in affected areas.

Household follow up surveys were conducted by systematic random sampling from household lists supplied by Gram Panchayat offices (rural sites) and municipal records (peri-urban sites); a random start and fixed interval were used to select households to obtain socio-economic, demographic data by interacting with entire family in general about this issue to find the general perspective, and then individuals who were primarily responsible for livelihood earning and the person extensively involved in most agricultural activities were selected for interviews by listing all eligible members from each household and one individual was randomly selected by

drawing a number from the household roster (paper slip); up to two callbacks were attempted for absentees and substitutions were recorded. We also assessed monkey roadkills along National Highway 534, specifically along the stretch from Kotdwar to Dugadda within the study area, and conducted 12 monitoring visits per year (four visits over three months). Data on monkey bite incidents and crop damage were compiled and analyzed using descriptive statistics (frequencies, percentages, and year-wise comparisons) in Microsoft Excel (Microsoft, 2018). The study is based on secondary records and field observations, and the analysis was limited to descriptive approaches due to the nature of the available data.

RESULTS AND DISCUSSION

Annual incidence of monkey bite injuries

A notable increase in monkey bite cases was observed (Table 1) over the three consecutive annual study periods with an upward trend from 168 (2015-2016), to 180 (2016-2017), and 191 (2017-2018). We gathered information on the number of bite injuries and the age groups and sex of those bitten, but did not classify the data by type and scale of injury. Out of 504 villages surveyed, 352 respondents reported varying degrees of impact from these incidents. The data indicates a higher prevalence of bites among males, with 283 medical incidents compared to 256 incidents in females out of total cases reported (N = 539) (Table 1), which may be attributed to the fact that males are generally more involved in outdoor activities. However, it must be emphasized that at the current level of analysis, there was no significant sex difference.

Table 1. Annual occurrence of monkey bites in rural and peri-urban areas in Lansdowne Forest Division

Three annual periods	Number of incidents (N=539)	Sex of bite recipients (relative %)	
		Male	Female
2015-2016	168	51	49
2016-2017	180	53	47
2017-2018	191	53	47

Age-based classification of monkey-bite injuries

The results show that during the three annual study periods, the highest percentage (39%) of the bite injury recipients were in the age group of 16 to 35 years and the lowest were 56 years and older (Table 2).

Table 2. Relative frequency of monkey bites by age group in Lansdowne Forest Division

Three annual periods	Age group of bite recipients (relative %)			
	Below 15	16-35	36-55	56- Above
2015-16 (n=168)	31	40	20	09
2016-17 (n=180)	35	40	15	10
2017-18 (n=191)	36	40	17	7

Crop damage

Crop-raiding in the study area was the most significant of the human-monkey conflicts during the study period. Of the 504 villages surveyed, 352 respondents were affected by crop-raiding, and villagers' farmers claimed that they could not farm due to fear of damage caused by monkeys in the fields. Our observations revealed that many villagers gave up cultivation and moved to other places (out-migration), especially in the Terai region. Our previous studies (Kukreti & Bhatt, 2014; Rathi & Bhatt, 2020) and current observation revealed that such internal migration occurred primarily due to crop damage by monkeys and other wildlife. This issue was also highlighted in the report of the Uttarakhand Rural Development and Migration Commission (RDMC, 2019).

In our study, farmers claimed that monkeys caused 25-30% of the damage to their legumes and vegetable crops. The owners of the mango orchards in the study region have indicated that monkeys inflict 20-25% of the annual damage to mango harvests. Other researchers have also documented similar instances of crop destruction (Roonwal & Mohnat, 1977; Ahsan & Uddin, 2014). Rhesus macaque crop destruction has been observed in different areas of India and other nations (Dela, 2011; Nahallage & Huffman, 2013: Saraswat et al., 2015). Today, macaques behave aggressively towards people, attacking them for food, with a growing inclination towards kleptoparasitism or stealing their handbags, and people behave aggressively towards them in return (Dittus, 2012). Due to intolerable behaviors, most of the intolerable behaviors, a most of residents in the region surveyed strongly consider rhesus macaques to be an undesirable species rather than one that deserves protection.

Factors that affect human-monkey conflict (HMC)

This section examines the key drivers of HMC in the LFD and explains how each factor contributes specifically to both rhesus macaque bite incidents and farmer-reported crop damage.

Availability of food

Throughout the study period, it was observed that the food sources for monkeys in areas inhabited by humans were greater than those found in forests, due to the plentiful orchards and fruit trees present in these human communities. In some forest ranges (namely Kotdwar and Laldhang), it was observed that the unlawful occupation of forest areas for housing and farming, along with the forest tree-felling and the introduction of non-native tree species, led to incursions of rhesus macaque and likelihood of aggressive encounters that results bites into villages and human habitats, which provided a variety of edible fruit trees and plants as sustenance (Table 3).

Table 3. **Plant species consumed by rhesus macaques in Lansdowne Forest Division (LFD)**

Binomial	Common name
Mangifera indica	Mango
Artocarpus heterophyllus	Jackfruit
Musa acuminata	Banana
Solanum tuberosum	Potato
Solanum melongena	Brinjal (eggplant)
Solanum lycopersicum	Tomato
Hordeum vulgare	Barley
Saccharum officinarum	Sugarcane
Psidium guajava	Guava
Phaseolus vulgaris	Common bean
Vigna unguiculata	Cowpea
Vigna mungo	Black gram
Lablab purpureus	Hyacinth (lablab) bean
Pisum sativum	Pea
Lagenaria siceraria	Bottle gourd
Luffa acutangular	Ridge gourd
Cucumis sativus	Cucumber
Cucurbita pepo	Pumpkin
Abelmoschus esculentus	Okra (lady finger)
Brassica juncea	Indian mustard
Brassica rapa	Field mustard (turnip)
Brassica oleracea	Cauliflower
Litchi chinensis	Lychee
Prunus persica	Peach
Annona squamosa	Sugar apple

Improper household and agricultural waste disposal

We observed waste mismanagement in certain parts of the study areas, such as foothill areas like the Kotdwar forest range, which attracted monkeys for food and resulted in incursions of human settlements. Kitchen waste is typically given to livestock in villages in the Lansdowne and Dugadda forest ranges. Similar results have been reported by Devi and Saikia (2008) in Assam, Reddy and Chander (2016) in Himachal Pradesh and Sharma and Acharya (2017) in neighboring Nepal, which found that macaques leaving forests to urban, semi urban and rural areas for easy food, created HMC of crop damage and physical injuries.

Roadkill (wildlife-vehicle collision)

The likelihood of fatalities from traffic accidents rises when a national highway (NH-534) is present. Over the study period, we recorded 71 macaques and eight cattle roadkill incidents. Similar incidents have been documented (Hatti & Mubeen, 2019) in the state of Karnataka, India.

Rising human monkey conflict (HMC)

In the study area, there is a noticeable adverse interaction between humans and monkeys, characterized by aggressive and unpredictable behaviors such as attacks, an increase tendency of kleptoparasitism and crop raiding. The increased HMC is reminiscent of similar incidents reported in the nearby mountainous state of Himachal Pradesh, as noted by Saraswat et al. (2015) and Reddy and Chander (2016). Giving people insight into the situation and steps they can take to reduce the number of unexpected encounters would also help minimize losses in the region (Cabral et al., 2018). The perspectives of Rittem et al. (2024) are in such a range that it illustrates the significance of the well-being and welfare of animals, people, and ecosystems.

Suggested measures to minimize HMC

Short-term

- Immediate ban on provisioning (residents provisioning food).
- Capture, wildlife fertility control, and relocation of monkeys to wildlife sanctuaries or possibly reserved forest areas by forest department.
- Forced repelling of monkeys from the study area utilizing sticks, drums, fireworks, and other means.
- Proper disposal of kitchen and household waste in garbage bins (preferably 'monkey-proof'), restrictions on waste disposal in open spaces and roadsides adjoining households, and waste management by municipal corporations at the peri-urban level and village panchayats at the rural level.
- To reduce HMC, it is advisable to implement physical barriers, such as electric fences and netting. Additionally, employing non-lethal deterrents like bioacoustics devices, chili spray can effectively discourage monkeys from encroaching on human territories.

Long-term

- Management of the encroachment on unauthorized forest areas by forest department and state government.
- Given the severity of crop-raiding by wild animals and the migration of villagers from the LFD, the Uttarakhand government should prepare a long-term plan in consultation with HWC experts to address the issue.
- Education and promotion of conservation programs by individuals and community with cooperation from local government, such as municipal corporations, village panchayats, government colleges, schools and forest department.
- Placing monkeys in natural places (for example, healthy forests) and taking steps to keep populations within the carrying capacity of the areas.
- The incorporation of trees into agricultural landscapes through agroforestry to minimize HMC. The method diminishes attraction of crops to monkeys, provides substitutes for food and can improve economic quality of life for the host regions.
- HMC is due to, among other things, food scarcity in forested areas with multiple causes, and a severe increase in the number of rhesus macaques. Habitat fragmentation, degradation and human incursion into forested areas are also the leading contributors to rising HMC. Preventive strategies need to be implemented, including efforts to halt degradation of natural habitats, conduct awareness training for community on human-monkey interaction through workshops and awareness initiatives, ensure food waste/litter disposal guidelines, and relocate monkeys to wildlife reserves/zoos.

CONCLUSION

This study emphasizes the need for short-term and medium-term interventions to manage human-monkey conflict in the Lansdowne Forest Division. Here, immediate action would include physical separation and training of the community on the optimal waste disposal to minimize human-monkey conflict where applicable. Long-term effectiveness requires management strategies that promote sustainable land-use practices balancing agricultural activities with wildlife conservation. These should include the setting up of protected areas and the promotion of the agroforestry. To reduce conflicts and improve environmental health, promoting sustainability is of paramount importance, especially in peri-urban and agricultural areas. Community-led programs, restoration efforts, and the establishment of wildlife corridors may help improve human–monkey coexistence, as suggested in previous studies. To maintain ecological stability in hilly areas such as the present study region, it is important to address the underlying drivers of conflict and promote balanced interactions between humans and wildlife. However, the present study did not incorporate detailed demographic or land-use/land-cover variables, which may influence patterns of human–monkey conflict. Future studies incorporating these factors could provide a more comprehensive understanding of these interactions.

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AUTHOR CONTRIBUTIONS

RR: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Software, Supervision, Validation, Writing – original draft; **MK:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing.

CONFLICTS OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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ETHICAL APPROVAL AND PERMITS

The study did not need formal ethical approval since it posed minimal risk and only gathered anonymized data. Participants were briefed on the study's purpose before collecting any data, and we guaranteed their confidentiality and anonymity throughout the process.

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